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The Procrustean Approach

**Setting Exposure Standards for Telecommunications
Frequency Electromagnetic Radiation**

A thesis submitted in fulfilment of the
requirements for the award of the degree

Doctor of Philosophy

from

University of Wollongong

by

Donald Raymond Maisch

Science, Technology and Society Program
Faculty of Arts

2009

Abstract

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

Certification

I, Donald R. Maisch, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Arts, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Donald R. Maisch

Date:

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Preface

My interest in the somewhat arcane issue of telecommunications frequency standard setting for human health protection dates back to March 1994 when the late Australian Democrats' Senator Robert Bell from Tasmania asked me if I would be interested in writing a Senate background paper on electromagnetic radiation (EMR) exposure standards. The Democrats were then involved in a controversial Eastlink powerline inquiry on a proposed 1500 kilometre high voltage power line to link the New South Wales and Queensland electricity grids and wanted a close look at the adequacy of the public safety standards. This report was tabled in the Senate in October 2004 and focused primarily on the standards relevant to powerline exposures and the inadequacies for public health protection. By late 1995 Senator Bell's office was receiving frequent calls from the public over concerns of possible hazards from mobile phones and towers and I was given the task of preparing a background report on what was known on the topic at the time. This was tabled in April 1996 with numerous copies being sent to local governments and other interested organizations. Then, in 1997, I was given the opportunity to further my interest in EMR exposure standard setting when I was offered a place on the Standards Australia TE/7 Committee on Human Exposure to Electromagnetic Fields. My position on the committee, along with another committee member, was to represent the interests of the Consumers' Federation of Australia (CFL), the national peak body for consumer groups in Australia. Our role in the TE/7 committee was basically to represent the public interest – and this included the concerned public activists with whom we closely worked .

It seemed apparent at the first of the final series of meetings in early 1998 that the factions wanting to incorporate the RF guidelines of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) had the required voting majority (80%) to approved the draft standard in their own right. We thought it was inevitable that the ICNIRP based proposed standard would be approved by the TE/7 committee in the end. The other CFL representative and I therefore worked out a strategy where we would be prepared to vote in favour of the proposed standard, thus offering the industry the tantalizing possibility of short-circuiting community opposition in

Australia. Our proviso, however, was that we would only do so if the standards included a strong precautionary approach, including a clear statement on the limitations of the standard for health protection. We considered that if our recommendations were accepted it would be the best possible outcome that we could achieve for the public interest.

As Chapter 5 examines, however, at the final round of TE/7 meetings none of our recommendations were adopted and we could only cast a no vote. Surprisingly, the other 6 no votes of dissenting TE/7 members were enough to block the passing of the proposed ICNIRP standard and TE/7 was terminated after failing to approve the standard. This was a unique situation as no other Standards Committee had ever been terminated for failing to approve a standard.

The legacy of this direct involvement was a keen interest in how scientific knowledge can be suppressed or ignored in regulatory standard setting when the process is allowed to be influenced by vested interests (including government policy considerations) directly affected by that regulation.

Introduction

Beginning a thesis on telecommunications with a brief reference to Greek mythology may seem somewhat unusual, but some ancient subject lessons it would seem are still relevant today– with some still to be learnt. Take for example the mythological Greek bandit Damastus, also nicknamed Procrustes, which means “he who stretches”. Procrustes is remembered for his iron bed on which he invited, or if need be compelled, passing members of the public to lie upon. If the person was shorter than the bed, Procrustes stretched the unfortunate victim by hammering or racking the victim’s body to fit. Alternatively, if the victim was longer than the bed, he cut off his limbs to make the body fit the bed’s dimensions. In either event the victim died. Procrustes was essentially an enforcer of conformity who was eventually slain by his own method by Theseus, a legendary king of Athens who, as a young man, had the habit of slaying robbers and monsters whenever he encountered them on his travels.

One of the derived meanings of Procrustean bed is an arbitrary standard to which exact conformity is demanded. It was used to refer to Western radiofrequency (RF) exposure standard setting by Professor V. Parin from the former Soviet Union’s (USSR) Academy of Medicine in the Foreword of A.S. Presman’s 1970 book on Soviet bioelectromagnetic research, *Electromagnetic Fields and Life*. To quote:

EMFs [electromagnetic fields] can have nonthermal effects and that living organisms of diverse species – from unicellular organisms to man – are extremely sensitive to EMFs. Some of the discovered features of the biological action of EMFs clearly do not fit the Procrustean bed of the heat theory.

Parin was referring to the prevailing scientific theory, being developed primarily by the U.S. Air Force at the time, that in setting radiofrequency human exposure standards the only hazardous biological effect was from acute RF exposures of sufficient power to raise body temperatures in excess of 1 degree centigrade. This ‘thermal-effects-only’ viewpoint was in direct contradiction to alternative Russian and other Eastern European research that claimed to have found a whole range of

RF / biological interactions at power levels far below that which was needed to cause tissue heating (non-thermal or athermal). As a consequence, Russia and several other Eastern European nations had developed RF standards that were up to a thousand times more restrictive than those being developed in the U.S.

Parin's comment on Procrustes serves as a metaphor for the theme of this thesis which takes up the debate over telecommunications RF standard setting from the seminal work of policy researcher Nicholas Steneck in his 1984 book *The Microwave Debate*, to the current World Health Organization's efforts to have one global RF standard.

These two significantly differing viewpoints have always been, and continue to be, the central issues directly relevant to the creation and maintenance of RF exposure standards. Of primary importance is the well-established hazardous biological effect of tissue heating from exposure to brief but high level RF exposures, which is the central concern of most RF standards. This bio-effect is also recognized by the Russian RF standard and its research data-base. There is little controversy here and preventing hazardous thermal effects is an important consideration when setting RF standards.

What can be said of the RF standards discussed in this thesis: IEEE C95.1, the ICNIRP RF Guidelines, and the Australian RF standard AS 2772.1, is that they do provide a level of protection from the known and established thermal biological effects of exposure to RF. In this regard they serve an important purpose by providing protection in situations where people may be inadvertently exposed to brief but high-intensity RF power levels, such as in occupational settings. This thesis makes no issue with these standards in this regard and many governments, such as Australia (Chapter Five), have based their national RF standards based on preventing hazardous thermal bio-effects. This remains the predominant approach to RF health protection globally to this date.

This thesis argues, however, that by limiting RF exposure limits to thermal considerations the various organizations charged with setting and maintaining the

above RF standards have cut off from consideration scientific data that does not conform to their understandings of how RF exposures interact with biological tissue and in that respect they follow what could be considered a Procrustean Approach.

The central theme of this thesis will be to critically examine the extent that conflict of interests within RF standard setting committees has led to this approach which has been in existence for over half a century.

This thesis will examine the development of the two above mentioned RF standards / guidelines that have come to dominate the RF health effects issue in both national and international settings. They are the American C95.1 Standard under the authorship of the Institute of Electrical and Electronics Engineers (IEEE C95.1), and the guidelines of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) promoted by the International EMF Project (IEMFP). Also examined as a case study is the development of the Australian RF standard AS 2772.

There are a number of other RF standards/exposure guidelines, such as the Canada's Safety Code 6, the NATO RF Standard, the Physical Agents Committee of the American Conference of Governmental Industrial Hygienists (ACGIH 1992), and the European Council Directive of 12 July 1999, just to name a few. However, as these are based on the same literature foundation as used by IEEE and ICNIRP, and are primarily limited to protect against excessive body heating from high level RF exposures, they are not examined in this thesis. RF standard recommendations are also set by the U.S. National Council on Radiation Protection and Measurements (NCRP), which are more restrictive than IEEE C95.1 and take into consideration possible effects other than heating. They will be briefly examined in Chapter 3.

The approach taken in this thesis to set the background for the above discussion will be to examine the development of risk assessment (or analysis) in Chapter 1 and the process of peer review in Chapter 2. The practice of risk assessment is

often presented as an objective, rational and scientific method of determining the extent of environmental and human health risks resulting from modern technological developments where a high degree of uncertainty exists. However, it will be shown that there have been significant differences on how to address the uncertainty problem. In the U.S. regulatory setting, especially as established by the U.S. Environmental Protection Agency (EPA), scientific uncertainty over potential hazards meant that worst-case scenarios should be used in assessing risk as a precautionary measure (better safe than sorry). These were called conservative risk assessments. However this approach was considered by the industrial sector and some members of Congress as placing an unnecessary burden on industry and the economy.

In response to what was considered unwarranted government interference with their activities the industrial sector became an active player in the scientific debate by creating industry trade organizations, think-tanks and Washington-based lobbyists in order to re-define the scientific assessment of environmental risks to health. The outcome of industry concerns over regulation was the creation of what regulatory standards expert Adam Finkel termed a “revisionist” approach to risk assessment that sought to counter government agency conservative risk assessments. The corner-stone of the revisionist viewpoint on risks was that conservative assessments were far too rigid, mishandled the issue of uncertainty and led to not only an unfair and unnecessary burden on industry, but also created unwarranted fears and paranoia in a gullible public. In revisionist risk assessments uncertainty is treated as a reason not to regulate until the exact parameters of the risk are known. This was supposed to be achieved by using a complex set of risk analysis procedures that require the help of professional risk assessors, trained in the revisionist methodology, in order to navigate through the complexities. This process has been referred to as “paralysis by analysis” where the sheer weight and complexity of the analysis overwhelms the decision making process, preventing any effective outcome that could lead to restrictive regulation. Technology theorist Langdon Winner saw the whole risk assessment process as one where the ultimate aim was to delay and befuddle pollution controversies in order to maintain an industrial status quo relatively free of enforced limits.

A direct linkage will be examined in Chapter 1 with the risk assessment process promoted by John D. Graham founder of the industry-funded think tank, the Harvard Center for Risk Analysis (HCRA) and later administrator of the Office of Management and Budget (OMB), with EMF/RF standard setting. Examined in detail (Appendix 1) will be the Keynote Presentation by Graham at a WHO International EMF Project (IEMFP) international seminar on EMF risk perception and communication in Ottawa, Canada in 1998. IEMFP's central task is to undertake risk assessments of the EMF literature, which are then used in setting exposure guidelines by the International Commission on Non-Ionizing Radiation and Protection (ICNIRP). Although Chapter 1 will examine risk assessment primarily in the U.S. context it will be shown that the revisionist viewpoint on risk found favour internationally through the WHO / IEMFP platform.

Chapter 2 will examine peer review panels and expert advisory committees, predominantly in the U.S. context. As a general rule, peer review panels review original works for significance and scientific quality before publishing. Expert advisory committees then review the body of peer reviewed and published research papers in a particular area in order to issue expert advice in that area. There is a blending of roles in many instances. For example both the IEEE and IEMFP have committees that review previously peer reviewed research results in order to issue exposure standard recommendations. These are then relied upon by national agencies as essentially peer reviewed expert advice. In this respect, expert advisory committees can be considered as filters that accepts or rejects previously peer-reviewed research according to their particular needs (or agenda). IEEE, IEMFP and ICNIRP refer to the importance of peer review as an essential gateway that scientific research findings must pass through in order to be included in standard setting considerations. For these organizations peer review is presented as an unproblematic process to ensure scientific truth. However, as will be explained in Chapter 2, peer review is not a single unified methodology but more of a general term to describe a number of models that can be applied in differing situations by a number of interests for various reasons. Five alternatives to the traditional peer review concept will be given to illustrate that these differing

approaches to peer review show that the process can have a strong subjective social context depending on the approximate model followed and the context in which it is used. In addition, peer review can be subject to both industry and political manipulation and a number of examples will be explored in the chapter. The regulatory peer review process also became a focus of attention for the OMB under John Graham, mentioned previously, where a whole raft of bills were created that complicated the peer review process with an increasingly complex web of risk analysis and assessment requirements. This made passing of effective environmental regulations far more difficult by tying up agency time and resources trying to meet requirements and defend their decisions.

Chapter 2, and to an extent Chapter 1, will argue that the processes of both peer review panels and expert advisory committees are prone to vested interest manipulations and that, in such instances, the outcomes of these expert groups may reflect predetermined decisions that have little to do with objective assessments of the available scientific data.

Chapter 3, in some ways the central chapter of this thesis, will examine the establishment of the first U.S. RF standard in the 1950's as primarily a military activity stemming from military technological development and the conflict with the Soviet Union. It will be shown how pre-existing understandings of the heating ability of RF energy, combined with Cold War defensive concerns led to an emphasis on thermal effects (acute levels of RF causing immediate tissue heating hazards) as the prime consideration in setting exposure standards that did not pose a threat to technological developments. The simple thermal model on which the first military exposure standard was founded became the basis for the first American Standards Association RF standard (ASA C95.1-1966). This standard was just 1.2 pages long and was developed primarily by the military and their civilian corporate contractors to suit their service requirements. Later revisions to the 1966 standard further refined the understanding of thermal interactions but the scientific research base of C95.1, right up to the latest ANSI/IEEE C95.1-1996 version, was based on a simple model of food motivated behavioural disruption in small laboratory animals (rats and monkeys) exposed to acute RF exposure levels.

Chapter 3 will show that even though it has been admitted that this model was a poor model from which to derive human exposure standards, the latest standard (ANSI/IEEE C95.1-2006) contained a significant relaxation that significantly increased the allowable energy that could be deposited in human tissue, apparently for the benefit of the mobile phone industry. Chapter 3 will also examine a number of expert criticisms of the IEEE standard that centred around the failure of the IEEE to take into consideration possible biological effects not related to heating (non-thermal effects).

As justification for the increased exposure limits in the C95.1-1996 standard, a series of papers were published in *Bioelectromagnetics Supplement 6* (2003) that were to serve as a peer-reviewed scientific basis for the increase in exposure limits and establish so-called “guiding principles” for the IEEE’s RF standard setting process. Chapter 3 will briefly examine these papers as well as conflicts of interests and affiliations of the authors of these papers who predominantly represent one sector, the U.S. Department of Defence (DoD), primarily through the Air Force, and their corporate defence contractors developing weapons systems for the DoD. Another sector well represented on the standard setting committee has been the cell phone industry, mainly represented by Motorola. It will be shown that it is from this pool of experts that the people who do the review of papers for consideration IEEE’s standard setting process are drawn. Chapter 3 will show that it is apparently the service requirements of these sectors that determine the parameters of the C95.1 standard.

Chapter 4 will track the founding of the efforts to establish an international RF standard from the establishment of a committee formed by the U.S. Health Physics Society (HPS) in the early 1960s to the establishment of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in 1992 and International EMF Project (IEMFP) in 1996. IEMFP’s mission is to conduct risk assessments on the scientific evidence of possible health effects of EMF in the frequency range from 0 to 300 GHz. IEMFP promotes the ICNIRP guideline recommendations internationally as expert exposure guidelines that all national health protection agencies should adopt without question or deviation. The

ICNIRP RF Guidelines are founded on essentially the same the literature base as C95.1, - a simple model of food motivated behavioural disruption in small laboratory animals (rats and monkeys) exposed to acute RF exposure levels. On this basis IEMFP and ICNIRP claim that the primary health hazard (other than shocks and burns from physical contact with a transmitting source) are immediate biological effects (tissue heating) as a result of acute (high level) exposures. Chapter 4 will examine the issue of conflict of interest in both IEMFP and ICNIRP risk assessment, review and standard setting processes and will show that the problem of conflict of interest is an important determining factor in their decision-making. Chapter 4 will also give a number of examples of national responses to accepting the ICNIRP RF guidelines for their nations' standards. Evidence will be given to show that economic considerations played a prime role in convincing governments to accept ICNIRP.

Chapter 5 will give the case study of the Australian experience in RF standard setting and the eventual acquiescence to ICNIRP's rationale. The Australian Commonwealth Science and Industrial Research Organization (CSIRO) will be shown to have been an important force in Australian RF standard setting for many years. The CSIRO had long opposed the adoption of the ICNIRP RF guidelines. This opposition was based on CSIRO's risk assessment review that took into account the possibility of hazards from low-level RF exposures not related to ICNIRP's (and IEEE's) simple heating model. This assessment was supported by a number of publications by CSIRO and former CSIRO scientists. Besides CSIRO's opposition to ICNIRP Guidelines on the Standards Australia TE/7 Committee: Human Exposure to Electromagnetic Fields, a number of other organizational representatives in TE/7 also opposed the ICNIRP draft, eventually blocking the acceptance of the ICNIRP based draft RF standard. Chapter 5 will show that it was an inability to reconcile differing interpretations of the scientific literature and come to an agreed definition of a suitable precautionary approach that directly led to the failure of TE/7 to approve the draft ICNIRP based standard. This chapter will also examine the eventual acceptance of the ICNIRP Guidelines as a basis for the Australian RF standard by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). It will be shown that this acceptance was

accomplished by establishing a new committee constituted in such a way to ensure passage of the standard by eliminating the level of opposition that was seen in the earlier TE/7 committee.

By first examining the processes of risk assessment and peer review and then the IEEE, IEMFP, ICNIRP and Australian RF standard setting processes, this thesis presents the case that RF standard setting today in the so-called Western World is indeed Procrustean. With all these standard setting organizations conflict of interest will be shown to be endemic in their decision-making processes. This thesis argues that this situation has resulted in the maintenance of RF standards that have eliminated from consideration scientific evidence inimical to the interests of those who have set the parameters of the standards. It is important to note that this situation is not just for telecommunications but also includes all environmental controversies where industry and other vested interests, which equate adequate public health protection as a risk to their bottom line, have been able to influence the parameters for regulation of their activities. It is the Procrustean Approach.

Chapter 1

Risk Analysis/Assessment: Valid science or spin?

Risk assessment has developed from an arcane practice of interest to a few regulators, academics and specialists in industry to a major factor in evaluating sources and sizes of risks to health...Risk assessment is a method of using scientific information to make informed decisions.

George M. Gray, "Key Issues in Environmental Risk Comparisons" (1995)

To my mind, risk assessment is in danger of being subverted just as it is coming into its own as a scientific discipline. Sometimes I feel like a chemist who thought his field was finally about to take off, only to discover the government was poised to mandate alchemy as the official state science.

Adam M. Finkel, "Who's Exaggerating?" (1996)

Overview.

A logical starting point for a critical examination into telecommunications standard setting, specifically the risk assessment methodology used to establish the known health hazards from radiofrequency exposure, is to examine the practice of technological risk assessment as established in the U.S. in the early 1970s. During this time there arose a popular awareness that there may be a number of unforeseen health hazards from new technological advances, mainly in the chemical and nuclear power industrial sectors. Little was known about these possible hazards, especially their long-term impact on human health. From the regulators' perspective a method was needed to estimate, with an acceptable degree of accuracy, the extent of these new risks and then establish regulations to protect human health despite a high degree of scientific uncertainty. Technological risk assessment was developed as a way of dealing with these possible hazards to health where there was a great deal of uncertainty as to the extent of that risk. However, two differing viewpoints on how best to address risks quickly arose. From the regulator's viewpoint, because of the scientific uncertainty, it was 'better to be safe than sorry' when regulating industrial hazards than risk exposing people to health hazards, such as from new industrial chemicals. This has been termed 'conservative risk assessment' and was used by the U.S. Environmental Protection Agency (EPA) and other agencies in their health risk assessments for chemical

regulations. From the regulated industry viewpoint, however, unfounded public fears and paranoia were fuelling calls for unnecessary and excessive regulation and this posed a risk to both the affected industry and the nation's economy. This second viewpoint, promoted by what Professor Adam Finkel, Executive Director of the University of Pennsylvania Law School's Program on Regulation has termed the "revisionists" was essentially a counter-reaction to agency conservative risk assessments that posed a risk to industrial activity through regulation. With revisionist risk assessment the issue of possible risks to human health was essentially downplayed with an emphasis on the economic risk to industries faced with regulation of their activities. This is relevant to the topic of this thesis because it is shown herein that there is a direct philosophical linkage between the revisionist risk assessment viewpoint and the risk assessments used by the World Health Organization's International EMF Project (IEMFP) in its formulation of so-called international RF standards.

Risk assessment, also referred to as quantitative risk assessment (QRA) in the regulatory context, is the scientific and technical quantitative evaluation, involving expert value judgements, of a potential hazard to human health and wellbeing (usually environmental contaminants) and is usually the initial phase of an overall risk analysis of a hazard under examination. The assessment process usually consists of four steps: hazard identification, hazard characterization, exposure assessment and risk characterization. Once an assessment has been conducted, or during the assessment process, expert value judgements are made on how to best manage that risk (risk management). This can be a decision as to what extent regulation is necessary to protect human health, who is to be protected, to what extent and at what cost. Another integral part of risk analysis is risk communication: the informing of the public over how the regulatory authorities have acted in order to protect human health and wellbeing (risk perception). Risk communication can take on a deceptive and one-sided aspect, as exemplified in Chapter 5, page 206, where a joint government/industry video/DVD presentation on the safety of telecommunications technology claimed safety existed by making a number of unsupported claims that did not reflect the science.

In this thesis the main focus of risk assessment (referring to QRA - hereafter referred to as just risk assessment) is its application for the investigation of the possible harmful effects of human exposure to radiofrequency and microwave (RF/MW) non-ionizing radiation from telecommunications technology. This assessment includes what kinds of risks have been identified (such as tissue heating at acute exposure levels), and what has been excluded from consideration (possible adverse effects from sub-thermal exposures). Risk management is how these risks are addressed through regulatory standards and risk communication is how the regulatory approach to risk is explained to the concerned public. In the wider context, the definition of “risk assessment” may vary according to the area it is applied to, from financial risk in the insurance industry, to the likelihood of a catastrophic core-meltdown in nuclear power plants and the eventual number of cancer deaths from the Chernobyl disaster. In fact, the development of the techniques used in risk assessment/analysis owes much to the early development of civilian nuclear power plant design, where there was an unquantifiable risk of catastrophic failure from an exceedingly complex technology with little or no data on which to ensure reactor safety. The task for the industry then was to somehow address the uncertainties to be able to give assurances of safety and to be able to continue developing the technology. In essence, risk analysis/assessment was a technological process that gave a justification to be able to proceed with the development of nuclear power in the face of significant uncertainty.

From its beginnings in the 1970’s risk analysis has expanded to be a widely used and recognized tool to handle an increasing number of technological issues, such as designing car seat belts, public transport systems, setting occupational health & safety standards, exposure guidelines for telecommunications frequencies and the likelihood of a heat shield failure in the space shuttle just to mention a few. Its main application, however, has been to estimate carcinogenic risks from exposure to industrial chemical substances in order to determine “safe” or “allowable” levels for humans.

It needs to be noted here that although this chapter focuses on the politics and development of risk analysis/assessment in the US context, it is still relevant

internationally (in the context of this thesis) as the principles have been recognized internationally by such organizations as the World Health Organization's International EMF Project (IEMFP) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP) examined in Chapter 4.

Although the roots of risk assessment can be traced back to the 14th Century where Spanish Maritime insurance companies needed a reliable quantitative estimation of the value of expected cargo losses over time in order to set insurance rates, modern technological risk assessment owes much to both the development of nuclear power and the manufacture, mass marketing and sale, of thousands of new chemical products after WWII. With nuclear power, the methodology was developed by Chauncey Starr in the U.S. to estimate the likelihood of what he termed "maximum credible accidents" at a time when no empirical data (failure examples) existed which could be used to determine reliable risk estimates. Additionally, by the late 1960s - 1970s, the public and government regulatory agencies in the U.S., mainly the Environmental Protection Agency (EPA), were becoming increasingly concerned about reports of hazardous effects to both humans and wildlife from exposure to the thousands of new chemicals being released into the environment. Like the problem faced by the nuclear industry, the early chemical risk assessments employed by U.S. regulatory agencies, such as EPA, had little or no empirical data to determine the carcinogenic potential of the thousands of industrial chemicals that they were called upon by congress to evaluate for regulation. With the resulting high level of scientific uncertainty, a precautionary risk assessment approach was followed, designed to avoid as much as possible the danger of underestimating the level of risk to individuals and populations when evaluating a substance with incomplete data. This approach came to be known as "conservative risk assessment" based on "worst case scenarios", given the level of scientific uncertainty in risk assessment. The viewpoint was that it was better to assume the worst rather than potentially expose people to a significant risk. Although the EPA's risk assessments came under attack from the environmental movement because they saw it as a way to sacrifice lives and the environment for corporate profit, the main opposition came

from what regulatory standards expert Adam Finkel¹, called the “revisionist” movement, made up of sections of academia, the chemical and other industrial sectors as well as some members of Congress. The revisionists argued that EPA and other agency conservative risk assessments were based on overestimates of the magnitude of adverse environmental effects, thereby resulting in over-restrictive regulations that unnecessarily burdened American industry. In addition, in their opinion, these overestimates were fuelling public paranoia over risks.²

An influential player in the development and promotion of the revisionist movement’s methodology of risk assessment is John D. Graham, founder and Director of the Harvard Center for Risk Analysis (HCRA) from 1990 to 2001 and later administrator of the Office of Information and Regulatory Affairs in the Federal Administration’s Office Of Management and Budget (OIRA/OMB) from 2001 to 2006. Under Graham’s influence, which is examined in this chapter and in chapter two, the revisionist philosophy of what constitutes proper risk assessment became a mature risk policy initiative with a profound influence on U.S. government regulatory policy under the G.W. Bush administration.

Borrowing from Finkel the term “revisionists” is used in this thesis to refer to professionals involved in risk analysis/assessments who also serve on expert advisory committees and who follow a risk philosophy that actively opposes what have been called “conservative risk assessments”. Conservative risk assessments are essentially a precautionary risk assessment approach, designed to avoid as much as possible the danger of underestimating the level of risk to individuals and populations when evaluating a substance with incomplete data, as mentioned previously. It is based on “worst case scenarios”, given the level of scientific uncertainty in risk assessment. The viewpoint is that it is better to assume the

¹ Adam Finkel is currently the Executive Director, Penn Program on Regulation, University of Pennsylvania Law School. He was formerly the Director of Health Standards Programs at the Occupational Safety and Health Administration (OSHA) and has 20 years of experience improving risk assessment and cost-benefit analysis methods to protect workers and the public from environmental hazards. <http://www.law.upenn.edu/cf/faculty/afinkel/>, Accessed Jan. 14, 2009.

² A. Finkel, A Second Opinion on an Environmental Misdiagnosis: The Risky Prescriptions of Breaking the Vicious Circle, Symposium on Risk Assessment in the Federal Government, *New York University Environmental Law Journal*, 1995.

worst rather than potentially expose people to a significant risk. The revisionist risk expert, on the other hand, sees such an approach to technological risks as systematically overestimating the magnitude of what they consider to be trivial environmental problems, thereby resulting in over-regulation of industry, which damages the national economy. The revisionist viewpoint considers that by taking an over-cautious stand on possible hazards, conservative risk assessments have fuelled a disproportionate level of worry and paranoia amongst a gullible public.³ Central to the revisionists' overall risk analysis is the concept of uncertainty and how to best incorporate it into the overall analysis. In order to address uncertainty a whole web of complex techniques has been created that require the professional services of the risk expert to navigate. These are: probabilistic methods of uncertainty analysis, distributional methods of variability analysis, comparative risk analysis, risk based priority setting, benefit/cost analysis, and substitution analysis. In addition is the call for external peer review of agency science by experts selected for their technical risk assessment expertise. As well as their impact on American regulatory policy, Graham's views have also had a significant influence on both the World Health Organization's (WHO) International EMF Project (IEMFP)⁴ and the International Commission on Non-Ionizing Radiation Protection (ICNIRP)⁵. The results of this influence are examined in this thesis in relation to telecommunications guidelines/standards.

I will ground my discussion in the theoretical term of 'reflexive modernisation' and the 'risk society' as defined by German sociologist Ulrich Beck in his influential critique of industrial society.⁶ Beck, influenced by the Green movement and by writers such modernization theorists Habermas and Giddens, has done much to popularise his theories through the German press in addition to his

³ Finkel, 1995.

⁴ WHO, EMF Risk Perception and Communication, Proceedings of the International Seminar on EMF Risk Perception and Communication, Ottawa, Ontario, Canada, Aug. 3–Sep. 1, 1998.

⁵ WHO, ICNIRP, Risk Perception, Risk Communication and its Application to EMF Exposure, Proceedings of the International Seminar on Risk Perception, Risk Communication and its Application to EMF Exposure, Vienna, Austria, Oct. 22, 23, 1997.

⁶ U.Beck , *Risk Society: Towards a New Modernity*, Sage Publications, 1992. Also see *The Reinvention of Politics*, 1997, and *Reflexive Modernisation*, 1994.

academic work.⁷ Though originally written mainly for a German /European audience, Beck's thesis has applications internationally. My thesis will examine present day technological risk assessment as primarily a 'revisionist' counter-reaction to the rise of reflexive modernity in the 1960s - 1970s with the rise of public environmental awareness and concern in the Western world.

The rise of the risk society: the golden years and the loss of innocence

By the 1950s, after the tribulations of WWII, the Western World was experiencing the actualisation of the industrial mass production consumerist age, with increasingly large corporations aggressively seeking ever expanding markets for a dazzling array of consumer items combined with new mass media marketing. No longer was traditional society restricted by a scarcity of material goods that characterised the first half of the 20th century. Now society enjoyed an absolute over-abundance. An age of material enlightenment was finally here with progress synonymous with increasing production, consumer consumption and the increasing exploitation of nature leading to a never-ending addition to human understanding and wellbeing. Any awareness of hidden side effects that might run counter to progress was restricted to the fringes of society.

It was during the 1960s that doubts first began to emerge, coinciding with the birth of the environmental movement in America. This was a result of a widespread dawning in the public awareness that there were many unforeseen hazardous by-products of our modern technological world that had an adverse impact on quality of life. Much of this awareness can be traced back to Rachel Carson's *Silent Spring*, which in 1962 exposed the hazards of the pesticide DDT. Carson questioned humanity's faith in technological progress and helped set the stage for the later environmental movement. The effectiveness of Carson's book in influencing public opinion (and subsequently government regulation) has been compared to Thomas Paine's *Common Sense* that galvanised radical sentiment in the early days of the

⁷ Beck, 1992, see Introduction by Lash. S and Wynne B, p. 1.

American revolution, and *Uncle Tom's Cabin* by Harriet Beecher Stowe, that roused Northern antipathy to slavery in the decade leading up to the Civil War.⁸

Public concerns over a growing disillusionment with industrial progress were reflected in an extensive 1965 White House environmental report that began with a letter signed by President Lyndon Johnson who said:

Ours is a nation of affluence. But the technology that has permitted our affluence spews out vast quantities of wastes and spent products that pollute our air, poison our waters, and even impair our ability to feed ourselves.⁹

The report identified numerous major sources of environmental contamination: municipal and industrial sewage, animal wastes, municipal solid wastes, mining wastes, and "unintentional releases," which included automobile exhausts, smoke stack emissions, pesticide mists, and agricultural chemicals draining into waterways, among others. The main report contained sub-panel reports on soil contamination, the potential for global warming by carbon dioxide, the effects of chlorinating wastes, the human health effects of environmental pollution, and the effects of pollutants on other organisms.¹⁰

In 1969, the U.S. Secretary of Health, Education and Welfare issued another extensive report titled: "Pesticides and Their Relationship to Environmental Health." The report stated:

Recent evidence indicates our need to be concerned about the unintentional effects of pesticides on various life forms within the environment and on human health. It is becoming increasingly apparent that the benefits of using

⁸ Natural Resources Defence Council, *The Story of Silent Spring*, <http://www.nrdc.org/health/pesticides/hcarson.asp>, Accessed Feb 27, 2007.

⁹ J.W. Tukey. *et al*, *Restoring the Quality of our Environment*; Report of the Environmental Pollution Panel [of the] President's Science Advisory Committee, Washington, D.C.: U.S. Government Printing Office, November, 1965.

¹⁰ P. Montague, *Environmental Trends # 613*, Environmental Research Foundation, <http://ces.iisc.ernet.in/hpg/envvis/doc98html/miscrw829.html> , Accessed Feb 27, 2007.

pesticides must be considered in the context of the present and potential risks of pesticide usage. Sound judgments must be made.¹¹

This arising awareness led to a defining event in 1970 – the first Earth Day. Organised by Senator Gaylord Nelson, Earth Day was reported widely in the U.S. media, including the New York Times, Time Magazine, and many other significant media outlets.¹² A whole raft of new legislation soon followed from that event: the National Environmental Policy Act, the Clean Air Act, the Water Quality Improvement Act, the Water Pollution and Control Act Amendments, the Resource Recovery Act, the Resource Conservation and Recovery Act, the Toxic Substances Control Act, the Occupational Safety and Health Act, the Federal Environmental Pesticide Control Act, the Endangered Species Act, the Safe Drinking Water Act, the Federal Land Policy and Management Act, and the Surface Mining Control and Reclamation Act. Earth Day gave voice to a growing environmental movement in society that viewed the fossil-fuel industry and its many by-products as having disastrous consequences for humanity and nature. It was a call for a change in society away from consumerism and toward conservation, away from militarism and toward nurturance of life.¹³

In the 1970s the awareness of the downside of the modern industrial society was widespread in both society and regulatory advisories. The enlightened age was becoming tarnished with fears of a poisoned landscape if corrective action was not taken. Now an increasing concern by the public and regulatory agencies was **not** solely on the production and acquisition of consumer items (wealth) but on the co-production of environmental risks to health and well being - risks that had heretofore been an unrecognised side effect of overproduction in industrial society. This new awareness is what Beck would term “the risk society” and its impact on political/regulatory policy as “reflexive modernisation” which I would define as

¹¹ E.M. Mrak *et al*, Report of the Secretary’s Commission on Pesticides and their Relationship to Environmental Health, Parts I and II, Washington, D.C.: U.S. Department of Health, Education, and Welfare, Dec. 1969.

¹² G. Nelson, How the First Earth day Came About, 1980, <http://earthday.envirolink.org/history.html> , Accessed Feb. 27, 2007.

¹³ G.Nelson, Earth Day 70’: What it Meant, 1980, <http://www.epa.gov/history/topics/earthday/02.htm>, Accessed Feb. 27, 2007.

society becoming aware of and confronting the limits and newfound risks inherent in modern, rapid, technological development. Reflexive modernisation heralded a change in the way the management of risks was handled. Previously, unintended risks that were produced by the industrial sector remained largely hidden and marginalised with a public consensus that all social, environmental and political risks could be solved simply by applying existing scientific and technological expertise. This would then assure continuing progress.¹⁴ However when the environmental risks created by the industrial sector of society moved to the centre of public attention in the 1960s-70s, the industrial sector took a different viewpoint on what risks they needed to address and manage. Reflexive modernization was characterized by an increasing public awareness and concern over the negative consequences of industrial and technological development but it is important to document that the industrial corporations responsible for the public's concerns have not been passive in this threat to their autonomy and profit base.

The new 'risks' for them were the raft of new legislation being created as a result of reflexive modernisation within society. They viewed this as risk to the "foundations of industrial society" as Beck saw it.¹⁵ The challenge for industrial society then was how best to respond to the new legislative restrictions on their activities, and the science that led to those restrictions. For their purposes a way had to be found that would at the very least delay the day of reckoning if not cancelling it altogether. In response to the challenge, the "Business Roundtable" was established in 1972 as an association made up of many of America's corporate CEOs for the express purpose that "the business sector in a pluralistic society should play an active and effective role in the formation of public policy" and to ensure that there "would be less unwarranted intrusion by government into business affairs."¹⁶ According to Joel Bakan in *The Corporation*, this time saw the business sector mobilize politically by establishing lobby offices in Washington, the creation of industry organizations, and industry backed think tanks to assert their

¹⁴ U. Beck, 'The Reinvention of Politics: Towards a Theory of Reflexive Modernization', in *Reflexive Modernization: Politics, Tradition and Aesthetics in the Modern Social Order*, U. Beck, A. Giddens, S. Lash (eds.), Stanford University Press, 1994, p. 1-55.

¹⁵ Beck, Giddens, Lash, 1994.

¹⁶ J. Bakan, *The Corporation: The Pathological Pursuit of Profit and Power*, Free Press, 2004, p. 103.

collective influence.¹⁷ In an apparent response to their concerns, an influential book “*A Time for Truth*” was published in 1978 by William Simon. Simon, who had longstanding professional ties with Wall Street, called on the financial and business sector to take back the power and privileges they had lost as a result of Roosevelt’s New Deal. Simon saw the federal government as having “gone haywire”, as an expanding parasitic state that threatened both the economic and political freedom of the country – something that Simon called “The New Despotism”. Simon claimed that the 1973 oil crisis was a direct result of the federal government’s interventionalist regulatory policies. Given Simon’s previous experience as Secretary of the Treasury from 1974 to 1977 under Nixon, the book was quite effective in influencing the coming political climate in the country.¹⁸ Simon’s views on the regulatory state were bluntly spelt out in his book:

Bureaucracies themselves should be assumed to be noxious, authoritarian parasites on society, with a tendency to augment their own size and power and to cultivate a parasitical clientele in all classes of society.¹⁹

A similar attitude toward federal government regulation of industry was promoted by John D. Graham who established and directed the influential Harvard Centre of Risk Analysis²⁰ (HCRA) from 1990 to 2001. From December 2001 to early 2006 Graham served as administrator of the Office of Information and Regulatory Affairs (OIRA) in the White House Office of Management and Budget (OMB).²¹ As Graham has played a central role on re-defining the practice of risk assessment, his involvement is examined in detail later in this chapter. In stark contrast to Beck’s viewpoint of a society increasingly concerned over the many

¹⁷ Bakan, 2004.

¹⁸ B. Moyers, *This is the Fight of Our Lives*, Keynote speech, Inequity Matters Forum, New York University, June 3, 2004. <http://www.commondreams.org/cgi-bin/print.cgi?file=/views04/0616-09.htm>, Accessed Apr. 9, 2007.

¹⁹ W.E. Simon, *A Time For Truth*, Reader’s Digest Books, McGraw-Hill Book Company, 1978.

²⁰ B. Burton, *Corporate influence on the executive makeup and funding for the HCRA*, Sourcewatch, Jan. 2004, http://www.disinfopedia.org/wiki.phtml?title=Harvard_Center_for_Risk_Analysis#Funding, Accessed Feb. 28, 2007.

²¹ R. Rushing, M. Brennan, G. Bass, M. Agrast, S. Ferguson, R. Shull, ‘Special Interest Takeover: The Bush Administration and the Dismantling of Public Safeguards’, The Centre for American Progress & OMB Watch for The Citizens for Sensible Safeguards Coalition, 2004, <http://www.ombwatch.org/files/regs/2004/sitreport.pdf>, Accessed Mar. 18, 2008.

risks to society from by-products from new technology/industrialisation in late modernity, Graham, reflecting a revisionist viewpoint, simply dismissed society's criticisms of technological risks as a syndrome of "paranoia and neglect".²² This disparaging view on society is extensively documented by Stauber & Rampton in "*Trust Us, We're Experts*". According to the authors, the overriding concept behind industrial society is that the public cannot be trusted to make political decisions because they are "irrational, emotional, and illogical". For example one well-known risk assessor H.W. Lewis is quoted as saying that people worry about non-problems like nuclear wastes and pesticides because they are "irrational and poorly educated".²³

This thesis, in line with Beck, that technological risk assessment has developed essentially into a counter-reaction to society's reflexive modernity is strengthened by an examination of how technological/industrial risks are handled by the US federal administration under the direction of John Graham. To quote from the public interest report "*Special Interest Takeover: The Bush administration and the Dismantling of Public Safeguards*":

Special interests have launched a sweeping assault on protections for public health, safety, the environment, and corporate responsibility – and unfortunately the Bush administration has given way. Crucial safeguards have been swept aside or watered down; emerging problems are being ignored; and enforcement efforts have been curtailed, threatening to render existing standards meaningless. This agenda puts special interests above the public interest, sacrificing a safer, healthier, more just America at the behest of industry lobbyists, corporate campaign contributors, and professional ideologues – many of whom the president has appointed to "regulate" the very interests they used to represent.²⁴

²² J. Graham, 'Making Sense or Risk: An agenda for Congress', EMF Risk Perception and Communication, the International Seminar on EMF Risk Perception and Communication, Ottawa, Ontario, Canada, 31 Aug. – 1 Sept. 1998. M. Repacholi, A. Muc (eds), WHO, pp. 1-31.

²³ S. Rampton and J. Stauber, *Trust Us, We're the Experts: How Industry Manipulates Science and Gambles with your Future*, Jeremy P. Tarcher/Penguin, 2002, p. 111.

²⁴ Rushing, et al, 2004.

This crisis in protecting society from modernization risks was foreseen by Beck as a fundamental conflict within modernization. Beck saw that while individuals needed to release themselves from structural constraints in order to actively shape the modernization process (i.e. the environmental movement, etc.) modernity also tends to impose constraints of a traditional kind on science (and therefore risk assessors and regulatory bodies that depend on that science). This imposes a defined identity upon those players by their need to identify with particular social institutions (notably those providing funding, employment) and their ideologies in concepts of risk.²⁵

The new globalised risks

Technical risk assessment deals with those environmental risks created as a direct consequence of modern technological and industrial development. Risks that have a widespread and even a globalised potential for harm of a level and scope that society has never faced before the advent of the industrial/technological age. Unlike previous risks, many of these new risks are totally undetectable by our senses and so modern western society depends upon expert advice to address and regulate such risks. As examined here, however, the danger of conflict of interest influencing expert risk assessment is of concern, as in many cases the expert voices who assess the risks for society also represent the industries that created the particular risks under their consideration.²⁶ A prime example of these new risks is the potential for harm from exposure to ionizing radiation from accidental releases from the nuclear fuel cycle, be it from groundwater contamination from mining tailings dams, fuel processing and enrichment facilities, power generation plants, radioactive waste storage facilities, the creation of weapons grade uranium and plutonium, nuclear weapons testing, and the increasing use of depleted uranium in regional wars.

²⁵ Beck, 1992, p. 3.

²⁶ B. Burton, Corporate influence on the executive makeup and funding for the HCRA, *Sourcewatch*, 2004.

Another example, of increasing concern to trade union organizations,²⁷ can be seen in the modern office workplace. As Western economies move into the so called 'information age' society and away from the earlier industrial one²⁸ the major form of employment involves spending the work week inside modern air conditioned office buildings working with a whole range of electrical equipment, computers, photocopying machines, plastic furniture, and carpeting, all which emit a mix of chemicals into the air and are breathed in by the occupants.²⁹ In effect we have replaced the many visible hazards of working in the old industrial factory, with a predominantly male workforce in most industries, with invisible hazards of the modern information technology (IT) workplace, with significant numbers of women exposed to new hazards. These invisible hazards are volatile organic chemicals (VOCs) out-gassing from electrical equipment, circuit boards, paints, craftwood furniture, carpets, etc. As most office building air conditioning systems largely recirculate the air (to save money on heating or cooling) in an enclosed system VOC levels can exceed the indoor air standard allowable levels by many times³⁰ These chemicals include isocyanates, furfuran, formaldehyde and the flame retardants polybrominated diphenyl ethers (PBDE) and others.³¹ Studies in Sweden have found levels of brominated flame-retardants in human breast milk are "dramatically" increasing annually. Before 1972 the levels were so low they could scarcely be measured.³² This illustrates another feature of technological risks – their potential to impact on unborn generations.

A third example, central to my thesis, is the ubiquitous presence of radiofrequency/microwave radiation as a result of telecommunications technology. For the first time in the history of civilization practically everyone is now exposed to an ocean of man-made electromagnetic radiation made up of a myriad of different frequencies and strengths that did not exist a century ago.

²⁷ The Swedish Union of Clerical and Technical Employees in Industry (SIF), No Risk in the IT environment, 1999.

²⁸ In reality we see a shift in heavy industry, with its associated pollution, from Western society into third world countries where running costs are far cheaper. Any mention of an "end of the industrial age" has no relevance on a global scale.

²⁹ SIF, 1999.

³⁰ CSIRO media release, 'Beating The \$12 Billion Cost of Polluted Air', Mar. 17, 1998.

³¹ SIF, 1999.

³² SIF, 1999.

Exposures from this technology, although concentrated in the developed world are rapidly spreading to the so-called “undeveloped world” initially in the form of mobile phone systems that are cheaper, quicker and far easier to deploy than the older wired telephone systems. Exposure levels are increasing significantly as a consequence of the continuing development of new generation wireless devices operating at ever-higher frequencies where little or no research exists as to the possibility of long-term health hazards. Now as the ambient electromagnetic environment continues to intensify from the mass marketing of cellular and cordless phones, numerous wireless communications systems, the effects of exposure from cumulative sources and prolonged exposure to low levels is an issue of great public controversy³³. The controversy is fuelled by the perception of a seeming inability of western RF standard setting bodies³⁴ risk assessments to acknowledge the possible existence of low level/long term (non-thermal) biological effects that would put the safety of the technology very much in question.

The rise of risk analysis

As mentioned previously, the mid-1960s saw a great increase in both public environmental concerns coupled with tightened federal government agency environmental regulations. An important legislative outcome from the environmentalists’ lobbying was the National Environmental Act of 1969, which required all federally funded projects to be justified in environmental impact statements which were to set out the various benefits and costs, preferably in quantitative form.³⁵ When this legislation was written, the requirement for impact statements was regarded as a minor feature, which environmental groups favoured as they felt the impact statement was a point of leverage for their protests. However, through a series of court decisions the impact statement ended

³³ S. Barnett, ‘Report on the Status of Research on the Biological Effects and safety of Electromagnetic Radiation: Telecommunications Frequencies’, CSIRO, June 1994.

³⁴ With the notable exception of the RF standards developed in the Soviet Union and now used by the Russian Federation.

³⁵ A. Mazur, ‘Societal and Scientific Causes of the Historical Development of Risk Assessment’, in Conrad, J, *Society Technology and Risk Assessment* by J. Conrad, Academic Press, 1983. pp. 151-157.

up emerging as an important and voluminous stage through which any proposed federal project must pass.³⁶ By the 1970s the widespread awareness of the pollution problem led to the US Congress enacting further environmental laws (new social regulation) and creating new agencies to deal with the issues.³⁷ As a result of these new regulations, by the mid 1970s a sizable industry of professionals had formed to prepare the necessary impact statements – and looking for applications for their new profession. According to controversy researcher Allan Mazur, this development was probably the single most important cause for the rise of the modern risk assessment community.³⁸

Nuclear Power

In the 1960–70s, nuclear power was widely hailed as the wave of the future by industry proponents such as Westinghouse and General Electric. In addition the Atomic Energy Commission (AEC) had the somewhat conflicting roles of regulating to make sure nuclear power plants were safe, and promoting the growth of nuclear power. Advising the AEC in its decision making process were the Advisory Committee on Reactor Safeguards made up of scientists concerned with how to ensure reactor safety, and the national laboratories, concerned over technical reactor engineering questions. All three groups were therefore dominated by technological enthusiasts who all had an interest in seeing nuclear plants being commissioned. Risk was considered a technical issue, one best left to the experts to handle. Something that could be found in facts and figures, in engineering calculations and materials testing.

It was the many problems and challenges to nuclear power plant safety design that gave rise to using risk assessment as a way to address the inevitable uncertainties with such a complex technology. A major early challenge for the engineers was to design a steel containment building around the reactor that would withstand the

³⁶ Mazur, 1983.

³⁷ P. Montague, *The Waning Days of Risk Assessment* # 652, Environmental Research Foundation, May 26, 1999, <http://ces.iisc.ernet.in/hpg/envis/doc98html/miscrww9966.html> , Accessed Feb. 28, 2007.

³⁸ Mazur, 1983.

worst possible accident that might occur (maximum credible accident). To do this it was necessary to envision all the possible accidents that may occur and then incorporate these in the design. During those early days little consideration was given to how likely such an accident was. If it was physically possible then it had to be taken into account regardless of the likelihood of it happening. This gave rise to conflict between the technical engineers at the Advisory Committee on Reactor Safeguards (ACRS) and the AEC who had the responsibility to see that nuclear power plants got constructed - after all they had the job of promotion, and did not want to delay construction while every possible thing that could conceivably go wrong was addressed in design.

Chauncey Starr

In the late 1960s, physicist and nuclear-energy pioneer Chauncey Starr³⁹ came up with the solution by pioneering the use of risk assessment within the nuclear industry that estimated the likelihood of “maximum credible accidents” to be extremely unlikely. As Alvin Weinberg, the then head of Oak Ridge National Laboratory explained: “ Instead of claiming that because reactors were contained, no accident would cause off-site consequences, we had to argue that, yes, a severe accident was possible, but the probability of its happening was so small that reactors must still be regarded as ‘safe’.”⁴⁰

In his article “Social Benefit vs. Technological Risk”⁴¹ Chauncey Starr introduced into the nuclear safety debate the concept of “socially acceptable risks”. Using arbitrary figures Starr claims that, using the current “socially acceptable risk” (rate of fatalities) for coal-burning power plants as a guide, it would be equivalent to the risk of one catastrophic accident at a nuclear power plant which would cause 10 lethal cancers and destroy a major portion of the plant every three years! Using this

³⁹ For part of his long career Chauncey Starr was corporate vice president at Rockwell International and president of the company's Atomics International Division, which worked closely with the Atomic Energy Commission to develop nuclear power for civilian purposes. He was also the founder of the U.S. Electric Power Research Institute (EPRI) and can be considered the father of the U.S. civilian nuclear power industry.

⁴⁰ R. Pool, *Searching for Safety. From Beyond Engineering: How Society Shapes Technology*, Oxford University Press, 1997. See: <http://www.pbs.org/wgbh/pages/frontline/shows/reaction/readings/search.html> , Accessed Feb 28, 2007.

⁴¹ C. Starr, Social Benefit versus Technological Risk, *Science*, vol 165, no. 3899, Sept. 19, 1969, p. 1232-1237.

hypothetical figure, perhaps akin to those medieval theologians who spent years debating how many angels could fit on the head of a pin, he then was able to claim that since the nuclear industry would not tolerate that rate of accidents, their economic concerns were more stringent than the present socially-accepted risk for conventional power plants.⁴² Starr stated as a given that “[a]ll such plants are now so safe that it may be 30 years or longer before meaningful risk experience will be accumulated.” He saw the problem as being one of gaining the public’s acceptance of an incredibly small risk, balanced against the many benefits of the technology. Acceptable risk is a valuable quantity in the management of hazardous technologies, for risks that fall below the acceptable level mean that business can continue without worrying further about the risks that are imposed on the public.⁴³

The Compensating Wage Differential (CWD)

Starr also mentions the concept of “voluntary” risk by individuals as a function of income benefits. In other words the acceptance of an increased risk in the workplace is an exponential function of his/her wage⁴⁴, - known as the compensating wage differential (CWD) originally formulated by Adam Smith (1723-1790), philosopher and founder of the modern economic system.⁴⁵ This assumption, which Starr actively promoted, was to become enshrined in ionizing radiation exposure standards (as well as in other polluting industries) and later carried over to the non-ionizing exposure standards as well, where it is accepted that maximum exposure levels can vary greatly between public (involuntary) and workplace (voluntary) exposures. Starr’s view has since been widely accepted among the risk assessment profession.⁴⁶ The CWD has been justified on the grounds that workers in hazardous environments receive, as compared to other workers in less hazardous workplaces, a “hazard-pay premium”, or as it is called

⁴² Mazur, 1983, pp. 154-155.

⁴³ B. Fischhoff, ‘Acceptable Risk: A Conceptual Proposal’, Franklin Pierce Law Center, <http://www.piercelaw.edu/risk/vol5/winter/Fischhof.htm>, Accessed Mar. 1, 2007.

⁴⁴ Starr, 1969.

⁴⁵ K. Shrader-Frechette, ‘Risky Business Nuclear Workers, Ethics, and the Market-Efficiency Argument’, *Ethics & the Environment*, vol. 7, no. 1, 2002. <http://www.iupijournals.org/ethics/ee7-1.html>, Accessed Mar. 1, 2007.

⁴⁶ Shrader-Frechette, 2002.

in Australia, “danger money” where workers appear to have a risk work wage increment that is nearly triple that of comparable U.S. workers⁴⁷. The theory being that the workers will willingly trade safety for extra wages. This is enshrined in US legislation where, before 1990, ionizing workplace standards allowed nuclear workers to receive up to 10 times as much radiation in any year as a member of the public. After 1990 the public exposure limit was lowered but not the workers’ exposure, - thus allowing a workplace limit 50 times greater than the public⁴⁸. Starr justified this on the grounds that occupational and public exposures to ionizing radiation were not analogous because environmental risks accepted “voluntarily”, through one’s occupation, can be regulated by means of standards less strict than those of public risks, precisely because of the CWD. This is essentially an economic solution of how to control occupational hazards. However, a key ingredient for this assumption to work is that workers must have an adequate knowledge of their particular risk situations. By being aware of the risks involved they can then make decisions based on a wage differential. However, numerous surveys by risk assessors, including Starr have found that most people are generally unaware of the hazards they face⁴⁹, thus making CWD decisions impossible for those people.

Kristin Shrader-Frechette detailed reasons for doubting that the CWD can provide an ethical justification for hazardous working environments because it may not even exist at all. She found that although the CWD formula appeared to work (risk and salary increase proportionally) if all workers were simply grouped from low to high salary, when other socio-economic groupings were used the formula did not apply. The CWD formula tended to hold true for white, male, unionised, college-educated, or skilled workers but not for non-white, female, non-unionised, non-college educated, or non-skilled workers, where there was a negative wage differential; as risk increased wages became lower. In fact it was found that hazardous jobs can pay twenty to thirty percent less than safe employment for this

⁴⁷ T.J. Kniesner, J.D. Leeth, ‘Compensating wage differentials for fatal injury risk in Australia, Japan, and the United States’, *Journal of Risk and Uncertainty*, vol. 4, no. 1, Jan. 1991, pp. 75-90.

⁴⁸ Shrader-Frechette, 2002.

⁴⁹ As referenced by Shrader-Frechette above: Starr and Whipple (1980, p. 1115-17), as well as Fischhoff, Slovic, Lichtenstein (1980, p. 192, 202, 208) and other risk assessors (Starr 1976, 16; Bergman 1978, p. 192-3; Kates 1978, p.168-74; Siebert and Wei, 1998, p. 171-81.

group of workers. Shrader-Frechette concluded that the CWD formula for all workers combined appeared to be “merely an artefact of data aggregation.”⁵⁰ Even if it were ethically valid for workers to accept a higher risk for a CWD they may be exposing others to an involuntary risk, such as workers exposing their families to workplace carcinogens, such as asbestos, through their work clothes. So acceptance of a CWD inevitably puts other people who have not agreed to the risk in jeopardy. If the chemical in question is also a mutagen, they may also be exposing their future descendants to the hazard.⁵¹ To this could be added the contradiction that once a CWD has been set for a hazardous occupation then all those who wish to work in that industry in the foreseeable future have no choice but to accept it.

A final critique of the CWD is the fact that Starr and other CWD proponents try to have it both ways when it comes to worker and public perceptions of risk in standard settings. They maintain that once employees are adequately educated and compensated with a CWD regarding the risks they face, regulations ought to follow employees' risk preferences. In addition they also say that regulators have no right to tell workers they cannot follow their preferences for higher risks. However, when these same proponents of the CWD wish to justify government imposition of a standard for public exposure, they take the opposite tack, arguing, when faced with citizens' demands for stricter regulations on risks, that the public's risk perceptions, even those of highly educated laymen, are subjective, intuitive, and generally inaccurate. CWD proponents would then argue that regulators should rely only on risk assessments calculated by the experts because these assessments are "rational" preferences and regulators should therefore implement them in exposure standards.⁵² Shrader-Frechette points out an apparent contradiction with this viewpoint. If the argument to regulate according to workers' risk preferences is because they are being compensated for accepting increased risks, this conflicts with another fundamental tenet of the risk assessor – the acceptance of voluntary versus involuntary risks. Starr and virtually all risk assessors maintain that voluntary risks are more acceptable than risks of the same

⁵⁰ M.P. Beck, 'Dualism in the German Labor Market', *American Journal of Economics and Sociology*, vol. 57, issue 3, July 2006, pp. 261-283.

⁵¹ Shrader-Frechette, 2002, p. 8.

⁵² C. Starr, C. Whipple, 'Risks of Risk Decisions', *Science*, vol. 208 (4448), 1980, p. 1115-1117.

level that are involuntarily imposed⁵³. If so, it would be reasonable to give greater weight to the risk preferences of those who are involuntarily exposed over those who have already been compensated for their accepted exposure. Shrader-Frechette argues that if Starr, Whipple, and other risk assessors or economists are correct in rejecting public preferences about societal risks, then it is highly questionable for them to invoke worker preferences in order to use the CWD as a justification for riskier workplace environments.⁵⁴

Nuclear power and the rise of probabilistic risk assessment

Starr and others' assurances about the safety of nuclear power were not shared by the new environmental movement, especially the Union of Concerned Scientists, who not only disagreed over the industry's assurances of safety but, in effect, declared war on the technology. The American nuclear industry, as a result, was pressed to demonstrate that the benefits of nuclear energy production justified its risks. This conflict, though largely an American phenomenon, also spread to Europe and Japan. In 1957, Congress mandated a congressional review over all applications to build and operate nuclear power plants, and in 1969 they passed the National Environmental Policy Act (NEPA). NEPA was interpreted for the Atomic Energy Commission by the Calvert Cliff decision of 1971 to require a quantified risk-benefit analysis.⁵⁵ It was this decision that legitimatised the use of risk assessment for the nuclear industry.

Sociologists Mazur and Otway have described the emergence of risk assessment as a professional activity that was basically inspired by the environmental social movement and was institutionalised through the political process in the form of the 1969 National Environmental Policy Act (NEPA). Prior to NEPA and the publication of Starr's 1969 paper "Social Benefit versus Technological Risk" in the

⁵³ Starr, 1969, and also in C. Starr, 'General Philosophy of Risk-Benefit Analysis', *Energy and the Environment*. Ed. H. Ashley, R. Rudman, and C. Whipple. New York: Pergamon, 1976.

⁵⁴ K. Shrader-Frechette, *Risk and Rationality*. Berkeley: University of California Press. 1991.

⁵⁵ H. Otway, 'Societal and Scientific causes of the Historical Development of Risk Assessment', in: *Society Technology And Risk Assessment*, J Conrad, Academic Press, 1980, pp. 163-164.

journal *Science*, only about 10-15 people were involved in risk research.⁵⁶ The problem for the fledgling risk industry, however, was that as nuclear power technology was relatively new, there was little working experience with nuclear power plants (failure data) that could be used to determine reliable⁵⁷ technical risk assessments. The gap in knowledge was conveniently bridged by devising a hypothetical systems approach to devise accident/reliability scenarios. It was this effort by the industry that largely set the tone of risk assessment as it is practised today. The problem with their approach, however, was that it created an in-built bias as industry preferences (benefits/costs) was the driving force behind the outcomes of its assessments. Simply put, the industry policy determined assessment outcomes, whereas risk assessment should ideally determine policy. According to Mazur "It appears that risk assessment has become a means of rationalising one's own policy preference, at least in the nuclear power controversy, which is the most prominent arena for application."⁵⁸

With the public awareness of the potentially catastrophic results of a core meltdown (as popularised by the movie "The China Syndrome" in the late 1960s), the industry could no longer simply hold to their story that even in the event of a worst-case accident, the public would be protected. The catastrophic nature of this possible event meant that the industry proponents needed to come up with a way to still be able to claim safety. (A severe accident was possible, but the probability of its happening was so remote that reactors must still be regarded as safe). The approach that the nuclear community gradually adopted was called 'probabilistic risk assessment' which evaluated a risk by taking into account both the probability of a certain accident occurring and the estimated consequences of that accident. Thus a core meltdown accident which was estimated to occur only once in a million years of reactor operation (hypothetical guess work) and that might kill a thousand people could be treated as equivalent to an accident calculated to happen once in a thousand years with only one death expected. Each worked out to one

⁵⁶ Otway, 1980.

⁵⁷ In the insurance industry for example, empirical data from previous years determines the expected risks associated with an activity.

⁵⁸ Mazur, 1983, p. 154.

expected fatality per thousand years of reactor operation.⁵⁹ The problem with this kind of rationalisation, as mentioned above, was that there was little failure data on which to base reliable technical risk assessments. As such, an estimation of one core meltdown in a million years of reactor operation was purely subjective guesswork.

Robert Pool, in *BEYOND ENGINEERING: How Society Shapes Technology* (1997) examined the many problems faced by using probabilistic risk assessments for estimating the likelihood of nuclear accidents. To quote:

But the major weakness of probabilistic risk assessment was a practical, technical one. Calculating the probabilities for various accidents was next to impossible. In theory, it was done by identifying the possible chains of events that might lead to an accidental break in a pipe, the failure of a sensor to detect it, an operator throwing the wrong switch, a back-up generator not starting up - and estimating how likely each of the events in the chain was. By multiplying the probabilities for the separate events, one calculated the probability that the whole chain of events would occur. Then by adding the probabilities for various chains of events, one arrived at the probability for a given accident. But because nuclear power was still a new technology, identifying the possible chains of events and estimating the probability of each event involved a good deal of guesswork. The reactor designers could list all the sequences they could think of that might lead to an accident, but inevitably they would overlook some, perhaps many, of them. And while experience in other industries might help in estimating how likely it was that a pipe would break or a pump would fail, much of the equipment in a nuclear plant was unlike that found anywhere else and it operated under unique conditions. Inevitably, until there was much more experience running nuclear power plants, much of the probabilistic risk assessment would be done by guess and by gosh.⁶⁰

⁵⁹ Pool, 1997.

⁶⁰ Pool, 1997.

The Rasmussen Report

In order to update their assurances of safety the Atomic Energy Commission (AEC) in 1972 commissioned MIT nuclear engineering professor Norman Rasmussen to calculate the likelihood of a major nuclear power plant accident. Released in 1975 at a cost of \$4 million, Rasmussen and a team of 40 scientists used a hypothetical model called a “fault tree analysis” to assess data from two reactor sites that were taken as representative of U.S. nuclear power plants generally. Their assessment, estimated that the chances of a core meltdown was once in every 17,000 years, or as a Nuclear Regulatory Commission press release stated: “a person was about as likely to die from an accident at a nuclear power plant as being hit by a meteor.”⁶¹ Rasmussen concluded that “the risk from nuclear reactor accidents was small, even in the worst case of a meltdown, and much lower than the risks society routinely ‘accepts’ from other sources”⁶² - a hypothetical conclusion based on arbitrary assumptions, according to Mazur.⁶³

With the number of nuclear power plants then operating in the U.S. Rasmussen’s optimistic assessment meant that the industry expected to operate for many centuries without a single meltdown. Unfortunately the Three Mile Island (TMI) partial meltdown in 1979 failed to conform to the report’s 17,000-year prediction. What TMI demonstrated was that the complexity of the technology was a contributing factor. It created a situation where a number of seemingly minor events, both mechanical and human error interacted to produce a major accident. Although the Rasmussen Report’s probabilistic prediction was out by a mere 16,996 years (taking 1995 as a starting point) it did, however, make a valuable contribution. By working out various scenarios of ways in which an accident may happen, it identified types of accidents that had not been considered previously, such as accidents where the loss of coolant happened gradually instead of suddenly from a major break in the coolant system or containment vessel. It was the first time that a report focused on the types of accidents that could be caused

⁶¹ Mazur, 1983, p. 155.

⁶² Mazur, 1983.

⁶³ Mazur, 1983, p.153.

by the combination of several relatively minor mishaps that individually would not be a problem. In this regard it did somewhat predict what happened at TMI. The legacy left by both Chauncey Starr and the Rasmussen Report was that probabilistic risk assessment methods developed for the nuclear industry came to be the preferred template used routinely today to assess environmental risks in all technological systems.

According to George Gray from the Harvard Center for Risk Analysis (HCRA), modern risk assessment came of age at this time as a brain child of a few regulators, academics and industry specialists who wanted to “devise a workable way to evaluate sources of exposure and the size of various risks to health”⁶⁴. Adam Finkel who has been involved in the development of risk assessment practically from its beginnings, views the profession as originally trying to give policymakers the information they need on which to base regulatory decisions upon. According to Finkel, however, the practice has been “embraced” by the political right (the revisionists) to the extent that they have been pushing for legislation that would require risk assessments to be an integral part of virtually all regulatory decisions. These assessments would require that any health benefits of regulation (to society) justified its costs (to industry). Central to this requirement is the premise that current agency risk assessments exaggerate risks, which have resulted in huge and unnecessary costs to American industry.⁶⁵

In contrast to Finkel’s concept of a young scientific technique that began as an honest enterprise that has been subverted by the revisionist movement, Langdon Winner, an academic and political theorist on technology, considers the practice of risk assessment as bad right from the start. In his essay titled, “*On not hitting the tar baby*”⁶⁶, Winner suggests that the original rise of risk assessment in the 1970s was a counter-reaction to increasing environmental activism. This new concept of risk ended up redefining terms like “environmental crisis”, “dangerous side effects”,

⁶⁴ G.M. Gray, ‘Key Issues in Environmental Risk Comparisons’, Reason Public Policy Institute, Policy Study No. 205, May 1996, <http://www.heartland.org/pdf/23133b.pdf>, Accessed Mar. 3, 2007.

⁶⁵ A. Finkel A, ‘Who’s Exaggerating?’, *Discovery*, vol. 17, no. 5, May 1996, pp. 48-54.

⁶⁶ L. Winner, *The Whale and the Reactor: A Search for Limits in an Age of High Technology*. University of Chicago Press, 1986.

“health hazards” and the like into questions of “risk”.⁶⁷ According to Winner, by changing the emphasis into assessing risk, the issue became far more complex and introduced a willingness to compare expected gain with possible harm. When the issue was shifted from one of dealing with a hazard, danger or threat (such as air pollution and cancer), to one of ‘risk’ that introduced the concept of ‘uncertainty’. As scientific research normally has a level of uncertainty, the risk assessor has to make decisions based on scientific uncertainties and value judgements over the relative size of the risk, the chance of it happening, the magnitude of harm in the event it did happen, comparisons to other ‘socially accepted’ risks, conducting a cost/benefit analysis to determine how much risk is ‘acceptable’ and determining what methods to use in the overall assessment. Faced with all these uncertainties, and a high value being placed on not being proven wrong by insisting on a high level of scientific certainty, the risk assessor’s task becomes very conservative⁶⁸ tending not to determine the best way to remedy the situation but to call for further research to lessen the uncertainty before action is taken.⁶⁹ According to Winner: “[I]t seems to me that the ultimate consequence of this new approach will be to delay, complicate, and befuddle issues in a way that will sustain an industrial status quo relatively free of socially enforced limits”.⁷⁰ Winner does point out, however, that he does not suggest that the whole field of risk assessment has become corrupted by economic interests. He mentions that a lot of good work is being done under the banner of risk assessment. He does emphasise, however, that discussions about risk, for the above reasons, inevitably tend to have a strong bias which favours the status quo of production and consumption in industrial society.⁷¹

⁶⁷ As defined in: Starr : Social Benefit Versus Technological Risk, 1969.

⁶⁸ NOTE: Winner describes ‘conservative’ as a point of view that tends to favour the industrial status quo. This is the opposite of what George Gray describes as “conservative risk assessment” which can be defined as assessments following a public health precautionary approach by taking worst-case-scenarios into consideration.

⁶⁹ Winner, 1986, p. 138-154.

⁷⁰ Winner, 1986, p. 139.

⁷¹ Winner, 1986, p. 149.

Handling uncertainty

However, the picture is not as black and white as Winner suggests. Right from the early days of risk assessment, a conflict within the risk assessment community itself highlights at least two schools of thought on how best to handle risk. The bone of contention was mainly the Carcinogen Assessment Group (CAG), formed by EPA to centralize its in-house expertise on cancer. Between 1976 and 1983 CAG assessed the carcinogenicity of some 150 chemicals, including arsenic, benzene, dioxin and coke oven emissions, all substances whose risks to health were contested by the relevant industry.⁷² The risk assessment approach taken by CAG was to avoid as much as possible the danger of underestimating the level of risk when evaluating a substance with incomplete information. CAG risk assessments therefore, were based on “conservative” or “worst case scenario” situations. The EPA justified CAG’s precautionary approach to risk on the grounds that, given the scientific uncertainty in risk assessment, it is better to assume the worst rather than potentially expose people to a significant risk.⁷³ CAG’s conservative approach to risk assessment came under much criticism from the industries affected by their determinations and by sections of the growing risk assessment community that saw the approach as distorted and unfair to industry.⁷⁴ An example of this criticism comes from the Harvard Centre for Risk Analysis (HCRA) mentioned previously. HCRA is funded by more than 100 large corporations and trade associations, including Dow Chemicals, 3M, DuPont, Monsanto and Exxon, the Chlorine Chemistry Council, the American Automobile Manufacturer’s Association, the American Petroleum Institute, and the American Chemistry Council.⁷⁵ The risk assessment methodology promoted by HCRA and its founder, John D. Graham, is examined in detail later in this chapter. A position paper by HCRA Director George M. Gray accused the EPA’s approach as deliberately inflating risk estimates in order to avoid setting regulatory limits that might not be safe. Gray

⁷² S. Jasanoff, *The Fifth Branch, Science Advisers as Policymakers*, Harvard University Press, 1990, p. 184.

⁷³ Gray, 1996.

⁷⁴ Gray, 1996.

⁷⁵ L. MacCleery, *et al*, ‘Safeguards At Risk: John Graham and Corporate America’s Back Door to the Bush White House’, *Public Citizen*, March 2001,

<http://baywood.metapress.com/index/6NVWM0K53VNU92WP.pdf>, Accessed March 3, 2007

claimed that the high degree of uncertainty meant that regulatory limits based on EPA values might be placing an unfair and unnecessary burden on industry.⁷⁶ According to Gray: “The perception that conservative risk assessment is skewing regulatory priorities, misleading the public about the relative size of different sources of risk to their health, and leading to large expenditures to generate very small reductions in risk has brought risk assessment onto the radar screen of the US Congress...the changing uses of risk assessment require that conservatism be removed from risk assessment procedures.”⁷⁷ John D. Graham criticised EPA’s CAG “conservative” approach during his Keynote presentation at an international electromagnetic field (EMF) risk assessment seminar in Ontario, Canada in September 1998⁷⁸ and is examined in this chapter.

However, a far more influential criticism of CAG’s conservative risk assessment approach came from none other than the National Academy of Sciences (NAS) for what they saw as excessive rigidity and conservatism in its risk-assessment methodology.⁷⁹ NAS criticisms were based on their members’ professional scientific viewpoint of wanting a high level of scientific proof of harm before taking regulatory action. However, insisting on a high level of proof, or wanting ‘conclusive evidence’ can result in the exclusion of a significant amount of scientific data that may indicate reasons for precautionary regulatory intervention. An example of this is the 1996 NAS peer review report, prepared by the National Research Council (NAS-NRC). Titled, *Possible Health Effects of Exposure to Residential Electric and Magnetic Fields*, the report reached a conclusion that there was no “conclusive and consistent” evidence that exposure to residential EMF’s had any adverse health impact by insisting on conclusive evidence of an EMF - cancer link.⁸⁰ This requirement, and that of only considering residential exposures, excluded approximately half of the scientific data that would have been available for consideration. This included both occupational and laboratory studies that did

⁷⁶ Gray, 1996.

⁷⁷ Gray, 1996.

⁷⁸ Graham, 1998.

⁷⁹ Jasanoff, 1990.

⁸⁰ L. Slesin, ‘Views on the News: The NAS-NRC Report’, *Microwave News*, Nov/Dec 1996, vol. 16, no. 6, p. 8.

indicate that environmental level power frequency magnetic fields can have an adverse health impact. This significant limitation of the NAS review was not reported in media statements by NAS/NRC committee chairman Dr. Charles Stephens, where he is quoted as saying simply that “The findings to date do not support claims that EMFs are harmful to a person’s health”.⁸¹ The NAS/NRC report was hailed by the electrical industry in Australia as “an important benchmark document in the history of the EMF scientific debate against which future research findings will need to be viewed”. They saw the report as concluding that ‘the current body of evidence does not show that exposure to these fields presents a human health hazard...’⁸²

The NAS/NRC report’s insistence on a high level of proof in effect biased the group’s findings in favour of the affected industry, not from an improved level of peer reviewed expertise, but review by exclusion. This suggests that an insistence on strict scientific certainty, when dealing with contentious issues with high levels of uncertainty, is inappropriate for public health considerations. This is a consideration that apparently EPA and CAG followed. In effect, the NAS’s insistence on a high level of scientific certainty (conclusive and consistent) in its decision-making process placed everything of lesser certainty into the category of “uncertainty” and thus was simply rejected. Rejecting scientific findings of possible harm because of uncertainty is unjustified from a public health perspective. This issue was examined by public health researchers David Michaels and Celeste Monforton in their paper, “Manufacturing Uncertainty: Contested Science and the Protection of the Public’s Health and Environment”. The authors point out that both epidemiologic and laboratory research have many uncertainties and the task for scientists (and regulators) is to extrapolate from this evidence (not simply reject it), make causal inferences and recommend protective action where absolute certainty is not available. According to the authors, the tactic of manufacturing uncertainty was primarily developed in the mid 1950s by the public relations corporation Hill & Knowlton (H&K) on behalf of the tobacco industry.

⁸¹ *EMF Health Report*, published by Information Ventures, Issue Nov/Dec 1996.

⁸² *EMF Update*, newsletter of the Electrical Supply Association of Australia (ESAA), Jan. 1997.

H&K came up with three points that are still frequently used by opponents of environmental regulation:

- Cause and effect relationships have not been established in any way
- Statistical data do not provide the answers
- Much more research is needed.⁸³

In July 1959 H&K officials stated in a confidential document that after five and a half years effort, they successfully created “an awareness of the doubts and uncertainties about the cigarette charges” and that tobacco industry funded research had “forced a recognition that the cigarette theory of lung cancer causation is not established scientifically” and “raised many cogent questions concerning the validity of the cigarette theory”.⁸⁴ As one tobacco executive put it succinctly at the time: “Doubt is our product since it is the best means of competing with the ‘body of fact’ that exists in the minds of the general public. It is also the means of establishing a controversy”.⁸⁵ After giving many case histories of how claims of uncertainty delayed necessary regulation of hazardous substances such as asbestos, lead and vinyl chloride, Michaels & Monforton conclude (in part):

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. It is important that those charged with protecting the public’s health recognize that the desire for absolute scientific certainty is both counter-productive and futile.⁸⁶

In 2008 David Michaels consolidated his writings on the use of scientific uncertainty as a tactic to delay regulation of a wide range of industries. Of note is his examination of the George W. Bush administration and the activities of John D. Graham as administrator of the Office of Information and Regulatory Affairs

⁸³ 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.

⁸⁴ Michaels & Monforton 2005, p. S40.

⁸⁵ Michaels & Monforton 2005.

⁸⁶ Michaels & Monforton 2005, p. S45.

within the Office of Management and Budget (OMB-OIRA). Using scientific uncertainty to counter regulation had evolved from an industry tactic to federal government policy.⁸⁷

Addressing uncertainty with the Precautionary Approach

From a public-health perspective, a far more suitable way of addressing potential threats to health and wellbeing in situations where there is a high level of scientific uncertainty over technological hazards is the Precautionary Principle, also called the Precautionary Approach. Although there is no universally accepted definition, the two main definitions widely used are the 1992 Rio Declaration (Principle 15) and the January 1998 Wingspread Statement, as follows:

The Rio Declaration:

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.⁸⁸

The Wingspread Statement:

Where an activity raises threats of harm to health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically.⁸⁹

⁸⁷ D. Michaels, *Doubt Is Their Product, How Industry's Assault on Science Threatens Your Health*, Oxford University Press, 2008.

⁸⁸ United Nations Environment Programme, The Rio Declaration on Environment and Development, 1992, <http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=78&ArticleID=1163>, Accessed April 4, 2007.

⁸⁹ The Global Development Research Center, The Wingspread Statement on the Precautionary Principle, 1998, <http://www.gdrc.org/u-gov/precaution-3.html>, Accessed April 4, 2007.

According to *“The Precautionary Principle in Action: A Handbook”* by Tickner, Raffensperger and Myers (1998), technological risk assessment is fundamentally in conflict with the precautionary principle in its approach to potential hazards. Some of these can be defined as: 1) risk assessment arbitrarily assumes that humans and the environment can tolerate a certain level of a toxin below which it is ‘acceptable’ to release into the environment; 2) risk assessments focus on quantifying and analysing problems, not on solving them; 3) risk assessment outcomes depend upon at least 50 subjective and arbitrary assumptions over factors such as exposure, dose-response relationships, and extrapolating study findings on animals to humans. As such, risk assessment outcomes are highly dependent on these assumptions; 4) risk assessments focus on single chemical toxicity and avoid complexities such as synergistic effects from multiple chemical exposures; 5) risk assessments tend to avoid effects on especially sensitive population sub-groups, such as children, the elderly and chemically sensitive; 5) risk assessments tend to focus on cancer to the exclusion of other environmentally influenced diseases; 6) risk assessment methodology works on the premise that increased exposure leads to increased effects (linear dose-response) and fails when this is not the case, as with hormone disrupters⁹⁰ where vanishingly low doses may be more harmful than larger doses.⁹¹ The authors concluded, in part, the following:

Risk assessment allows dangerous activities to continue under the guise of acceptable risk. [It] provides an air of quantitative, technical sophistication to inexact, assumption-laden, and politically driven science. It allows the continuation of activities that lead to greater pollution and degradation of health under the premise that it is either safe or acceptable to those who are exposed. It staves off regulation and action in the face of uncertainty and insufficient evidence.⁹²

⁹⁰ As the human endocrine system responds to hormone levels in parts per trillion there is no safe or ‘acceptable’ level of exposure to hormone mimicking chemicals, such as Bisphenol A for example. ‘Fact Sheet on Bisphenol’, *The Breast Cancer Fund*.

<http://www.breastcancerfund.org/site/pp.asp?c=kwKXLdPaE&b=2638145>, Accessed April 6, 2007.

⁹¹ J. Tickner, C. Raffensperger, N. Myers, ‘The Precautionary Principle in Action’, *The Science and Environmental Health Network*, 1998, p. 14-15, <http://www.sehn.org/precaution.html>, Accessed April 4, 2007.

⁹² Tickner, Raffensperger, Myers, 1998.

In its policy on risk assessment and the precautionary principle, the U.K.'s Interdepartmental Liaison Group on Risk Assessment (ILGRA) made the key point that the purpose of the precautionary principle "is to create an impetus to take a decision notwithstanding scientific uncertainty about the nature and extent of the risk, i.e. to avoid 'paralysis by analysis' by removing excuses for inaction on the grounds of scientific uncertainty".⁹³

How the telecommunications industry views the precautionary principle, however, as applied to their activity diverges significantly from the above descriptions. According to Quirino Balzano, former researcher for Motorola, and Asher Sheppard, telecommunications industry consultant, the precautionary principle is based on fear, resulting in wasteful and misguided regulations. To quote:

[T]he precautionary principle lends itself to regulation based on the perception of a threat or fear itself. In the absence of scientific evidence for risk, recent application of the precautionary principle to questions about radiofrequency electromagnetic fields of cellular telephones and cellular telephone base stations has produced wasteful and misguided regulations and questionable advice to the public.

Balzino and Sheppard recommend as a solution, the creation of scientific 'fire brigades' that would ensure that precautionary policies would be based on quantitative risk assessment.⁹⁴

Keeka Kheifets, Gordon Hester and Gail Banerjee examined the use of the precautionary principle specific to EMF (power-frequency) exposures. They

⁹³ United Kingdom Interdepartmental Liaison Group on Risk Assessment (UK-ILGRA) The Precautionary Principle: Policy and Application, Health and Safety Executive, Jan. 2004, <http://www.hse.gov.uk/aboutus/meetings/ilgra/pppa.htm>, Accessed April 4, 2007.

⁹⁴ Q. Balzano, A. Sheppard, 'The influence of the precautionary principle on science-based decision-making: questionable applications to risks of radiofrequency fields', *Journal of Risk Research*, vol. 5, no. 4, 2002, pp. 351 – 369.

identified a number of problems in its application, as they saw it, and suggested that the precautionary principle could only provide a general framework in the overall decision-making process. In their view, weighing the significant benefits of electricity against the enormous costs of reducing magnetic field levels made the application of cost/benefit essential when applying a precautionary principle to EMF. They wrote, “ to be more useful, the precautionary principle needs to have direct ties to risk evaluation”.⁹⁵

An early exploration of how to apply risk/benefit analysis (risk assessment) to RF

In the early 1980s the U.S. federal government agencies (notably the Environmental Protection Agency) began investigating on how to incorporate risk assessment (risk/benefit analysis) into regulatory decisions. In response to this interest, a team of researchers from the University of Michigan, led by Nicholas Steneck, Director of the Collegiate Institute for Values and Science, took up the issue specific to the emerging microwave health hazards debate. Their investigation consisted of asking a number of people involved in various relevant sectors (government agencies, industry RF users and developers, the military and academia) to write down their opinions on the suitability of using of risk/benefit analysis for the RF health hazards issue and what important issues should be weighed in such an analysis.⁹⁶ Some of their value judgements warrant a brief examination, as many of the points raised were a foretaste of what was to come in the risk assessment evaluation of RF hazards for regulatory purposes. This eventually resulted in the World Health Organization’s International EMF Project’s risk assessment process examined in Chapter 4.

Edward Groth, Director of Public Service Projects for the Consumers Union saw risk/benefit analysis as having many disadvantages, such as a lack of understanding on the extent of health hazards (insufficient data), putting a

⁹⁵ L.Kheifets, G. Hester, G. Banerjee, ‘The Precautionary Principle and EMF: implementation and evaluation’, *The Journal of Risk Research*, vol. 4, no. 2, Apr. 2001, pp. 113-125.

⁹⁶ L. Steneck (ed.), *Risk/Benefit Analysis: The Microwave Case*, San Francisco Press, 1982.

numerical value on human pain and suffering and the necessity of making many subjective judgements in order to come up with recommendations. Nevertheless, Groth saw a role for risk/benefit analysis, “if its use is kept in proper perspective”, and was “part” of the overall policy-making process. He thought it would be useful as a tool to attempt to quantify some of the costs and benefits of efforts to reduce RF exposure. He recommended a precautionary policy that stated: “We should take every technologically feasible step to reduce exposure to the lowest level possible, without incurring unreasonable costs”.⁹⁷

Om P. Gandhi, professor of electrical engineering and bioengineering research professor at the University of Utah, and whose work formed much of the basis of the IEEE C95.1 standard, saw the uses of RF and microwave energy in communications, industrial and medical applications as a burgeoning economic sector. He considered the adverse media publicity given to alleged biohazards had “conditioned the public to be suspicious of any and all of the applications of this energy. There is obviously a great need for public education in this regard, if mankind is to reap the full advantages of this promising technology”. He concluded, however, that there was the need for a continued and vigorous research effort to better understand the bio-effects issue.⁹⁸

Zory Glaser, Standards and Regulatory Manager in the Division of Compliance of the Bureau of Radiological Health and Christopher Dodge from the Congressional Research Service of the Library of Congress examined the implications of the Eastern European RF standards for the risk assessment of RF bio-effects. In relation to the establishment of occupational RF exposure standards, Glaser and Dodge noted that in the Soviet Union, that had far stricter standards than the West, “workers are apparently subjected to comprehensive, multifaceted, and periodic physical and mental (i.e., psychological) examinations”. The authors contrasted this to the West where “workers often receive only a general physical examination, if any at all, and follow-up examinations are generally not required”. They pointed

⁹⁷ E. Groth, ‘Defining Costs, Benefits, and Other Variables’, in *Risk/Benefit Analysis: The Microwave Case*, Steneck (ed.), 1982, pp. 25 – 38.

⁹⁸ Om Gandhi, ‘Present and Future Benefits: Applications of Radiofrequency and Microwave Energy’, in *Risk/Benefit Analysis: The Microwave Case*, Steneck (ed.), 1982, pp. 39 – 52.

out that a problem for comparing RF risks between East and West is that both blocks have different definitions for 'risk', 'hazard', 'benefit', 'cost' and the interpretation of the bio-effects of RF energy. The authors acknowledged that there was a certain level of agreement (or awareness) that the existence of low level microwave effects was being established, but they were unable to say if there were benefits to the Eastern European populations from stricter standards. As for the Soviet and Eastern European data being included in a Western RF risk assessment they hoped that this would be discussed in future international conferences and technical exchanges.⁹⁹

Robert Cleveland from the Office of Science and Technology of the Federal Communications Commission (FCC) presented the results of an inquiry designed to clarify the role of the FCC's regulatory responsibility in the area of potential harmful effects of RF radiation. More than 25 responses were received, the vast majority from RF and microwave users, including broadcasters, telecommunications companies, industrial manufacturers, trade and professional organisations. The other respondents were the EPA, the Natural Resources Defense Council (representing the public interest) and two private individuals. Virtually all respondents considered that the social benefits of RF technology should be weighed against risks. The majority expressed concern over potentially adverse effects [restricting development of new wireless technology] from unnecessary restrictive standards. [This was also an issue in the Australian RF standard. See Chapter 5.] Some respondents raised the issue of methods that could be used to minimize potential RF hazards and they should be part of any cost/benefit analysis. Cleveland mentioned that the issue of potential risks was not addressed to any great extent by the responders (other than some who claimed that none existed at the levels currently used). He concluded that, considering the potential of low-level RF hazards was still a matter of controversy within the scientific community, until that is resolved with some degree of certainty, a

⁹⁹ Z. Glaser, C. Dodge, 'Comments on Occupational Safety and Health Practices in the USSR and Some Eastern European Countries: A Possible Dilemma in Risk Assessment of RF and Microwave Radiation Bioeffects', in *Risk/Benefit Analysis: The Microwave Case*, Steneck (ed.), 1982, pp. 53 – 67.

meaningful and complete cost/benefit analysis would be a difficult undertaking”.¹⁰⁰

John Osepchuk from Raytheon and who was centrally involved in the development of the C95.1 RF standard saw as a major risk one that threatened the development of microwave technology. He considered that this risk was an ill-founded fear on part of an irrational public, largely due to media stories, which had resulted in regulatory and Congressional oversight activity that was a significant cost to the taxpayer and consumer. In Osepchuk’s view this represented a diversion of precious resources from more real problems of society. He felt that until public misinformation and confusion were cleared away it was premature to attempt a cost/benefit analysis of non-ionizing radiation.¹⁰¹ Osepchuk’s views are mirrored by those of John D. Graham, examined later in this chapter and in Appendix 1.

Richard Albanese and Mary Winfree, both from the USAF School of Aerospace Medicine, wrote a detailed reply on the suitability of using cost/benefit analysis in RF regulation. One of their points was that such an analysis would have to address the problem of applying suitable safety factors because for RF research “a significant number of biological endpoints remain to be evaluated in a statistically valid manner, particularly for the case of chronic exposure, including life length shortening, cancer induction, cardiovascular pathology, and renal and endocrine functions”. They also pointed out that little public health or epidemiological research had been done to their knowledge and that the National Standards Institute of America (ANSI) in its deliberations (C95.1) had “focussed its attention on animal data, albeit none of it of the life-length or disease-incidence variety”. [It needs to be clarified at this point that the animal data Albanese and Winfree refer to was collected by exposing small laboratory animals to short-term acute RF levels to test for their thermoregulatory responses (how their bodies dissipate heat). This

¹⁰⁰ R. Cleveland, ‘Opinions on Costs, Benefits, and Risks: results of an Inquiry by the Federal Communications Commission on Potential Hazards of Radio-Frequency Radiation’, in *Risk/Benefit Analysis: The Microwave Case*, Steneck (ed.), 1982, pp. 69 – 96.

¹⁰¹ J. Osepchuk, ‘Dealing With Misperception: On The Costs Of Perceived Versus Real Risks Of Microwave Radiation’, in *Risk/Benefit Analysis: The Microwave Case*, Steneck (ed.), 1982, pp. 97 – 115.

data would then be extrapolated to human exposures (See Chapter 3).] The authors also noted that due to the complexity of an analysis value judgements would have to be made during the process. However the authors concluded that a properly performed cost/benefit analysis would be able to fully document the difficult process of decision.¹⁰²

Samuel Koslov from the Johns Hopkins University Applied Physics Laboratory, and with an extensive background in military research, concluded in his paper that there were substantial and well recognised benefits in the military use of RF technology and that alternative technology (that would reduce personnel RF exposures) was not possible. As for the issue of possible adverse bio-effects (other than thermal) he felt that they clearly were not significant. Koslov considered that the existing data base was adequate to permit the establishment of interim standards and there was an urgency to establish these standards to “assure reasonable protection without impediment of technical capabilities”. He concluded that the main “adverse effect” was a failure to establish those standards which hindered the development of technical capabilities of both the industry and the military.¹⁰³

Mays Swicord from the Bureau of Radiological Health stressed the importance of establishing standards for public health protection despite the uncertainties over the possible effects of low-level RF exposures. He said that it had been substantiated that detrimental effects occur in animals exposed at high RF levels but also admitted that “low-level exposure apparently stresses the biological system, but how this stress occurs or the ultimate consequences is not known”. Swicord saw as a major problem in setting standards a lack of trust and cooperation among government, industry, labour unions and consumer groups. He considered this was a consequence of individual distrust or destructive

¹⁰² R. Albanese, M. Winfree, ‘Approaches To Risk Assessment: A Suggested Use For Cost/Benefit Analysis In The Microwave Debate’, in *Risk/Benefit Analysis: The Microwave Case*, Steneck (ed.), 1982, pp. 117 – 128.

¹⁰³ S. Koslov, ‘The Logical Consequence Of Application, Cost, Risk, Benefit And The Military’, in *Risk/Benefit Analysis: The Microwave Case*, Steneck (ed.), 1982, pp. 129 – 137.

competitiveness within organizations which could affect the productivity, manufacturing costs and perhaps even the survival of the economy. In this situation, Swicord said, conducting a cost/benefit analysis for microwave bio-effects was difficult, if not impossible because of “the extreme I-am-right-you-are-wrong position taken by all parties concerned”. He thought that perhaps a more immediate task than risk/benefit considerations was to somehow remove the motivation for the mistrust and competitiveness and establish an atmosphere of trust and cooperation, which was needed in order to develop protection methods. Swicord examined the internal conflicts within the C95.1 committee that had delayed the completion of C95.1 approximately 7 years (up to the date of his writing-1982). The overall committee was split between those who thought the thermal mechanism was the only proven bio-effect and those who felt non-thermal mechanisms also existed and therefore rejected the standard. Swicord said that because of this, “ [t]he real issues of health effects of [RF] radiation were thus obscured by apparent special-interest concerns of those who contended they were right, while all others were extremists and wrong”. He concluded (in part) that “[i]t is time for all parties involved in standard-setting activities to come together to seek the common goal of a quality environment with economic stability”.¹⁰⁴ It is interesting to note that Swicord’s comments about conflict within the early C95.1 committee (Chapter 3) is closely mirrored by remarkably similar conflicts within the Australian RF committee SAA and later TE/7 (Chapter 5). In the case of TE/7 a consideration of non-thermal bio-effects in the RF standard proved incommensurable with a cost/benefit analysis because it would restrict the introduction of new wireless communications technology (economic goal). Thus there could be no coming together for a common goal because there was no commonality in what was important to the two factions.

Howard Johnston, retired Staff Vice President of Product Safety for the Radio Corporation of America (RCA) and a member of several RF technical committees, considered it an urgent need to set a federal public health RF standard because of the “increasing popularity of the Russian standard in the USA”. This was causing a

¹⁰⁴ M. Swicord, ‘The Importance Of The Policy-Making Environment: Right, Wrong, And Regulation’, in *Risk/Benefit Analysis: The Microwave Case*, Steneck (ed.), 1982, pp. 139 – 149.

growing level of public opposition to the siting of RF facilities. Johnston mentioned one example where RCA had difficulty in obtaining permits for a satellite earth station on the West Coast due to public opposition. Johnston felt that “for the United States to be upstaged by the Soviet Union in this matter [was] ridiculous” and that “our national pride should force us to solve this problem promptly”. Failure to address the problem would result, according to Johnston, in a situation where “we shall increasingly see the exposure standard of the USSR quoted as the only safe standard”.¹⁰⁵ The essence of Johnston’s report was that the Russian RF standard was a significant factor in generating public opposition to RF emitting facilities and thus adversely affecting the wireless industry in America. This would suggest that a risk assessment for an American RF standard that took into consideration non-thermal bio-effects would result in a restriction to technological development and the economy.

Don Justesen, from the U.S. Veterans Administration Hospital favoured a harm/benefit analysis in preference to a risk/benefit analysis because he defined risk as “negative hope, which is fear”. He added that “fear as expressed by the human species, is inherently subjective, inherently modulated by whim and fancy, and on a social scale is inherently unquantifiable”. As for considering risk in exposure standards, Justesen considered that “to the extent that fear breeds positive assumptions from the absence of evidence, irrational practice will enter into the assessment of risk and into the establishment of exposure standards”. He defined the difference between risk assessment and harm/benefit analysis as one where the emphasis is shifted from perception of risk to judgement of injury. According to Justesen: “One moves, that is, from educated guesswork [uncertainty] toward greater certainty because it is much easier to judge the tangible evidence of actual harm than the intangibles of possible or potential insult”. Justesen added that his “distain for risk analysis” is “simply a recognition

¹⁰⁵ H. Johnston, ‘Cost Benefit Analysis: An Idea Whose Time May Not Have Come!’, in *Risk/Benefit Analysis: The Microwave Case*, Steneck (ed.), 1982, pp. 151 – 158.

that the best of [mathematical] models can lead to the worst of conclusions if the basic assumptions are existentially unsound”.¹⁰⁶

Przemyslaw Czerski, advisor to the World Health Organization (WHO), member of the International Non-Ionizing Radiation Committee (INIRP – forerunner of ICNIRP, Chapter 4), and the Committee on Man And Radiation (COMAR) of the IEEE, presented the international dimension to RF standards. This consisted of an examination of the rationales used in the development of RF standards for both the WHO/INIRP and the Eastern Bloc nations. A point of interest for this thesis was mention of a statement from Michael Repacholi in 1981 that WHO/INIRP used a health risk assessment to determine the bioeffects of RF exposure.¹⁰⁷

Rochelle Medici, a neuro-psychologist and consultant to numerous government agencies, focused on what she considered as limitations being placed on much of the RF research effort. According to Medici, the broad decisions made at the pre-experimental level about what kind of experiments needed to be conducted and what parameters should be studied, had led to a scientific cul-de-sac where the research gained was largely insignificant. To quote from Medici: “It is as though scientists had retreated from doing challenging, frontier studies because such research engendered too much controversy or elicited too much criticism. We are left with “safe” but meaningless experiments. The results of such experiments are foregone conclusions”.¹⁰⁸

Allan Frey, a biologist who had conducted numerous lines of research and published papers on microwave bio-effects, offered a viewpoint that a great deal of the public and courtroom dramas over alleged RF hazards have, in fact, been fostered by a small group of scientists. This group had spent much time in the media trying to reassure the public that there were no hazards to worry about.

¹⁰⁶ D. Justesen, ‘Dealing With Terminology And Values: Risk Versus Harm Analysis In The Formation Of Protective Standards’, in *Risk/Benefit Analysis: The Microwave Case*, Steneck (ed.), 1982, pp. 159 – 165.

¹⁰⁷ P. Czerski, ‘After Cost/Benefit Analysis: Nonionizing Electromagnetic Standards And Their Implementation’, in *Risk/Benefit Analysis: The Microwave Case*, Steneck (ed.), 1982, pp. 167 – 176.

¹⁰⁸ R. Medici, ‘Considerations For Science: Where Has All The Science Gone?’, in *Risk/Benefit Analysis: The Microwave Case*, Steneck (ed.), 1982, pp. 177 – 196.

According to Frey: “In an ironic turn of events, their attempts to reassure the public or to forestall questions and complaints have only fostered uneasiness, dissent, and debate. Questions and concern, even from legislators and courts, appear to have been met with what many people regard as stonewalling and misinformation”. Frey also documented from the public record of committees, publications, and courtroom records how the RF health debate had been taken over by this same group. His observations very much support the central tenet of this thesis. To quote from Frey:

This small group of scientists began making public statements in the early 1970s which implied that the bio-effects of non-ionizing radiation were reasonably well understood; that no hazard existed; and that there was no biological mechanism by which the living organism could be affected, except by gross heating from high-intensity energy. As time went on, this small group of scientists appointed each other to committees, made public statements that supported their own earlier statements, and supported the testimony of each other. New studies and new information were ignored or unjustly criticized; the results of studies from abroad were discounted.

The way in which all this happened has little or nothing to do with what was going on in the laboratory. Rather, it had to do with extrascientific issues: committees, power, press releases, and, most important, control of publication of and federal funding for research.¹⁰⁹

Considering the various points of view of the various authors in *Risk/Benefit Analysis: The Microwave Case*, outlined in the preceding pages, it is apparent that the conflicting values and approaches to the risk assessment of RF exposure in 1982 have changed little in the intervening years. It is also argued that what is also apparent from the historical account in *The Microwave Case* is that a Procrustean Approach is very much a *modus operandi* for many of the parties involved.

¹⁰⁹ A. Frey, ‘From The Laboratory To The Courtroom: Science, Scientists, And The Regulatory Process’, in *Risk/Benefit Analysis: The Microwave Case*, Steneck (ed.), 1982, pp. 197 – 223.

Telecommunications and manufacturing uncertainty

As examined previously, the practice of risk assessment is generally a technique for factoring in scientific uncertainty when evaluating the extent of a risk to human health. Depending on one's viewpoint, however, uncertainty can be either a reason to take a precautionary approach by enacting restrictive regulation to protect public health, or its exact opposite, as a reason not to regulate until there is a high level of scientific justification for a need to regulate at all. When it comes to risk assessment for telecommunications the second reason seems to be the operative force with public health precautionary approaches actively discouraged and the seeming maintenance of scientific uncertainty to avoid the need for change. When considering the possible range of health risks¹¹⁰ from telecommunications technology (RF emissions) precautionary approaches to address public concerns have been dismissed in the advice given by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). As will be examined in Chapter 4, ICNIRP Chairman Paolo Vecchia is on record at an International Conference on the biological effects mobile phones as stating, in pure revisionist speak, that "precautionary actions to address public concerns may increase rather than mitigate worries and fears of the public. This constitutes a health detriment and should be prevented as other adverse effects of EMF"¹¹¹

The tactic of generating scientific uncertainty, in this case with the telecommunications sector, is apparent in a survey conducted by the New York based publication *Microwave News* in 2006. The survey consisted of examining papers on microwave effects on DNA that were published in peer-reviewed journals since 1990. A total of 85 papers on the topic were identified. 43 of the papers reported finding a biological effect and 42 did not. Of the 42 no-effect papers, 32 were identified as having been funded by either the U.S. Air Force or industry. With the 43 papers that reported effects, only 3 were identified as being

¹¹⁰ This range includes the known hazards of heating (thermal effects) at acute exposure levels and the uncertain extent of low-level, long-term biological effects not related to heating (non-thermal).

¹¹¹ 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.

funded by Air Force or industry. This survey thus suggests that the source of funding has a strong influence on the outcome of research. The published results, however, with an approximately equal mix of positive and negative studies, supports the mobile phone industry's viewpoint that negative studies cancel out positive ones. According to *Microwave News*, "[p]romoting no-effect studies has long been part of their strategy to keep a lid on the microwave-health controversy".¹¹² What is interesting in the article, however, is the reporting of one positive study by Jerry Phillips that was funded by Motorola. According to Phillips, Motorola attempted to stop him writing up his positive findings. Phillips went ahead anyway, and the study was later peer reviewed and published against the wishes of Motorola. *Microwave News* also examined the publication *Radiation Research* and found that over the past 16 years, out of the 22 papers on microwave DNA effects the journal published, only 1 reported finding effects. 17 of the 21 papers were funded by either the Air Force or industry, predominantly Motorola with the lone study reporting effects on DNA from microwave exposure by Pam Sykes et al, Flinders University, South Australia.¹¹³

What could be argued from the above is that the financial involvement in microwave/health research by the military/industrial sector disproportionately generates no-effect studies, thereby increasing scientific uncertainty. It could also be argued that for the purposes of the cell/mobile phone industry, 'inconclusive' studies are far more preferable than studies that report effects. For this reason, direct involvement by the Air Force/industry in evaluating studies and influencing research priorities inevitable leads to conflict of interest and bias. This is examined in reference to the U.S.A. in Chapter 4 and Australia in Chapter 5.

¹¹² L. Slesin, 'Radiation Research and The Cult of Negative Results', *Microwave News*, vol. 26, no. 4, July 2006.

¹¹³ *ibid.*

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.¹¹⁴ 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), as examined in this thesis. This thesis explores reasons why a risk assessment paradigm developed in the so-called 'Western world' that only provides protection from obvious adverse effects at high-intensity (acute) exposures unlikely to be encountered in the environment.¹¹⁵ 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. This has been pointed out in a Swiss government agency publication *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

¹¹⁴ A. Fan, R. Howd, B. Davis, 'Risk Assessment of Environmental Chemicals', *Annual Review of Pharmacology and Toxicology*, vol. 35, 1995, p. 341-368.

¹¹⁵ For RF/MW EMR this is to prevent excessive heating of body tissue (cooking). For ELF EMF the main concern is prevention of induced electrical currents being generated in the body (shocking).

at lower radiation intensities, especially with long-term exposure".¹¹⁶ This thesis proposes 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. This assessment 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.¹¹⁷

John D. Graham and a primer for a 'revisionist' risk assessment process

Any discussion over risk assessment would be remiss if it did not include mention of the significant impact on the process by John D. Graham, who, as mentioned earlier, was founder and Director of HCRA from 1990 to 2001 and then regulatory administrator for the G.W. Bush administration at OIRA/OMB from 2001 to 2006. HCRA has been an influential organization in promoting risk assessment for U.S. regulatory policy and this was, to an extent, implemented into the U.S. regulatory policy by the Bush administration. Graham, who was a tenured Professor of Policy and Decision Sciences at the Harvard School of Public Health,¹¹⁸ established the Harvard Center for Risk Analysis (HCRA) at the Harvard School of Public Health in 1990 with \$10 million in project grants and philanthropic contributions.¹¹⁹ Much of the funding came from over a hundred industrial corporations and industry trade organizations with a direct interest in regulation. This included Dow, 3M, DuPont, Monsanto, Exxon, the Chlorine Chemistry Council, the American Petroleum Institute and the American Chemistry Council. As well HCRA Executive Board, its Advisory Council included senior executives from a number

¹¹⁶ 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.

¹¹⁷ Michaels, Monforton, 2005.

¹¹⁸ Indiana University School of Public and Environmental Affairs, Environmental Science and Public Affairs Faculty, John D. Graham, Dean, 2009, <http://www.iu.edu/~speaweb/faculty/JGG.php>, Accessed January 8, 2009.

¹¹⁹ *ibid.*

of major chemical, oil and other corporations (March 2001)¹²⁰. Although HCRA previously listed all financial contributors on its website, they are no longer publicly available.¹²¹ At HCRA Graham was able to perfect a risk assessment methodology to the extent of establishing a faculty at the Harvard School Of Public Health and Harvard University to train masters and doctoral students in risk analysis.¹²² According to the public interest group *Center for Media and Democracy*, “Graham has argued that smog protects people from too much sunlight, dioxin might reduce cancer in some cases, safe housing codes can kill people and pesticides on foods are a trivial problem that does not constitute a health hazard”. In addition, by using a theory which he had created, Graham has claimed that “environmental regulations contributes to the death of 60,000 people”¹²³.

In his role as administrator at OIRA/OMB Graham headed a team of career policy analysts who reviewed all major regulatory proposals before they could be enacted.¹²⁴ OMB’s policy analysis role was essentially to ensure that environmental regulations conformed to the administration’s political and economic policy of the day. After resigning from OMB in March 2006 Graham took up tenure as Dean and Chair in policy analysis at RAND Corporation’s Frederick Pardee RAND Graduate School in California and in April 2008 Graham took up a new tenure as Dean of the Indiana University School of Public and Environmental Affairs.¹²⁵ Graham’s work has had a large influence on debates over health, safety, and environmental regulation in the United States. In particular, Graham’s claims regarding the costs of federal regulation and the life-saving potential of a rearrangement of US regulatory priorities have been widely circulated and widely accepted by other scholars, elected representatives, and the interested public.¹²⁶ When Graham was

¹²⁰ MacCleery, *et al*, 2001.

¹²¹ HCRA: Funding. <http://www.hcra.harvard.edu/funding.html> , Accessed Jan. 8, 2009.

¹²² HCRA: Academic Study. <http://www.hcra.harvard.edu/academics.html> , Accessed Jan. 8, 2009.

¹²³ B. Burton, C. Kenny, ‘John D. Graham’, Sourcewatch, Nov. 11, 2008, http://www.sourcewatch.org/index.php?title=John_D._Graham, Accessed Jan. 12, 2006.

¹²⁴ Indiana University, 2009.

¹²⁵ Indiana University press release, ‘John Graham to lead IU School of Public and Environmental Affairs’, April 17, 2008.

¹²⁶ L. Heinzerling, Testimony of Professor Lisa Heinzerling Concerning the Nomination of John D. Graham to be Administrator of the Office of Information and Regulatory Affairs, Office of Management and Budget, Public Citizen, 2001, http://www.citizen.org/congress/regulations/bush_admin/articles.cfm?ID=5262, Accessed Jan. 12, 2006.

setting up the HCRA he was not working in a vacuum but had inspiration from other influential revisionist writers of the day. This is seen in Graham's remarks to the National Economists Club on March 7, 2002 when he acknowledged that he shared the vision of Supreme Court Justice Stephen Breyer in Breyer's book *"Breaking the Vicious Circle"* in justifying the role of OMB in overseeing agency regulations.¹²⁷ Breyer, while serving as a law professor at Harvard Law School, wrote two highly influential books on deregulation that promoted a viewpoint that over-regulation of industry was harming the nation.¹²⁸ As Breyer taught at Harvard until 1994, his writings would have been very influential in the formation of the risk regulation policies promoted by the Harvard Center for Risk Analysis established by John Graham in 1990. Breyer argued the revisionist line that the government suffered from a "regulatory gridlock" as a result of a "vicious circle" of biased technical methods, haphazard congressional actions and skewed public perceptions leading to a "public hungry for worst-case scenarios to inflame its fears, and a class of risk assessors all too eager to fuel this fire". In order to correct this, Breyer recommended the creation of a new group of risk experts within the Executive Branch.¹²⁹ Mirroring Breyer's sentiments on influencing the Executive Branch, Graham, while he was Director of HCRA remarked in a June 1992 letter to White House advisor, Jonathan Weiner¹³⁰ that, "In light of this example, [the EPA risk assessment of environmental tobacco smoke] think more broadly about future EPA risk assessments of electromagnetic fields, video display monitors, styrene, formaldehyde, carbon dioxide emissions, and so forth. As matters stand now, the White House and the nation are very vulnerable to EPA (and other agency) risk assessments that are not based on sound science or do not adequately convey the degree of uncertainty in the science. ... A small, yet well-qualified group of risk

¹²⁷ J. Graham, Presidential Management of the Regulatory State, Remarks Prepared for Delivery to the National Economists Club, OMB, Mar. 7, 2002, <http://www.whitehouse.gov/omb/legislative/testimony/graham030702.html> , Accessed January 8, 2009.

¹²⁸ S. Breyer, *Regulation and its Reform*, Harvard College, 1982 and *Breaking the Vicious Circle: Toward Effective Risk Regulation*, Harvard College, 1993.

¹²⁹ Finkel, 1995.

¹³⁰ Policy Council of the George H.W. Bush White House Office of Science and Technology Policy as well as senior staff economist for environmental and regulatory issues at the White House Council of Economic Advisers.

assessors in the White House could make an enormous difference on these issues, particularly if they established credibility among agency risk assessors.”¹³¹

Graham’s plan for a revisionist risk assessment playing a pivotal role in U.S. governmental regulatory policy was spelled out in a presentation given at a 1998 World Health Organization (WHO) International Seminar titled “EMF Risk Perception and Communication”.¹³² Graham’s presentation at this seminar is important for two reasons. First, the presentation was essentially a ‘primer’ of what he would later implement as OIRA/OMB administrator for the Bush administration. This was a position where he effectively became the “regulatory czar” for the administration, acting as a regulatory gatekeeper, passing judgment over all major national health, safety, and environmental standards¹³³. Secondly, Graham’s presentation was the “Keynote Presentation” at the Seminar, which was organised by the World Health Organization’s International EMF Project (IEMFP) which conducts EMF risk assessments for the International Commission of Non-Ionizing Radiation Protection (ICNIRP). Both IEGMP and ICNIRP were founded and headed by Dr. Michael Repacholi who spoke immediately after Graham about IEGMP’s EMF concerns. Thus, clearly Graham’s views on risk assessment were very influential in regulatory risk-policy followed by IEMFP and ICNIRP, as will be examined in Chapter 4. For these reasons, Graham’s arguments raised at the International Seminar are examined in detail in Appendix 1.

Risk assessment, perception and communication as applied to EMF

In addition to John Graham’s Key Note Presentation at the 1998 WHO International Seminar on EMF Risk Perception and Communication, a number of other presenters explored a range of viewpoints on how to address the issue of EMF health risks. Appendix 2 summarises the majority of presentations that are of

¹³¹ A. Landman, Harvard Center for Risk Analysis and Big Tobacco, Sourcewatch, http://www.sourcewatch.org/index.php?title=Harvard_Center_for_Risk_Analysis_and_Big_Tobacco, Accessed Jan 19, 2009.

¹³² Graham, 1998.

¹³³ Burton, Kenny, 2008.

particular relevance to telecommunications risk assessment. A number of presentations primarily on powerline magnetic field issues are not included.

Graham on influencing government policy

As mentioned previously, in 1992 Graham wrote to a George H. Bush policy advisor, J. Weiner, about how “a small, yet well-qualified group of risk assessors in the White House could make an enormous difference”. This was expanded upon in his 1998 WHO presentation when Graham said that although various power structures in Washington DC and elsewhere have “capitalised and prospered” from the syndrome of paranoia and neglect, a “small band of reformers” are showing the way. The viewpoint of this ‘reform movement’ was that the federal government had failed in its duty by not conducting ‘proper’ risk assessments and applying them in public policies. According to Graham, this failure meant that the government was not protecting human health, safety and environmental quality. According to the public interest group, *Public Citizen*, however, when Graham took charge as OIRA/OMB administrator the result was an administration actively interfering with supposedly impartial expert committees to influence their expert advice to support the administration’s science policy. As a result, agency science was being repeatedly suppressed, distorted and obstructed to suit political and economic and ideological goals.¹³⁴

As mentioned previously, John Graham resigned from his position in OMB in early 2006 to take up a position as Dean at Rand Corporation’s Frederick S. Pardee RAND Graduate School on March 1, 2006.¹³⁵ According to the website of the RAND school they aspire “to be the world’s leading Ph.D. program in policy analysis” with a goal “[t]o produce Ph.D. graduates whose dissertations make important intellectual contributions to practical issues and whose careers distinguish them as powerful intellectual influences on public life”.¹³⁶ This fits in well with what Graham said at the 1998 EMF risk perception and communication

¹³⁴ Landman, 2008.

¹³⁵ Pardee RAND Graduates School press release, ‘John D. Graham Appointed Dean of Pardee RAND Graduates School’, Mar.1, 2006, <http://www.rand.org/news/press.05/10.17.html>, Accessed Apr. 2, 2007.

¹³⁶ Pardee RAND Graduate School website, <http://www.prgs.edu/curriculum/>, Accessed Apr. 2, 2007.

seminar, examined above. He said at the time that, in order to cure the “prevailing syndrome of paranoia and neglect of risk”, “it is increasingly apparent that the concept of risk needs to be integrated into the way scientists and professionals are trained. Otherwise, the needs of the public and private sectors for experts and keen decision makers will not be met.¹³⁷ Reflecting Graham’s long emphasis on influencing the Executive Branch of government, the first issue of RAND’s 2007 graduate school newsletter is titled, *Preparing for January 2009: How the Next President Can Lead the Executive Branch*. The overall theme in the newsletter is in support of a massive reorganisation of the federal government to assist the future president in leading the country “with a small but capable group of leaders who rival the White House staff in both the Oval Office access and policy impact”.¹³⁸ In other words, Graham was instrumental, with his reformist (revisionist) colleagues, in organising a well-planned and executed piece of political engineering to create the conditions whereby corporate-academia trained policy experts indoctrinated in the revisionist viewpoint on risk, would be posed to wrest U.S. regulatory policy from federal agency control. What the RAND corporate university administration may have thought about the academic worth of Graham’s 2006 OMB risk assessment guidelines is not known. However, the National Research Council (NRC) in January 2007, after reviewing Graham’s guidelines, concluded “that the OMB Bulletin is fundamentally flawed” and recommended that “it be withdrawn”.¹³⁹

Influencing EMF risk governance (regulation) globally

In November 2009 the Geneva-based International Risk Governance Council (IRGC) made up of a supposedly independent group of government, industry and academic leaders, published a handbook on how to assess health risks on a

¹³⁷ *ibid.*

¹³⁸ J. Graham, E. Brown, ‘Policy Insight, Preparing for January 2009: How the Next President Can Lead the Executive Branch’, Pardee Rand Graduate School, vol. 1, issue 1, Feb. 2007. also see: E. Brown, J. Graham, ‘Leading the Executive Branch: Strategies and Options for Achieving Success’, http://www.rand.org/pubs/occasional_papers/OP181/, Accessed Apr. 2, 2007.

¹³⁹ National Research Council, ‘Scientific review of the proposed risk assessment bulletin from the Office of Management and Budget’, 2007, <http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=11811>, Accessed Apr. 4, 2007.

number of current controversies, including genetically modified foods, mad cow disease and electromagnetic fields.¹⁴⁰ One of the four principal authors of the overall report is John Graham and the EMF case study within that report is also illustrative of the potential for conflict of interest to bias an objective assessment of risk. This section was written by Leeka Kheifets from the U.S. power industry group, the Electric Power Research Institute (EPRI) and John Swanson from the U.K. electric utility, the National Grid with the help of Shaiela Kandel from the Soreq Nuclear Research Center, Israel. Kandel is also the Israeli contact for the International EMF Project (IEMFP), examined for conflict of interest in Chapter Four.

As for the potential health risk associated with both power frequency and RF technologies these authors state in their case study that “it is widely accepted that the health effect, even if real, is not of major public health significance.” By making this judgement, discounting the EMF health risk issue in a handbook on how to conduct risk assessments, it has the potential to bias an objective EMF assessment altogether for anyone using the handbook as guidance.

If the requirement for action according to the IRGC is one of a “major public health significance”, it is argued by this author that, with the globally deployment of mobile phones and other RF emitting devices, even a lesser ‘minor public health RF hazard’, possibly affecting only a small percentage of the population, must be considered a potentially significant hazard simply due to the billions of people exposed.

Life after Graham: OMB blocks EPA’s ability to conduct risk assessments

On April 4, 2007, President George W. Bush chose Susan Dudley as Graham’s replacement as ‘regulatory czar’ at OMB/OIRA, during a Congressional recess,

¹⁴⁰ International Risk Governance Council, ‘Risk Governance Deficits: An Analysis and Illustration of the Most Common Deficits in Risk Governance’, Nov. 2009.
http://www.irgc.org/IMG/pdf/IRGC_rgd_web_final.pdf, Accessed Mar. 11, 2010.

where no debate was possible.¹⁴¹ Dudley's main qualification for the appointment was her previous employment as the Director of the Regulatory Studies Program at the Mercatus Center, an anti-regulation industry funded think-tank. While at the Centre, Dudley wrote submissions attacking proposed regulations and mounted campaigns against existing regulations; called for all federal agencies to wait until near-perfect estimates of the exact causes and effects of regulated hazards were known; pushed for cost considerations to be included in public health protections; voiced opposition to all automotive safety standards, arguing that the free market economics would maximize safety; advocated mandatory expiration dates for all health protective standards; and most appalling of all, she supported a plan to use a "senior death discount" for risk assessments that counted the lives of senior citizens as worth less than the lives of the young, to cite just a few examples.¹⁴²

In March 2008 the United States Government Accountability Office (GAO) published an extensive analysis of the effectiveness of the EPA's Integrated Risk Information System (IRIS) that is vital for the agency's ability to conduct risk assessments. IRIS contains EPA's scientific position on the potential Health effects on over 540 chemicals and is a an important element of EPA's ability to conduct scientifically valid risk assessments and regulatory decisions. GAO found that under new OMB requirements, including two OMB/interagency reviews needing to be be carried out on all EPA draft risk assessments, the changes effectively "limits the credibility of IRIS assessments and hinders EPA's ability to manage them". GAO expressed concern that the new OMB managed reviews lack public scrutiny as other agency comments on any EPA draft assessment need not be made part of the public record.¹⁴³ Under the new OMB requirements, all risk assessments carried out by the EPA would undergo the scrutiny of other agencies, such as the Department of Defence (DoD), who would now be able to block the progress of

¹⁴¹ B. Gunn, Bush Recess Appointment Threatens Public Protections, OMB Watch press release, Apr. 4, 2007.

¹⁴² G. Anderson, M. Pelkey, G. Smith, R. Shull, 'The Cost Is Too High: How Susan Dudley Threatens Public Protections', Public Citizen and OMB Watch, Sept. 2006, <http://www.citizen.org/publications/release.cfm?ID=7448>, Accessed Apr. 12, 2007.

¹⁴³ GAO Report to the Chairman, Committee on Environment and Public Works, U.S. Senate, Chemical Assessments: Low Productivity and New Interagency Review Process Limit the Usefulness of EPA's Integrated Risk Information System, Mar. 2008. <http://www.gao.gov/cgi-bin/getrpt?GAO-08-440>, Accessed Jan 22, 2009.

any further EPA risk assessments of chemicals it deemed vital to its interests. Under this new requirement OMB has directed EPA to terminate five risk assessments that for the first time addressed acute, rather than chronic chemical exposure. OMB gave no reason for this termination even though this type of assessment was used to help implement the Clean Air Act.¹⁴⁴

On Weight of Evidence (WOE)

“Weight of evidence”(WOE) or “weight of scientific evidence” is a term used in referring to published scientific, legal and policy-making literature and is often used in the context of risk assessment, including RF risk assessment, its definition depending on the context in which it is used. It was introduced in the early 1990s to improve the risk assessment of Superfund toxic disposal sites in the U.S.¹⁴⁵. Sheldon Krinsky, researcher on science/technology, ethics/values and public policy, describes WOE as characterizing “a process or method in which all scientific evidence that is relevant to the status of a causal hypothesis is taken into account”¹⁴⁶. The Institute of Electrical and Electronics Engineers (IEEE) defines WOE as an approach to assessing the scientific literature on possible biological effects from RF exposure for standard setting as a process involving an “evaluation of the quality of test methods, size and power of study designs, the consistency of results across studies and the biological plausibility of dose-response relationships and statistical associations”.¹⁴⁷ When evaluating RF literature, only “[w]ell-conducted and published confirmation and replication of studies that produce the same result contribute to the weight of evidence.”¹⁴⁸ Many other Western¹⁴⁹ national and international organizations, such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP-Chapter 4) also follow the IEEE’s

¹⁴⁴ *ibid.*

¹⁴⁵ S. Krinsky, ‘The Weight of Scientific Evidence in Policy and Law’, *American Journal of Public Health*, Supplement 1, vol. 95, no.S1, 2005.

¹⁴⁶ Krinsky, 2005.

¹⁴⁷ C-K, Chou, From IEEE RF Safety Standard to Address Base Station and Mobile Phone Safety Concerns (powerpoint presentation, slide 8), IEEE /ICES meeting Apr. 16, 2007, http://www.citel.oas.org/sp/ccp2-radio/Taller-Ionizante/P2!R-1370r1_i.ppt, Accessed Nov. 17, 2008.

¹⁴⁸ F. Barnes, B. Greenbaum, (eds.), *Handbook of Biological Effects of Electromagnetic Fields. Biological and Medical Aspects of Electromagnetic Fields*, CRC Press, 2007, p. 151.

¹⁴⁹ “Western” refers to the Western world countries that were not connected to the Former Soviet Union or China where a more restrictive WOE was followed to RF standard setting.

WOE approach in establishing RF exposure standards. A “weight of evidence approach” to assessing the RF literature base is also followed by the Australian Centre for Radiofrequency Bioeffects Research (ACRBR) and the National Health and Medical Research Council (NH&MRC).¹⁵⁰

Through the accumulation of published scientific data that go to make up the “weight of evidence” a body of expert scientific advice on a topic is created and continually added to. This is usually presented to the public, especially for the RF/health hazards question, as a body of expert advice that is above question by other reputable experts in the field. The primary feature of the WOE approach as used in RF standard setting health risk assessment is to exclude the biological relevance of RF exposures at levels below official standards, which are based on limiting biological tissue heating from RF exposure to protect against thermal damage at high level exposures. This is exemplified in the IEEE’s RF standard setting committee’s collection of review papers, as published in *Bioelectromagnetics Supplement 6* (2003) where low-level, non-thermal biological effects have been excluded from their ‘weight of evidence’ for setting standards (examined in Chapter 3). This would appear to be in line with Krimsky’s observations that when the WOE approach is used a number of presuppositions must be adopted which have the potential to restrict both the range of scientific opinion and consensus over including differing evidence in the risk assessment. Thus, an inherent potential for bias in the outcomes of a WOE analysis is created. He also points out the obvious that “the “weighing instrument” for “weighing evidence” is human cognition, which has never been calibrated to the task”.¹⁵¹ A number of problems with the WOE approach were also highlighted in a U.S. National Cancer Institute analysis of the term “weight of evidence” as used in 92 published papers available through *PubMed* from the period 1994 through 2004. These included a lack of consensus of the meaning of the term and many different kinds of weights used, including qualitative and quantitative that are applied to risk assessment.¹⁵²

¹⁵⁰ ACRBR/NH&MRC Position Statement, <http://www.acrbr.org.au/FAQ/Khurana.pdf>, Accessed Nov. 17, 2008.

¹⁵¹ Krimsky, 2005.

¹⁵² D.Weed, ‘Weight of Evidence: A Review of Concept and Methods’, *Risk Analysis*, vol. 25, no. 6, Dec. 2005, pp. 1545-1557.

Conclusions

Technological risk assessment is often presented as an objective, rational and scientific method of determining the extent of environmental and human health risks resulting from high technology. Its establishment can be traced back to several important events in the second half of the 20th Century. First was the development of nuclear power and the need to determine the likelihood of power plant accidents, where no empirical data yet existed. Second was the introduction of thousands of new chemical consumer products, where data on possible adverse effects on the environment and exposed humans was limited. This created a novel situation where regulatory decisions had to be made in areas of significant scientific uncertainty. Coinciding with these developments, a “risk society” arose with a new awareness that technological advancements, although they came with the promise of significant benefits, also came with new risks that threatened not only modern society, but unborn generations as well, if not reined in by government. In response, federal agencies, mainly the EPA, devised a method of “conservative” (or precautionary) risk assessment that, due to the uncertainties, used a “worst case scenario” to establish toxicological regulations with the viewpoint that it was better to assume the worst rather than risk exposing people to a significant risk. In these developments, which Ulrich Beck termed “reflexive modernisation”, the industrial sector saw a danger to their very foundations if not countered. In response, during the early 1970s, the industrial sector took up the challenge by creating industry organizations, think-tanks and Washington-based lobbyists to enable the sector to become an active player in the formation of public policy to counter what they saw as an “unwarranted intrusion by government into business affairs”. Central to industrial policy was the need to counter the science behind so called “conservative risk assessments” by EPA and other agencies by not only attacking these assessments, but by creating what Adam Finkel termed a ‘revisionist’ school of thought on risk assessment to better evaluate sources of exposure and the size of various risks to health. A corner-stone of the revisionist viewpoint on risk was that conservative assessments were far too rigid and mishandled the issue of uncertainty, which led to not only an unfair and unnecessary burden on industry, but also created unwarranted fears and paranoia

in a gullible public. In the revisionist viewpoint, uncertainty is reason not to regulate until the exact parameters of the risk are known by using a complex set of risk assessment and management procedures, such as probabilistic methods of uncertainty analysis, distributional methods of variability analysis, comparative risk analysis, risk-based priority setting, benefit/cost analysis and substitution analysis. In addition, there is the call for external peer review of agency science by experts selected for their technical expertise. For the revisionist risk assessment industry, the more uncertainty the better. In this way, it can be claimed that as long as uncertainty exists, more analysis and research is needed before regulation is possible, lest society runs the risk of over-regulation of industry and thereby harming the nation's economy. It is essentially the reverse side of a precautionary policy. From a corporate and pro-industry viewpoint, the maintaining of a high level of uncertainty in the science appears more desirable than fostering research to reduce uncertainty about possible health implications for their respective products.

In answer to the question raised in the title of this chapter, 'is risk analysis/assessment valid science or spin?', this discourse has shown that while the technique is pictured as an objective, rational input into the decision-making process, in reality it can be used in order to justify a previously-made decision on the safety of a product or in support of the introduction of new technology. This theme is followed up in this thesis, specific to telecommunications, where it will be shown that the risk assessments conducted by various standard setting organizations have acted to validate increases in the allowable 'safe' limits to insure that those limits did not act as a barrier to the introduction of new technology.

One of the claims made by those who support the revisionist risk assessment viewpoint for US government regulatory policy is that all federal agency risk assessments (or analyses) should be reviewed by an external peer review committee made up of non-government scientists from academia and non-profit research organizations. Members should be selected on the basis of their technical expertise rather than their affiliation with particular stakeholder groups. It is assured that such a process will improve both the quality of technical risk

assessments and public confidence in the outcomes. For this reason, Chapter Two examines the pros and cons of peer review and how revisionist changes to risk assessment have impacted upon the peer review process. In addition, Chapter 5 examines the pitfalls of ignoring stakeholder affiliations in relation to establishing expert peer review committees and research organizations.

Chapter 2

Peer review and expert advisory committees: towards 'sound science'?

Scientific communication is in the process of metamorphosis. Will it change into a dung beetle or into a beautiful butterfly? Here is one possibility that some might argue is as frightening as Kafka's story: "As Gregor Samsa awoke from unsettling dreams one morning, he found himself transformed in his bed into a monstrous bug."- Kafka's *Metamorphosis* ¹

Overview

The organizations examined in this thesis that have established telecommunications frequency human exposure standards, both at a national and international level², frequently refer to the need to base human health assessments on peer reviewed scientific literature. The inference given is that the process of peer review automatically assures the best possible way to achieve an objective body of unproblematic scientific literature that expert advisory committees can rely upon in setting exposure standards to protect human health.

This chapter, specific to the above claim, examines a number of definitions and uses of peer review, as originally formulated by the British Royal Society and currently applied, in various forms, throughout the world by the scientific establishment. Examples are given of a number of U.S. scientific organizations that have defined the process specific to their activities, including the National Science Foundation, the National Research Council and the National Institutes of Health. Also examined are a number of criticisms of peer review and alternatives to traditional peer review. Closely allied with peer review is the use of expert advisory committees in interpreting the peer reviewed literature and other sources of scientific data in order to make recommendations specific to regulation. The

¹ Quoted from the introduction of: LaPorte RE, *et al*, Papyrus to PowerPoint (P2P): metamorphosis of scientific communication, *British Medical Journal*, Vol 325 no. 7378, p. 1478-1481, Dec. 21, 2002.

² These are the Institute of Electrical and Electronics Engineers (IEEE), the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the Australian Standards TE/7 Committee and the Australian Radiation Protection And Nuclear Safety Agency (ARPANSA).

central issue in this chapter is the relatively recent attempts (since the 1970s) to revise the definition and role of peer review and expert advisory committees, specific to environmental regulation, in areas that may pose a financial risk or burden on industrial corporations. Examples of actions to re-define the process are those of the Royal Society, the U.S. Supreme Court Daubert ruling, and the U.S. federal Office of Management and Budget (OMB). These changes have happened during the same time frame (1970s-onwards) as the internationalisation of RF standards as examined in Chapter 5.

An essential part of modern scientific practices and the environmental regulatory system is the concept of peer review, a system of quality control used by the scientific and medical community based on examination of scientific research findings and research proposals by other scientists - peers - to ensure that work is scientifically significant and of a high standard in procedure and interpretation of findings. In theory, by applying the peer review process, a reliable and scientifically valid literature base accumulates which (in the context of regulation) is then used for the establishment of reliable regulatory policy.

In the case of the typical peer review process, as exemplified by the journal *Reproductive Toxicology*, research manuscripts are reviewed by two or three scientists with good knowledge of the subject, and are drawn from all three sectors: academia, industry and government. After initial reviewing, manuscripts are frequently returned to the authors for revision. The revised manuscripts are then re-evaluated by the reviewers and often returned to the authors with additional comments for another revision. All comments must be satisfactorily addressed before manuscripts are deemed suitable for publishing in the journal.³ Of arguably equal importance to the peer review process is the role played by expert advisory committees (or panels) in interpreting the body of relevant peer reviewed literature in making regulatory decisions or recommendations to government agencies on a wide range of issues. Quite often there is a blending of roles, as illustrated in Chapter 3 where the radiofrequency (RF) standards setting

³ Correspondence with Thomas B. Knudsen, PhD, Editor, *Reproductive Toxicology*, University of Louisville and the US EPA, Feb. 5, 2008.

committee of the Institute of Electrical and Electronic Engineers (IEEE) utilizes its committee members to conduct in effect an internal peer review of submitted papers for suitability of being included in the body of literature used for IEEE's RF standard setting. Chapter 4 examines the international expansion of IEEE's RF standard setting philosophy through the World Health Organization's (WHO) International EMF Project and the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Chapter 5 follows this up with an examination of the process by which the Australian RF standard was eventually harmonized (made compliant) with ICNIRP. Central to the Australian case was the Standards Australia TE/7 Committee: Human exposure to electromagnetic fields. This expert advisory committee was charged with evaluating the relevant scientific literature base in order to establish revisions to the Australian RF standard.

This chapter examines the peer review and expert advisory committee process mainly as it has developed under the United States federal regulatory regime, because it was in the U.S. that the predominant philosophy in RF standard setting was first developed and then 'internationalized' to much of the rest of the world. An overarching theme in this chapter is to examine to what extent 'procrustean tendencies' have infiltrated these processes to the detriment of what might be called science in the public interest.

Peer review takes hold of the scientific process

Although there are a number of historical forerunners, the process of peer review of submitted manuscripts is generally credited to the Royal Society of London. In 1752, the Society formed a "Committee on Papers" charged with the review of all articles submitted for publication in the journal *Philosophical Transactions*.⁴ In their examination of the foundations of the Royal Society, *Institutionalized Patterns of Evaluation in Science* sociologists Robert Merton and Harriet Zuckerman show that the practice of peer review evolved as a social contract amongst the emerging scientific community that served to validate their society, lend authority to the

⁴ D.A. Konick, 'Peer Review in 18th Century scientific journalism' *JAMA* vol. 263, no. 10, Mar. 9, 1990, pp.1321-3.

enterprise and most importantly, ensure the highest quality possible in the accumulating body of literature that served as their knowledge base.⁵ From its beginnings at the Royal Society, science has relied on peer review as the primary means of identifying research that is of sufficient quality to enter the accumulating body of scientific literature. Peer reviewing procedures have come to be generally regarded in the scientific and medical communities as the most efficient way of validating science in two quite different spheres of professional activity: prepublication review of papers submitted to journals and screening of applications by federal research-sponsoring agencies.⁶

Peer review in the American regulatory setting was heavily influenced by the 1945 report *Science The Endless Frontier* by Vannevar Bush, Director of the Office of Scientific Research and Development. This was a blueprint of a proposed design for a post-war science policy that raised the proposition that the federal power had both the authority and responsibility to support the self-directed research of university scientists. The report recommended that a single new agency, the National Research Foundation (NRF), be established to provide such support, including defence and medically related research. In addition, an expert peer review board, the National Science Board (NSB), would be created, made up of representatives from the scientific community. It would have been their job to allocate congressionally appropriated funds and appoint and discharge the foundation's Director. This set-up effectively cut the president and his administration out of the decision making process as the proposed NSB was designed to provide universities with research support that was designed to be both non-bureaucratic and apolitical.⁷ In 2003 similar concerns would be raised in the House of Representatives over peer review, only this time on behalf of federal agency peer review committees who, it was claimed, were being taken over by vested interests on behalf of those to be regulated.⁸

⁵ R.K. Merton, H. Zuckerman, 'Institutionalised Patterns of Evaluation in Science', in *The Sociology of Science*. N. W. Storer (ed), The University of Chicago Press, 1971.

⁶ S. Jasanoff, *The Fifth Branch, Science Advisors as Policymakers*, Harvard University Press 1990, p. 61.

⁷ Jasanoff, 1990.

⁸ US House of Reps., Committee on Government Reform-Minority Staff, Special Investigations Division, 'Politics and Science in the Bush Administration', prepared for Rep. Henry A. Waxman, US House of Reps.,

Definitions and pros and cons of peer review

There is no single definition of peer review that would encompass the many forms that the process takes, let alone define the changing character of the process in the United States during the recent years. The practice of peer review has been both praised and scorned in different quarters and has come under intense examination and criticism. It is worthwhile to distinguish between *grants* peer review that allocates the distribution of limited research funds, *manuscript* peer review that guards the entry into the scientific literature, and advisory body *regulatory* peer review that evaluates scientific research, both published and sometimes unpublished, to advise federal agencies on regulatory matters.

A U.S. House of Representatives subcommittee report on peer review as used by the National Science Foundation defined the peer review system as "any method of evaluating a specialized creation such as a proposal to perform scientific research which involves having a group of people knowledgeable in the area of specialization evaluate the creation."⁹ Both the NSF and the National Institutes of Health (NIH) expressed the view that "peer review operates fairly to identify and support the best science".¹⁰

The U.S. General Accounting Office (GAO), in a 1999 report, found that there was no single definition of peer review as used across the various government agencies. However the GAO in 1999 described that agency peer reviews "contained the fundamental concept of a review of technology or scientific merit by individuals with sufficient technical competence and no unresolved conflict of

Aug. 2003, http://oversight.house.gov/features/politics_and_science/pdfs/pdf_politics_and_science_rep.pdf, Accessed Mar. 10, 2008.

⁹ Subcommittee on Science, Research and Technology of the House Committee on Science and Technology, 94th Congress, 2nd Session, National Science Foundation Peer Review 13 (Committee Print 1976).

¹⁰ L.E. Trachtman, R. Perrucci, *Science under Siege?: Interest Groups and the Science Wars*, Rowman & Littlefield, 2000, pp. 22-23.

interest.”¹¹ As this thesis will examine, the problem of conflict of interest is a contentious issue remaining unresolved in both peer review and advisory committees.

The U.S. National Research Council (NRC) of the National Academies, describes federal agency peer review as “a long-standing tool of science policy in the United States, peer review is widely recognized as the preferred method for judging the merits of proposals for research funding. Across the federal government, it is used in a variety of contexts and for a variety of purposes—both scientific and political in nature. It is at once a tool with which scientific judgment is formalized and decisions about the allocation of scarce public resources are legitimized.”¹²

From an analysis in 2004 the NRC drew six major conclusions on agency peer review:

- Peer review serves a number of worthwhile purposes such as the identification and support of high-quality research and the further development of a culture of rigorous inquiry in the field.
- Federal agencies use a range of models for peer review that serve different purposes and objectives.
- Developing peer review systems involves balancing multiple, and sometimes conflicting, values and thus often requires making trade-offs.
- Peer review in the federal government is a tool by which agency goals are accomplished and therefore can only be developed, evaluated, and understood as framed by these objectives.
- Although peer review is not perfect, it is the best available mechanism for identifying and supporting high-quality research.

¹¹ D.H. Guston, ‘The expanding role of peer review processes in the United States’, Chapter 6 in *Learning from Science and Technology Policy Evaluation*, P Shapica and S Kuhlmann (eds.), Edward Elgar (pub.), 2003.

¹² L. Towne, J.M. Fletcher, L.L.Wise(eds.), *Strengthening Peer Review in Federal Agencies That Support Education Research*, Committee on Research in Education, Center for Education, Division of Behavioral and Social Sciences and Education, National Research Council of the National Academies, The National Academies Press, Washington, D.C., 2004. http://books.nap.edu/openbook.php?record_id=11042, Accessed Mar. 30, 2008.

- Peer review of education research proposals in federal agencies could be improved in a number of ways.¹³

Sociologists Daryl Chubin and Edward Hackett in their 1990 book, *Peerless Science* examined many of the controversies and challenges (as of 1990) with the U.S. regulatory peer review process. They defined peer review as "[a]n organized method for evaluating scientific work which is used by scientists to certify the correctness of procedures, establish the plausibility of results, and allocate scarce resources (such as journal space, research funds, recognition, and special honour)."¹⁴ They considered it as a "flywheel" that lends stability to research in an area and a way to test new proposals against the cumulative store of shared knowledge and established theory. As such, peer review is important as it judges whether new ideas are truly new and worth pursuing. They described some of the other attributes of peer review as:

- Peer review is a source of expert advice for the researcher that can improve the product investigation and for the decision maker, a way to determine wiser allocations.
- Peer review approval of a project gives the successful applicant an endorsement of the project through critical evaluation and a public commitment which can help keep a project on course despite setbacks that may occur during the investigation.
- Peer review is a communication channel that circulates research ideas in their formative stages to other experts in the field that can help prepare the ground for new ideas by first circulating in the speculative format of a proposal, which will be followed by colloquia, presentations at meetings, and papers submitted for publication. Research proposals may also result in criticism and advice that can be used to improve the quality of the research project.
- Peer review is a "boundary process", as it spans the boundaries of several social worlds placing it at the intersection of science and policy, of academia

¹³ Towne, Fletcher Wise, 2004.

¹⁴ D.E. Chubin, E.J. Hackett, *Peerless Science: Peer Review and U.S. Science Policy*, SUNY Press, 1990.

and government. It may straddle interdisciplinary fields or research initiatives. Peer review may also cross boundaries of knowledge production and professional practice, of research and policy. A boundary process that “directs attention to the mix of communities, purposes, evidential standards, argumentative procedures, ethical percepts, theoretical frameworks, epistemic cultures, principles of fairness and the like that mingle and collide in the review process”.

- Peer review is an entry point for adding “value beyond quality” to research decisions by taking into account factors such as geographic distribution, age, gender or ethnicity of the investigator. Also by including participation of colleges and other academic institutions other than the large universities.
- Peer review is ideally expected to be “meritocratic, judging proposals and scientists equally in accordance with the stated criteria.” An example is the National Institutes of Health (NIH) that instructs its reviewers to evaluate all the science and nothing but the sciences in any proposal. It is expected to apply standards of fairness of ideas apart from consideration of a scientist’s reputation, personal characteristics, geographic or academic position, the economic potential of the proposed work or its relevance to pressing national needs. The concept (above) of “value beyond merit” departs from meritocratic principles but most people are fine with the deviation most of the time.
- Enriching traditional peer review with the involvement of “lay review” by citizens, such as done by the NIH *Director’s Council of Public Representatives*, a federal advisory committee, made up of members of the public, who advise the NIH Director on issues related to public participation in NIH activities, outreach efforts, and other matters of public interest.
- Reflecting peer review as a boundary process, peer review is also an assertion of professional authority by creating a buffer or boundary where scientists can make decisions in a privileged space, apart from the general public and political influence. This is done according to principles that reinforce their professional culture.
- Taking into account the apparent conflicting views in the previous two points, a good review system limits the amount and character of public

participation, shaping the form of input allowed and preserving professional autonomy while still permitting lay participation. This requires federal agencies to carefully balance deference to expert evaluation untainted by politics, yet, still be sensitive to societal needs and “extrascientific” values, such as questions of research application, risk and benefits to whom, and long-term versus short-term consequences.^{15 16}

Weaknesses of peer review

Like any human endeavour, however, peer review is also subject to errors and biases, and has been criticized on the grounds that:

- A review may be subjective or biased as the reviewers may be the author’s competitors who may also use the opportunity to steal or plagiarize ideas they are reviewing¹⁷.
- Reviewers draw upon their collective knowledge of a field to critically evaluate a proposal’s claim as weighed against the established body of knowledge. Where ideas run counter this body of knowledge, reviewers may tend to defend tradition against claims of originality¹⁸.
- It delays publication of research results¹⁹.
- The possibility of financial conflicts of interest impacting on peer review was raised at the International Committee of Medical Journal Editors in a statement issued in 2003.²⁰

¹⁵ Hackett, Chubin, 1990.

¹⁶ E.J. Hackett, D.E. Chubin, ‘Peer Review for the 21st Century: Applications to Education Research’, National Research Council Workshop, Washington, D.C., Feb. 25, 2003, http://www7.nationalacademies.org/core/HackettChubin_peer_review_paper.pdf, Accessed Mar. 30, 2008.

¹⁷ F. Anderson, ‘Science Advocacy and Scientific Due Process’, *Issues in Science and Technology*, National Academy of Sciences, Summer 2000, <http://www.issues.org/16.4/anderson.htm>, Accessed Mar. 30, 2008.

¹⁸ Hackett, Chubin, 2003.

¹⁹ H.A. El-Munshid, ‘Evaluation Of Peer Review In Biomedical Publication’, *The Annals of Saudi Medicine*, Editorial, vol. 21, issue 5,6, 2001.

²⁰ The ICMJE stated that: “Conflict of interest exists when an author (or the author’s institution), reviewer, or editor has financial or personal relationships that inappropriately influence (bias) his or her actions . . . The potential for conflict of interest can exist whether or not an individual believes that the relationship affects his or her scientific judgement. 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. *Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical*

- Hackett and Chubin point out a financial disincentive to getting expert reviewers and competent reviews. Members on expert advisory and other peer review committees are, as a rule, paid little for their services, while at the same time are expected to put in considerable time evaluating proposals.²¹ This can create a significant opportunity for bias, however, as industry members serving review and advisory committees would expect to receive financial remuneration in one form or another for their time from their employers whereas this would normally not be the case for academic and private organizations representing the public interest. This was a recurring problem on the Standards Australian TE/7 Committee: Human Exposure to Electromagnetic Fields (Chapter 4). In that committee only travel expenses were provided by Standards Australia and even that not in all cases. The extensive amount of time required to review papers for consideration was on one's own time. This was in stark contrast however, to industry or government representatives who were on full pay while doing TE/7 work, as well as travel + expense account bonuses. In one example, Professor Ivan Beale, representing the public interest organisation "Adopt Radiation Controls" in New Zealand, was unable to attend many Australian based TE/7 Committee meetings because he was not provided travel expenses to attend meetings. Other NZ members, however, had their expenses paid by their employers.
- Hackett and Chubin also point out the tension between an innovative peer review system versus the traditional system.²² This has specific relevance to the traditional system employed in Western RF standard setting where the research paradigm established by the body of accepted knowledge (thermal bio-effects only) imposes skeptical restraint on new ideas that cast doubt on that paradigm.
- Lack of sufficient time for peer reviewers to fully evaluate submitted papers. As an example, Catherine DeAngelis, editor in chief of the Journal of the American Medical Association (JAMA), when discussing how to deal

Publication, International Committee of Medical Journal Editors, Nov. 8, 2003.

<http://www.icmje.org/index.html#peer>, Accessed June 23, 2007.

²¹ Hackett, Chubin, 2003.

²² Hackett, Chubin, 2003.

with submitted drug studies omitting data and “inconvenient “ details, stated that some medical journal editors maintain that “it’s impossible to sift through thousands of pages of raw data to check a paper’s fairness” and that peer reviews might “fail to notice suspicious omissions and changes in focus” in studies or “lack the time or inclination to follow them up.”²³

- According to Epidemiologist David Michaels who served as Assistant Secretary of Energy for Environment, Safety and Health during the Clinton administration, success in the peer review system is pretty much a luck of the draw as whoever gets to review a paper has a huge influence on its fate.²⁴
- Peer review is prone to Merton’s “Matthew Effect” where there is favoritism toward known and established researchers from prestigious institutions at the expense of lesser known individuals regardless of their scientific expertise.²⁵
- Peer review is blind to industry influence. David Michaels has written of a whole industry that has sprung up in the U.S. that re-analyzes scientific peer reviewed data on behalf of polluting industries to contradict that data. This is then published in a second-rate peer reviewed journal with the opposite conclusions of the original study. One example given is a beryllium industry re-analysis of a Centers for Disease Control and Prevention (CDC) study that found a significant increase in lung cancer amongst beryllium exposed workers. By changing some of the parameters the significance disappeared and the industry re-analysis was then published in “Inhalation Toxicology”. This study was then promoted by the industry as evidence that the government agencies were wrong.²⁶

²³ Kaiser Family Foundation, ‘Some Medical Journals More Critical of Studies Omitting Findings’, The Kaiser Family Foundation Health Policy report, May 10, 2005, quoting Wilde Mathews in the *Wall Street Journal*, May 10, 2005. http://www.kaisernetwork.org/daily_reports/rep_index.cfm?hint=3&DR_ID=29952 , Accessed March 30, 2008.

²⁴ D. Michaels, Peer Review Standards for Regulatory Science and Technical Information Workshop, Science, Technology and Law Program, The National Academies, Washington DC, Nov. 18, 2003.

²⁵ R.K. Merton, ‘The Matthew Effect in Science’, *Science*, vol. 158, no. 3810, Jan. 5, 1968, pp. 56-63,

²⁶ Michaels, 2003.

Rustum Roy critiques traditional peer review

Rustum Roy, a critic of traditional peer review, considers the process as 'draconian', a system that exists only to insure that scientific publications fit in with current scientific paradigms and obstructs developments that are truly revolutionary. Roy considers its track record is far from admirable. As an illustration Roy uses four research papers published in the prestigious journal *Science* over a two-to-three year period. All of these papers have since been challenged and discredited, two withdrawn by their authors. Roy understandably considers that a 100% rate of gross errors appalling, especially as they were previously passed by the journal's peer review process.²⁷ Roy sees the peer review process as bound to reject paradigm-breaking discoveries because "reviewers can never, repeat never, assure the truth or accuracy of any paper. All they can check is whether it is consistent with their paradigm. And if it isn't, they must, quite logically, reject". In Roy's estimation "no really new work can get past peer reviewers".²⁸ Roy's views are similar to Thomas Kuhn's on "normal science" and paradigm shifts. Within a given scientific paradigm normal problem solving science continues but when contradictions arise that run counter to the paradigm they are rejected rather than being allowed to threaten the paradigm. Only when these contradictions have accumulated to a point that they cannot be avoided does a shift in the paradigm happen.²⁹ Another of Roy's reasons for having "absolutely no faith in peer review" is that during the slow process of having a research paper published it can give the peer reviewers unfair research advantages.³⁰ While Roy rejects peer review as "draconian" he expresses a surprising willingness to accept, as a superior alternative to peer review, the judgements of industry managers, as stated in 1997:

²⁷ R. Roy, 'Science Teachers and Recent Research', *Bulletin of Science Technology Society*, vol. 18, 1998, pp. 3-6.

²⁸ Roy, 1998.

²⁹ As outlined in: T. Kuhn, *The Structure of Scientific Revolutions*, University of Chicago Press, 1962, <http://search.eb.com.ezproxy.uow.edu.au:2048/eb/article-9113237>, Accessed Mar. 21, 2008.

³⁰ A. Ivan A, R. Roy: 'PR is a better system than peer review. (publicizing new method of diamond synthesis through lay press)', *Science*, vol 258, no 5083, Oct. 30, 1992.

“Most significantly, the U.S. Department of Defense [DoD], the country’s premier funding agency which proactively seeks out the best, has obviously managed very well, thank you, by trusting the judgements of highly informed managers (as in industry).”³¹

[Note: Chapter 3 examines the central role played by DoD in developing the U.S. C95.1 RF standard and its involvement in the peer review process to evaluate scientific studies used in RF standard setting.]

The Royal Society reconstructs ‘independent’ peer review

As mentioned previously, the Royal Society, credited with establishing peer review in 1752 with its “Committee on Papers” to review submitted manuscripts, had for over 200 years a firm policy of not becoming involved in public controversies. As stated in “Philosophical Transactions”: “It is an established rule of the Royal Society...never to give their opinion, as a Body, upon any subject”, a statement later dropped from the journal in the 1960s.³² For most of the Society’s long history funding for its activities came from public funds but by the 1990’s substantial funds were being received annually from the biotechnology, oil, gas and nuclear industry sectors. As for a possible conflict of interest in accepting funding from industrial sectors the Society stated that such donations would ensure that it can “formulate balanced judgements about the use of science to solve national, social, economic and industrial problems... independent of vested interests”.³³ An investigative report on the Royal Society and its involvement with genetic modification (GM) technology by the public watchdog organization GMwatch, however, found that in addition to donations from industrial sources individual members of the Society frequently have extensive financial connections with the same sources, either directly or by a dependency on the bio-tech industry funding for their research. In addition, the expert GM committee set up by the Royal

³¹ Roy, 1998.

³² T. Wakefield, ‘The Appliance of Science’, *The Ecologist*, vol 30, no. 5, , July - August 2000, p. 56.

³³ GM Watch, Profiles, Royal Society, <http://www.gmwatch.org/profile1.asp?Prid=113>, Accessed Oct. 31, 2006.

Society consisted almost exclusively of members who were known supporters of GM technology, who in 1998 issued its first report on GM technology that concluded that “the use of GM plants had the potential to offer benefits in agricultural practice, food quality, nutrition and health”.³⁴ Soon after this report was issued the Royal Society became embroiled in a very public controversy when it was revealed in the U.K. *Guardian* Newspaper that the Society’s former Vice President and Biological Secretary Sir Peter Lachmann had attempted to block the publishing in *The Lancet* a peer reviewed paper by Dr. Arpad Pusztai that was critical of GM technology. According to the *Guardian* interview with Richard Horton, editor of *The Lancet*, Lachmann threatened Horton that if the Pusztai paper was published it would “have implications for his personal position” as editor.³⁵ In *The Lancet* editorial over the Pusztai episode, Horton criticized the Royal Society for attempting to stifle the public debate over the GM issue by berating critics rather than engaging with them. He made mention of the unfortunate actions by the Royal Society in attacking the Pusztai paper before the data was reviewed and published in the proper way. An action that Horton said “will only intensify public scepticism about science and scientists.”³⁶ The contentious issue of GM foods is outside of this thesis other than to note the recent change in the Royal Society mirrors the international trend of corporate industrial interests increasingly becoming ‘embedded’ in peer review and expert advisory panels. In this situation what may be considered as scientific ‘truths’ becomes more a form of “social constructionism”³⁷ where ‘facts’ are prone to be more of a convenient intellectual construct of a particular sub-section of society, such as in the case of the ‘capture’ of the Royal Society by the GM industry. Elements of this type of purpose-built social construct are seen throughout this thesis with a particularly noteworthy case on page 34-40 with the Weinberg Group’s proposal to Dupont Chemicals to manufacture a consensus science to their benefit.

³⁴ *ibid.*

³⁵ L. Flynn, M.S. Gillard, ‘GM food: special report’, *The Guardian*, Nov. 1, 1999.

<http://www.guardian.co.uk/print/0,3858,3923559-103528,00.html>, Accessed Oct. 31, 2006

³⁶ Horton R, ‘Commentary’, *The Lancet*, vol. 354, Oct. 16, 1999, p. 1315.

³⁷ P.L. Berger, T. Luckmann, *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*, Anchor Books, 1966.

Several alternatives to the traditional peer review model

1) Super Peer review

Rustum Roy sees the solution to the problems inherent in traditional peer review by using a innovative process of “super peer review” which is utilized by the journal “Materials Research Innovations” of which Dr. Roy was Editor-in-Chief.³⁸ (Ceased publication on December 31, 2003) In contrast to traditional peer review, which Roy sees as a review of the content of papers, Roy defines “super peer review” as being based on “sound epistemology”. It recognizes that the quality of any research is the product of the “quality” of the person doing it and the quality of the work done. Super peer review is based on reviewing the authors, not the particular piece of work. Roy claims that the “quality” of the author can be reviewed easily with an objective criteria. That criteria is that the author (s) shall have published in the open, often peer-reviewed literature a large (30-50 papers) body of work, thereby giving them a track record to preserve. Secondly the work under review must be “new” and a “step-function advance” in knowledge. For those researchers less well published they need to submit through a journal editor, or a senior colleague, who will serve as a personal guarantor.³⁹ How this will foster innovative research by less well-published researchers who do not yet have a proven “track record” is not clear. The possibility of being accepted then rests on finding a single senior colleague or editor who, in effect, will do a mini peer review on the paper/proposal in question before becoming a guarantor. This puts another hurdle to pass for less well-published researchers that may stifle new innovative research. Elements of Roy’s “super peer review” can be seen in the Radiofrequency (RF) peer review process that developed in the US for building up a body of research to be used in establishing a human exposure standard for RF (Chapter 3) where the “track record” of researchers in supporting the thermal-effects only paradigm became the all-important criteria in gaining access to research funding.⁴⁰

³⁸ R. Roy, Editor-in-Chief, *Materials Research Innovations*, Springer-Verlag, publisher, 1997, <http://www.in-cites.com/journals/MaterialsResearchInnovations.html> , Accessed Mar. 21, 2008

³⁹ *ibid.*

⁴⁰ N. Steneck, *The Microwave Debate*, MIT Press, 1984, p. 48-49 (factors in the establishment of the first U.S. RF standard).

Considered in this light, super peer review can operate to maintain an existing paradigm and inhibit research that questions that paradigm.

2) The DARPA model

In the above quote, Roy is referring to an alternative grant decision-making process where a single strong manager makes decisions according to his or her best judgment, such as done in the Defense Advanced Research Projects Agency (DARPA). As Hackett and Chubin (2003) describe this process, in effect it is a peer review with one peer, who would need to be on a par (intellectually and in stature within the field) with those applying for support. This manager plays the roles of advocate, broker, collaborator, evaluator and in some cases terminator. The manager, of necessity, needs to understand the field and its needs to insure that decisions and allocations are wise, legitimate, and effective.⁴¹ In the DARPA model the program being managed has well defined objectives and the manager is the accountable person for performance outcomes. There is a focus on practical projects, not programs. DARPA sponsored projects focus on a common objective or idea, has a beginning and end and a specific, hoped for outcome that may have very high risk. Programs on the other hand emphasize particular academic disciplines or general technologies, tend to be very open-ended and are not supported by DARPA. This emphasis on projects, not programs, is supposed to give outcomes that are based on good ideas with clear, exceptionally beneficial consequences.⁴² A problem with the strong manager/DARPA alternative is that any biases that the manager has could influence the direction of research projects and interpretation of the findings of that research. This is examined in detail in Chapter 3, using as an example the 1950s U.S. Military Tri Service Program. This program had been set up to determine a safety limit to radiofrequency and microwave radiation, mainly for military personnel working in the vicinity of military radar. In spite of an earlier 1953 conference at Bethesda Naval Hospital that raised the necessity of including independent review boards, objective interpretations of the data and exploring conflicting points of view in the Tri

⁴¹ Hackett, Chubin, 2003.

⁴² Hackett, Chubin, 2003.

Services Program, the whole program was turned over to just one man to manage it, Colonel George Knauf who ended up as head of the entire Program and having the final say in issues of the focus of scientific research, interpretation and application.⁴³ As Steneck explains in *The Microwave Debate*, Colonel Knauf's personal views on RF bio-effects (that there were no level bio-effects other than heating) came to be the paradigm in the Tri-Services Program by essentially ignoring any evidence that questioned that paradigm.⁴⁴

3) Expert elicitation

The process of expert judgement elicitation, is used to gain necessary information in areas of uncertainty where hard data is lacking and is not available through other means, such as data collection or experimentation. Simply put, it is a process of eliciting the considered opinions of experts who are well known and respected in their respective fields. Using a "standard elicitation protocol" their written responses from questionnaires and panel discussions are combined to give the best possible advice in the absence of hard data. Expert judgement was first developed by the U.S. Nuclear Regulatory Commission (NRC) in the safety studies of nuclear reactors⁴⁵. In that case hard data on the various scenarios that could happen in the event of a nuclear mishap did not exist and learning situations such as Three Mile Island and Chernobyl were still in the future.

As risk assessment is increasingly being used in both government agencies and the industrial sector for a variety of decision making there is a corresponding increase in the use of expert elicitation to provide information in safety related decision making. Expert elicitation judgements are now being used in most steps of risk assessment, hazard identification, risk estimation, risk evaluation, analysis of options and quality assurance/quality verification.⁴⁶ Dr. Christopher Frey, in his

⁴³ Steneck, 1984.

⁴⁴ Steneck, 1984.

⁴⁵ S. Hora, M. Jensen, 'Expert Judgement Elicitation', Swedish Radiation Protection Authority, *SSI Rapport*, Sept. 2002.

⁴⁶ T. Rosqvist, 'On the use of expert judgement in the quantification of risk assessment', *VTT Industrial Systems*, VTT Publications 507. Dec. 2003. <http://virtual.vtt.fi/inf/pdf/publications/2003/P507.pdf>, Accessed Oct. 18, 2006.

analysis of the process, sees the use of expert elicitation as introducing an “unavoidable dimension of uncertainty” in risk assessment when the bases for risk assessment assumptions are explicitly subjective, such as expert elicitation judgements. There may be subjective components to expert judgements that may consist of strongly held assumptions that could carry over to be included in quantitative data analysis and introduce bias that is difficult to quantify.⁴⁷

4) Open peer review (open to public comment)

In June of 2006 the journal *Nature* trialed an open peer review system to gauge the interest of researchers in an alternative to the traditional system of peer review that included a public comment phase. *Nature* receives approximately 10,000 papers annually with about 60% being rejected without review. Of those papers reviewed only 7% are approved for publication. *Nature's* trial ran between June 1 and September 2006 and consisted of an invitation to all authors whose submitted papers had survived the initial editorial assessment to have their papers hosted on an open Internet server for public comment. Of 1,369 papers sent out for expert peer review during the trial, only 71 authors agreed to have their papers also displayed on the Internet for open comment. These papers also underwent *Nature's* standard peer review process. All public comments were required to be signed and examined for any legal problems and inappropriate language. Once the journal's standard peer review process was completed, the editors collected all received public comments and then removed the papers from the Internet. The final published papers were therefore the result of both the journal's standard peer review process and the open review process. At the end of the trial the journal concluded that the system worked as well as any system of peer review could with 74% of participating authors agreeing that the new system improved their paper, 20 % felt there was no change and only 6% thought it adversely affected their papers.⁴⁸ The journal *Atmospheric Chemistry and Physics* also uses an open peer

⁴⁷ C. Frey, July Risk Forum, *The ORACBA Newsletter*, vol. 5, no. 4, Oct, 2000.
<http://www.usda.gov/agency/oce/oracba/newsletter/news54.pdf>, Accessed Oct. 18, 2006.

⁴⁸ P. Campbell (Editor-in-Chief), ‘Peer Review Trial and Debate’, *Nature*, Dec. 2006,
<http://www.nature.com/nature/peerreview/>, Accessed Oct. 18, 2007.

review system in a 2-stage Internet system where peers, authors and the interested public can discuss the paper.⁴⁹

5) The extended peer community

Funtowicz and Ravetz (2003) see the need for extended peer communities in complex new environmental issues where risks cannot be quantified or when possible damage is irreversible. In these situations, where political policy must be made in areas of high uncertainty, traditional forms of expertise and problem-solving methodologies are inadequate to assure quality in addressing such risks. The maintenance of quality can only be met with an open dialogue between all parties involved – an “extended peer community” consisting of all interested people, not just those with institutional expertise, who wish to participate in finding resolutions in an issue. It is through the Internet that extended peer communities have achieved enormous influence through mutual education on the issues and coordinating international activities to engage with corporate vested interests on far firmer ground than previously was possible.⁵⁰

These differing approaches to the peer review process clearly indicate that the process has a strong subjective social context, very much depending upon the models approximately followed. Roy’s super peer review model may work well for purely technical innovations where there is little controversy, but in areas of controversy it may operate to stifle alternative viewpoints. The military DARPA model relies on a single expert (strong manager) in the particular field. It is used for practical projects where there is a clear goal in mind, such as designing an improved technology. Any biases in the strong manager, however, will be carried over into the outcomes of the project. The expert elicitation model is used in areas of uncertainty where the considered opinions of various experts in the field in question are sought. It is frequently used in risk assessment but the personal

⁴⁹ M. Reinhart, ‘Peer Review’, The Institute for Research Information and Quality Assurance (Germany), Oct. 2006, http://www.research-information.de/iq/agora/Peer_Review/_peer_review.html, Accessed Mar. 30, 2008.

⁵⁰ S. Funtowicz, J. Ravetz, ‘Post-Normal Science’, International Society for Ecological Economics, Feb. 2003. <http://www.ecoeco.org/pdf/pstnormsc.pdf>, Accessed Mar. 18, 2008.

judgements of the experts can have strong subjective assumptions that affect the overall assessment. In contrast to the above, the open peer review model is used in parallel with the more traditional peer review process to open up comment over a paper to a wider audience of peers and the general public. These comments are then taken into consideration by the expert peer review panel. Taking this a step further, the extended peer community model is designed for complex environmental issues where the high level of uncertainty brings into question the quality of expert peer review risk assessments (such as with the first three above models). In this situation, quality can only be assured with an open and democratic dialogue undertaken with all stakeholders, including the concerned public and public interest organizations.

The Daubert Appeal and Judges as “gatekeeping” court evidence reviewers

As a result of the growing reflexive awareness over the possibility of unintended health hazards from chemicals that arose in the 1960s-70s, by the 1980s the US Federal court system was increasingly hearing a number of large-scale toxic tort litigation cases with the Supreme Court increasingly intervening in Circuit Court cases⁵¹. Many of these cases were marked with a range of inconsistent judicial decisions in relation to the admissibility of evidence. Resolving this inconsistency in rule-making appeared to be the stimulus for the Supreme Court’s rulings in a 1993 appeal over the drug Benedictin, manufactured by Merrell Dow Pharmaceuticals, thereafter known as the Daubert appeal.⁵² Benedictin, made from a combination of Vitamin B6 and an antihistamine, to help reduce nausea associated with morning sickness had been prescribed to more than thirty-five million American women between 1956 until 1983 when it was withdrawn from the market by the manufacturer due to a number of litigation cases against the drug claiming it caused birth defects. In 1980 a federal court in Florida ruled in favour of the Mekdeci family’s claim that their son’s birth defects was caused by

⁵¹ G. Edmond, D. Mercer, ‘Litigation Life: Law Science Knowledge Construction in (Benedectin) Mass Toxic Tort Litigation’, *Social Studies of Science*, vol. 30, 2000, pp. 265-316.

⁵² G. Edmond, D. Mercer, ‘Daubert and the Exclusionary Ethos: The Convergence of Corporate and Judicial Attitudes towards the Admissibility of Expert Evidence in Tort Litigation’, *Law & Policy*, vol. 26, no. 2, , Apr. 2004, pp. 231-257.

his mother's use of Benedictin during her pregnancy. According to law professor Michael Green this case signalled the start of the Benedictin toxic tort case that saw several thousands of similar litigation claims made against Merrell Dow.⁵³

In the Daubert case (*Daubert v. Merrell Dow Pharmaceuticals, Inc.* 1993), Merrell Dow was sued by two families, over two children, Jason Daubert and Eric Schuller who were born with serious birth defects, and whose mothers had taken Benedictin during their pregnancy. During this time a number of other industries involved in toxic tort cases were vilifying plaintiff's experts who they claimed were using "junk science" in order to extract huge verdicts in product liability and toxic tort cases.⁵⁴ In the original circuit court case, the Daubert v. Merrell Dow plaintiffs argued that their child's birth defects had been caused by Benedictin which the mothers took during their pregnancy. Their case depended on the testimony of eight experts who were relying on animal studies, chemical structure analyses and a non-peer reviewed unpublished re-analysis of epidemiological studies in order to show that the drug caused birth defects. The court dismissed this evidence, ruling that it did not meet the "Frye test" for admissibility.⁵⁵ This was based on the Frye case in 1923 when a Circuit Court of appeals reaffirmed a trial court's ruling "that expert opinion based on a scientific technique is inadmissible unless the technique is "generally" accepted" as reliable in the relevant scientific community". This meant that expert testimony that diverged "significantly from the procedures accepted by recognized authorities in the field...cannot be shown to be generally accepted as a reliable technique".⁵⁶ For scientific evidence to be admissible in the courts, it generally had to conform to the "generally accepted" relevant theory or technique of the day. The plaintiff's attorneys then appealed the Circuit Court decision to the Supreme Court, arguing that the "Frye test" had been superseded by the 1975 Federal Rules of Evidence (FRE). To quote:

⁵³ M.D. Green, *Bendectin and Birth defects: The Challenges of Mass Toxic Substances Litigation*, University of Pennsylvania Press, 1996.

⁵⁴ M. Berger, 'What Has a Decade of *Daubert* Wrought?', *American Journal of Public Health*, Supplement 1, vol. 95, 2005, pp. S59-S65, <http://www.ajph.org/cgi/content/full/95/S1/S59>, Accessed May 18, 2009.

⁵⁵ *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993), <http://supct.law.cornell.edu/supct/html/92-102.ZS.html>, Accessed Feb. 12, 2008.

⁵⁶ E.P. Richards, C. Walter, 'Science in the Supreme Court: Round Two', *IEEE Engineering in Medicine And Biology*, no.2 , pp. 124-125, Mar.-Apr. 1998. Quoting from: *Frye v. United States*, 293 F. 1013 (1923).

Rule 702: Testimony by Experts: If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise.⁵⁷

The Supreme Court agreed with the plaintiff, finding that the FRE was intended to broaden the scope of admissible evidence. As the judges stated:

The drafting history [of the FRE] makes no mention of Frye, and a rigid “general acceptance” requirement would be at odds with the “liberal thrust” of the Federal Rules and their “general approach” of relaxing the traditional barriers to “opinion” testimony (*Daubert v. Merrill Dow Pharmaceuticals, Inc*, 1993 at 588).⁵⁸

Most importantly, according to Edmond and Mercer the majority of the Supreme Court judges in the *Daubert* appeal, “sought to articulate an alternative, and ostensibly more liberal, standard in accordance with the FRE”.⁵⁹ The Supreme Court then reversed the Circuit court’s exclusion of the plaintiff’s expert testimony and sent the case back to the Circuit court for reconsideration. It is apparent from this that the Supreme Court was acting in a reflexive manner, seeking to establish a more liberal standard for scientific admissibility than what previously was restricted by Frye standard, which had been relied upon by the earlier Circuit Court ruling. However, even with more discretion allowed for scientific testimony by the *Daubert* Supreme Court decision, the Circuit court considered that their earlier reasoning under the Frye standard also included sufficient justification to exclude the evidence under the Supreme Court’s *Daubert* appeal.⁶⁰ Although later Supreme Court appeal decisions (notably *General Electric Co. v. Joiner* (1997) and

⁵⁷ Edmond, Mercer, 2004.

⁵⁸ Edmond, Mercer, 2004.

⁵⁹ Edmond, Mercer, 2004.

⁶⁰ Richards, Walter, 1998.

Kumho Tire Co. v. Carmichael (1999)) gave an increasingly revisionist slant (as discussed below), to what has been called the Daubert Standard.⁶¹ Edmond and Mercer point out that many judges and legal commentators “have promoted Daubert as [a] vehicle capable of addressing concerns about liberal admissibility standards – such as weak formulations of Frye – permitting ‘fringe’ or ‘weak’ (or junk) scientific claims to be heard by courts and to produce legal outcomes which are apparently inconsistent with those dictated by ‘mainstream’ science.”⁶²

In order to aid the court four “Daubert criteria” were established for aiding judges in evaluating the admissibility of expert testimony:

- “(1) whether the methods upon which the testimony is based are centered upon a testable hypothesis;
- (2) the known or potential rate of error associated with the method;
- (3) whether the method has been subject to peer review; and
- (4) whether the method is generally accepted in the relevant scientific community.”⁶³

Although the Supreme Court ruling on the Daubert appeal did not emphasize the role for judges as ‘gatekeepers’ in deciding whether or not expert testimony would be allowed or rejected in court cases, later trials and decisions emphasized this role with judges becoming, in effect, court ‘peer reviewers’ by reviewing all scientific testimony before the court and deciding on its reliability and relevance for the case under consideration. This gatekeeping role gave judges additional powers to be able to summarily dismiss expert scientific testimony if they deemed it unreliable or unsuitable for the case under consideration. Although the Supreme Court did not regard the Daubert criteria as a definitive checklist but more as a guide, in subsequent Daubert hearings judges tended to exclude scientific evidence if they considered that it was lacking in any single criteria, not on the totality of

⁶¹ Referring to the Supreme Court Daubert appeal ruling as a ‘standard’ is exemplified on the Internet Wikipedia site. http://en.wikipedia.org/wiki/Daubert_Standard, Accessed May 18, 2009.

⁶² Edmond, Mercer, 2004.

⁶³ DaubertExpert.com, ‘An Introduction to Daubert v. Merrell Dow’, http://www.daubertexpert.com/basics_daubert-v-merrell-dow.html, Accessed Feb. 18, 2008.

evidence.⁶⁴ With such increasingly strict interpretations of the Daubert appeal, according to a RAND study, in 90% of court Daubert hearings it was the plaintiffs' expert evidence that was excluded for failing to meet the judge's interpretation of the Daubert criteria.⁶⁵ The net outcome of the Supreme Court Daubert appeal decision was to put federal courts as the final arbiter in matters of complex scientific controversies where specialized knowledge is essential to explore all the issues. In Edmond and Mercer's analysis of the Daubert rulings, a strict interpretation of both gatekeeping and the four Daubert criteria were solidified in a number of subsequent court rulings, notably *General Electric Co. V Joiner* and *Kumho Tire Co. v Carmichael*, where, in both cases, the plaintiffs' expert evidence was excluded and, in the Joiner case, even the lack of relevant experience did not excuse a judge from exercising his or her gatekeeper role.⁶⁶ In the Kumho case the judge's 'gatekeeping' was extended beyond "scientific" knowledge to include "technical" and "other specialized" knowledge as well.⁶⁷ The expanded powers given to judges to enable them to arbitrarily dismiss evidence is illustrated in *Wade-Greaux v Whitehall Labs*. In this ruling the court rejected animal toxicological research studies as invalid because the court considered that animal studies could not be extrapolated to humans without supportive epidemiological studies. For justification Judge Douglas Weed stated that "[t]he notion that one can accurately extrapolate from animal data to human to prove causation without supportive epidemiologic studies is scientifically invalid because it is inconsistent with several universally accepted and tested scientific principles. The principle of species specificity has been tested and demonstrates that different species can react differently to the same agent."⁶⁸ Weed's opinion, however, is at odds with the International Agency on Research on Cancer (IARC). In their evaluation of carcinogenic risks to humans IARC stated that "In the absence of adequate data on humans, it is biologically plausible and prudent to regard agents and mixtures for

⁶⁴ What is the Daubert Standard?, <http://proliberty.com/observer/20070710.htm>, Accessed May 18, 2009.

⁶⁵ L. Dixon, B. Gill. 'Changes in the Standards for Admitting Expert Evidence in Federal Civil Cases Since the Daubert Decision'. RAND Institute for Civil Justice. 2002.

http://www.rand.org/pubs/monograph_reports/MR1439/MR1439.pdf, Accessed May 18, 2009.

⁶⁶ Edmond, Mercer, 2004.

⁶⁷ Edmond, Mercer, 2004.

⁶⁸ Berger, 2005.

which there is sufficient evidence of carcinogenicity in experimental animals as if they presented a carcinogenic risk to humans".⁶⁹

Daubert stalls mobile phone / brain tumour lawsuits

Concerns about mobile phone product liability were first raised in 1993 when David Reynard filed a lawsuit against NEC Corporation, alleging that his wife's fatal brain tumour was caused by her mobile phone use. Reynard aired his accusation on CNN's *Larry King Live* with the story soon receiving world media attention. This directly prompted a congressional investigation and led to the establishment of an industry funded research project called "Wireless Technology Research"⁷⁰ Over the next decade there were a number of substantial lawsuits against the mobile phone industry alleging that mobile phone use had resulted in brain tumours. The most notable of these cases was *Newman v Motorola* where Christopher Newman, a neurologist, launched action in a Baltimore, Maryland City court against Motorola, Verizon, Cellular One and the Cellular Telecommunications Industry Association (CTIA), alleging that his brain tumour had been caused by his use of a mobile phone from 1992 to 1998.⁷¹ On December 6, 2000, prominent lawyer Peter Angelos took over the Newman case and on November 15, 2001 the legal firm of Morganroth & Morganroth filed a brain tumor lawsuit against Motorola with 10 more lawsuits planned.⁷² By 2002 there were 12 personal injury cases underway against mobile phone manufacturers. Five of these were filed in Washington D.C. courts in February 2002 with over six billion in damages being claimed against the industry.⁷³ By the time of the *Newman v Motorola* case it was looking like the litigation flood-gates were about to open against the mobile phone industry. The Newman case was heard in the District Court of Maryland before District Judge Catherine Blake with both sides filing

⁶⁹ R.L. Melnick, 'A Daubert Motion: A Legal Strategy to Exclude Essential Scientific Evidence in Toxic Tort Litigation', *American Journal of Public Health*, vol. 95, no. 51, July 2005, pp. 530-534.

⁷⁰ L. Slesin, 'The 1994 DNA Breaks Study', *Microwave News*, vol. 25, no. 1, Mar. 2005.

⁷¹ L. Slesin, 'Baltimore Doctor Files Cell Phone-Brain Cancer Lawsuit; His Lawyer Plans a Dozen More by December', *Microwave News*, vol. 20, no. 5, Sept./Oct. 2000.

⁷² L. Slesin, 'High-Profile Criminal Lawyer Takes on Wireless Industry', *Microwave News*, vol. 21, no. 6, Nov./Dec. 2001.

⁷³ Edmond, Mercer, 2004.

objections against each other's evidence with a Daubert hearing taking place from February 25 to March 1, 2002.⁷⁴ In Judge Blake's memorandum, dated October 1, 2002 she ruled in favour of the defendants' motion to exclude the plaintiff's expert testimony on the grounds that it failed to meet the Daubert criteria. As for the plaintiff's motion to exclude certain defense expert testimony it was denied. In Blake's discussion of cell phone safety in her October Memorandum there is an unquestioned acceptance of the thermal effects only paradigm, expressed in units of specific absorption rate (SAR), as being the established criteria to establish safety, provided the SAR limits are not exceeded. According to Blake, "there is a substantial body of literature to consult in order to determine whether the plaintiffs' theory and technique of demonstrating cancer causation has attained acceptance in the scientific community."⁷⁵ By relying on this body of literature, the development of which is examined in Chapter 3, any chance of proving in a court of law that cancer is a consequence of exposure is virtually nil as this literature only considers immediate biological damage from excessive heating as a consequence of microwave exposure. Blake ruled that cancer causation had not gained acceptance in the general scientific community and quoted a number of epidemiological studies, provided by the defendants, that had found no scientific basis for such a contention.⁷⁶ The plaintiff's expert's testimony, particularly that of Lennart Hardell, was deconstructed in exacting detail, including correspondence with various journal editors, and excluded as failing to meet the Daubert standards while, on the other side, the defendant's expert evidence was unquestionably accepted as scientifically valid. Edmond & Mercer argue that Blake's scepticism and depth of forensic investigation into Hardell's research, though appearing to be scientifically unaccountable, is explained by Jasanoff:

Scientific peer review is likely to differ markedly in its objectives and impact from review carried out by an expert in a litigation context. In legal review, the goal is neither to make good work better nor to retrieve what might be of value

⁷⁴ L. Slesin, 'Cell Phone-Brain Tumor Lawsuit Hangs on a Single Swedish Study', *Microwave News*, vol. 22, no. 2, Mar./Apr. 2002.

⁷⁵ Memorandum, *Newman v Motorola et al*, Civil No. CCB-00-2609, p. 4-5.

<http://news.findlaw.com/hdocs/docs/cellphone/newmanmotorola93002mem.pdf>, Accessed May 18, 2008

⁷⁶ *ibid.*

from work of lesser significance. It is instead, to seek to aggressively as possible discredit the proffered evidence and to deploy in the process all the sceptical resources that experts specifically engage for this purpose can muster.

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Edmond & Mercer conclude about the Newman v Motorola case that “Blake’s critiques ...demonstrate the way post-Daubert visions of science, coupled with a tough gatekeeping ethos, can be used to restrict the entry of (novel) scientific claims” and that: “While simplistic images of the sciences are *de rigueur* in legal formulations and contexts (exemplified by Daubert), “real world” science is considerably more complex”.⁷⁸

In a subsequent appeal against Blake’s ruling Circuit Judges Widener, Michael and Shedd reaffirmed Blake’s dismissal of Newman’s expert evidence.⁷⁹ Although the Supreme Court’s original 1993 Daubert appeal ruling was an effort to lessen the backlog of toxic tort cases by eliminating ones that were clearly not based on science, and to give the courts a reflexive standard for admissibility of expert evidence, subsequent court Daubert rulings have tended to support a politically conservative agenda. By vesting this power in judges who would rarely have the training to understand the nature of scientific uncertainty, or recognize hidden assumptions or biases in scientific data, especially in the defendant’s expert evidence, judges have relied on their own interpretation of the Daubert standards. As a result, judges have tended to insist on a high level of scientific certainty that was virtually impossible to provide before a plaintiff’s expert can present his or her evidence before a jury.⁸⁰ Ronald Melnick, from the NIEHS/NTP Program, points out that in the situation, where there are no clear guidelines on how to objectively judge scientific validity, judges can revert to making decisions based on their own

⁷⁷ Edmond, Mercer, 2004, op.cit., p. 241, Quoting from Jasanoff S, Research Subpoenas and the Sociology of Knowledge, *Law & Contemporary Problems*, vol. 59, 1996, pp. 95-118.

⁷⁸ Edmond, Mercer, 2004, op.cit., p. 242.

⁷⁹ United States Court of Appeals for the Fourth Circuit, No. 02-2424, Decided Oct. 22, 2003, <http://pacer.ca4.uscourts.gov/opinion/pdf/022424.U.pdf>, (unpublished appeal), Accessed May 18, 2008.

⁸⁰ D. Michaels, C. Monforton, ‘Manufacturing Uncertainty: Contested Science and the Protection of the Public’s Health and Environment’, *American Journal of Public Health*, Supplement 1, vol. 95, 2005, pp. S39-S48.

values, and preconceived viewpoints. This can lead to the rejection of evidence vital to a plaintiff's case and allow defendants to push for the exclusion of incriminating evidence.⁸¹ This is of concern considering that in the selection of Supreme Court Judges, ideological and administration policy considerations have consistently been found to be significant factors in conservative presidential appointments to the Supreme Court.⁸²

According to Dr. George Lakoff at the University of California, Berkeley, the Daubert ruling acts as a "strategic initiative" that brings American conservative politics into the U.S. courts. Daubert opens up the possibility of conservative federal court judges being able to apply a conservative agenda to court decisions, especially where those decisions involve large corporations in product liability and toxic tort litigations. Federal judges now have the power to exclude plaintiff's expert testimony and summarily rule in favour of the corporate defendant without the case ever going to a jury. Such a ruling would be in line with the conservative agenda that tends to favour corporate interests in preference to the public interest in order to protect the economy.⁸³ This goes against the very concept of the right to a trial by jury of one's peers and can be compared to the concept of the historical British "Star Chamber" court where cases were heard without the right of jury trial, and in many cases, judgements made support the policy of the government of the day. In addition, Daubert puts science itself on trial by creating a situation whereby a scientifically incompetent judge can declare a scientist's testimony (almost always for the plaintiff), or a methodology, as being scientifically incompetent and thereby bring into question the competency of the scientist or method. This works in favour of defending corporations because, according to Margaret Berger, from the Brooklyn Law School, when a judge excludes a scientist as an expert witness this can include some cutting remarks in print, such as referring to "junk science". According to Berger this can discourage scientists from becoming involved in legal cases altogether.⁸⁴

⁸¹ Melnick 2005.

⁸² L.J. Barker (Editor), *New Perspectives in American Politics*, Transaction Books, 1989, p. 116.

⁸³ G.P. Lakoff, 'A Cognitive Scientist Looks at Daubert', *American Journal of Public Health*, Supplement 1, vol. 95, 2005, pp. S114-S120.

⁸⁴ Berger, 2005.

Edmond & Mercer see a convergence in judicial and corporate ideologies in relation to the exclusionary orientation of the Daubert standards with a number of conservative “think tanks” working on behalf of polluting corporations claiming responsibility for its inclusion.⁸⁵ What the Daubert ruling fostered was a new industry for corporate think tanks in preparing *amicus curie* briefs to the courts in Daubert hearings. These papers support the corporate defendant’s claims without the claimant’s lawyers being able to challenge their scientific validity before the court.

Sheldon Krimsky, researcher into linkages between science/technology, ethics/values and public policy, sees the general interpretation of the Daubert decision as being in fundamental conflict with the concept of using the “weight of evidence” as is increasingly being used in regulatory decisions.⁸⁶ The general approach in Daubert rulings is to critique the plaintiff’s science as individual studies in isolation from the rest of the body of submitted evidence. As individual studies almost all have weaknesses in methodology, data collection and analysis, these individual weaknesses are then highlighted as a reason to dismiss each study individually and therefore weaken the plaintiff’s science. Under Daubert, the judge does not have to subject his ruling to an independent evaluation. His or her opinion, even if it is in obvious error, is the final say in whether or not the case proceeds.

In contrast, use of the term “weight of evidence”(WOE), although it has a wide range of definitions depending upon its application, when applied to the risk assessment of environmental risks to health broadly means that all of the available evidence should be evaluated and not just a subset of the evidence. The WOE approach is usually applied when no individual study or other body of evidence (e.g., animal studies, epidemiological, *in-vitro*, etc.) is sufficient enough to

⁸⁵ Edmond, Mercer, 2004.

⁸⁶ S. Krimsky, ‘The Weight of Scientific Evidence in Policy and Law’, *American Journal of Public Health*, Supplement 1, vol. 95, 2005, pp. S129--S136.

demonstrate a cause-effect relationship on its own.⁸⁷ The WOE approach, by aggregating or weighing up the results from that diverse body of evidence, arrives at an estimation of harm. Suter, in his book *Ecological Risk Assessment* defines the WOE approach as one where “the separate lines of evidence must be evaluated, organized in some coherent fashion, and explained to the risk manager so that a weight of evidence evaluation can be made”.⁸⁸ Krimsky sees a danger in the *Daubert* ruling being used as an excuse for disbarring WOE analysis in risk assessment and preventing jurors from learning about the limitations of science as applied to litigation.⁸⁹ Michaels and Monforton came to the same conclusion that both *Daubert* and the *Data Quality Act* (examined later in this chapter) “are structured to force the piece-by-piece examination of scientific evidence, in contrast to the weight-of-the-evidence approach used by most scientists in reaching conclusions in the face of uncertainty.”⁹⁰ As peer review is an essential step in the accumulation of published scientific data that goes into the establishment of the weight-of-evidence approach both *Daubert* and the *Data Quality Act* are essentially the antithesis of peer review.

Thomas McGarity from the University of Texas School of Law describes the *Daubert* ruling as a “profoundly bad idea”. According to McGarity, attorneys who have successfully used the *Daubert* ruling to get their clients (polluting companies) out of having to account for the harm that their products and by-products have caused are now urging the federal courts to apply *Daubert* to all regulatory agencies. McGarity quotes one corporate attorney who stated this was necessary to “promote the full disclosure of all of the Agency’s underlying principles, assumptions, and facts and obligate the Agency to come completely clean on the foundation for its scientific decision”.⁹¹ If this came to be the case for federal regulations to protect the public health from polluting corporations the WOE approach would no longer apply and agencies would have to apply strict scientific

⁸⁷ Krimsky, 2005.

⁸⁸ G.W. Suter, *Ecological Risk Assessment*, Lewis Publishing Co. 1993. P. 86. As referenced in Krimsky, 2005.

⁸⁹ Krimsky, 2005.

⁹⁰ Michaels & Monforton, 2005.

⁹¹ T.O. McGarity, ‘*Daubert and the Proper Role for the Courts in Health, Safety, and Environmental Regulation*’, *American Journal of Public Health*, Supplement 1, vol. 95, 2005, pp. S92—S98.

validity for each piece of evidence they used in regulatory determinations. Corporate attorneys would then be able attack each piece of evidence in isolation for any perceived weakness. Instead of a WOE approach, each piece of evidence would be deemed simply “admissible” or “inadmissible” depending on the whim of the court judges. This would effectively tie up regulatory agencies in trying to meet Daubert criteria for every piece of scientific evidence they depend upon to enact regulation. According to McGarity the end result would be an overall reduction in health, safety and environmental regulations. He sees the situation as one where corporate regulatory “reformers” (or revisionists) are attempting to gain regulatory relief for industry through the courts by gaining more power for judges that they perceive are sympathetic to conservative goals to reign in regulatory agencies.⁹² In order to ‘aid’ these conservative judges Lakoff mentions a “cottage industry” that has been created specifically to train corporate lawyers in how to attack plaintiff’s scientists and their evidence in *Daubert* hearings.⁹³ An example of how such an ‘industry’ functions is given by McGarity in relation to the tobacco industry’s challenge to the EPA’s risk assessment of environmental tobacco smoke (ETS). To quote:

From the moment that the tobacco industry learned that an epidemiological study suggesting an association between exposure to ETS and lung cancer would soon be published in a scientific journal, the industry and its lawyers launched an all-out crusade to discredit that study and subsequent studies. Industry consultants were hired to flood the scientific journals with letters critiquing the study. Public relations consultants filled the media with attacks on the studies and statements from industry-funded scientists that the question of the health risks of ETS was still very much up in the air. Industry lawyers and sympathetic politicians attempted to determine the composition of the agency’s advisory committee with a flood of industry-funded comments and criticisms of the agency’s early drafts. All this was undertaken with the expectation that the agency would ultimately back off and write more

⁹² McGarity, 2005.

⁹³ Lakoff, 2005, op.cit., p. S118.

equivocal document, but it was also done with an eye toward litigation that would follow if the agency did not retreat.⁹⁴

OMB peer review

As stated at the beginning of this chapter a fundamental goal of peer review in the regulatory context is to build up a reliable scientific body of literature necessary for basing regulatory policy on. As seen in the following section, however, economically based political actions instigated in the 1990s and 2000s by the U.S. federal administration have had the purposeful effect of placing a very restrictive peer review process on federal agencies. The overall result of this policy, enacted through the Office of Management and Budget (OMB) under the control of OMB Administrator John D. Graham, (whose philosophy on risk is examined in Chapter 1), is to create a revisionist 'peer review' process to block the accumulation of a scientific literature base inimical to American industrial interests.

The 1990's saw an increasing expansion in the requirements for peer review with numerous governmental acts and proposed congressional bills that required agencies to conduct program and performance peer assessments to justify and evaluate their performance. A number of bills required agencies to use peer review cost-benefit and risk analysis of major rules and to require peer review of all regulations supported by scientific data. There was also a provision to peer review all data used in standards promulgated by the Occupational Safety and Health Administration.⁹⁵ These rules and bills served not only to increase peer review requirements but to complicate the peer review process with an increasingly complex web of risk analysis and assessment requirements. This made passing of effective environmental legislation more difficult by tying up agency time and resources defending their decisions, to the benefit of those to be regulated. Many of these rules were quietly inserted into federal appropriations bills with no debate by congressmen on behalf of industry lobbyists with an interest in delaying or

⁹⁴ McGarity, 2005, op.cit., p. S97.

⁹⁵ Hackett, Chubin, 2003.

blocking regulatory processes.⁹⁶ An example is the Shelby Amendment that consisted of a two-sentence amendment inserted without debate in the 1999 financial year federal appropriations bills. The amendment, written by industry lobbyist Jim Tozzi⁹⁷ and introduced by Republican Senator Richard Shelby, directed OMB to revise OMB Circular A-110 which dealt with grants to non-profit organizations, to allow public access to federally funded research data through Freedom of Information Act (FOIA) requests. The amendment, however, only applied to research funded by the federal government, not private contractors.⁹⁸ This would give industry access to all federally funded regulatory science while at the same time exempting industry funded research. Apparently many of parties that expressed support for the amendment understood it to be a tool to challenge federal regulations, especially for environmental and workplace protections.⁹⁹ The Shelby amendment came under much criticism and was debated in a U.S. House of Representatives committee on July 15, 1999 with another bill by Rep. George Brown that if passed, would have repealed the Shelby amendment.¹⁰⁰ Due to extensive opposition to provisions in the Shelby Act with slightly over 4,000 public submissions opposing the proposed changes, in October 1999, OMB issued a revision to Circular A-110 that addressed many of the concerns about confidentiality, the cost of compliance, and the meaning of 'data' in the Act.¹⁰¹ The National Academy of Sciences, however, while complimenting OMB on the improvements in the revision, still expressed concern that there were still too many uncertainties about how the revision would be applied and how it would impact

⁹⁶ OMB Watch, 'Background on Data Quality Guidelines', May 28, 2002.

<http://www.ombwatch.org/node/645>, Accessed Mar. 24, 2008.

⁹⁷ C. Mooney, 'Paralysis by Analysis-Jim Tozzi's regulation to end all regulation', *Washington Monthly*, May 2004.

⁹⁸ M. Madia, 'The Data Quality Act', OMB Watch, Oct. 5, 2007,

<http://www.ombwatch.org/article/archive/231?TopicID=2> Accessed Mar. 22, 2008.

⁹⁹ OMB Watch, 'Analysis of the Draft of the Second OMB Proposal', July 15, 1999,

<http://www.ombwatch.org/npadv/1999/a110draft2.html>, Accessed Mar. 22, 2008.

¹⁰⁰ House Committee on Government Reform, Subcommittee on Government Management, Information, and Technology, Legislative Hearing on H.R. 88, regarding Data Available Under the FOIA, Committee on Government Reform, July 15, 1999, http://www.agiweb.org/gap/legis106/foia_hearings.html, Assessed Mar. 22, 2008.

¹⁰¹ AAAS Policy Brief: Access to Data, Center for Science, Technology and Congress, Feb. 10, 2005,

<http://www.aaas.org/spp/cstc/briefs/accesstodata/index.shtml>, Accessed Mar. 22, 2008.

on administrative costs.¹⁰² Building from the foundations laid down by the 1999 Shelby Amendment new 'Data Quality Guidelines' guidelines for OMB were inserted in Section 515 of a 2001 Treasury and General Government Appropriations Act in the last minute by Rep. Jo Ann Emerson with no debate. With both the Shelby amendment and the Data Quality Guidelines the same tactic was used to circumvent democratic debate in Congress by quietly inserting them in other legislation at the 11th hour when there was no time to debate the merits or otherwise, of the bills. The 2001 bill directed OMB to issue, by September 30, 2001. "policy and procedural guidance to Federal agencies" that were subject to the Congressional Paperwork Reduction Act (44 U.S.C. chapter 35).¹⁰³¹⁰⁴

Specifically the Data Quality Guidelines (Act)¹⁰⁵ required federal agencies to:

- "Adopt a high standard of quality (as defined by OMB) by ensuring the "objectivity", "utility" and "integrity" of all information they disseminate". This provision ensures that no federal agency information is released to the public before it has been approved by OMB.
- "Establish administrative mechanisms to allow for challenges from "affected persons" and implement an appeals process to allow anyone disagreeing with an agency's decision to mount a data quality challenge to "file for reconsideration within the agency" (public correction mechanisms for inadequate data)." These provisions gave regulated industries a mechanism to challenge or block any regulatory science that it considered inimical to its interests.
- "Submit draft guidelines to OMB by July 1, 2002 with a report on how the agency will achieve OMB's data quality guidelines. Agencies are to report to

¹⁰² Letter to OMB by Academy President Bruce Alberts on OMB Circular A-110 Revision, 1999, http://www7.nationalacademies.org/ocga/Other/Bruce_Alberts_Letter.asp, Accessed Mar. 22, 2008.

¹⁰³ OMB Watch, 2002.

¹⁰⁴ AAAS Policy Brief, 2005.

¹⁰⁵ OMB, Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies, Oct. 1, 2001, http://www.whitehouse.gov/omb/fedreg/final_information_quality_guidelines.html, Accessed Mar. 25, 2008.

OMB annually on how many complaints they had received and how they were resolved.”

This essentially gave agencies notice that they will be closely monitored by OMB for their performance as judged by OMB standards.

These guidelines did not apply to contractors or industry science, only information generated by federal agencies. As for a process of peer review to ensure objectivity OMB stated that “objectivity involves a focus on ensuring accurate, reliable, and unbiased information,” which can be achieved “using sound statistical and research methods”. OMB considered that “independent external peer review” might generally be presumed to be of acceptable objectivity”. However OMB considered that peer review might not be deemed to be objective if a “persuasive” showing is made to the contrary.¹⁰⁶

For an industry facing regulation of its activities because of an agency’s peer reviewed body of findings indicating a health hazard, such a provision would encourage the creation of industry funded research to create the science necessary to challenge the agency’s peer reviewed data. This provision sets OMB as final judge and jury over all agency peer review research. The Data Quality Act does not require a balanced representation of viewpoints on peer review panels but does stipulate the selection process to be “primarily on the basis of necessary technical expertise”.¹⁰⁷ As seen in RF standard setting this is also the general rule for expert committees and inevitably creates a significant level of conflict of interest as technical experts are usually employed in the regulated industry and will tend to support the industry’s interests.

Using the Data Quality Act to block science

In 2003 the European Union declared atrazine an endocrine disrupter and withdrew regulatory approval for the widely used herbicide, manufactured by Syngenta Crop Protection, due to groundwater contamination and research finding it was disrupting hormones in wildlife -- in some cases turning frogs into bizarre

¹⁰⁶OMB Watch, 2002.

¹⁰⁷ *ibid.*

creatures bearing both male and female sex organs. The chemical was the most used herbicide in the U.S., where more than 60 million pounds were being applied annually on corn, sorghum, sugarcane, Christmas trees, woodlands and golf courses.¹⁰⁸

According to a *Washington Post* investigation, after the EU withdrew its approval for atrazine, Syngenta hired a risk assessment service EcoRisk Inc. of Washington to arrange experiments on atrazine's biological impacts. These tests, conducted by Tyrone Hayes at the University of California at Berkeley, confirmed the herbicide was a hormone disrupter with frogs – down to just 0.1 parts per billion, 1/30th of the level allowed in US drinking water. Repeated studies by Hayes replicated the findings. Syngenta, being the organization paying for (and owning) the research, refused Hayes' request to publish his findings. Hayes then quit EcoRisk, expanded and repeated his testing of atrazine on frogs. His findings again found deformities in atrazine-exposed frogs. His paper was peer reviewed and published in *Nature* in 2002 and the *Proceedings of the National Academy of Sciences* in 2003. EcoRisk then paid other researchers to conduct research that did not find the results published by Hayes. These studies were later discredited by a special EPA science panel. Yet, despite these findings, and the fact that its own seasonal water quality risk estimates were above "acceptable" levels, U.S. EPA re-approved the registration of atrazine in January, 2003. It also mandated a program of weekly water quality monitoring to be conducted seasonally by Syngenta in areas of high atrazine use. The reason for this approval was because of a single sentence that was added to the EPA's final scientific assessment in 2002 that stated "Hormone disruption cannot be considered a "legitimate regulatory endpoint at this time" -- that is, it is not an acceptable reason to restrict a chemical's use -- because the government had not settled on an officially accepted test for measuring such disruption."¹⁰⁹ Those words, which effectively rendered irrelevant a large body of scientific evidence, including peer-reviewed research, were adopted by the EPA as a result of a petition filed by EcoRisk on behalf of Syngenta. The petition was filed under the

¹⁰⁸ Organic Consumers Association, 'EU Bans Toxic Atrazine Herbicide Still Widely Used in US Corn Belt', Oct. 24, 2003, <http://www.organicconsumers.org/foodsafety/atrazine102703.cfm>, Accessed Mar. 18, 2008.

¹⁰⁹ R. Weiss, 'Data Quality' Law Is Nemesis Of Regulation', *The Washington Post*, Aug. 15, 2000, <http://www.washingtonpost.com/ac2/wp-dyn/A3733-2004Aug15?>, Accessed Mar. 18, 2008.

Data Quality Act on the grounds that, while the EPA has certain guideline tests that can automatically trigger regulation, the EPA had no designated tests that would serve as a “gold standard” of proof of hormone disruption in frogs. In effect the DQA had the effect of blocking the EPA’s ability to express anything that it couldn’t back up with extensive data. The *Washington Post* analysis of government records found that in the first 20 months since the act was fully implemented, it has been used predominantly by industry. Setting aside the many Data Quality Act petitions filed to correct narrow typographical or factual errors in government publications or Web sites, the analysis found 39 petitions with potentially broad economic, policy or regulatory impact. Of those, 32 were filed by regulated industries, business or trade organizations or their lobbyists. Seven were filed by environmental or citizen groups. Some environmental groups are boycotting the act, adding to the imbalance in its use. Of the 39 Data Quality Act petitions included in the *Washington Post* analysis, five have resulted in at least some of the changes sought – all of them filed by industry interests. Five were denied, five were diverted by the agencies to other bureaucratic avenues and 24 were pending as of August 2004. As an example of what the DQA was designed to be used for, one needs to go no further than the petition filed by the DQA author Jim Tozzi in June of 2004, representing the Kansas Corn Growers Association and the Triazine Network a coalition set up in 1995 to defend atrazine and related herbicides. This petition was aimed at the National Toxicology Program which is part of the National Institutes of Health that reviews chemicals to see if they cause cancer. The program had announced in the Federal Register that atrazine was among a long list of chemicals that it was considering for examination. In his petition, Tozzi relied on a few sentences from the program’s description of its chemical review procedures to claim that those sentences contained discrepancies that violated the Data Quality Act. Therefore, he wrote, the program should be barred from reviewing the cancer-causing potential of any chemicals. In particular the petition mentioned atrazine.¹¹⁰ What is apparent is that the manufacturer of atrazine, working through its private consultants, effectively used the DQA to block, or at

¹¹⁰ *ibid.*

least delay, the EPA's ability to regulate the herbicide despite clear evidence of a major public health hazard.

Jim Tozzi's company the Competitive Enterprise Institute (CRE) circulated letters to the American Association of University Professors and a number of universities warning them that academic research that is used or disseminated by a federal agency that is found to be afflicted with "significant omissions, inaccuracies, and manifest biases" will be subject to DQA complaints and so universities need to update their policies to comply with DQA requirements. There was also a CRE suggestion that DQA challenges against research will ultimately lead to a cut off in funding.¹¹¹ Besides the threat of funding cuts, Michaels considered the Data Quality Act as a tactic to silence agencies over potential hazards to the public. According to Michaels:

The new peer review process sounds to me like a recipe for silent government. With all these checks and balances...if I were an agency head I'd think twice about putting out any information unless I absolutely had to. And this is precisely the goal of the OMB effort: To silence agencies that protect the health, safety and environment of the public.¹¹²

On September 15, 2003 OMB published the *Proposed Bulletin on Peer Review and Information Quality* that detailed new requirements for federal agencies' use of peer review for all regulatory decisions. The document stated that "important scientific information shall be peer reviewed by qualified specialists before it is disseminated by federal government agencies in order to enhance the quality and credibility of the government's scientific information". As well as implying that problems existed with the previous systems employed by federal agencies the 2003 proposed Act stated that government scientists or scientists that had previously done work

¹¹¹ S. Shapiro, R. Steiner, 'Recent Developments that Threaten the Freedom and Integrity of Academic Research', The Centre for Progressive Regulation, http://www.progressiveregulation.org/articles/Sound_Science_Overview.pdf, Accessed Mar. 18, 2008.

¹¹² D. Michaels (statement) Integrity in Science Plenary Debate, The Data Quality Act and OMB Peer Review-Honest Evaluations or New Tools for Manufacturing Doubt and Delay? http://cspinet.org/integrity/cf_plenarydebate.html, Accessed may 18, 2009.

for government agencies had a conflict of interest and therefore couldn't participate on peer review committees.¹¹³ This restriction included university scientists who had ever received government research funding. No such restrictions, however, applied to industry employed scientists. This provision, which OMB called a "formal, independent, external" peer review process essentially gave the peer review process for regulatory decisions over to the scientific sector that was left - scientists who were employed by affected industries. Dr. Anthony Robbins, professor of Public Health at Tufts University School Of Medicine publicly stated about the OMB proposal:

For those of us who have worked in government for most of our scientific lives and who did so to serve the people, it is particularly distressing to learn that the Bush administration sees us a threat to America.¹¹⁴

In its comments to OMB/OIRA on the proposed peer review Bulletin, the National Petrochemical & Refiners Association (NPRA), representing the US petroleum industry, supported both the OMB Bulletin and the Data Quality Guidelines and recommended the Bulletin should be an integral part of the Data Quality Guidelines to ensure a further tightening of peer review requirements on all federal agencies. NPRA stated that EPA and other agencies' regulatory determinations had a sufficient impact upon the industry's business activities and therefore they had a "direct interest in ensuring that peer reviews are conducted to ensure that the technical information underpinning regulatory policies meets the Data Quality Standards". NPRA also recommended the addition of a requirement that journal peer review only be considered "adequate" for 'data quality' if the journals provided the agency with "sufficient documentation of the reviewers' qualifications and the merits of the review".¹¹⁵ Besides NPRA's restrictive requirement that journals would have to provide a justification for why they were publishing particular papers, identifying peer reviewers would give the affected industry the opportunity to directly attack reviewers (whose identities are

¹¹³ Federal Register, 'Office of Management and Budget', vol. 68, no. 178, Sept. 15, 2003, <http://www.whitehouse.gov/omb/fedreg/030915.pdf>, Accessed Mar. 21, 2008.

¹¹⁴ A. Robbins, 'Science for special interests', *The Boston Globe*, July 12, 2003.

¹¹⁵ L. Swett, 'NPRA comments to OMB's Proposed Bulletin on Peer review and Information Quality', Dec. 15, 2003. <http://www.whitehouse.gov/omb/inforeg/2003iq/111.pdf>, Accessed Mar. 24, 2008.

normally kept confidential) papers the industry considered inimical to its interests. This would serve to make it difficult for journals to find peer reviewers in areas of contention because identification of the reviewers could expose them to attacks on their credibility by adversely affected parties.

David Michaels pointed out the outrageous situation in the proposed bulletin that would ban a university scientist who had received National Institutes of Health (NIH) funding from serving on federal advisory committees but not a scientist receiving funding from a company directly impacted by the regulation. Among other things Michaels also expressed his concerns over OMB's Office of Information and Regulatory Affairs (OIRA) attempting to define itself as the final arbitrator on what it considers as good science when it is not a science agency. Michaels' concluding remarks were to ask John Graham to withdraw the proposed bulletin "in the interest of protecting our system of protecting the public's health and environment".¹¹⁶

Shelia Jasanoff, Pforzheimer Professor of Science and Technology Studies at Harvard University's John F. Kennedy School of Government, emphasised in her submission to OMB the negative impacts of the proposed peer review Bulletin. She pointed out the far reaching impacts its provisions would have right across the federal agencies by inappropriately imposing a uniform, standardized approach to peer review that would impart a substantial adverse impact on policy development at the cost of protecting public health, safety and the environment. She considered the Bulletin a reflection of OMB's institutional and administrative approach to its primary responsibility for economic efficiency which was at odds with the needs of scientific and public policy which called for a more flexible and discretionary approach. Jasanoff identified a number of flaws in the Bulletin, some of which are summarized here:

¹¹⁶ Michaels, 2003.

- Although the bulletin is concerned about the possibility of reviewer bias in relation to financial ties to regulatory agencies it does not address the possibility of reviewer's financial ties to particular industry interests.
- Unlike pure or 'normal' research science which is produced under "trusting research environments" with generally agreed upon methodologies based on an accumulated knowledge base, regulatory science is emergent and has to deal with significant uncertainties. Regulatory science has to work with a very limited knowledge base (such as on untested chemicals) and rely upon contested methodologies to make precautionary determinations to protect public health. Additionally it can be politically sensitive and be conducted in "highly sceptical environments" in which reviewers can have firm predetermined points of view and are prone to attack contrary results rather than giving constructive criticisms.

In attempting to impose a rigid OMB-supervised peer review process (a one-size fits all) approach to the complexities of regulatory peer review Jasanoff concluded that the proposed Bulletin failed "to meet basic standards of scholarly accountability".¹¹⁷ In 1990 Jasanoff in *The Fifth Branch: Science Advisors as Policymakers*, deconstructed the argument that importing peer review into the regulatory process somehow improves that process. Her analysis of the empirical literature on peer review suggests peer review's ability to objectively sort out 'acceptable' science from the 'unacceptable' is very much in doubt. Jasanoff gives numerous examples of how faulty peer reviews have given temporary credibility to industry research that later was found to contain major methodological problems and outright fraudulent data. Evidence also indicates that scientific claims may be accepted all too easily when the author is of high standing in the research community or affiliated with an elite institution.¹¹⁸ The objectivity of the process is also brought into question when the program managers and journal editors who select peer review panels are also in a position to wield an influence on the outcomes of peer review simply by the selection of the reviewers where

¹¹⁷ S. Jasanoff, Comment on Office of Management and Budget (OMB) Proposed Bulletin on Peer review and Information Quality, Dec.16, 2003, <http://www.whitehouse.gov/omb/inforeg/2003iq/159.pdf>, Accessed Mar. 21, 2008.

¹¹⁸ Jasanoff, 1990, op.cit., p. 73.

they may already know how a reviewer will comment on a proposal beforehand. Jasanoff sees peer review more of a situation where standards for deciding what is acceptable are matters of negotiation and compromise, and that peer review is simply part of the process by which scientists certify some claims and conventions as valid.¹¹⁹ This is a far more flexible concept than that expressed in the OMB's bulletin that presents peer review as an unproblematic process that can be applied to all forms of science, as a kind of "audit mechanism for regulatory science that can be applied to both pure research science and regulatory science".¹²⁰

As a result of the high level of opposition from within the scientific and academic community to OMB's peer review Bulletin, on April 15, 2004 OMB released a revised Bulletin on Peer Review that addressed a number of concerns with a number of changes, including (to quote:)

- provides more discretion to federal agencies in determining what type of peer review guidance is needed;
- provides exemptions for time-sensitive medical, public health and safety information and other compelling circumstances;
- indicates that the guidance does not create any new rights for litigation against federal agencies;
- defines a more transparent process for public participation in peer review planning;
- and requires the most rigorous form of peer review only for highly influential scientific assessments.¹²¹

Michaels saw a victory for the American scientific community as OMB significantly modified the Bulletin, especially the change in the conflict-of-interest provisions which now allowed scientists who have ever received agency funding to participate on peer review panels. In addition OMB deferred to the National Academy of Sciences (NAS) in a number of areas. NAS panel reports were not

¹¹⁹ Jasanoff, 1990.

¹²⁰ Jasanoff, 2003.

¹²¹ OMB, 'OMB Releases Revised Bulletin on Peer review: Seeks Additional Public Comment', Apr. 15, 2004, http://thefdp.org/OMB_2004_08.pdf, Accessed Mar. 21, 2008.

required to undergo further peer review and OMB now required agencies to adopt the NAS policy on conflict of interest with the selection of non-government members of peer review committees. Previously OMB was silent on this issue. However, according to Michaels the new Bulletin provisions still appeared to be part of an OMB strategy (manufacturing uncertainty) to enable industry to delay regulation and avoid litigation. Michaels wrote: "It seems likely that the newly implemented peer review requirements, while less onerous than those originally proposed, will provide new and convenient opportunities for special interests to promote an anti-regulatory agenda".¹²² This agenda, orchestrated by OMB/OIRA under Graham, is made transparent in his 2003 OIRA report "*Reining in the Regulatory State: The Smart-regulation Agenda*".¹²³

According to the OIRA report, smarter regulation could be accomplished by launching three initiatives: more openness in deliberations, better regulatory analysis and higher quality technical information for use by regulators. OIRA saw its role as establishing more rigorous standards for what it expected from agencies in the way of analysis, in the areas of cost-effectiveness analysis, formal probability analysis, and careful consideration of quantitative and intangible values. OIRA would also help agencies develop peer-review procedures for technical information, thereby better assuring quality before release. Also planned were "formal correction mechanisms" that the public [and industry] could use to fix poor quality information that has been placed on agency web sites or written into rulemaking documents. OIRA saw information policy as another form of regulation that needed greater quality control through checks and balances.¹²⁴ The results of these initiatives, according to Graham, was a considerable reduction in new regulation under the G.W. Bush administration, from \$8.5 billion under Bush Senior's term and \$5.7 billion under Bill Clinton's two terms to under \$1.0 billion annually under G.W. Bush. Graham stated that "we have slowed the flow of costly

¹²² R. Steinzor R. (ed.), *Rescuing Science from Politics: Regulation and the Distortion of Scientific Research*, Cambridge University Press, 2006, p. 236-237.

¹²³ J. Graham, 'Reigning in the Regulatory State: The Smart-Regulation Agenda', CATO Institute, 3, 2003, <http://www.whitehouse.gov/omb/inforeg/speeches/031003graham.pdf>, Accessed Mar. 18, 2008.

¹²⁴ This introduces a rather Orwellian concept of "Newspeak" where "poor quality information" can be stripped out of previous written documents if it is in agreement with current administration policies. Who decides what poor quality information is?

rules without slowing the flow of inexpensive rules". The report also included a wish list for renovating the sea of 36,219 existing regulations passed since 1981 by OMB. and identified promising opportunities for deregulation. The two pieces of OMB legislation designed to 'rein in the regulatory state' were above mentioned "*Data Quality Act*" that took effect in November of 2002, and the "*Information Quality Bulletin for Peer Review*" that was amended and republished as a final draft in December 15, 2004. In "*Reining in the Regulatory State: The Smart-Regulation Agenda*" it was mentioned that the sea of existing federal regulations needs to be "renovated" and the need to identify "promising opportunities for deregulation" as less regulation promises better quality services and lower prices. Graham mentioned that thought must be given to how regulators, OMB and Congress should modernize the huge existing stock of regulations.¹²⁵

In the 2,000 page spending plan that G.W. Bush submitted to Congress in 2005 that outlines funding to the various federal agencies for their many programs was inserted a single paragraph that gave unprecedented power to the president and the OMB to eliminate programs and regulations that failed to meet their expectations. This proposal set out a process whereby all federal government agency programs/regulations would automatically expire at the end of a set period of time unless Congress affirmatively voted to retain them.¹²⁶ In order for Congress to gauge whether or not to keep a program, the president would appoint an eight-member panel called the "Sunset Commission" to conduct reviews of the program's effectiveness and its advice would be the basis for Congress's decision. Such a panel could rightly be considered a super-peer review panel with power over all other agency expert panels. Other "Results Commissions" were planned be established to consolidate programs that cross-departmental or congressional committee jurisdictional lines to improve performance and increase efficiency. Results Commissions, would have been made up of experts in relevant fields, and would be established as needed to review consolidation proposals. The Congress

¹²⁵ Graham, 2003.

¹²⁶ OMB Watch, 'Budget Includes Anti-regulatory Proposals', Feb. 7, 2005, <http://www.ombwatch.org/node/2263>, Accessed Mar. 18, 2008.

would then consider the Commission's recommendation through expedited review authority.¹²⁷

The predictable results of the numerous OMB instigated changes to regulatory policy, such as the Data Quality Guidelines, have had the effect of dramatically reducing the introduction of new regulations to protect human health. For example, since 2001 FDA new rulemaking has decreased by 50% from the previous two administrations, EPA by 57% and the Food Safety and Inspection Service (FSIS) by approximately 75%.¹²⁸ To add still more complexity to the regulatory process OMB has taken control over the EPA's Integrated Risk Information System (IRIS) for evaluating the human health hazards for chemical substances. Under the new system, announced on April 10, 2008, OMB will be involved in all stages of the IRIS risk assessment process, including a new requirement that allows OMB to alter the agency's risk assessment even after it has undergone external peer review. Another change gave the Department of Defense (DoD) the right to intervene in the IRIS process to block the regulation of chemicals it uses in its military operations.¹²⁹ An important issue with the many changes proposed and made by OMB was that the legislative changes had the effect of inhibiting the further accumulation of a scientific data base that was necessary to base effective regulation on. Without a reliable data base uncertainty would remain as a reason not to regulate, as Michaels & Monforton pointed out in *Manufacturing Uncertainty: Contested Science and the Protection of the Public's Health and Environment*.¹³⁰ If placing road-blocks to prevent the accumulation of new scientific knowledge were not enough, OMB also attempted to eliminate the existing collection of data, relevant to regulation of polluting industries. This was seen in OMB's cutting back on funding for the EPA's National Library Network, the largest and most extensive environmental library in America. Even though a cost benefit analysis found far more savings to EPA than costs from the running of the library network, OMB cut

¹²⁷ *ibid.*

¹²⁸ M. Madia, 'Public Protection Standards Have Dropped under Bush', OMB Watch, Mar. 31, 2008. <http://www.ombwatch.org/node/8743>, Accessed May 18, 2008.

¹²⁹ M. Madia, 'White House Gains Influence in Toxic Chemical Assessments', OMB Watch, Apr. 15, 2008. <http://www.ombwatch.org/node/3642>, Accessed May 18, 2008.

¹³⁰ Michaels, Monforton, 2005.

the Library's budget for 2007 from \$2.5 million to just \$500,000 – a massive 80% reduction as a cost saving measure¹³¹. Although EPA stated that it wanted to replace the libraries with digitised information only about 10% of its holdings were suitable for this¹³². The result of this budget cutback was that the Libraries faced closure with the loss of the availability of the extensive scientific data bank for both researchers and the public. However, opposition to the OMB budget cuts from the Congress, the Government Accountability Office (GAO) and a range of public interest groups saw Congress in late 2007 approve \$3 million to restore service at the EPA's technical and research libraries.¹³³ As one of the aims of peer review is the accumulation of a reliable scientific data-base, OMB's machinations can be seen as being against the very purpose of the peer review process and as such, represents a hazard to public health.

Conclusions: Science quality under threat

The corner stone of modern science is the practice of peer review, an evaluation process universally used by the scientific, technological and medical communities to assure the highest level of quality control over research findings, interpretation of those findings, and research proposals. This is achieved through a critical evaluation by a select number of one's peers in the relevant field who weigh up the research findings or proposals against the cumulative knowledge in the field according to their personal expert understandings. Through the peer review process a reliable and scientifically valid literature base is established and built upon which enables (in the context of this thesis) expert advisory committees to evaluate the 'weight-of-evidence' in order to establish reliable exposure standards to protect human health.

¹³¹ American Library Association, 'EPA Libraries', *Social Responsibilities Round Table of the American Library Association*, issue 154-155, June 2006, pp. 12-17.

¹³² M. Churchill, 'EPA Blasted for Library Closings', OMB Watch, Mar. 18, 2008, <http://www.ombwatch.org/node/3640>, Accessed May 21, 2008.

¹³³ N. Oder, 'Congress Backs EPA Funding', *Library Journal*, Feb. 1, 2008, <http://www.libraryjournal.com/article/CA6523463.html>, Accessed Jan. 21, 2009.

The U.S. National Science Foundation (NSF) and the National Institutes of Health (NIH) have given their expert view that peer review is a fair process that identifies and supports the best science. The National Research Council (NRC) identified peer review as the best available process of formalizing scientific judgement and enabling the best decisions on how best to allocate public resources. The Council considered it as an essential part of American science policy and was the preferred method for evaluating the merits of proposals for research funding. Chubin & Hackett (1990) described the peer review process as a “flywheel” that gives stability to research and enables research proposals to be weighed against the cumulative literature and established theory. They mentioned a number of attributes of the process, including it being a source of expert advice for the researcher, an endorsement of a research project, a communication channel to encourage further research and giving review criticisms that can improve the quality of the research, among others.

As with all human endeavours, however, there are differing opinions over how to best conduct peer review, how it can be applied in differing situations, who should be involved in the process, its effectiveness and most importantly, how to address conflicts of interest that may influence expert opinions.

A number of writers mentioned in this chapter have pointed out many of the problems with peer review, including the limited number of suitable qualified reviewers in some fields, some of whom may be competitors. They also mention the possibility of plagiarism by reviewers, reviewers judging research and research proposals against an established body of knowledge, and thereby inhibiting research that runs counter to that understanding. There is a lack of financial reimbursement for peer reviewers’ time, (whereas peer reviewers from industry usually would receive reimbursement from their employers for their time) and a lack of sufficient time for reviewers to properly evaluate research. There can be favouritism for researchers from prestigious institutions over those from less known organizations and delays in publication of results. An important issue is how to address conflicts of interest with review board members which may influence reviewers’ evaluations. Also, a fundamental problem is that peer review

is blind to industry influence. Some of these issues are also specific to RF standard setting as examined in the following Chapters.

Following on from the discussion this far there are five alternatives to the traditional peer review model which are briefly examined in this chapter.

- **Super peer review** evaluates the author based on an assumption that the quality of the research is the product of the quality of the researcher. In addition, preference is given to researchers who have previously published 30 to 50 papers, giving them a track record to preserve. The work must be “new” and a “step-function advance” in knowledge. For less published researchers they need to submit their papers through a senior colleague or journal editor who will be their personal guarantor. Such a system, however, can stifle innovative research that may question existing understandings.
- The **DARPA model** uses a “strong manager” to act as a single peer reviewer over a subordinate’s research or proposal. Thus the opinions of the manager would of necessity affect the outcomes. This is seen in Chapter 3 in relation to the Tri Services Program.
- In the **expert elicitation** model a number of recognized experts in a field are asked to evaluate research findings /proposals. As with the above two previous alternative models, this could tend to perpetuate existing paradigms and inhibit research that questions that understanding.
- The **open peer review** model works in conjunction with the traditional peer review process but invites open comment from other researchers and the public through resources such as the Internet. The final published paper is the result of both the traditional and open peer review models.
- In the **extended peer community** model dialogue is encouraged between all parties concerned, not just those with institutional expertise. Quality is assured through an open and democratic dialogue between all stakeholders, including the concerned public and public interest organizations. These differing approaches to peer review clearly indicate that the process has a strong subjective social context depending on the approximate model followed and the context in which it is used.

A central theme in both Chapter 1 and this Chapter, is to argue that in the U.S. regulatory arena industrial, economic and political interests have worked to revise the methodology of risk assessment, the role of regulatory peer review and the make up of expert advisory committees. This was done specifically to delay or block regulation of industrial activities. These interests are conveniently defined as “revisionists” as mentioned by Adam Finkel in Chapter 1. The hand of the revisionists is seen in the Daubert Supreme Court ruling (appeal) that placed judges in a role of vetting claimant’s science expert’s testimony for conformity with ‘mainstream science’ as they believed it to be. In effect, judges became peer reviewers by reviewing all scientific testimony before the court and deciding on its reliability and relevance for the case before the court. This put federal courts as the final arbiter in matters of complex scientific controversies where specialized knowledge was essential to explore all the issues. This allowed judges, who had little or no scientific training to understand the nature of scientific uncertainty, to arbitrarily dismiss scientific evidence by insisting on a high level of scientific certainty for all submitted evidence. This was done without ever having to defend their decision in an open court with a jury. With many judges coming from the conservative political sector the Daubert ruling has benefited polluting corporations with courts tending to favour corporate interests in preference to the public interest in order to protect the economy.

Another significant impact on U.S. regulatory peer review has been the G.W. Bush administration’s Office of Management and Budget (OMB) under John D. Graham who used his position to install a restrictive (revisionist) risk assessment (Chapter 1) and peer review process that placed onerous requirements on regulatory agencies with the intent of blocking the ability of agencies to build on a scientific literature base inimical to the American industrial sector. This is also seen in OMB’s proposed 2007 budget proposal to cut \$2 million from the EPA National Library Network’s \$2.5 million budget as a cost-benefit measure. This effectively would have closed the libraries if the Congress and the Government Accountability Office (GAO) had not opposed Graham’s OMB proposal. The libraries, the nation’s oldest and biggest environmental library network, serve as

an extensive environmental scientific database and information for EPA researchers, interested organisations and the public. By attempting to close the EPA library network OMB under Graham was acting to thwart the very goals of traditional peer review, the accumulation of a reliable scientific literature base essential for environmental regulation.

Under Graham, OMB instigated a number of legislative changes that served to co-opt regulatory peer review to serve OMB interests. The *Data Quality Guidelines* (Act) gave corporate America a mechanism to challenge or block any regulatory science that it considered inimical to its interests; ensured that no federal agency information would be released to the public unless it was approved by OMB; and established a system to closely monitor agencies for their OMB mandated performance. In addition the Guidelines stated that representation on peer review panels was to be “primarily on the basis of necessary technical expertise”. As technical experts usually are in the employ of industry, such as telecommunications for example, this set up a significant conflict of interest in both peer review and expert advisory committees which is examined the following chapters.

OMB’s 2003 *Proposed Bulletin on Peer Review and Information Quality* laid out detailed new requirements for federal agencies’ use of peer review. It stated that agency research information was to be peer reviewed by ‘qualified specialists’ before being released by the agencies in order to enhance the quality and credibility of the information. OMB called this an independent external peer review process. However “qualified experts” excluded government scientists or any scientist who had previously worked for, or received funding from the government as OMB considered this a conflict of interest. This stipulation essentially gave the regulatory peer review process over to the scientific sector that was left – scientists who were employed by affected industries. David Michaels found it an outrageous situation when a university researcher who had received funding from the NIH was barred from serving on federal advisory committees but not a scientist receiving funding from an industry directly impacted by regulation. Shelia Jasanoff, in her submission to OMB emphasised the far reaching

impacts of the OMB proposal which inappropriately imposed a uniform, standardized approach to regulatory peer review that would result in a substantial adverse impact on policy development at the cost of protecting public health, safety and the environment. As a result of a high level of opposition to the 2003 Proposed Bulletin on Peer Review and Information Quality in April 2004 OMB issued a revised Bulletin that removed the conflict of interest provision that barred scientists who had ever received agency funding from expert panels, gave agencies more discretion in what type of peer review guidance was needed. It deferred to the NAS in a number of areas, gave a number of exemptions and clarified that the guidance would not create new avenues for litigation against agencies. It also defined a more transparent process for public participation and required the most rigorous form of peer review only for “highly influential” scientific assessments. Although these changes were hailed as a victory for the scientific community Michaels saw it as still part of OMB’s strategy to enable industry to delay regulation and avoid litigation and to promote the anti-regulatory agenda.

The major role of John Graham as OMB administrator in promoting the revisionist agenda cannot be understated. Chapter 1 examined the revisionist changes to risk assessment and Graham’s influential role in promoting it on behalf of his industrial benefactors while head of the Harvard Center for Risk Analysis (HCRA). After being appointed as administrator at OMB he worked to instil a revisionist stamp on both agency risk assessments, peer review and advisory panels, as examined in this chapter. Although this chapter deals with peer review problems in the U.S. context it is relevant to this thesis (RF standard setting) for the following reasons.

As this chapter contends, the revisionist attempts to revise U.S. regulatory risk assessment and peer review essentially are aimed at transferring control over the regulatory processes to the industrial sector of the U.S. economy. These attempts are done under the guise of improving regulatory science, but in reality they are to gain control over the regulatory process in order to protect economic interests at the expense of public health protections. The revisionist risk assessment and peer review policy, as espoused by John Graham, will be discussed further in Chapter Five in relation to his keynote presentation at a 1998 WHO Seminar on EMF risk

perception and communication. Graham's keynote presentation laid out his revisionist agenda that was later put into action at OMB. Since a keynote presentation is one that covers the underlying theme of a meeting it is fair to conclude that Graham's views on risk and maintaining quality in science were held in high regard by the seminar organizers – the WHO and the International EMF Project, a WHO entity. As IEMFP's task at WHO is to conduct risk assessments and expert evaluations of the scientific literature for recommended exposure limits, an inquiry into the extent that revisionist sympathies have embedded themselves in RF standard setting is a central theme of this thesis.

Chapter 3

The Development of the IEEE C95.1 RF standard

The weight of evidence approach was used for the [C95.1] standard development. This process includes evaluation of the quality of test methods, the size and power of the study designs, the consistency of results across studies, and the biological plausibility of dose-response relationships and statistical associations.

IEEE RF Safety Standard: Statement from the Inter-American Telecommunication Commission, Organisation of American States, June 2007

The overwhelming [scientific] community commitment to thermal thinking severely limited the creativity of RF bioeffects research. Rather than attempting to learn from reports of athermal effects, the RF bioeffects community by and large devoted most of its attention to clarifying and proving what it already knew or to disproving claims believed to be false. This approach to research encouraged a single-mindedness that rigidly adhered to the thermal solution, a single-mindedness that can be seen in responses formulated when athermal effects were reported.

Nicholas Steneck in *The Microwave Debate*, 1984

Overview

Any analysis on the development of the U.S. RF standard, now under the auspices of the Institute of Electrical and Electronics Engineers (IEEE), would be remiss if it did not acknowledge the significant contribution to the debate by Nicholas Steneck, Director of the Research Ethics and Integrity Program at the Michigan Institute for Clinical and Health Research. Steneck is also Professor Emeritus of History at the University of Michigan and a consultant to the U.S. Federal Office of Research Integrity, Department of Health and Human Services. In 1980 Steneck and colleagues published in *Annals of Science* an analysis of the early research on microwave radiation and in 1984 Steneck published his seminal work, *The Microwave Debate*, that was a case study on the unfolding RF debate over the safety of radiofrequency and microwave technology and the problems involved in assessing and managing possible technological hazards. He raised important questions over conflicting values, the influence of vested interests in influencing the direction of the debate, and the role of scientific uncertainty as it was unfolding in the development and marketing of RF emitting technology. However, Steneck's 1984 analysis stopped before the advent of the mobile phone revolution which had a significant impact on standards development. It also was not able to explore the

important later developments on the internationalization of RF standards through the IEEE, the World Health Organisation's International EMF Project (IEMFP) and the International Commission on Non Ionizing Protection (ICNIRP). Another influential books at the time, *The Zapping of America* (1977), *Currents of Death* (1989) and *The Great Power-Line Cover-Up* (1993) by Paul Brodeur played a large part in bringing the public's attention to the microwave controversy but Brodeur's thesis has come under much criticism, including comments from Steneck over shortcomings in Brodeur's analysis and physicist Robert Park (examined later in this chapter). This Chapter draws on Steneck's 1984 work for the early U.S. standard developments because, in this author's opinion, it is the most reliable source available and covers a great deal of historical data not covered in the IEEE's historical review of the standard development.

Another important source of information on U.S. RF standards development used in this chapter is the New York City based newsletter *Microwave News*, edited by Louis Slesin PhD. This newsletter, published bi-monthly, has covered the RF debate since 1981 with extensive personal interviews with the people directly involved in the debate, and direct attendance to a large number of RF related conferences. It has been recognized as a fair and knowledgeable source of information that is not connected with industry or government agencies. Slesin, however, is not without his detractors, for example, physicist Robert Park claimed in his book *Voodoo Science* that *Microwave News* "had given the public a seriously distorted view of the scientific facts". Park's viewpoint needs to be understood in light of his physicist's understanding that while ionising radiation packs enough energy to break chemical bonds and thereby cause DNA damage, non-ionizing radiation does not have sufficient energy to do this. Therefore, according to Park, hazardous EMF biological effects below acute thermal interactions are an impossibility and anyone who claims differently is dabbling in Voodoo Science.¹ In 2003 *Microwave News* ceased a print form of its newsletter to be replaced with an Internet site. *Microwave News* is important for an analysis of the RF debate because

¹ Park, 2000, *Voodoo Science, The Road from Foolishness to Fraud*, Oxford Univ. Press, Chapter 7, Currents of Fear pp. 140-161.

much of the detailed information contained in the newsletter is not available elsewhere.

The central feature in the development of the American radiofrequency and microwave (RF/MW - hereafter referred to as RF) exposure standard, from the establishment of the American Standards Association C95 Committee in 1960 to the current C95.1 RF standard sponsored by the Institute of Electrical and Electronics Engineers (IEEE), has been that the only hazardous biological effect² from RF exposure to humans is tissue heating at high level exposure. The basis for this concept arose from previous medical experience with the use of RF as a therapeutic medium that was considered at the time to have beneficial effects through selectively heating human tissue. When a number of adverse health effects from RF emitting apparatus were observed, it seemed reasonable to attribute them to excessive heating of tissue from over-exposure to RF. By the mid 1930s the prevailing medical view was that the only biological effect of RF physical therapy (diathermy) treatments was tissue heating and that claims for other biological effects that were not related to heat were without foundation. This concept, or the “thermal-effects-only” school of thought, was given further scientific validity in the 1950s through the writings of Biophysicist Herman Schwan whose calculations indicated that an RF level of 10 milliWatts per square centimetre (10mW/cm²) was a safe level of exposure to avoid excessive tissue heating. This level was adopted by the U.S. Air Force (USAF) and later became the basis for the first American National Standards Institute (ANSI) C 95.1 RF standard of 1966. Acceptance of the thermal concept was also significantly boosted by the emerging Cold War between the U.S. and the Soviet Union.

In 1957 the Soviet Union had a number of spectacular satellite launches that translated into a capability to launch nuclear missiles deep into America. This presented the U.S. military with an urgent imperative to develop high power early warning radar systems to be able to detect a possible Soviet attack. This coincided

² Other than obvious electroshock and burns from direct contact with a high power RF transmitting source. See: M. Stock, ‘Technical Note 124: RF Shock and Burn: Notes from the research side’, LBA Group, <http://www.lbagroup.com/associates/lbatn124.php>, accessed Feb 4, 2009.

with the first military RF research program in America, the Tri-Services Program (1957-1960) which essentially had the task establishing 'ground rules' for the development of worker and personnel RF exposure standards that would not threaten the development of new high-power radar systems. By the conclusion of the Tri-Services Program Schwan's 10mW/cm² thermal limit had been accepted by the majority of interested parties, (the military and manufacturers) as the only scientifically justifiable end-point for standard setting. Subsequent standards development, under the later sponsorship of the industry body, the IEEE, continued the work of further refining the understanding of thermal interactions with human tissue. This also saw the increasing exclusion of any other possible interactions not related to heating as outside the realm of accepted science used in standard setting.

It is important to note that this discussion on the development of the IEEE C95.1 RF standard is not intended to be a critique of the validity of the scientific database that underlies the standard. What can be said in defence of C95.1 is that its data base is quite extensive and well researched in relation to the known and well established thermal biological effects of exposure to RF, based on over half a century of laboratory animal research. In this respect C95.1 provides a useful purpose in providing a significant level of protection against thermal biological damage from acute short-term exposures. In its latest (2003) review of over 1,300 research papers the scientific committee overseeing IEEE C95.1 set out a number of "guiding principles" that they followed in their evaluation of the scientific literature base in setting exposure limits. They concluded, in part, that the thermal effect is the only established adverse effect and that only this should be used to base maximum exposure limits on. In relation to non-thermal RF biological effects the committee considered they were not established.

This chapter explores reasons why the thermal paradigm came to be the primary focus in RF standard setting while other possible biological effects were arbitrarily rejected for reasons other than scientific quality control. Seen in the development of the IEEE C95.1 RF standard are how military and corporate interests (users and makers of the technology) were able to assume control over the standard setting

debate right from the very beginning and establish faulty risk assessment and science evaluation procedures. These were to their mutual benefit to assure that setting exposure limits would never become a threat to the development of new RF emitting technology, be it for military or commercial purposes.

The contribution of this chapter to the RF standard setting debate is to use the C.95.1 standard development process to argue that hazard risk assessments did not fully evaluate the scientific literature or “weight of evidence” for standard setting in situations where organisations responsible for the creation of the risk to be regulated, effectively control the process. This can also apply to other environmental issues with the central problem on how ensure that conflicts of interest do not bias regulatory outcomes remaining unresolved.

The foundations of a thermal approach for RF standard setting: electrotherapy & diathermy

By the end of the 19th Century the many incremental discoveries and advances in wireless telegraphy (in 1896 referred to as telecommunications) heralded in the birth of the modern electronic age. Along with the revolutionary inventions by Edison, Marconi and Tesla, just to name a few of the many pioneers, came an inevitable army of entrepreneurs wanting to take advantage of the publicity surrounding the new technological revolution. Their contributions to the field consisted of an amazing array of electro-therapeutic devices that it was claimed could cure practically every disease known to man. There were electrical machines for pain relief; electric tubs for treating foot problems, electric baths with vaginal tubes, electric stools, electrical poison extractors, electrical belts for weak and debilitated conditions, and an electric hair brush to prevent baldness, falling hair, dandruff and headache, to mention a few.³ Of course none of these devices had the slightest evidence as to their efficacy but by 1894 it was estimated that over 10,000

³ G. Gadsby, *Electroanalgesia: Historical and Contemporary Developments*, Section 3.2.11, *Electroanalgesia in the 20th Century United States*. <http://www.drgordongadsby.talktalk.net/page11.htm>, Accessed Apr. 17, 2006.

medical practitioners in the U.S. were regularly using some form of electrotherapeutic device to treat their patients⁴.

By 1900 most doctors in the United States had at least one electrical therapy device in their office. None of these devices utilised high frequency microwaves but their widespread use imbued in the medical community an awareness of the possibility of electromagnetic fields being used as a therapeutic tool. The widespread use of these many devices in the medical community, coupled with extravagant advertising in popular publications of the day, brought calls for the need of standards for medical education and clinical practice from the medical establishment. This resulted in the passage of the Federal Pure Food and Drugs Act of 1906⁵ and soon after, the publication of the Flexner report in 1910 established science as the basis for medicine and clinical education. Electrotherapy was declared scientifically unsupportable and was legally barred from clinical practice⁶. Although this new regulation, the first ever to attempt to regulate EMF devices, did eliminate a wide range of very dubious devices, the acceptance of using radiofrequency as a therapeutic medium soon was on the ascendancy with the rapid development of radio technology that took off in the early 1920s. This era saw an amazing proliferation of businesses established to manufacture radio sets, and in many cases starting up their own transmitting stations as well. Companies sprang up in many countries, manufacturing radio components and marketing them nationally and globally through new trade magazines and catalogues.⁷ It was seen as a wondrous technology and following on from the earlier electrotherapy craze, a new breed of entrepreneurs soon found new therapeutic applications for the technology in name of diathermy. By the 1930's diathermy, using radiowaves to heat tissue as a therapy was widely accepted as a beneficial new use of RF technology by the medical fraternity and it was used to treat

⁴ B.H. Lipton, *Bioelectromagnetism and Energy-Medicine* 2001

<http://www.brucelipton.com/bioelectromagnetism.php>, Accessed Apr. 17, 2006

⁵ U.S. Food and Drug Administration, 'The Long Struggle For The 1906 Law', *FDA Consumer Bulletin*, June 1981, <http://www.cfsan.fda.gov/~lrd/history2.html>, Accessed April 17, 2006.

⁶ Lipton, 2001.

⁷ T. White, *United States Early Radio History*, <http://www.earlyradiohistory.us/index.html>, Accessed April 7, 2006

everything from backaches and muscle pain to cancer⁸. Besides the diathermy devices, that worked by generating heat, there were other RF emitting medical devices that claimed not to depend upon a heating effect, such as George Lakhovsky's "Multiple Wave Oscillator" that was used in treating cancer⁹. Variants of the Lakhovsky oscillator continue to be used today.¹⁰

There were warnings as early as 1928 when Helen Hosmer from the Albany Medical College warned General Electric that their employees should use "extreme care" when working on radiowave apparatus due to the risk of extreme heating. In 1930 GE commissioned additional research at the Albany Medical College which consisted of exposing patients to RF heating. Some of the subjects complained of headaches, nausea, and/or dropping of blood pressure during exposure. As these symptoms were also reported during illnesses that cause fever, the General Electric researchers were not overly concerned. They reported that the patients did "not appear to be greatly distressed or fatigued when the maximum temperature is maintained for one hour and then allowed to return to normal while the patient is well blanketed." The researchers concluded that using the technology was safe provided caution was taken in its application.¹¹ The heating ability of RF fitted in well with the view amongst many physicians at the time that artificially produced fevers could help cure diseases, fevers being associated with the body's natural curing mechanism. In 1928 R.V. Christie from the Rockefeller Institute for Medical research expressed the prevailing view in medical circles that "the only constant effect which is known to be produced by high frequency alternating currents is that of heat production".¹² By 1930 research on the therapeutic use of radiowave-induced fevers was widespread in the U.S. and other countries. The next decade saw international conferences on the topic and hundreds of articles were published

⁸ N. Steneck, *The Microwave Debate*, MIT Press, 1984, p. 25.

⁹ C. Smith, S. Best, *Electromagnetic Man: Health & Hazard in the Electrical Environment*, JM Dent & Sons Ltd. London, 1989, pp. 14-16.

¹⁰ Dr. John Holt (now retired) of the Microwave Therapy Centre, Perth, West Australia, using a Lakhovsky derivative device to treat cancer patients, was featured in a series of programs on the Australian national TV program *A Current Affair* in late 2004.

¹¹ Steneck, 1984, op. cit., p. 27.

¹² H. Cook, N. Steneck, A. Vander, G. Kane, 'Early Research on the Biological Effects of Microwave Radiation: 1940-1960', *Annals of Science*, Vol. 37, pp. 323-351, 1980.

extolling the beneficial uses of diathermy heating.¹³ Diathermy had become big business.

In the early 1930's a German physician and entrepreneur, Erwin Schliephaki, was quick to capitalise on the use of higher frequencies for the use in diathermy by developing short-wave diathermy machines and publicising his machines in Germany and the U.S. with advertising campaigns making all sorts of claims for the curative power of his short wave devices. As a result of these claims the American Medical Association became concerned, and attacked Schliephaki's claims in a 1935 article published in the *Journal of the American Medical Association (JAMA)*. The article mentioned that many of their membership had been bombarded with "hyperenthusiastic" literature with "extravagant therapeutic claims" about the curative advantages of the therapy.¹⁴ In 1935 the AMA convened its Council on Physical Therapy (CPT) to investigate Schliephaki's claims and the companies marketing his machines. Their findings set the tone for future discussions on non-thermal (athermal) bio-effects. The CPT stated their view that: "the burden of proof still lies on those who claim any biologic action of these currents other than heat production". All bio-effects from diathermy, regardless of frequency used, were simply put down to a heating effect. The CPT ruling had the effect of casting the existence of other possible non-thermal bio-effects as a rather dubious "hyperenthusiastic" claim.¹⁵ According to Steneck, the research-orientated physicians who gave advice to the AMA, "clung firmly to the position that unless indisputable scientific evidence were found to the contrary, there were no athermal effects".¹⁶ This viewpoint was illustrated by a number of medical conferences at the time. For example, in 1937 at the First International Conference on Fever Therapy, held at Columbia University, the overwhelming majority of papers on short-wave therapy stated that there was no other purpose of exposure but to raise tissue temperatures. In that same year at the First International Congress on Short Waves, held at Vienna, Austria, the general agreement was that no other effects besides

¹³ Steneck, 1984, op. cit., pp. 25-26.

¹⁴ Steneck, 1984, op. cit., p. 74.

¹⁵ Steneck, 1984, op. cit., p. 76.

¹⁶ Steneck, 1984, op. cit., pp. 77-78.

systemic heating had been proven to exist.¹⁷ It was this viewpoint that was inherited by the military planners when they made assessments over possible hazards from radar microwave emitting technology in the 1940s –1950s.

By the late 1940s, enough evidence had accumulated to indicate that diathermy, and in particular the short wave (microwave) frequencies being increasingly used, could selectively elevate internal body temperatures without the patients feeling the increase due to the pain receptors being located in the skin (thus the possibility of internal damage with no warning until after the event). In addition there was evidence from animal studies that areas with insufficient blood flow to remove excess heat, such as the eyes and testicles, could be damaged. As cataracts took some time to form after exposure, this meant that delayed bio-effects existed. As far as the supposed exposure thresholds for thermal damage, researchers from the University of Iowa found that testicular damage to rats occurred at power levels below these thresholds, causing the researchers to suggest that “damages may result in part from factors other than heat”. These concerns, and the obvious implications over the possibility of litigation against physicians who used diathermy machines, led to the abandonment of medical diathermy by the mid 1950s.¹⁸ However the legacy of the previous widespread medical use of diathermy was a general medical opinion that:

- Hazards of RF exposure were solely from excessive heating of human tissue.
- Due to the AMA discrediting Schliephaki’s extravagant claims, the issue of other possible effects not related to heating (non-thermal) were ‘tarred with the same brush’ as being rather dubious.
- A burden of proof was established by the AMA that would later manifest as one that placed this burden on scientists and the concerned public to prove that there were hazards other than thermal, not on the manufacturers and users of RF technology.

¹⁷ Cook, *et al.*, 1980, op. cit., p. 329.

¹⁸ Steneck, 1984, op. cit., pp. 78-79.

Early research focuses on heating

It was well known that uncontrolled heating outside the doctor's surgery, such as occupational heat stress, from whatever source (such as the sun), could have serious consequences, such as fatigue, increased pulse rate and heat stroke. For this reason the U.S. Navy's Bureau of Medicine and Surgery in July 1930 started an investigation of possible heat based health hazards posed by powerful new 80 MHz radio transmitters being used. Personnel who were working in the vicinity of these transmitters reported symptoms that clearly indicated body heating was taking place such as an unpleasant warmth and sweating of the feet and legs, general body warmth and sweating, drowsiness, headaches, pains about the ankles, wrists, and elbows, weakness, and vertigo.¹⁹ What the Navy needed to know was the severity of the symptoms and if they could lead to permanent damage. The study consisted of six volunteers who were required to stand near an active transmitter until it became unbearable. The tests found that the volunteer's body temperature did increase a few degrees and that there were drops in blood pressure, however all symptoms disappeared when the transmitter was turned off with no apparent lasting ill health effects. Subsequent tests on the subjects did find that symptoms came on faster and recovery was slower, indicating a possible cumulative effect from repeated exposure, but this was simply dismissed as all subjects returned to apparent normal after the tests. Possible long-term effects were not a factor in the tests. As for possible dangers to human health posed by the new transmitters, the conclusion of the Navy investigators was that, as long a proper precautions were undertaken, "from a practical point of view there are none". Precautions would be to keep exposure to a minimum, use protective screening wherever possible, and keep workrooms well ventilated.²⁰ The Navy's results seemed to confirm that the effects felt by the test subjects were similar to those felt by workers in high-temperature environments. By the mid 1930s a clear consensus began to emerge that the dangers from RF radiation were from heat induced stress, which was not an unreasonable trade-off, given the significant benefits of the technology and that thermal effects were considered tolerable and reversible if

¹⁹ Steneck, 1984, op. cit., pp. 27-28.

²⁰ Steneck, 1984. op. cit., pp. 28-29.

kept within reasonable levels, the control of which was considered easily manageable.

In 1942, a year-long U.S. Navy test on 45 personnel who worked with radar including blood tests, physical exams and case histories, reported finding no evidence of significant effects. Some radar operators reported headaches, warming of the extremities and a flushed feeling. As these did not persist after exposure it was considered just a transitory thermal effect with no need for concern, especially as the average power of the units was about the same as some diathermy machines. A similar study by the Aero Medical Laboratory in Boca Raton, Florida in 1945 of 124 servicemen reached essentially the same conclusion. The investigators also made a comparison with maximum radar power levels being in the order of that used in diathermal therapy.²¹

In 1947 the Mayo Clinic in Rochester, Minnesota was able to access a new short-wave microwave generator from the military and their studies confirmed that the higher microwave frequencies provided an effective tool for inducing heating. They could be more easily focused than the older radiowave diathermy units and were more easily absorbed by the body. The microwaves could be readily directed to specific parts of the body. They announced that "Heating by microwaves offered the promise of considerable usefulness in the practice of physical medicine."²² The important issue now became one of studying just how the body disposed of excess heat and what microwave levels could be tolerated in various parts of the body without causing adverse effects from heating. It was known that the blood circulatory system was the principle mechanism to remove excess heat from the core of the body to the surface, where sweating and evaporation then remove the heat. Two areas of the body, the eyes and testes, however, do not have efficient cooling systems and research had found in the 1940s that infrared, ultraviolet and ionizing electromagnetic radiation could produce cataracts. Therefore the question was could microwaves also produce the same bio-effect in these parts of the body?

²¹ Steneck, 1984. op. cit., pp. 29-30.

²² Steneck, 1984, op. cit., p.31.

Research at Northwestern University Medical School in 1947 that focused microwaves directly on the eyes of dogs reported no adverse effects. The researchers said that if the same held true for humans then “this method should be a safe and excellent means for the application of localised heat to the eye.” However, a research team from the State University of Iowa funded by Collins Radio (Air Force subcontractors) found an opposite effect. They exposed rabbits to either one brief high power exposure or several low power exposures to microwave and found significant effects. The rabbits given one brief/high power exposure began to develop cataracts three days later. The rabbits given several low-power exposures developed cataracts as long as 42 days later. The researchers wrote that their findings should not in any way discourage the use of microwaves for diathermy but did note “that precautionary measures may be of value to workers and patients frequently exposed to the radiations of microwave generators.” When the researchers turned their efforts to the testes they also found evidence of tissue damage and they again issued precautionary advice: “precautions should be taken by those working in the field of high energy electromagnetic generators and by those giving treatments with microwave generators.”²³ The researchers concluded in their report to Collins Radio that for both the eyes and testes “definite evidence has been found that injury may occur at relatively low field intensity”. As a result of this research, Collins Radio warned in *Electronics* (1949) that “microwave radiation should be treated with the same respect as are other energetic radiations such as X-rays, α -rays, and neutrons”. John Clark, writing for Collins Radio said that “it would be highly desirable in the light of these observations to set about establishing standards for the protection of personnel exposed to intense microwave radiation before anyone is injured. We have here a most unusual opportunity to lock the barn door before, rather than after, the horse is stolen”.²⁴

The research up to the 1950’s focused on using brief exposures to high (acute) RF levels in animal studies in order to determine what were the thermal bio-effects of exposure. Low level studies on humans exposed to levels that could be

²³ Steneck, 1984, op. cit., pp. 32-33

²⁴ Cook, *et al.*, 1980, op. cit., p. 334.

encountered in medical treatment were not conducted and this emphasis on high level thermal effects was to set the pattern for all future research that formed the foundations of U.S. and Western RF/MW standard setting.

The importance of radar realized during WWII

In the early years of WWII it became apparent to both the Allied and Axis powers that radar was an important technology to extend the capabilities of both the air and naval forces, primarily in a defensive capacity. For example a chain of radar stations covering the South-East of England allowed Britain to track incoming German warplanes during the Battle of Britain in 1940 and gave Fighter Command an early warning to get their planes airborne in time to respond. Radar also avoided wasting valuable fuel reserves as the radar operators could give exact bearings to the incoming enemy planes. Radar installed in Hawaii in 1941 successfully detected the Japanese attack on Pearl Harbour, but unfortunately the radar data was misinterpreted by inexperienced operators.²⁵ Research into radar was also underway in France, Italy, The Soviet Union and Japan during the war. Germany had an extensive radar development program but internal rivalries and organizational problems hindered its wartime development.²⁶ In the Soviet Union radar units were in operation as early as 1939 and during WWII a number of ground-based, air-borne and ship-borne radar systems were developed and deployed in the Soviet Union. By the end of the war the Soviets had started a major research development program for military radar systems with priority given to surveillance radars for air defence.²⁷ In the U.S. the importance of radar was seen in the fact that research on developing radar technology during WWII was given the same priority as research on developing the atomic bomb.²⁸

²⁵ C. Trueman, The Radar and the Battle of Britain, http://www.historylearningsite.co.uk/radar_and_the_battle_of_britain.htm, Accessed Mar. 26, 2010.

²⁶ Aviation During World War II: The German Side of the Story, http://www.century-of-flight.net/Aviation%20history/WW2/german_radar.htm, Accessed March 26, 2010.

²⁷ V.S. Chernyak, Ya. Immoreev, B.M. Vovshin, 'Radar in the Soviet Union and Russia: A Brief Historical Outline', *IEEE AES Systems Magazine*, Dec. 2003, pp. 8-12.

²⁸ Cook, et al., 1980, op. cit., p. 330.

Five years after WWII another impetus for a rapid development of all forms of military radar was the Korean War which saw increased funding for upgrading existing military radar systems to ones that could track the high performance jet fighters that were rapidly replacing propeller aircraft. In addition the Soviet Union was producing large numbers of long-range bombers capable of reaching American cities. This necessitated the development of airborne surveillance radar on all weather fighter aircraft.²⁹ Radar had become an absolute necessity for effective national defence. Considering this importance, any discussion on the development of RF standards must be seen in light of the corresponding development of military radar.

The search for standards during the early Post War years

During WWII radar and other RF/MW emitting equipment had power outputs that were roughly equivalent to the power outputs of diathermy equipment, typically in the tens to hundreds of watts. A direct comparison to diathermy devices was therefore possible – and since diathermy was thought to be beneficial, the hazards therefore were considered minimal, provided precautions were undertaken. By the 50s, however, new radar systems had outputs in the millions of watts and within the decade their power outputs had increased a thousand-fold more. At these power levels comparisons to diathermy were no longer relevant and by the early 1950s evidence started coming out that there may be adverse health consequences for those working with the new systems.

In October 1951 a microwave technician employed by the Sandia Corporation visited the company's medical director, Dr. Frederic Hirsch, complaining of blurred vision, which Hirsch diagnosed as bilateral cataracts and acute inflammation of the retina. Subsequent investigations by Dr. Hirsch found that the technician routinely exposed his head to the antenna radiations when checking to see if it was generating properly. Hirsch estimated the power level to be about 100 mW/cm². In his report Hirsch recommended that the case was useful "as a means

²⁹ R. Strong, 'Radar: The Evolution Since World War II', Aerospace and Electronic Magazine, IEEE, Vol. 20, Issue 1, Jan. 2005.

of recalling the attention of ophthalmologists, industrial physicians, and microwave operators to the potentialities of microwave radiations in order that the use of this form of energy will be accompanied by appropriate respect and precautions".³⁰

In 1952 an investigation by Dr. John McLaughlin at Hughes Aircraft found numerous cases of internal bleeding in Hughes workers, as well as possible cataract formation amongst employees working with radar. Further investigation by McLaughlin of both civilian and Air Force personnel developing radar systems uncovered two reports of leukaemia amongst a group of 600 radar workers and reports of jaundice and headaches in personnel working with microwave equipment. McLaughlin also conducted a literature search that indicated thermal effects may not be the only mechanism causing bio effects and wrote up a report to Hughes that was made public in February 1953. McLaughlin's report clearly stated his case that hazards may exist with exposure to microwaves. It was this report that caused Hughes Aircraft to ask its military clients for research to verify, or not, McLaughlin's findings. Within two months two major military sponsored conferences were convened and a full-scale effort to study the microwave effects issue was created.³¹ Even at that early stage a list of potential problems that were to prove to be endemic to the RF standard setting process were raised at the 1953 Navy conference at the Bethesda Naval Hospital. The list is as follows:

- Extrapolation from animal exposure studies to the human body was difficult.
- Research findings interpreted by one researcher as evidence of effects can be interpreted by another as evidence of no effects. This subjective interpretation would therefore affect the standard setting process
- How can an objective interpretation of the data be done by an expert body when that body is of necessity made up of people from the same sector?
- Exposure data collected under field conditions were difficult to control and were usually not replicable.

³⁰ P. Brodeur, *The Zapping of America*, W.W. Norton & Co., 1977, p. 26.

³¹ Steneck, 1984, op. cit., p. 34.

- There were no outside observers to staff a neutral board with the necessary technical understanding to conduct an objective review, therefore both researcher and reviewed may represent the same school of thought.
- Once a standard is set, some exposed people would then be able to take legal action for perceived harm from previous exposures over that limit. This sets up an incentive for not reducing exposure levels below previously accepted levels.
- There is the problem of basic philosophies on who is to be protected, from what and to what extent.
- Also discussed at the Bethesda conference were other issues, such as funding constraints, peer group pressure and implications of experimental results all having an impact on the course of science progress.³²

If these points were followed through in the subsequent Tri-Service Program the progress of standard setting may have been far different than what eventuated. As it turned out, however, these concerns were largely ignored in subsequent standard work.

As a direct result of the 1953 McLaughlin report the Air Force's Air Research and Development Command directed the Cambridge Research Centre to investigate the biological aspects of microwaves with the aim to determine tolerance levels for both single and repeated exposures.³³ Once tolerance dosages were worked out with experimentation then appropriate exposure standards could be set. As time was to tell however, setting "appropriate" standards would prove not to be that straightforward. The navy also commenced investigations to establish the amount of RF induced heating energy that the human body could absorb and eliminate through normal body functions. Using only calculations an exposure level was initially set at 100mW/cm². Biophysicist Herman Schwan, working at the University of Pennsylvania, and employee of the Navy from 1947 to 1951, disagreed with that level. Schwan's re-calculations showed that the 100mW/cm² level was more than twenty times greater than what the body could dissipate.

³² Steneck, 1984, op. cit., p. 46.

³³ Steneck, 1984, op. cit., p. 45.

Schwan then recommended a 10mW/cm² level, based on his thermal model to limit temperature rise.³⁴ Schwan's 10 mW/cm² calculated value was supported by experimental data showing that the threshold for eye cataracts was greater than 100mW/cm², therefore giving a 10 fold factor of safety against a biological effect of considerable interest at that time.³⁵ By 1960 all three branches of the U.S. military, as well as their industrial contractors, had concluded that the 10 mW/cm² level was a safe level of exposure to prevent excessive tissue heating. This later became the basis for the first ANSI C 95.1 microwave standard in 1966, which Schwan was instrumental in drafting as chairman of the C95.1 committee.

Schwan's thermal model was based on his assumption that:

[C]ell membranes are not likely to be affected directly by microwaves since fields of interest can only apply potentials across the membranes that are vanishingly small in comparison with potentials needed to yield significant membrane responses, and significant responses of biopolymers require field strength levels very much higher than those causing undue heating.³⁶

This hypothesis, a valid assumption for the early 1950s, went on to become the only accepted mechanism for RF bio-effects in the U.S. and Western standards without ever being critically evaluated in light of subsequent research. It was a bio-effect that was readily observable in animal research. Alternative theories proposed later by Adey, Blackman, Frey and others that proposed other bio-effects that were not related to heating were largely ignored by the standard setting bodies³⁷. This avoidance is apparently to do with the fact that these alternative theories undermined Schwan's 10 mW/cm² thermal hypothesis and therefore threatened the very foundations of

³⁴ Steneck, 1984, op. cit., pp. 49-50.

³⁵ J.M. Osepchuk, R.C. Petersen, 'Historical Review of RF Exposure Standards and the International Committee on Electromagnetic Safety (ICES)', *Bioelectromagnetics Supplement* 6, 2003, pp. S7-S16.

³⁶ H.P. Schwan, 'Physical properties of biological matter: some history, principles and applications', *Bioelectromagnetics*, vol. 3 no.1, 1982.

³⁷ For a review of the scientific literature on non-thermal RF biological effects and possible mechanisms of interaction see the Bioinitiative Report, August 31, 2007. Available online at: <http://www.bioinitiative.org/>, Accessed March 16, 2008

the U.S. military/industrial RF standard's risk assessment. To retreat from the 10mW/cm² basis for standard setting and set a lower level to take into account other mechanisms would threaten the very basis for the military's assurances of safety for personnel working with the equipment and other people exposed to radar emissions.

Conflicts of interest endemic

The problem right from the beginning was that the only organization that had the resources, interest and authority to investigate the dangers from what was at the time primarily military equipment was the military itself. The medical community would have seemed a good candidate but there were concerns raised that many medical professionals were heavily committed, and were firm believers in the therapeutic uses of microwaves by diathermy machines. Thus a conflict of interest would have been inevitable if they were also charged with the conducting of research that was indicating that diathermy level microwaves were a health hazard.³⁸ Thus in the 1950s the emerging health effects issue was seen as a military problem, radar being primarily a military technology. An obvious conflict of interest with the military developing radar systems for national defence and evaluating the possible hazards of radar technology apparently went unchallenged. This conflict of interest was to prove to be a significant factor in subsequent RF standards development both in the U.S. and internationally as examined in this thesis. The issue of corporate conflict of interest with RF standard setting has been a problem right from the start of the research effort, and is the central theme of this thesis. As far back as 1953, Hughes Aircraft researcher John McLaughlin wrote of his concerns in a memo attached to his report, mentioned above. McLaughlin had claimed that the Raytheon corporation, a major manufacturer of diathermy equipment, was upset by the adverse publicity caused by the publication of reports of microwave cataracts and was putting pressure on the Navy to discontinue funding the research that had led to the reports.³⁹

³⁸ Steneck, 1984, op. cit., p. 35.

³⁹ Steneck, 1984

There was a conflict of interest within the military as well. On one hand the operational branches had as their mission an urgency to get new microwave radar equipment deployed in the field, therefore improving their defensive capabilities. After all it was the start of the Cold War with the Soviet Union. On the other hand, the services research branches' mission was concerned with the possible health hazard issue and basic research questions. When the first RF exposure guidelines were devised in the late 1950's the operational branches were not in favour of any restrictions that they perceived might be detrimental to their basic mission to provide an adequate defence for the nation.⁴⁰

The Tri-Service Research Program

As an outcome of the two military conferences in 1953, by 1957 the military's newly created *Tri-Service Research Program* (1957-1960) was ready to start its stated mission to clear up any unknowns about microwave exposure and discover the basic mechanisms of microwave-tissue interactions. It was hoped that this would then lead to setting exposure standards to protect civilian and service personnel working on RF/MW generating equipment. The Air Force, however, not willing to wait for the program to come up with guidance, adopted its own 10mW/cm² in-house exposure standard for RF/MW, based solely on Schwan's thermal calculations, one month before the program started in June 1957.⁴¹ As for the goals of the Tri-Service Program, a high ranking Air Force officer testified at a Senate hearing that the objectives were "to acquire through laboratory experimentation, a basis for validating protective criteria to insure a safe radiation environment for personnel at the least possible cost to military operations."⁴²

His testimony indicated that the Air Force saw the Tri-Service Program not as an open inquiry to investigate all possible mechanisms for RF/MW bio-effects, but simply to validate the Air Force's thermally based "protective criteria" that its in-house standard was based on.

⁴⁰ Steneck, 1984, op. cit., pp. 36-37.

⁴¹ Steneck, 1984, op. cit., p. 50.

⁴² Brodeur 1977, op. cit., p. 32.

From its inception the over riding research effort in the Tri-Services program was to first find the mechanism of interaction. There was a level of intellectual bias here as any of the medical doctors who assisted in the effort firmly believed, because of diathermy, that the only possible adverse bio-effect from RF exposures was excessive thermal increases. Thermal considerations therefore easily became the main focus to the exclusion of any other possible bio-effect. This viewpoint was also shared by most of the biologists and engineers involved in the Tri-Service program and as a result the emphasis of the studies conducted for the program focused on examining in detail just what happens with RF radiation exposures in the 10mW/cm² to 100mW/cm² range. Rats, rabbits, dogs and monkeys were the animals used in the exposure studies, with power densities in the 10 to 100 mW/cm² range aimed at producing thermal effects. Power density levels in this range seemed to fall in a tolerable range that did not overwhelm the body's normal cooling system.⁴³

One of the principal investigators, veterinarian Sol Michaelson from Rochester University, started out by testing animals to known high-level thermal doses of RF energy (165 mW/cm²) to establish the features of thermally caused bio-effects. Other experiments were designed to determine how the excess heat affected the animals' bodies. Unexpectedly, some of Michaelson's research indicated that high-level, short-term exposures produced effects could be duplicated by lower-level, longer-term exposures, - suggesting that duration of exposure may be a factor to consider. The Tri-Service Program concluded however, that the bio-effects of RF energy were only short term and reversible in nature and that the body's natural cooling system could, up to a point, protect it from the potential dangers of RF exposure. Therefore the task was to find the maximum level exposure that the natural defence against excess heat stress provided protection.⁴⁴

Experiments to test the validity of the thermal-only viewpoint by conducting exposure studies below the presumed thermal level to see if any bio-effects still occurred were not done. As stated above, the emphasis with the Tri-Services

⁴³ Steneck, 1984, op. cit., p. 37-39.

⁴⁴ Steneck, 1984, op. cit., p. 42.

studies was to clarify the thermal threshold for effects and not to look for other possible interactions that would only bring into question the Air Force's "protective criteria". As the Tri-Service Program progressed, those concerns expressed at the 1953 Bethesda conference on the necessity of independent review boards, objective interpretations and exploring conflicting points of view, etc., eventually disappeared. As Nicholas Steneck pointed out in *The Microwave Debate*:

Conflicting points of view were passed over, scientific ambiguity was ignored, and contrasting philosophies left unexplored as a single-minded approach gradually crept in and came to dominate all decisions.⁴⁵

This single-minded approach saw the Tri-Services program gradually come under the control of just one man, Colonel George Knauf, a military surgeon with experience on the latest high-powered radar systems. Knauf was initially placed in charge of the Tri-Service Program's effort at Rome Air Force Base in Rome, New York. Gradually, however, his interest in the program and enthusiastic statements about its progress led to him being assigned to head the entire program, essentially having the final say in issues of scientific interpretation and application. The emphasis on validating the Air Force's "protective criteria" was apparent in the 1957 statement by Knauf at a Tri-Services conference that "I think this might be a good time to say that up to date there has not been any effect produced or even hinted at power levels which remotely approach our established maximum safe exposure level." At the concluding Tri Services conference in 1961 Knauf enthusiastically said that: "I am indeed pleased to say that up to today we have not seen any research data which shakes our faith in the validity of this arbitrary safe exposure level, which we sponsored some five years ago."⁴⁶ Knauf's conclusions were not questioned by the military at all, as it gave closure to the earlier concerns raised by Laughlin at Hughes and others – all was well as long as the 10 mW/cm² standard was not exceeded. The symptoms reported in the investigations on humans exposed to microwaves in the course of their work was considered as transitory, as symptoms appeared to disappear after exposure ceased. Knauf

⁴⁵ Steneck, 1984, op. cit., p. 48.

⁴⁶ Steneck, 1984, op. cit., p. 50.

considered that only immediate permanent damage as a result of excessive heating as a significant biological effect. Minimal overheating was accepted because the body had the ability to cool itself. Testicular damage that could occur around the 10 mW/cm² level was ignored and cataract damage was considered to occur only above the 100mW/cm² level.⁴⁷

Colonel Knauf's 'quick-fix' was what the military urgently needed considering the political climate that existed at that time. On October 4, 1957, the Soviet Union successfully launched Sputnik I, the world's first artificial satellite and then followed by another, the successful launch of Sputnik II on November 3rd 1957, carrying Laika, a dog, into orbit.⁴⁸ In comparison America's efforts were plagued with a series of failures and it was not until January 31 that they were able to successfully launch Explorer I, America's first satellite.⁴⁹ As acknowledged by NASA, the Soviet Sputnik achievements ushered in new political, military, technological, and scientific developments and marked the start of the space age and the American/Soviet space race.⁵⁰ What was also important about the Soviet space achievements was that it caused concern in the U.S. that the Soviet's proven ability to launch satellites meant that the Soviets now had the capacity to launch ballistic missiles capable of reaching American cities. According to an Australian ABC TV documentary *Space Race: Race For Satellites* American concerns at that time were that Soviet ballistic missiles were being developed, not to launch satellites, but as the best means for destroying the U.S.⁵¹

An obvious influence to decisions made during the running of the Tri-Services program and the acceptance of the Air Force's "protective criteria" was the creation of the Defense Advanced Research Projects Agency (DARPA) in 1958 as a response to the Soviet Union's launching of Sputnik. DARPA reported directly to

⁴⁷ Steneck, 1984, op. cit., p. 53.

⁴⁸ NASA, 'Sputnik and the dawn of the Space Age', Oct. 10, 2007, <http://history.nasa.gov/sputnik/index.html>, Accessed Apr. 28, 2006.

⁴⁹ C.M. Green, M. Lomask, 'Vanguard – A History', NASA Historical Reference Collection, NASA History Office, NASA Headquarters, Washington, DC., 1970, Chap 12: 'Success – and After' <http://history.nasa.gov/SP-4202/chap12.html>, Accessed Apr. 28, 2006.

⁵⁰ NASA, 2007.

⁵¹ ABC TV (Australia), 'Space Race: Race For Satellites', Oct.15, 2006.

the Secretary of Defense and was given a mission to assure that the U.S. maintained “a lead in applying state-of-the-art technology for military capabilities and to prevent technological surprise from her adversaries”.⁵² As a primary state-of-the-art technology being developed at the time was high-power early warning radar, discussions of possible adverse effects below the Air force’s “protective criteria” would have been viewed with concern and possibly as a threat to national defence (radar development) if allowed to continue. This was an era when a fear of the extent of the Soviet threat to America’s very survival was paramount. Senator Joseph Mccarthy was making accusations that the U.S. Army and State Department had been infiltrated by Soviet agents. A communist army had taken over China and thousands of American soldiers had been killed fighting communist forces in Korea. There was an attempted communist takeover in Greece, and strong communist political movements in Italy and France. According to Stephen Kizner, author and veteran New York Times correspondent, during the 1950s the political leadership in the U.S. was “gripped by a fear of encirclement, a terrible sense that it was losing the postwar battle of ideologies”.⁵³ There was, therefore, an urgency to develop and deploy new improved radar systems to detect any Soviet missiles launched over the Arctic Circle. Any consideration of non-thermal bio-effects from radar was seen as having the potential to adversely impact on systems deployment. This was stated by Michaelson when he admitted that if the U.S. adopted stringent RF standards, similar to the Soviets, “the harm that would be done to industry and the military would outweigh any proposed public-health benefit.”⁵⁴

By the time the Tri-Service Program was terminated in 1961, the thermal effects only viewpoint, as exemplified by Knauf and Schwan, was well on its way to becoming accepted as the only way that RF microwave exposure interacted with human body. The military’s de-facto 10 mW/cm² “protective criteria” was the favoured standard. The possibility of other biological effects not related to actual heating was clearly rejected in the Tri-Service program. According to Robert O.

⁵² DARPA website, <http://www.darpa.mil/body/overtheyears.html>, Accessed Aug. 26, 2008.

⁵³ S. Kinzer, *Overthrow: America’s Century of Regime Change from Hawaii to Iraq*, Times Books, 2006.

⁵⁴ A. Marino, J. Ray, *The Electric Wilderness*, San Francisco Press, p. 16, 1986.

Becker, author of *Cross Currents*, as more advanced radar was developed, research evidence for non-thermal effects came to be viewed as a threat to national security'.⁵⁵ - See the section on PAVE PAWS in this chapter for an example of this. Becker pointed out in his book *The Body Electric* (1985) (co-authored with Gary Selden) that in the year before the book was published the military was essentially buying the science it wanted with two-thirds of the \$47-billion federal research budget going into military research projects with those organizations dolling out research finding primarily interested in preserving the current orthodoxies.⁵⁶ Becker's point on radar development was in agreement with what was stated in Paul Brodeur's book *The Zapping of America*. According to Brodeur, by the conclusion of the Tri-Services Program the military knew some of its high-powered radar systems already exceeded the 10 mW/cm² level. For example, leakage from the Air Force's Ballistic Missile Early Warning System could expose nearby personnel to microwaves in excess of that level. As well, the Navy knew that average microwave levels on the flight decks of aircraft carriers exceeded that level and could not be lowered without drastically curtailing their operations.⁵⁷ Obviously from the military's point of view, funding research that brought into doubt the safety of military technology, and therefore national defence capabilities, could be considered a threat to national security.

Becker has written in some detail on political attempts to curtail his research programs at the Veterans Administration, apparently as a consequence of his very public involvement in powerline hearings over possible health impacts of a planned transmission line in New York State. Apparently most of the pressure to cut his funding originated from the Department of Defence (DOD).⁵⁸ The connection with civilian powerline fields (extremely low frequency fields) and DOD concerns would have been because of Becker's previous work with the Navy on the Sanguine project that used ELF magnetic fields as a world-wide communications medium to communicate with submarines.⁵⁹ On New Years day

⁵⁵ R. Becker, *Cross Currents*, Jeremy P. Tarcher, Inc. Los Angeles, 1990, p. 299.

⁵⁶ R. Becker, G. Selden, *The Body Electric*, Quill publications, 1985, p. 333.

⁵⁷ Brodeur, 1977, op. cit., p. 34.

⁵⁸ Becker, Selden, 1985, Postscript, pp. 330 – 347.

⁵⁹ Marino, Ray, 1986, pp. 1 – 4.

1981 Becker's lab, as one of the few bioelectromagnetic laboratories outside of DOD control, was disbanded.⁶⁰

Soviet standards

Launching satellites was not the only area where the Soviets led the way. By taking a completely different research approach to understanding how RF/MW interacts with living tissue, Soviet scientists came up with radically different conclusions as to what was a safe level of exposure for standard setting and concentrated their research on possible non-thermal hazards. This was in stark contrast to the U.S. Tri-Service Program which focussed on identifying hazardous thermal effects through animal studies using high-dose short-duration microwave exposures (thus dismissing the non-thermal problem as an inconvenience). As mentioned previously in this thesis this fundamental difference was expressed by Professor V. Parin in the Foreword to Presman's 1970 book on Soviet bioelectromagnetic research, *Electromagnetic Fields and Life*:

EMFs can have nonthermal effects and that living organisms of diverse species – from unicellular organisms to man – are extremely sensitive to EMFs. Some of the discovered features of the biological action of EMFs clearly do not fit the Procrustean bed⁶¹ of the heat theory.⁶²

At the same time as the Tri-Services was just concluding its basic thermal research in 1960, the Academy of Medical Sciences in the USSR published a report *Biological Action of Ultrahigh Frequencies* (UHF - 300 MHz to 3000GHz) that identified numerous bio-effects from both animal and human exposure to radiofrequencies above 300 MHz.⁶³ Similar to what Schwan found, the Soviet scientists observed a detectable thermal effect at 10mW/cm² and above. However, in contrast to the Tri-

⁶⁰ Becker, Selden, op. cit., 1985, p 347.

⁶¹ Defined as an Arbitrary and often ruthless disregard of individual differences or special circumstances.

⁶² V. Parin in Foreword to *Electromagnetic Fields and Life*, by A.S. Presman, Plenum Press, New York-London, Foreword xi, 1970.

⁶³ 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.) As quoted in *Microwave Sickness* by Lucinda Grant, Part 1, 1996.

Services high-level (over 10mW/cm²) exposure studies, the Soviet scientists primarily were concerned about bio-effects below the thermal threshold of 10mW/cm². Much of the work was documenting the actual health impacts on workers working with UHF. Symptoms reported in the Russian literature include: fatigue and slow recovery of energy, muscle weakness, reduced intellectual activity, absent mindedness, diminished sex drive, headaches, sleeplessness, dizziness, heart palpitations, fast or slow heart beat, hair loss, overactive thyroid, changes in the menstrual cycle, breathing problems, etc.⁶⁴

The report concluded that:

Illness after the influence of UHF (radiofrequency/microwave) is characterized primarily by functional disorders of the nervous and cardiovascular systems, manifested in the development of an asthenic symptom complex, symptoms of vascular hypotension, bradycardia, and dystrophy of the myocardium, and changes in the crystalline lens (cataract) in the case of a considerable intensity of influence.⁶⁵

It was this taking into consideration actual bioeffects of Soviet workers exposed to RF/MW levels below the thermal limit that played a significant part in the Soviet 1958 occupational exposure standard being set at 0.01mW/cm², 1000 times lower than the U.S. thermal protective standard limit of 10mW/cm². The Soviets used a safety factor of ten: their standard was one-tenth of the exposure intensity at which symptoms were known to occur in humans. (1mW/cm² exposure for one hour divided by a ten-hour workday equals 0.1 mW/cm² exposure level, divided by the safety factor of 10). For the Soviet public the exposure limit was set at 0.001 mW/cm².⁶⁶ Other differences between the U.S. and Soviet standards were that the Soviet standard required, by law, pre-employment medical examinations of all prospective RF/MW workers. Applicants who had a history of blood diseases,

⁶⁴ 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 Ministry for Postal Services and Telecommunications, Berlin 1997.

⁶⁵ Letavet, Gordon, 1960.

⁶⁶ L. Grant, *Microwave Sickness*, 5 part series, *Electrosensitivity News*, vol. 1, no. 6 1996 and vol. 2, no. 1-4, 1997.

epilepsy, cataracts, central nervous system diseases, endocrine diseases, ulcers, glaucoma, cardiovascular injuries, etc were deemed unfit to work with UHF's because exposure could exacerbate these conditions. Another consideration of the Soviet standard was the possibility of cumulative effects of non-thermal RF/MW exposures over time, including the possibility of reproductive and genetic effects.⁶⁷ It is interesting to compare the Soviet standard's emphasis on actual subjective and objective symptoms of personnel working with RF/MW equipment with the "biological endpoint" of the U.S. RF standard which is based on food motivated learned behaviour in laboratory animals exposed to acute levels of RF/MW.⁶⁸ A question arises here on why the Soviet Military planners were apparently not concerned about compliance with strict occupational RF/MW standards that were up to 1000 times lower than the US standard. It may have been the case, as Sol Michaelson claimed, that the Soviet military was exempt from compliance and could happily go about its business unfettered by having to meet limits⁶⁹. It may have been the case, however, that the Soviets were far more careful not to expose their service men and women to what they considered harmful microwave levels. This would seem to have been the situation according to the detailed requirements for personnel working with microwave equipment as laid out in the Soviet regulation: *Safety Regulations for Personnel in the Presence of Microwave Generators* (Nov. 1958). These requirements were far stricter than those practised in the U.S. at the time.⁷⁰ It is also possible that with the Cold War, the Soviets also saw a possible propaganda advantage in undermining international confidence in the US standard by maintaining a far stricter one. Whatever the case may have been, the Soviet era scientists and standard setters apparently worked in a scientific environment apparently free of interference from a Capitalist military industrial complex. As a result they were able to work out what they considered was a safe level for human exposure to RF/MW free of Western style risk assessment cost-benefit considerations. The fundamental difference in research priorities can be seen in the fact that as microwave research the U.S. declined after the Tri-Services program finished (the military had the answers it wanted), the Soviet (Russian)

⁶⁷ Grant, 1996.

⁶⁸ Osepchuk, Petersen, 2003.

⁶⁹ Correspondence with Andrew Marino, October 20, 2006.

⁷⁰ Brodeur 1977, op. cit., p.37.

scientific community and other Eastern Block nations pursued an active research program specifically on identifying low-level, chronic effects.^{71 72}

Tri-Services Program: pros and cons

Becker and Brodeur saw a conspiracy in the Tri-Services Program's focus solely on thermal considerations⁷³ but it must be acknowledged that, at the time, no epidemiological studies of RF exposed populations had yet been conducted, at least outside of the Soviet Union. In addition there was a mindset already established on thermal considerations, largely as a result of diathermy and Knauf, being a medical doctor, would have been well versed in the therapy. Due to the urgency of needing to come up with definitive answers, the most obvious course of action was to concentrate on the known effect of tissue heating, determine a hazardous level, and then to set standards to prevent this. The Tri-Service Project had to go with what limited information it had managed to accumulate and come up with recommendations based on that information. Its recommendations had to be expressed in a framework that would not impede the military's operational imperatives at a time when it was thought the Soviets had a tactical nuclear weapon advantage. The Tri-Services program concluded that perceptible pathological burns were produced by exposure to 100 mW/cm² microwave radiation and by using a safety factor of 10 came up with Schwan's original calculation of 10 mW/cm² to protect against thermal hazards.⁷⁴ Even though there certainly was a vested interest in maintaining a thermal outlook right from the beginning, it is reasonable to assume that, considering the limited literature base at the time, basing recommendations only on thermal effects may have been the best that they could do. Allowing that viewpoint to become a paradigm in spite of later research is another matter though.

⁷¹ Cook, *et al.*, 1980, *op. cit.*, p. 348.

⁷² A detailed discussion of Eastern Block research is given in: K. Marha, J. Musil, H. Tuha, *Electromagnetic Fields and the Life Environment*, (translation) San Francisco Press, 1971.

⁷³ Becker, 1990, *op. cit.*, p. 299, and Brodeur 1977, *op. cit.*, p. 34.

⁷⁴ L. David, 'A Study of Federal Microwave Standards', U.S. Department of Energy, 1980, p. 21.

The Tri-Services Program had a number of significant weaknesses.

- As the Tri Services Program progressed, too much interpretive power was given to just two men, Air Force Colonel Knauf and Herman Schwan. The research program essentially then turned out to be a two-man show, with investigators being free to express opinions, but with no power to influence either Knauf's decision making process or Schwan's belief in his 10mW/cm² safe level. Therefore, the foundation of the first C95.1-1966 RF standard was not based on decisions of neutral review boards and objective scientific interpretations as was originally proposed at Bethesda, but on an untested assumption of the correctness of Schwan's 10mW/cm² calculations.
- The Tri-Services Program failed to test the scientific validity of the 10 mW/cm² level, which was based solely on Schwan's calculations on non-biological models. This is because none of the Tri-Service studies were conducted at intensities below Schwan's level⁷⁵, with the majority of experiments using exposures above 100 mW/cm².⁷⁶ Reports by American, German and Soviet scientists that exposures below 10 mW/cm² could cause biological effects were arbitrarily dismissed as incompetent and not worthy of consideration.⁷⁷
- Unlike their Soviet counterparts, the Tri-Services Program failed to include in its overall work a detailed investigation of the actual symptoms being reported by personnel exposed to microwaves, and at what levels these symptoms were occurring. These symptoms were considered to be only transitory in nature and of no significance, an opinion reinforced by Schwan's belief that reports of non-thermal injuries were anecdotal and unreliable.⁷⁸ Shared beliefs in thermal effects combined with the pressures of the Cold War to field high power radar systems for national security made

⁷⁵ Marino, 1986, op. cit., p. 15.

⁷⁶ David, 1980.

⁷⁷ Marino, 1986, op. cit., p. 16.

⁷⁸ Marino, 1986, op. cit., p. 14.

it all too easy and convenient to dismiss the possibility of non-thermal bio-effects from the technology. It was this dismissal that laid the foundation for all Future Western RF/MW exposure standards and led to a scientific confrontation with Russia and China by the start of the 21st Century over which school of thought was most scientifically valid for human health protection. This will be examined in Chapter 4.

- 75% of the research papers that came out of the Tri-Service Program failed to list all the accepted parameters that should be included in a research paper, such as frequency used or type of experimental animal used.⁷⁹
- Problems of dosimetry (determining actual exposure levels) and a lack of replication of findings (a key scientific requirement) brought into question the scientific validity of the overall program.⁸⁰
- Largely due to the influence of Schwan and Knauf, the program concluded that only immediate permanent damage was significant.⁸¹

Early and short-lived alternatives to the military's 10 mW/cm² standard.

During this time, civilian industry developing microwave technology (mainly radar) for the military was trying to develop guidelines to protect their employees working on the equipment. Bell Telephone Laboratories and General Electric, both major military contractors, sponsored a meeting that put more emphasis on the empirical data (subjective and medical reports of actual harm, similar to what the Soviets were doing) as they were not satisfied that the military's thermal only approach was adequate. Particular attention was paid to the 1952 work of Frederic Hirsch of the Sandia Corporation who found cataract formation in laboratory technicians regularly exposed to microwaves at power levels of around 100mW/cm², which was the exposure level at which actual thermal damage was

⁷⁹ David, 1980, op. cit., p. 16.

⁸⁰ Cook, *et al.*, 1980, op. cit., p. 349.

⁸¹ Steneck, 1984, op. cit., p. 53.

known to occur.⁸² There was no question about this being a hazardous level but how large a safety margin needed to be to provide protection was in dispute. Therefore in 1954, one year after the 1953 Bethesda Naval conference, General Electric (GE) set its in-house standard of 1mW/cm², using a 100 fold safety factor and Bell used a 1000 fold safety factor, giving a standard of 0.1 mW/cm² (100uW/cm²). These limits set by GE and Bell were considered to be “safe under all conditions” whereas any exposure over the military’s 10mW/cm² was considered hazardous⁸³. Unlike the Soviets however, these levels were only in consideration of thermal hazards. These lower levels, and alternative viewpoints on providing extra safety margins, questioned the adequacy of the military’s 10-fold safety factor for the 10 mW/cm² standard. This difference was to end after a series of meetings between Knauf and Benjamin Vosburgh, GE’s standards consultant. Soon after, in 1958, both GE and Bell acquiesced to the military’s 10-fold safety factor thereby validating the 10mW/cm² standard.⁸⁴

Steneck pointed out however that there was another strong factor for both GE and Bell abandoning their initial strict in-house standards, a factor that was to dominate the RF standard setting scene forever after. New technological advances meant that old safety standards could no longer be maintained as microwave levels steadily increased. GE was able to initially set a 1mW/cm² standard for its factories but with the steady advancement of higher power radar equipment that level became increasingly more difficult to maintain. In some cases whole areas had to be vacated while new equipment was being tested, thus placing an impediment on technological advancement.⁸⁵ Thus began the pattern that continues to this day, where human health protection is considered only to the point that it does not impede technological development. This was the case 40 years later in the Australian RF standard setting committee in 1998 as will be examined in Chapter 5. In the Australian case the industry’s stated reason to increase the allowable RF limits was to accommodate the new 3G wireless

⁸² B.B. Levitt, *Electromagnetic Fields, A Consumer’s Guide to the Issues and How to Protect Ourselves*, A Harvest Original, 1995, p. 22.

⁸³ Osepchuk, Petersen, 2003, op. cit., p. S7.

⁸⁴ Steneck, 1984, op. cit., p. 51.

⁸⁵ Steneck, 1984, op. cit., p. 52.

technology that had emissions in excess of the existing Australian / New Zealand RF/MW standard of 200uW/cm².

When GE's Vosburgh agreed to relax his company's in-house standard to accommodate the military he did express reservations that the safety factor issue may need a re-appraisal. He saw the 10mW/cm² level as being close to a 'safety-risk' line and he recommended constant monitoring at a 1mW/cm² level in order to allow for harmonics and spurious waves.⁸⁶ Vosburgh also expressed the possibility of non-thermal and cumulative effects. He saw a possible re-appraisal to the safety factor "if and when it has been proven that some important part of that [microwave signal] is absorbed by susceptible tissues in the form of non-thermal energy having a cumulative effect".⁸⁷

Despite Vosburgh's reservations he articulated the growing philosophy on risk versus benefits that was taking shape. Vosburgh said that "[i]t is reasonable to err on the safe side but not so far that it hurts; not so far that progress in the art becomes jeopardised; not so far that we will one day laugh too loudly at our present day fears".⁸⁸

Though the standard setting focus at that time was on occupational and service personnel exposures, those early decisions on "safety factors" as voiced by Vosburgh, meant a shift of the burden of risk to those who are exposed for the benefit of the military and industries developing the new technology. Safety became a goal subservient to the operational requirements of technological development. Uncertainty over bio-effects other than heating was not considered sufficient grounds to impede development. This meant that as long as uncertainty existed, it was not a threat to the development of newer and ever more powerful radar systems. Andrew Marino expressed the situation as one of risks versus benefits, with the risks of harm that could be done to industry and military from a

⁸⁶ Steneck, 1984.

⁸⁷ Steneck, 1984.

⁸⁸ Steneck, 1984.

strict standards of far greater weight than any proposed public health benefit.⁸⁹ With the Cold War clash with the Soviet Union for global supremacy in full swing by the late 1950's, not placing restrictions on the development and deployment of new technology was a significant consideration in setting US standards.

Robert O. Becker, one of the early researchers into bioelectromagnetics who had served on a panel of experts evaluating a number of Navy funded projects in the early 1970s, described the U.S. military complex as very much like a living organism "constantly sensing its environment, integrating information, and reaching decisions, and then acting on those decisions by using the appropriate weapons systems". Becker described this organism as having a "central nervous system" based on information transmitted by electromagnetic fields with its sensory organs being microwave scanners [radar], satellites, and sensitive listening devices to listen in to the enemy's radio communications. The nerve impulses of this organism were radio communications from ELF to microwave frequencies. In order for this organism to operate at a peak level it depended upon the "unrestricted use of all frequencies in the electromagnetic spectrum at unlimited power densities".⁹⁰

PAVE PAWS: Health concerns or a threat to national security?

In the late 1970s the U.S. Air Force proposed to increase the range and power levels of its coastal early warning radar systems by installing a new system, PAVE PAWS (Precision Acquisition of Vehicle Entry Phased Array). The new system used more than 10,000 individual fixed antennas (i.e. they did not rotate) that were controlled by computers to create a single beam that could be quickly directed in any direction in a 240-degree field and could detect an object as small as a football up to 1,500 miles away. One was built at Beale Air Base, California and one at Otis Air Force base on Cape Cod, Massachusetts. In both cases citizens' coalitions sprang up in opposition to having the systems in their areas. In Cape Cod apparent cancer clusters heightened community concerns and this led to a number of expert panels

⁸⁹ Marino, 1986, op. cit., p. 16.

⁹⁰ R. Becker, *Cross Currents*, Jeremy P. Tarcher, Inc, 1990. pp. 297-298.

giving an all-clear to the PAVE PAWS system. Quite aside from the alleged cancer cluster issue, the PAVE PAWS controversy is important for the theme of this thesis as an example of how novel scientific claims are handled in RF standard setting.

The PAVE PAWS system operated at a carrier frequency of between 420 and 450 MHz and was pulsed at 18.5 hertz. This is very close to the 16 Hz modulation frequency riding on a 450 MHz frequency that Ross Adey⁹¹ and co-workers have identified as a biological frequency window that can alter biological processes at non-thermal levels. In one study, Calcium-efflux was increased in isolated chicken cerebral tissue⁹² and in another, this time on live cerebral cortex of cats, the researchers saw alterations in brain chemistry in about 70% of the exposed cats.⁹³ In his 2002 letter to Dr. Rick Jostes from the National Academy of Sciences Board on Radiation Effects Research (NAS/NRC PAVE PAWS committee) Adey pointed out the conflict of interest and bias problem within the USAF and the IEEE Subcommittee 28 in their refusal to acknowledge the existence of nonthermal ELF and microwave biological interactions. Adey stated that “for more than 20 years, the USAF has aggressively asserted that microwave fields have only one mode of biological interaction – through tissue heating. There has been a consistent denial of nonthermal interactions, and as a corollary, that tissues have no capacity to demodulate pulse – or amplitude-modulated microwave fields”. Adey also mentioned how the USAF has spread its thermal doctrine internationally through the NATO countries as well as dominating IEEE Standard setting process.⁹⁴

In addition to the concerns expressed by Adey, Dr. Richard Albenese, a USAF physician at Brooks Air Force base in San Antonio, Texas, and colleague Professor Kert Oughstun, researcher and author of the textbook *Electromagnetic Pulse*

⁹¹ Ross Adey (deceased) is one of the best known and published bioelectromagnetics researchers in the U.S. He was an elected fellow of the IEEE for his contributions in the fields of radio physics and radio engineering and pioneered the detection system now used in modern broadband detection technology.

⁹² S. Bawin, W. Adey, I. Sabbot, ‘Ionic factors in release of $^{45}\text{Ca}^{2+}$ from chicken cerebral tissue by electromagnetic fields’, *Proc. Natl. Acad. Sci.* vol. 75, no. 12, pp. 6314 – 6318, Dec. 1978.

⁹³ W. Adey, S. Bawin, and F. Lawrence. Effects of Weak Amplitude-Modulated. Microwave Fields on Calcium Efflux From Awake Cat Cerebral Cortex. *Bioelectromagnetics*. 1982;3(3):295-307.

⁹⁴ W. Adey, letter to Dr. Rick Jostes, Senior Program Offices. Board on Radiation Effects research, NAS, JUL. 31, 2002.

Propagation in Causal Dielectrics with G.C. Sherman and member of the editorial board of *IEEE Transactions on Antennas and Propagation* also expressed safety concerns. Albanese and Oughstun were concerned that not enough research had been done on the high powered electric and magnetic microwave pulses emitted by the individual elements of the PAVE PAWS radar. Their calculations indicated that the pulses may be powerful enough to generate Brillouin precursors created when a very fast pulse of radiation enters the body and induces a burst of energy that can penetrate far deeper into the body than conventional radar. Far from being a theoretical concept Brillouin precursors are being utilised in recent ultra wide band imaging technologies and in USAF research on improved airborne surveillance.⁹⁵ Despite evidence for the existence of Brillouin precursors being of biological significance, however, they were rejected for consideration by the IEEE's standard setting committee. The committee's reason was because there was no "evidence in the peer-reviewed scientific literature supporting Brillouin precursors as being biologically important at RF frequencies".⁹⁶ Physicist Robert Adair went further in claiming that Brillouin precursors were far too weak to ever effect biology and that Albanese and Oughstun were practicing voodoo science. Adair also stated that the claims of possible hazards from Brillouin precursors were "damaging to the Air Force and in its role in defence of the United States – my country – and my Air Force".⁹⁷ It can be argued that on one level Adair is correct about the danger posed by work of Albanese and Oughstun on Brillouin Precursors. If their alleged bioeffect on the human body was established by further research/replication studies and peer reviewed publishing it would invalidate the whole concept of safety through SAR calculations that lay at the foundations of both IEEE C95.1 and ICNIRP. This would not only be a problem for PAVE PAWS type radar systems but all manner of new communications and surveillance systems being developed by the military and industrial sectors, a possibility raised by Oughstun. In a 2002 *Microwave News* article, Oughstun mentioned that "as data

⁹⁵ L. Slesin, 'Introducing Brillouin Precursors: Microwave Radiation Runs Deep', *Microwave News*, vol. 22, no. 2, Mar/Apr. 2002, pp. 1, 10-12.

⁹⁶ L. Slesin, 'IEEE Says No to Brillouin Precursors', Standards, *Microwave News*, vol. 22, no. 4, Jul./Aug. 2002, p. 16.

⁹⁷ L.Slesin, 'Brillouin Precursors: Robert Adair, Albanese and Oughstun' Letters to the Editor, *Microwave News*, vol. 22, no. 3, May/June 2002, pp. 13-14.

transmission rates continue to increase, wireless communications systems will approach closer to and may, at some time in the not-to-distant future, exceed the conditions necessary to produce Brillouin precursors in living tissue”.

Exactly eight years later (as of April 2010) there is no known further research being conducted on the biological significance of Brillouin precursors (other than possibly restricted military research). This means that the IEEE can rightfully claim that there is no evidence in the peer-reviewed scientific literature supporting Brillouin precursors as being biologically important at RF frequencies.

Keeping with the Procrustean Approach theme of this thesis, what is apparent from the rejection of the research by Adey, et al, Albanese and Oughstun in the PAVE PAWS case was that this body of evidence clearly lay outside of the thermal strictures of IEEE C95.1. For the USAF and the IEEE standard setters to acknowledge this science would be to bring into question the safety of high power systems like PAVE PAWS and therefore undermine the basis of the very standard itself.

Microwaves get bad press

During the late 1980s and early 1990s a series of articles by journalist Paul Brodeur were published in *The New Yorker* that served as a vehicle to bring the EMF issue into the public domain. Brodeur’s *New Yorker* articles and later books on the topic were a wake-up call for the general public that poweline EMFs and microwaves from new technology may be a hazard to their health. Brodeur’s first book on the issue was provocatively titled *The Zapping of America, Microwaves, Their Deadly Risk, And The Cover-Up* (1977). This was followed by *CURRENTS OF DEATH, Power Lines, Computer Terminals, and the Attempt to Cover Up Their Threat to Your Health* (1989) and *THE GREAT POWER-LINE COVER-UP, How the Utilities and the Government Are Trying to Hide the Cancer Hazards Posed by Electromagnetic Fields* (1993). Although Brodeur’s writings caused a storm of controversy and outright condemnation from a number of quarters his work has been credited as being the

prime mover in taking the EMF/RF microwave health issue from almost total obscurity to becoming a major environmental priority for the public.⁹⁸

Although agreeing with much of Brodeur's concerns Nicholas Steneck was not in agreement with the way Brodeur researched and wrote his first book, *The Zapping of America*. Quite separate from the reality of the issue, Steneck wrote that Brodeur "employed ambiguity and vagueness as tools to create the sensational cover-up story that has been used to popularise his book". Steneck added: "By confusing chronology, taking statements out of context, ignoring evidence or presenting it in negative ways, relying primarily with sources that agree with his point of view, and many other techniques, he is able to craft a history of the development of the microwave debate that suits his purpose and that supports his conclusions".⁹⁹

Detractors of Brodeur's writings also include physicist Robert Park, who, in his book *Voodoo Science*, devoted an entire chapter to critiquing Brodeur's writings, specially *Currents of Death*. Park accused Brodeur of engaging in baseless conspiracy theories in his claims that microwaves were harmful and that there was a cover-up underway. Park went on to give reassurances of safety from Eleanor Adair (a major author of the C95.1 RF standard development) and Robert Adair (Eleanor's physicist husband – mentioned previously in relation to PAVE PAWS). Eleanor found Brodeur's claims of a supposed cover-up "preposterous" and Robert considered claims of non-thermal hazards (cancer causation) from microwave exposure false because the energy was not strong enough to break chemical bonds necessary for DNA damage. According to R. Adair "there was no known mechanism that could account for reports of health_effects from low levels of microwave radiation", (meaning levels that did not cause a thermal effect).¹⁰⁰ Park also dismissed Brodeur's claims of powerline hazards.

Park makes a number of valid points over Brodeur's interpretation of the scientific evidence and his emotive fear generating language in trying to make his point but

⁹⁸ L .Slesin, 'Why EMF Risks Get No Respect', *Microwave News*, http://www.microwavenews.com/nc_dec2004.html , Accessed Apr. 3, 2010.

⁹⁹ Steneck, 1984, op. cit., p.196.

¹⁰⁰ R. Park, *Voodoo Science*, The Road from Foolishness to Fraud, Oxford Univ. Press, 2000. pp. 140-149.

in a number of places Park is guilty of committing similar sins. For example, Park accused Brodeur of giving a biased and incorrect recounting of research findings. In his account of the 1996 National Academy of Sciences/ National Research Council (NAS/NRC) review of the power-frequency EMF literature Park simply wrote that the unanimous NAS conclusion was that “the current body of evidence does not show that exposure to these fields presents a human health hazard”.¹⁰¹ Therefore Brodeur’s contention that there was a power-line health hazard would have to be disproved.

What Park failed to report, however, was fact the NAS/NRC Committee only considered approximately half the evidence which was available to it. Dr. Kjell Hansson Mild of the National Institute for Working Life in Sweden, asked Dr Stevens, chair of the NRC Committee, how “the report turned out to be so biased in its selection of papers”. Mild, past president of the Bioelectromagnetics Society, noted that the report mainly included papers that showed no effect and omitted those that found a biological response.¹⁰² The committee acknowledged that workplace studies “have increased rather than diminished the likelihood of an association between occupational exposure to [EMFs] and cancer”. The NAS committee only did what has been called a “superficial overview” of this literature because it claimed it was not directly relevant to the committee’s assignment.¹⁰³ Because the committee was looking for conclusive evidence of a connection with EMFs, it was able to dismiss all data which failed to meet this criterion. Epidemiology looks for increases in risk factors, it does not deal with conclusive proof. By setting such an impossible standard, the NAS/NRC was able to dismiss a possible EMF link with cancer and announce to the world that there was nothing to worry about. In a paper examining the limitations of the NAS/NRC review this writer concluded that the review appeared to be designed to give an assurance of

¹⁰¹ *ibid*, p. 158.

¹⁰² K. Hansson Mild, letter to Dr. Charles Stevens, chairman of the NAS Committee as reported in *Microwave News*, vol. 17, no. 1, Jan/Feb 1997, p. 2

¹⁰³ L.Slesin, ‘NAS Finds No EMF-Cancer Link: Report Stirs Controversy’, *Microwave News*, vol. 16, no. 6, Nov/Dec. 1996, pp. 1, 5 – 7.

powerline EMF safety when the overall body of evidence did not warrant that conclusion.¹⁰⁴

In another brief study analysis by Park, this time the 1997 National Cancer Institute Linet study on childhood leukaemia and EMFs, he claimed the study findings slammed the door shut on any possible EMF health effects. To quote from Park: “The supposed association between proximity to power lines and childhood leukaemia, which had kept the controversy alive all these years, was spurious – just an artefact of the statistical analysis. As is so often the case with voodoo science, with every improved study the effect had gotten smaller. Now, after eighteen years, it has gone entirely”.¹⁰⁵

However Park failed to mention significant limitations of the Linet study in shutting the door. Alasdair Philips from the U.K. pressure group *Powerwatch*, pointed out that in fact the researchers acknowledge, in no less than four places, a statistically significant (24%) increase in acute lymphoblastic leukemia (ALL) in children exposed to powerline magnetic fields in excess of 3 milliGauss. Philips’ pointed out that this was a confirmation of many previous studies which have shown a similar level of association between childhood leukemia and EMF exposure.¹⁰⁶

On July 4th 1998 this writer contacted Professor Ross Adey,(now deceased) who was one of the best known bio-electromagnetic researchers in the world. Dr. Adey was the author of numerous books and research papers on the bio-effects of EMFs. He had conducted a \$3 million research program for Motorola and was a committee chairman on the USA National Council on Radiation Protection and Measurements (NCRP). His comments on the NCI study in reply are as follows:

¹⁰⁴ D. Maisch, ‘Power Frequency Electromagnetic Fields and Human Health – Is it time to end further research? An Overview of Three Recent Studies’, *JACNEM*, vol. 17, no. 1, June 1998, pp. 5 -16.

¹⁰⁵ Park, 2000, p.159-160.

¹⁰⁶ A. Philips, The Powerwatch Network Responds - July 2, 1997, Re: RESIDENTIAL EXPOSURE TO MAGNETIC FIELDS AND ACUTE LYMPHOBLASTIC LEUKAEMIA IN CHILDREN, *New England Journal of Medicine*, July 3, 1997. <http://www.feb.se/Bridlewood/NCISTUDY.HTM>, Accessed Apr. 5, 2010.

A number of us worked on the NCI paper through last weekend. Sam Milham, the Washington State epidemiologist and a pioneer in this field, points out that if they had included the 3 mg level in their cutoff, the conclusions would have been exactly the opposite - that there is a significant risk. And selection of 2 mG is quite arbitrary. David Savitz used 3 mG in some of his work. Obviously there is no steep threshold beyond which risks rise exponentially. At the recent Bologna International Symposium, Schuz from the University of Mainz had a paper combining kids from Berlin and Southern Saxony in high exposure homes to give leukemia odds ratio of 6.8 for young kids (under 4 years). So the dismissive attitude of NCI is totally unrealistic.¹⁰⁷

Allen H. Frey, author of *On the nature of electromagnetic field interactions with biological systems*, (1994) also conducted an analysis of the NCI Linet study. Frey queried: "are the conclusions of the Linet epidemiological study and associated editorial by Campion justified? I think not. As is often the case in science, the fault is in assumptions made before the study began, assumptions upon which the study is based. If the assumptions can not be shown to be true, then the conclusions are not valid".¹⁰⁸

In summing up the Brodeur/Park conflicting interpretation of the EMF science, it is argued that Brodeur has emotively overstated the case (EMF hazards) to make his point to the public over an issue in order to popularise his books. Park, on the other hand, has deliberately understated the case by presenting a very one-sided description of the data to conform to his opinion that it is physically impossible for there to be a hazard. This is somewhat ironic as Park accused Brodeur of giving the public a seriously distorted view of the scientific facts.¹⁰⁹ This is very much another example of a procrustean approach on the part of Park who appears in his book to have rejected any research evidence that environmental level EMFs may have a hazardous biological impact. This is because of his understanding as a physicist

¹⁰⁷ Correspondence with Ross Adey, Jul. 7, 1997.

¹⁰⁸ A. Frey, statement on the NCI Linet study, Jul 13, 1997, .
<http://www.feb.se/Bridlewood/NCISTUDY.HTM>, Accessed Apr. 5, 2010

¹⁰⁹ Park, 2000, p.158.

that non-ionizing radiation has insufficient energy to break molecular bonds, creating charged particles called ions and breaking DNA. Carolyn Miller in her article *"Disciplinary Differences in the Response to Anomaly"* (2005) explored the wide differences in expert understandings on EMF bio-effects between physicists on one hand and bioelectromagnetic scientists on the other.¹¹⁰ In one case she recounted how physicists were excluded from a review panel on EMF effects because an insider alleged in a *Science* article that "physicists were considered too sceptical of EMF bioeffects and that they had had trouble accepting what's going on in the field".¹¹¹ Considering the views of physicists Park and Adair (above) this may have some validity.

The Moscow affair: inconvenient signals

About a year after the end the Tri-Services program, it was discovered that from approximately November 1962 the Soviets had been beaming highly focused microwaves directly into the US Embassy in Moscow at an estimated power density that ranged from .005 mW/cm² to .018 mW/cm².¹¹² Averaged measurements determined that although the intensity reaching the Embassy was approximately 500 times less than the US standard for occupational exposure, it was twice the highest limit allowed in the Soviet standard.¹¹³ This created a quandary for the US, for if they truly believed their thermally-based 10 mW/cm² standard was safe they could hardly conclude that the level of microwaves at their Embassy was undermining the health of the Embassy staff. Concerns were raised about the purpose of irradiation of the Embassy. Was it eavesdropping or a more sinister attack on the health of the employees? An initial study was done on the Moscow personnel in 1967 that examined a group of 43 workers, (37 exposed and 7 not exposed). They were tested for abnormalities in chromosomes and 20 out of the 37 were above the normal range among the exposed, compared to 2/7 among

¹¹⁰ C. Miller, 'Novelty and Heresy in the Debate on Nonthermal Effects of Electromagnetic Fields', in Harris, Randy Allen (ed.) *Rhetoric and Incommensurability*, Parlor Press, 2005. p. 464 - 505.

¹¹¹ C. Miller, 2005, op. cit., p. 475.

¹¹² J. Goldsmith, 'Epidemiologic Evidence of Radiofrequency Radiation (Microwave) Effects on Health in Military, Broadcasting, and Occupational Studies', *International Journal of Occupational and Environmental Health*, vol. 1, no. 1, Jan.-Mar. 1995.

¹¹³ L. Dalton, *Radiation Exposures*, Scribe Publications, 1991, p. 31.

the non-exposed. In the final report the scientists urged a repeat and follow-up study which was clinically indicated for 18 persons, but was not undertaken by the end of the contract period, June 30, 1969.¹¹⁴ The evidence of chromosome changes was strong enough to have triggered clinical guidelines that would have recommended ceasing reproductive activity until the condition had improved.¹¹⁵ At a Superpower summit in June 1967 the irradiation of the Moscow Embassy was the subject of a confidential exchange between US President Lyndon Johnson and Soviet Prime Minister Alexi Kosygin. Johnson asked that the Soviet Union stop irradiating its Moscow Embassy with microwaves and harming the health of American citizens.¹¹⁶ In 1966 a covert study, called *Project Pandora*, was commenced to study the possible effects on health from the microwave irradiation of the Moscow Embassy staff, who were not told the true reason for the investigation. In a related study, *Project Bizarre*, a primate was exposed to microwaves at half that permitted by the US standard. The findings of this study concluded, “[t]here is no question that penetration of the central nervous system has been achieved, either directly or indirectly into that portion of the brain concerned with the changes in work functions”.^{117 118}

A haematologic study by J & S Tonascia in 1976 found highly significant differences between Moscow Embassy employees and other foreign service staff (control group). White blood cell counts were much higher in the Moscow staff as well as several other significant changes noted over time. These results were never published, but obtained under the Freedom of Information Act.¹¹⁹ At this time there was a US Congressional radiation inquiry underway and the Department of Defense (DoD) was arguing that the US RF/MW Standard was already strict

¹¹⁴ J. Goldsmith J. ‘Where the trail leads’, *Eubios Journal of Asian and International Bioethics* vol. 5, Jul. 1995, p 93.

¹¹⁵ Goldsmith, *Epidemiologic Evidence*, 1995.

¹¹⁶ Dalton, 1991.

¹¹⁷ Dalton, 1991, *op. cit.*, pp 31-32.

¹¹⁸ N. Steneck, *et al.* ‘The Origins of US Safety Standards for Microwave Radiation’, *Science*, vol. 208, 1980, pp.1230-7.

¹¹⁹ Steneck, 1980.

enough. They argued that there was no scientific evidence for the Soviet Standard being set at a level one thousand times lower than the US standard.¹²⁰

The Moscow Embassy employees and dependants were studied for possible health effects of microwave irradiation by a team from John Hopkins University, under the direction of epidemiologist Professor Abraham Lilienfeld. Dr Lilienfeld noted that the study group was quite small and that the follow-up time too short to generally identify significant health effects such as cancer. He recommended that continued health status surveillance should be carried out, but this was not done. The incidence of sickness and death were compared with employees & dependents in other Eastern European embassies, and with the average US rates.¹²¹ The incidence of multiple-site cancers was far more frequent in the Moscow Embassy group than in any other population studied. It was noted that while multiple-site cancers are characteristic of older populations, the Moscow Embassy group was relatively young. According to Goldsmith, concerns of the John Hopkins team were “downgraded” by the state department and the wording of the team report altered to lessen its impact. Lilienfeld strongly recommended that additional follow up studies be undertaken since the latency periods for some types of cancer had been insufficient for cancer to occur, if indeed it were to result from microwave exposure. Nevertheless, according to Goldsmith, the overall findings were consistent with excess cancer incidence both in the Moscow Embassy cohort and in the other Eastern European embassy personnel.¹²² Data on exposure and occurrence of some cases of cancer were withheld from Professor Lilienfeld until after his report was completed and it was too late to include in the results. Reviews of the work done by contract investigators were interpreted as inconclusive because the State Department had failed to complete the necessary follow-up work which was recommended by the Lilienfeld team.¹²³

Goldsmith concluded that the evidence from the Moscow study was suggestive for four health effects, (a) chromosomal changes, (b) haematological changes, (c)

¹²⁰ Dalton, 1991. op. cit., p. 32.

¹²¹ Dalton, 1991, op. cit., pp. 52-53.

¹²² Goldsmith, ‘Epidemiologic Evidence...’, 1995.

¹²³ Goldsmith, ‘Where The Trail leads’, 1995, op. cit., p. 93.

reproductive effects, and (d) increased cancer incidence from the microwave irradiation in Moscow.¹²⁴

In spite of the above, it is interesting to note that in the 1998 published ICNIRP Guidelines, supposedly including only quality peer reviewed research, the Moscow embassy affair is only briefly mentioned in relation to the 1978 Lilienfeld study. ICNIRP concluded that the study “found no evidence of increased morbidity or mortality from any cause”¹²⁵ even though it can be argued that the inadequacies in the study should have prevented it from being referenced as such by ICNIRP.

The international dimension

Another challenge for American military planners during the 1950s - 1960s was that as many of their weapons and high power early warning radar systems were being deployed in Western Europe, the stricter RF standards in Russia and the Eastern European countries posed a potential threat to their operations. This was especially so if any of America’s Western European allies were tempted to adopt the stricter standards, based on what the Soviet scientists were saying, thus possibly placing restrictions on American radar deployment. This meant that not only was there a need for the US military to discredit the Soviet standards but also to discredit the very basis for those standards - the existence of low-intensity biological effects not related to heating. For maximum effect this attack on Soviet science was best played out in an international setting. This meant that, concurrent to the space/arms race with the Soviets, there was an RF standards race, played out in various international organizations such as WHO and the North Atlantic Treaty Organization (NATO).

After the end of the Tri-Services program in 1961 the careers of Herman Schwan and Sol Michaelson advanced significantly, with both being funded by the

¹²⁴ *ibid.*

¹²⁵ ICNIRP, ‘Guidelines For Limiting Exposure To Time-Varying Electric, Magnetic, And Electromagnetic Fields (Up To 300 GHz’, *Health Physics*, vol. 74, no. 4, Apr. 1998, pp 494-522.

Department of Defense (DoD).¹²⁶ Both men, especially Michaelson, began being appointed to numerous expert committees and testifying at court hearings as to the safety of both power frequency EMFs and RF facilities, using the 10 mW/cm² limit as a safe level below which no effects could possibly happen.¹²⁷ By 1973, Michaelson was a member of an extensive array of expert committees of the Academy of Sciences, WHO, NATO, the President's Office of Telecommunications Policy, Electric Power Research Institute, Veterans Administration, National Institutes of Health, Walter Reed Army Institute of Research, the Navy and the American National Standards Institute, where he would have worked on developing the C95.1 RF standard.¹²⁸ Michaelson, in particular, made a point of viciously attacking the credibility of any researcher who dared release scientific research findings that questioned the 10 mW/cm² limit, including the Soviet research.¹²⁹ It was Michaelson's membership in WHO and NATO committees developing RF standards that served as a vehicle to spread DoD's thermal effects viewpoint to Western European countries. The WHO committee to which Michaelson was appointed was the Task Group on Environmental Health Criteria for Radiofrequency and Microwaves, convened in 1971 by WHO and the International Radiation Protection Agency (IRPA).¹³⁰ In 1974, Michaelson and Michael Suess from the WHO Regional Office for Europe (WHO/EURO) jointly authored a paper, titled, *An International Program For Microwave Exposure Protection*, that called for the establishment of an international program on non-ionizing radiation protection, run by an International agency, such as WHO. An emphasis on only thermal considerations is seen in the reporting on a consensus statement from a 1973 symposium on microwave bioeffects that classified microwave intensities "for convenience and uniformity of approach" in three broad categories. To quote:

¹²⁶ Marino, 1986, op. cit., p. 23

¹²⁷ Marino, 1986

¹²⁸ Marino, 1986, op. cit., p. 16-17.

¹²⁹ Marino, 1986.

¹³⁰ S. Michaelson, M. Suess, 'An International Program For Microwave Exposure Protection', *ITT Transactions on Microwave Theory and Techniques*, Nov. 1974, pp. 1301-1302.

- levels above 10 mW/cm², at which thermal effects occur and in some instances (at high average power densities) may prove hazardous;
- levels below 1 mW/cm², at which thermal effects are improbable;
- intermediate range in which weak but noticeable thermal effects occur as well as direct field effects.¹³¹

The 1971 WHO/IRPA Task Group, mentioned above, went on to establish the International Radiation Protection Association (IRPA) which eventually became the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in 1992, established by Michael Repacholi. Repacholi was chairman of a 1979 WHO review meeting on RF/MW criteria, in Washington D.C., with Michaelson a member of the working group. Michaelson also authored a chapter on RF/MW radiation in the 1982 WHO publication, *Nonionizing Radiation Protection* (WHO Regional Publications, European Series, Vol. 25).¹³² In addition, both Repacholi and Michaelson spoke at the 1984 NATO conference on the biological effects of low-level non-ionizing radiation.¹³³ All this indicates a clear lineage from Schwan's original 10 mW/cm² calculations, on the U.S. DoD 10 mW/cm² standard that went on to become ASA C95.1 -1966 and the basis for the present day RF standards/guidelines of both IEEE and ICNIRP. This line of inquiry will be examined in more detail in Chapter 4. The vital point to be made here is that opposition to recognition of low-intensity biological effects in RF standard setting appears to be primarily a result of super-power rivalry, and the personal convictions of a few key players in the issue and not due to superior science on part of the US. The consequences of a recognition of low-intensity effects in US RF standards was seen as a potential threat to the development and deployment of high power radar equipment that was necessary to detect a possible Soviet nuclear first-strike. Simply put, recognition of low-intensity effects was seen as a risk to national security where any possible health benefits of such recognition were far outweighed by the risk of national, if not global nuclear annihilation. It was under this threat that the central players such as Knauf, Schwan, Michaelson and

¹³¹ Michaelson Suess, 1974.

¹³² Correspondence with Louis Slesin, editor Microwave News, Oct. 12, 2006.

¹³³ B. Dumpe, *X-Rayed Without Consent*, unpublished, Ergotec Association Inc., 1989.

Repacholi, developed their concept of what was proper for RF standard setting. Once the commitment to the thermal 10 mW/cm² standard was cemented into place, there was really no way to retreat from it, even after the collapse of the Soviet Union. It is arguably a surviving legacy of the Cold War years.

ASA C95.1 (1966)

In 1958, DoD delegated the task of RF “standardisation responsibility” jointly to the Air Force and the Navy which soon created factionalism between the two military branches over who would control the scientific research effort and who would be in charge of the standardization process. The RF bio-effects research responsibility still resided with Knauf’s Air Force laboratories at Rome Air Force base, but in 1959 the Navy took a controlling lead in setting standards when its Bureau of Ships enlisted the help of the American Standards Association (ASA), conveniently headed by Admiral G.F. Hussey Jr.¹³⁴ Although Colonel Knauf expressed his concerns over the Navy assuming the lead in the standard setting arena, by the end of 1959 the Navy had assumed the leading role in directing the course of the ASA and later ANSI deliberations.¹³⁵ It was agreed that the ASA would convene a special committee, called C95, to evaluate the hazards from RF/MW radiation. The Bureau of Ships and the American Institute of Electrical Engineers (AIEE) would then jointly sponsor C95’s work¹³⁶. Even before the first meeting faction fighting between the Navy and AIEE created difficulties. AIEE complained that the Navy was pushing ahead without adequately consulting AIEE. The agreed procedure to appoint a chairman also broke down with the Navy asking Herman Schwan (who was not even on the previously agreed to list) to be chairman without consulting AIEE’s representative J. Paul Jordan.¹³⁷ It is very likely the military preferred Schwan as chairman because of Schwan’s firm belief in the military accepted 10mW/cm² level and his dismissal of low level, nonthermal effects. As chairman of C95.1, Schwan could be counted on to maintain

¹³⁴ Later to become the American National Standards Institute (ANSI).

¹³⁵ Steneck, 1984, op. cit., p. 56.

¹³⁶ Later renamed The Institute of Electrical and Electronics Engineers (IEEE).

¹³⁷ Steneck, 1984, op. cit., p. 56-57.

the growing acceptance of the thermal paradigm. Jordan, as Steneck puts it, “hit the roof” and objected to Schwan’s nomination. Concerns were raised by another person at the meeting that Schwan would accept no compromise to his own ideas. Jordan however later reluctantly agreed to Schwan assuming the chairmanship, with reservations, and on February 15, 1960 the ASA C95 Committee met for the first time to start work on an occupational RF/MW standard.¹³⁸ Schwan set up six sub-committees (C95.I to C95.VI) each with a specific task to investigate and with a quarterly time-table to adhere to, during which progress reports would be tabled and further deadlines set. It was planned that this work would result in enough information gathered to enable C95 to begin drafting a standard within the year.¹³⁹ Schwan set this brief time frame because the scientific base of the standard setting effort was to be the work previously carried out by the Tri-Services program¹⁴⁰. Interpretations of the Tri-Services Project data would form the bulk of the work on which to draft a standard. Schwan’s viewpoint was that it was not the function of C95 and its sub-committees to undertake research to fill in any gaps in the knowledge base, but simply to go with what was already known – meaning that Schwan’s 10mW/cm² limit would be the only logical end point to consider. However, all did not go according to plan. A ‘turf-war’ conflict again surfaced between the AIEE and the Navy over controlling the effort. The sub-committee’s work did not progress well, resulting in no quarterly meetings for well over a year and several sub-committees folding. As Steneck reports, the progress of both the C95 full committee and its sub-committees were hampered by members failing to show up for planned meetings, making the preparation of progress reports difficult, if not impossible. Rather than Schwan’s ambitious one-year time frame it took six years of squabbling between the factions before an agreed occupational standard could be adopted in May 1966, and that only after several unsuccessful months spent trying to get enough members present to achieve the required consensus to approve the standard. That was only achieved by lowering the number required to reach consensus.¹⁴¹

¹³⁸ Steneck, 1984

¹³⁹ Steneck, 1984.

¹⁴⁰ David, 1980, op. cit., p.21.

¹⁴¹ Steneck, 1984, op. cit., p. 59.

When the first occupational standard (C95.1-1966) was finally adopted six years later in November 1966, it took months just to assemble the votes required to pass the standard, and that could only be achieved by lowering the number required to reach a quorum.¹⁴² C95.1 (1966) was based on a simple thermal model that limited absorbed power to 100W with the recommended whole-body exposure limit set at 10mW/cm².¹⁴³ This essentially mirrored the thermal paradigm established by the Tri-services Program. As Steneck stated “The early standard setters accepted thermal thinking as a fact of science and ignored the weaknesses of their evidence through an act of faith.”¹⁴⁴ When the 1966 standard was sent out for a vote amongst the full committee members the membership was divided up into interest groups to demonstrate a supposed broad base of support for the standard. It is interesting to note that the organisations listed as representing the consumer interests in the 1966 standard were as follows:

American Petroleum Institute

Armed Forces Institute of Pathology

General Dynamics

National Aeronautics and Space Administration

U.S. Department of the Air Force, Rome Air

U.S. Department of the Army, Environmental Hygiene Agency

U.S. Department of the Army, Material Command

U.S. Department of the Army, Office of the Surgeon General

U.S. Department of the Interior, Bureau of Mines

U.S. Department of the Navy, Bureau of Medicine and Surgery

U.S. Department of the Navy, Bureau Naval Weapons

U.S. Department of the Navy, Bureau of Ships

U.S. Department of the Navy, Marine Corps

U.S. Department of the Treasury, Coast Guard

U.S. Public Health Service.¹⁴⁵

¹⁴² Levitt, 1995, op. cit., p. 25.

¹⁴³ Osepchuk, Petersen, 2003, op. cit., p. S8.

¹⁴⁴ Steneck, 1984, op. cit., p. 60.

¹⁴⁵ Steneck, 1984, op. cit., p. 61.

This list supports Steneck's view that the 1966 standard was developed primarily by producers for industrial and military users, not by consumers or for consumers.¹⁴⁶

ASA C95.1-1966 was approved as an occupational standard on November 9, 1966, covering 10 Mhz to 100 Ghz. Remarkably, the entire 1966 standard that took six years to adopt was only 1.2 pages in length.¹⁴⁷ Before further work on refining the standard could be started however, Schwan withdrew from active involvement with C95 leaving the issue to a future committee.

Later revisions of the ASA C95.1-1966 were published in 1971 under the auspices of the American National Standards Institute (ANSI C95.1-1971), in 1982 (ANSI C95.1-1982), in 1991 (IEEE C95.1-1991) which became ANSI/IEEE C95.1-1992 . The latest complete revision, ANSI/IEEE C95.1-2006 is still to be approved by the FCC as of January 2009.

Saul Rosenthal of the Polytechnic Institute of Brooklyn took over as chairman of the full C95 committee in June of 1968. Noting that the 1966 standard was based almost exclusively on data collected prior to and during the Tri-Services era, Rosenthal stated that C95.1-1966 was "an excellent one [that] still leaves much to be desired because its data base was deplorable", thus hinting that a vigorous research effort was needed in order to validate the standard.¹⁴⁸

Arthur Guy took over the chairmanship of the C95.IV sub-committee in June 1970 and set up the following five groups to "identify and document the requirements for additional information needed to modify or improve present standards"¹⁴⁹ These five sub-committees were as follows:

¹⁴⁶ Steneck, 1984.

¹⁴⁷ P. Mason, M. Murphy, R. Peterson, 'IEEE EMF Health & Safety Standards', WHO Meeting on EMF Biological Effects and Standards Harmonization in Asia and Oceania, Shilla Hotel, Seoul, Korea, 22-24 October, 2001, http://www.who.int/peh-emf/meetings/southkorea/en/IEEE_EMF_HEALTH_-_Mason.pdf, Accessed Aug. 29, 2006.

¹⁴⁸ Steneck, 1984, op. cit., p. 150.

¹⁴⁹ Steneck, 1984.

- Near Zone field effects, chaired by John Osepchuk from Raytheon
- Frequency effects chaired by Albert Kall from Ark Electronics and Sidney Kessler from the U.S. Information Agency
- Low-level (athermal) and modulated effects chaired by Allan Frey from Randomline.
- Environment chaired by Bill Mumford from Bell Telephone
- Population Groupings chaired by William Mills from the Bureau of Radiological Health (BRH)¹⁵⁰

Addressing the perceived limitations of the 1966 standard, ophthalmologist Milton Zaret wrote an open letter to ANSI with a number of recommendations for future revisions. Zaret noted the lack of epidemiological studies on large populations and therefore recommended the standard should state that it was not intended to apply to the general public. Also noting the lack of data, he was of the opinion that pulsed RF radiation with peak powers more than 100 times their average and non-uniform fields should be excluded from the standard. To address other potential problems Zaret suggested requiring wording in the standard stating: “When a radiation generating system either is capable of exceeding the recommendations or is not adequately defined by this guide, then...the user should ensure its safety by performing appropriate biological assay experiments.” In order to avoid an impression of certainty where none existed, Zaret recommended changing the phrase explaining the safety of below threshold exposures from “will not” to “is believed not to result in any noticeable effect to mankind.”¹⁵¹ Zaret’s recommendations were discussed by the committee and rejected, with vigorous opposition being expressed by industry representatives John Osepchuk (Raytheon) and Paul Crapuchetts (Litton Industries). Had Zaret’s proposals been accepted it would have changed the accepted thermal-only protocol for ANSI’s RF bioeffects studies and would have shifted the onus on ANSI to justify its scientific information before issuing a standard. As well, long-term, low level (non-thermal) bioeffects studies would have to be done as well as public and occupational epidemiological studies. Such recommendations would have been more in line

¹⁵⁰ Steneck, 1984.

¹⁵¹ Steneck, 1984, op. cit., p. 151.

with chairman Rosenthal's call for a vigorous and active program of research to validate the standard but unfortunately this was not to be the case. Both the military and industry members on the ANSI C95 committee would have been aware that the changes along the lines of Zarat's recommendations would have put the onus on them to further verify the safety of the technology for the people operating it or being exposed to it before the equipment was deployed. Keeping the thermal-only emphasis of the standard brought certainty for the rapidly developing technology for both civilian and military applications. Consideration of other possible lower-level bioeffects not related to thermal increases was fraught with uncertainty and the need to somehow deal with the concept of risk that it implied.

Epidemiological studies may uncover evidence of hazards at low level, prolonged exposures, something that the C95 committee members would have been aware of from what the Russian data suggested. Evidence of low-level environmental hazards could adversely impact on operational requirements of the military. Litigation and product recalls could be a problem for the corporations if their products were found to have emissions implicated with non-thermal hazards. In other words, rejection of Zaret's recommendations could be considered as a strategic decision with little to do with science but all to do with protecting the roll-out of new wireless technology, which at the time was mainly radar. One additional problem would have been that the majority of RF bio-effects researchers on the committees would have been schooled in the thermal-effects-only philosophy, giving an intellectual conflict of interest against recommendations that ran counter to their understanding. As it turned out Rosenthal did not get his call for a "vigorous and active program of research to validate the standard". Instead, the final report from the study groups, "Research Needed for Setting of Realistic Safety Standards" stayed safely within the previous thermal bioeffects structure – conducting animal experiments to learn more about the basic thermal mechanism. Little attention was paid to epidemiological population studies or low-level-long term studies.¹⁵²

¹⁵² Steneck, 1984, op. cit., p. 151-152.

Subservience of future revisions to C95.1 to military operational needs was spelt out in a June 5, 1968 letter to Senator Warren Magnuson, chairman of a Commerce Committee hearing testimony on electronic device emissions and public health. The letter was from the acting general council for DoD. To quote:

It is understood, however, that the development of product standards to protect the public health will not necessarily preclude the use of devices, e.g., radars, communications transmitters, etc., which are designed to intentionally emit large quantities of radiation. The use of such devices is often essential to meet requirements of the national defense. It is anticipated that in developing standards, the Department of Health, Education and Welfare will give consideration to the use and purpose of these devices and will consult with other federal agencies on the development of standards which could have such an effect on these devices. Moreover, if standards are developed that do have an effect on the operation of devices essential to the national defense it is understood that this will be a matter subject to exemption under section 360 (A0 (b)).¹⁵³

ANSI C95.1 – after 1966

The thermally restricted philosophy embodied in the 1966 standard ensured that the ANSI C95.1-1974 standard would, like its predecessor, also be based on a simple thermal model, limiting the “absorbed power” to less than 100 Watts, a value comparable to the resting metabolic heating of an adult human. The recommended power density limit for whole-body exposure was still 10 mW/cm² but the 1974 standard added electric and magnetic field limits (E₂ and H₂) to account for near-field exposures at frequencies below a few hundred MHz. The 10 mW/cm² value continued to be applied to continuous exposures. However, for short time exposures, a time factor was introduced to come up with the 10mWh/m², based on an averaging time of 0.1 hour (6 minutes). The 6 minute averaging time was because it was considered an appropriate thermal time

¹⁵³ Brodeur, 1977, op. cit., p. 46.

constant for important organs, such as the eyes and testes.¹⁵⁴ The same limits applied for both the workplace and the public (a single tier).

In 1978 the IEEE Committee on Man and Radiation (COMAR) held a workshop that included a discussion on an ongoing level of cooperation between Soviet and American engineering and biological scientists that was apparently of mutual advantage to both countries. Most importantly a dismissal of the Soviet sciences was not apparent from what is written about the proceedings. In fact, it is quite the opposite. To quote from COMAR:

The American delegates have learned that Soviet biological studies often possess an important feature lacking in Western studies: ecological validity – or what might be called experimental modelling that more nearly resembles the way that RF radiation is encountered by people in the real world. Soviet biologists have conducted many long-term experimental studies; only a handful has been reported by western investigators. Soviet physicians have conducted numerous epidemiological surveys; few have been attempted in the West. And finally, the long-term Soviet studies, experimental and epidemiological are closely matched; i.e., animals are exposed in settings that closely resemble those that characterize workers who are exposed to RF fields. The Western scientist can make a good case for the tightly controlled environmental conditions that have characterized his researches, but he is beginning to realize that a pooling of methodologies that incorporate the environmental and dosimetric rigor of the West with the long-term exposures and ecologically valid designs of the East will be necessary if the potential hazards of low-level fields are to receive credible scientific evaluation. In short, the Soviet scientist has profited from U.S. engineering, and the U.S. scientist from Soviet methodology.¹⁵⁵

In a Department of Energy /NASA study of microwave standards done in 1980 it was reported that there was a trend toward a convergence (harmonization) of the

¹⁵⁴ Osepchuk, Peterson, 2003.

¹⁵⁵ David, 1980, op. cit., p. 17.

differing RF standards worldwide. The proposals were to lower Western levels while some Eastern European countries increase their standards. For the next revision to ANSI standard (1982) the changes would have seen a frequency dependent reduction of exposure limits to 1 mW/cm² for the 10 – 400MHz range, and 5 mW/cm² for the higher microwave frequencies.¹⁵⁶ Unfortunately, however, the proposed changes did not carry over to the 1982 ANSI RF standard which re-affirmed the maximum permissible exposure of 10 mW/cm². It is surmised here that U.S. military planners decided that any departure from the 10 mW/cm² limit was a defacto acknowledgment of the possibility of non-thermal bio-effects and therefore posed the possibility of impacting on their operational requirements.

A major feature of the 1982 standard was the departure from being a ‘flat standard’, meaning simply limiting absorbed power to less than 100 Watts with a maximum power density of 10 mW/cm² regardless of frequency, to a frequency dependent whole-body-average “Specific Absorption Rate” (SAR), measured in Watts per kilogram (W/kg). For a given volume of tissue, the SAR indicates the average rate at which energy is absorbed for each kilogram, or gram of tissue. This change was due to accumulated evidence that RF energy thermal-effects are not simply related to the power density of the energy (mW/cm²) but how much energy is actually being absorbed in tissue, especially sensitive areas such as internal organs, the eyes and testes, for example¹⁵⁷. Although the introduction of the SAR concept in the 1982 standard gave a far more accurate picture of how microwave energy actually penetrates into the body to be converted into heat, it also introduced a high level of complexity. This was in the recognition that the rate of energy absorption and distribution of energy inside the body depended upon many factors. These include the dielectric composition of the tissue (ability to conduct electricity), the size of the object relative to the wavelength of the energy¹⁵⁸, shape, geometry and orientation of the object, and distance of the object from

¹⁵⁶ David, 1980, op. cit., p. xii.

¹⁵⁷ As early as 1955 Herman Schwan and G.M Piersol reported that there was a danger of causing burns when RF energy is applied over bony prominences. Their explanation for this observed effect was that non-uniformities, such as bone ridges and irregular fat layers caused the energy to be absorbed non-uniformly within the body or head. In: Kane, Robert, “*Cellular Telephone Russian Roulette; A Historical and Scientific Perspective*”, 2000, p. 42.

¹⁵⁸ For example at 1.8 MHz the wavelength is 171 meters and at 460 MHz it is 65 cm.

the radiating source. In addition to making the distribution of energy in an irradiated body extremely complex and non-uniform, a further complexity is the acknowledgment of the creation of “hot-spots” of concentrated energy in body tissue, the location of which depends on the above factors.¹⁵⁹

SAR calculations acknowledge resonance effects between the energy and human tissue. If the object is equal in size to one wavelength, or certain fractions of that wavelength (1/2, 1/4, etc.) the tissue is likely to resonate with the energy and thus absorb more of the energy. When there is no resonance much less energy is absorbed as it is simply reflected or passes through the object. Less absorbed energy means less heating. So as the frequency increases in the GHz range, for example, there is a decreasing resonance effect with the size of the body or its organs and therefore less heating takes place.¹⁶⁰ The frequencies from about 700 MHz to 1,000 Mhz have the greatest resonance with human tissue and therefore yield the greatest energy absorption.¹⁶¹

Acute exposure studies had determined that 4 W/kg was the hazard level for thermal damage and by including a safety factor of 10 the standard came up with a safe SAR limit of 0.4 W/kg that was meant to apply to all possible size and age groups of humans, including children.¹⁶² This level, termed the RF Protection Guide (RFPG) limit, applied for frequencies between 100kHz and 6 GHz. The 1982 standard also stipulated that a local SAR limit in any one gram of tissue in the form of a cube averaged over a 6 minute period must not exceed 20 times the whole-body-average limit i.e., 8W/kg.¹⁶³

¹⁵⁹ H. Lai, ‘Neurological Effects of Radiofrequency Electromagnetic Radiation’, Workshop on Possible Biological and Health Effects of RF Electromagnetic Fields, Mobile Phone and Health Symposium, Vienna, Austria, Oct. 25-28, 1998.

¹⁶⁰ G. Lapin, Understanding SAR, ARRL RF Safety Committee.
<http://www.arrl.org/rfsafety/lapin/2000/08/29/1/index.html>, Accessed May 4, 2006.

¹⁶¹ R. Kane, *Cellular Telephone Russian Roulette: A Historical and Scientific Perspective*, Vantage Press, 2001, p. 4.

¹⁶² IEEE/ICES, Unapproved minutes, SCC-28 Subcommittee 4, 8th Revision Working Group Meeting, National Electrical Manufacturers Association, Rosslyn, VA, Sept. 25, 2003.
<http://grouper.ieee.org/groups/scc28/sc4/sc-4%208th%20rwg%20minutes-september%202003.pdf>, Accessed May 18, 2009.

¹⁶³ O. Gandhi, G. Lazzi, ‘The ANSI/IEEE RF Safety Standard and its Rationale’, invited report for the IEEE Antennas and Propagation, Man and Radiation Committee (undated) <http://www.ece.tamu.edu/~eml/AP-S/comar/ANSIstandar1.pdf>, Accessed April 18, 2006.

The SAR 4 W/kg “hazard level”, considered the “biological endpoint” on which the 1982 RF standard was based, went on the basis for all subsequent Western RF standards. This “biological endpoint” was simply based on acute short term exposure findings from several laboratories that behavioural disruption¹⁶⁴ of laboratory animals such as rats and monkeys occurred at a whole body average SARs of 4 to 8 W/kg applied for 30 to 60 minutes.¹⁶⁵ ¹⁶⁶ In comparison, the “biological endpoint” of the Soviet RF standard was both subjective and objective symptoms reported amongst RF exposed workers.¹⁶⁷

The problem of dealing with “hot spots” that may actually exceed C95.1 standard limits and cause selective thermal damage to tissue especially in the brain, was avoided by averaging SARs over a 1 gram block of tissue (later increased to 10 grams).¹⁶⁸ This conveniently averaged out hot spot levels for compliance purposes, but of course in the real world exposure situation the hot spots would still be there selectively heating tissue. This was a problem seen in research conducted by Lin, Guy and Caldwell (1977) on rats irradiated in the near-field region. They found hot spot creation with energy levels up to 1,500+ times the expected level. They proposed that even at low SARs microscopic hot-spot destruction may be occurring unnoticed.¹⁶⁹ This is a clear thermal effect not covered by C95.1-1982 and still avoided to this day by averaging in Western RF standards. As seen in the most recent revision of C95.1, explored later in this chapter, simply by increasing the averaging mass for compliance testing effectively increases the allowable exposure levels. Steneck made an interesting comparison about this type averaging methodology:

The average whole-body momentum delivered by a 1 ounce bullet travelling at 500 feet per second is about one hundred times less than that delivered by a

¹⁶⁴ Defined as changes in food motivated learned behavior.

¹⁶⁵ Gaundi, Lazzi, (undated), op. cit.

¹⁶⁶ Osepchuk, Peterson, 2003.

¹⁶⁷ Hecht, Balzer, 1997.

¹⁶⁸ Kane, 2001, op. cit., pp. 42-55.

¹⁶⁹ Kane, 2001.

200 pound football player running at 12 miles per hour. The fact would offer little consolation if the point of impact of the bullet were the heart.¹⁷⁰

Steneck concluded that the type of logic inherent in C95 .1 RF standard, a logic that aims to maximise the levels of allowable RF energy, is a desire to maximise opportunities to expand the use of RF technology. He also concludes that as the values of the military and Industry are predominant in C95.1-1982, “at heart C95.1-1982 is a military-industrial standard”.¹⁷¹ Steneck noted:

This conclusion should come as no surprise. C95 activities are coordinated by the navy and IEEE, two user-orientated organizations. Roughly two of every three C95 members represent military or industrial interests. Many of the scientists who advised during the standard setting process, including C95.IV chairman Bill Guy, were funded by the military. At every critical juncture the main input into C95.1-1982 came from the user community. That it should as a result reflect the values of that community is natural.¹⁷²

Like the 1966 and 1974 standards, the 1982 standard was single tier, ie. the same limits applied in the workplace and for the public.¹⁷³

Steneck summed up what the available research indicated by 1982 in that:

- The work related to [product] safety had not been performed;
- The overwhelming indications are of a hazard to near-zone exposure;
- Many types of “hot spot”-generating mechanisms compounded the effects of even low-level radio frequency radiation exposures;
- Humans cannot be used for the potentially deadly experiments to determine safety/hazard levels.¹⁷⁴

¹⁷⁰ Steneck, 1984, op. cit., p. 237.

¹⁷¹ Steneck, 1984, op. cit., p. 238.

¹⁷² Steneck, 1984, op. cit., p. 239.

¹⁷³ Osepchuk, Petersen, 2003.

¹⁷⁴ Steneck, 1984, op. cit., p. 63.

In 1988, the C95 committee was re-named Standards Coordinating Committee 28 (SCC28) under the sponsorship of the IEEE Standards Board. In September 1992, the IEEE Standard Board approved the IEEE Standard: *Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*, (IEEE C95.1-1991). This standard added the issue of electrostimulation at frequencies below 100kHz and surface heating over 6 GHz. Averaging times were altered to eliminate the possibility of skin burns for short exposures and limits for induced and contact current were also included. Exposure values for electric and magnetic fields were calculated by spatially averaging over an area equivalent to the vertical cross-section of the human body rather than using the previous local values. This allowed considerably higher limits when non-uniform, rather than uniform, whole-body SARs were involved. For the first time a two-tier level in the 100 kHz to 6 GHz region was added. Rather than define populations as occupational or public the concept of controlled and uncontrolled environments¹⁷⁵ was introduced.¹⁷⁶ The two-tier system saw the introduction of an additional factor of 5 being applied to the lower tier, resulting in a safety factor of 50 for the uncontrolled environment, which included the general public¹⁷⁷.

In November 1992, the American National Standards Institute (ANSI) approved the IEEE C95.1-1991 standard to be called “ANSI/IEEE C95.1–1992, “Safety levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields”, 3 kHz to 300 GHz”. What is seen in the history of the C95-1 standards is that the emphasis was on further defining thermal effects and providing safety against those, and how to side step the issue of thermal hot spots by averaging. As newer microwave emitting technology utilised ever higher frequencies a relaxing of the standard was seen under the pretext that higher frequencies penetrated less into the body and thus gave a lower SAR value and allowable power density level at higher frequencies. This was much the argument given in the Australian TE/7 committee as will be examined in Chapter 4.

¹⁷⁵ The two-tier approach sets exposure limits both for workers who supposedly knew how to work around an RF environment (controlled), and members of the public that might be exposed (uncontrolled).

¹⁷⁶ Osepchuk, Petersen, 2003.

¹⁷⁷ IEEE/ICES, Rosslyn Virginia, 2003, op. cit.

The original opinions of Knauf and Schwan back during the Tri-Services era as to the non-existence or non-importance of RF bio-effects effects not related to SAR heating of body tissue had become the paradigm in subsequent standard work. To quote from the 1992 ANSI/IEEE standard:

No verified reports exist of injury to human beings who have been exposed to electromagnetic fields within the limits of frequency and [specific absorption rate] specified by previous ANSI standards . . ."Measurements have shown that routine exposure of users and other persons to low power portable and mobile transceivers and cellular telephones do not induce rates of [radio frequency] absorption that exceed any of the maximum permissible rates of energy absorption defined by these guidelines" [IEEE, ANSI]. Therefore, based on present knowledge, the exposures from low-power transceivers are considered to be without risk for the users and the public.¹⁷⁸

And as described by IEEE members Osepchuk and Petersen :

Contemporary RF/Microwave standards are based on the results of critical evaluations and interpretations of the relevant scientific literature. The SAR threshold for the most sensitive effect [heating] considered potentially harmful to humans, regardless of the nature of the interaction mechanism, is used as the basis of the standard. To account for uncertainties in the data and to increase confidence that the limits are below levels at which adverse effects could occur, somewhat arbitrary safety factors (typically 10-50) are applied to the established threshold.¹⁷⁹

¹⁷⁸ ANSI IEEE C95.1-1992, 'IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz', As stated in the IEEE USAB Entity Position Statement Human Exposure to Radio frequency Fields from Portable and Mobile Telephones and other Communication Devices, December 2, 1992.

¹⁷⁹ Osepchuk, Petersen, 2003.

Challenges to the 1992 ANSI/IEEE standard

In May 1991 the Ground Systems Group of Hughes Aircraft, a major military contractor and a subsidiary of General Motors Corporation, effectively rejected the IEEE C95.1-1991 RF standard (accepted by ANSI in 1992) by formally adopting for its employees the 1984 'in-house' RF/MW standard set by Johns Hopkins University Applied Physics Laboratory (JHU-APL).¹⁸⁰ The Hopkins group had set a 'flat' 100uW/cm² maximum exposure standard for the frequency range of 30 Mhz to 100 GHz. This was 10 times lower than ANSI C95.1-1982 for the 30-300 MHz band and 50 times lower at frequencies above 1500 MHz.¹⁸¹ JHL-APL's move was prompted by studies by JHL-APL's Henry Kues and the FDA's Jack Monahan that found SAR levels below the accepted ANSI/IEEE threshold level of 4W/Kg could cause persistent eye damage. This cast doubt on the assumption by ANSI/IEEE that there were no adverse health effects of RF/MW radiation below 4 W/Kg. According to *Microwave News* the ANSI/IEEE subcommittee that drafted the 1992 standard largely ignored the research by Kues and Monahan.¹⁸²

In a surprising break with military policy, in 1993 the ANSI/IEEE C95.1-1992 standard was challenged by the Phillips Laboratory at Kirkland Air Force base. In June of that year Dr. Brendan Godfrey, the director of the Advanced Weapons and Survivability Directorate at the Phillips Lab, instituted a policy for their employees that limited exposures to a flat 100 uW/cm² for frequencies between 30 MHz to 100 GHz, similar to the 1984 JHU-APL RF standard.¹⁸³ This new policy was prompted by Dr. Cletus Kanavy, chief of the biological effects group at the Phillips Labs. Kanavy wrote to Godfrey that he had concluded, based on a survey of the scientific community engaged in RF/MW radiation bioeffects research, that there is a "consensus" that "nonthermal effects do exist and that the ANSI/IEEE standards are deemed inadequate to protect human health." According to Kanavy,

¹⁸⁰ L. Slesin, 'ANSI RF/MW Standard Challenged, U.S. Air Force and Hughes Units Adopt Limits up to 100 Times stricter', *Microwave News*, vol. 13, no.5, Sept/Oct 1993.

¹⁸¹ L. Slesin, 'Hopkins Lab Sets 100 uW/cm² RF/MW Safety Standard', *Microwave News*, Nov/Dec 1984.

¹⁸² Slesin, 'ANSI RF/MW Standard Challenged...', 1993.

¹⁸³ *ibid.*

“The literature published in the late 1980’s is abundant with information on nonthermal effects which are produced at levels below the ANSI standards.” In the ANSI/IEEE standard, he added, “The existence of nonthermal effects is essentially denied by omission.”¹⁸⁴ In September 1993 Kanavy wrote to the Environmental Protection Agency (EPA) that: “We have long felt that the athermal effects are real and that a [continuous wave] thermal standard was not sufficient for human exposure protection.”¹⁸⁵ Kanavy therefore highlighted the necessity of including modulation effects in standard setting. The position by the Phillips Laboratory did not go unchallenged, however, as the Air Force’s Armstrong Laboratory in Brooks Air Force base in San Antonio Texas disputed the claims of the Phillips Laboratory over the existence of athermal effects. Dr. David Erwin, chief of the Radiofrequency Radiation Division at the Armstrong Laboratory, claimed that his team had reviewed and attempted to replicate claims “concerning athermal and other unsubstantiated bioeffects. Although we still accept the possibility, we have not yet seen any good evidence for athermal bioeffects.” In a letter to Dr. Brendan Godfrey, Kanavy’s supervisor, Erwin said that to use claims of such effects to revise U.S. RF health standards “would be alarmist”.¹⁸⁶ Kanavy replied that “It is absolutely shocking to hear the Armstrong Laboratory [Dr. Erwin] deny the existence of any biological effects which are not thermal...Something is drastically wrong here.” To support his claims Kanavy wrote a White Paper on the biological effects of RF/MW radiation in which he asserted that the U.S. research community was aware of the Soviet research findings of adverse bio-effects below the ANSI standards. These were initially rejected because they were unable to replicate the Soviet research but by the mid-1980’s researchers began to successfully duplicate Soviet findings and started a research program to expand upon and test the Soviet non-thermal theories.¹⁸⁷ Kanavy wrote that “a comprehensive search of [the] worldwide literature” found that “a large amount of data exists...to support the existence of chronic, nonthermal effects...produced at levels below the ANSI standard”. Kanavy also claimed that a consensus of RF researchers outside of the

¹⁸⁴ *ibid.*

¹⁸⁵ *ibid.*

¹⁸⁶ *ibid.*

¹⁸⁷ C. Kanavy, ‘Biological Effects of Microwave Radiation: A White Paper’, Reproduced in *Microwave News*, vol. 13, no. 5, Sept./Oct., 1993, p. 12.

Armstrong Lab were in favour of establishing a national program “to investigate the biological effects of electromagnetic radiation under the auspices of an independent committee”.¹⁸⁸ Dr. Ross Adey, a leading researcher at the Veterans Administration Hospital in Loma Linda, California, backed up Kanavy’s claims at a hearing before a U.S. Senate subcommittee in August 1992. Adey testified that “[a]s a matter of policy, the Air Force denies existence of biological effects attributable to athermal fields. Nevertheless, evidence for athermal bioeffects is incontrovertible for both low-frequency and [RF] exposures.”¹⁸⁹

Both the Armstrong laboratory and the ANSI/IEEE standard were criticised by Dr. Edward Elson from the Department of Microwave Research at the Walter Reed Army Hospital at a meeting in Florida in June 1992. While presenting a paper that challenged the adequacy of the ANSI/IEEE, Elson predicted that his research on high-power microwaves would be stopped if the responsibility for it were transferred to the Armstrong Laboratory.¹⁹⁰ The Armstrong Laboratory also came under criticism in a letter published in *Health Physics* (Feb. 1991) from Dr. Dennis Hjeresen from Los Alamos National Laboratory in New Mexico. Hjeresen said that, “The U.S. Air Force [Armstrong Laboratory] has consistently suggested to us that there are no effects of low-level microwave exposure despite evidence to the contrary presented in the peer-reviewed literature.”¹⁹¹ In an apparent case of intellectual bias, Kanavy’s White Paper mentioned that when the Phillips Laboratory attempted to share its extensive literature base on biological effects of microwave radiation with the Armstrong Laboratory, Dr. Dave Erwin at the Armstrong Laboratory proceeded to delete the publications of researchers he believed were not credible. According to Kanavy they were researchers who had reported finding nonthermal effects.¹⁹² One of the recommendations in Kanavy’s proposed research program was to conduct a long-term health-monitoring program of microwave workers at the Phillips laboratory. Erwin opposed the

¹⁸⁸ Kanavy, 1993.

¹⁸⁹ L. Slesin, ‘U.S. Air Force v. U.S. Air Force: Labs at Odds over RF/MW Health Risks’, *Microwave News*, vol. 13, no. 5, Sept./Oct. 1993, pp.11-12.

¹⁹⁰ *ibid.*

¹⁹¹ *ibid.*

¹⁹² *ibid.*

research and in a letter to Godfrey made a revealing statement that “the consensus opinion is that such a limited program would yield no legal or scientific benefit to the Air Force and might even have a negative impact.”¹⁹³

In early 1993 the Federal Communications Commission proposed adopting the ANSI/IEEE C95.1-1992 RF standard for evaluating RF/MW hazards as part of its responsibilities under the National Environmental Policy Act ¹⁹⁴. Comments were called for on this proposal and about 100 were received in total. A brief examination of some of the main submissions to the FCC are illustrative of the vast chasm that separates public health protection considerations from those of fostering unfettered technological advancement. A similar division was seen in the Standards Australia TE/7 committee, as will be examined in Chapter 5.

The telecommunications industry had long been urging the FCC to adopt the ANSI/IEEE 1992 RF standard. However, several government agencies and professional organizations had reservations about the proposed move. The main points raised against ANSI/IEEE were as follows:

The Environmental Protection Agency (EPA) recommended that the FCC should instead consider the recommendations from the 1986 National Council on Radiation Protection and Measurements (NCRP) report¹⁹⁵ in preference to the 1992 ANSI/IEEE standard. EPA pointed out that NCRP was established by the US Congress specifically to develop radiation exposure recommendations and even though both ANSI/IEEE and NCRP used a similar literature base, NCRP and was more protective of human health for the following reasons:

- ANSI/IEEE increased by twofold the allowable exposure limits in the higher frequencies, whereas NCRP did not.

¹⁹³ *ibid.*

¹⁹⁴ L. Slesin, ‘Standards: FCC Seeks To Adopt 1992 RF/MW Limits’, *Microwave News*, Mar./Apr. 1993.

¹⁹⁵ NCRP Report No. 86: Biological Effects and Exposure criteria for Radiofrequency Electromagnetic Fields. See:

<http://www.ncrponline.org/Publications/86press.html>, Accessed Aug. 12, 2007

- ANSI/IEEE's two level controlled and uncontrolled limits were not well described, discretionary and not directly applicable to any population group, whereas NCRP gave exposure limits specifically for both workers and the public.
- ANSI/IEEE's conclusions that there was no evidence of sub-groups of the population who may be at greater risk from RF did not agree with the evidence.
- ANSI/IEEE's claim that their limits were protective of all mechanisms of interaction of RF and the body was unwarranted because the standard's limits were based solely on thermal effects.

EPA recommended that the FCC request NCRP to revise its 1986 report to be able to provide a critical and up to date comprehensive review of the biological effects of RF radiation and recommendations for exposure criteria.¹⁹⁶

The FDA's Centre for Devices and Radiological Health (CDRH) was more lenient on the 1992 ANSI/IEEE standard and considered most of the provisions in the standard "appropriate" as they considered the changes would provide a greater level of protection to the general public. The CDRH disagreed, however, with the "low-power exclusion clause" that exempted certain RF devices from the provisions of the standard because they emitted less than a specified amount of power. They considered this disregarded the concept of limiting the SAR induced in the body - thus recognizing the problem of 'hot spots' where SAR levels can exceed the specified limits, an issue not addressed in the standard. In addition, CDRH did not see the standard as addressing the issue of long-term chronic exposures to RF fields.¹⁹⁷

The National Institute for Occupational Safety and Health (NIOSH) saw the lack of involvement in the process by experts with a public health perspective as a weakness. Associated with this was the rejection of epidemiology studies as not being useful in the standard setting process, something NIOSH disagreed with. NIOSH felt that these limitations should be acknowledged by FCC for regulating

¹⁹⁶ L. Slesin, 'EPA Assails ANSI RF/MW Standards as Seriously Flawed', *Microwave News*, vol. 14, no. 1, Jan/Feb 1994, p. 10.

¹⁹⁷ *ibid*

both occupational and environmental RF exposures. The standard's two-tier limits, controlled versus uncontrolled, were seen as problematic as the designation very much depended on the workers' knowledge even though the standard did not give any guidance or training to workers to clearly understand the differences. As a result NIOSH recommended taking a more conservative approach and adopting the more restrictive uncontrolled limit for both workers and the public. NIOSH also noted that the standard was based on thermal considerations only and ignored the existence of possible non-thermal biological effects even though they were being reported in the scientific literature and were the subject of ongoing research. NIOSH felt that it should be acknowledged in the standard that health effects may be caused by other interactions than just by heating. Other omissions in the standard, according to NIOSH, were guidance on control measures, medical surveillance, worker training and hazard communication.¹⁹⁸

The American Radio Relay League's (ARRL) bioeffects group was pointedly critical about the FCC proposal to adopt the ANSI/IEEE guidelines. They considered it as arbitrarily based and not suitable for communications facilities. They saw no justification for the controlled versus uncontrolled environment, and called for the termination of the proceedings.¹⁹⁹ Some of the ARRL committee members recommended the adoption of stricter RF standard limits.²⁰⁰

ARRL member Dr. Mark Haggmann acknowledged the importance of some of the new recommendations in the 1992 standard and expressed concern over a bias in the inappropriateness of limiting current measurements to the point of entry on the human body as well as the upper frequency limit for current measurements. He considered this was the result of "a relevant conflict of interest in the leadership of the IEEE SCC28 committee."²⁰¹

¹⁹⁸ L. Slesin, 'Industry Urges FCC Adoption of ANSI/IEEE C95.1-1992', *Microwave News*, vol. 14, no. 3, May/June 1994, pp. 13-14.

¹⁹⁹ *ibid.*

²⁰⁰ L. Slesin, 'ARRL Bioeffects Committee Quits in RF/MW Controversy', *Microwave News*, Jul./Aug. 1994, p. 9.

²⁰¹ Slesin, 'Industry Urges FCC Adoption...', 1994.

What can be seen in the above agency comments is a concern for public health protections over possible non-thermal long term exposures and that the IEEE's thermal limitations were lacking in this regard. Many of these concerns were also expressed by a number of committee members on the Australian RF standard setting committee which will be examined in Chapter 5.

Industry reasoning in favour of the standard

Whereas the above agencies and organizations took a critical look at the ANSI/IEEE 1992 standard and highlighted various inadequacies that had implications for worker and public health, the industry took a very different stand by steadfastly supporting their industry voluntary standard. A number of companies called for exemptions from state and local RF regulations that may have stricter limits than the ANSI/IEEE RF standard.

The Cellular Telecommunications Industry Association (CTIA) considered the standard to be "sound and scientifically based" and assured the safety of all new telecommunications products as long as they met all the relevant health and safety requirements. They were concerned that SAR compliance not be a hindrance to manufacturers.²⁰²

The American Telephone and Telegraph (AT&T) Corporation supported the standard, but recommended that since emission levels from cellular phone base stations and other microwave transmitters did not exceed the new standard limits they should not be required to be tested for compliance. They did say, however, that some types of wireless equipment should not be excluded because emissions from some wireless devices "may exceed the new limits".²⁰³ This would be of interest, especially for people who would be using or be in close proximity to such devices. According to the IEEE's Committee on Man and Radiation in the controlled environment the user/controller is expected to only be aware that the

²⁰² *ibid.*

²⁰³ *ibid.*

device emits an RF signal.²⁰⁴ Nothing is said of the awareness of the person as to the power output level or SAR that the device is delivering to their body, which may be exceeding the standard. In the majority of cases a person would not be aware of the power output or SAR level of the device he or she is using, and therefore would not be aware of what they are being exposed to. Without such information being freely provided to users the concept of controlled versus uncontrolled environments is of little value.

The Electromagnetic Energy Policy Board (EEPA) felt that “the large and diverse membership of the IEEE committee reflects a more accurate consensus of the scientific community compared with smaller panels of selected experts such as Scientific Committee 53 of the NCRP and IRPA/INIRC...in adopting a revised RF radiation regulatory scheme.”²⁰⁵ However, it is arguable whether achieving an unbiased consensus of the scientific community is possible, when the IEEE committee has such a large military presence. For example, in 1996 17 of the 31 members of the IEEE standards committee were associated with the Department of Defense.²⁰⁶

GTE Service Corporation believed that the industry was in compliance with the proposed standard and reasoned that it was necessary to block those who opposed the roll-out of new technology. According to GTE, due to “press scares and media hype, consumers have become confused regarding the safety of exposure to RF radiation caused by wireless services”. GTE saw this as potentially resulting in “unjustified state and municipal restrictions [that] could have particularly severe consequences in the area of mobile services. The FCC’s farsighted efforts...could be derailed by state regulations more onerous than scientific data warrants, inflamed by “press scares and media hype.” To counter this possibility, GTE recommended legislation aimed at “pre-empting those that interfere with the development of “a

²⁰⁴ *ibid.* (According to COMAR “When an excluded device meets the requirement of the controlled environment for the user/controller, who can be expected to be aware that the device emits an RF signal, the device also ipso facto satisfies the uncontrolled specification for the neighbouring/adjacent nonuser.”)

²⁰⁵ Slesin, ‘Industry Urges FCC Adoption...’, 1994.

²⁰⁶ L. Slesin, ‘ANSI/IEEE v. NCRP: battle for Control of Rf/MW Standards’, *Microwave News*, vol. 16, no. 2, Mar./Apr. 1996, p. 1, 12.

rapid, efficient, nationwide and worldwide wire and radio communications service”²⁰⁷

Hammett & Edison Corporation also called for the FCC to pre-empt non-federal agencies from setting RF standards that are more restrictive than the 1992 standard. It also called for the FCC to “specify threshold distances for all facilities beyond which no consideration of RF effects need be made, but within which account must be taken of every such station.”²⁰⁸

Motorola recommended that the FCC adopt the ANSI/IEEE low-power device exclusion provisions and called for exclusions for other radio types, such as those used in the private land mobile radio services. Motorola did say that with some devices, such as cell phones, it might be necessary to routinely measure SAR levels because the 2.5 cm spacing requirement for exclusion was not met.²⁰⁹

The National Association of Broadcasters (NAB) urged the FCC to adopt the standard “in a fashion that will minimise burdens on broadcasters (and other regulatees) yet still adhere to the standard’s provisions”. NAB recommended that the FCC “continue the ‘three-pronged’ approach whereby stations generally will be able to avoid making actual measurements to assess and certify compliance. Instead, the majority of broadcasters should be able to determine their compliance through the use of charts and graphs.”²¹⁰ NAB also urged the FCC to take on the issue of pre-exemption to block “nonfederal opposition to the introduction of new communications technologies.” NAB considered that the very implementation of such new technologies was threatened if preemption was not introduced.²¹¹

CBS Corporation gave its reasons why the ANSI/IEEE standard was the best available and mentioned that “the commission should ensure that federal policies are not undermined by inconsistent state or local regulation. Prompted by

²⁰⁷ Slesin, ‘Industry Urges FCC Adoption...’, 1994.

²⁰⁸ *ibid.*

²⁰⁹ *ibid.*

²¹⁰ *ibid.*

²¹¹ *ibid.*

unsubstantiated fears, several states and municipalities have already prevented commissioned licensees from fully deploying their systems...”²¹²

Raytheon supported the concept of the “controlled” and “uncontrolled” environment as they believed that the new standard was correct in rejecting the thesis that “certain subgroups of the population are more at risk than others.” Raytheon also supported the continuing “*categorical exclusions*.” They also rejected the inclusion of modulation in the guidelines as they claimed that there was no “scientific rationale” for the practice in the NCRP RF guidelines they said was “authored in 1986 by a small group.”²¹³

A common theme in the above industry responses, in stark contrast to agency and other criticisms of the proposed standard, was a stated belief that the standard assured that all RF emitting technologies were safe as long as exposures were kept below the recommended limits. There was a concern that the standard should not be an impediment to the deployment of RF technology and that action was needed to counter local or state government legislative opposition to the introduction of new technology. Agency criticisms were ignored, such as evidence for the existence of non-thermal effects, and public concerns were dismissed as being founded on media hype and unfounded fears. The industry stance reflected a shared self-interest in gaining approval for the proposed standard because it would validate their overarching concern - standard limits should not impede technological development.

²¹² *ibid*

²¹³ *ibid.*

Turf Wars: The battle of the standards for FCC approval

Under the U.S. Telecommunications Act of 1996 the FCC was required to adopt a new RF/MW exposure standard by August 5, 1996. This re-ignited the 1993 debate when the

FCC first asked for comments on its proposal to adopt the ANSI/IEEE C95.1-1992 standard. The FCC quickly came under immense corporate lobby pressure to adopt the ANSI/IEEE standard outright and reject the older 1986 NCRP RF standard outright. Comments submitted to the FCC by the corporate sector included concerns that the NCRP standard was “seriously flawed”, it “arbitrarily set limits that lack scientific basis”, it “has not even been subject to peer review” and contained “unsubstantiated claims of nonthermal effects and modulation” as well as encouraging “prudent avoidance philosophies”.²¹⁴ Other industry concerns were that if the FCC adopted the NCRP standard it would “result in increased nuisance litigation for persons and companies involved with RF radiation”. Adopting the lower NCRP 5 mW/cm² limit in preference to the ANSI/IEEE’s 10 mW/cm² would “increase litigation concerning products, services and installations previously approved by the FCC.” They continued that the NCRP “recommendations cannot be considered to be the product of scientific method” and that “the NCRP report does not even constitute a conclusive academic study of the problem at this stage and, therefore, it should not be used to guide an industry.”²¹⁵ All this was in sharp contrast to several federal agencies’ concerns, previously mentioned, that the ANSI/IEEE 1992 standard had “serious flaws”. The opposition expressed by the communications industry against the NCRP RF guidelines can be seen to be due to possible restrictions placed on some new technologies by the NCRP guidelines and the NCRP’s consideration of non-thermal biological effects.

In a letter to the FCC, urging it to adopt the ANSI/IEEE standard, Hewlett Packard representative Cynthia Johnson wrote that HP’s new class of short-range computer

²¹⁴ L. Slesin, ‘Industry Pressures FCC To Adopt ANSI RF/MW Exposure Standard’, *Microwave News*, vol. 16, no. 2, Mar./Apr. 1996, p. 11.

²¹⁵ *ibid.*

communications devices that will operate at 59-64 Ghz would be “impractical” if the NCRP limit of 5 mW/cm² were applied. Johnson claimed that the NCRP standard “cannot be considered to be the product of scientific method” and that limitations were unnecessary because “scientific data simply does not exist for health effects of power levels at these frequencies.”²¹⁶ In other words, when new technology was being developed that operated at frequencies where no bio-effects research had yet been conducted, that meant that as there was no evidence of a health hazard no limitations were necessary. Hewlett-Packard’s argument was that at the millimeter wave band the energy (heating) only penetrates up to four-tenths of a millimeter into the skin but did admit that an area of possible concern was the eye.²¹⁷

The 1986 NCRP standard did take into consideration nonthermal (a-thermal) effects, an unpopular concept to the industry and the IEEE as it undermined previous IEEE statements. As NCRP member Ross Adey explained:

[T]he U.S. National Council on Radiation Protection and Measurements 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 a-thermal interactions.²¹⁸

Adey’s statement on non-thermal (athermal) interactions was similar to points made some years later in an IEEE White Paper by L. Heynick. At a June 2001 IEEE SCC-28 committee meeting Heynick mentioned that his paper included “a list of

²¹⁶ L. Slesin, ‘Millimeter-Wave Eye Research Funded by Hewlett-Packard’, *Microwave News*, vol. 16, no. 2, Mar./Apr. 1996, pp. 9-10.

²¹⁷ *ibid.*

²¹⁸ Communication with NCRP committee member Ross Adey, Aug. 1995. Cited in: Maisch D, *Mobile Phones and Their Transmitter Base Stations: The Evidence For Health Hazards, Australian Senate Hansard*, Apr. 1996.

citations on non-thermal effects considered established.”²¹⁹ E. Mantiply from the FCC asked at the June SCC-28 meeting whether “non-thermal effects that are considered established would be considered by the committee.” The answer was yes.²²⁰

In a critical 1989 SCC28 meeting that was voting on provisions for the next C95.1 standard revision, approximately a quarter of those present represented various sections of the military. In addition there were representatives from military’s civilian defence contractors, including AT&T, General Electric, IBM, Lockheed, and Raytheon. Representatives from the broadcasting and communications industries were also present.²²¹ This illustrates that the interests of the military, manufacturers and users of RF/MW technology were an important consideration. In contrast the NCRP was a congressionally chartered organization with a degree of public accountability. It was this accountability that favoured consideration of bioeffects not considered by the IEEE’s SCC28 subcommittee.²²² As mentioned in *Microwave News* in April 1996, if the FCC decided to adopt the NCRP standard it would likely diminish the influence of the industry and military dominated IEEE SCC-28 committee. As *Microwave News* editor Louis Slesin put it: “AT&T, the CTIA, Raytheon and the DoD know a good thing when they have it and are fighting to regain control.”²²³

In an effort to forestall any chance that the FCC would adopt the 1986 NCRP standard in preference to the ANSI/IEEE guidelines, in May 1996 the Cellular Telecommunications Industry Association’s (CTIA) president Thomas Wheeler met with EPA administrator Carol Browner with a request that her staff “back off” from its objections to the ANSI/IEEE standard. Browner still continued, however, to support the EPA’s recommendation to adopt the stricter NCRP RF standard.²²⁴

²¹⁹ IEEE, SCC-28, Radisson Riverview Hotel, St. Paul, Minnesota, 2001, <http://grouper.ieee.org/groups/scc28/sc4/sc-4%20minutes-june%202001.pdf>, Accessed May 15, 2006.

²²⁰ *ibid*

²²¹ L. Slesin, ‘Revising ANSI RF/MW Limits: Debate Often Contentious’, *Microwave News* reprint service, RF/MW Standards, Sept./Oct. 1989.

²²² *ibid*.

²²³ *ibid*.

²²⁴ L. Slesin, ‘Cellular Phone Notes’, *Microwave News*, vol. 16, no. 3, May/June 1996, p. 9.

In spite of strong industry pressure, the FCC, going largely on the advice of the EPA, adopted new RF/MW regulations largely based on those of the 1986 NCRP RF guidelines²²⁵. As examined by *Microwave News*, provisions of the FCC standard meant that the FCC:

- Rejected the ANSI/IEEE exclusion clause for low powered devices and followed the recommendations of the Food and Drug Administration by requiring that all new cellular and personal communications services (PCS) hand held phones be tested to ensure that emissions were not over 1.6 W/kg SAR. Compliance was to be either by computer modelling or laboratory measurements.
- Denied industry requests to extend federal preemption of state and local RF/MW health regulations for personal wireless services to all communications facilities.
- Acted “out of an abundance of caution” to require routine evaluation of cellular and PCS antennas if they are mounted lower than 10 meters above the ground and have a total power output over 1kW.
- Endorsed the distinction between “occupational” and “general population” as defined in the NCRP standards.
- Set limits of 1mW/cm² for public exposures and 5mW/cm² for occupational exposures above 1500 MHz. This provision was up to ten times more stringent than those recommended by ANSI/IEEE.
- The FCC however rejected the NCRP consideration of modulation effects as “premature”.²²⁶

The new FCC RF standard soon came under fire from the industry group the Electromagnetic Energy Alliance²²⁷, the Department of Defense, other industry companies, as well as several activist groups. The industry wanted the FCC

²²⁵ L. Slesin, ‘FCC RF/MW Rules Favor NCRP Limits; Cell Phones To Be Tested for Safety’, *Microwave News*, vol.16, no. 4, Jul./Aug, 1996, pp. 1, 13.

²²⁶ *ibid.*

²²⁷ The Electromagnetic Energy Alliance (EEA) made up of members from AT&T, General Electric, Motorola, Raytheon, the National Association of Broadcasters and the American Radio Relay League, who had changed their previous stand against the ANSI/IEEE standard.

regulations to preempt local and state regulation on the siting of all RF/MW transmitters. In addition to the Electromagnetic Energy Alliance industry group, Ameritech Mobile Communications called on the FCC to preempt state and local regulation of the operation of Personal Communications Systems (PCS) facilities and to rule on the issue of liability for “environmental effects of RF emissions”. In other words AMC wanted a rule that as long as industry complied with the standard they would be protected against any health hazard liability.²²⁸ A desire on part of industry and the military to stick solely with the ANSI/IEEE standard was expressed by the Department of Defense and US West when they criticised the FCC for not sticking firmly to the ANSI/IEEE standard.²²⁹

In spite of the exemptions laid out in the Telecommunications Act and an executive order by President Clinton expediting the use of federal land and buildings, the issue of continuing opposition, especially community siting moratoriums, continued to be a sore point with the Industry. The CTIA’s stand on moratoriums was that they “violate the rights of wireless service providers.”²³⁰ No mention was made about violating the rights of local communities and governments to have a say in siting decisions. In Jan 1997 the CTIA’s Wheeler petitioned both the FCC and President Clinton. The CTIA’s complaints listed 150 communities that had moratoriums in place against towers that Wheeler claimed were “too often being used as a subterfuge to avoid complying with federal law”. Wheeler also complained that local and state governments were still attempting to set their own RF/MW standards in spite of the Act. Wheeler wrote to president Clinton that “the wireless telecommunications industry continues to experience significant antenna siting resistance from far too many federal agencies in defiance of your order and the law.”²³¹ Supporting the CTIA’s efforts the Personal Communications Industry Association (PCIA) also petitioned the FCC to preempt moratoriums longer than

²²⁸ L. Slesin, ‘Industry, Activists Challenge FCC’s New RF/MW Rules’, *Microwave News*, vol. 16, no. 5, Sep./Oct. 1996, pp. 9-10.

²²⁹ *ibid.*

²³⁰ L. Slesin, ‘FCC Reaffirms Health Rules Based on NCRP Limits’, *Microwave News*, vol. 17, no. 5, Sept/Oct 1997, p. 10-11.

²³¹ L. Slesin, ‘Wireless Notes’, *Microwave News*, vol. 17, no. 1, Jan./Feb. 1997, p. 8.

three months and to end the prohibition of preemption for antennas on existing buildings.²³²

On August 25, 1997 the FCC reaffirmed its previous decision to base its RF standard mainly on the NCRP RF recommendations of 1986. FCC spokesperson Robert Cleveland stated that “we have based our guidelines on the recommendations of the Environmental Protection Agency, the Food and Drug Administration and the National Institute for Occupational Safety and Health.”²³³ All of these agencies had long opposed the FCC adopting the industry standard ANSI/IEEE C95.1–1992 apparently as a result of these agencies’ mission to address human health and safety issues. In contrast, the IEEE C95.1 Committee’s mission represented the interests of industry and military users of RF technology. For example, IEEE’s SCC-28 committee chair John Osepchuk for many years represented Raytheon on the standards committees. Dr. Eleanor Adair as vice-chair (and later chair) was a senior researcher at the Brookes Air Force Base and the secretary Ron Peterson was from Lucient Technologies. The chairs of SCC-28 IV were Dr. C-K Chou from Motorola and John D’ Andrea from the Naval Medical Research Institute at Brookes AFB.²³⁴

The FCC decision was apparently in line with a central tenet of this thesis: When vested interests control the standard setting process over their activities, the primary consideration is that standard limits should never be an impediment to their various operational requirements. According to those interests, public health considerations must therefore conform to that requirement. The FCC decision was apparently due to the concerns raised by federal agencies that the IEEE proposed RF standard was insufficient for public health protections.

²³² *ibid.*

²³³ Slesin, ‘FCC Reaffirms Health Rules...’, 1997.

²³⁴ L. Slesin, ‘IEEE Adopts Some Changes in Standards for RF/MW Exposure’, *Microwave News*, vol. 19, no. 3, May/Jun. 1999, pp. 5-6.

The Radiofrequency Interagency Work Group (RFIAWG)

The Radiofrequency Interagency Work Group is a governmental interagency committee reconstituted in February 1993 as a result of an oversight meeting by a telecommunications sub-committee of the House of Representatives' Committee on Commerce. Agency membership includes the Food and Drug Administration (FDA), the Center for Device and Radiological Health (CDRH), the National Institute for Occupational Safety and Health (NIOSH), the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the National Telecommunications and Information Administration (NTIA), and the Federal Communications Commission (FCC).²³⁵ With this work group make up, a significant difference of opinion was expressed over the adequacy of the proposed standard, compared to that of the industry make up of the IEEE standard setting committee SCC-28. This again illustrates the differing scientific interpretations of the same scientific literature base depending on one's affiliations. This can be generalized as agency public health considerations as opposed to industry operational requirements.

On June 1999, Gregory Lotz, representing NIOSH on the RFIAWG, presented the Chairman of the SCC-28 subcommittee IV a list of issues that RFIAWG considered needed to be addressed in the IEEE RF standard. The list was in response to previous requests from the work group for greater participation in SCC-28 discussions on RF standards.²³⁶ In particular, RFIAWG criticised the biological rationale of the standard 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. This was seen in the standard's limiting the definition of an "adverse effect level" to only acute exposure situations and the use of time-averaged calculations that were not suitable for prolonged exposure situations and therefore may not adequately protect the public. RFIAWG

²³⁵ E. Jacobson, Deputy Director, Center for Devices and Radiological Health, FDA Letter Regarding Cellular Phones, May 5, 1997, <http://www.osha.gov/SLTC/radiofrequencyradiation/fda.html>, Accessed Oct. 3, 2007.

²³⁶ G. Lotz, RFIAWG, RF Guideline Issues: Identified by members of the Federal RF Interagency Work Group, June 1999, letter from Gregory Lotz to Richard Tell, Chair of IEEE SCC28 IV, http://www.emrnetwork.org/position/exhibit_a.pdf, Accessed June 23, 2006

recommended that a clear rationale needed to be developed to also include chronic exposures.²³⁷ Another concern was the standard's incorrect assumption that all tissues are equally sensitive (other than the eyes and testicles) to RF. This failed to take into consideration the differing sensitivity of human tissue when calculating SAR limits.²³⁸ There was also a concern expressed about failure to include consideration of the body of research on the biological effects of exposure to ELF-modulated and pulse modulated RF that was relevant to public exposures. In addition, the SAR time-averaging calculations as used in the standard hid any biological effects resulting from modulated RF exposures.²³⁹ RFIAWG also questioned the biological validity of the IEEE's two-tier exposure classification, "controlled" vs. "uncontrolled". Besides not being adequately explained, a rationale needed to be given as to why people in uncontrolled environments needed to be protected to a greater extent than persons in controlled environments, when such situations historically were based on biological considerations.²⁴⁰ Another issue for RFIAWG was the rationale for the relaxation of the exposure limits above 1.5 Ghz that "caused 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."²⁴¹ To address these concerns the working group recommended a comprehensive review of long-term, low-level exposure studies that had relevance to environmental chronic occupational RF exposures and neurological-behavioural effects to better define the adverse effect level for RF, and micronucleus assay studies with relevance to carcinogenesis.²⁴²

IEEE SCC-28 Subcommittee 4 tackles the mobile phone compliance problem.

An ongoing problem for the cell phone manufacturers in the U.S. was ensuring that their phones were in compliance with the FCC'S SAR mobile phone limit of

²³⁷ Lotz, op. cit., p. 1-2.

²³⁸ *ibid.*

²³⁹ Lotz, op. cit., p. 5.

²⁴⁰ Lotz, op. cit., pp. 3-4.

²⁴¹ Lotz, op. cit., p. 6.

²⁴² Lotz, op. cit., p. 7.

1.6 W/kg averaged over 1 gram of tissue. This was seen in testing by Motorola's Libertyville Cellular Electromagnetics Laboratory in Illinois in 1993 and 1994 when testing Motorola phones for compliance with the FCC limit. The Motorola laboratory found wide variations in SAR measurements (up to 4 fold) and in many situations the phones were in excess of the FCC limit.²⁴³ In addition, Dr. Om Gandhi from the University of Utah, found in 1999 that under the 1.5 W/kg and 1 gram criteria, many U.S. phones violated the FCC limits because of high exposures to the ear.²⁴⁴ This compliance problem was solved when SCC-28 SC-4 voted in Sept 2000 to reclassify the human ear as an "extremity", thereby increasing the allowable limit for the ear from a mobile phone from 1.6 W/kg averaged over 1 gram of ear tissue to 4.0 W/kg averaged over 10 grams of tissue.²⁴⁵

How to address compliance issues was a major discussion point in the June 8-9, 2001 meeting of IEEE SCC-28 Subcommittee 4. During the discussions over revisions to the C95.1-1991 standard Richard Tell summarized various points on a questionnaire sent out to members. An important issue on the agenda was whether or not the 1-gram averaging mass for SAR levels should be increased. The majority of the responses were in favour of an increase. Co-chairman C-K Chou from Motorola did not mention any implications for bio-effects issue, but said that "a small change in the averaging volume could have a large impact on industry, for example on cellular phone manufacturers." He then went on to say "a realistic low-power device exclusion is needed". Chou suggested that "unless there are reasons not to, the ICNIRP peak spatial-average SAR limits should be considered." Such a change would increase the averaging volume to 10 grams of tissue which would serve the purpose of averaging out peak exposures, the so called "hot spots" that occur when a mobile phone is held close to the head of the user. The larger the volume to be measured, the more peak exposures can be averaged away, a concern expressed by RFIAWG. This proposal was later successfully incorporated in C95.1-2005. R. Peterson from Lucient technologies agreed that "a

²⁴³ L. Slesin, 'Motorola Memos: Small Changes in Manufacturing or Test Procedures Can mean Big Changes in SARs', *Microwave News*, vol. 19, no. 5, Sept./Oct. 1999, p. 12.

²⁴⁴ L. Slesin, 'Industry Seeks Higher Exposure Limit for the Ear', *Microwave News*, vol. 19, no. 6, Nov/Dec. 1999, pp. 1, 11,

²⁴⁵ L. Slesin, 'SCC-28/SC-4 Okays Ear as "Extremity"', *Microwave News*, vol. 20, no. 5, Sept./Oct. 2000, p. 5.

low-power device exclusion should be included in the revision but the exact values could not be determined until the averaging volume issue was resolved". Peterson said "[t]he consensus is to move to a larger volume and perhaps higher limits for the spatial average SAR, e.g., adopt the ICNIRP limits." J. Osepchuk then reviewed his proposal for new averaging times. He pointed out that the reason for a change is to "resolve the issue of the eyes and testes caveat in the partial body relaxation."²⁴⁶ In other words, by increasing the averaging times in the proposed relaxation, this eliminated the problem of exposures to the eyes and testes possibly being in excess of the limits. The solution was to increase to a 10-gram mass to average out peak exposure levels.

The problem the cell phone industry has with the FCC's compliance limit was highlighted on the U.S. "20/20" ABC TV cell phone investigative documentary, aired on October 20, 1999. When the program decided to test five mobile phones for compliance with the FCC emissions standard they found that all four US testing labs approached to do compliance testing refused to do the work. It was suggested on the program that this refusal might have been because anyone who did the testing would be blacklisted by the industry. 20/20 then went to Dusseldorf, Germany, at the institute for mobile and satellite technology, a research laboratory which does work for both industry and government in Germany and was on a list supplied by the American FCC. Dr. Achim Bahr ran the tests for 20/20. Following standard compliance testing it was found that, depending on the position of the phone during the tests, four out of the five analogue phones tested were over the FCC prohibited SAR measurement of 1.6 W/kg. In other words a phone could be in or out of compliance depending on the test position. These tests were normally done by the industry with their results then submitted to the FCC. When asked about this on 20/20 Dr. George Carlo, former head of the Cellular Telephone Industry Association's (CTIA) Wireless Technology Research group (WTR), said, "It is possible for the industry to submit

²⁴⁶ IEEE SCC-28 Subcommittee 4, Radisson, St Paul, Minnesota, 2001, op. cit.

the findings that are favourable to them and have the FCC only review those. In fact this industry is regulating itself.”²⁴⁷

In a report from the ARRL RF Safety Committee²⁴⁸ to its board of Directors in July of 2000 concerns were raised about the reliability of wireless equipment testing and measurements used in its environmental assessments as a result of the 20/20 program.²⁴⁹ It was also mentioned in the ARRL report that possibly as a result of the 20/20 program, the FCC’s Dr. R. Cleveland (also a member of SCC-28 Subcommittee 4) embarked on a study of how cellular phones were usually held, with the goal to improve the testing requirements for FCC Maximum Permissible Exposure (MPE) compliance.²⁵⁰

With concerns being in the media about cell phone compliance with FCC limits the industry now faced the problem of how to ensure that cell phones being sold in the U.S. adequately met U.S. compliance standards. The industry had at least three options to ensure that mobile phones are in compliance with FCC regulations:

- To redesign phones so that they had lower emission levels (at least in all test positions) and therefore meet the FCC’s Maximum Permissible Exposure (MPE) limits. This would obviously be a very expensive exercise.
- To gain a “low-power” exemption to avoid the issue altogether for cell phones. This was difficult proposition given the concerns expressed by RFIAWG in 1999 and the adverse publicity from the 20-20 program in 2000.
- Relax the relevant IEEE standards on averaging times and tissue mass used in calculating compliance with localized MPE’s, then lobby the FCC to adopt the relaxed IEEE standards in preference to those of the stricter NCRP.

²⁴⁷ ABC News, ‘Worried About Your Wireless?’ 20/20 program transcript, Brian Ross (interview reporter), Oct. 20, 1999, <http://www.junkscience.com/oct99/2020tran.htm>, Accessed Sept. 12, 2006.

²⁴⁸ The Amateur Radio Relay League (ARRL) is the peak organization that represents American Short Wave ham operators and has representation on the IEEE SCC-28 RF Safety committee.

²⁴⁹ ARRL, ‘Report of the RF Safety Committee to the ARRL Board of Directors’, Jul. 2000, <http://www.arrl.org/rfsafety/Rpt-7-00.htm>, Accessed May 12, 2005.

²⁵⁰ *ibid.*

What is apparent from examining the 102 page minutes from the June 8-9, 2001 meeting is that the prime consideration of the SCC-28 Subcommittee 4 members was the third option, to ensure that the standard complies with the service requirements of whatever new wireless technology is in the offering. This is plainly seen through the ongoing efforts of SCC-28 Subcommittee 4 to push through a relaxation of the limits. The 1999 recommendations of the RFIAWG to the IEEE were not addressed in the June 2001 meeting, other than possible in veiled comments, such as from L. Heynick when mentioning non-thermal effects. He stated that he was not sure “how to proceed with other ‘low-field’ effects” and pointed out “that it is important to proceed because of misplaced criticism and attacks on the IEEE for not including these studies.”²⁵¹ Such an emphasis on service requirements is perhaps understandable when the list of those attending the conference is considered. Out of 60 attendees present (64 members in total) 30 were from the wireless industry sector (6 from Motorola alone), 12 were from the military, 7 “consultants” who do work for the industry, 4 from various U.S. government health agencies, 2 from other foreign agencies, and 5 academics. Unlike the practice in other committees, such as SCC-34 where member organisations are limited to one vote, in SCC-28 each attendee gets a vote, thus giving Motorola, for instance, more voting power than all federal health agencies combined. The Chairman of SCC 28 was John Osepchuk, who had represented Raytheon from the very beginning of the standards process before becoming an “independent consultant”. Co chairs were J.A. D’Andrea, from the Naval Health Research Detachment and C-K Chou from Motorola.²⁵²

Other uses of microwaves

At the same time Osepchuk was a member of IEEE C95.1 Subcommittee IV (later renamed SCC-28 Subcommittee 4), validating the 1997 edition of the 1991 RF/MW exposure standard, he was also promoting microwave technologies designed to cause thermal effects that the standard specifically set out to prevent. In an interview with *New Scientist*, in December 1996, Osepchuk and Charles Buffler,

²⁵¹ IEEE SCC-28 Subcommittee 4, Radisson, St Paul, Minnesota, 2001, op. cit.

²⁵² *ibid.*

another member of C95.1 Subcommittee IV, who was also working on the standard, both spoke in favour of experimental research on developing the use of microwaves as a home heating device. It is very likely that Osepchuk and Buffler were talking “tongue-in-cheek” with their promotion of the idea but at the very least it speaks of an underlying intellectual belief in a benign nature of microwaves, even at thermal levels. Such an attitude coming from people very much involved in the setting of exposure limits, especially with Osepchuk as chairman of the SCC-28 standards committee, indicates that any serious consideration of non-thermal health effects was a non-issue. The system Osepchuk and Buffler discussed with *New Scientist* was one being developed by the Microwave Research Centre in Marlborough, New Hampshire, U.S.A.. The system used a conventional 800 watt microwave oven transmitter, placed behind a hole in a wall, that heated by beaming microwaves into the room. The report in *New Scientist* describes how researchers at the Microwave Research Centre were acting as “guinea pigs” for the experimental home heating system, which warms people by exciting the body’s water molecules, thus raising body temperature. The researchers discovered that they felt some warmth at microwave levels that were “several hundred times less than the level inside a microwave oven”. The article does not say what that level may be, but the “normal leakage” of a microwave oven is about $50 \mu\text{W}/\text{cm}^2$ at about 12 inches from the case,²⁵³ so given that, “several hundred times less” than the level inside the oven would have to be well in excess of $50\text{-}100 \mu\text{W}/\text{cm}^2$, especially if the actual room microwave levels were designed to give a heating effect. Compare this level to the levels measured in a large-scale five-year study on people living near a short-wave transmitter in Schwarzenburg, Switzerland, where 55% of residents suffered from disturbed sleep, and 35% from full insomnia. The researchers reported that “sleep difficulty was especially disturbing. This leads on to increasing fatigue and reduced feelings of well-being.” The sleep disturbance was associated with power density exposures from $0.7 \text{ uW}/\text{cm}^2$ to the maximum found of $1.85 \text{ uW}/\text{cm}^2$. The study found a statistically significant association between extremely low intensity RF exposures averaging $0.236 \text{ uW}/\text{cm}^2$ and a wide range of health and well-being variables. Interestingly

²⁵³ Correspondence with Cindy Sage, Sage Associates, Feb 6, 2005.

the researchers were able to have the transmitter turned on and off on different nights and symptoms were greatly reduced when the transmitters were turned off.²⁵⁴

Charles Buffler, who worked at the Microwave Research Centre, said that the heating system would be a highly efficient way of keeping warm. He calculated that microwave heating systems could cut household heating bills by 75%. An added bonus would be that since microwaves cause light bulbs to fluoresce, such a heating system could also double as the power supply for a system of wireless lights. Osepchuk, stated to *New Scientist* that "Getting public acceptance of the idea will be the biggest problem"..."At the moment we have a pervasive electrophobia. People are scared stiff of the prospect".²⁵⁵ As mentioned in the *New Scientist* article, There are several other problems with such a heating system, other than "pervasive electrophobia", which may make microwave home heating a hard sell to the public:

- Microwave heating would not necessarily make you feel warmer because while microwaves would heat up internal organs, the skin always remains in contact with cool air so the occupant still could feel cold.
- Furniture would have to be covered in a material that also heats up with exposure to microwaves so that it wouldn't feel cold to the touch.
- The microwaves would interfere with radio and TV reception, as well as distorting TV and computer monitors.
- Small metal objects, such as keys and coins, would become extremely hot.
- As Buffler admitted in the article, heat might build up in parts of the body that are particularly exposed or poorly supplied with blood. "The main areas of concern are the cornea and the testicles"²⁵⁶.

²⁵⁴ Swiss Federal Office of Energy, 'Study on Health Effects of the Shortwave Transmitter Station of Schwarzenburg, Berne, Switzerland (Major Report)', BEW Publication Series, Study No. 55, August 1995. Also see, N.Cherry, 'Swiss shortwave transmitter study sounds warning', http://www.emfacts.com/forum/issue2/mag_9.html, Accessed Aug. 17, 2006.

²⁵⁵ P. Moore, 'Not cooking but Warming', *New Scientist*, vol. 152, no. 2061/2, 21-28 Dec. 1996.

²⁵⁶ *ibid.*

Osepchuk went on in the *New Scientist* to proclaim how he believed microwaves could transform society. "One of the things I foresee is a solar satellite system - satellites that collect solar power and beam it to the earth using microwave radiation" he said. "This radiation could be used to heat an entire state, perhaps even preventing frost and the millions of dollars of damage it does to citrus crops." Of course anyone in the area would also heat up, whether they wanted to or not, a prospect that is nothing to worry about, says Osepchuk. "Let's face it, as it's freezing they'd appreciate a little bit of heat", he told *New Scientist*.²⁵⁷ Osepchuk and Buffler's proposal to use microwave energy to heat buildings was based on work by Harvard Professor and Nobel Laureate Robert Pound who wrote a paper in 1980 that advocated using microwaves to heat homes.²⁵⁸ Buffler and Osepchuk's attitude toward microwave energy may seem a bit extreme but their enthusiasm is not unusual for the IEEE SCC-28 fraternity. A case in point is senior SCC-28 member Dr. Eleanor Adair who has for many years worked on microwave induced behavioural thermoregulation for the US Air Force and has been a driving force in establishing the IEEE's RF standard. As a member of IEEE's Committee on Man and Radiation (COMAR) she has been an outspoken advocate of "quality science and science-based health and safety standards". Between 1996 and 2001 she served as Senior Scientist in Electromagnetic Radiation Effects for the Human Effectiveness Directorate of the Air Force Research Laboratory (AFRL). Since 2001 she continued her work as a member of the AFRL Senior Scientist Emeritus Corps²⁵⁹ and as a member of the senior executive service at Brooks Air Force Base holds the equivalent rank of Brigadier General.²⁶⁰ In an interview with the *New York Times* in January 2001 Adair expressed her deep faith in the absolute safety of microwave radiation. Adair explained that, unlike gamma and X-rays, which can break chemical bonds and therefore damage cells and cause cancer, microwaves can only heat cells. According to Adair, cell death can only occur at high levels (like in a microwave oven), therefore cell phones are harmless. She explained that the quantum energy in the microwave band is so low it "can't do any damage to

²⁵⁷ *ibid.*

²⁵⁸ R.V. Pound, 'Radiant Heat for Energy Conservation', *Science*, vol. 208, p. 494, May 2, 1980.

²⁵⁹ M. Murphy, 'Dedication: Eleanor Reed Adair', *Bioelectromagnetics Supplement 6*, pp. S1-S2, 2003.

²⁶⁰ G. Kolata, 'A Conversation with Eleanor R. Adair; Tuning In to the Microwave Frequency', *The New York Times*, Jan. 16, 2001.

the cells whatsoever". Adair claimed that in her many years of microwave research on monkeys, starting in 1975, she never saw any adverse effects and in fact the monkeys "would really thrive on the microwave radiation...we never saw any cancer in any animal. We never saw anything but happy, healthy, thriving monkeys". According to Adair when they took the animals out of the chamber after the experiments "the animals that were taken out of the microwaves would sort of pine away. It was as though they were saying, "Come on. It's about time to go back in the box."²⁶¹ Even though this observation indicated the possibility of an addictive reaction to the microwave exposure, with possible implications for mobile phone users, it apparently was not picked up.

In relation to microwave home heating mentioned previously, Adair said that, when they heard about Pound's proposal, "A lot of us had thought, Oh, gosh, wouldn't this be a great way to heat yourself in a cool house?" She then claimed that "we are still pushing it as one of the peaceful uses of microwave energy". As for the research effort on possible health hazards from powerline EMFs, cell phones and radar Adair stated that the money could better be spent on other health issues, "because there is really nothing there".²⁶²

The central role of Adair in evaluating research on behalf of SCC-28 (renamed the International Committee on Electromagnetic safety (ICES) in March 2001) can be seen in the Minutes of the SCC-28 subcommittee 4 of June 29, 2002. Attachment 4 is titled: "Setting a Science-Based Standard for Safe Human Exposure to RF Electromagnetic Fields: A Tribute to Dr. Eleanor R. Adair, U.S. Air Force Laboratory Workshop".²⁶³ Attachment 6 of the minutes lists the total number of In-Vivo papers reviewed for SCC-28 by each of the 34 reviewers listed. The time frame is pre-1998 to 2001. Adair tops the list with 143 papers evaluated during this time.²⁶⁴

²⁶¹ *ibid.*

²⁶² *ibid.*

²⁶³ IEEE/ICES, Unapproved Meeting Minutes, SCC-28 Subcommittee 4 Meeting, Hotel Loews Le Concorde, Quebec, Canada, June 29, 2002, p. 21, <http://grouper.ieee.org/groups/scc28/sc4/sc-4%20minutes-june%202002.pdf>, Accessed May 15, 2006.

²⁶⁴ *ibid.*, p. 23.

Standard setting, 2001-

In September 2001 the revision working group within SCC-28 SC-4 circulated a draft proposal of their exposure standard to the full sub committee for comments. This draft was developed as a result of discussions that took place during and after the June IEEE SCC-28 SC-4 meeting (above). Under the new draft the specific absorption rate (SAR) limit for mobile phones would increase from 1.6 W/kg to 10 W/kg (local exposure) and change the way SARs are measured, from 1 gram of tissue to 10 grams. The effects of these two changes would increase the allowable exposure to cell phone radiation by a factor of 12.²⁶⁵ The SC-4 committee also decided to opt out of the two-tier exposure level of the 1991 IEEE standard and go for one tier. Thus the 0.4 W/kg for controlled environments (workers) would also apply for the general population (uncontrolled environments), increasing the 0.08 W/kg limit for uncontrolled environments to the 0.4 W/kg level. This change meant that the power density limits for the general public would increase from 200µW/cm² between 100 and 300 MHz to 1,000µW/cm², with higher power densities allowed at higher frequencies.²⁶⁶ Dr. Eleanor Adair, who had by then taken over from Osepchuk as chair of SCC-28 (ICES), had pushed for an even greater relaxation of those limits – from 0.4 W/kg to 1 W/kg. That would have meant a 10-fold increase in allowable public exposure.²⁶⁷ When the revision working group met again in January 10-11, 2002, however, they rejected many of the central elements in the draft standard. They decided to keep the two-tier approach, the whole-body average SAR of 0.4 and 0.08 W/kg, and leave the peak SAR value and average volume at 1 gram of tissue.²⁶⁸ This was done with the insistence of the attending members of the federal agencies. Dr. Robert Cleveland from the FDA said of the changes: “I think we are moving in the right direction toward a scientifically supportable standard.” Dr. Niels Kuster from the Laboratories for Research on Information Technologies in Society (IT’IS) in Zurich said that, “[t]he earlier draft

²⁶⁵ L. Slesin, ‘IEEE Drafts Major Relaxation of RF/MW Human Exposure Limits’, *Microwave News*, vol. 21, no. 5, Sept/Oct 2001, pp. 1 & 10.

²⁶⁶ *ibid.*

²⁶⁷ *ibid.*

²⁶⁸ L. Slesin, ‘Revision of RF/MW Standard Stalls As IEEE Panel Is Split on Key Issues’, *Microwave News*, vol. 22, no. 1, Jan/Feb 2002, pp. 1 & 7.

was based on faulty concepts and we are back to a more acceptable proposal.”²⁶⁹ These statements are at odds with the U.S. Air Force’s Dr. Eleanor Adair (new Chair of SCC-28) who said of the draft relaxation revisions: “The IEEE charged our committee to produce a science-based standard.”²⁷⁰ Surprisingly the four Motorola members at the working group meeting appeared to support the federal agency’s revisions, as Dr. Greg Lotz said to Microwave News: “Motorola’s participation was definitely helpful in revising the proposal drafted by the Revision Working Group.”²⁷¹

When the full SCC-28 (4) met only a week later, however, its larger membership voted to ‘edit’ the wording made by its working group. Mention of “unknown health consequences” [referring to non-thermal bioeffects] was struck out; reference to the WHO temperature workshop in respect to determining averaging volume and peak SAR limits was struck out; and the word “keep” in reference to retaining the two-tier approach, peak SAR value and averaging volume was changed to “reconsider” – thus keeping the issue on the agenda for possible change.²⁷² The reason for the change in heart was that those representing the federal agencies *failed* to attend the later full meeting²⁷³ – a rather surprising lapse, considering the agencies’ opposition to relaxing the standard. Why they failed to attend is not known but it was very ‘convenient’ for it allowed industry and military representatives on the standards committee to pass what they wanted without opposition. This again illustrates the subjective nature of RF standard setting, when industry and military vested interests on the committee were given a free pass to write into the standard what they wanted based on their own risk assessment. This was done in order to protect their interests at the meeting without opposition from other members who had a different viewpoint on the science more in line with the public interest. The divisions within SCC-28 over provisions in the draft standard were between the federal agencies concerned with health protection and members working for, or allied with, the Department of Defense (DoD), who

²⁶⁹ *ibid.*

²⁷⁰ Slesin, ‘IEEE Drafts Major Relaxation...’, 2001.

²⁷¹ Slesin, ‘Revision of RF/MW Standard Stalls...’, 2002.

²⁷² *ibid.*

²⁷³ *ibid.*

were only concerned with service requirements and getting new technology on-line as quickly as possible. The federal agencies made it clear that they would not support a standard that significantly relaxed key provisions of the existing standard. In particular, Robert Curtis from the U.S. Occupational Safety and Health Administration (OSHA) said that “[a] standard that does not recognize the need for safety factors for different members of the population would have little value.”²⁷⁴ This conflict prompted some members of SCC-28 to back away from a full-scale revision in favour of making small, incremental changes²⁷⁵. The problem for the cell phone industry however, as stated by Chou at the June 2001 SCC-28 SC-4 meeting, was that the SAR averaging change “could have a big impact on . . . cell phone manufacturers”. This was especially urgent because of the uncertainties of cell phones meeting the FCC SAR compliance limits, as raised by the 20/20 program. The issue was put on hold by SCC-28 until after a WHO/Motorola organised thermo-regulation workshop on March 21-22 in Geneva, where it was hoped the proposed relaxation in the IEEE’s standard could gain further ‘science-based’ justification.²⁷⁶

Reflecting differing views within the IEEE itself, in the August issue of IEEE Spectrum, Raymond Kasevich, chief scientist of CS Medical technologies, a developer of microwave treatment technology for prostate and cardiology treatments based in Great Barrington, Maine, expressed a view supporting the concerns of the federal agencies. Kasevich called for the RF/MW standard to be revised “using all of the available results and information – not just the data that fit previously held assumptions.” He wanted the work of Drs. Richard Albanese, Henry Lai and Dariusz Leszczynski (all work examining non-thermal mechanisms) to be taken into account. Kasevich added, “[t]he telecommunications industry, which is in deep denial, needs to face reality.”²⁷⁷

²⁷⁴ *ibid.*

²⁷⁵ *ibid.*

²⁷⁶ *ibid.*

²⁷⁷ L. Slesin, ‘Standards’, *Microwave News*, vol. 22, no. 4, Jul./Aug. 2002, p. 16.

SCC-28's Risk Assessment Working Group on revisions

As “risk assessment” is a key theme running through this thesis it is worthwhile to consider a few pertinent points from SCC-28's Risk Assessment Working Group (RAWG) on the standard revisions. These are taken from internal emails circulated within RAWG and obtained by *Microwave News*.

Richard Tell, from Richard Tell Associates Inc., made the point that the 4W/Kg threshold level for a non-hazardous effect was determined in the context of very short duration exposures only. Tell said that “most of the researchers who have developed this data agree that this threshold would turn into a really hazardous threshold if the exposure had been longer...So, sometimes, I sense that we are sort of talking like the 4 W/Kg figure is no big deal, but we know better”.²⁷⁸

James Hatfield from Hatfield and Dawson Consulting Engineers, took a more philosophical view that belied Adair's belief that the process was based on sound science. “We are obsessed by our own definition of ‘science.’ This standard is a lot more than science whether we like it or not. There have always been politics and sociology in the setting of MPE limits. Where do you think the lower public MPEs come from? Not quite the tooth fairy.” Hatfield said.²⁷⁹

Vitas Anderson from EME Australia Ltd. and later an associate investigator at the Australian Centre for Radiofrequency Bioeffects Research (ACRBR) took a viewpoint mirroring John D. Graham's use of unrelated risk comparisons (Chapter 1). Anderson compared the 0.4 W/Kg whole-body-average SAR limit heat load “to other sources of heating that are routinely accepted by the community without any qualms, including for example: increasing the ambient air temperature by a few degrees; stepping out into the sunshine; hugging your children; almost any form of physical exertion, including tapping out these words on my computer.”²⁸⁰

²⁷⁸ L. Slesin, ‘IEEE RF/MW Exposure Limits: Revise or Stand Pat?’, *Microwave News*, vol. 22, no. 4, Jul./Aug. 2002, p. 9.

²⁷⁹ *ibid.*

²⁸⁰ *ibid.*

Dr. David Black from *Enviromedix IT* New Zealand, came right out against the guiding principle used in radiation protection, the ALARA principle²⁸¹. "I don't support the use of ALARA in RF standards ... there are good reasons to believe that there are true thresholds with RF below which there is no effect at all even across a large population. Using ALARA in RF weakens its importance in IR [ionising radiation]. We have deliberately removed it from the Australian and NZ standards for that reason."²⁸² Black did not mention the significant amount of opposition within the Australian TE/7 standards committee to removing that provision (more accurately debated around a precautionary approach) to the point that TE/7 was dissolved because it failed to agree to its removal. This will be examined in detail in Chapter 5.

The above quotes illustrate the subjective nature of IEEE's RF standard setting science. Tell pointed out the significant limitation of the basic 4W/Kg supposed threshold level for non-hazardous effects in that it is only based on short-term exposures. Hatfield acknowledged the inclusion of political and social factors in determining the exposure limits. Anderson took a page right out of John Graham's revisionist risk analysis primer covered in detail in Chapter 1 and Black resorted to a disingenuous re-interpretation of history in trying to make his point. The significance of Anderson and Black's statements, in particular, are two-fold. First they show a complete alignment with the thermal viewpoint, without any reservations whatsoever - to the point of stretching the truth in trying to make their points. Secondly, both Anderson and Black were also prominent members on the Australian TE/7 Committee, as will be examined in Chapter 5.

By 2003 it was clear that the proposed IEEE SCC-28 RF relaxed standard was facing an uphill battle to be accepted by the FCC , EPA and other federal agencies who continued to oppose IEEE's relaxed standard in preference to the stricter FCC

²⁸¹ The guiding principle behind radiation protection is that radiation exposures should be kept "As Low As Reasonably Achievable (ALARA)," economic and social factors being taken into account. This common-sense approach means that radiation doses for both workers and the public are typically kept lower than their regulatory limits. Taken from the Health Physics Society:

<http://hps.org/publicinformation/radfactsheets/radfact1.html>

²⁸² Slesin, 'IEEE RF/MW Exposure Limits...', 2002.

NCRP based RF standard. For example in 2002, the Cellular Telecommunications Industry Association (CTIA) put pressure on the EPA to reconsider its advice to the FCC in favour of the IEEE standard. In Sept 15, 2002 the EPA responded in a letter to the CTIA reaffirming its support for the FCC's RF exposure standard.²⁸³

Harmonization with ICNIRP on the agenda

In 2001, the name of the SCC-28 committee was changed to the "International Committee on Electromagnetic Safety" (ICES)²⁸⁴ "in order to continue its work globally" according to Osepchuk.²⁸⁵ Harmonization with the International Commission on Non-Ionizing Radiation Protection (ICNIRP) was on the agenda for the June 8-9, 2001, IEEE SCC-28 (4) meeting (mentioned previously). In that meeting Osepchuk reported that members of SCC-28 leadership had met twice with ICNIRP members during the past year. A joint workshop on thermophysiology²⁸⁶ had been planned with an agreement to exchange documents. Osepchuk stated that another meeting with the leadership of SCC-28 and ICNIRP might be held in December 2001 if SCC-28 met in Luxembourg. Osepchuk also discussed WHO goals for establishing a framework for global standards.²⁸⁷

SCC-28 Chair Eleanor Adair elaborated on the planned SCC-28/ICNIRP workshop, the goal of which was to develop a single model that could be used to predict the effects on humans exposed to RF fields, based on thermophysiology and dosimetry. Dr. Om Gandhi from the University of Utah moved a motion that SCC-28 SC4 consider harmonizing with ICNIRP on the peak and average SAR limits. The motion was tabled until more information was obtained.²⁸⁸

²⁸³ L. Slesin, 'EPA: Current RF Limits Are Adequate for Thermal Risks', *Microwave News*, vol. 22, no. 5, Sept./Oct. 2002, p. 8.

²⁸⁴ Osepchuk, Petersen, 2003.

²⁸⁵ *ibid.*

²⁸⁶ Defined as the science concerned with how the normal vital processes of the living organism are affected by heat. Obviously this would exclude any consideration of non-thermal effects and indicates the bias against non-thermal RF bio-effects.

²⁸⁷ IEEE /ICES, St. Paul, Minnesota, 2001. *op. cit.* Also see: WHO Standards and Guidelines

http://www.who.int/peh-emf/standards/EMF_standards_framework%5b1%5d.pdf Accessed August 24, 2006.

²⁸⁸ IEEE /ICES, St. Paul, Minnesota, 2001. *op. cit.*

Peterson reported at the meeting that “the consensus is to move to a larger averaging volume...and perhaps higher limits for the peak spatial-average SAR, e.g., adopt the ICNIRP limits.”²⁸⁹

Consideration of harmonizing with ICNIRP was not on the agenda three years earlier when members of IEEE SCC-28 committee and ICNIRP met at a Forum on EMF safety Standards and Science, sponsored by the U.S. Air Force in Munich, Germany on June 11, 2000. Both groups trying to ‘claim the high ground’ in regards to which RF standard was most based in science. As one participant put it to the publication *Microwave News*, “It’s a turf battle, pure and simple”. Soon after the meeting however, the two groups held a further meeting that apparently resulted in constructive exchanges and an agreement that harmonization of non-ionizing radiation was “the prime objective of both organisations.”²⁹⁰ The standards setting stalemate that continued well after 2000 may have convinced SCC-28 that ICNIRP was a viable option, provided it was presented in such a way to be accepted by the FCC and other federal agencies.

Although the IEEE is primarily an American organisation with its roots dating back to the founding of the AIEE in 1884, it has long been actively involved in RF standard setting internationally with about one third of its 325,000 current members from outside the United States.²⁹¹ Its international members, besides telecommunications corporations, include many of the representatives on various national RF standard setting and regulatory bodies, ensuring that IEEE viewpoints are widely disseminated internationally. Through IEEE’s SCC28 committee (later ICES) the development of internationally recognized voluntary standards was a priority²⁹², reflecting the IEEE’s mission of “Networking the World”.²⁹³ As IEEE members Om Gandhi and Gianluca Lazzi explained: “... following the lead of the

²⁸⁹ *ibid.*

²⁹⁰ L. Slesin, ‘Efforts to Harmonize RF/MW Exposure Standards in Disarray’, *Microwave News*, vol. 20, no. 4, Jul./Aug. 2000, pp. 1,8-9.

²⁹¹ P. Mason, M. Murphy, R. Peterson, IEEE EMF Health & Safety Standards, WHO Meeting on EMF Biological Effects and Standards Harmonization in Asia and Oceania, Shilla Hotel, Seoul, Korea, 22-24 Oct., 2001, http://www.who.int/peh-emf/meetings/southkorea/en/IEEE_EMF_HEALTH_-_Mason.pdf, Accessed Aug. 29, 2006.

²⁹² *ibid.*

²⁹³ As stated on the IEEE web site: <http://grouper.ieee.org/groups/scc28/>, Accessed Aug. 18, 2006.

1982 ANSI/IEEE C95.1 Standard “RF safety standards all over the Western World were altered to Frequency-dependent SAR exposure limits that recognized resonance of the human body, and limited exposures to whole-body averaged SARs of 0.4 W/kg for occupational exposures and 0.08 W/kg for general public.”²⁹⁴ Thus the model for SAR values, first seen in the C95.1-1982 standard became the template for most of the Western world’s RF safety standards, including those of the U.K. National Radiological Protection Board (NCRP). North Atlantic Treaty Organisation (NATO), the U.S. Department of Defense (DoD), and the RF guidelines from the International Commission on Non-Ionizing Radiation Protection (ICNIRP)²⁹⁵ and the Australian Radiation Protection and Nuclear safety Agency (ARPANSA).

Disregarding the advice from the federal agencies, ICES (SCC- 28) pushed ahead in late 2002 with its proposal to relax the limit for exposures to mobile phone radiation. Researcher Dr. Om Gandhi, from the University of Utah, stated in a December 2002 open letter to ICES that their proposal would create “the most relaxed RF safety standard in the world”. Gandhi pointed out that the proposed changes would make the IEEE SAR limit “3 to 5 times higher than the limit set by ICNIRP.” Gandhi said to *Microwave News* that the newly proposed ICES/IEEE RF safety standard would potentially allow cellular telephone radiations that would be 8 to 16 times those currently allowed in the U.S. According to Gandhi, “they would also be larger than twice those allowed under the ICNIRP Guidelines – this vitiating the desire to have a harmonized safety standard for cellular telephones.”²⁹⁶ The ICES committee, chaired by Motorola’s C-K Chou and the U.S. Navy’s John D’Andrea also voted to increase the averaging volume used in calculating SARs from 1 gram to 10 gram, relax the SAR limit from 1.6 W/kg to 2 W/kg. These two changes brought the mobile phone limits in line with ICNIRP’s limit of 2 W/kg over 10 grams of tissue. Committee members also wanted to relax the exposures to the outer ear (the pinnae) from 1.6 W/kg over 1 g. to 4.0W/kg

²⁹⁴ Gandhi, Lazzi, ‘The ANSI/IEEE RF Safety Standard...’, undated, op. cit.

²⁹⁵ Mason, Murphy, Peterson, 2001.

²⁹⁶ L. Slesin, ‘IEEE Move To relax Cell Phone SAR Exposure Limit Under Fire’, *Microwave News*, vol. 23, no. 3, May/June, 2003, p. 4.

over 10 g.²⁹⁷ These proposals to increase the IEEE standard in order to make cell phones sold in America compliant are all examples of the Procrustean Approach. This is especially seen by the Motorola proposal to relax the standard for the pinnae – essentially cutting off the outer ear because it did not conform to the standard limits.

The trend towards harmonization of RF standards, the one promulgated by IEEE and that of ICNIRP is an inevitable consequence of globalisation, the growth of international telecommunications corporations and the global deployment of U.S. military technology. Be it a cell phone or a missile defense radar system, the prime consideration for the manufacturers and users of the technology is to be able to market globally without inconvenient national standards standing in the way of trade or competing standards suggesting a disagreement in health protection. It may be that IEEE's significant relaxation of its standard in the latest revision was, in fact, a sort of 'ambit claim' when negotiating details with ICNIRP over harmonization in order to get the best deal for the cell phone industry. What is apparent from this is that harmonisation is not about better health protection but all about international trade, be it civilian or military. This can only be achieved, unfortunately, by a continuing denial, or maintaining a continuing ignorance and uncertainty over the possibility of health hazards that are not related to the simple thermal model that was developed in the 1950s and maintained to this day.

ICES meeting of September 2003

The ICES SCC-28 Subcommittee 4 "unapproved minutes" accounts the meeting between ICES SC-4 and the Federal Government's RF Interagency Work Group (RFIAWG) on Sept 25, 2003. At this meeting the FCC, FDA/CDRH and the EPA each had three representatives. As well, OSHA and the NTIA had one representative each.²⁹⁸

The overwhelmingly wireless industry/military make up of ICES SC-4 was reflected in the ICES representatives at the meeting: C.K. Chow and M. Swicord

²⁹⁷ *ibid.*

²⁹⁸ IEEE/ICES, Rosslyn, Virginia, 2003, *op. cit.*

from Motorola, D'Andrea from the US Navy, Peterson (Ex, Lucient Technologies - now "independent"), R. Tell (Richard Tell Associates – "independent") and an observer from Siemens Corp.²⁹⁹

The purpose of the meeting was to discuss the approach to standards as well as discussing the concerns, examined earlier in this chapter, that had been sent to SC-4 by the RFIAWG. During the September 2003 meeting discussions involved reviewing and attempting to resolve definitions of "margin of safety", "safety factor", and "margin of uncertainty"³⁰⁰. The members selected to do this work were M. Meltz from the University of Texas and John Osepchuk. Considering that Osepchuk has previously supported microwave home heating, his viewpoint on margins of safety etc. may be biased in regards to what constitutes a safe level of microwave exposure. Other working groups were assigned tasks to refine "spatial averaging", "thermal/nonthermal", "penetration depth and "partial-body exposure".³⁰¹

A report by the Risk Assessment Working Group by Richard Tell examined the rationale behind safety factors for the two-tier exposure system introduced in the 1991 IEEE standard. A paper by Vitas Andersom and Richard Tell was discussed that argued that the safety factor should be more solidly based. However J. Osepchuk and L. Heynick (independent consultant) both criticised the Anderson/Tell paper as not being scientific. At this point David Fichenberg an activist from the Cellular Phone Taskforce, added (by phone) that "given a lack of scientific basis for the safety factors, risk assessment methods should be used".³⁰² It was then added by the meeting secretary at this point that "[t]here is a huge literature on risk assessment, including reports to Congress", this being an apparent reference to John Graham's and Robert Hahn's risk assessment reports to congress³⁰³ mentioned in Chapter 1 and 2 of this thesis.

²⁹⁹ *ibid.*

³⁰⁰ *ibid.*

³⁰¹ *ibid.*

³⁰² *ibid.*

³⁰³ J. Graham, 'Making Sense of Risk: An Agenda for Congress', *EMF Risk Perception and Communication*, Proceedings of the International Seminar on EMF Risk Perception and Communication, WHO, Ottawa, Ontario, Canada, Aug. 3–Sep. 1, Repacholi MH, Muc A (eds), pp. 1 – 31.

Proposals to relax the compliance standard from a 1 gram cube of tissue at 1.6 W/kg to the EU compliance of 10 gram cube at 2 W/kg were discussed with reference to harmonizing with ICNIRP. Swicord reviewed the existing hazard level of 4 W/kg, based on work stoppage in animals that was accompanied by an increase in temperature of 1 degree C. A paper by Adair and Black was discussed that conveniently suggested the RF safety factors could be raised (thus increasing the standard limits). According to Adair and Black, the RF exposure safety factors were largely based on rodent data, and small animals are poor models for human beings, who exhibit far better, thermoregulatory response. The authors stated that, "the conclusion is inescapable that humans demonstrate far superior thermoregulatory ability over other tested organisms during RF exposure at, or even above current human exposure guidelines."³⁰⁴ It was stated that if the safety factor of 10 was then applied to the 4 W/kg level (based on rodent studies) this level (tier 1- controlled or occupational) "would be well within the daily fluctuations of body temperature, even in an impaired person."³⁰⁵ Adair wrote that a SAR of 0.4 W/kg was only 35% of the resting Metabolic heat production of a human adult "and was the equivalent of donning a light sweater"³⁰⁶. The minutes of the meeting then record that it was "clear to all that the present rationale for the lower tier is not good".³⁰⁷ The inference was that if the first tier (controlled/occupational) was protective against harmful thermal increases in body temperature, a stricter lower tier (for the public) was unnecessary. This paper is briefly examined later in this chapter in the section on the review papers in Bioelectromagnetics Supplement 6. At the close of the first day Richard Tell brought up the problem presented by calculations by Dimbylow on the SARs for small children exposed above 1 Ghz. For example, above 1 Ghz, data for children go to a SAR of 0.167 W/kg when they are exposed at the MPE of 0.08 W/kg (a factor of 2 above the basic restriction.³⁰⁸ In issue no. 24 of the minutes the question of the impact of the Dimbylow/Gandhi data was raised on SAR's and children.

³⁰⁴ IEEE/ICES, Rosslyn, Virginia, 2003, op. cit.

³⁰⁵ *ibid.*

³⁰⁶ *ibid.*, p. 7.

³⁰⁷ *ibid.*

³⁰⁸ *ibid.*, p. 10.

The comment was “that when this work is done, regulators will have a problem with 2 W/kg instead of 1.6 W/kg. The new numbers are based on biology (1.6 W/kg), but we like round numbers and the whole world, other than US, Canada, Taiwan and South Korea is using the 2 W/kg limit.”³⁰⁹ It was also briefly mentioned that Vitas Anderson had shown that temperature rise is better correlated with a 10 gram average than with 1 gram.³¹⁰ It was also announced at the meeting that Motorola’s C.K. Chow would take over the SC-4 web site.³¹¹ What is clearly seen from reviewing the minutes of the above meeting is a continuing effort to scientifically justify reasons to increase the RF limits, with the main emphasis apparently on ensuring that cell phones and other new technology operating in the Ghz range would, with a Procrustean Approach, be in compliance with the standard under all test situations. In other words, the standard was being revised to suit the needs of the industry.

ANSI/IEEE-C95.1 (2006)

The IEEE’s Standards Board on October 3, 2005 formally approved the IEEE standard C95.1-2005, prepared by ICES (formerly SCC-28). Titled “*Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*” it replaced the previous 1991 IEEE C.95.1 standard ³¹². In November 2, 2006, the American National Standards Institute (ANSI) approved the new IEEE standard to be designated ANSI/IEEE C.95.1-2006.³¹³ This standard, being a complete revision from all previous standards, can be considered the summation of almost 50 years of U.S. RF standard setting that began in 1957 with the establishment of research for the Tri-Services Program. The next step for IEEE was to petition the FCC to adopt the standard and its increased limits for the FCC’s

³⁰⁹ *ibid*, p. 16.

³¹⁰ *ibid*.

³¹¹ *ibid*, p.17.

³¹² J. Lin, ‘Health Effects: Update of IEEE Radio frequency Exposure guidelines’, *IEEE Microwave Magazine*, Apr. 2006, pp. 25-26.

³¹³ L. Slesin, ‘ANSI Approves Revised IEEE RF/MW Standard’, *Microwave News*, vol. 26, no. 6, Nov. 2006, p. 1.

compliance requirements³¹⁴. However, as of June 2, 2009, this has not yet happened.³¹⁵ According to C-K Chou from Motorola and co-chair of SC4, a major revision criteria for the new standard was harmonisation with ICNIRP's RF guidelines³¹⁶ however there are several important differences from both ICNIRP and C95.1-1991 that favour the interests of the cellphone industry with compliance issues.

A significant change is the exposure relaxation from the previous 1991 IEEE standard's basic restriction SAR value for localized exposures of 1.6 W/kg averaged over any 1 gram of tissue (and used by FCC). This was increased to 2 W/kg averaged over any 10 gram of tissue (ICNIRP is 2 W/kg averaged over any 1 gram of tissue). This increases further with the exclusion of the outer ear from the rest of the head, mentioned earlier in this chapter. The basic SAR restriction for the ear therefore increases from the new 2 W/kg basic restriction for localised exposure to 4 W/kg over 10 grams. According to ICES member James C. Lin in his article in *IEEE Microwave Magazine* (2006), the increase in tissue mass from 1 to 10 grams "can have a profound influence on the actual quantity of RF energy allowed to be deposited in tissue by the new exposure standard". Lin considered the 1991 SAR mass of 1 gram of contiguous tissue as "scientifically a more precise representation of localized RF or microwave energy absorption and a more biologically significant measure of SAR distribution inside the body or head."³¹⁷ This relaxation was first introduced by C-K Chou from Motorola at a SC4 meeting on October 17, 1999, basically for "decisions on compliance testing". At that meeting Dr. Veli Santomaa from Nokia gave a presentation, explaining the reason behind the proposal. According to Santomaa, the SAR level is highest in the ear (when using a cell phone) and since the outer ear "is not a vital organ" it was not necessary to "protect the [outer ear] against RF exposure at the same level as the brain." The reason for the need to relax the allowable SAR level in the ear was so

³¹⁴ L. Slesin, 'Will the FCC Adopt Looser Cell Phone Safety Standards?', *Microwave News*, vol. 27, no. 5, Apr. 2007, p. 4.

³¹⁵ Correspondence with Louis Slesin, June 2, 2009.

³¹⁶ C-K Chou, 'New IEEE RF safety standard C95.1-2005', *info-CITEL electronic Bulletin*, No. 25, Jul. 2006, http://www.citel.oas.org/newsletter/2006/julio/rni-ieee_i.asp, Accessed Sept. 5, 2006.

³¹⁷ *ibid.*

that “maximum power of phones will not be limited unnecessarily” according to Santomaa.³¹⁸ This was clearly an admission that a Procrustean Approach was being followed. For comparison, in the ICNIRP Guidelines, the pinnae are treated as an integral part of the human head.³¹⁹ According to Dr. Om Gandhi from the University of Utah, when provision for an ear is removed from plastic dummy heads used by the industry for SAR cell phone compliance testing, the earless model head can underestimate the peak SAR by as much as 40%-60% of the actual SAR level.³²⁰ In addition to the Procrustean act of chopping off the test dummy’s ear, averaging over the larger mass of 10 grams artificially flattens out the SAR distribution resulting in a lower overall SAR value and smooths out peak points of energy (hot spots) when compared to the 1-gram mass. An example given by Lin is the spherical shaped human eye with a mass of about 10 grams. To quote:

The use of an averaging volume as large as 10 grams does not attribute any distinctions among tissues in the eye and completely ignores the wide variation of SAR distribution throughout the eyeball. The choice of 2 W/kg over a 10-g tissue volume in the shape of a cube could permit the deposition of RF or microwave energy in different parts of the eye that exceeds the basic SAR restriction by a large margin, while keeping the SAR for the entire eye below 2W/kg.³²¹

Although ICNIRP also uses a 10 gram tissue volume in its SAR calculations, an important difference from the IEEE’s 10 gram mass is that ICNIRP uses 10 grams of contiguous tissue. The difference is that 10 gm of contiguous tissue means the volume to be considered can be filled with tissue of different types. The 1996 ANSI/ IEEE standard considers only a specific tissue and any lack of that particular tissue within that volume is considered as air with zero SAR³²². Thus, the IEEE exposure standard is based on a testing model that treat human beings as merely a jelly filled phantom with certain electrical properties that can be

³¹⁸ Slesin, ‘Industry Seeks Higher Exposure Limit...’, 1999.

³¹⁹ Lin, 2006.

³²⁰ *ibid.*

³²¹ *ibid.*

³²² *ibid.*

measured in the laboratory. According to Lin, who took over the position of associate editor of Bioelectromagnetics from C-K Chou, IEEE's method is rather ambiguous and could result in a wide range of SAR values. Lin considers ICNIRP's 10-gram contiguous tissue as a more scientifically precise representation of energy absorption of RF/MW energy and a more biologically significant measure of SAR distribution in the body or head than the IEEE/ICES method.³²³ What is apparent from this method is a greater level of uncertainty in exposure assessment. According to Lin, the process of harmonisation must not proceed just for harmonisation's sake but aim toward improved SAR calculations and less uncertainty in exposure assessment to give a more scientifically based and commonly recognized exposure standard.³²⁴ Of course both methods are only relevant to thermal effects and do not apply to possible biological effects that are not related to heating. The importance of Lin's critique of the ANSI/IEEE C95.1-1996 RF standard is that even the standard's ability to provide health protection against thermal exposures is questioned.

In ANSI/IEEE C95.1-1996 the definition of, "established adverse health effects" is restricted to heating effects only for telecommunications frequencies. They are defined as: (1) "aversive or painful electrostimulation due to excessive RR internal electric fields, (2) RF shocks and burns due to contact with excessively high RF voltages, (3) heating pain or tissue burns due to excessive localized RF exposure, and (4) behavioural disruption, heat exhaustion or heat stroke due to excessive whole body RF exposures. The standard states that, in their definition, adverse effects do not include: "biological effects without a harmful health effect, changes in subjective feelings of well-being that are a result of anxiety about RF-effects or impacts of RF infrastructure that are not physically related to RF emissions, or indirect effects caused by electromagnetic interference with electronic devices".³²⁵ This strict definition of an adverse health effect is at odds with the definition as stated in the WHO Framework for developing EMF Standards (2003). To quote:

³²³ *ibid.*

³²⁴ *ibid.*

³²⁵ IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields 3 kHz to 300 GHz, IEEE Std. C95.1 – 2005, IEEE International Committee on Electromagnetic Safety (SCC39), 19 April 2006.

Annoyance or discomforts caused by EMF exposure may not be pathological per se but, if substantiated, can affect the physical and mental well being of a person and the resultant effect may be considered as an adverse health effect. A health effect is thus defined as a biological effect that is detrimental to health or well-being. According to the WHO Constitution, health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.³²⁶

In the December 2005 ICES TC95 Subcommittee-4 meeting D'Andrea said that the WHO statement that "include effects related to feelings of well being" may be "an important stumbling block regarding harmonization".³²⁷ The IEEE's strict definition of an adverse health effect, ignoring 'well-being' from RF exposure, shows a fundamental misunderstanding of the concept of 'risk' in an advanced technological society. No room is given to either the public's concerns over possible adverse consequences from new wireless devices or alternative voices from within the scientific community over the existence of non-thermal biological hazards not related to heating. A related change in the 1996 standard is its definition of the microwave (RF) hearing effect as a "benign biological sensation" whereas ICNIRP considers it to be an "adverse effect".³²⁸ The ICNIRP definition would be in line with a paper by Frey (1962) on microwave hearing research that concludes that the microwave hearing effect is a "biologically significant phenomenon"³²⁹

Of relevance to new generation wireless devices operating in the GHz range, the upper frequency boundary of the basic restriction, based on the whole body averaged SAR, was reduced from the 1991 6 GHz level to 3 GHz. Also, the upward ramp that starts for the relaxation of the power density limits for localized

³²⁶ M. Repacholi, E.van Deventer , WHO Framework for Developing EMF Standards, Proceedings of the International Conference on Non-Ionizing Radiation at UNITEN (ICNIR 2003) Electromagnetic Fields and Our Health, Oct. 20-22, 2003.

³²⁷ IEEE/ICES TC95 Subcommittee 4, Unconfirmed Minutes, San Antonio, Texas, Dec. 10, 2005, pp. 3, 5, http://www.ices-emfsafety.org/documents/Minutes/TC95_december%202005%20minutes.pdf, Accessed Apr. 25, 2006.

³²⁸ *ibid.*

³²⁹ A. Frey, 'Human auditory system response to Modulated electromagnetic energy', *J. Applied Physiology*, vol.17, no.4, 1962, pp. 689-692.

exposure has been reduced from 6 GHz to 3 GHz.³³⁰ This was an issue raised in June 1999 by the Radiofrequency Interagency Work Group (RFIAWG). The Work Group suggested, at the microwave frequencies, a ramp function somewhere between 30-100GHz is more realistic in order to be consistent with the laser standard. They saw no justifiable reason for a lower ramp and mentioned that using a much lower ramp would raise “concerns 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.” It would seem to be the case that this downward relaxation in the 2005 standard may be to ensure that new high frequency devices operating over 3 GHz will not be in non-compliance with the standard. There are other areas of difference in ANSI/IEEE C95.1-1996 with both the 1991 standard and that of ICNIRP, but the most significant change is that increasing the SAR limit to 2 W/kg as well as increasing the averaging volume to 10 grams effectively eliminates the compliance problem by doubling the allowable amount of radiation absorbed from a mobile phone.³³¹ At the December 2005 meeting of ICES TC95 SC4 the issue of harmonization with ICNIRP was discussed, with Osepchuk stating that he was not optimistic about co-operation with ICNIRP.³³²

A syndrome of paranoia and neglect

Looking at the evolution of RF standard setting in the U.S. which has led to ANSI/IEEE C95.1-1996, it is apparent that public concerns over telecommunications technology, and the ever increasing development of new devices, are dismissed by the IEEE standard setters as simply based on public ignorance and unfounded fears. As examined in Chapter 1, this mind-set was clearly stated by John D. Graham as keynote presenter at the International Seminar on EMF Risk Perception and Communication (1999). Graham, speaking to an audience deeply involved in EMF standard setting, called public concerns over technological risks as simply a “syndrome of paranoia and neglect”. Graham’s

³³⁰ Lin, 2006.

³³¹ Email correspondence with Lloyd Morgan, a director of the United States Central Brain Tumor Registry, Aug. 28, 2006.

³³² IEEE/ICES TC95, San Antonio, Texas, 2005, op. cit.

solution was a series of recommendations to the U.S. Congress to require quantitative risk assessment before making any protective decisions.³³³ Central to these recommendations was that the Environmental Protection Agency (EPA) should ignore public concerns in regulatory decision making, but base its decisions solely on so-called “scientific assessments on the level of risk”.³³⁴

Shades of Graham’s “syndrome of paranoia and neglect” can be seen in the ICES meeting of June 26, 2005 in Dublin, Ireland, where committee member Ralf Bodemann, gave a presentation reporting on the outcomes of the WHO IAC meeting, June 13-14, 2005. Bodemann’s concluding point stated:

[E]lectrically hypersensitive”persons do not exist. ...These persons suffer not due to their exposure to EMField, but because they develop a psychosomatic syndrome. [...]All known facts can be explained by the ESS syndrome (Environmental Somatization Syndrome). [...]Nevertheless, the complaining people may be hypersensitive indeed, but not to electromagnetic fields. They are hypersensitive to rumours, alarming messages, false reports, false alarm and fictitious news. They do not trust to the scientific results and develop psychosomatic syndrome, often quite serious. Their troubles should be treated by a psychologist or by a psychiatrist, not by lowering the EMF limits or by removing the alleged sources of EMFs.³³⁵

It is important to note that the IAC is an advisory body to the WHO’s International EMF Project (IEMFP) with the role of approving documents published by WHO.³³⁶

Central to the IEEE’s definition of an RF/MW adverse health effect (electrostimulation, RF shocks and burns, heating pain or tissue burns or behavioural disruption, heat exhaustion or heat stroke), that can only result from

³³³ Graham, 1998.

³³⁴ W. Freudenburg, ‘Risky Thinking: Irrational Fears About Risk and Society’. The Annals of the American Academy of Political and Social Science, vol. 545 annals 44, May 1996.

³³⁵ R. Bodemann, ‘Report on WHO IAC meeting June 13-14, 2005’. IEEE ICES TC95 Meeting, Approved Minutes, Dublin, Ireland, June 26, 2005, http://www.ices-emfsafety.org/documents/Minutes/TC95_june%202005%20minutes.pdf, Accessed Apr. 28, 2006.

³³⁶ Bodemann, 2005, op. cit., p. 6.

high level RF/MW exposure, is a dismissal from consideration the issue of low-intensity, non-thermal biological effects. This was clearly stated by C-K Chou and D'Andrea in their Introduction to the RF reviews in *Bioelectromagnetics Supplement 6*, commissioned by ICES as a justification for the 1995 IEEE standard. They state that “nonthermal RF biological effects have not been established and none of the reported nonthermal effects are proven adverse to health.”³³⁷

Bioelectromagnetics Supplement 6 and IEEE's compromised peer review process

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.”³³⁸ 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”³³⁹.

³³⁷ C-K. Chou, J. D'Andrea, ‘Reviews of Effects of RF Fields on Various Aspects of Human Health: Introduction’, *Bioelectromagnetics*, Supplement 6, 2003, pp. S5-S6.

³³⁸ Chou, D'Andrea, 2003.

³³⁹ *ibid.*

Publishing in a peer review journal was meant to place the literature summaries before the bioelectromagnetics scientific community and the public³⁴⁰ 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?”³⁴¹

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 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

³⁴⁰ 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.

³⁴¹ K. Rothman, ‘Conflict of Interest: The New McCarthyism in Science’, *JAMA*, vol. 269, issue 21, June 2, 1993, pp. 2782-2784.

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)."³⁴² 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."³⁴³

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."³⁴⁴

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."³⁴⁵

³⁴² 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.

³⁴³ *ibid*

³⁴⁴ 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://www.icmje.org/index.html#peer>, Accessed Sept. 28, 2006.

³⁴⁵ E. Marshall, 'When Does Intellectual Passion Become Conflict of Interest?', *Science*, vol. 257, July 31, 1992, pp. 620-623.

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 Force³⁴⁶, 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 Laboratories, Florida.³⁴⁷ The role of BEMS Newsletter Editor was then taken over by Mays Swicord, also a senior researcher at Motorola Laboratories.³⁴⁸ ³⁴⁹ 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

³⁴⁶ 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.

³⁴⁷ M. Swicord, (ed.), ‘C-K Chou will receive the 2006 D’Arsonval Award’ *Bioelectromagnetics Newsletter*, no. 188, Jan./Feb. 2006, pp. 1, 3.

³⁴⁸ *ibid.*

³⁴⁹ 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.

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.³⁵⁰

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".³⁵¹ 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"³⁵² whereas in *Bioelectromagnetics Supplement 6* she is listed as "Air Force Senior Scientist Emeritus."³⁵³
- In *Bioelectromagnetics Supplement 6*, Louis Heynick is listed as 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.³⁵⁴
- Supplement 6 lists Martin Meltz as affiliated with The University of Texas Health Science Center, but in the ABC documentary "20/20" in October

³⁵⁰ 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.

³⁵¹ M. Swicord, (ed.), 'New Disclosure Policy Begins With This Issue', *Bioelectromagnetics Newsletter*, no. 188, Jan./Feb. 2006, p. 4.

³⁵² Internal membership list "SCC28_SC4_Active_1" supplied by SC4 member anonymously, Nov. 1997.

³⁵³ E. Adair E, D. Black, 'Thermoregulatory Responses to RF Energy Absorption', *Bioelectromagnetics Supplement 6*, 2003, pp. S17 – S38.

³⁵⁴ 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.

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.”³⁵⁵ The University of Texas is in financial and “educational partnership” with the Brooks City Air Force Base, both located at San Antonio, Texas.³⁵⁶

- 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.³⁵⁷

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.³⁵⁸ 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.”³⁵⁹ (See Table 1)

³⁵⁵ ABC News, 20/20 program transcript (report on cell phones), Oct. 20, 1999.

<http://www.junkscience.com/oct99/2020tran.htm>, Accessed Sept 23, 2006.

³⁵⁶ ‘Brooks City-Base diversifying its strategy’, *San Antonio Business Journal*, Sept. 1, 2006.

³⁵⁷ 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.

³⁵⁸ 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.

³⁵⁹ C-K. Chou, J. D’Andrea, ‘Reviews of the Effects of RF Fields on Various Aspects of Human Health: Introduction’, *Bioelectromagnetics, Supplement 6*, 2003, pp. S5-S6.

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	(former AT&T/Bell labs/Lucent)	1
Mark Ellwood	Epidemiology	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 can be considered in setting safety standards. Chou and D'Andrea list 12 "guiding principles"³⁶⁰ that ICES Subcommittee 4 used in revising the RF standard. To Quote:

³⁶⁰ Chou, D'Andrea, 2003. P. S6.

- 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.³⁶¹

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.

³⁶¹ *ibid.*

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.³⁶²

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".

³⁶² M. Ellwood, 'Epidemiological Studies of Radio Frequency Exposures and Human Cancer', *Bioelectromagnetics Supplement 6*, 2003, pp ; S63 – S73.

The authors conclude that “the only firm conclusion that may be drawn is the potential for hazardous thermal consequences of high power RF exposure”.³⁶³

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.³⁶⁴

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.³⁶⁵ 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 COST281³⁶⁶ 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

³⁶³ J. D’Andrea, C-K. Chou, S. Johnston, E. Adair, ‘Microwave Effects on the Nervous System’, *Bioelectromagnetics Supplement 6*, 2003, pp. S107 – S147.

³⁶⁴ Adair, Black, 2003.

³⁶⁵ Osepchuk, Petersen, 2003.

³⁶⁶ Acronym for "European Cooperation in the Field of Scientific and Technical Research".

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 Texas³⁶⁷ who is a member of ICES Subcommittee 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 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”.³⁶⁸ 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.³⁶⁹

Conclusions

Common to all the standards and guidelines examined in this chapter is a scientific assumption that the only hazardous biological effect from RF exposure is thermal in nature. This viewpoint was originally established by just a few individuals charged with setting an American military exposure standard in the 1950s during

³⁶⁷ L. Slesin, ‘News & Comment: What’s New’, *Microwave News*, Jul. 22, 2004, http://www.microwavenews.com/nc_ja2004.html, Accessed Sept. 30, 2006.

³⁶⁸ Abstracts: FGF-Workshop: “*Influence of RF Fields on the Expression of Stress Proteins*”, Helsinki, Finland, 28-29 April 2004.

³⁶⁹ Slesin, ‘Industry Rules RF...’ 2004.

the Cold War, when the Soviet Union appeared to be winning the nuclear arms race. The overriding problem confronting standard-setting military planners at the time was the need to provide health protection to personnel developing and working on new high power radar systems while at the same time not restrict the development of the technology that was considered essential for national survival in the event of a possible Soviet nuclear attack. Considering this, and the urgency to quickly come up with a workable standard in the midst of an escalating nuclear arms race, the best fit for addressing the problem was to rely on the already existing medical opinion that had built up since the late 1920s that as long as thermal increases to body temperature were restricted to tolerable limits, no adverse or irreversible biological effects were possible.

Initial exposure standards based on this thermal model fit the planner's problem nicely. Radar development could continue while assurances of safety could be given. Research could be conducted to further understand the thermal-regulatory capacity of the body (both animal and human) when exposed to RF/MW, thus strengthening the literature base that, in turn, supported the standard. Standards could then be updated and refined to provide protection against thermal biological damage without restricting the development of new technology being developed by both the military and private corporations. When there were questions in later years over the standard limits providing adequate protection against newly developed higher frequency technology, such as mobile phones, there was room available to further relax the standard's thermal limits to accommodate increasing exposure levels from that technology. All this was in general agreement with what was historically known about acute RF exposure levels – it could heat up tissue and thereby cause obvious biological damage.

Although early assumptions on RF biological hazards (heating) may be somewhat justified during the 1950s Cold War conflict with the Soviet Union, those assumptions quickly became a paradigm that excluded considerations of possibly adverse biological effects not related to heating. As seen in the ANSI/IEEE C-95.1 – 1996 RF standard, industry concerns over possible cell-phone compliance issues have led to adopting measures that allow increasing the limits in order to

accommodate technological operational requirements while relegating research into non-thermal biological interactions with RF as operating on a level of “beliefs and speculations” and therefore being “extra-scientific”. This relegates research that questions the thermal paradigm as somewhat tainted and beneath serious consideration.

With members linked to the ‘military-industrial complex’ firmly in control of the IEEE’s RF standards committees right from the beginning, their continuing task was essentially to further refine the thermal paradigm by encouraging research to further add validity to the thermal theory and not to test its basic assumptions. It is apparent that those actively involved in revising the latest 2005 C95.1 standard, writing various research papers for an updated risk-assessment of RF as well as those conducting peer review of papers for consideration have been thoroughly trained in the paradigm to the extent that any other non-thermal biological interactions with RF were well beyond consideration.

This chapter has tracked the development of the IEEE C95.1 RF standard from its foundations in the early 1950s and through various revisions by IEEE standard setting committees to illustrate the continual resistance to acknowledging the possibility of non-thermal effects in setting exposure limits. This resistance is linked to committee members’ ties to industrial and military organizations with a vested interest in maintaining the thermal paradigm. This paradigm has been challenged on a number of occasions by knowledgeable experts and government agencies but without success. As is seen in the various IEEE standards committee meetings the central arguments over standard revisions are technical, such as increasing the averaging volume of tissue to assure cell phones can safely meet compliance testing. These technical changes are seen in the light of working within the thermal paradigm to assure that the standard is always in compliance with the needs of the technology. What is apparent from this continuing situation is that an essential ingredient for the maintenance of the thermal paradigm is for supporters of that paradigm to control the standard setting process through their membership on RF standard setting committees. In this regard, conflict of interest has long been an essential policy to block the possibility of change inimical to those who control

the process. The importance of this chapter is to expose the subjective nature of the existing RF standard setting process as it has played out in the U.S. This Chapter takes the view that objective scientific hazard risk assessments in the public interest cannot function in the standards setting arena when those directly affected by regulation control the process. It is important to note that this situation can also apply to a wide range of other potential environmental hazards where those responsible for the potential hazard try to control the debate. In this context, the problem of conflict of interest in standard setting committees remains as the proverbial 1000-pound gorilla long ignored in the corner of the room.

Chapter 4

The thermal paradigm spreads internationally

The WHO's International EMF Project (IEMFP) and the International Commission on Non Ionizing Radiation Protection (ICNIRP)

While all the scientific literature was reviewed, the only adverse effects on humans that were fully verified by a stringent evaluation were short term, immediate health consequences such as stimulation of peripheral nerves and muscles, functional changes in the nervous system and other tissues, shocks and burns caused by touching conducting objects, and changes in behaviour caused by elevated tissue temperatures. There are also data for chronic low level exposure that indicate that there may also be other health effects. It is, however, ICNIRP's view that in the absence of support from laboratory studies the epidemiological data are insufficient to allow an exposure guideline to be established.

ICNIRP Statement, Mar 31, 1999¹

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.

Professor Huai Chiang²

Overview

Although the IEEE's C95.1 standard and the ICNIRP RF guidelines, promoted by the WHO's International EMF Project (IEMFP), may appear to be two distinct entities, they share common roots grounded in the 1950s development of the thermal approach towards RF biological effects in the U.S. and embodied in the IEEE C95.1 RF standards. The lineage between IEEE and the establishment of an international thrust through WHO was briefly mentioned in Chapter 3. Thus, all the factors explored in the previous chapter on the development of C95.1 are also a common inheritance for ICNIRP's thermal emphasis. As with C95.1, ICNIRP claims that the only proven hazard from exposure to RF is heating at acute (high level) exposures, below which no health effects occur. Unlike the IEEE standards

¹ ICNIRP, 'Use of the ICNIRP EMF Guidelines' Mar. 31, 1999, <http://www.icnirp.de/documents/Use.htm>, Accessed Feb. 4, 2009.

² Opening remarks by Professor Huai Chiang at the 3rd International EMF Seminar in China, 13-17 October 2003.

process, where industry and military interests openly take centre stage in standard setting, IEMFP and ICNIRP's RF risk assessment process claims to be independent from industry influence with ICNIRP members barred from being in the employ of industry. This stipulation also applies to all members on IEMFP's task working groups. In addition ICNIRP members are not paid for their work for the Commission and ICNIRP does not accept funding from industry. These stipulations are supposed to ensure that IEMFP and ICNIRP both remain as independent advisory bodies, untainted by an industry bias that would bring doubt on their scientific credibility. Much of the information that ICNIRP provides is published in the form of scientific reviews and reports and the proceedings of scientific meetings. The results of these reviews, combined with risk assessments carried out in collaboration with IEMFP, result in the publication by ICNIRP of Exposure Guidelines. Examples of these are guidelines limiting exposure to electromagnetic fields, to laser radiation, to ultraviolet radiation, to incoherent optical radiation and to ultrasound. In relation to electromagnetic fields in the range of 0 to 300 GHz the WHO runs the IEMFP that is developing a risk assessment framework for a global standard for this frequency range. This chapter examines the various factors that influence the risk analysis philosophy that lies behind both IEMFP and ICNIRP's determinations. In this regard, Chapter 1 establishes the background to this discussion. It needs to be said at this point, however, that this chapter (4) is not intended to be a critique of ICNIRP's scientific data-base in relation to providing protection from thermal hazards of high-intensity RF exposure. This data-base, essentially the same one which IEEE C95.1 is based upon (Chapter 3), is quite extensive in its understanding on how high-intensity RF exposure can damage biological tissue, based on animal research. This is then extrapolated to what is thought would happen in the human body under similar exposure situations. In this regard, ICNIRP's RF standards, as with IEEE C95.1, can be said to provide a level of protection against thermal biological damage from acute short-term exposures. In ICNIRP's latest review of the literature (2009) they concluded that "the most marked and consistent effect of RF exposure is that of heating" and that "the plausibility of various non-thermal mechanisms that have been proposed is very low"³

³ ICNIRP, 'Exposure to high frequency electromagnetic fields, biological effects and health consequences (100

Taking ICNIRP's advice, many governments have incorporated ICNIRP's thermal based guidelines into their national RF standards with ICNIRP promoting an international harmonization of all national RF standards based on these guidelines. ICNIRP's other guidelines for Laser, ultraviolet, incoherent optical and ultrasound radiations are not part of this thesis discussion.

The central argument in this chapter is that IEMFP and ICNIRP claims of independence from industry (which should also include military interests – although this is not mentioned) must be considered a necessary requirement for their scientific credibility. This is especially so as this has been specifically stated by Michael Repacholi, the founder of both ICNIRP and IEMFP. As is seen, however, these claims do not stand up under examination in the case study of IEMFP's Task Group writing a new Environmental Health Criteria for power frequency EMFs. In stark contravention of WHO guidelines to ensure that WHO processes were not undermined (addressing the tobacco industry attempts to do so) the IEMFP Task Group had direct representation by power industry representatives, at the invitation of Repacholi. At the group meetings industry representatives played a central role in influencing the decision making process in a similar way, as was examined in the IEEE C95.1 RF standard setting process in Chapter 3. Also examined in this chapter are a number of national situations where the ICNIRP RF Guidelines have been presented as a virtual "Gold Standard" which all nations should adopt (harmonize with). Although ICNIRP claims that economic considerations are not part of their advice, these considerations have formed a major part of the push to accept ICNIRP's Guidelines, even at the expense of conflicting science that questions the safety of those guidelines (Russia, the Czech Republic and China). Another important dimension behind the push for international harmonization examined in this chapter is the hidden role of the U.S. Department of Defense (DoD) in maintaining the thermal paradigm via ICNIRP in order to protect its significant investment in global missile defence radar systems.

The WHO International EMF Project

The WHO International EMF Project (IEMFP) was established by Michael Repacholi in 1996 and he was in overall charge of the project until his retirement in June 2006. The organization is made up of three main committees: an International Advisory Committee; a Research Coordinating Committee; and a Standards Harmonization Committee.⁴ A large number of international and national agencies that have responsibilities in non-ionizing radiation issues are members as well as a number of collaborating institutions. International organizations include the International Labour Organization (ILO); the International Electrotechnical Commission (IEC), the International Agency for Research on Cancer (IARC), the North Atlantic Treaty Organization (NATO); the European Commission (EC); and ICNIRP, a non-government organization authorized by WHO to deal with non-ionizing radiation protection.⁵ IEMFP work does not involve developing standards. This a task left for ICNIRP. Its primarily function is to conduct a three-part risk analysis consisting of risk assessments derived from the scientific literature; risk management in the form of recommending a global standard, the ICNIRP Guidelines; and risk perception/ communication in the form of various public relations mediums, such as web sites, fact sheets, seminars, working groups, etc. An important feature of the overall IEMFP risk assessment process is the work of WHO Task Groups that help determine health risk assessments that make up WHO Environmental Health Criteria publications, which are then used to derive ICNIRP's guideline recommendations.⁶

Establishment and make-up of ICNIRP

The foundations of an international effort to address both ionising and non-ionizing radiation protection can be traced back to the American Health Physics

⁴ IEMFP, 'The International EMF project Progress report 2001-2002', http://www.who.int/entity/peh-emf/project/en/PR2001_2002.pdf, Accessed Sept. 4, 2008.

⁵ M. Repacholi, Inquiry into Electromagnetic Radiation, Standing Committee on the Environment, Communications, Information Technology and the Arts, (Australian Senate) May 2001. Testimony of Michael Repacholi, Sect. 2.233, pp. 76-77.

⁶ IEMFP Progress Report 2001-2002.

Society (HPS), founded in 1956, a year before the establishment of the U.S. Tri-Service Research Program (Chapter 3, pages 83-86). In the early 1960s an HPS committee was established to explore the need for an international health physics organization and through the work of this committee the International Radiation Protection Association (IRPA) was founded in 1964 representing 15 health physics and radiation protection national societies.⁷

In 1971 WHO convened a working group meeting which recommended that the protection of humans from exposure to RF/MW should be a high priority. This led to a meeting of the 3rd International IRPA Congress in 1973 where the first session to address non-ionizing radiation protection was established. This was followed up in 1974 by the formation of a Working Group on non-ionizing radiation and in 1975 by a study group to review the field of non-ionizing radiation. In 1977, at the 4th IRPA International Congress, the International Non-Ionizing Radiation Committee (INIRC) was created and in 1981 a joint WHO/IRPA group issued the first Environmental Health Criteria for Radiofrequency and Microwaves. In 1988 Repacholi was appointed Chairman of INIRC till 1992 when he became Chairman of INIRC's replacement, ICNIRP at the IRPA 7th International Congress⁸. ICNIRP then adopted Repacholi's 1984 IRPA proposal that the only health issue to address in standard setting were short-term effects due to the absorption of RF/MW energy of sufficient power to be converted to heat. The frequency range of 10 MHz to 10 GHz was selected with a basic restriction for whole-body Specific Absorption Rate (SAR) derived from a SAR of 4 W/kg.^{9 10} The ANSI/IEEE C95.1 1982 RF standard was referenced in Repacholi's 1984 proposal later adopted by ICNIRP¹¹. In their historical review of the development of Western RF standards, IEEE C95.1 committee members Osepchuk and Petersen (2003) mention that C95.1 became the

⁷ IRPA, Foundation,

http://www.irpa.net/index.php?option=com_content&task=blogcategory&id=178&Itemid=113 Accessed Sept. 6, 2008.

⁸ ICNIRP, Aim and Roots, 2007, <http://www.icnirp.de/aim.htm> , Accessed Apr. 2, 2008.

⁹ M. Kundi, Environmental Health Issues of Radiofrequency and Microwave Exposure, [http://www.salzburg.gv.at/Proceedings_\(06\)_Kundi.pdf#search=%22Environmental%20Health%20issues%20of%20Radiofrequency%20and%20Microwave%20Exposure%22](http://www.salzburg.gv.at/Proceedings_(06)_Kundi.pdf#search=%22Environmental%20Health%20issues%20of%20Radiofrequency%20and%20Microwave%20Exposure%22), Accessed Oct. 9, 2006.

¹⁰ R. Repacholi , 'Problems with Regulating Radiofrequency (RF) Radiation Exposure', IRPA 6, May 1984, pp. 1291-1294, http://www.2000.irpa.net/irpa6/cdrom/VOL.3/B3_96.PDF, Accessed Sept. 4, 2008.

¹¹ Repacholi, 1984.

foundation for most contemporary RF standards (including ICNIRP) and was based on a simple thermally orientated biological endpoint of observed disruption of food motivated learned behaviour in laboratory RF exposed animals.¹² A very influential book at the time also supported the developing international thermal-effects-only paradigm and was written by the North Atlantic Treaty Organization (NATO) with Sol Michaelson, who played a central role on the development of C95.1 from the original 1950s Tri Services Project, being a major contributor to the 1983 document. Michaelson's paper laid out the thermal fundamentals and biological interactions of RF exposure.¹³ Thus a significant amount of sharing of ideas had taken place between the IEEE C95.1 standard setters and the international development of ICNIRP's RF guidelines with a thermal emphasis taken as the scientific basis for RF standard setting.

Unlike the IEEE standard setting process, where a number of individuals played a role in the formation of C95.1, both IEMFP and ICNIRP were established, chaired and guided for many years by just one person, Michael Repacholi. He was a founding member of INIRC/IRPA, chaired both INIRC and ICNIRP and In May 1996 was elected Chairman Emeritus of ICNIRP. He was also the founder and head of IEMFP from its beginning in 1996 until his retirement in June 2006¹⁴. Thus a history of the two organizations is very much a history of the activities of Michael Repacholi in his international promotion of the thermal-effects-only philosophy in RF standard setting.

The current ICNIRP Guidelines, as published in *Health Physics* in 1998, are a reconfirmation of the earlier INIRC guidelines published in 1988 which were, in turn, based on the 1984 interim INIRC guidelines. The 1984 interim guidelines were based on the 1981 review of biological effects compiled by the United Nations Environmental Program (UNEP) /WHO/IRPA as Environmental Health Criterion

¹² J. Osepchuk, R. Petersen, 'Historical Review of RF Exposure Standards and the International Committee on Electromagnetic Safety (ICES)', *Bioelectromagnetics*, Supplement 6, 2003, pp. S7-S16.

¹³ M. Grandolfo, S. Michaelson, A. Rindi, *Biological Effects and Dosimetry of Nonionizing Radiation: Radiofrequency and Microwave Energies*, NATO Advanced Study Institute on Advances in Biological Effects Dosemetry and NATO Scientific Affairs Division, Plenum Press, 1983.

¹⁴ ICNIRP, 'Main Commission: Members' Biographical Information', 2008, <http://www.icnirp.de/cv.htm#Repacholi>, Accessed Sept. 12, 2008.

16¹⁵. ICNIRP was established as a body of scientific experts consisting of a main Commission of 14 members, 4 Scientific Standing Committees covering Epidemiology, Biology, Dosimetry and Optical Radiation and a number of consulting experts. The stated mission of ICNIRP and its various committees and consultants is to address and provide expert advice on the possible adverse effects on human health of exposure to non-ionizing radiation.¹⁶ For the purposes of this thesis, ICNIRP's guidelines for exposure to radiofrequency and microwave exposure are examined. ICNIRP's exposure guidelines for Extremely Low Frequency (ELF) power frequency electric and magnetic fields, while outside the scope of this thesis, are useful in the examination of industry influence and conflict of interest in developing expert advice. This is examined below in relation to an IEMFP task group in charge of writing a new environmental health criteria for power frequency extremely low frequency (ELF) EMFs.

According to the ICNIRP web site, ICNIRP's members are independent experts in the scientific disciplines necessary for non-ionizing radiation protection. The main Commission members are elected by the Commission under the rules of its Charter. Nominations are invited from all the national radiation protection bodies represented by IRPA, and from ICNIRP's main Commission itself. The Chairman and Vice-chairman of the Commission are elected by the members of the main Commission. Individual membership of the main Commission is limited to 12 years. Members of the Scientific Standing Committees are nominated by the Chairmen of the Standing Committees and the members of the main Commission and agreed by the main Commission. Consulting experts are similarly nominated and agreed. ICNIRP Commission members are not supposed to represent either their countries of origin or their institutes nor can they be employed by industry. Members are reminded frequently of the need to declare any interests detrimental to ICNIRP's status as an independent advisory body.¹⁷ This system of selecting

¹⁵ WHO, Environmental Health Criteria 16: Radiofrequency and Microwaves. World Health Organization, Geneva, 1981, *International Journal of Radiation Biology*, Vol. 42, Issue 3, Sept. 1982, p. 354.

¹⁶ ICNIRP's committees also issue advice on the optical radiations (ultraviolet, visible and infrared - and lasers).

¹⁷ ICNIRP, 'An Independent Voice In NIR Protection', 2007, <http://www.icnirp.de/what.htm>, Accessed Sept. 12, 2008.

members is based on an assumption that there can be scientific objectivity and therefore ICNIRP committee scientists should decide who are suitable to be involved in developing (or maintaining) ICNIRP's guidelines. However, if we assume that decision making within the regulatory framework does not exist without some level of value judgements, then ICNIRP's membership mechanism will tend to reinforce any existing tendencies (or biases) amongst the group. One example of such a bias could be the fundamental tenet of ICNIRP that the only biological hazards from RF exposure are thermal in nature. This tendency is also seen in the various committees that were involved in writing the various versions of the IEEE's C95.1 RF standard as examined in Chapter 3 where RF thermal considerations became an unquestionable guiding principle. With the ICNIRP selection process, scientists who support the possibility of hazardous effects below the standard guidelines would be unlikely to be invited onto an ICNIRP committee.

Statements on RF/MW adverse health effects

According to Repacholi, IEMFP's (and therefore ICNIRPs) understanding is that:

[T]he known hazards of exposure are to high levels of RF fields, which result in tissue heating and form the basis for current international RF standards (ICNIRP, 1998). Thermal hazards are associated with acute exposures and are thought to be characterised by threshold exposures, below which no health effects occur. There is no confirmed evidence that exposure to RF fields has any long-term health consequences.¹⁸

This advice has remained unchanged since his 1984 IRPA proposal that the only health issue to address in standard setting were short-term effects due to the absorption of RF/MW energy of sufficient power to be converted to heat.¹⁹

¹⁸ M. Repacholi, Conference statement by Repacholi as quoted in: Maisch D, *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, January 2005.

¹⁹ Repacholi, 1984.

According to Paolo Vecchia, the current Chairman of ICNIRP, the only established effects from exposure to RF/MW electromagnetic energy is an increase in body temperature (Thermal effects) which are related to the Specific Absorption Rate (SAR) which is the energy absorbed per unit time and per unit mass (W/kg). "There is no convincing evidence that exposure to RF shortens the life span of humans, induces or promotes cancer."²⁰

Conflict of Interest or a shared interest?

ICNIRP is registered in Germany as a non-profit making organization. All its income is used to offset the year-on-year costs of its various activities including carrying out its scientific programme, organising scientific meetings and producing scientific publications. Its income derives from various sources and it claims to not accept funding from industry. The regular income that ICNIRP receives is an annual grant from IRPA. It has also received support from national governments, most notably from the German Environment Ministry for ICNIRP's Scientific Secretariat based in Munich. All other income is generated by the Commission through contract work (to the exclusion of any work for industry), organization of scientific meetings and sales of its scientific publications. Currently, ICNIRP's contract income comes from contracts placed by various organizations such as the European Commission to produce a review report on possible health effects from the use of electronic surveillance devices; from WHO to carry out scientific reviews of the epidemiology, biology and physics and engineering aspects of exposure to extremely low frequency electric and magnetic fields; and the International Labour Organization, ILO, to produce a Health and Safety at Work Publication on protecting indoor and outdoor workers from ultraviolet radiation. ICNIRP also receives income from the sales of its publications that defray some of its expenses. As stated previously, ICNIRP members are not paid for their work for the Commission - it is entirely voluntary. Only travel and necessary costs for attendance at meetings are reimbursed to members.

²⁰ P. Vecchia. 'Epidemiological results and Policy Implications' Electromagnetic Fields and Epidemiology, Erice, Italy, Mar. 26-Apr. 2, 2008, http://www.ccsem.infn.it/ef/emfcsc2008/bioelectromagnetics/Vecchia_Epidemiology%20and%20Guidelines.ppt.pdf Accessed Apr. 2, 2009.

At the Australian Senate Inquiry into Electromagnetic Radiation (2000-2001) Michael Repacholi informed the Senate Committee that the WHO had a firm policy against industry involvement in its processes. To quote:

[T]he World Health Organization does not allow industry to participate in either standard setting or in health risk assessment. The WHO takes the view that there cannot be industry representation on standard setting working groups. There cannot be someone on the working group who is having an influence on health effects for an industry when they derive benefit from that industry.²¹

ICNIRP clearly states on its website that in order to maintain this independence from industry or other vested interests it is stated:

Members are reminded frequently of the need to declare any interests detrimental to ICNIRP's status as an independent advisory body. [And]: ICNIRP as an organization does not accept funding from industry. [And in summary]: "ICNIRP is independent from industry in both membership and funding."²²

These requirements were established so that the credibility of ICNIRP's advice could not be said to be influenced by industry vested interests. Dr. Ken Joyner from Motorola stressed the independence of ICNIRP from industry at the Australian Senate "Inquiry into Electromagnetic Radiation Joyner stated:

If you want to look at one standards body that has specifically excluded any industry representatives, there is the ICNIRP body. You cannot be a member of the ICNIRP if you are part of industry. They exclude you from that process.²³

²¹ Repacholi, 'Inquiry into Electromagnetic Radiation...', 2001, op. cit., Section 4.115, p. 151.

²² ICNIRP, 'An Independent Voice...', 2007.

²³ K. Joyner, Inquiry into Electromagnetic Radiation, Standing Committee on the Environment, Communications, Information Technology and the Arts, (Australian Senate) May 2001, Section 4.68, page 137.

Scientific literature reviews by ICNIRP members are combined with risk assessments carried out by IEMFP with the resultant being the publication of ICNIRP's EMF exposure guidelines.²⁴ Therefore claims that ICNIRP's scientific advice is value-free from industry influence must also include the same requirement of IEMFP's risk assessment task groups. That was what Repacholi clearly stated to the Australian Senate Committee in May 2001 (as quoted previously). "There cannot be someone on the [IEMFP] working group who is having an influence on health effects for an industry when they derive benefit from that industry"

The close working relationship between ICNIRP and IEMFP's task group assessing the power frequency (extremely low frequency) scientific literature for a new Environmental Health Criteria was seen in the make up of the membership of the WHO task group as of October 2005. Out of the 20 members from 17 countries²⁵, there was Paolo Vecchia, the current ICNIRP Chairman, Anders Ahlbon, Larry Anderson, and Rudiger Matthes as members of ICNIRP's main commission, with Ahlbon also on ICNIRP's Standing Committee on Epidemiology. Other ICNIRP Standing Committee members included Christoffer Johansen, Jukka Juutilainen, Alasdair McKinlay and Zhengping Xu. Eric van Rongen is a consulting expert for ICNIRP. The task group also included, Michael Repacholi, head of IEMFP and Chairman Emeritis of ICNIRP.²⁶ Including Repacholi, exactly half of the make up of the IEMFP task group were also members of ICNIRP, so it is obvious that there would be no secrets between ICNIRP and IEMFP.

As reported by the New York based publication *Microwave News*, on October 1, 2005, the 20 member IEMFP Task Group writing a new Environmental Health Criteria (EHC) document on power frequency EMFs, included, at the request of Repacholi, representatives from the electrical utilities, or organizations with close

²⁴ ICNIRP, *An Independent Voice...*, 2007.

²⁵ L. Slesin, 'WHO Welcomes Electric Utility Industry To Key EMF Meeting, Bars the Press', *Microwave News*, Sept. 22, 2005 <http://www.microwavenews.com/fromthefield.html#partners> , Accessed October 10, 2005.

²⁶ *ibid.*

ties with the industry. Their tasks were to assist in writing the initial draft and review the completed draft.²⁷ This is in clear conflict with what Repacholi stated in his testimony at the 2001 Australian Senate inquiry hearings: "There cannot be someone on the working group who is having an influence on health effects for an industry when they derive benefit from that industry." One of the central authors of the draft, and member of the WHO's EHC Task Group, Leeka Kheifets, was a former IEMFP assistant to Michael Repacholi. She disclosed in Sept. 2005 in a letter (declaring any potential conflicts of interest) to the *British Medical Journal* that she "works with the Electric Power Research Institute [EPRI]... and consults with utilities."²⁸ Kheifets, currently on ICNIRP's Standing Committee on Epidemiology and formerly manager of IEMFP (2001-2003), previously worked for many years at EPRI who paid her \$50,000 in 2005, while a member of ICNIRP, to write a review paper for a WHO workshop on EMF risks to children. Her paper supports EPRI's theory that discounts the observed link between childhood leukaemia and power frequency magnetic fields.²⁹ Other power industry representatives who assisted Kheifets on preparing the IEMFP Environmental Health Criteria (EHC) draft were Gabor Mezei, from the EPRI, Jack Sahl from Southern California Edison, USA, and Jack Swanson from the National Grid, UK. When Repacholi sent a draft of the EHC out for review in early July 2005, the reviewers included representatives from the power industry bodies: The Federation of Electric Power Companies of Japan, Pacificorp (USA), Hydro-Quebec (Canada), the Utility Health Sciences Group (USA) and Exponent Inc, (USA).³⁰

The question of possible liability was apparently on the agenda, as Exponent Inc has described its business activities as follows:

Exponent serves clients in automotive, aviation, chemical, construction, energy, government, health, insurance, manufacturing, technology and other

²⁷ L. Slesin, 'WHO and Electric Utilities: A Partnership on EMFs', *Microwave News*, Oct. 1, 2005. <http://www.microwavenews.com/fromthefield.html#partners>, Accessed October 10, 2005.

²⁸ L. Kheifets, 'Letters, Childhood cancer and power lines', *British Medical Journal*, vol. 331, p. 634-638, Sept.17, 2005.

²⁹ L. Slesin, 'Money Talks and the WHO Follows', *Microwave News*, Aug. 8, 2005. http://www.microwavenews.com/nc_aug2005.html, Accessed Sept. 12, 2005.

³⁰ *ibid.*

sectors of the economy. Many of our engagements are initiated by lawyers or insurance companies, whose clients anticipate, or are engaged in, litigation over an alleged failure of their products, equipment or services.³¹

In addition to IEMFP staff, the only other observers that Repacholi invited to the IEMFP Task Group meeting in Geneva on 3 October to recommend exposure limits were eight representatives from the power industry. Members of the press were barred from attending.³² In addition the meeting was not publicised on either the IEMFP web site meetings list or the Bioelectromagnetics Society Newsletter's conference calendar and very few members of the EMF scientific community, including important EMF epidemiologists, were even aware of the meeting.³³ Only industry representatives received invitations. The epidemiologists who were directly involved in the research that the WHO's risk assessment task group would be reviewing were not invited as either observers or reviewers.

The *Microwave News* article points out that a number of independent researchers were involved in the preparation and review of the draft, but it was "highly unusual, if not unprecedented, for a WHO health document to be reviewed by so many with such strong ties to the affected industry."³⁴

One example of an industry reviewer's viewpoint, seeking to downplay potential health hazards, is seen in the comments from Michel Plante, representing Hydro-Quebec:

The whole section on cancer seems more like a desperate attempt to maintain some positive statistical association from epidemiological studies alive than a factual and honest presentation of arguments both, for and against, carcinogenicity.³⁵

³¹ S. Bohme, *et al*, 'Maximizing Profit and Endangering Health: Corporate Strategies to Avoid Litigation and Regulation', *Int J Occup Environ Health*, vol. 11, No. 4, Oct./Dec. 2005, pp.338-348.

³² Slesin, 'WHO Welcomes Electric Utility Industry...', 2005.

³³ *ibid*.

³⁴ *ibid*.

³⁵ *ibid*.

Plante's role as a protector of his employer's interests in denying a cancer link with EMFs was amply demonstrated in his involvement, as a Hydro-Quebec representative, in suppressing potentially damaging cancer data in a 1994 Hydro-Quebec funded epidemiological study By Dr. Gilles Theriault *et al.* from McGill University. The initial analysis of the data collected from three electric utilities found that workers who had the greatest exposures to magnetic fields had twelve times the expected rate of astrocytomas, a type of brain tumour, based on a small number of cases.³⁶ In a later re-analysis of the data³⁷, this time looking at high frequency transients (HFT), the McGill University team found up to a 10-fold increased risk of developing lung cancer amongst highly exposed utility workers, with a "very clear" exposure-response relationship.³⁸ When Gilles Theriault's McGill team wanted to further analyse the HFT data for other associations, Hydro-Quebec, which funded the \$3 million study, and therefore owned the collected data, refused further access to the data. Plante said at the time that "[w]e have a contract problem that has to be resolved and there will be no new mandate until it is solved." Plante argued that by Theriault publishing the findings on HFT he had violated the contract with the utilities. Many senior EMF researchers and epidemiologists saw the HFT data as having important implications and needing further analysis by other researchers.³⁹ As of June 2009 no further analysis of the Hydro-Quebec HFT data has been done as the data has been withheld from any further analysis from the scientific community by Hydro-Quebec. Plante, as Hydro-Quebec's representative at the centre of that suppression was asked by Repacholi in the 2005 WHO task group meeting to review the WHO's Environmental Health Criteria risk assessment. It is not known if Plante was asked at the meetings about the "positive statistical association" seen in the Hydro-

³⁶ G. Theriault, *et al.*, 'Cancer Risks Associated with Occupational Exposure to Magnetic Fields Among Electric Utility Workers in Ontario and Quebec, Canada, and France: 1970-1989', *American Journal of Epidemiology*, vol. 139, 1994, pp. 550-572.

³⁷ B. Armstrong, *et al.*, 'Association Between Exposure to Pulsed Electromagnetic Fields and Cancer in Electric Utility Workers in Quebec, Canada, and France', *American Journal of Epidemiology*, vol. 140, 1994, pp. 805-820.

³⁸ L. Slesin, 'Transients and Lung Cancer: A "Strong" Association and a "Remarkable" Exposure-Response', *Microwave News*, vol. 14, no. 6, Nov/Dec 1994, pp. 4-6.

³⁹ *ibid*

Quebec HFT data but if this was asked one reply could have been that it was not important because it had not been replicated.

The Utility Health Sciences Group (UHSG), another power industry group that Repacholi asked to review the EHC draft document, plainly indicated that they considered increased costs to industry (a risk assessment cost/benefit consideration) should take precedence over health considerations when they proposed a change in the chapter on protective measures that stated:

It should also be pointed out that redirecting facilities or redesigning electrical systems may be so expensive as to be inconsistent with the low-cost and no-cost steps typically viewed as prudent avoidance.⁴⁰

UHSG also proposed a statement, possibly to ward off possible future litigation, to be included in the summary”

It would be useful for the summary to include a clear statement that the scientific research does not establish ELF EMF as a cause or contributing factor in any disease or adverse health effect, including cancer.⁴¹

As mentioned previously, the ICNIRP web site states that in order to protect its status as an independent advisory body, “ICNIRP as an organization does not accept funding from industry”⁴². When it comes to the WHO’s International EMF Project, however, no such restrictions apply. Repacholi stated in 2004 that the “[EMF] Project can receive funding from any source through Royal Adelaide Hospital; an agency established through WHO Legal Department agreement to collect funds for the project.”⁴³ Questions of a conflict-of-interest were raised when it was revealed by *Microwave News* that Repacholi, as head of the EMF Project,

⁴⁰ Slesin, WHO and Electric Utilities: A Partnership...’, 2005.

⁴¹ *ibid.*

⁴² ICNIRP, ‘An Independent Voice...’, 2007.

⁴³ M. Repacholi, Welcoming presentation, 9th International Advisory Committee (IAC) meeting, Istanbul Turkey, Jun. 7, 2004. http://www.who.int/entity/peh-emf/meetings/archive/en/repacholi_iac_welcome.pdf, Accessed Sept 14, 2005.

received \$150,000 annually from the cellphone industry.⁴⁴ However, Repacholi could rightfully still claim that he did not receive any direct funding from industry sources since it is channelled through the Royal Adelaide Hospital. This arrangement may be in violation of current WHO rule against employees and consultants accepting any “gift or remuneration” from external sources “incompatible” with their duties at WHO.⁴⁵ That was what Repacholi clearly stated to the Australian Senate Committee in May 2001 (as quoted previously). “There cannot be someone on the [IEMFP] working group who is having an influence on health effects for an industry when they derive benefit from that industry”

A questionable oversight committee

According to a fact sheet *New Electromagnetic Fields Exposure Guidelines* published by the European Commission in December 2005, an “International Advisory Committee” (IAC) has been set up to provide oversight to IEMFP. This committee consisted of representatives of international organizations, independent scientific institutions and national governments who are supporting the Project.⁴⁶ In this case IAC oversight should essentially operate much the same as judicial oversight where a judicial branch of the government watches or monitors what is going on or happening in a case or matter. In the judicial arena it is a form of checks and balances that operates to keep law officers from abusing their powers. In the case of the WHO’s EMF Project IAC oversight should operate to prevent WHO officials from abusing their powers - and this should include preventing officials, such as Repacholi, allowing Environmental Health Criteria risk assessments to be influenced by direct industry involvement in the process. It would also be important for the IAC to maintain an “arms-length” distance from the project activities that it is supposed to monitor.

⁴⁴ Communication with Louis Slesin, editor of Microwave News, Nov. 21, 2005.

⁴⁵ G. Brundtland, ‘Response of WHO to the Report of the Committee of Experts on Tobacco Industry Documents’, WHO, June 10, 2000. http://www.feel-free.info/uploads/media/Document_14.pdf, Accessed Sept. 14, 2005.

⁴⁶ European Commission, ‘Science for Environment Policy, New Electromagnetic Fields Exposure Guidelines’, European Commission DG ENV, News Alert, issue 3, Dec. 2005.

The question then needs to be asked of the IAC: Why have they failed to intervene in the case of blatant industry influence on the WHO's ELF/EMF Task Group? Perhaps the answer to that was partially given by Sociologist Sheila Jasanoff when she observed that most of the relevant literature suggested that when regulatory advisers became part of a hybrid socio-technical process, they tended to lose their authority as neutral experts.⁴⁷

Forgotten lessons: Big Tobacco and protecting the integrity of WHO decision making

In July 2000 the WHO Committee of Experts on Tobacco Industry Documents released a 260-page report detailing the tobacco industry's strategies to undermine the work of the WHO.⁴⁸ At the same time the WHO issued a 15-page response document listing steps to ensure that the WHO was never undermined again. Just a few of the 58 recommendations were as follows:

#6. WHO should urge other UN organizations to investigate possible tobacco company influences on their decisions and programs, and to report their findings publicly.

7. WHO should advocate implementation and consistent enforcement of effective conflict of interest and ethics policies throughout UN agencies.

#8. WHO should urge Member States to conduct their own investigations of possible tobacco company influence on national decisions and policies, and to publish reports on their findings."

#11: Appoint an ombudsman or other independent officers, outside the standard lines of reporting authority, with autonomy and clear authority for enforcing ethical rules.

⁴⁷ S. Jasanoff, *The Fifth Branch: Science Advisers as Policymakers*, Harvard University Press, 1990, p. 9.

⁴⁸ WHO, Tobacco Company Strategies to Undermine Tobacco Control Activities at the World Health Organization, Report of the Committee of Experts on Tobacco Industry Documents, July 2000. http://www.who.int/tobacco/policy/who_inquiry/en/print.html, Accessed Sept. 18, 2005.

#12. Disseminate conflict of interest rules more broadly.

14. Introduce a formal process for vetting prospective employees, consultants, advisers, and committee members, to identify conflicts of interest.

19. Prohibit employees, consultants, advisers, and committee members from holding any substantial financial affiliation with the tobacco industry, including any employee or consulting relationship. . . “

#20. Disqualify any professional services from performing work on behalf of WHO if the firm also provides a tobacco company with services likely to be adverse to the interest of public health. . . “

#21. Prohibit employees, consultants, advisers and committee members from accepting any item of value from a Tobacco company or its affiliates. . . “

35. WHO and IARC should take steps to educate their scientific investigators and collaborators about tobacco company efforts to undermine research and the need for special vigilance in protecting the integrity of tobacco-related research.”⁴⁹

Although the above sampling of WHO recommendations was in response to Big Tobacco's attempts to undermine WHO integrity, it has direct relevance to other large industrial interests and cannot be ignored, be it the power or telecommunications industries. Unfortunately it seems that in this case at least, WHO has forgotten the hard lessons learnt with its previous experiences with Big Tobacco. In the case of WHO's Task Group writing the new Environmental Health Criteria (EHC) for power frequency EMFs, a violation of the above recommendations urgently calls for an independent evaluation to protect both public health and WHO's public credibility. Such a blatant disregard for both ICNIRP and IEMFP statements on remaining independent from industry influence in their RF guidelines and risk assessment processes undermines their scientific

⁴⁹Brundtland, 2000.

credibility, not only for powerfrequency risk assessment but for the whole range of their activities, including RF. What is apparent in this section is that essentially the problem is not so much of a conflict of interest but very much that there is a shared interest. An interest shared by IEMFP / ICNIRP and industry to maintain standards commensurate with the industry's requirements.

Setting the scene internationally

Through WHO, the ICNIRP Guidelines for RF/MW and ELF non-ionizing radiation exposure standards are being promoted globally to virtually every nation in an effort to make it a truly internationally accepted template for national standards. Chapter 5 examines the case for Australia, where the clear impetus for the introduction of ICNIRP's RF guideline limits was based on economic considerations so that new telecommunications technology could be legally sold in Australia without contravening the RF standard. The following few examples are only a brief sampling of this global effort. Though details vary according to the particular situation in each country, what remains constant is the promotion of the ICNIRP Guidelines as a global 'Gold Standard' that is based on sound science that is above reproach, or an 'unproblematic body of sure and certain knowledge', a viewpoint that this thesis takes issue with and which has been questioned by various national authorities as the following examines.

EU / CENELEC

The European Union has passed a recommendation which implements the ICNIRP guideline exposure limits, thereby harmonizing all EC countries' EMF standards with ICNIRP. In addition, the European Committee for Electrotechnical Standardisation (CENELEC), which is not an EC institution, produces EMF assessment standards for all electrical products that produce electromagnetic fields and are sold or imported into the EU. CENELEC now refers to the ICNIRP exposure levels in its compliance standards. The result is that any product, such as

mobile phones or domestic appliances sold or imported into the EU, must comply with ICNIRP Guidelines.⁵⁰

Current former Eastern European countries that have, or had, the strict Russian RF standard and are now members of CENELEC are: the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Slovakia, Slovenia, and Poland. Albania, Bosnia/Herzegovina, Bulgaria, Croatia, Romania and Ukraine are currently 'affiliate members' with a view to becoming full members.⁵¹

The United Kingdom

In a press statement released on 31 March 2004, the United Kingdom's National Radiological Protection Board (NRPB) recommended the adoption of the ICNIRP Guidelines⁵². This recommendation followed advice from UK and international scientific experts and groups, including the UK's Advisory Group on Non-Ionizing Radiation (AGNIR).⁵³ The main difference between the previous NRPB RF limits and those of ICNIRP is that while the occupational limits are the same in both guidelines, for public exposure, ICNIRP limits are a factor of five lower⁵⁴ so in the U.K. context, ICNIRP's lower limits in comparison to the higher NRPB limits was simply taken as a precautionary approach as recommended by Sir William Stewart, chairman of the Independent Expert Group on Mobile Phones (IEGMP) in 2000.⁵⁵ According to an April 5th 2004 press release by NRPB, "This new recommendation by NRPB to adopt ICNIRP Guidelines reflects a detailed

⁵⁰ WHO, USAF, 'Electromagnetic Fields, Research, Health Effects, and Standards Harmonization', Asia-Pacific EMF Conference, Bangkok, Thailand, Jan. 26-30, 2004, p. 44, <http://www.bankokemf.com>, Accessed Aug. 27, 2005.

⁵¹ CENELEC, 2007, <http://www.cenelec.eu/Cenelec/About+CENELEC/Our+organization/CENELEC+Members/Default.htm>, Accessed Aug. 30, 2007.

⁵² NRPB, Statement by the National Radiological Protection Board. Advice on Limiting Exposure to Electromagnetic Fields (0 – 300 GHz). Doc. NRPB 15 (2) 2004. ISBN 0-85951-532-X, Available on NRPB website http://www.nrpb.org/publications/documents_of_nrpb/abstracts/absd15-2.htm, Accessed May 23, 2004.

⁵³ NRPB Press Release, Apr. 5, 2004, http://www.nrpb.org/press/press_releases/2004/press_release_5_04.htm Accessed May 25, 2004.

⁵⁴ *ibid.*

⁵⁵ IEGMP, *Mobile Phones and Health*, report of the Independent Expert Group on Mobile Phones, 2000, p. 110 – 113.

assessment of the risks involved, and also the need for a precautionary approach when there are genuine uncertainties in our knowledge.”⁵⁶

This viewpoint is in sharp contrast to the considered statements of members of the Australian TE/7 committee who rejected ICNIRP as failing to follow a precautionary approach (See Chapter 5). The difference was that in Australia, the ICNIRP limits were significantly higher than those of the old Australian standard so that accepting the ICNIRP limits would have meant a significant increase in the allowable limits from 200uW/cm² for the mobile phone frequencies of around 800-900 Mhz to 450 uW/cm².

The Russian Federation

At the international conference titled: *Mobile Communications and Health: Medical, Biological and Social Problems*, held in Moscow on September 20-22, 2004, both Paolo Vecchia and IEMFP head Repacholi promoted ICNIRP as the only choice for the Russian agencies if they wanted to live in a global community.⁵⁷ Repacholi spoke about one of the initiatives of the EMF Project as providing a framework for the harmonization of RF standards world-wide. This would include an international agreement on developing guidelines to provide protection of the public and workers from exposure to EMF. However, by the end of the conference it was obvious that “developing guidelines” would only be those developed by ICNIRP. Speaking on behalf of the Russian National Commission on Non-Ionizing Radiation Protection (RNCNIRP) Yuri Grigoriev stated on numerous occasions that ICNIRP’s thermal effects criteria were not a suitable approach to providing health protection. Numerous papers were given from a range of Russian organizations that claimed to find adverse biological effects at levels far less than ICNIRP’s thermal only limits. All of the Russian organizations present at the conference, including the Russian Academy of Science and the Russian Academy of Medical Science, were of the firm opinion that Russia’s low level non-thermally based RF standard was the preferred way to provide health protection. They

⁵⁶ NRPB Press Release, 2004.

⁵⁷ 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.

considered that ICNIRP's thermal effects only approach was not protective of workers and the public as it did not take into account possible long-term, low-level adverse biological effects, including immunological from RF exposure.⁵⁸ Yuri Grigoriev said that ICNIRP's "thermal effects for criteria or standards is not a suitable approach" and that the WHO was being "insufficient on the precautionary principle."⁵⁹

The dilemma facing the Russian scientific community is that while their citizens are rapidly embracing the whole range of available telecommunications technology, much of that technology is technically illegal in Russia as the emission levels are in excess of the allowable exposure limits in the Russian standard. This was pointed out to the chairman of the RNCNIRP, Yuri Grigoriev, at the Moscow conference by Michael Repacholi, who said: "What is the use of the Russian Standards if the millions of phones sold in Russia met the ICNIRP Guidelines but not the Russian ones?" Repacholi added, "How can you tell the public to give up their phones because they are in excess of the [Russian] standard?"⁶⁰ This situation forces the Russian scientists into a no-win situation. The economically rational option would be to simply adopt ICNIRP's thermal only philosophy and join the Repacholi's international club. However, for the Russian scientists involved, to retreat from their strict RF standards and adopt the ICNIRP thermal effects only philosophy would be to admit that their science on providing health protection from RF exposure was wrong and thus their entire scientific literature base and credibility, built up over half a century, was worthless. Another pressure on Russian scientists according to Vladimir Binhi, one of the Moscow conference organizers and member of RNCNIRP, was that acquiescing to ICNIRP was being presented to the Russian government as a requirement for being accepted as a member of the World Trade Organization (WTO).⁶¹ This was in agreement with Repacholi who said at a January 2004 conference in Thailand that a WTO requirement for all countries who are a signatory to the General Agreement on

⁵⁸ *ibid.*, p. 2.

⁵⁹ *ibid.*, p. 3.

⁶⁰ *ibid.*, p. 8.

⁶¹ Correspondence with Vladimir Binhi, Oct. 23, 2004.

Tariffs and Trade (GATT) was to harmonize with international standards.⁶² As of June 2005, Russia was in conflict with the WTO over the many terms of membership with the organization⁶³ and as of August 2008 still has not joined the WTO⁶⁴. RNCNIRP chairman Grigoriev summed up the problem for the Russian Federation RF standard setting body when he mentioned that modern telecommunications might inherently be incompatible with adequate health protection.⁶⁵

As stated at the Moscow conference by Repacholi, the WHO's statement on RF health effects is the following:

Hazards of exposure to high levels of RF fields, which result in tissue heating, are basically understood and form the basis for current international standards (ICNIRP, 1998). Thermal hazards are associated with acute exposures and are thought to be characterised by threshold exposures, below which no health effects occur. There is no confirmed evidence that exposure to RF fields has any long-term health consequences.⁶⁶

Repacholi also commented that national RF limits should not be lower than the ICNIRP exposure standards. In support of Repacholi, ICNIRP Chairman Paolo Vecchia said in his presentation that:

Only solid science is taken into consideration in setting guidelines: quality of study and consideration of results... ICNIRP only considers acute effects [thermal] in its precautionary principle approach. Consideration of long-term effects [is] not possible.⁶⁷

⁶² M. Repacholi, 'WHO Framework for Developing EMF Standards', Asia Pacific EMF Conference, Electromagnetic Fields, Research, Health Effects, and Standards Harmonization, Bangkok, Thailand, page 46, Jan., 2004, p. 46.

⁶³ No author, 'Russia comes into serious crisis with its WTO membership talks', *Pravda*, Jun. 29, 2005. http://www.english.pravda.ru/main/18/89/356/15722_WTO.html Accessed Aug. 18, 2005.

⁶⁴ A. Smolchenko, 'Putin casts doubt on Russia's WTO accession', *The Moscow Times*, Aug. 25, 2008. <http://www.iht.com/articles/2008/08/25/business/wto.php>, Accessed Sept. 10, 2008

⁶⁵ Correspondence with Yuri Grigoriev, Chairman of RNCNIRP, Sept. 21, 2004.

⁶⁶ Maisch, 2005, op. cit. p. 6.

⁶⁷ *ibid*, p. 7.

As for a precautionary approach in the ICNIRP Guidelines Vecchia stated that:

Precautionary actions to address public concerns may increase rather than mitigate worries and fears of the public. This constitutes a health detriment and should be prevented as other adverse effects of EMF.⁶⁸

As of October 2008 the strict Russian RF standard is still in place with the thermal rationale for the ICNIRP Guidelines still being rejected by RNCNIRP. This can be seen in RNCNIRP's precautionary advice, issued on April 14, 2008, that people under the age of 18 should not use mobile phones in order to protect children's health from possible negative influences from mobile phone emissions.⁶⁹ At an IEEE standards meeting in San Antonio, Texas in December 2005, C-K Chow from Motorola mentioned that the Russians were "still behind in their thinking regarding an appropriate metric for establishing limits." John D'Andrea from the U.S. Naval Health Research agreed and added that, "it will be a long time before the old guard is gone and there is a change in philosophy in Russia".⁷⁰

China

China, like the Russian Federation, has established far stricter RF standards than those of ICNIRP (or IEEE C95.1), based on research indicating adverse biological effects other than just tissue heating. As a result of their research, China has long had one of the world's strictest standards for exposures to microwave radiation for both the public and workers.⁷¹ China, like Russia, has been pressured by a number of groups, including WHO and Motorola, to heed WHO's advice and adopt the

⁶⁸ *ibid.*

⁶⁹ RNCNIRP, 'Children and Mobile Phones: The Health of the Following Generations is in Danger', RNCNIRP, Apr. 14, 2008, http://www.emfacts.com/papers/rncnirp_children.pdf, Accessed Sept. 4, 2008.

⁷⁰ IEEE/ICES TC95 Subcommittee 4, Approved Minutes, San Antonio, Texas, Dec. 10, 2004, p. 3. http://www.ices-emfsafety.org/documents/Minutes/TC95_december%202005%20minutes.pdf, Accessed Apr. 28, 2006.

⁷¹ L. Slesin, 'China Weighs 1 W/Kg SAR Limit for Mobile Phones', *Microwave News*, vol. 22 no. 3, May/June 2002, p. 6.

ICNIRP Guidelines for its RF exposure standard.⁷² For example, a major focus of the Third International EMF Seminar, held in Guilin, China, in October 2003, was international standards harmonization.⁷³ Michael Repacholi, representing the WHO's International EMF Project (and one of the sponsors of the Seminar) and Bernard Veyret, representing ICNIRP, were pushing for ICNIRP to be accepted by China's Standardization Administration. Repacholi's position was that as China was a member of the WTO it had to abide by the WHO requirement to apply ICNIRP limits, such as the 2 watt/kg SAR limit for mobile phones.⁷⁴ Repacholi's WTO argument was rejected by the Chinese RF standards agency people and at the Guilin seminar when they outlined their draft standard that halved ICNIRP's maximum cell phone specific absorption rate of 2 W/kg over 10 grams of tissue to 1 W/kg per 10 grams of tissue. As an additional precaution, China proposed to require all handsets to reduce their RF emissions after 2 hours of steady use. For base stations the draft standard proposed reducing emissions from broadcast facilities to a quarter of ICNIRP limits.⁷⁵

At the Seminar, Hai Chiang of the Bioelectromagnetics Laboratory at Zhejiang University, Hangzhou, stressed that the public health significance of EMFs had been underestimated in China. Chiang also reviewed the rationale for China's strict EMF standards. In response to Repacholi's and Veyret's suggestion that China should consider joining Europe and much of the international community by accepting ICNIRP's exposure guidelines, Dr. Chiang replied in the negative.⁷⁶ In her review of the Chinese research Chiang said that after a wide-ranging review of the relevant studies useful for an RF health risk assessment, there were so many inconsistent experimental results pointing to "many reports of nonthermal potential health effects," plus important questions about the limitations of using

⁷² Motorola, 'Motorola fact sheet, China Standard', July 2003. <http://www.motorola.com/content/0,,2387-5025.00.html>, Accessed Aug. 18, 2004.

⁷³ M. Swicord, 'Third EMF Seminar in China a Success', *Bioelectromagnetics Newsletter*, no. 174, Sept./Oct. 2003, pp. 8-9.

⁷⁴ Interfax News Agency [no author], 'China Considers Setting New Cell Phone Radiation Standards', China, Oct. 20, 2003, http://www.buergewelle.de/body_emf_omega-news_24-10-03.html, Accessed Aug. 18, 2005.

⁷⁵ IEEE Spectrum [no author], 'China May Draw a Sharp Lower Line on Mobile Phone Radiation', *IEEE Spectrum*, Aug. 13, 2002.

⁷⁶ Swicord, 2003.

SAR in standard setting. Chiang saw “growing evidence that magnetic fields penetrate cells, tissues and may cause bioeffects by themselves” (not just ICNIRP’s induced current criteria for ELF fields) and as such, “it would be too much to expect China to adopt the ICNIRP Guidelines at this point.”⁷⁷ In a paper presented at a Korean conference in 2001, Chiang wrote that the ICNIRP limits “are based on short-term, immediate health effects,” but that “there is a body of literature which suggests that biological effects can be shown at levels of radiation which do not produce heating or stimulation.”⁷⁸

Unlike Russia, where cell phones and other wireless technology have essentially been proliferating without consideration of the strict standards and effectively making their standards irrelevant, China’s insistence on lower cell phone standards has forced overseas manufacturers to customise their phones to Chinese regulations. The reason for this flexibility is economic - China potentially represents almost a third of the world market.⁷⁹ For this reason representatives from both Lucent and Motorola have been mentioning to the Chinese the vast financial opportunities waiting for them⁸⁰ as soon as they change their strict standard to conform to ICNIRP’s.⁸¹

The basic consideration in Chinese RF standards is an assessment of health hazards based primarily on observations on the health status of personnel exposed to RF fields. Investigations on the health effects of occupational and environmental exposures to differing frequencies found that chronic exposure to RF (and ELF) are associated with a variety of non-specific symptoms, including increased frequency of neuroses, adverse effects on the nervous system and changes in peripheral blood, lens, and non-specific immune function. The threshold for such effects in the RF range (over 30 MHz) is in the range of 50 –200 uW/cm², well below the

⁷⁷ *ibid.*

⁷⁸ Slesin, ‘China Weighs 1 W/Kg SAR Limit...’, 2002, *op. cit.*, p. 7.

⁷⁹ IEEE Spectrum, 2002.

⁸⁰ One example mentioned was rebuilding cell phones and cell phone batteries.

⁸¹ Correspondence (confidential) with IEEE SCC-28 committee member, Aug. 25, 2005.

ICNIRP limits.⁸² The current Chinese RF exposure standards were set up in 1988 and 1989 and based on a Chinese Tentative Standard from 1981. However, as stated in a paper by Chiang and Zhejiang Xu, at the 2003 Guilin Seminar, “because of the new and rapid development of telecommunication facilities, the economic globalization, and the need for standard harmonization, a draft of an amended EMF exposure standards was proposed by an United Working Group in China”.⁸³ The draft Chinese RF standard covered the entire frequency ranges of the ICNIRP Guidelines. Also, like in the ICNIRP Guidelines there are two classes, i.e. basic (preliminary) restrictions and reference levels (exposure limits), and the basic restrictions are current density (for electric field only), SAR, and power density. Two tier standards, i.e. occupational and general public, are also adopted but at levels less than those of ICNIRP. The reasons stated in the draft standard for the stricter levels are as follows (for RF exposures):

- The ICNIRP Guidelines are based on short-term, immediate health effects (heating) whereas there is a body of literature which reports that health effects can be shown at a level of radiation that does not produce heating.
- SAR thresholds of behaviour-disruption have been observed at levels much lower than ICNIRP’s 4 W/kg basic restriction level.
- There are a number of animal studies showing immune system effects from RF/MW exposure in SAR levels far lower than ICNIRP’s 4 W/kg basic restriction. In addition changes in immune system function were observed in humans exposed to environmental low-level RF radiation.
- For *in-vitro* studies, the evidence of RF non-thermal bioeffects is increasing.
- In summary, there are many reports on non-thermal potential health effects from microwave radiation. The SAR threshold for the adverse effects in the frequency range from 100 kHz to 10 GHz may be at 0.5 to 1.0 W/kg, rather than ICNIRP’s 4.0 W/kg threshold.
- SAR is a valid measure of energy absorption rate during RF exposure, but not a quantity indicator of biological effects. Examples given were the significantly

⁸² H. Chiang, Z. Xu, Discussion on Rationale for China EMF Exposure Standards, Bioelectromagnetics Lab, Zhejiang University School of Medicine, Hangzhou 310031, China, 3rd International EMF Seminar in China, 13-17 Oct. 2003.

⁸³ *ibid.*

differing bioeffects observed between continuous and intermittent RF exposure, between modulated and unmodulated microwave exposure at the same SAR level. For this reason the Chinese question using SAR as a basic restriction.

- Considering the above, the Chinese standard setting working party chose a whole body average SAR of 0.1 W/kg as the restriction for occupational exposure, and 0.02 W/kg for the general public.
- For cell phones the localised SAR for the head and trunk is restricted to 1.0W/kg averaged over 10 g of tissue.⁸⁴

Huai Chiang concluded at the 2003 Seminar at Guilin:

The present knowledge in assessment of possible health effects related to exposure to EMF has not provided a sufficient rationale to establish satisfactory and general acceptable exposure limits yet, though there are growing evidences of highly potential health effects from EMF exposure. The draft of the amending exposure standard in China is still questionable and far from perfect, but it is reasonable and has scientific basis. As the scientific advances, including the rapid development of molecular biology with powerful techniques and adoption of novel concepts, researchers may settle many arguments about the health effects of EMFs. However, the exposure standards are aimed at protecting people, and the development of electricity and communication are of great benefit to people, a general acceptable and practical exposure standard should be produced after taking cost and benefit analyses with precautionary principle.⁸⁵

In response to Chiang, Repacholi asked the Chinese Standards committee to provide a scientific rationale for their standard when it was finalised so everyone in the world would know what was the basis for the Chinese standard. He said that this would be very important for the harmonization of standards around the

⁸⁴ *ibid.*

⁸⁵ *ibid.*

world.⁸⁶ According to Chiang at the 4th EMF Bioeffects Seminar, held in Kunming, China in Sept 2005, the Chinese delegation still had not agreed to use the ICNIRP Guidelines.⁸⁷

At an IEEE standards meeting in San Antonio, Texas in December 2005, C-K Chou from Motorola was asked if China would adopt the IEEE's C95.1 RF limits. Chou replied that so far China has only adopted the basic restriction specifically for cell phones, i.e., 2 W/kg averaged over 10 grams of tissue. This relaxation was because China already has over 350 million citizens using mobile phones. Other issues, such as MPEs and other basic restrictions were not agreed to.⁸⁸

The Czech Republic

Like Russia and China, the Czech Republic (formerly part of Czechoslovakia) for many years maintained a strict RF/MW exposure standard for both the public and workers. In collaboration with Soviet scientists, Czechoslovakia had conducted much of the research on the bioeffects of RF exposure, both thermal and non-thermal, and their standard was based on eliminating both these effects. This research was conducted at the Institute of Industrial Hygiene and Occupational Diseases and the Occupational Diseases Clinic in Bratislava and in both research laboratories a wide range of non thermal bioeffects were found that reinforced their strict RF standard.⁸⁹ However, in January 2001, the Czech Republic replaced its former strict Soviet based COMECOM⁹⁰ RF limits with much relaxed limits based on the ICNIRP Guidelines. The reason for the change was an apparent political decision made in favour of economic considerations against the expert

⁸⁶ WHO, 3rd International EMF Seminar in China, 2003, Meeting Summary, <http://www.who.int/peh-emf/meetings/archive/en/china03mtgsummary.pdf>, Accessed Aug. 24, 2005.

⁸⁷ Correspondence with Professor Huai Chiang, Sept. 26, 2005.

⁸⁸ IEEE/ICES TC95 Subcommittee 4, 2005.

⁸⁹ K. Marha, J. Musil, *Electromagnetic Fields and the Life Environment*, Institute of Industrial and Occupational Diseases, Prague, English publisher San Francisco Press, 1971.

⁹⁰ A. Uegaki, 'Russian Federation's Foreign Economic Relations', Economic and Social Research Institute, Mar. 2001, www.esri.go.jp/en/tie/russia/russia5-e.pdf, Accessed Aug. 17, 2005. NOTE: Under the Soviet system, internal trade agreements and standards were conducted through COMECOM, the Soviet Union-led trading system. After the fall of the Soviet Union, COMECOM tended to be seen by former member states as a hold over from the old Soviet system.

advice of the Czech National Institute of Public Health's Advisory Board on Non-Ionizing Radiation.

Dr. Jan Musil⁹¹, chair of the Czech Republic's National Institute of Public Health's Advisory Board on Non-Ionizing Radiation had opposed the adoption of the ICNIRP limits. In early 2000, on behalf of the ten member board, Dr. Musil sent a statement to the US based publication *Microwave News* expressing concerns that that the WHO had failed to apply the precautionary principle adequately in its evaluation of EMFs. Musil also asserted that the 1999 EU Council of Ministers recommendations to accept ICNIRP limits ignored the opinion of the European Parliament that ICNIRP's "basic restrictions" adopted by the council "include large safety factors only with respect to the thresholds for acute effects." The statement went on to say:

Emphasis on the need for more caution in words only, without introducing more stringent limits for chronic exposure in numerical form, can be intended only for an ideal world with ideal people. The Italian and Swiss governments are taking a more practical approach to real-world situations, with stringent limits for long-term exposure. We also welcome the concerns expressed last year by the U.S. government's Radiofrequency Interagency Work Group on the revision of the ANSI/IEEE RF/MW exposure standard. We refer particularly to the sections on acute and chronic exposures...on pulsed or frequency-modulated RF radiation ("Exposure guidelines based on thermal effects...and concepts...that mask any differences between intensity-modulated RF radiation exposure and CW exposure...may not adequately protect the public") and on time averaging (The 0.1 hour approach historically used should be reassessed.)."⁹²

In an open letter to colleagues around the world, Dr. Musil explained that he opposed the adoption of ICNIRP Guidelines and that he had been removed as the

⁹¹ Dr. Musil is co-author of *Electromagnetic Fields and the Life Environment*, 1971.

⁹² L. Slesin, 'Czech Panel on the Precautionary Principle and Numerical Limits', *Microwave News*, vol 20, no. 3, May/Jun. 2000, p. 14.

chair of both the National Reference Laboratory and the Advisory Board on Non-Ionizing Radiation. Dr. Musil said that he “was replaced by a person with no research experience in this area, who was willing to accept ICNIRP limits without biophysical qualification.” Musil stated that he was against the “hurried harmonization of standards without objective verification of the facts.”⁹³

From the viewpoint of the Czech government they had to respond to the economic dilemma also faced by the Russian Federation with their strict RF limits. These very low limits, especially for long-term exposure of general public, were introduced in the country in early seventies and re-affirmed by the Czech ministry in 1990. However, with the rapid rollout of new wireless technology, difficulties in conforming to these limits soon appeared. In one case, TV and FM transmitters installed on a new TV tower in Prague were not allowed to broadcast for several months, as the limit for 24 hours resident exposure (0.01 W/m² for the frequency range 30 MHz to 300 MHz) was slightly violated on a nearby square, and the ban was lifted only after the power radiated by these transmitters was lowered. With the introduction of mobile phones in the 1990's it became apparent that emissions from mobile phone technology violated the maximum power densities allowed by the 1990 regulations, making the use of the technology technically illegal.⁹⁴ Thus the conclusion that can be drawn from the Czech experience is that the government's decision to adopt ICNIRP was not based on a balanced assessment of the scientific literature but more on economic and military considerations with Musil and his committee's expert advice sacrificed for the sake of ICNIRP harmonization. Another factor in the Czech Republic moving away from its previous strict RF standard would be a popular desire to move away from conformity to dominant Soviet perspectives during the Cold War era, even though much of the research had in fact been conducted by Czech scientists. An unintended consequence of this, however, is the likely introduction of high power US military radar on Czech territory that conforms to ICNIRP RF standard limits. Under the former Czech national standard this introduction would have been

⁹³ L. Slesin, 'Czech Government Now Follows ICNIRP', *Microwave News*, vol. 21, no.1, Jan./Feb. 2001, p. 7.

⁹⁴ L. Pekarek, Our experiences with introducing ICNIRP Guidelines,

http://www.forum.europa.eu.int/.../jrc/jrc_eis_emf/library?l=/preliminary_country/czech_republicdoc/EN_1_0_&a=d, Accessed Aug. 17, 2005.

illegal. In addition this has made the proposed Czech radar sites a potential nuclear target for Russia.⁹⁵

The military dimension of harmonization : The Asia-Pacific 2004 EMF Conference

Besides IEGMP, ICNIRP and the telecommunications industry having a big stake in promoting global RF standard harmonization, a brief examination of the January 2004 Asia-Pacific EMF Conference titled: *“Electromagnetic Fields, Research, Health Effects, and Standards Harmonization”*, in Bangkok, Thailand, is illustrative of the heavy involvement of the U.S. military in pushing the harmonization line for its own purposes. One of the objectives of the conference was to summarise a framework for the harmonization of international EMF exposure standards and present and discuss a model for EMF exposure regulation and compliance. The conference was organized by the WHO’s International EMF Project (IEMFP), the U.S. Air Force Research Laboratory -Directed Energy Bioeffects Division - Radio Frequency Radiation Branch, at Brooks City-Base, Texas and the Ministry of Public Health, Thailand. Out of the 11 member International Organizing Committee, 8 members represented various sectors of the US Air Force, these being the Asian Office of Aerospace Research and Development (AOARD), which is a foreign detachment of the U.S. Air Force Office of Scientific Research⁹⁶ ; the European Office of Aerospace Research and Development (EOARD), a sister office to AOARD with its areas of interest being Europe, the mid-East, Africa, and countries of the former Soviet Union⁹⁷; the Air Force Research Laboratory at Brooks City-Base, Texas and “Advance Information Systems, Inc”, also located at the Brooks City-Base, Texas. The three non-military representatives were Michael Repacholi (WHO), a member from the Ministry of Public Health, Thailand, as well as a

⁹⁵ J. Neoral, The anti-missile shield cannot defend the Czech Republic, Trokavec against the radar (A Czech web site opposing the introduction of US military early warning radar systems.) <http://www.trokavec.cz/en/about-the-radar/articles-about-the-radar/the-anti-missile-shield-cannot-defend-the-czech-republic>, Accessed Sept. 28, 2008.

⁹⁶ AFOSR fact sheet, <http://www.tokyo.afosr.af.mil/aboutaoard.html> , Accessed Aug. 26, 2005.

⁹⁷ *ibid.*

representative from Health Canada.⁹⁸ Of the three editors of the proceedings of the conference, two were from Advanced Information Engineering Services, Inc, Brooks City-Base, Texas, one from Air Force Research Laboratory, Brooks City-Base and the person in charge of the proceedings website from the Air Force contractor, General Dynamics.⁹⁹

The US Air Force has a very important reason to be actively involved in the world harmonization process. The U.S. has long been maintaining an interlocking web on overseas bases that supports U.S. objectives for securing access to markets, and obtaining natural resources, especially oil.¹⁰⁰ As part of a new strategy, many of the old massive bases dotted around the world are being replaced by a global network of what the Pentagon planners call “lily pads” – small forward bases in remote, dangerous corners of the world that can act as jumping-off points when crises arise.¹⁰¹ In the past couple of years, US bases have been established in the former Soviet republics of Kyrgyzstan, Uzbekistan and Tajikistan, and in former Eastern Bloc states, Bulgaria and Romania.¹⁰² This presence has increased tensions between these nations and Russia who has asked these countries to ask the U.S. forces to leave.¹⁰³ With Russia, China and other former Eastern block nations having strict RF standards, the very existence of these standards can act as an impediment to global deployment of U.S. bases as RF/MW emissions of US military radar equipment would in all probability be in excess of stricter national RF limits, in nations where they apply. This could cause local public opposition to the bases if it were known and could be used as an excuse for governments to ask the bases to leave. From the U.S. military point of view, as well as civilian contractors who manufacture their equipment, it would be far better to simply have just one global RF standard that was high enough to make the maximum military use of the RF

⁹⁸ WHO, USAF, Min. Pub. Health, Thailand, ‘Electromagnetic Fields, Research, Health Effects, and Standards Harmonization’, Asia-Pacific EMF Conference, Bangkok, Thailand, Jan. 26-30, 2004, p. 44, http://www.who.int/peh-emf/meetings/archive/en/bangkok04_proceedings.pdf, Accessed Aug. 27, 2005.

⁹⁹ *ibid.*

¹⁰⁰ J. Lindsay-Poland, ‘U.S. Military Bases in Latin America and the Caribbean’, *Foreign Policy in Focus*, vol. 9, no. 3, Aug. 2004, <http://www.fpif.org/briefs/vol9/v9n03latammil.html>, Accessed Aug. 26, 2005.

¹⁰¹ M. Mainville, U.S. Bases Overseas Show New Strategy, July 26, 2004, GlobalSecurity.org. <http://www.globalsecurity.org/org/news/2004/040726-us-bases.htm>, Accessed Aug. 26, 2005.

¹⁰² C. Ferguson, ‘Bait and Switch: Is Anti-North Korean Missile Defense Designed for China?’, *Journal of the Federation of American Scientists* (FAS) vol. 52, no. 6, Nov./Dec. 1999.

¹⁰³ Mainville, 2004.

spectrum possible, without the embarrassment of violating someone's RF standard. ICNIRP limits, as well as the U.S. IEEE C-95 RF standard, conveniently meet that requirement, at least at the moment.

A brief run-down on some of the conference presentations relevant to RF standards and international harmonization illustrates that despite some concerns being raised over low-level biological effects from RF exposures there is an unquestioned acceptance of the two RF standards, ICNIRP and IEEE C95.1, to meet their various requirements.

1) C-K Chou from Motorola said that the weight of the evidence continues to support the IEEE C95.1-1991 RF standard's 4 W/kg threshold level for potentially adverse health effects for short-term exposures of animals and that more than 50 years of research has shown that thermal effects are the only established adverse effects for fields above 100 kHz. Nonthermal RF bioeffects have not been established and none of the reported nonthermal effects are proven adverse to health. The IEEE C95.6-2002 standard established safety limits to protect against recognized short-term effects. IEEE found insufficient evidence of adverse effects from exposures found in community or occupational environments, and no confirmed mechanism to support the existence of such effects, including cancer.¹⁰⁴ A Motorola presentation on the final day of the conference by Swicord, Morrissey, Elder and Chou reviewed the epidemiological evidence and called for public health officials to "bring closure to public health related questions as rapidly as possible." They concluded that the question of how much research is necessary has to be answered from a public health perspective and not from interests of researchers.¹⁰⁵ In other words, thermal adverse effects from RF exposure are the only issue from a public health perspective. As IEEE C95.6-2002 and ICNIRP provides public health protection from these effects, Motorola considered that there was no need to waste efforts in conducting any further research on possible nonthermal effects as they are not proven adverse to health, if they exist at all. In essence an 'end of history' for EMF research.

¹⁰⁴ WHO, USAF, Min. Pub. Health, Thailand, Asia-Pacific EMF Conference, 2004, op. cit., p. 20.

¹⁰⁵ *ibid*, p. 66.

2) The presentation of the manager of Nokia's Bioelectromagnetics Research Centre, Sakari Lang, supported Motorola's line and claimed that most of the approximately 1,300 studies on the IEEE's database that are listed on the WHO web site are directly relevant to the issues of whether low-level exposure to RF energy can initiate or promote cancers. Sakari said that the "weight of evidence approach" shows that mobile phones and base stations cannot be linked to adverse health effects in humans and there is no established data supporting frequency specific or modulation specific health (non-thermal) effects.¹⁰⁶

3) John A D' Andrea from the Naval Health Research Centre Detachment, Brooks City-Base, expressed a far less extreme view on the RF literature base than that of the Motorola and Nokia presenters. He agreed that at high RF power densities thermal effects are prevalent and can lead to adverse consequences. D' Andrea added however that "on the other hand, some results have been found which suggests EMFs at low-power levels can alter biological systems especially following long-term exposures. There are a variety of reports of low-level exposures producing negative effects on the nervous system, visual system, cardiovascular system and cellular regulation and proliferation."¹⁰⁷

4) Michael Murphy from the Directed Energy Bioeffects Division, Human Effectiveness Directorate, Air Force Research Laboratory, said that contemporary military activities employ extensive RF emitting equipment that results in some human exposure to low-level RF fields, often for long periods of time. He stated that some of the activities of his Division were to assess the risks from RF exposures and determine and mitigate the potential RF hazards to personnel health, safety and job performance. The overall mission was to support the maximum safe use of the RF spectrum and the setting of scientifically based health and safety standards.¹⁰⁸

¹⁰⁶ *ibid*, p. 57.

¹⁰⁷ *ibid*, p. 22.

¹⁰⁸ *ibid*, p. 27.

5) Dr. Michael Repacholi (WHO) gave a run-down on the WHO's International EMF Project, concluding that the WHO has determined that EMF exposures below the ICNIRP limits did not appear to have any known consequences on health. Repacholi added that if precautionary measures were introduced, he recommended that they be voluntary, and that health-based exposure limits be mandated to protect public health.¹⁰⁹ In a later presentation by Repacholi and Emilie van Deventer, also representing WHO, they acknowledged that since protecting populations was part of the political process it was to be expected that different countries, in responding to their citizen's wishes, may provide different levels of protection against environmental hazards. Differences can arise from different interpretations of the scientific data, from different philosophies for public health standards development and deficiencies in communications between scientists in different regions. According to Repacholi and van Deventer, however, differences can increase public anxiety which is further exacerbated by the introduction of new technologies, which are often associated with increased EMF exposure.¹¹⁰

6) In a presentation by various members of the IEEE C95.1 standards committee that explained the status of the standard revision it was mentioned that the peak spatial-average SAR limits were proposed to harmonize with those of ICNIRP.¹¹¹ Though not mentioned by the presenters, this is a significant relaxation of the US standard for mobile phones as the averaging volume goes from that holding 1 gram of tissue to 10. This move was most likely due to the fact that some of the mobile phones sold in the U.S. were out of compliance with the IEEE C94.1 –1991 standard because of the 1-gram averaging weight¹¹². Increasing it to 10 grams would effectively eliminate the non-compliance issue. The speakers concluded that their goal was to develop “scientifically based exposure limits that protect against known adverse effects with an adequate safety margin”.¹¹³

¹⁰⁹ *ibid*, p. 33.

¹¹⁰ *ibid*, p. 46.

¹¹¹ *ibid*, p. 35.

¹¹² Kane R, *Cellular Telephone Russian Roulette: A Historical and Scientific Perspective*, Vantage Press, New York, 2001, pp. 10-15.

¹¹³ WHO, USAF, Min. Pub. Health, Thailand, Asia-Pacific EMF Conference, *op. cit.*, p. 35.

7) Dr. Peter Gajsek from the Institute of Non-Ionizing Radiation in Slovenia, a former state of the Soviet Union, gave a talk on the pressures of harmonization now facing the Eastern European (EE) countries who have carried on with the strict Soviet era RF standard. Gajsek explained how over the past 10 years, new political and economic situations in the Eastern European countries have dramatically changed international relations with many of the EE countries. New, democratically elected governments are looking outwards and joining the European Union (EU) and NATO and adapting their regulations and standards to suit. Therefore, both EMF standards and legislation in the EE countries are a subject for harmonization with EU legislation for both civilian and NATO standardisation for military purposes. Gajsek saw this as the first step in a long-lasting process of the global harmonization of EMF standards.¹¹⁴

8) David Black's presentation was titled "Australasian Standards and the Precautionary Principle". Black briefly ran through his version of the failure of TE/7 to accept the ICNIRP limit revised standard in the 1990's, the subsequent approval of the standard for New Zealand after the incorporation of what Black called precautionary approach provisions which resulted in "stabilisation of RF deployment" in N.Z. Black said that after TE/7 failure ARPANSA then took over the task with a "wide ranging consultative process"¹¹⁵ He then claimed that the new Australian and New Zealand RF standards incorporated "recommendations for precaution", while retaining the basic restrictions recommended by ICNIRP and were consistent with other international standards [IEEE C-95].¹¹⁶

9) In contrast to the above speakers the presentation by Huai Chiang and Zhengping Xu from the Bioelectromagnetics Lab, Zhejiang University School of Medicine, China, saw significant inadequacies in the ICNIRP approach to health protection. Chiang and Xu explained the main differences between ICNIRP and the Chinese RF standard. They saw ICNIRP as based on short-term, immediate

¹¹⁴ *ibid*, p.43.

¹¹⁵ This process did not include the majority of TE/7 members who had earlier voted against the ICNIRP Guidelines.

¹¹⁶ Asia-Pacific EMF Conference, *op. cit.*, p. 42.

health effects such as stimulation of peripheral nerves and muscles [for ELF] and elevated tissue temperature resulting from absorption of energy during exposure to RF/MW. They said, however, that the Chinese research base consisted of a growing body of literature which reported health effects down to such a level that did not produce heating or stimulation. They then outlined the rationale for China's draft EMF standard that, although making some concessions to accommodate the ICNIRP limits, still retained stricter exposure limits.¹¹⁷

What the 2004 Asia-Pacific EMF Conference amply illustrates is the intense involvement of the U.S. Department of Defense, primarily through the Air Force, in determining the scope of RF standard setting in both IEEE C95.1 and ICNIRP. Although historically this was bound up with fears of a Soviet nuclear threat, as examined in Chapter 3, its current involvement seems to be more to ensure that the RF standard (C95.1 or ICNIRP) would never be in a position to threaten the viability of U.S. military radar tracking technology. This technology includes advanced early warning radar systems that are a vital part of the DoD's National Missile Defense (NMD) program and its international deployment as the advanced Theater Missile Defense (TMD) system aimed at the so-called rogue states such as North Korea and Iran. A TMD system in Taiwan is also apparently designed to counter possible Chinese missiles.¹¹⁸ According to 2008 military budget figures the NMD program is DoD's single biggest program development budget with \$8.8 billion allocated for that year alone.¹¹⁹ Central to the development of the NMD program (including TMD) is the development and deployment of Ground Based Radar (GBR), including Upgraded Early Warning Radar (UEWR) facilities and new high-resolution X-Band Radars (XBRs). The corporate partners developing these systems for DoD work through the United Missile Defense Company (UMDC), a joint venture equally owned by Lockheed Martin, Raytheon and TRW Incorporated, Boeing North America, is also working with UMDC to develop the

¹¹⁷ *ibid*, p. 40.

¹¹⁸ Ferguson, 1999.

¹¹⁹ Department of Defense: 2006-2008 Program Acquisition Costs by Weapon System, http://www.defenselink.mil/comptroller/defbudget/fy2008/fy2008_weabook.pdf, Accessed Dec. 28, 2008.

NMD program.¹²⁰ In essence this program is an example of the workings of the modern U.S. military-corporate industrial complex with a harmonious blending of perceived national defence needs with private corporate profit-orientated objectives. As for protecting the health of the public living in the vicinity of NMD/TMD radar facilities, ANSI/IEEE C95.1-1991 is quoted as ensuring safety.¹²¹

The international deployment of these inter-related missile and radar systems obviously requires the co-operation of national governments where the systems are to be based. This is seen with the Czech Republic and Poland where the respective governments have given approval to build a NMD facility in each country: a missile interceptor launch facility in Poland¹²² and a radar facility in the Czech Republic.¹²³ These developments have not been without public protests in both countries. In an August 2008 survey conducted by CBOS, a publicly funded institute based in Warsaw, they found that 56% of Poles were against the deployment in Poland as they thought it could increase the possibility of a Russian attack on the country. In October 2008, as a result of the Russian attack on Georgia, that increased to almost 66%.¹²⁴

A public opinion survey of Czech citizens, conducted by the Public Opinion Research Centre, Institute of Sociology, Academy of Sciences in the Czech Republic found similar opposition to MND facilities in their country. 66% of the Czech citizens surveyed did not agree with the siting of the U.S. anti-missile radar in their country with 71 % respondents expressing their opinion that this question should be decided in a referendum.¹²⁵ Protests centred on concerns that the base could

¹²⁰ Federation of American Scientists, 'National Missile Defense', *FAS Special Weapons Monitor*, <http://www.fas.org/spp/starwars/program/nmd>, Accessed Dec. 28, 2008.

¹²¹ S. Aftergood, Federation of American Scientists, 'Ground Based Radar [GBR] X-Band Radar [XBR]', *FAS Special Weapons Monitor*, <http://www.fas.org/spp/starwars/program/gbr.htm>, Accessed Dec. 28, 2008.

¹²² V. Gera, 'Polish Support for Missile Deal Soars' ABC News, Aug. 18, 2008, <http://abcnews.go.com/International/wireStory?id=5602563>, Accessed Dec. 31, 2008.

¹²³ M. Dokoupil, 'Czech Upper House Approves Missile Shield', ABC News, Nov. 27, 2008, <http://abcnews.go.com/International/wireStory?id=6347932>, Accessed Dec. 31, 2008.

¹²⁴ B. Roguska, 'The Poles about the anti-missile shield', Polish Public Opinion, Oct. 2008, http://www.cbos.pl/PL/publikacje/public_opinion/2008/10_2008.pdf, Accessed Dec. 31, 2008.

¹²⁵ J. Cervenka, 'Citizens on U.S. Anti-Missile Base in Czech Republic', Public Opinion Research Centre, Czech Republic, Nov. 7, 2008,

make the country a target for Russia if hostilities ever broke out. Although there was an article in the *Financial Times*¹²⁶ and on the BBC News¹²⁷ that villagers close to the planned radar facility were concerned about possible health hazards from the radar emissions, this does not appear to be the case in other parts of the country. Although it is not known what is the extent of wider Czech public awareness of their nation's former RF standard (and the reasoning behind it), the continuing existence of the stricter Russian Federation RF standard could lend credibility to possible Czech public concerns over the possibility of hazards not addressed by the ICNIRP guidelines and the IEEE C95.1. standard. Thus, the Russian Federation's strict RF standard has the potential to complicate the international planned deployment of U.S. NMD radar systems as it brings into question the credibility of the standards that underlay claims of safety. If public concerns in the Czech Republic, and other Eastern European countries that may host U.S. radar systems, expanded into one of possible non-thermal long-term effects from the radar systems then this would be a threat to the successful implementation of US military objectives. For the DoD and their contractors, any hint or admission that there may be biological hazards from their weapons technologies at levels below the official thermally based standards would validate the Russian Federation's RF standard and undo half a century's assurances of RF safety. This obviously would make continuing military radar development and deployment difficult with a significant financial loss for the corporations developing the technology for the DoD. For this reason they cannot back away from supporting the thermal status-quo in RF standard setting regardless of any advances in scientific understanding. This may be a factor the IEEE's ICES Subcommittee 4 decision to establish "guiding principles" that only thermal effects (established adverse health effects) can be considered in setting safety standards (Chapter 3).

<http://www.cvvm.cas.cz/index.php?disp=zpravy&lang=1&r=1&s=&offset=&shw=100837> , Accessed Dec. 31, 2008.

¹²⁶ J. Cienski, Czech village fears over US missile shield plan, *Financial Times*, Mar. 30, 2007, <http://www.trokavec.cz/en/about-trokavec/articles-about-trokavec/financial-times-czech-village-fears-over-us-missile-shield-plan>, Accessed Dec 31, 2008.

¹²⁷ S. Fottrell, 'Czech fears over missile defence radar', *BBC News*, Jun. 6, 2007. <http://news.bbc.co.uk/2/hi/europe/6726619.stm> , [Accessed Dec. 31, 2008].

The U.S. DoD and their corporate defence contractors have been involved in RF standards development right from the beginning in the 1950s. Considering this and their huge current financial commitment to development and deployment of high power military radar systems, it cannot be understated that the issue of low-level long-term (non-thermal) biological effects has been kept off the RF standard setting table for reasons far removed from an objective assessment of the risks that may be involved.

ICNIRP's illusory precautionary approach

An emerging global concern (discussed below) is that the increasing use of mobile phones by children may have unintended long-term adverse health consequences and therefore a precautionary approach is advisable to protect against possible damage to young developing brains. In June 2004 the WHO convened an international meeting specifically to address this concern. ICNIRP Chairman Carlo Vecchia summed up both the WHO's and ICNIRP's stand on the issue by stating:

The protection system using basic restrictions and reference levels makes the ICNIRP Guidelines flexible and applicable to virtually any exposure condition, and any group of population. Therefore, there is no need, or justification, for a special approach to the protection of children.¹²⁸

When David Black referred to "recommendations for precaution" (point #8 in the previous section) this was essentially ICNIRP's so-called precautionary approach, which was a central feature of disagreement within the Australian TE/7 committee. As examined in Chapter 5, the TE/7 committee failed in March of 1999 to approve the ICNIRP Guidelines for RF because a significant number of committee members, after extensive consideration, did not consider that ICNIRP recommendations followed a precautionary approach for all possible hazardous situations. This was due to the fact that much of the scientific basis for the ICNIRP

¹²⁸ P. Vecchia , 'The approach of ICNIRP to protection of children', *Bioelectromagnetics*, vol.26, issue S7, 2005, pp. S157-S160.

limits was from short term, acute exposure (thermal) studies on animals and not long term, low level, chronic effects which many public and committee member submissions were concerned with. What was wanted by a significant number of TE/7 members was a precautionary approach specifically to address public concerns over possible health hazards from prolonged exposure to low-level RF emissions from telecommunications facilities. As was stated in a joint committee member submission to TE/7:

Comments on recent statements regarding the precautionary principle in the new draft: Unlike the Interim Standard [the previous Australian/New Zealand RF standard], the new draft [based on ICNIRP] does acknowledge that it is based on thermal effects only. The 'safety margin' of 50 (for the public) is based on thermal considerations only. It cannot be said therefore to constitute a precautionary measure for non-thermal effects. The public is concerned about whatever non-thermal effects may occur at exposure levels possible in accessible areas near a transmitter. These levels are of the order of a few microwatts/cm². If there are effects at such levels, clearly they are not covered by the thermally-based exposure limits.¹²⁹

These concerns expressed within the TE/7 committee are reflected by the later (2004) conclusions of ICNIRP's peer review Standing Committee on Epidemiology in their review of the available RF epidemiological literature. This was undertaken to update the earlier RF epidemiological section in the ICNIRP Guidelines, summarise the current scientific understanding, improve future methodologies and plan for future studies. The committee concluded, in part, that:

Results of these studies to date give no consistent or convincing evidence of a causal relation between RF exposure and any adverse health effect. On the other hand, the studies have too many deficiencies to rule out an association...Despite the ubiquity of new technologies using RFs, little is known about population exposure from RF sources and even less about the

¹²⁹ I. Beale, D. Maisch, J. Lincoln, Joint Submission to TE/7 Committee by the Australian & New Zealand Community / Consumer Committee Representatives, Mar. 3, 1999.

relative importance of different sources. Other cautions are that mobile phone studies to date have been able to address only relatively short lag periods, that almost no data are available on the consequences of childhood exposure and that published data largely concentrate on a small number of outcomes, especially brain tumor and leukemia... Another gap in the research is children. No study population to date has included children, with the exception of studies of people living near radio and TV antennas. Children are increasingly heavy users of mobile phones. They may be particularly susceptible to harmful effects (although there is no evidence of this), and they are likely to accumulate many years of exposure during their lives.¹³⁰

In spite of the apparent need to take a precautionary approach in face of the uncertainties stated by the ICNIRP epidemiological committee, especially to protect the future health of children, ICNIRP chairman Vecchia ruled out such an approach at the September 2004 international conference on mobile phones and health, held in Moscow. According to Vecchia:

Precautionary actions to address public concerns may increase rather than mitigate worries and fears of the public. This constitutes a health detriment and should be prevented as other adverse effects of EMF.¹³¹

As examined in this chapter on the promotion of the ICNIRP Guidelines internationally, those pushing for these guidelines as a basis for national RF standards present them as an internationally sound basis for providing full protection to the public from any hazards from the use of telecommunications technology. As an ARPANSA spokesperson stated in 2004, the Australian ICNIRP based RF standard “provides protection for people of all ages and health conditions (including children) whether they're exposed to EME irregularly or for 24 hours a day, 7 days a week.”¹³² IEMFP makes a similar claim that the ICNIRP Guidelines “are designed to avoid all identified hazards from short and long term

¹³⁰ A. Ahlbon, A. Green, L. Kheifets, D. Savatz, A. Swerdlow, ‘Epidemiology of Health Effects of Radiofrequency Exposure’, *Environmental Health Perspectives*, vol. 112, no. 17, Dec. 2004, pp. 1741–1754.

¹³¹ Maisch, 2005, op. cit., p. 7.

¹³² ARPANSA/ACA, *Mobile Communications and Health*, (6 minute DVD presentation), Dec. 2004.

exposure, with a large margin of safety incorporated into the limit values”.¹³³ This claim, however, is in conflict with what Vecchia stated at the Moscow conference that “ICNIRP only considers acute effects in its precautionary principle approach. Consideration of long term effects is not possible”.¹³⁴

IEMFP incorporates risk assessment considerations into its definition of a suitable precautionary principle (or approach) for EMF/RF such as an “economic cost/benefit analysis”. When such considerations are added to the RF precautionary equation the result is an emphasis on keeping extra costs to industry at a minimum by merely reducing RF emissions that are not necessary for the technology to function. Any consideration of costs to society if there was an uncertain level of health hazards is not part of the equation. This was the case for Australia’s (and New Zealand’s) “precautionary approach” in the current RF standard as will be examined in Chapter 5.

According to Adam Burgess, author of *Cellular Phones, Public Fears, And A Culture of Precaution* ICNIRP Chairman Paulo Vecchia provided him with valuable insights for his book that addressed the precautionary approach. In Burgess’ opinion precautionary measures called for in the U.K. by the Independent Expert Group on Mobile Phones (IEGMP-May 2000), such as limiting children’s use of cell phones, were simply the result of an institutional insecurity in British culture which has been influenced by a media-driven fear campaign over “unsubstantiated worries” about cell phone technology. Burgess considered the IEGMP as being responsible for enflaming the mobile phone health scare by its very consideration – thereby conferring a level of legitimacy to the debate, irrespective to the validity of the claims. Burgess argues that the various public campaigns which have sprung up in the UK over alleged health hazards are largely in response to “the agenda promoted by the media and government”.¹³⁵ He called the cell phone risk debate (and the wider debate over health hazards from all wireless technology) as purely

¹³³ WHO, ‘Electromagnetic Fields and Public Health Cautionary Policies’, WHO Backgrounder Fact Sheet, Mar. 2000, <http://www.elettra2000.it/pdf/report/oms-eng.pdf>, Accessed Jul. 4, 2008.

¹³⁴ Maisch, 2005.

¹³⁵ A. Burgess, *Cellular Phones, Public Fears, And A Culture of Precaution*, Cambridge University Press, 2004, p. 14.

socially and politically constructed. He dismissed all evidence of adverse health effects as “hypothetical” and just “an idea” not based on any demonstrable evidence. A dismissal of any possible harm from cell phone use is seen where Burgess stated (perhaps referring to the ICNIRP RF guidelines) that the accepted scientific orthodoxy is “that only direct heating effects from [RF] radiation can be considered, and that these are simply too weak to cause harm”.¹³⁶ If only heating effects can be considered in the risk evaluation of cell phone technology for standard setting, as Burgess suggests, then this conveniently avoids the need to consider the large level of uncertainty over health risks not directly related to heating such as those mentioned by ICNIRP’s peer review Standing Committee on Epidemiology mentioned above.

However, the views of Vecchia, Anderson and Burgess are at variance with accepted definitions of situations where a precautionary principle (approach) is called for. For example, according to the United Kingdom Interdepartmental Liaison Group on Risk Assessment (UK-ILGRA):

[W]here there is scientific uncertainty the precautionary principle establishes an impetus to make a decision that seeks to avoid serious damage if things go wrong ...The purpose of the precautionary principle is to create an impetus to take a decision notwithstanding scientific uncertainty about the nature and extent of the risk, i.e. to avoid 'paralysis by analysis' by removing excuses for inaction on the grounds of scientific uncertainty.¹³⁷

An excuse for inaction that claims to be a precautionary approach is a hazard in itself because it increases the worries and fears of the public and not only goes against the very concept of the precautionary principle, but casts the “public” as scientifically ignorant, prone to needless fears and anxieties and needing to be comforted that their fears and worries are unfounded. This is very much in conformity with John Graham’s revisionist “syndrome of paranoia and neglect”

¹³⁶ *ibid.*, p. 4.

¹³⁷ United Kingdom Interdepartmental Liaison Group on Risk Assessment (UK-ILGRA) <http://www.hse.gov.uk/aboutus/meetings/ilgra/pppa.htm#3> , Accessed Jul. 8, 2008.

examined in Chapter 1, which discounts all environmental risks as a social problem of public misperceptions rather than objective environmental hazards.

Expert criticisms of the thermal limitations of both IEEE C95.1 and the ICNIRP Guidelines

On August 31, 2007, an international working group of 14 scientists, researchers and public health policy professionals (The Bioinitiative group) released an extensive scientific literature review of over 2,000 studies titled the *“BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)”*.¹³⁸ The purpose of the report was to document the information that the report’s authors considered needed to be considered in the debate over the adequacy, or inadequacy, of existing public exposure standards. This included both extremely low frequency (ELF) and radiofrequency/microwave standards. The report included detailed scientific data, with references, documenting a whole range of chronic low-intensity, non-thermal adverse biological effects that have been established to occur at exposure levels well below ANSI/IEEE C95.1-1996 and ICNIRP limits. The report reviewed the risk assessment carried out by IEEE and WHO/ICNIRP that serve as the common basis for the thermally-based standards and documented a systematic filtering out of scientific studies that reported low-level bioeffects and potential health effects. The report specifically examined the limitations and deficiencies of the proposed IEEE SC-4 C95.1 draft standard as well as similar deficiencies in the ICNIRP Guidelines. In calling for new biologically based RF (and ELF) safety standards the report contains 11 chapters examining key scientific studies and reviews that have identified low-intensity (non-thermal) biological effects which provide a scientific basis for new safety limits based on traditional public health protection approaches. The fundamental reason for the writing of the report was the increasing concern by a number of bioelectromagnetics researchers, scientists and public policy health

¹³⁸ C. Blackman, M. Blank, M. Kundi, C. Sage, D. Carpenter, Z. Davanipour, D. Gee, L. Hardell, O. Johansson, H. Lai, K. Hanson Mild, E. Sobel, 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>, accessed August 31, 2007.

experts over the unquestioned acceptance of IEMFP/ICNIRP claims that only immediate hazards from acute levels of EMF are to be considered as the only “established” health hazards from exposure. Understandably such a departure from standard setting orthodoxy would not escape criticism from organizations that have staked their own credibility on adherence to that orthodoxy. For that reason it is worthwhile to briefly examine the criticisms of the Bioinitiative report by two organizations, the Australian Centre for Radiofrequency Bioeffects Research (ACRBR) and the Health Council of the Netherlands (HCN).

The Australian Centre for Radiofrequency Bioeffects Research (ACRBR), a university research partnership with Telstra has criticized the BioInitiative report as “largely inconsistent with current scientific consensus”. To quote:

“Do the BioInitiative Report authors represent an authoritative international body? Often in assessing public health issues, bodies are formed to evaluate evidence and offer recommendations about particular issues. The model that most scientific expert bodies in this area (e.g. World Health Organisation (WHO)) employ is to engage independent experts to provide a review and recommendations on an issue. Independent experts are engaged because it is meant to provide an objective evaluation of the issue. This contrasts strongly with the BioInitiative Report, which is the result of the opinions of a self-selected group of individuals who each have a strong belief that does not accord with that of current scientific consensus.¹³⁹

The Health Council of the Netherlands (HCN), in its review of the BioInitiative report made a number of criticisms of various sections of the report but their main criticism centres around the divergence from the ‘official’ guidance. To quote in part:

“A report published on 31 August 2007 is playing an increasingly prominent role in the debate on electromagnetic fields and health: the BioInitiative Report:

¹³⁹ ACRBR, <http://www.acrbr.org.au/FAQ/ACRBR%20Bioinitiative%20Report%2018%20Dec%202008.pdf>, Accessed Apr. 24, 2009.

A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF). The report contains recommendations on establishing limits for exposure to electromagnetic fields that are much lower than the limits that are currently applied in the Netherlands and in many other countries, and is receiving increasing attention from society....Scientific advisory reports are usually the result of a process in which a group of experts, using the current state of science, extensively discusses a topic until a consensus is reached. The group is made up of independent experts from the various areas of expertise relevant to the topic. In the case of electromagnetic fields, for example, this would be biologists, epidemiologists, technical experts, physicians and in some cases also psychologists and risk experts. This procedure is followed by bodies such as the World Health Organization (WHO) [IEMFP] and the Health Council, as well as organizations involved in drafting proposals for exposure limits, such as the International Commission on Non-ionizing Radiation Protection (ICNIRP) and the International Commission for Electromagnetic Safety (ICES) of the Institute of Electrical and Electronics Engineers (IEEE). The various experts and the interactions between them, combined with a review of all relevant scientific information, ensure that a balanced judgment on the latest scientific knowledge can be reached. It is of importance that this process is transparent. This multidisciplinary weight-of-evidence method leads to a scientifically sound judgment that is as objective as possible. The BioInitiative report did not follow this procedure."¹⁴⁰

The above statements clearly illustrate the entrenched nature of the thermal paradigm. When detailed evidence is given that casts doubt on that paradigm, that evidence is rejected because it is not in conformity with the current orthodoxy. The ACRBR and HCN statements give the impression that the standard setting science of IEMFP, ICNIRP and the IEEE is a body of sure and certain knowledge that is above reproach. This thesis has presented the case that this is far from the truth of the matter.

¹⁴⁰ Health Council of the Netherlands, <http://www.gr.nl/pdf.php?ID=1743&p=1>, Accessed April 24, 2009.

On September 4, 2008, The European Parliament voted 522 to 16 to recommend tighter safety standards for cell phones based on growing evidence of a link between brain tumours and cell phone use. The Parliament stated that "[t]he limits on exposure to electromagnetic fields [EMFs] which have been set for the general public are obsolete" . The EU Parliament specifically mentioned that their recommendations were also based on the Bio-Initiative report and the need to "address vulnerable groups such as pregnant women, newborn babies and children."¹⁴¹

On September 17, 2007, the European Environmental Agency issued a press release that supported the conclusions and recommendations of the Bioinitiative report. The EEA had contributed to this report with a chapter drawn from the EEA study "Late lessons from early warnings: the precautionary principle 1896-2000", published in 2001. Professor Jacqueline McGlade, Executive Director of the EEA, stated the following:

There are many examples of the failure to use the precautionary principle in the past, which have resulted in serious and often irreversible damage to health and environments. Appropriate, precautionary and proportionate actions taken now to avoid plausible and potentially serious threats to health from EMF are likely to be seen as prudent and wise from future perspectives. We must remember that precaution is one of the principles of EU environmental policy.¹⁴²

On November 3, 2008 the U.S. Congressional Committee on Oversight and Government Reform sent an official request, in the form of a letter, to the Chairman of the Federal Communications Commission (FCC) to provide the Domestic Policy Subcommittee with a detailed description of what measures FCC has taken to protect public health from a significant increase in public RF

¹⁴¹ University at Albany, Institute for Health and the Environment , 'European Parliament Recommends Stricter Safety Limits for Cell Phones', Sept. 8, 2008, <http://www.emfnews.org/European-Parliament-Recommends-Stricter-Safety-Limits-for-Cell-Phones.html>, Accessed Sept. 19, 2008

¹⁴² European Environment Agency, press release, Radiation risk from everyday devices assessed, Sept. 17, 2007, <http://www.eea.europa.eu/highlights/radiation-risk-from-everyday-devices-assessed> , Accessed Sept. 18, 2007.

exposures as a result of new communications devices operating in the “White Spaces spectrum”.¹⁴³ The letter specifically mentioned two expert group statements that questioned the adequacy of the existing RF standards in regards to protecting the public from non-thermal chronic exposures.¹⁴⁴ The oversight committee called upon the FCC to “match its concern for commercial interests with concern for human health of the future consumers of this technology”.¹⁴⁵

On February 23, 2009 the European Parliament Committee on the Environment, Public Health and Food Safety adopted a resolution in a 43-1 vote to urge the European Commission to recognize the growing public and scientific concern over health risks from EMFs. Part of the 29-point resolution called for a review of the adequacy of the existing EMF (including RF) limits.¹⁴⁶

On April 2, 2009 the full European Parliament adopted a report on avoiding the potential risks of electromagnetic fields with 559 votes in favour, 22 against with 8 abstentions. The report, drafted by Frederique Ries from Belgium, urged the European Commission to review “the scientific basis and adequacy of the EMF limits as laid down in recommendation 1999/519/EC”¹⁴⁷ which are based on the ICNIRP guidelines.

Yuri Grigoriev, Chairman of the Russian National Committee on Non-Ionizing Radiation Protection (RNCNIRP), addressed the issue of over-restrictive interpretations of health hazards from RF exposure (addressing both IEEE C95.1

¹⁴³ This refers to the largely unused portions of the radiofrequency spectrum, particularly the range allocated for analogue television and those acting as buffers to prevent interference between TV channels. With the switch over to digital television this frequency range will become available for new wireless technologies.

¹⁴⁴ National Toxicology Program (U.S.), Fact Sheet: ‘Studies on Radiofrequency Radiation Emitted by Cellular Phones’, National Institute of Environmental Health Sciences, 2005. And: National Research Council of the National Academies (U.S.), *Identification of Research Needs Relating to Potential Biological or Adverse Health Effects of Wireless Communication Devices*, The National Academies Press, 2008.

¹⁴⁵ D. Kucinich, Chairman, Domestic Policy Subcommittee, Re: White Spaces Unlicensed Operation in the TV Broadcast Bands (ET Docket No. 04-186). Letter to FCC Chairman Kevin Martin, U.S. Congressional Committee on Oversight and Government reform, Nov. 3, 2008.

¹⁴⁶ European Parliament, Motion For A European Parliament Resolution On Health Concerns Associated with Electromagnetic Fields. <http://www.europarl.europa.eu/oeil/file.jsp?id=5680652>, accessed Mar. 3, 2009.

¹⁴⁷ European Parliament, Directorate for the Media, Press release, ‘Avoiding potential risks of electromagnetic fields’, Apr. 2, 2009. Full resolution at: <http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P6-TA-2009-0216+0+DOC+XML+V0//EN>, accessed Apr. 7, 2009.

and ICNIRP interpretations). In his letter to *Bioelectromagnetics* (2004) Grigoriev used the example of the Health Council of the Netherlands erring in its unquestioned acceptance of the ICNIRP Guidelines when it concluded that it saw “no reason for recommending limiting the use of mobile phones by children”. According to Grigoriev, the problem was that a “one- sided analysis of the problem had been made, using only a physical approach and not taking into account worldwide experience in monitoring and investigations by physiologists, psychologists, morphologists, paediatricians, and other specialists and fields”. It was Grigoriev’s opinion that including these additional factors was essential in determining the actual hazards to health.¹⁴⁸

In arriving at its latest recommendations, the IEEE SC-4 C95.1 committee (ICES) stated that it had conducted “a comprehensive review of the scientific data...including those studies that involve low level exposures where increases in temperature could not be measured or were not expected.” The committee dismissed the issue of low-level, non-thermal, biological effects with the statement that, as a result of their review, a “lack of credible scientific and medical reports showing adverse health effects for RF exposures at or below similar exposure limits in past standards supports the protective nature of the exposure limits.”¹⁴⁹ However, in his review of the IEEE’s data-base, theoretical biophysicist Vladimir N. Binhi from the Russian Academy of Sciences wrote that the IEEE’s dismissal of non-thermal effects was essentially based on flawed reasoning. According to Binhi, the IEEE incorrectly considered non-thermal effects as not possible since they contradict the known laws of physics and evidence for such effects are simply artefacts since they are not replicated in other labs. Where they have been replicated, IEEE considered that they had no significance for human health.¹⁵⁰ Binhi analysed the IEEE data-base used as the rationale for the IEEE standard. Although it contained over 1300 references, a discrepancy is seen between the

¹⁴⁸ Y. Grigoriev , ‘Letter to the Editor, Mobile phones and children: Is precaution warranted?’, *Bioelectromagnetics*, vol. 25, Issue 5, 9 June 2004, pp. 322-323.

¹⁴⁹ IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz" (IEEE Std C95.1-2005), 1.3 Introduction, p. 2.

¹⁵⁰ N. Binhi , Some notes to the new IEEE electromagnetic safety standards, General Physics Institute of the Russian Academy of Sciences, 2006, <http://www.safewireless.org/Portals/1/Documents/Binhi.IEEE.notes-2006-electromagnetic%20standards%20to%20IEEE.pdf> , accessed August 28, 2006.

number of non-thermal papers cited in the IEEE standard compared to a 2005 Swedish review of research on non-thermal biological effects of microwaves. This review, by Igor Belyaev,¹⁵¹ included 115 references for peer reviewed and published non-thermal research papers, of which only about 25% are referenced by IEEE's RF/MW standard. Another 85 recently published papers, most showing non-thermal effects, were not included in the references for the IEEE standard¹⁵². Given this discrepancy, Binhi stated that "consumers of the electromagnetic safety standards might expect a more attentive and careful attitude to human health."¹⁵³

The above criticisms of the thermal paradigm maintained on an international setting by IEEE, IEMFP and ICNIRP raises serious questions over their risk assessment methodology that has long maintained that possible prolonged low-intensity (non-thermal) biological effects are beyond the scope of RF standard setting. Despite these criticisms, however, the thermal paradigm still reigns paramount with most government radiation protection agencies.

Why this is so can be seen as a consequence of a number of interrelated factors:

- There has been a strong vested interest (military and corporate) involvement from the very beginnings in establishing a thermally based RF standard philosophy that conformed to their various operational requirements which was promoted on the global stage through the WHO and international scientific seminars as a body of sure and certain knowledge that was above serious criticism.
- The necessary research effort has long been predominantly under the control and funding of the telecommunications industry with little, if any, interest in conducting truly independent research that could challenge the thermal-only validity of the standards.

¹⁵¹ I. Belyaev , 'Non-thermal Biological Effects of Microwaves', *Microwave Review*, p. 13 –29, Nov. 2005

¹⁵² Belyaev, 2005.

¹⁵³ Binhi, 2006.

- The increasing trend to base national standards on so-called global international standards, such as ICNIRP, promoted by the World Health Organization (WHO). After all why re-invent the wheel!
- Global standards are also stipulated as World Trade Organization (WTO) requirements where national standards are not to be a barrier to economic and technological development.
- There is a huge financial incentive for national governments to promote the introduction of new wireless technology through taxes, the sale of spectrum licences and in the case of Australia, being a major share holder of Telstra, the nation's premier carrier. In this case there is a strong incentive for agencies to follow government policy.
- There are extensive advertising campaigns by industry and their public relations groups extolling the many benefits of new technology to all age groups and downplaying any possible health hazards whatsoever.
- Society has developed a love of new communications technology that has radically transformed modern life resulting in a reluctance to question the safety of such convenient devices. This can be expressed as an opinion that 'if it was dangerous it wouldn't be allowed on the market' (notwithstanding the sale of cigarettes!). This opinion is strengthened with media reports of conflicting studies that reinforce the level of uncertainty over the existence of possible health hazards.
- The telecommunications industry coordinates its activities on a well-planned global scale using professional public relations firms, industry trade organizations and lobby groups commissioned to maintain the status quo. In comparison, public concerns and activist opposition tend to be on a local or regional scale (NIMBY) which only last until their particular battle is either won or lost.

These factors combine to make a powerful force in maintaining the status quo for RF standard setting: WHO promoted international standards (or guidelines re. ICNIRP) that maintain the paradigm for the benefit of the corporate and military users who developed the standards; national governments supporting that paradigm for economic reasons; national radiation protection agencies following government policy; and a relentless bombardment of advertisements in all medias promoting public consumption and the indispensability of new wireless technology.

As a consequence of these factors in current day Australia, the United States the U.K and many other so-called Western countries, trade unions, environmental and consumer organizations, and political parties have largely avoided questioning the adequacy of the RF standards and safety aspects of telecommunications technology. This is a prime reason why the thermal paradigm still reigns supreme.

Conclusions: An inability to learn?

The ICNIRP Guidelines are being promoted internationally as an unproblematic body of sure and certain knowledge that is above reproach. At various international EMF conferences this has been the consistent message given by Dr. Michael Repacholi, when he headed IEMFP and as Chairman of ICNIRP. As illustrated by the case of Australia (Chapter 5), the ICNIRP Guidelines have been portrayed by factions pushing for ICNIRP incorporation in the RF standards committee as the state-of-the-art in providing health protection from all 'known' hazards from telecommunications technology. This viewpoint was steadfastly maintained despite attempts by a significant number of other committee members to include consideration of other bioeffects not related to simple heating.

In an ever increasingly globalized world the reliance on international organizations to set standards to protect public health seems inevitable. Proposed internationalised standards such as ICNIRP's recommendations act as an aid to economic development by not hindering trade that might conflict with more strict national standards (such as the Russian Federation, the Czech Republic's former

standard and China for example). In the delicate trade-off between economic benefits and adequate health protection international organizations should ideally be “eternally vigilant” to ensure that their tasks are not co-opted by vested interests groups that are the producers of risks to be regulated. This is illustrated by the WHO having to establish guidelines against intrusion by “Big Tobacco” interests. WHO apparently had forgotten that lesson, however, when it came to the WHO’s EMF Task Group which, while writing a new Environmental Health Criteria for power frequency EMFs, allowed power industry representatives to have a significant say in the drafting of the document. In essence the producers of the risk were being allowed to set the parameters of the regulation of their activities.

Both IEMFP and ICNIRP have, from their establishment, insisted that the scientific evidence clearly indicates that the primary adverse effect from RF exposure is from high level exposures that excessively heat and thereby damage biological tissue. The challenge for these organizations is how to address the continuing evidence for other adverse health effects not related to heating as well as the calls for precautionary actions, especially with children and mobile phone use. ICNIRP claims to be open to change if new evidence comes to light, but it has not changed its thermal-only stand after 24 years of existence. IEMFP and ICNIRP may fear that to be seen as having to change their ‘science based’ guidelines would be a blow to their credibility as it would be an admission that they previously had it incorrect and were not an infallible source of expert scientific advice after all. Such an admission would also undermine the credibility of individual ICNIRP members who have spent their professional lives allied to a thermalist approach and have written many published papers in support of that approach. For them it would be extremely unpleasant to admit they were in error after all.

Another factor that acts against any change in the current thermal limitations of the ICNIRP Guidelines is that a primary purpose for some nations to incorporate the ICNIRP Guidelines has been to facilitate the introduction of new wireless technology, or as David Black put it, the aim was the “*stabilization of RF deployment*”. This is seen in the case of Australia (Chapter 5) and the Czech

Republic (this chapter). Any tightening of the limits in light of the possibility of low-level effects not related to heating could make a number of widely deployed wireless technologies out of compliance with tightened standards. This would bring up questions of liability and compensation for affected individuals and industries and then who would be liable? In either case IEMFP/ICNIRP's claims to be able to objectively assess the scientific literature and set adequate human health standard recommendations are compromised because of blatant industry influence in the process contrary to their claims of independence. This exposes their fundamental risk assessment "quality criteria" as being based on considerations other than objective science¹⁵⁴. By refusing to acknowledge human fallibility ICNIRP's authors have ignored a fundamental lesson about the evolution of scientific knowledge.

As Ulrich Beck, the German sociologist, observed, the history of scientific discovery was always less a history of the pure acquisition of knowledge than one of learning from mistakes and practical lapses in scientific objectivity. Scientific 'knowledge', 'explanations', and practical 'suggested solutions' have contradicted each other over time, at different places, in different schools of thought, and cultures. Beck points out that this need not imply any loss in the credibility of scientific rationality claims so long as the sciences can succeed in handling the mistakes, errors and criticism of their methods within science.¹⁵⁵ According to Beck:

If side effects [health hazards] are no longer to be accepted, techno-scientific development must guarantee the ability to learn at every stage, at its pace and through the ways it advances. This presupposes that developments which create irreversible situations will be avoided. What is important, in contrast, is to reveal and work out those variants of techno-scientific development that leave room for mistakes and corrections. Technological research and policy

¹⁵⁴ As stated in the ICNIRP Guidelines, "Development of guidelines on exposure limits requires a critical, in-depth evaluation of the established scientific literature using internationally accepted quality criteria..."

¹⁵⁵ U. Beck, on 'Infallibility or Ability to Learn' in *Risk Society: Towards a New Modernity*, Sage Publications, 1992, p. 159.

must proceed from the 'theory' that has to this point proven most confirmed and most attractive: that of the entrapment of human thought and actions in mistakes and errors. Where technological developments begin to contradict this one certainty . . . they encumber humanity with the unbearable burden of infallibility. As risks multiply, the pressure grows to pass oneself off as infallible and thereby deprive oneself of the ability to learn.¹⁵⁶

On the part of both IEMFP and ICNIRP, a disregard for their own stated principles on independence from industry and following questionable criteria for evaluating science, suggests an agenda to cut off the scientific controversy over EMF human health hazards by less than scientific means. It could be argued that IEEE's openly industry and military dominated standard setting process is at least more honest than WHO / ICNIRP masquerading as independent scientific voices free of vested interest machinations.

If successful, will IEMFP/ ICNIRP's harmonization attempts end the scientific debate in RF standard setting by relegating all opposing science to a pseudo-scientific wilderness? According to ICNIRP Chairman Paolo Vecchia there are a number of benefits in nations accepting the ICNIRP Guidelines, such as increasing public confidence, reducing the debate and fears about EMF/RF, avoiding public confusion and provide public health protection at the same high level, to list a few.¹⁵⁷ As this thesis contends, however, by accepting these guidelines precautionary public health protections are sacrificed for the benefit of a Procrustean conformity defined by industry and military dimensions.

¹⁵⁶ *ibid.* p. 177.

¹⁵⁷ P. Vecchia, 'Electromagnetic Fields and Health: Effects, Perception, Protection', ICNIRP, Montevideo, Uruguay, Mar. 5, 2009, <http://www.msp.gub.uy/andocasociado.aspx?2819,16619>, Accessed April 3, 2009.

Chapter 5

A case Study on ICNIRP Harmonization and the Australian RF exposure standard

“The weight of national and international scientific opinion is that there is no substantiated evidence that exposure to low level RF EME causes adverse health effects.”¹

Overview

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

A driving factor in the various revisions of the Australian RF standard from the 1970s to the 1990s was the introduction of new wireless technological innovations, operating at increasingly higher frequencies. In many cases these new devices operated with emission levels that were close to, or in excess of, the then current Australian RF exposure standard. This led to calls from both government and industry to relax (increase) the RF standard limits in order to assure compliance of new technologies with the RF standard. The fact that the standard was supposed to be health based, while very little research had been carried out on the possible health hazards at these higher frequencies, posed moral and ethical questions for the committee members charged with updating the RF standard. Did the benefits to society from the technology justify the possibility that some members of society may be placed at increased risk? Would public participation enhance the standard setting process? Should the telecommunications industry have inordinate influence in setting standards? As the government was a major share-holder of Telstra, the major Australian telecommunications company, and therefore a major

¹ ARPANSA, Electromagnetic energy and its effects, Fact Sheet, EME Series No. 1, Apr. 2008.

benefactor of the roll-out of new wireless technology, would this bias its judgement on evaluating possible health impacts? Could agency scientists freely give advice without fear of repercussions if that advice ran counter to both government and industry corporate policy? In such a committee, made up of various stake holders with significantly differing views on hazard protection, was a consensus even possible?

To address the setting of RF exposure standards for both the workforce and general public, successive Australian federal governments had long relied on committees created and run under the auspices of the Standards Association of Australia, later re-named Standards Australia. In these committees scientific, industry and other professional experts, as well as community representatives in the later years, addressed the above questions in attempting to reach a consensus for a health based RF standard. During this time the Commonwealth Scientific and Industrial Research Organisation (CSIRO) played an active role in the standard setting process, essentially acting in the public interest and recommending areas that urgently needed research. After the Standards Australia TE/7 Committee failed to reach a consensus and was wound up, the job of drafting the RF standard was taken over by the Australian Radiation Protection And Nuclear Safety Agency (ARPANSA). This Chapter will follow the above questions to determine what has been the impact of this complex interplay of stakeholders and the public participatory interests on the Australian RF standard setting process, and whether the final outcome reflects an unbiased understanding of the scientific literature.

The story of the development of the Australian RF exposure standard is intimately bound up with the involvement of the CSIRO from the very beginning in the late 1970's by Dr. David Hollway, up till October 2003 when CSIRO representative on the ARPANSA RF standard working group, Dr. Stan Barnett, resigned after consultation with CSIRO management because he saw no further benefit to CSIRO continuing its involvement in the RF standard setting process. The long involvement of CSIRO in the RF standard setting process was very much in the mould of the traditional role of government scientific advisers providing objective information to the policy makers, or as the turn of phrase goes, "speaking truth to

power” even when that advice was counter to government policy. As this Chapter examines however, there were many other influences at work, quite unrelated to the scientific literature, which had a major impact in determining the eventual policy on RF exposure that was established by the Australian Radiation Protection & Nuclear safety Agency (ARPANSA) on behalf of the Australian government.

CSIRO and the Standards Association of Australia’s (SAA) Committee 1979 - 1984

Following the original US military standard, a limit of 10,000 uW/cm² (for both public and workers) had been informally adopted in Australia through a series of recommendations passed by the relevant Australian radiation authorities during the years 1955 to 1979. At that time Australia had no official RF exposure standard. It was Dr. David Hollway, from the CSIRO’s National Measurement Laboratories, who was instrumental in having the Standards Association of Australia (SAA) establish in 1979 a committee to draft an Australian RF exposure standard. This committee (renamed the TE/7 Committee in 1984) finally reached an uneasy agreement after seven years of discussions and in 1985 Australia’s first RF standard, AS 2772-1985, was established, which set RF limits for both the general population and in the workplace².

The philosophy of the SAA was that the best people to set standards were those with the relevant technical expertise and managerial experience in handling the technology. Accordingly membership of the RF committee was limited to technical experts from the military services, the electronic communications industry and allied professional bodies, including Hollway from the CSIRO.³ The problems with such a narrow body of expertise on advisory committees were examined by Sheila Jasanoff in *The Fifth Branch*. According to Jasanoff the ‘ideal’ committee member needs to be more than a mere technical expert, but one who can transcend disciplinary boundaries with a breadth of knowledge from several fields, as well as

² A. Doull, C. Curtain, ‘A Case For Reducing Human Exposure Limits Based On Low Level, Non Thermal Biological Effects’, Unpublished, 1994, p. 1.

³ L. Dalton. *Radiation Exposures. The hidden story of the health hazards behind official ‘safety’ standards*, Scribe publications, 1991, p. 37.

understanding the limitations of regulatory science.⁴ Only by a balanced representation in make-up will committee advice to government be widely accepted by most sections of society. Only after the drafting process was well underway were trade unions allowed membership. Community, environment and public health organisations were not invited on the committee⁵. The CSIRO always pushed for community representation on the committee⁶ but it was not until 1998, as a result of CSIRO insistence, that two community representatives (representing the Consumer's Federation of Australia) were finally allowed on the TE/7 standard committee. This was a move that was to prove crucial to the eventual outcome of TE/7 and brought up questions about whether a democratic voting process was possible in RF standard setting.

From the outset Hollway, as the CSIRO's representative on the SAA committee, pushed for a standard that, at least to some measure, gave protection against low-level RF exposures. In the later TE/7 Committee meetings such a position was termed a 'precautionary approach'. Hollway stated at the time:

The proper course to adopt in setting a standard of this kind, where the effects of "low" levels of radiation are largely controversial, is to give first priority to the safety of people⁷

One of the factors in Hollway's stand was his awareness of the divergence in thinking between the U.S. and Russian RF standards. He was also well aware of and supported the stringent RF exposure standard used by the Applied Physics Lab at Johns Hopkins University (Chapter 3). His concern was to establish an Australian Standard that provided a sufficient margin of safety for adequate protection of the Australian general public – and he clearly supported the adoption of exposure limits that took into account non-thermal effects for the general

⁴ Jasanoff S, *The Fifth Branch Science Advisers as Policymakers*, Harvard University Press, 1990, pp. 243 – 245.

⁵ Dalton, 1991.

⁶ Discussion with John Hunter, CSIRO representative on TE/7 at TE/7 meeting, Nov. 1998.

⁷ Doull, Curtain, 1994.

population.⁸ During the seven years of debate in the SAA committee Hollway was outnumbered by the representatives of institutions and industry which were fundamentally opposed to any restrictions and denied or minimised all of the published evidence of harm⁹. Getting agreement was not an easy matter. The thousands of scientific papers in the international literature that were available in the late 1980s were divided on the issues of thermal vs. non-thermal bio-effects and how non-ionizing radiation interact with living systems. Above all, there was disagreement in the SAA committee over what could be considered a “safe” dose.¹⁰ The majority of the members on the SAA committee favoured the U.S. ANSI limit of 5mW/cm², which was based on limiting but not eliminating the heating effect of RF¹¹ whereas Hollway favoured a standard designed on preventing more subtle (non-heating) effects such as those on the nervous and endocrine system which, it was claimed, could lead to chronic health problems¹².

The initial proposal to the SAA committee by Hollway, representing the CSIRO’s stand, was 40 uW/cm² for the general public, and was based on the possibility of non-thermal effects. This was unacceptable to the industry and military representatives and so a 100uW/cm² limit was initially accepted for the public over a 24 hour period. As the work on drafting the standard drew to a close, the Department of Communications pointed out that levels around Broadcast House in Adelaide exceeded the proposed 100 uW/cm². In addition the electronic media representatives then pointed out that they could not meet the 100uW/cm² limit. The allowable ‘safe’ level for public exposure was then increased to 200uW/cm² to accommodate all the requirements of the various SAA committee members.¹³ The final limits set by the SAA committee were 200uW/cm² public exposure for a 24 hour day and an occupational 1000uW/cm² exposure (in the microwave band) for an 8 hour day. Committee chairman Dr. Michael Repacholi took an opposing view

⁸ Correspondence with A. Doull, Apr. 19, 2006.

⁹ *ibid.*

¹⁰ *ibid.*

¹¹ *ibid.*

¹² *ibid.*

¹³ Dalton, 1991, *op. cit.*, p. 41.

to the CSIRO in later statements about the level negotiated in the 1985 standard. To quote:

I was involved in the early attempts to develop an Australian standard. The standard was developed primarily on the international standard at the time and follows the international standard except in one region, called the microwave region. There was so much discontent about this that the level ended up being a negotiated level. It was not based on the science. Everything was based on the science up to that point, but the last part was not based on the science - it was negotiated between the unions and the government at the time.¹⁴

Repacholi's recommendation in the Australian RF safety standard committee during his time as chairman was to use the World Health Organization's review of the scientific literature which he had edited for the WHO. This WHO publication recommended the exposure limits published by the International Non-Ionizing Radiation Committee (INIRC) in 1988¹⁵. The INIRC limit recommendations were later incorporated into the guidelines of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in 1993. A foundation for both INIRC and ICNIRP limits was a 1984 IRPA proposal written by Repacholi that set out that the only health issue to address in standard setting was tissue heating from acute exposure levels.¹⁶ Although Repacholi's position as Chief Scientist at the Royal Adelaide Hospital cast him as an independent advisor on TE/7 and as such, suitable for an impartial Chairman, a conflict of interest was revealed in documentation from a 1990 New Zealand High Court decision, where Repacholi testified as an expert witness on behalf of Broadcast Communications Limited (BCL) contesting a legal challenge from community groups regarding transmitter emissions from the BCL transmitter at Waitatarua. The resident groups withdrew

¹⁴ M. Repacholi, Inquiry into Electromagnetic Radiation, Standing Committee on the Environment, Communications, Information Technology and the Arts, (Australian Senate) May 2001. Testimony of Michael Repacholi, Sect. 4.39, p. 131.

¹⁵ *ibid.*, Sect. 4.52, p. 134.

¹⁶ R. Repacholi, Problems with Regulating Radiofrequency (RF) Radiation Exposure, IRPA 6, May 1984, pp. 1291-1294, http://www2000.irpa.net/irpa6/cdrom/VOL.3/B3_96.PDF, accessed Sept. 4, 2008.

their case when costs started to get out of their budget, and because BCL had reduced exposure levels to a fraction of what they had been. The judge then gave a judgement for BCL's legal costs against the residents' group. As part of BCL documentation filed with the High Court in Wellington, the corporation provided documentation for its expenses which included a \$40,000 NZ payment to Repacholi for his services.¹⁷

Due to the inevitable negotiations and trade-offs that had led to the 1985 standard's 200uW/cm² limit, Hollway was concerned that this level did not provide a sufficiently large safety margin for the general population and urged this to be addressed in future reviews. He also pointed out aspects of the occupational exposure standard that he considered very good (in comparison to the old U.S. ANSI occupational standard of 5000uW/cm²) and which should be adopted in international standards.¹⁸ Hollway's concerns were expressed in his 1985 paper, somewhat aptly titled: "The Australian Safety Standard for RF Radiation – A Curate's Egg".¹⁹

One view is we should 'play safe' by setting low levels now and raise them only if later research shows higher levels to be harmless. This view usually appeals to those who are actually being irradiated in the course of their daily work. The opposed view is that the level of radiation that everyone agrees causes demonstrable harm, should be found as accurately as possible and the permitted level should be set at a not-too-large factor of safety below the danger level. This view has more appeal to those owning and controlling sources of RF radiation. Eloquent claims are made that this is the only scientific method of setting maximum exposure levels because they are then

¹⁷ Correspondence with former TE/7 member Dr. Ivan Beale who assisted the Waiatarua Action group in the High Court Case, November 23, 24, and 25, 2005.

¹⁸ Doull, Curtain, 1994. op. cit., p. 3.

¹⁹ Cu-rate's egg (plural cu-rate's eggs) noun U.K. something with good and bad parts: something that may be described as only partly bad, especially when this makes the whole thing unacceptable. From a cartoon in *Punch* magazine, 1895, in which a curate, when served a bad egg at the bishop's table, assured his host that "parts of it are excellent."

based on proven facts. My view is that far from being scientific this procedure is unintelligent at best and is often disingenuous.²⁰

Perhaps with a bit of foresight Hollway warned that in the future there may be attempts to weaken the 1985 limits and the most likely the way these attempts would be presented.

As the good features listed above are departures from the ANSI standard, there is a danger of there being removed in some future revision on the pretext of compliance with standards in use overseas. The community should be on guard against this. . . Is it over optimistic to hope that instead of taking this retrograde step, the Standards Association, through its representation on international bodies will be able to convince other countries that they should adopt the good features of the Australian standard?²¹

When the final 1985 standard was finalised controversy almost immediately erupted when the Australian Council of Trade Unions (ACTU) withdrew from the committee and refused to endorse the standard, on the grounds that it was not in accord with the most recent research findings on non-thermal effects²²

However the important feature of the 1985 Australian RF standard, even though it was basically a thermal standard, was that it did recognise the possibility that more subtle non-thermal effects could not be entirely discounted. In an unusual step for a Western country, Australia had taken a stand on considering the possibility of non-thermal effects by establishing tougher standard limits than the U.S.²³ To quote from the Foreword of the 1985 Standard:

It has been demonstrated that low-level, long term exposure can induce a variety of effects in the nervous, haematopoietic and immune systems of small

²⁰ D. Hollway, The Australian Safety Standard for RF Radiation – A Curate’s Egg. CSIRO Manuscript, 31st Jan. 1985.

²¹ Hollway, 1985.

²² Dalton, 1991.

²³ Doull, Curtain, 1994, op. cit., p.1.

animals. Such exposure may influence the susceptibility of such animals to other influencing factors. Thermal influences seem inadequate to account for these and other effects.²⁴

The Standards Australia TE/7 Committee: Human Exposure to Electromagnetic Fields, 1984 to 1999.

The Standards Australia TE/7 Committee: Human Exposure to Electromagnetic Fields was established in 1984, taking over in name from the previous SAA committee with essentially the same membership. It became a joint Australian/New Zealand committee in 1992. As Hollway had predicted, attempts to alter the standard limits began soon after the first standard was approved in 1985 and by 1990 the standard had its first revision, though still retaining the 1985 limit restrictions. These years saw an ongoing series of committee meetings where members continued to argue their particular viewpoints over what were acceptable limits for the standard, positions that were virtually unchanged since the very beginnings of the standard setting process in the late 1970's. Changes to the Standard were wanted by the representatives from the telecommunications and broadcasting industries, allied professional bodies, the military and government representatives²⁵. According to CSIRO scientist Alexander Doull, who was one of the CSIRO representatives on TE/7, ever since the 1985 Standard, the pressure from these representatives was to push for much higher levels of exposure (the ICNIRP limits); to completely delete any references to fundamental principles of radiation safety; to minimise any explicit references to harmful effects; and to delete the previous acknowledgment of the existence of non-thermal effects on living organisms. Mr. Doull stated that he believed that the changes in

²⁴ Standards Association of Australia, Foreword: Australian Standard 2772, Maximum Exposure Levels – Radiofrequency Radiation – 300kHz to 300 GHz, 1985.

²⁵ As of August 1998 these consisted of representatives from: the Australasian Radiation Protection Society, Australian Communications Authority, Australian Electrical and Electronic Manufacturers Association, Australian Mobile Telecommunications Association, Australian Radiation Laboratory, Australian Telecommunications Users group, Broadcast Communications Ltd. NZ, the Department of Communications and the Arts (Aust.), Department of Defence (Aust), Institute of Engineers Australia, National Radiation Laboratory NZ, NZ Association of Radio Transmitters, Optus Communications, Telecom NZ, Telstra (Aust.), Wireless Institute of Australia, Electrical Supply Association of Australia, Ministry of Commerce NZ, Institute of Occupational, Environmental Medicine NZ., and the Australasian Faculty of Occupational Medicine.

the official Standard that the industry wanted would have probably have the effect of protecting the industry from future litigation.²⁶

The alternative viewpoint on TE/7 came from eight committee members representing organisations²⁷ which were against any relaxation of the standard due to the possibility of non-thermal effects at levels far lower than ICNIRP 'safe' levels. They questioned various aspects of the scientific validity of the risk assessment of ICNIRP and whether or not the proposed limits provided adequate protection in both the public and occupational settings. What constituted "adequate protection" and what constituted a "precautionary approach" occupied much of the debate.

Essentially the TE/7 committee was charged with conducting an evaluation of the risk assessment of the ICNIRP RF guidelines as it applied to radiofrequency and microwave exposure in order to come up with what was called a "health based" standard. ICNIRP was presented by both government and industry as the preferred "international" standard, which all national governments should adopt in order to "harmonise" standards in a global economy. This was the line specifically pushed by Michael Repacholi while he served as chairman of TE/7 after 1985 and currently through WHO. According to Doull, Repacholi was specifically brought in to overturn the 1985 standard.²⁸ There was very much an impression given during the committee meetings that ICNIRP was 'state-of-the-art' in its approach to assessing the relevant scientific literature and was above reproach.

²⁶ A. Doull, Inquiry into Electromagnetic Radiation, Standing Committee on the Environment, Communications, Information Technology and the Arts, (Australian Senate) May 2001, Testimony of Anthony Doull, Sect. 4.42, p. 132.

²⁷ Commonwealth Science & Industrial Research Organisation; Australian Council of Trade Unions; Adopt Radiation Controls NZ; Consumers' Federation of Australia (two voting members); Communications Electrical Plumbing Union; National Occupational Health & Safety Commission; and Local Government NZ (later to change no vote on the separate NZ standard).

²⁸ Correspondence with A. Doull, Aug.31, 2005.

TE/7 Standard Revisions

From 1984 to its demise in 1999 the TE/7 committee published three interim RF standards, with a separate fourth revision approved by the New Zealand contingent in May of 1999. Standard AS2772.1:1985 reviewed but found inadequate an American National Standards Institute (ANSI) proposal for exposure limits in the frequency range 300 kilohertz (300 kHz) to 100 gigahertz (100 GHz). The SAA committee took a more cautious approach by choosing lower exposure levels for the radiofrequency and microwave emissions; and an averaging time of one minute was adopted for all exposure conditions, regardless of the field strength, rather than the six minute averaging time suggested by ANSI. It also contained reference to the ALARA Principle²⁹ whereby all doses should be kept as low as reasonably achievable, economic and social considerations being taken into account.³⁰

AS 2772.1:1985 also established differing exposure limits for the general public and those occupationally exposed to RF. The rationale behind this was the idea that the occupationally exposed population consists of adults who are exposed under controlled conditions, and who are supposed to be trained to be aware of potential risks and to take appropriate precautions. The duration of occupational exposure was limited to the length of the working day or duty shift per 24 hours, and the duration of the working lifetime.³¹ The general public (the non-occupationally exposed population) was seen to be comprised of individuals of all ages and different health status. It was recognized that the resonant range is different for adults and children affecting the level of RF energy absorption in various body parts. It was recognized that some individuals may be particularly susceptible to radiofrequency radiation. In addition, members of the public are not always aware that exposure takes place and they can be exposed 24 hours per day, and over their entire lifetime. They cannot reasonably be expected to take precautions against

²⁹ As Low As Reasonably Achievable (ALARA).

³⁰ Parliament of Australia, 'Inquiry into Electromagnetic Radiation', Report of the Senate Environment, Communications, Information Technology and the Arts References Committee, May 2001, Sect. 4.34-4.35, pp. 130-131.

³¹ Parliament of Australia, 'Inquiry into...', 2001, op. cit., Sect. 4.36, p. 131.

radiofrequency and particularly burns and shocks. For these reasons lower basic (and derived) exposure levels were adopted for the non-occupational population than for the occupationally exposed population.³² The 1985 Standard had excluded devices which operated below 1 GHz and had a power output of below 7 watts from compliance with the Standard. It was decided that it would be unlikely that these devices could couple enough energy into any size human body such that the average whole body Specific Absorption Rate (SAR) of 0.4 W/kg would be exceeded. In addition, it was not expected that there could be any spatial peak SAR in the human body exceeding 8 W/kg averaged over any one gram of tissue.³³ The limits set out in the 1985 Standard are specified in basic restrictions which affected industries argued were difficult and, in many cases, impractical to measure³⁴

In 1988, the Standard was renamed Australian Standard 2772 - 1985 Radio Frequency Radiation Part 1 - Maximum Exposure Levels - 300 kHz to 300 GHz.³⁵

The 1990 Standard superseded the 1985 standard and introduced changes which included extension of the frequency range down to 100 kHz, and included limits for body-to-ground radiofrequency currents. However, the limits for both occupational and non-occupational maximum exposure remained unchanged.³⁶ There was added a 'deemed to comply' provision for all radio-communications transmitters like mobile phones operating below the frequency of 1 GHz. If the output power of the transmitter was less than 7 watts, the device was automatically deemed to comply with the Standard. Concern was expressed that, because of the proximity of the radiating antenna to the head, mobile phones on the market were exceeding the exposure limits of the Standard for the general public despite being deemed compliant.³⁷

In 1994, Amendment 1 introduced various corrections and changes, in particular, more explicit requirements for exposure limits for users of transmitters, including

³² op. cit., Sect. 4.37, p. 131.

³³ op. cit., Sect. 4.44, p. 132.

³⁴ op. cit., Sect. 4.38, p. 131.

³⁵ op. cit., Sect. 4.45, p. 133.

³⁶ op. cit., Sect. 4.46, p. 133.

³⁷ op. cit., Sect. 4.47, p. 133.

hand-held and mobile transmitters. It also lowered the “deemed to comply” threshold for hand-held digital mobile phones to 0.7 watts and introduced a requirement to label devices.³⁸

Consideration of public submissions to TE/7 in 1995.

As standards are reviewed every five years the proposed draft of AS 2772.1:1990 , (DR 95900) proposed rationalizing exposure levels with international standards, which, if approved, would have seen a significant increase in allowable exposure levels, to harmonize with those of the ICNIRP Guidelines. DR 95900 was advertised for public comment on 15 January 1995 with submissions closing on 15 March 1995. 35 written submissions were received along with a public petition of 80 signatures. An additional three submissions were received from the technical committee TE/7/1 or TE/7 itself, making 38 submissions in all. Of these, one supported a relaxation of the standard and another four did not oppose it. The remaining 33 submissions and public petition expressed strong opposition to the proposed relaxation of the standard. All submissions had been circulated to committee members well before the April 1995 TE/7/1 (technical subcommittee of TE/7) meeting.³⁹

Consideration of the draft, submissions and voting took place on the subcommittee TE/7/1 meeting in Melbourne, held on 20-21 April 1995. The meeting started with a debate over how the committee should proceed with the chairman Michael Repacholi proposing that the technical committee should formally vote on a New Zealand proposed⁴⁰ motion to approve a relaxation of the standard before consideration of the 38 submissions. Voting was then carried out and the motion was carried nine for, seven against with five abstentions. This meant that TE/7/1’s recommendation to the full TE/7 committee was to approve the increased exposure standard before even considering any submissions. After the voting was finalized, a brief examination of each submission was carried out to see if it

³⁸ op. cit., Sect. 4.48, p. 133.

³⁹ R. Matthews, Consideration of Public Submissions on the Draft Australian/New Zealand Standard DR 95900, Report to the New Zealand Local Government Association and Auckland City Council. May 1995.

⁴⁰ Proposed by Trevor Woods, BCL NZ Ltd. and Andrew McEwan, Director NZ National Radiation Laboratory.

identified any new scientific studies not previously known to the committee. If not then the submission was dismissed.⁴¹ This was to be a continuing restriction in TE/7: the existing RF literature was not to be reviewed and only new research not seen previously by the committee would be considered. In a surprising twist TE/7/1's motion was unanimously opposed by the Australian industry representatives and unanimously supported by the New Zealand industry representatives. In fact, Telecom Australia stated at the April meeting that they would stick with the 1990 levels as an in-house standard regardless of the outcome.⁴²

According to Roger Matthews, Representative for Local Government NZ, on TE/7 and TE/7/1, the final position of the technical committee TE/7/1 on RF standard setting was as follows:

- New Zealand/Australian Standards should be rationalised with international ones, almost at all costs; Standard setting and public policy development are different and separate processes; The Standard is a scientific document that should reflect proven data only; Submissions are only relevant when they identify factual, grammatical or spelling errors and new scientific studies unknown to the committee; As Standards are based on science, Government policy is not a relevant consideration; Public concerns are largely uninformed and irrelevant to the process.⁴³
- The Waitakere City Council submission was dismissed as the majority of the committee was of the opinion that the draft standard was a science based standard and not a consensus document, therefore the submission was dismissed on the grounds that it contributed no new scientific data.⁴⁴

⁴¹ Matthews, 1995.

⁴² *ibid.*

⁴³ R. Matthews, Letter to Walter Secord, Sutherland Shire Council, Sydney from Roger Mathews, May 8, 1995

⁴⁴ *ibid.*

- The submission of the Hutt City Council was dismissed on the basis that a precautionary approach should be put into perspective with other hazards, such as cars on the road.⁴⁵
- The submission from the professor of Physics, Monash University, Victoria, and three of his academic staff was dismissed because it did not contribute anything new and they claimed it showed a poor understanding of the science.⁴⁶

The majority of nine were of the firm opinion that standards should be based purely on scientific data, therefore a public policy approach (precautionary approach) had no place in the process. Dr. McEwan from the New Zealand National Radiation Laboratory (NRL) stated at the time that:

The nature of making a standard is that it's based on good science. Whether people feel comfortable with it or not is irrelevant.⁴⁷

Though the small majority of the technical committee were able to push forward its recommendations 9 to 7, those seven who voted against the recommendations were of the opinion that the relaxation was unjustified at that time and that all environmental standards should include a precautionary approach.⁴⁸

The full TE/7 committee, when considering the above recommendations from its technical committee, was unable to reach agreement on the draft's proposal to increase allowable exposure limits. The draft was therefore released as an Interim Standard, AS/NZS 2772.1:1998, while being further considered in a later round of meetings, starting in 1998.⁴⁹

The Interim Standard was based on the International Radiation Protection Association (IRPA) Specific Absorption Rate (SAR) Guidelines, but covered an extended frequency range down to 3 kilohertz (kHz). The basic limits (whole body average SARs) between the Interim Standard and its predecessor standards did not

⁴⁵ *ibid.*

⁴⁶ *ibid.*

⁴⁷ *ibid.*

⁴⁸ *ibid.*

⁴⁹ Parliament of Australia, 'Inquiry into...', 2001, *op. cit.*, Sect. 4.49, p. 133.

change - occupational exposure limits to radiofrequency fields were based on the 0.4 W/kg level and the non-occupational exposure limit of 0.08 W/kg were derived from values one-fifth (or less) those of the occupational limit.⁵⁰ However, there were changes in the derived exposure levels in the frequency range around 1 megahertz (1 MHz) to bring the Interim Standard into line with the recommendations of ICNIRP. On the other hand, the derived exposure levels in relation to frequencies between 400 MHz and 2 GHz were set lower than other International Standards, in accordance with the precedent set in the 1985 Standard. Evidence suggested that the IRPA/ICNIRP methodology would lead to progressively rising derived levels and thereafter to a level which is constant with frequency between 400 MHz and 2 GHz. The TE/7 Committee did not support this approach.⁵¹

The Interim Standard was criticized by those members concerned with the public interest because the limits were to be relaxed, and the peak exposures diluted by the use of the six minute averaging time rather than the 1 minute averaging time in the 1985 standard. The non-uniform exposure levels were also criticized.⁵² Faced with opposition to increased exposures AS/NZS 2772.1(Int):1998 introduced different “deemed to comply” provisions for handheld and portable transmitters. The new provisions were based not only on output power, but also on the transmitter’s duty cycle and the body-antenna separation distance. The result of the new provisions is that mobile phone handsets need testing to demonstrate compliance with the Standard.⁵³

The AS/NZ S2772: 1998 Interim standard departed significantly from AS 2772.1: 1990 in that it introduced significant changes to the exposure limits, similar to the older DR 95900, which brought it more into line with the limits set by ICNIRP. (For instance at the mobile phone frequency range of 800-900 MHz the increase was from the old 200uW/cm² maximum to 450 uW/cm²). It was this increase in the public exposure levels that was opposed by the CSIRO and other organizations on

⁵⁰ Parliament of Australia, ‘Inquiry into...’, 2001, op. cit., Sect. 4.50, p. 134.

⁵¹ op. cit., Sect. 4.51, p. 134.

⁵² op. cit., Sect. 4.53, p. 134.

⁵³ op. cit., Sect. 4.65, p. 137.

TE/7. According to the CSIRO, it was because of this opposition that the Standard was published as an Interim Standard, which was due to expire in March 1999.⁵⁴ The interim standard was extended but the failure by TE/7 to approve the interim standard and public disquiet resulted in the interim standard being withdrawn with effect from 1 May 1999.⁵⁵ Public concerns over the Interim Standard were reflected a statement from the May 2001 Senate “Inquiry into Electromagnetic Radiation” where the committee acknowledged that the Interim Standard limits “represent a weakening of protection for both occupational and public exposure”.⁵⁶

At the very beginning of the last series of TE/7 meetings to consider the Interim standard in March of 1998, the committee chairman, Mr. Ian Hutchings (Ministry of Commerce NZ) proposed by a show of hands how many of the members were in favour of incorporating the ICNIRP Guidelines into the interim standard. It was taken that if there was a clear 80% in favour approving the interim standard it would be a quick process. However, the show of hands resulted 20 in favour, 6 against and 2 open to the possibility with qualifications. This presented those in favour of incorporating ICNIRP with the possibility of having the required 80% to approve the standard, provided they gained the votes of the two representatives from the Consumer’s Federation of Australia (CFA), of whom I was one⁵⁷. An extra bonus was that both representatives were representing the public interests and were known as community activists. If they gave their approval that would have done much to deflate community concerns and protests. Both CFA representatives were concerned over the high level of uncertainty that existed in the RF literature base in relation to safety from prolonged, low level (non-thermal) RF exposures. This understanding was reinforced by their reading of the January 1994 report by CSIRO scientists A. Doull and C. Curtain, “A Case for Reducing Human Exposure Limits Based on Low Level, Non Thermal, Biological Effects”, the June 1994 CSIRO report by Stan Barnett, “Status of Research on Biological Effects and Safety of Electromagnetic Radiation: Telecommunications Frequencies” and *Radiation Exposures* by retired CSIRO scientist Les Dalton.

⁵⁴ op. cit., Sect. 4.90, p. 142.

⁵⁵ op. cit., Sect. 4.29, p. 129.

⁵⁶ op. cit., Sect. 4.5, p. 124.

⁵⁷ The other CFA representative was John Lincoln.

A precautionary approach becomes centre stage

It was the opinion of the two CFA representatives that most likely the ICNIRP limits would eventually be approved, due to the overwhelming representation on the committee by industry and others pushing for ICNIRP. Therefore, their main aim was to introduce into the discussion a suitable precautionary approach and not an outright rejection of the Interim standard. The CFA community representatives both considered that a suitable trade-off was wording in the standard that stated the standard only gave protection from RF thermal effects and did not address the issue of possible low-level, long term exposures, namely that the standard was not the final word and liable to change as the science progressed. This concept was termed taking a “precautionary approach” and this concept was the main, non-technical issue that thereafter took up most of the discussions within TE/7. This proposed precautionary approach was distinct from the term “prudent avoidance” that was originally proposed for power frequency standard setting by the U.S. Congressional Office of Technology Assessment in 1989⁵⁸. While prudent avoidance looks for ways to reduce unnecessary exposure relative to cost involved, the proposed precautionary approach in TE/7 was restricted to acknowledging the limitations of the standard.

However the idea of the community representatives ‘doing a deal’ with industry was a surprise and concern to some of the other members who were openly opposing the interim standard altogether, notably CSIRO’s John Hunter and an outside observer from the Australian Democrats. Soon word was out in the community that their community representatives were ‘selling out’ to the industry for precautionary principles that may not be of sufficient practical utility to be worth trading against a more lenient standard.⁵⁹

⁵⁸ I. Nair, M.G. Morgan, H. K. Florig, ‘Biological Effects of Power Frequency Electric and Magnetic Fields’, Office of Technology Assessment, 1989.

⁵⁹ D. Mercer, ‘From Prudent Avoidance to Bureaucratic Avoidance: lessons from the recent RF standard setting process in Australia’, Paper delivered to the Gothenburg conference on Mobile Telephones and Health, Sweden, 16-17 Sept, 1999.

A 'precautionary approach' statement, as originally proposed by the CFA representatives and re-stated at all subsequent meetings in 1998-1999 was as follows:

This Standard [Guideline] provides guidance on human exposure to radiofrequency and microwave (RF/MW) energy and sets limits intended to avoid acute and obvious detrimental effects on health from high level (thermal) exposures. It does not cover the possible chronic or long-term effects of low-level prolonged exposures (non thermal) which are outside the scope of this Guideline. Following this line of thinking, the thermal nature of the Guidelines should be also mentioned in the title of the document, referring to "Maximum Acute Exposure Levels."⁶⁰

The two CFA reps considered that such an admission was the best that could realistically be expected and were willing to give an affirmative vote - provided the spirit of the above statement was included in the final version presented for voting. The position of the CFA representatives remained unchanged and at the meeting in November 1998 they were still willing to consider voting for incorporating the ICNIRP Guidelines into the Australian standard, provided a suitable precautionary approach was clearly stated in the standard.⁶¹ A precautionary approach statement that had been included in the draft sent out for public comment did acquiesce to some of the CFA's requests, as follows:

There is currently a level of concern about RF exposure, which is not fully alleviated by existing scientific data. It is acknowledged that data regarding biological effects, at levels below those determined in this Standard, are

⁶⁰ D. Maisch, Discussion Paper: The case for a strong Precautionary Approach, and statement of intent, which takes into account possible non thermal effects, to be included in the Australian Standard, Submission to Standards Australia Committee TE/7: Human Exposure to Electromagnetic Fields. Oct. 20, 1998. Presented at the Wellington New Zealand Meeting, Nov. 4-5, 1998. Online at: ,

<http://www.emfacts.com/papers/submissions.html>

⁶¹ *ibid.*

incomplete. As these data are neither clear nor consistent, these have not been used in setting the levels for basic restrictions in this Standard.⁶²

However after the 18-19 February 1999 meeting, where the public submissions were discussed it became apparent that those members wanting ICNIRP Guidelines had hardened their views and the wording of a precautionary approach that had been included in the draft sent out for public comment (above) had been changed to state:

While the basic restrictions in this Standard shall not be exceeded, the manufacturer/supplier, installer, employer/service provider and user must be able to demonstrate that exposure to workers and the general public is being kept to the lowest level that can be achieved, consistent with best contemporary practices and the cost effective achievement of service objectives. This is consistent with taking a precautionary approach. This precautionary approach involves application of best contemporary practice in achieving service, or process requirements to minimize incidental RF exposure.⁶³

In the final statement, any mention of uncertainties, limitations of the standard limits or incomplete data bases were removed and it was considered by those wanting to approve the Interim draft standard that this was an acceptable compromise to the CFA's original "precautionary approach". It was expected that the CFA should accept the new wording as it was the best they would get. However, in describing the final precautionary approach in the draft standard, Dan Dwyer of the Communications, Electrical and Plumbing Union (CEPU) described it as little more than a "feel good dose of prudent avoidance" and I, representing CFA, described it as a "homeopathic dose of avoidance".⁶⁴ The CFA representatives did not consider that the final statement in any way contained the spirit of their original position and therefore they could not justify either to their organization, or the Australian community, an affirmative vote.

⁶² Standards Australia, Draft Standard 98627 – Maximum exposure Levels – 3KHz to 300 GHz, Foreword.

⁶³ *ibid.*

⁶⁴ Mercer, 1999.

By the conclusion of TE/7 however, it was apparent to the dissenting voters that even though Standards Australia had opened up the process to include community representatives no effective dialogue was possible. The members wanting an ICNIRP based standard were unwilling to compromise for a precautionary approach that expressed any uncertainty about the science on the grounds that it was counter to ICNIRP standards.

Is a precautionary approach incompatible with standards?

Members on the committee wanting an affirmative vote saw the dissenters, particularly the CFA reps, as not being willing to compromise to reach a consensus so that the standard could be approved. This was a viewpoint given by Roger Lyle from Standards Australia and David Black at the May 2001 Senate Inquiry when asked how they accounted for the failure of the TE/7 Committee. Lyle said:

Consensus building means coming up with compromises. After the third meeting of the committee, my view was that there probably would be an outcome. But a few weeks later when the postal ballot was held it was fairly obvious that various members [CFA] on the committee had hardened their views, for whatever reason... We asked people when they vote in the negative to actually provide the reasons for that in order to help the committee try to work through compromises to be able to reach a consensus. It was fairly obvious that people just were not finding those compromises.⁶⁵

TE/7 committee member Dr. David Black made the observation at the Inquiry that, in his opinion, democracy does not work in scientific consensus building. Black stated:

In my opinion the support from Standards Australia during this time was particularly good, and the committee worked well. The limiting factor was the fundamentally flawed idea that a scientifically based document could be

⁶⁵ Parliament of Australia, 'Inquiry into...', 2001, op. cit., Sect. 4.102, p. 147.

produced by a democratic process of requiring virtual consensus from a group which deliberately included people with inevitably dissenting views.⁶⁶

Vitas Anderson, representing Telstra Research Laboratories, made an important point in his submission to TE/7 that if a precautionary approach was included in the draft it would be in breach of Standards Australia's Standardization Guide, which states:

A Standards committee is required to ensure that an Australian, New Zealand or Joint Australian/New Zealand Standard does not act as a barrier to innovative development, or otherwise unreasonably or unlawfully restrain competition or trade.

Anderson argued that the precautionary approach conflicts with the above requirement, as it would place unreasonable requirements on industry, suppliers, and users that are not required overseas. In addition, changes to the basic restrictions would stifle "innovative development". Other areas where Anderson saw the precautionary approach being in conflict with the rules laid out in the Standard Guide is that while the Guide stresses the need to avoid ambiguity and conflict with legislative requirements, Anderson said "the precautionary approach is not clear and precise, and is inherently ambiguous". Anderson quoted from the Guide that "Standards Australia and Standards New Zealand have a firm policy of adoption, wherever possible, of international Standards prepared by ISO and IEC as Australian, New Zealand or joint Standards". This, Anderson argued, gave support to adopting the international 1998 ICNIRP Guidelines.⁶⁷

If we take Anderson's comments as valid, and verified by what is written in the Standards Australia Standardization guide itself, then it was inevitable that insistence on a precautionary approach to be incorporated in the RF standard was doomed to fail. Even though the Australian/New Zealand RF standard and the

⁶⁶ *op. cit.*, Sect. 4.103, p. 147.

⁶⁷ V. Anderson, Analysis of technical breaches of SA/SNZ Standardization Guidelines in the AS/NZS 2772.1:1990 draft.

ICNIRP Guidelines are promoted as being health based⁶⁸, uncertainties over the assurances of safety that should trigger a precautionary approach cannot be used as a reason to oppose the standard as that would be a hindrance to industry. In essence, the RF risk assessment that TE/7 was charged to perform was cast within an economic and thermalist framework for those members pushing for the incorporation of ICNIRP. In opposition was the minority of TE/7 members who conducted their own risk assessment based on different scientific assumptions incommensurable with economic or thermal considerations.

Essentially the failure of the two TE/7 groups to come to an accommodation mirrored the wider EMF controversy internationally which was examined by Carolyn Miller, Professor of Rhetoric and Technical Communications at the North Carolina State University. In her discussion of the concept of *incommensurability*⁶⁹ specific to the EMF controversy. Miller examined the two sides of the controversy in the overall EMF debate (Thermal only vs. non-thermal bio-effects) and the various defensive strategies employed by those resisting paradigm change such as those of industry and military interests.⁷⁰ These strategies also played a central role in the arguments deployed by TE/7 members supporting the adoption of the ICNIRP limits.

Uncertainty or not?

Throughout the TE/7 process those members wanting to increase exposure levels to those of ICNIRP pictured the guidelines as a body of sure and certain knowledge that was above reproach. This was the sentiment expressed in a submission to TE/7 by the civil engineering firm Montgomery Watson, from New Zealand. Montgomery Watson, submitting on behalf of two of its clients, expressed concern that the inclusion of the precautionary approach undermined the intent

⁶⁸ See ICNIRP Statement, *USE OF THE ICNIRP EMF GUIDELINES*, Mar. 31, 1999. <http://www.icnirp.de/documents/Use.htm>, Accessed Sept. 24, 2007.

⁶⁹ Paul Feyerabend is credited with coining the term “incommensurability” that can be defined as situations where competing scientific frameworks or theories are lacking a common quality on which to make a comparison in order to determine which one is more accurate. This includes the interpretation of scientific observations or paradigms as being inexplicably bound up with underlying theoretical assumptions.

⁷⁰ C. Miller, ‘Novelty and Heresy in the Debate on Nonthermal Effects of Electromagnetic Fields’, in Harris, Randy Allen (ed.) *Rhetoric and Incommensurability*, Parlor Press, 2005, p. 464 - 505.

and purpose of the standard and suggested that the body promulgating the standard had some uncertainty about the effects of the standard that it was setting. They felt that on the basis of current knowledge no such reservations were needed as the standards adopt a very large safety margin against known effects.⁷¹

It would be fair to assume that whatever level of scientific uncertainty that existed in 1999, if any, would have further decreased with ongoing research that had taken place in the intervening 5+ years. However, a 2004 investigation by ICNIRP's peer review Standing Committee on Epidemiology concluded otherwise. The Committee undertook "a comprehensive review of epidemiologic studies about the effects of radiofrequency fields (RFs) on human health in order to summarize the current state of knowledge, explain the methodological issues that are involved, and aid in the planning of future studies."⁷²

The committee concluded from their review that:

Despite the ubiquity of new technologies using RFs, little is known about population exposure from RF sources and even less about the relative importance of different sources. Other cautions are that mobile phone studies to date have been able to address only relatively short lag periods, that almost no data are available on the consequences of childhood exposure and that published data largely concentrate on a small number of outcomes, especially brain tumour and leukemia... Another gap in the research is children. No study population to date has included children, with the exception of studies of people living near radio and TV antennas. Children are increasingly heavy users of mobile phones. They may be particularly susceptible to harmful effects (although there is no evidence of this), and they are likely to accumulate many years of exposure during their lives.⁷³

⁷¹ Montgomery Watson Inc., Standards Australia submission DR 98627 PuCo-057, Feb. 1 1999.

⁷² A. Ahlbon, A. Green, L. Kheifets, D. Savitz, A. Swerdlow, 'Epidemiology of Health Effects of Radiofrequency Exposure', *Environmental Health Perspectives*, vol. 112, no.17, Dec 2004, p. 1741 – 1754.

⁷³ *ibid.*

This conclusion is broadly in agreement with the conclusions of the CSIRO scientists mentioned above, Curtain, Doull, Barnett and Dalton. And indicates that perhaps TE/7's ultimate failing was an unwillingness on the part of industry members to admit to any uncertainty, which would have been the case if the possibility of non-thermal adverse bio-effects were mentioned in a precautionary approach statement. However, such a statement would have brought into question ICNIRP 's claims of being a source of sure and certain of expert knowledge and therefore threatened its hegemony if other nations took note and then pushed for a higher level of protection for their citizens.

With such a situation, where two groups within TE/7 had such irreconcilable differences, and an 80% consensus could not be reached, gridlock was the outcome.

The Shirley School Decision

During the final round of TE/7 meetings in 1998/99 discussions included an examination of a 1998 Environment Court case in Christchurch New Zealand. That case ruled that the ICNIRP Guidelines incorporated a precautionary approach and therefore any extra level (tier) of precaution was unnecessary. This was used in TE/7 by David Black to argue that no extra tier of precaution was therefore needed in the Standard. It was argued, however, in the meetings that Black's assertion was only true for thermal effects but not so for possible non-thermal effects. For clarification, a brief examination of the Shirley School case is hereby given.

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 was 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".⁷⁴ The attendees urged a "precautionary approach on the most vulnerable groups in our society"⁷⁵ 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 is 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.⁷⁶

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.⁷⁷

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

⁷⁴ 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.

⁷⁵ L. Slesin, 'New Zealand Bans Cellular Antennas at Public Schools', *Microwave News*, vol.16, no. 5, Sept/Oct 1996, p. 7.

⁷⁶ *ibid.*

⁷⁷ Correspondence with Ivan Beale, Nov 8, 2004.

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/cm². On the roof of the DSW building exposure levels as high as 52 uW/cm² 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.⁷⁸

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”.⁷⁹

In making his 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

⁷⁸ 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.

⁷⁹ 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.

information as a basis for setting limits on human exposure to these [a-thermal] fields.⁸⁰

It was on these grounds David 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 a CFA member 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 as called for by CFA was specifically meant to cover the possibility of low-level non-thermal effects, similar to what was stated in the foreword of the 1985 standard. However, this did not stop those TE/7 members wanting ICNIRP standards from using the Shirley School Decision to try to deflect member's insistence of a precautionary approach to cover the possibility of these effects.

It was also noted in the CFA submission to TE/ that while the judge 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.⁸¹ For instance Judge Jackson stated that ICNIRP accurately portrayed the general scientific view of the research⁸², a viewpoint very much disputed by the many public and member submissions to TE/7.

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:

⁸⁰ *ibid*, p. 89.

⁸¹ FINAL VOTE submission by Don Maisch, March 3rd 1999. Available at: <http://www.emfacts.com/papers/submissions.html>.

⁸² Jackson, 1998, *op. cit.*, p. 87.

ICNIRP only considers acute effects in its precautionary principle approach. Consideration of long term effects is not possible. Precautionary actions to address public concerns may increase rather than mitigate worries and fears of the public. This constitutes a health detriment and should be prevented as other adverse effects of EMF⁸³

A 'paper tiger' to stifle dissenting voting within TE/7

In the email ballot sent out to all members in March of 1999 was a written requirement that all negative votes must be accompanied with a detailed technical explanation to justify their "no" vote. No such requirement was placed on assenting votes. Standards Australia Roger Corrigan wrote that:

Note: A negative vote MUST be supported by DETAILED TECHNICAL REASONS. These reasons MUST be returned as an ATTACHED FILE to this ballot paper. Editorial matters are not considered relevant grounds for a negative vote.⁸⁴

This was seen by all of dissenting members as an attempt to rule out reasons based on the removal of a precautionary approach in the final draft standard. Voting 'NO' because it was considered that the draft no longer contained a precautionary approach was an 'editorial matter' and therefore invalid. However, the dissenters simply decided to ignore Corrigan's requirement, reasoning that to reject any vote on this pretext would be a public relations misadventure for Standards Australia. It was seen as simply a 'paper tiger' – a desperate attempt to get the required 80% majority to approve the proposed standard. After all votes were registered with Standards Australia for the March 4th ballot, nothing further was said about not fulfilling the technical voting requirement. However this episode did suggest that Standards Australia had departed from its supposed neutrality in chairing

⁸³ 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.

⁸⁴ Mercer, 1999.

committee decisions. A bias to get the draft standard approved was apparent with the attempt to insist on technical reasons for a no vote and to exclude concerns over the precautionary approach as not constituting technical reasons.

Final TE/7 voting

The final ballot on the interim draft standard closed on March 4th, 1999 without Standards Australia's required 80% affirmative vote to approve a standard. As the interim standard was originally scheduled to be withdrawn on March 5th, the TE/7 members agreed to extend its expiry date to 30 April 1999, in order to give time to work out the differences within the committee to reach the required 80 % consensus. During this time the Standards Australia representative on the committee Roger Lyle tried to get at least some of the no voters to change their vote to the affirmative. This was unsuccessful and the interim standard was withdrawn on 30 April. As recounted by a representative from Standards Australia in the May 2001 Senate Inquiry into Electromagnetic Radiation, it was rare for a committee not to reach consensus. He stated that over the previous six or seven years he could not remember a Standards Australia committee not reaching consensus and he called it "a very rare event".⁸⁵

A detailed summary of the 7 submissions from TE/7 committee members who voted against accepting the proposed ICNIRP based RF standard is included in Annex 1 of this thesis. A brief combined summary of the organisational submissions is as follows:

The CSIRO representative John Hunter considered that with the high level of uncertainty a precautionary policy was appropriate by re-instating the levels in the 1985 standard. Local Government New Zealand representative Roger Matthews was concerned that the standard was difficult to verify in the field by local governments, that it emphasised the interests of industry over that of the community, there was no requirement for industry to minimise exposure levels

⁸⁵ Parliament of Australia, 'Inquiry into...', 2001, op. cit., Sect. 4.101, p. 146-147.

and that the final draft ignored submission calls for a precautionary approach. Therefore it was not a balanced document. The Communications, Electrical and Plumbers Union (CEPU) representative Dan Dwyer and the Australian Council of Trade Unions (ACTU) representative Sue Pennicuik considered the standard as nothing more than a ‘cooking standard’ that was written to suit the needs of the industry with any reference to a precautionary approach reduced to just a deceitful “feel good” statement that was aimed at misleading the public. They saw the increased limits as a significant benefit to the mobile phone industry while inconsistent with both a precautionary approach and public safety. They considered the entire process as “fundamentally flawed”. The Australian Consumers Federation representatives, John Lincoln and myself saw the draft standard as one designed to suit the needs of industry at the expense of public health. It was considered as essentially flawed in both omissions and the incorrect interpretation of the scientific literature. Submissions that questioned ICNIRP were ignored and the precautionary approach that was initially agreed upon was totally excluded from the final document for voting. Therefore it was inconsistent with public health standards. We specifically disagreed with claims that the ICNIRP Guidelines contained a precautionary approach specific to non-thermal adverse effects and called for a statement in the Draft Standard Foreword that acknowledged the limitations of the standard. These were ignored by the full TE/7 committee and therefore we could only vote against the proposed standard. The National Occupational Health and Safety Commission (NOHSC) representative Jim Leigh called for the standard discussion to halt the process until the International Agency for Research on Cancer (IARC) completed its evaluation on RF exposures. He saw the draft standard as inadequate for assurances of public safety and was concerned about the conflict of interest whereby the creators of RF involved in standard setting were giving their industry sector legal protection for their activities. He concluded with concerns over the almost arrogant dismissal of the public comments to the committee and the failure to follow a precautionary approach. Adopt Radiation Controls’ (ARC), New Zealand representative Ivan Beale rejected the thermal basis for the draft standard in that it failed to consider recent research that found adverse effects at levels below the standards maximum permissible levels. He noted that he and other members on the committee had

consistently argued for inclusion of this evidence in standard setting and that the standard did not serve the public health protection needs of the community. Beale concluded by supporting the CFA in calling for plain language in the standard to make it clear that the standard limits are not intended to provide protection from other effects not related to heating. As the final draft did not reflect these concerns he could not support it.

Attitudes to public participation

As mentioned previously, the majority of TE/7 government representatives as well as all of the varied industry members firmly supported the ICNIRP Guidelines as the 'gold standard' that accurately reflected the conclusions of the vast body of scientific literature on RF biological effects. As was seen at a Melbourne TE/7 meeting, where the whole day was taken up with submissions, the many public submissions were only briefly mentioned and then dismissed. Even extensive submissions criticising the ICNIRP Guidelines by Dr. Neil Cherry and others received scant attention and were dismissed. This was the same fate that met committee member submissions questioning ICNIRP standards. In comparison, industry technical submissions received extensive discussion – all dealing with technical matters and exact wording in various sections of the draft. At one point Telstra representative Vitas Anderson, when referring to the concerns contained in the public submissions, mentioned the need to “comfort the community”. This was taken to mean the public submissions were based on unfounded fears and not reflecting the weight of expert scientific opinion as expressed by ICNIRP. Therefore Anderson saw the main issue as a need to comfort the community that there was really nothing to worry about.

What was seen in many of the public submissions to TE/7 however was that a large number of submissions had access to detailed scientific information and to a large extent reflected the concerns of dissenting members of TE/7. A common thread in the public submissions was a reliance on the 1994 CSIRO report, other literature from a number of serving and retired CSIRO scientists, Dr Neil Cherry in New Zealand and myself which are briefly described in Appendix 2. These

documents, all specific to Australia and New Zealand, gave the public access to a large amount scientific information from which to draw upon for their submissions to TE/7. The common theme of these documents was a critical examination of the limitations of the Western thermally orientated RF standards, specifically focussing on the ICNIRP Guidelines. Besides these documents, activist groups in Sydney and Adelaide had access to Dr. Ross Adey's research material through him directly and other research material on RF from various library information retrieval systems and the Library of the Sydney County Council (NSW). In addition a number of activist groups had access to the U.S. industry watchdog newsletter *Microwave News*.⁸⁶

A level of scientific expertise of a concerned citizenry based on the above material was demonstrated by the residents of Waterfall, NSW, who were protesting against construction of the mobile base station close to the Waterfall school in 1995. At a community meeting with Telecom officials and scientists, one was overheard to remark to his colleagues "How did these people get to know so much?"⁸⁷ As a result of public pressure Telecom dismantled and removed the base station. The official reason given by Telecom was "the base station was relocated for technical reasons."⁸⁸ At a subsequent meeting chaired by Spectrum Management Agency a representative of SMA remarked that they had no idea that the public were so interested and concerned about the RFR issue until they received an extensive submission from the Sutherland Shire Environment Centre.⁸⁹ In spite of the many detailed public submissions sent into TE/7 during the public submission phase, these submissions received scant attention by industry and government. On one occasion, at an earlier meeting chaired by Michael Repacholi, he actually proposed to vote on the proposed 1998 Interim standard before public submissions were even considered. This met with opposition from several members, especially trade union and CSIRO representatives and was rejected.⁹⁰

⁸⁶ Correspondence with Betty Venables, convenor of the The Electromagnetic Radiation Alliance of Australia (EMRAA) Sutherland Shire Environment Centre, Sutherland, NSW. July 27, 2003.

⁸⁷ *ibid.*

⁸⁸ *ibid.*

⁸⁹ *ibid.*

⁹⁰ Correspondence with TE/7 committee representative Dan Dwyer, Nov. 1998.

Comforting the community

Telstra's TE/7 representative, Vitas Anderson, summed up the industry's viewpoint on the worth of public concerns by mentioning the need to "comfort the community" over their fears of "hypothetical" risks at the March 1999 TE/7 meeting. This author took this to mean that there was a need to give information to the community that would encourage them to stop worrying with irrational fears - according to the industry's viewpoint. Efforts to "comfort the community" later included education campaigns consisting of information sheets, videos and DVD presentations to create a more "scientifically literate" public who then would be more supportive of scientific research programs, be more enthusiastic about technological innovations, as well as being willing consumers of the technology. An example of this sort of viewpoint was given in 2003 by Associate Professor Andrew Wood, from Swinburne University, based in Melbourne, Victoria. Dr. Wood is a consultant to WHO/ICNIRP, a consultant to a number of industry groups including the Electrical Supply Association of Australia (ESAA) and Telstra. At the annual 2003 conference of the Australian Radiation Protection Society (ARPS), Wood gave a Powerpoint presentation that humorously compared the public's concerns over health hazards from EMF (including RF) exposure to a newspaper article about Russian museum worker's fears over a curse supposedly placed on a particular sacred antique icon painting on display in the museum. Apparently some of the workers were stricken with ailments that they blamed on the curse. Wood made a direct comparison with the public's supposedly irrational fears over EMF, possibly causing adverse health effects as well.⁹¹

An example of government attempts to "comfort the community" over the safety of telecommunications was an Australian government /Australian Communications Authority 6 minute video presentation created to inform the public on the science of "Mobile Communications and Health" (since withdrawn). This presentation was initiated by Telstra, supported by the Mobile Carriers Forum, and had "expert and independent" commentary by a representative from

⁹¹ A. Wood. 'Effective Protection against Non-Ionizing Radiation (NIR) or: the Devil's in the Detail', ARPS-28 Conference, Hobart Function and Conference Centre, Oct. 28, 2003.

the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). The presenter in the video was Australian TV broadcaster and journalist Jeff Watson, who is best known for his 1979 TV science production. Watson started off by giving a brief explanation of radiofrequency and microwave radiation which he terms Electromagnetic Energy (EME). To quote:

Putting it in basic terms, EME stands for Electro-Magnetic Energy ...A fact of everyday life...Almost everything in our homes emits electro magnetic fields to some degree... So if it's natural energy... and already in our everyday life, why do so many see it as harmful?⁹²

Watson then introduced the ARPANSA representative who stated:

The EME safety limits provides protection for people of all ages and health conditions whether they're exposed to EME irregularly, or for 24 hours a day, 7 days a week.⁹³

This statement was contradicted by ICNIRP Chairman Paolo Vecchia in 2004 at a international cell phone conference in Moscow, while speaking about the ICNIRP Guidelines, that "Consideration of long-term effects [is] not possible."⁹⁴

During the TE/7 meetings and in the public submissions it was pointed out that the "EME safety limits" the ARPANSA representative referred to (the ICNIRP limits), were in fact only addressing acute-short-term exposures as they are largely based on lab studies of animals following acute exposure to relatively high levels of RF/MW. ICNIRP itself has admitted that because of this, very few studies used as the foundation of the limits are relevant to the evaluation of RF exposure on the development of cancer in humans.⁹⁵ Thus, it was disingenuous that a

⁹² ARPANSA/ ACA, etc., *Mobile Communications and Health*, produced by the Australian government /Aust. Communications Authority, initiated by Telstra, supported by the Mobile Carriers Forum with commentary from the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), Dec. 2004.

⁹³ *ibid.*

⁹⁴ Maisch, 2005.

⁹⁵ ICNIRP. 1996, 'Health Issues Related to the use of Hand Held Radiotelephones and Base Stations', *Health Physics*, vol. 70, no. 4, Apr. p. 3.

representative from ARPANSA claimed that the EME safety limits provided protection to everyone over extended amounts of time when that is plainly not what the limits were designed to do.

According to the ARPANSA representative, “[t]he EME safety limits are well below the thresholds where health effects [thermal only] have been shown to occur” He said that EME radiations "are only known to heat...we can feel more relaxed over the issue of radiation." He then made a comparison to an electric heater. When asked if there are any long-term health effects (such as cancer) he simply stated that "the evidence is saying that there isn't really a problem".

The presentation then quoted from the ARPANSA website that “The weight of national and international scientific opinion is that there is no substantiated evidence that RF emissions associated with living near a mobile phone base station or telecommunications tower poses a health risk”.⁹⁶ Also quoted is a WHO statement, “Despite extensive research to date there is no evidence to conclude that exposure to low level electromagnetic fields is harmful to human health.”⁹⁷ These are the same arguments heard in TE/7 back in the late 1990's and they failed to comfort the concerned community, as seen in the many public submissions to TE/7. In addition, simply deferring to international scientific opinion as the final say in the matter was rejected by a number of TE/7 committee members, including the CSIRO (See Appendix 1).

The dismissive attitude over public health concerns on part of ARPANSA, the Australian Communications Authority (ACA) and industry from TE/7 up to the present day, as illustrated in the December 2004 video presentation mentioned above, can be understood in the context of these agencies following a deficit model of public understanding of science.⁹⁸ In this model, the agencies see a deficit in

⁹⁶ ARPANSA, Fact Sheet, EME Series no.9, ‘What about base stations and telecommunications towers - are there any health effects?’, 2007, <http://www.arpansa.gov.au/pubs/eme/fact9.pdf> , Accessed Sept. 12, 2007.

⁹⁷ WHO summary of Health Effects, <http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html> , Accessed Sept. 12, 2007.

⁹⁸ For a concise analysis of the concept see: P. Sturgis, and N. Allum, ‘Science in society: re-evaluating the deficit model of public attitudes’, *Public Understanding of Science*, vol.13, 2004, pp. 55-74.

public scientific understanding or knowledge that has led to an unjustified scepticism toward technological/scientific progress. Lacking a proper understanding of the scientific facts, the public are prone to fall back on irrational, and even paranoid fears of the new and unknown.⁹⁹ In the context of TE/7, the concerned public and by default, members of TE/7 who were against adopting ICNIRP limits were considered to be deficient in their understanding of the scientific literature and reasoning embodied within the ICNIRP Guidelines. In contrast, the ICNIRP standard was considered sufficient to assure safety – an ‘unprobabilistic body of sure and certain knowledge’ that was above reproach. The very questioning of ICNIRP science was therefore an admission of ignorance according to the deficit model. The deficit model of public understanding of science dovetails in well with the “revisionist” technocratic model of risk assessment as promulgated by John D. Graham at a WHO EMF Risk Perception and Communication Seminar in 1998. Graham saw the public’s general reaction to health, safety, and environmental dangers as best described as “a syndrome of paranoia and neglect”. Graham saw the public as paranoid in the sense that they devote large amounts of resources and attention to alleged dangers that are speculative at best and probably small or non-existent.¹⁰⁰ The fact that this was from Graham’s Keynote presentation at a seminar on EMF perception clearly puts public concerns over possible health hazards from EMF’s squarely into that syndrome. (See Chapter 1, for a further discussion of Graham’s views, as well as a description of the revisionist philosophy by Adam Finkel.

⁹⁹ *ibid*, p. 57.

¹⁰⁰ J. Graham, ‘Making Sense of Risk: An agenda for Congress’, EMF Risk Perception and Communication, Proceedings of the International Seminar on EMF Risk Perception and Communication, WHO, Ottawa, Ontario, Canada, Aug. 3–Sep. 1, 1998, Repacholi MH, Muc A (eds), pp. 1 – 31.

Public trust in the experts

Such a dismissive, condescending attitude towards the public submissions to TE/7, coming from both industry and government regulatory agencies, did little to engender trust amongst the public. Add the conflicting views on the experts' science (CSIRO vs. ICNIRP) and the regulator's exemptions from community planning laws enjoyed by the telecommunications industry, there is the likelihood that the concerned public can lose trust in the regulator's determinations of acceptable risks for the community. In this case the concerned public have no recourse but to do their own informal risk assessment based on their own experience – including their negative experience dealing with the experts and telecommunications carriers. Such a risk assessment, though it may contain many subjective elements, should not be ignored as it reflects valid concerns of those who are being exposed, not just the views coming from those who, directly or indirectly, are responsible for the exposures. Such an informal risk assessment may include vastly different definitions of acceptable and unacceptable risks than those of industry. For example: Risks perceived by the public as the possibility of adverse health effects from technology, versus an industry that considers their primary risk (to the speedy rollout of new technology) as being interference from the concerned public.

Besides the issue of health risks that may be associated with RF exposures, the industry and government, by their tendency to label community concerns as public irrationality, are imposing another level of unacceptable risk on the public - psychological stress. There is abundant research showing the creation of psychological stress in people who are chronically exposed to uncertain environmental risks.¹⁰¹ ¹⁰² In other words, events impacting on people can contribute significantly to the development of physical or psychological disorders. Well-established stress reactions include changes in blood and urine chemistry, changes in cardiovascular reactivity, muscle potential, skin conductance and sleep

¹⁰¹ P. Martin, *The Sickening Mind: Brain, Behaviour, Immunity & Disease*, (Mind and Immunity) Flamingo Press (Harper Collins) 1998, pp. 81-105.

¹⁰² I. Beale, 'The Effects of Electromagnetic Fields on Mental and Physical Health', *Journal of Child and Family Studies*, vol. 6. no. 3, 1997, pp. 273-288.

patterns. Environmental stressors on the immune system can make the victim less resistant to infectious diseases. Stress reactions also include psychological symptoms such as depression and anxiety.¹⁰³ These psychological risks which can be directly associated with the siting of a particular technology, say a mobile phone base station tower next to a school or residential community, are not a consideration in expert risk assessments of the 'impact' of that particular technology. For example, in Australia the only 'impacts' on the community that are considered in siting base stations are 'visual impacts', ignoring the possibility of adverse psychological impacts on nearby residents by the imposition of the facility with the community given no say on where the facility was to be placed.

Daniel Westall from ARPANSA admitted at a conference in September 2001 that the regulators are suffering a loss of prestige and respect in the community. Westall said:

We have seen the community lose faith in regulators. It seems to some that society is the problem: 'people don't understand' or "they don't trust us'. In fact society could provide the solution, if we change our expectations of being understood and trusted, and respond to community expectations.¹⁰⁴

Westall went on to report on the outcomes of an Organization for Economic Co-operation and Development (OECD) Nuclear Energy Agency workshop in Switzerland in 2001. At this meeting leaders of the radiation protection and regulation community discussed the involvement of the community in regulatory decision making. Westall reported that "it was clear that interaction, not information, is needed, and that the community should be a part of the decision making process. The extent of this type of consultation and its form may vary, but in all cases it must be genuine."¹⁰⁵ Westall's viewpoint is in agreement with a 2008 report by The U.S. National Academy of Sciences, National Research Council (NAS/NRC) that public involvement in environmental decision-making is more

¹⁰³ *ibid.*

¹⁰⁴ D. Westall, Will Radiation Regulation Matter in the 21st Century?, Australian Radiation Protection Society (ARPS 26), Surfers Paradise, 17-21 Sept. 2001.

¹⁰⁵ *ibid.*

likely to improve than undermine the quality of agency decisions. The report found that even though scientists may be in the best position to make technological based decisions, public values and concerns are important to frame the scientific questions asked and ensure that decisions address all of the issues relevant to those affected. The report goes on to say that when there were cases of public involvement making matters worse, it is usually when participatory processes were set up to divert the public's energy away from criticism and into activities that were considered safe by an agency. The report concludes, in part, that the improper use of public participation to avoid conflicts on important issues is counterproductive in the long run.¹⁰⁶

Beyond TE/7: ARPANSA's Radiation Health Committee incorporates an ICNIRP based RF Standard for Australia.

TE/7's failure to approve the 1998 Interim standard left the Australian Government with a major dilemma, just at a time when they planned to sell further parts of the electromagnetic spectrum in the higher microwave range for new wireless technology.

Under the old 1990 standard exposure limits, much of the new high frequency communications systems, operating in the Gigahertz range (GHz), would have been in violation of the old limits. For both the Federal Government and Standards Australia, to be seen in the public eye as allowing technology to be sold in Australia that had emissions in excess of the "health based" standard was clearly unacceptable. The communications industry had a similar problem to be seen selling "unsafe" products would have clearly been unacceptable from a marketing perspective. To solve the government and industry's dilemma, the issue was passed over to the Australian Communications Authority that gave the job of incorporating the ICNIRP Guidelines into a Standard to the newly created Australian Radiation Protection And Nuclear Safety Agency (ARPANSA).

¹⁰⁶ T. Dietz, P. Stern, (eds.), Panel on Public Participation in Environmental Assessment and Decision Making, National Research Council, *Public Participation in Environmental Assessment and Decision-making*, National Academies Press, Aug. 22, 2008.
<http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=12434> , Accessed Sept. 15, 2008.

ARPANSA then gave the job to its Radiation Health Committee which then commissioned a working group committee to prepare a draft Standard. The working group had no voting rights but could only refer its recommendations on to the Radiation Health Committee and its chair, Colin Roy, would make the final determination.¹⁰⁷ When ARPANSA's Radiation Health Committee convened the new working group to carry on with the work of the now defunct TE/7 Committee, the CSIRO was asked to nominate an expert member. CSIRO management then selected Dr. Stan Barnett, from the Telecommunications and Industrial Physics (TIP) division, to attend the first two-day meeting. After discussion with CSIRO TIP management, Barnett tendered his resignation from the new committee. His reason was that:

[The] purpose of the new committee (although it had the same faces¹⁰⁸ as TE/7 but with a new chair) seemed to be way to push through a Standard that had failed to reach consensus under Standards Australia processes. I did not see how this could be achieved by the same group of people without a considerable amount of energy being spent on non-scientific issues. My concern was that there was no benefit to CSIRO in continuing its involvement. . . There was a very high risk that the exercise would be more of a public relations activity than a genuine attempt to pay attention and properly deal with the issues of "non-thermal bioeffects" and the "Precautionary Principle". I held some concerns about the process that was proposed. There was a clear reluctance to answer questions about the definition of "consensus". This was to be an agreed standard and the CEO of ARPANSA seemed to hold sway over whatever was accepted or rejected. Furthermore, this committee was to report to another committee which reported to the CEO. The Chair of this higher committee objected strenuously when questioned about the process. The CEO retained the authority to decide if any dissent by committee members need be considered." ¹⁰⁹

¹⁰⁷ Correspondence with ARPANSA working group member John Lincoln, Oct. 20, 2004.

¹⁰⁸ Virtually all of the faces that had voted in favour of the ICNIRP limits in TE/7 but with only a few members that had voted no. Thus ensuring the final vote would be overwhelmingly in favour of ICNIRP.

¹⁰⁹ Correspondence with Stan Barnett, Snr. Principal Research Scientist, CSIRO, 10 Oct., 2003.

Shortly after Stan Barnett resigned from the working group he was followed by David McKenna, representing the Community and Public Sector Union (CPSU), for reasons not stated.¹¹⁰

Out of the 8 members making up the working group, only two were against incorporating the ICNIRP Guidelines in the Australian RF standard. These were John Lincoln, representing the Electro Magnetic Radiation Alliance of Australia, and Dan Dwyer, representing the Telecommunications Officers Association. In addition to the 8 on the working group, there were 2 consultants, 2 on the Secretariat and 7 Observers, who sat in at the meetings; all of these people were firmly in favour of an ICNIRP based standard.¹¹¹ The final recommendation of the working group to the Radiation Health Committee was in favour of the proposed ICNIRP based RF Standard. Having no input from the public, other than the token representation of only one community representative on its non-voting working group, ARPANSA's RHC was able to simply ignore the many scientific and public submissions to the previous TE/7 Committee. Using virtually dictatorial powers the CEO of the Health Research Council (HRC) and ARPANSA was able to push through a Standard in a manner that Hollway warned about 19 years earlier. ARPANSA's Radiation Health Committee published its ICNIRP based RF Standard on 7 May 2002, titled: "Radiation Protection Standard – Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz".¹¹²

Democracy excluded from the RHC decision making process

As mentioned previously, Dr. David Black stated to the Senate Inquiry in May 2001 that he saw that democracy does not work in scientific consensus building. Black said, to quote:

¹¹⁰ Parliament of Australia, 'Inquiry into...', 2001, op. cit., Sect. 4.106, Table 4.4.

¹¹¹ Correspondence with working group member John Lincoln, representing the Electro Magnetic Radiation Alliance of Australia (EMRAA), Oct. 24, 2004.

¹¹² ARPANSA, Fact Sheet, EME Series no.4, 'The ARPANSA radiofrequency radiation exposure Standard', <http://www.arpansa.gov.au/pubs/eme/fact4.pdf>, Accessed Sept 24, 2007.

The limiting factor was the fundamentally flawed idea that a scientifically based document could be produced by a democratic process of requiring virtual consensus from a group which deliberately included people with inevitably dissenting views.¹¹³

From Black's comments, it would be fair to assume that those on TE/7 who had pushed for many years for ICNIRP standards, considered that the only way to get a satisfactory outcome was to exclude from future committees those who had a dissenting view - or only allow a small minority, with no power to influence the desired outcome. This would be not far from the viewpoint of the original 1978 SAA committee that the best people to set standards were those with the relevant technical expertise and managerial experience in handling the technology. This was essentially reinstated within ARPANSA after TE/7 concluded. Even though the ARPANSA working group would have contained four out of the ten members who were against an ICNIRP based standard (if Barnett and McKenna had not resigned), the working group had no voting rights, only an advisory role, to another higher committee. So any dissent within the advisory group would have had no impact on the final outcome as the CEO and head of the RHC had the absolute final say in the process. ICNIRP standards were a foregone conclusion. It would appear that the lesson learned by ARPANSA as a result of the failure of TE/7 to approve the Interim standard was that public participation was detrimental to their desire to reach a particular decision: ICNIRP standards. This clashes with the view that public participation in agency decision making processes is more likely to improve than undermine the quality of agency decisions and that avoiding public participation to avoid conflicts is counterproductive in the long run.¹¹⁴

Political considerations end CSIRO's involvement with telecommunications

In September 2003 Barnett, from CSIRO's Telecommunications and Industrial Physics Department (TIP), circulated a letter to announce that he had been forced

¹¹³ Parliament of Australia, 'Inquiry into...', 2001, op. cit., Sect. 4.103, p. 147.

¹¹⁴ Dietz, Stern, (eds.), 2008.

to accept “involuntary redundancy” from CSIRO and that his division had been told by senior management to cease all further research into the bioeffects and safety of ultrasound and non-ionizing radiation (RF). Barnett stated in his 2003 letter that:

CSIRO has chosen to stop all research into bioeffects and safety of diagnostic ultrasound and cease any involvement in safety of non-ionizing radiation in general. It seems that research for the good of the community is not considered a priority area unless it is politically attractive or able to attract funding from industry. Clearly, that is not the case for safety related research in a taxpayer-funded research organisation.¹¹⁵

This move ended CSIRO’s long involvement in telecommunications research and standard setting which began in 1979 with Hollway’s work establishing the original SAA RF committee. Henceforth, any research into possible health impacts of mobile phones or other health issues related to telecommunications would go through the National Health & Medical Research Council’s (NH&MRC) EME committee that had been established in 1996 by the government for this purpose. Concerned about the potential involvement of the telecommunications industry in this committee, a researcher for the Australian Democrats Senator Lyn Allison, wrote to the NH&MRC in early December 1996 asking about industry representation. On December 30 Richard Morris, Assistant Secretary of the Health Research Branch, replied in writing, stating that members of the telecommunications industry would not be involved. Morris stated that:

In regard to your concern about the involvement of industry in the NH&MRC process, let me assure you that members of the NH&MRC Expert Committee will be active researchers without links to the telecommunications industry. This independence from industry is seen as being of great importance to NH&MRC.¹¹⁶

¹¹⁵ Correspondence with Dr. Stan Barnett, Sept 22, 2003.

¹¹⁶ R. Morris, Letter from Richard Morris, Assistant Secretary, Health Research Branch, NH&MRC, to Sarah Benson, researcher for Senator Lyn Allison, 30 Dec. 1996.

Despite this assurance from the NH&MRC, when it came to appointing a key expert radiation adviser to its EME Expert committee, Dr. Ken Joyner, Motorola's Director of "Global EME Strategy and Regulatory Affairs", was given the position¹¹⁷. Dr. Joyner has also represented an industry group, the Australian Mobile Telecommunications Association (AMTA), on the standards committee¹¹⁸ and has represented the Mobile Manufacturers Forum.¹¹⁹ Such a complete reversal of their former stance that "independence from industry is seen as being of great importance" would likely have come about after pressure from within the government. Joyner had been closely associated with the formulation of government policy on RF exposure. This is seen in the *Bioelectromagnetics Newsletter* of July/August 1998. In his article titled "Australian Government Action on Electromagnetic Energy Public Health Issues" Joyner's affiliation was given as representing the Australian Federal Department of Communications and the Arts¹²⁰.

A direct comparison can be made here between the dismissal of Barnett and the removal of the CSIRO/TIP from the debate with similar contemporary events in the Czech Republic. In the case of the Czech Republic Dr. Jan Musil, chair of the National Reference Laboratory and the National Institute of Public Health's Advisory Board on Non-Ionizing Radiation, was removed and replaced by a person who was in favour of accepting ICNIRP Guidelines.¹²¹ As with Barnett, Musil had opposed the acceptance of ICNIRP Guidelines on similar grounds to that of the CSIRO and had called for the application of precautionary principles.¹²² (See Chapter 4, pages 160-162). In both cases, government advisory agencies were

¹¹⁷ National Committees for Science (Australia), ANNUAL REPORT TO COUNCIL on 2004 Activities, <http://www.ncrs.org.au/annual/2005.pdf>, Accessed Mar. 6, 2007.

¹¹⁸ Standards Australia, Committee TE/7: Human Exposure to Electromagnetic Fields, meeting No. 1/98, Minutes, 12 Aug. 1998.

¹¹⁹ Parliament of Australia, 'Inquiry into...', 2001, op. cit., Sect. 4.68.

¹²⁰ K. Joyner, 'Australian Government Action on Electromagnetic Energy Public Health Issues', *Bioelectromagnetics Society Newsletter*, no. 143, July/Aug. 1998.

¹²¹ L. Slesin, 'Czech Government Now Follows ICNIRP', *Microwave News*, vol. 21, no.1, Jan./Feb. 2001, p. 7.

¹²² L. Slesin, 'Czech Panel on the Precautionary Principle and Numerical Limits', *Microwave News*, vol. 20, no. 3, May/June 2000, p. 14.

giving advice inimical to political and economic interests and in both cases the agencies were silenced for reasons unrelated to science.

Conclusions

Ostensibly the task given to the original SAA committee and later the Standards Australia TE/7 Committee was to conduct a risk assessment on the available peer reviewed scientific literature for RF exposures and then draft a standard specifically for Australia (and New Zealand). However, two distinct and different risk assessments took place and by the time TE/7 was wound up, these proved to be irreconcilable.

On one hand the CSIRO played a central role in critically examining all the available information, including the Russian literature and the more restrictive RF in-house standard set by the Applied Physics Laboratory at Johns Hopkins University. As a result David Hollway from the CSIRO took a more conservative risk assessment approach taking into consideration the possibility of hazards from low-level RF exposures not related to heating. This assessment was scientifically supported by a number of publications by CSIRO and former CSIRO scientists.

Following CSIRO's lead, in the later TE/7 committee, a number of other standard committee members took a similar stance in their various written submissions to the committee. Their shared stand can loosely be termed as calling for a precautionary approach due to the many uncertainties and gaps in the literature. Some opposed the proposal to increase the limits to that of ICNIRP outright, while others indicated that they might support the increase, provided a strong precautionary statement was incorporated into the standard that acknowledged the level of uncertainty that existed in relation to low-level non-thermal exposures.

On the other hand, the opposing assessment supported by the majority of committee members (the telecommunications industry, broadcasters, the military, allied professional bodies, including government representatives from the Australian Radiation Laboratory) was that the assessment promoted by ICNIRP (originally proposed by Repacholi in 1984, see Chapter 4, page 1) was sufficient.

This was that the only health issue to address in standard setting was short-term effects due to the absorption of RF energy of sufficient power to heat up biological tissue. Their shared viewpoint was that the ICNIRP risk assessment was beyond question. This is seen in the TE/7 committee requirement that the only information they would consider in submissions was new scientific information not previously seen by the committee. Re-analyses of pre-existing data, such as referenced by ICNIRP was not to be considered. An example of the unwillingness to re-examine data was seen in a statement by David Black at a 2004 EMF Health Forum held in Hamilton, New Zealand on November 15, 2004. Black, a former TE/7 member and current consulting expert for ICNIRP, was replying to a criticism of another speaker who had incorrectly stated that the 1997 National Cancer Institute Linet study of 638 children with leukaemia was a negative study with no association with the disease and power-frequency EMF exposures. This writer pointed out that the higher exposed children in the Linet study did in fact have a positive association between leukaemia and EMF exposure but that these children had been removed from the analysis and so it was deceptive to claim, without this qualification, that no association was found. Black agreed that there was a positive association at a 3 milliGauss (mG) exposure level but then dismissed it by claiming that one must go with the published statements by the authors / journals for the purposes of standard setting. In this context this would suggest that one must take uncritically published statements used in standard setting regardless of their validity. This was apparently the case in TE/7 with those members wanting to approve ICNIRP Guidelines without qualification.

At the conclusion of TE/7 in 1999 the two opposing risk assessments could not be reconciled and the committee was concluded without approving the proposed ICNIRP based standard. This placed the Australian government in an unviable situation just when it was planning to sell off further parts of the electromagnetic spectrum in the microwave range to accommodate new technology as well as planning on selling more of its shareholdings in Telstra. With the failure of TE/7 to approve the draft ICNIRP based standard there was now no RF standard in force. In addition, the longer the stalemate continued the greater risk that the public would become increasingly concerned about possible health hazards from the

technology. The task of drafting and approving an ICNIRP based standard was then given to a newly created agency, ARPANSA, which convened a Radiation Health Committee (RHC) to finish the task of drafting an ICNIRP based standard for Australia and therefore end the uncertainty.

Thus it is concluded that the long push to increase Australia's former RF exposure standard's limits had little to do with better science but all to do with the 'realpolitik' of pushing through ICNIRP's thermal-effects-only paradigm in order to advance economic interests. This situation belies the claim by ICNIRP chairman Paolo Vecchia that ICNIRP's advice was solely based on established health effects, with no consideration given for economic or social issues.¹²³ The Australian experience was that the push to accept ICNIRP standards was, above all else, an economic imperative. This was borne out by essentially the same debate in the Czech Republic, examined in Chapter 4.

The whole history of SAA, TE/7 and finally ARPANSA's RHC committee is one where CSIRO scientific advice to government was largely ignored in favour of economic considerations in government policymaking. This is compatible with Collingridge and Reeve's observations in their analysis of technical policy in which they concluded that the impact of science advice on rational government policy was negligible. They saw science advice as always being placed in either an "under-critical" or "over-critical" environment and in each situation science loses out.¹²⁴ In the case of RF standard setting and ICNIRP's attempted hegemony over science this is especially the case because both environments apply.

In an "under-critical" environment a policy paradigm (such as ICNIRP Guidelines) already exists and any scientific claims or research findings that appears to support the paradigm are easily accepted, such as by pro-ICNIRP-standards TE/7 members. In the "over-critical" environment adversaries are sharply divided over science claims and research findings (such as the existence of low level non-

¹²³ P. Vecchia, P, 'Electromagnetic Fields and Health: Effects, Perception, Protection', ICNIRP, Montevideo, Uruguay, Mar. 5, 2009, <http://www.msp.gub.uy/andocasociado.aspx?2819.16619>, accessed April 3, 2009.

¹²⁴ D. Collingridge, C. Reeve, *Science Speaks To Power*, New York, St Martins Press, 1986.

thermal bioeffects from RF exposures) are subjected to intense analysis and differing conclusions by opposing factions. This was very much the case with TE/7 where all research that was presented to the committee to support a precautionary approach to RF standard setting was summarily dismissed as it conflicted with ICNIRP.

Collingridge and Reeve's observations about the fate of scientific advice in supposedly rational government policy making is reflected by the actions of the Australian government in ignoring CSIRO's advice, and later silencing CSIRO altogether. The government's actions can be attributed to the fact that CSIRO advice ran counter to its economic policy to facilitate the roll out of telecommunications technology. This was the underlying theme that was played out in the final round of TE/7 meetings.

Overall Conclusions:

RF standard setting: a weighted assessment of science

“In the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex. The potential for the disastrous rise of misplaced power exists and will persist.”

Public Papers of the Presidents, Dwight D. Eisenhower, 1960, p.
1035- 1040

This thesis has shown that the creation and maintenance of the thermal paradigm in RF standard setting for the past half century has not been one of a straight forward case of advancing scientific knowledge, but one of convenience in order to facilitate the unfettered development of technology free of regulatory restraints. During the opening years of the Cold War, RF standard setting decisions, made in an era of scientific ignorance and fear of Soviet malevolence, led directly to a pragmatic solution to meet the nation’s urgent security needs of the day. Consideration of possible health hazards from chronic low-level RF exposures was seen as not only a potential barrier to technological development but also as a threat to national security. In addition, the existence of strict Soviet RF standards that claimed to take into consideration the possibility of low-level non-thermal hazards was a challenge to the scientific hegemony of the U.S. standard. In this situation, scientists involved in the U.S. standard development research found that focussing their research on gaining better understanding over thermal biological effects was what was wanted, not research that questioned that line of inquiry.

The marginalisation of criticisms of the validity of the thermal approach to RF standard setting has been an important issue raised in this thesis and is what I call the Procrustean Approach, where all scientific evidence not in conformity with the thermal bed of knowledge is simply cut off from consideration. Such a state of affairs has been maintained by the creation of restricted risk assessment methodologies, conflicted peer review and expert committees constituted primarily by individuals who have a vested interest in maintaining the status quo. This has been illustrated in this thesis by the analysis of the IEEE’s peer review

processes for accepting research papers for consideration in RF standard setting, the IEGMP / ICNIRP's risk assessment committees and the case study of the Australian RF standard setting process. In all three cases the problem of conflict of interest can be more accurately described as a majority shared interest in maintaining the status quo in standard setting for vested interest considerations.

The extent of the problem for public health

A critical examination of the current RF standard setting approach is also important for public health considerations. When the need for an RF exposure standard first arose over half a century ago it was not considered a public health matter as the concern was restricted to military personnel and civilian contractors developing high power military radar systems. The restricted focus of exposure limits from that time, however, has been steadfastly maintained to become a foundation for the global telecommunications revolution. Besides the ubiquitous mobile phone, a large number of communication devices are continually being developed and marketed globally as telecommunications companies struggle to keep up their profit margins under market-place competition. As the electromagnetic spectrum frequencies inevitably become congested as a result, newer wireless devices are then introduced that operate at ever-higher frequencies. The predictable result of this on-going development is increasing RF exposures for society in general, in both the so-called developed and developing nations. If there are deficiencies in the telecommunications risk assessments conducted by RF standard setting organizations, both on a national and international level, the sheer number of people exposed to even a slightly increased risk that is ignored by the standards can equate to a significant risk for society. This was pointed out by the U.S. National Toxicology Program on the inadequacies in the existing thermally based RF standard. To quote:

Over 100 million Americans currently use wireless communication devices with over 50 thousand new users daily. This translates into a potentially significant public health problem should the use of these devices even slightly increase the risk of adverse health effects. ... The existing exposure guidelines

are based on protection from acute injury from thermal effects of RFR exposure. Current data are insufficient to draw definitive conclusions concerning the adequacy of these guidelines to be protective against any non-thermal effects of chronic exposures.¹²⁵

This thesis argues that the current data is insufficient because for too long the investigation has been hampered by a Procrustean Approach that has cut off avenues of research that were considered inimical to the maintenance of the existing thermal paradigm.

This should no longer be acceptable given the implications for global society if the standard setters have it wrong.

Future directions

There is obviously an immense problem in recommending how to reform an existing RF standard setting process that has been controlled from the start by individuals who have staked their scientific credibility, and careers, on defending the existing thermal paradigm for standard setting. There is also the problem of whether or not biologically relevant standards that address chronic low-level non-thermal exposures are even compatible with the continuing wireless revolution. These are problems, however, that urgently need addressing due to the possibility of a significant adverse global public health impact of the technology. This calls for an international re-assessment of the biological relevance of the existing RF standards: IEEE's C95.1 and ICNIRP's guidelines. This is already happening to an extent in the European Parliament, as examined in Appendix 3. A standard setting process is needed that can open up the assessment process to cover all possible health hazards that might be a consequence of RF technology, regardless of the economic consequences of that assessment.

¹²⁵ National Toxicology Program, Fact Sheet, Studies on Radiofrequency Radiation Emitted by Cellular Phones, 2005.
<http://ntp.niehs.nih.gov/files/Cellphone05.pdf> , accessed Feb. 12, 2009.

It is important to note that the concerns raised in this thesis also apply to other broader environmental debates where industry and other vested interests, following revisionist principles, have been able to influence the parameters for regulation of their activities. In this context, this thesis contributes to the debate over the role played by peer review and expert advisory committees by illustrating that these processes, far from being a source of unproblematic and objective expert advice, can be prone to conflict of interest and a biased interpretation of scientific information, as exemplified herein by the RF controversy.

Appendix 1

John D. Graham on risk assessment.

From Graham's Keynote Speech: 'Making Sense or Risk: An agenda for Congress', EMF Risk Perception and Communication, the International Seminar on EMF Risk Perception and Communication, Ottawa, Ontario, Canada, 31 Aug. – 1 Sept. 1998.

Unlike several other presenters at the Ottawa EMF risk seminar who argued that the public's perceptions need to be considered and addressed in the risk assessment/management and communication process, Graham instead, argued that they should be simply ignored. This attitude was expressed earlier in 1996 when Graham stated at a conference that "government agencies should be required to depend on expert analyses, rather than public views, in deciding which threats to regulate."¹

In contrast to Beck's "reflexive modernization", an inevitable and desirable consequence of the many hazardous risks from modern technology, Graham saw public concerns over all technology as a "syndrome of paranoia and neglect", a term repeatedly used throughout his presentation. Graham defines it as the lay public's 'over attention' to an expenditure of resources for alleged dangers that are speculative and possibly non-existent (overblown/paranoid concerns), while at the same time far more substantial dangers to public health and environmental quality are being neglected and tolerated (neglected hazards). Some of what Graham considers to be "paranoid concerns", which he defines as "alleged, speculative, small or non-existent", include: soil and ground-water contamination from abandoned hazardous waste sites; pesticide residues on fruits and vegetables; the 1990 Congressional amendments to the Clean Air Act²; and the EPA's proposed

¹ L. MacCleery, *et al*, 'Safeguards At Risk: John Graham and Corporate America's Back Door to the Bush White House', *Public Citizen*, March 2001, <http://baywood.metapress.com/index/6NVWM0K53VNU92WP.pdf>, Accessed March 3, 2007

² While the amendments address outdoor air pollution (from industrial sources) the considerable problem of indoor air pollution (largely a personal lifestyle issue) remains largely ignored. While this is correct, this example (in this context) tends to deflect attention away from controlling outdoor industrial sources.

regulations to reduce benzene industrial emissions in ambient air of urban & rural communities.³ It is worth noting that Graham's listing of "paranoid/alleged/speculative/small or non-existent" concerns all have to do with industrial sources of pollution created by industries that provide funding to Graham's HCRA. As for Graham's "neglected hazards", they are defined as well-documented and substantial dangers to public health and environmental quality, including: violence in families and communities; deteriorating lead paint in older homes; inadequate use of basic preventative health services such as immunisations, vaccinations and breast cancer screening; and hazardous lifestyles, such as smoking, abuse of alcohol, high fat diets, lack of physical exercise and failure to use basic safety devices such as smoke detectors and auto seat belts. Note that all these dangers originate from the public's "personal habits". Graham sees one example of the public's "misperception of risk" in surveys that found "A majority of Americans perceive that 'things in the environment' are at least as important as 'personal habits' in causing sickness and poor health. He goes on to say that the "best available scientific data indicate that personal habits are much more a cause of poor health than environmental". In Graham's view the best way to address the public's concerns over various risks is for the Congress to embrace risk analysis in public decision making and require by legislation all federal agencies to: strictly follow quantitative risk assessment before making protective decisions; use risk rankings in setting priorities; report to the public estimated risks/costs and benefits of new legislation; use external peer reviews; require that costs are reasonably related to benefits; and require affected citizens⁴ to seek judicial review in the event that agencies do not use an accepted risk-analysis framework.⁵

³ The EPA's proposal was estimated to cost in the range of \$200,000 to \$50,000,000 per year life saved (largely a cost on industry), compared to a cancer program of early detection and treatment of cancers estimated to cost in the order of \$1000 to \$10,000 per year of life saved (a cost borne by the public).

⁴ As corporations have the legal status of citizens in the USA this opens all agency regulatory decisions open to litigation by corporations that may be adversely affected by said regulations.

⁵ J. Graham, 'Making Sense or Risk: An agenda for Congress', EMF Risk Perception and Communication, the International Seminar on EMF Risk Perception and Communication, Ottawa, Ontario, Canada, 31 Aug. – 1 Sept. 1998. M. Repacholi, A. Muc (eds), WHO, pp. 1-31.

Graham's wish list of 11 points to Congress in order to have "responsible risk assessments" are outlined below and include my comments.

1) *Congress should compel agencies to make use of the "best available scientific information"*⁶

An example mentioned by Graham was "innovative biological studies that suggest that low doses of unleaded gasoline vapours, chloroform and formaldehyde pose less risk to people than previously thought". These "innovative" studies may not be the best available scientific information as they are still restricted to testing individual chemicals at low levels of exposure. According to Dr. Philip Landrigan, Director of the Centre for Children's Health and the Environment at Mount Sinai School of Medicine in New York City, much of the current risk assessment being done on chemical exposures is based on faulty premises. It reflects the single exposure of an individual at one particular age, and to one chemical. According to Landrigan, this does not reflect the realities of multiple exposures over a lifetime that recent research indicates are often synergistic and cumulatively damaging.^{7 8 9}

¹⁰ Graham also claims that where new scientific studies suggest that a hazard is more dangerous than previously thought (examples given: dioxin and fine particles), agencies tend to be slow to respond to the new information.

2) *When scientific knowledge about a risk is imperfect or deficient, Congress should require agencies to employ "probabilistic methods of uncertainty analysis"*.¹¹

Taking a precautionary approach in areas of scientific uncertainty over risks has no place in Graham's ideology. Instead there is a very complex system of risks

⁶ Graham, 1998, op.cit., p. 8.

⁷ P. J. Landrigan, B. Sonawane, R.N. Butler, 'Early environmental origins of neurodegenerative disease in later life', *Environmental Health Perspectives*, Sept. 1, 2005, vol.113, issue: 9, pp: 1230-1234.

⁸ T. Colburn, D. Dumanski, J. Peterson-Myers, *Our Stolen Future*, Dutton, Penguin Books (NY), excerpt from Chapter 3, Chemical Messengers.

⁹ Pesticides and Aggression, *Rachel's Environment & Health Weekly*, No. 648, Apr. 29, 1999.

¹⁰ W.P. Porter, J.W. Jaeger, I.H. Carlson, 'Endocrine, immune and behavioral effects of aldicarb (carbamate), atrazine (triazine) and nitrate (fertilizer) mixtures at ground water concentrations', *Toxicology and Industrial Health*, vol. 15, no. 1 / 2, 1999, pp. 133-150.

¹¹ Graham, 1998, op.cit., p. 9.

requiring a range of estimates as well as estimates of each estimate's likelihood of being correct!¹² Worst case scenarios need to be balanced by optimistic and "realistic" estimates of risk. Graham points out that since this task is quite complex "qualified experts" should be used. This provision, in effect, transfers a great deal of regulatory power to the hands of a "non-elected technical / political elite bureaucracy".

Speaking at an earlier International EMF risk perception & communication seminar in 1997, Ortwin Renn referred to the call for the return to technical handling of risk by the technical/political elite, an elite that questions the wisdom of the lay public in judging the seriousness of risks. Renn noted that many writers have warned that ignoring public concerns violates democratic principles, alienates those who feel they should be part of the decision-making process, and may also underestimate the level of input the public may be able to provide to the risk manager. Renn also raises the philosophical question of whether the technical handling of risk really represents an objective assessment of harm or if it is only the conventions of an elite group that may have no more validity or applicability than competing estimates of stakeholder groups or the lay public.¹³

3) *When a hazard poses more danger to some citizens than others, Congress should insist that agencies report that information through distributional methods of variability analysis.*¹⁴

This method of analysis takes into account the fact that the public's exposure to an environmental risk can vary considerably. Some citizens may be more sensitive to exposures due to genetic or lifestyle reasons. Some may have a higher level of exposure, and low-income and minorities often incur a disproportionate share of

¹² About as scientifically valid as trying to estimate the winning percentages for next year of all Sydney sports teams – basketball, football, hockey, rugby, etc. – and then come up with an estimate of the likely success for a particular athlete playing in that city.

¹³ O. Renn, 'Risk Management: A need to integrate risk assessment and perception', International Seminar on Risk Perception, Risk Communication and Its Application to EMF Exposure, Vienna, Austria, Oct. 22-23, 1997, pp. 23-50.

¹⁴ Graham, 1998, op.cit., p. 9.

risks¹⁵. This needs to be taken into account by agencies by making available to decision makers and the public, a report on the number of citizens exposed to various levels of risk and differences in susceptibility to hazards. Although the need to address the disproportionate sharing of risks is an laudable point, the requirement for an agency to determine the number of citizens exposed to various levels of risk and individual differences in susceptibility would be an arduous and complex task, making, for example, straightforward regulations on controlling chemical emissions from a chemical plant in a mixed residential neighbourhood into a exceedingly complex task, fraught with uncertainty for the a risk assessor. As Landon Winner (1986) said, when the risk assessor is faced with uncertainty, the task tends to switch from one of taking protective action to one of waiting for more research to be done before action is taken.¹⁶ So, in effect, rather than providing extra protection to those disproportionately exposed, it makes the likelihood of effective pollution controls in their area less likely.

4) To nurture the public's sense of perspective about risk, Congress should require agencies to make thoughtful use of risk comparisons.¹⁷

Graham calls these a “powerful communications and learning tool” provided that they are “crafted with foresight”. Graham considers that such a comparison can help citizens and journalists develop an intuition about relative magnitudes. He also mentions that since the purpose of these risk comparisons is “educational”, it is neither necessary nor appropriate for an agency to restrict the comparisons to hazards that happen to fall within its jurisdiction, or to ensure that the risks are comparable in terms of other dimensions, such as controllability or preventability. If value judgments are made as to acceptability, then dimensions of risk need to be considered, not just numerical magnitude. An example given is that when agencies report that the extra cancer risk from eating pesticide residues in food is one in a million lifetimes they should also compare this to other risks incurred in daily life, such as the increased risk of four in a million being killed on the ground by a

¹⁵ M. Weintraub, Disparities in Disease, Environmental Justice & Health Union, Aug. 2003, <http://www.ejhu.org/disparities.html>, Accessed Jan 15, 2006.

¹⁶ Winner, 1986, op.cit., p. 143-144.

¹⁷ Graham, 1998, op.cit., p. 10.

crashing airplane. The obvious inference here is, why worry about pesticides in your food when there's a 4 times greater risk of dying from a plane crashing on your head! Besides the farcical nature of such a comparison, Graham's mentioning of a risk of one in a million for cancer resulting from pesticides is in error because it ignores three things: 1) When assessing the risk from exposure to a particular pesticide, say DDT, the risk is calculated in isolation from other chemicals. 2) Other sources of pesticide exposure, such as widespread areas of America where tap water is contaminated with low levels of a mix of insecticides, weed killers and artificial fertiliser. The most common contaminants are carbamate insecticides, the triazine herbicides and nitrate nitrogen.¹⁸ 3) Research indicating that mixtures of these chemicals in concentrations similar to groundwater levels in agricultural areas have measurable detrimental effects on the nervous, immune and endocrine systems, with far more direct implications for humans than just cancer risk.¹⁹ So, coming up with risk estimations from eating particular pesticide residues in food does not take into account the total 'load' of exposure to other chemicals and other sources of exposure.

The danger of risk comparisons is that they can too easily be used to underplay the seriousness of risks. This was examined by the Washington-based public interest organization *Public Citizen* in their report on John Graham. In June 2000 when Graham was a member of the EPA Science Advisory Board that reviewed the agency's risk assessment on dioxin, he used this tactic to mislead the media about the seriousness of dioxin. To quote:

"The EPA announced a draft of its study, which showed that exposure to the level of dioxin currently in our environment causes an increase in the average American's lifetime cancer risk to as high as 1 in 100. The EPA's reassessment also found that dioxin, even at low levels of exposure, is linked to infertility, immune system damage and learning disabilities, with more than 90% of dioxin exposure

¹⁸ J.E. Barbash, E.A. Resek, *Pesticides in ground water--Distribution trends, and governing factors*: Ann Arbor Press, Chelsea, Michigan, 1996, p. 3. ; R. Wiles, B. Cohen, *Tap Water Blues*, Environmental Working Group, 1994. ; P. Montague, *Pesticides and Aggression # 648*, Environmental Research Foundation, April 29, 1999.

¹⁹ Porter, Jaeger, Carlson, 1999.

coming from food, especially fish, meat, and dairy products. But rather than acknowledging that dioxin poses an additional threat to human health, in his comments to the media Graham misleadingly downplayed the risk by comparing the EPA's finding to other types of risks, such as the risk of dying in a car crash. When compared with these risks, Graham suggested the risk posed by dioxin appears "normal".²⁰

5) *Congress should require agencies to assess a broad range of potential human health and environmental effects.*²¹

Graham makes the valid point that historically agencies have tended to focus solely on mortality effects (such as cancer), which ignores citizens' concerns about other health effects that may affect health and wellbeing. An example mentioned is the EPA's then proposed reassessment of cancer risks from dioxin where the levels of exposure associated with negligible cancer risk are not necessarily low enough to eliminate concern about possible immune and reproductive effects. Due to the complexities of the risk-analysis approach, Graham considers that it may make more sense for federal agencies to move their assessment function to an outside organization to "achieve a greater degree of objectivity and credibility". This suggestion is to transfer important decisions on public health from government agencies, theoretically answerable to the public via the elected government, to private bodies. If Graham's HCRA is considered, it is answerable to the many private corporations that fund its activities. And who makes the decisions about which private bodies receive this power?

6) *Risk-Based Priority Setting*²²

Graham mentions that while the Federal government conducts numerous risk analysis surveys each year little attention is being paid to the "big picture" questions on how resources are best allocated among various dangers. Giving one

²⁰ MacCleery *et al*, 2001.

²¹ Graham, 1998, *op.cit.*, p. 10.

²² Graham, 1998, *op.cit.*, p. 12.

of his risk comparisons, Graham compares the billions of dollars being spent to clean up soil at industrial sites where the probability of childhood exposures is low, versus the fact that little is spent on the problem of deteriorating lead-based paint in older homes, which does expose large numbers of children to lead. Again there is a shift in responsibility away from large industrial sources of pollution to a public “lifestyle” problem by comparing two completely unrelated health issues. In relation to his industrial site example, an important consideration he misses is that in some cases, previously industrial land may be re-developed in the future into residential allotments or adjacent to new residential areas. In this case, both adults and children could be later exposed if there was an inadequate clean-up in the first place. The classic example is the Love Canal toxic waste dump controversy in Niagara Falls, New York. During its use as a waste dump, there were no nearby residential areas, but years after its closure, lands on and adjacent to the site were re-developed as residential neighbourhoods and a school. After a record amount of rainfall, chemicals began leaching out of the ground and even waste disposal drums began breaking up through the ground in backyards. Plants and trees started dying and a faint choking smell was noted in the area. There were reports of abnormally high white blood cell counts, a possible precursor of leukaemia, increased rates of miscarriages and birth-defects in the Love Canal population.²³ A much-disputed study done for the EPA reported increased chromosomal abnormalities among 36 Love Canal residents.²⁴ The Love Canal development was later abandoned because it was found the concentration of toxic chemicals from the former dump had leached into the surrounding areas.²⁵

Graham considered that risk rankings were necessary to give Congress, regulatory agencies and the public what he called a “proper perspective” about the relative importance of each new danger reported in the mass media, which he terms the “risk of the month syndrome”. He recommended that Congress “require the executive branch to periodically rank hazards according to the seriousness and the available opportunities for cost-effective reduction”. Further tying the ranking of

²³ E.C. Beck, *The Love Canal Tragedy*, *EPA Journal*, Jan. 1979, <http://www.epa.gov/history/topics/lovecanal/01.htm>, Accessed Mar. 30, 2007.

²⁴ Jasanoff, 1990, *op.cit.*, p. 26-29.

²⁵ Beck, 1979.

hazards to a cost structure, Graham saw that the most serious dangers should not always be ranked the highest since the available risk-reduction strategies may be fairly ineffective or costly. Risks of only a moderate degree of seriousness may be ranked high if it is feasible to eliminate them at a low cost to society. (Low cost to society should be read as low cost to industry as Graham tends to intermix society's needs with industry needs). As ranking of risks would be a complex process, requiring what Graham called "delicate value judgments", agencies would need expert guidelines on risk-ranking drawn up by the Office of Science & Technology Policy and the Office of Management & Budget. According to Graham, Congress should require the development of guidelines and the application of risk-ranking by federal agencies. He mentions one example in relation to the inevitable degree of scientific uncertainty about the seriousness of every hazard. Graham was concerned that if "worst case" [EPA's conservative risk assessments] estimates of risk are used to characterise a hazard, this would bias that hazard toward a higher ranking, something Graham felt was unjustified. Graham's solution here is to incorporate further complexity by including "ranges or probability distributions that reflect uncertainty or simply refusing to rank poorly understood hazards". In addition, Graham felt that all stakeholders, including "laypersons" involved in the risk assessment process, must acknowledge and consider the use of risk ranking value judgements. Along the lines of his technocratic approach to risk, Graham felt that public participation by interest groups was not always the best approach since there may be a clear incentive to "game" the value judgment process in a way that favours industry, environmentalists or consumers. Comparisons could be made here with Graham's organization the HSRA and how HCRA value judgements clearly favour the industries that provide their funding base. A better solution in Graham's opinion is to elicit information on value judgments from a "representative citizen panel", objectively selected by a panel of social and physical scientists (a 'non-elected technical/political elite bureaucracy').

7) *Report Risks, Benefits and Costs*²⁶

Graham mentions that Congress must embrace a principle of considering the competing risks of regulation as well as the target risks in its legislative language. As an example Graham mentions several EPA initiatives under the Clean Air Act, designed to reduce industrial air pollution from the chemical, coke production and aerospace industries. He points out that EPA risk assessment included estimates on the level of reduced pollution emissions as well as the estimated cost to industry but “failed” to include “scientifically supportable” estimates of the pollution risks to health or the number of adverse health effects prevented by the estimated reduction.

The scientific evidence that industrial air pollution is a significant environmental health hazard is well established. Graham’s suggestions to Congress here adds another layer of complexity and difficulty in regulations, increasing uncertainty and requiring the services of the expert risk assessor. Graham mentioned that “The decision not to invest in benefits analysis will ultimately make it difficult for the EPA to present a persuasive case to congress and the public that their rule makings on hazardous air pollutants have been worthwhile.” He urged Congress to pass an across-the-board statutory requirement that all risk-protection rules be accompanied by risk estimates and estimates of benefits and costs.

8) *Reasonable Relationship between Cost and Risk Reduction*²⁷

Graham promotes the idea that “Congress should require agencies to make a plausible case that the benefits of legislation bear a reasonable relationship to costs. Graham asserts that his organization (HCRA) has “found that federal regulators frequently make investments in toxin control that would not be considered reasonable by the norms of preventative medicine”. Congress can correct this discrepancy by requiring agencies to achieve a reasonable and consistent balance

²⁶ Graham, 1998, op.cit., p. 15.

²⁷ Graham, 1998, op.cit., p. 19.

between benefits and costs. He gives the example of the EPA's rule requiring the formulation of gasoline to reduce human exposures to carcinogens, such as benzene and volatile organic compounds. Estimated annual costs to the industry in Phase I were \$700 million, and an additional \$250 million in Phase II. Estimated benefits of Phase I were 20 fewer cases of cancer and 115,000 fewer tons of VOCs. Phase II benefits were estimated to be 4 fewer cases of cancer and 42,000 fewer tons of VOCs.

9) *External Mechanisms of Scientific Peer Review*²⁸

Graham points out that as risk analysts wield a subtle but important power when conducting various types of risk analysis, Congress should insist that their reports be scrutinised and improved through the external mechanism of peer review. This could consist of a public advisory committee of non-governmental scientists from academia and non-profit research organizations. Members would be selected on the basis of their technical expertise rather than of the basis of their affiliation with particular stakeholder groups.²⁹ He claims that studies have shown that a public process of external peer review improves both the quality of the technical analysis^{30 31} and the degree of public confidence in decisions that are ultimately based on the analysis.³² In addition, he said, Congress should insist that agencies consider recommendations from international bodies but in conjunction with

²⁸ Graham, 1998, op.cit., p. 21.

²⁹ Selecting advisory committee members on a technical basis and ignoring their affiliation with stakeholder groups will insure that industry scientists, who do have the relevant technical expertise, but focused for the benefit of their industry, will have increased representation on committees. This requirement would alienate the participation of environmental or public interest/consumer groups.

³⁰ According to the International Committee of Medical Journal Editors (ICMJE) all too often the peer review can be undermined by corporate influences. Because of this, the ICMJE have revised their publication guidelines to require disclosures of corporate influence on submitted research papers. See ICMJE uniform requirements, <http://www.icmje.org/index.html#peer>, Accessed June 23, 2007.

³¹ P. Alderson *et al* performed a "meta-analysis" of editorial peer review using published studies as their data, applying statistical methods to the findings of the studies. They looked at the effects of peer review on various criteria, including methodological soundness, completeness and accuracy. When they surveyed the sum of research on peer review, they found only scattered empirical evidence supporting the use of editorial peer review as a mechanism to ensure quality of biomedical research. From: 'Truth or Consequences: Publication ethics', *The Economist*, vol. 360, Sept 13, 2001, pp. 62-63.

³² Excluding public representation from the public advisory committee is more likely to lose public confidence its in decisions.

independent review by a public advisory committee of scientists in the United States.

10) *Judicial Review under the Principle of Deference*³³

In order to make optional use of risk analysis and to insure that all agencies enact analytic practices in their decision making process, legislation is required which encourages agencies to take up risk analysis and which gives 'outside parties'³⁴ the opportunity to bring the agency to court for failure to do so. Graham also considers that risk analysis is unlikely to influence administrative decision makers unless they are compelled by legislation to seriously consider the findings of analysis when making decisions.³⁵ In Graham's opinion, legislative "reform" can be influential in addressing the mis-allocation of resources resulting from the public's current syndrome of paranoia and neglect about risk.

11) *Analytical Resources*³⁶

Graham's wish list for a congressional commitment to risk analysis also includes further budgetary and technical resources as well as more analytical requirements. He sees the need to "cultivate and support a cadre of career public servants who have broad multi-disciplinary experience in risk analysis". Graham sees the need for analytical resources pressing in all fields, but especially in the sub-field of ecological risk assessment, the most immature aspect of this growing discipline. He thought the ultimate solution to the syndrome of paranoia and neglect was in the education of scientists and professionals, and especially in the education curricula used to educate young people in math, science and economics.

³³ Graham, 1998, op.cit., p. 22.

³⁴ Essentially this refers to industries which felt that they were being adversely affected by agency decisions.

³⁵ This provision virtually would make all risk-assessment decisions by the non-elected technical/political elite de facto legal requirements that if not followed to the letter of the law by federal agencies could result in legal action of behalf of the affected industry. For agencies involved they would therefore have no recourse except to rubber stamp non-elected technical/political elite dictates.

³⁶ Graham, 1998, op.cit., p. 23.

Appendix 2

Other relevant presentations at the 1998 International Seminar on 'EMF Risk Perception and Communication', Ottawa, Ontario, Canada

Immediately following Graham's presentation Michael Repacholi, head of the WHO's International EMF Project (IEMFP) gave a presentation on the extent of the possible EMF problem for society and how IEMFP was addressing this issue. He pointed out that "[e]veryone in the world is now exposed to a complex mix of EMF frequencies. EMF has become one of the most pervasive environmental influences and exposure levels at many frequencies are increasing significantly as the technological revolution continues unabated and new applications using different parts of the spectrum are found". In order to address this problem IEMFP was set up to establish better health risk assessments to identify any environmental impacts of EMF exposure and these would then be used to develop an international consensus for exposure guidelines. No details on IEMFP's risk assessment methodology were given. Repacholi then went through the current (as of 1998) state of the scientific literature for both powerfrequency EMF fields and RF fields. His report was a fairly in-depth description of what was known, for both thermal and non-thermal biological effects and identified a number of areas where research was needed to clarify uncertainties.¹

Dr Philip Gray from the Programme Group MUI, Germany, cited the risk approach taken by the National Research Council (1996)² and the Presidential/Congressional on Risk Assessment and Risk Management (1997)³ as to why dialogue with all stakeholders should be an important part of the overall risk analysis process. Gray suggested that, without this communication, technical

¹ M. Repacholi, 'EMF concerns and WHO's International EMF Project', EMF Risk Perception and Communication, Proceedings of the International Seminar on EMF Risk Perception and Communication, Ottawa, Ontario, Canada, Aug. 3–Sep. 1, 1998, pp. 33-55.

² National Research Council (NRC) Committee on Risk Characterisation, "Understanding risk. Informing decisions in a democratic society", Washington D.C., National Academy Press, 1996.

³ Presidential/Congressional on Risk Assessment and Risk Management, "Framework for Environmental Health Risk Management. Final Report 1, Washington D.C., 1997.

risk assessment by itself was insufficient to be a useful process for risk characterization. Stakeholders would include independent consultants, citizen groups, industry representatives and other affected parties. This was meant to take into consideration the concerned public's risk perceptions but it would not necessarily affect the final risk assessment. Gray pointed out that, in practice, risk assessments may be framed by many implicit and explicit assumptions, subject to controversy both within and without the scientific community, subject to further consultation by decision makers with further review and decisions needing to be made in future years. As for the EMF controversy Gray considered that this dialogue was already happening to an extent with international organizations, such as IEMFP and at many national agency levels.⁴ Chapter 5 of this thesis examines the above points relevant to the Australia RF standards controversy.

Peter Wiedemann from Programme Group Humans, Environment & Technology Research Centre, Julich, Germany saw the EMF issue as primarily a communications problem. He presented a detailed public relations guideline, from primarily an industry viewpoint, on how to handle public anxieties and fears in EMF communications with the public. According to Wiedemann lay people show considerable gaps in their understanding and generally are unfamiliar with any scientific data/studies. Some of the strategies mentioned, when dealing with the public, are to explain the limit values (i.e. the exposure standard human exposure limits), information about the state of the art and the quality of the studies and reference to the experts, such as WHO (i.e. IEMFP) which "relies on the best scientists". A risk comparison was given that claimed that the basic exposure from natural EMF fields averages 0.003 W/m² and after the final extension of mobile phone networks the load of these fields would be 0.0002 W/cm². Therefore, according to Wiedemann's logic, "[e]xposure due to mobile radio technology is thus clearly lower than the already existing average background exposure of 0.003 W/cm²." This comparison is disingenuous on at least three points. Firstly, it ignores the increasing complexity of ever-higher frequencies in

⁴ P. Gray, 'Improving EMF Risk communication and management: the need for analysis and deliberation', EMF Risk Perception and Communication, Proceedings of the International Seminar on EMF Risk Perception and Communication, WHO, Ottawa, Ontario, Canada, Aug. 3–Sep. 1, 1998, pp. 57-76.

telecommunications that never before existed in the natural environment. Secondly, it is impossible to predict what the “final extension of the mobile phone network” will be and thirdly, it is at odds with what Repacholi said earlier at the same WHO seminar that “EMF has become one of the most pervasive environmental influences and exposure levels at many frequencies are increasing significantly.”⁵ Much of Wiedemann PR guideline consisted of explaining on how to defend the official RF standard limit values, which he termed “protective values.”⁶ In some respects Wiedmann’s PR guidelines were similar to what transpired with industry risk-communication with the concerned public in the Australian TE/7 RF standard setting process. Regardless of community and scientific concerns the industry and its factional supporters on the committee would not budge from the official limit “protective” values during the discussions (Chapter 5).

Gerry Kruk from Gerry Kruk & Associates Communications Ltd., Canada, argued at the Seminar that controversies over EMF risks from both powerline and telecommunications facilities can be effectively managed and resolved using the techniques developed for effective risk communication. After giving a run-down on the important features of risk communication, Kruk concluded that it is an effective strategy for avoiding and defusing EMF and other controversies. As with most of the other speakers at the seminar, the problem was not that there may be a real risk to be dealt with but how to reduce the public’s concern that there may be a risk to health.⁷

Of particular interest was the presentation by Judy Larkin, a principal from *Regester Larkin*, a UK-based crisis and issues management consultant firm. Larkin saw the problem as one where modern society now had “more time to spend contemplating over all sorts of long-term theoretical hazards”. Nowhere in her

⁵ Repacholi, 1998.

⁶ P.M. Wiedemann, ‘EMF risk communication: Themes, challenges and potential remedies’, EMF Risk Perception and Communication, Proceedings of the International Seminar on EMF Risk Perception and Communication, WHO, Ottawa, Ontario, Canada, Aug. 3–Sep. 1, 1998, pp. 77-107.

⁷ G. Kruk, ‘Risk Communication and the Management of EMF Risks’, EMF Risk Perception and Communication, Proceedings of the International Seminar on EMF Risk Perception and Communication, WHO, Ottawa, Ontario, Canada, Aug. 3–Sep. 1, 1998, pp. 109-135.

presentation is there any acknowledgement that the public's concerns may, in some instances, be justified. In addition, according to Larkin, due to past health controversies, such as asbestos, tobacco, genetically modified foods, mad cow disease, etc, the public had become "predisposed to expecting adverse outcomes, no matter whether the risk is real or perceived", and this included distrusting organizations that promote a particular technology. In relation to EMF, Larkin saw the problem internationally as one where the public perception over risks was being shaped by the media and anti-EMF activists, thereby causing high levels of anxiety and controversy. Larkin placed much of the blame for this situation on the media's marked increase in negative articles where "alarmist messages make better stories than reassuring messages". The problem, according to Larkin, was that both "scientists and activists were receiving considerably more airtime than industry". The challenge according to Larkin was to "minimise public anxiety and maximise the effectiveness of communication initiatives". A brief run-down was given on factors influencing the public's perception of risk with the central aim of achieving risk acceptance by the public.⁸ She said that as the public was easily influenced by the media, it is the responsibility of the scientists involved to "ensure the right information is available and inaccuracies are corrected when they appear in the media". Revealingly, Larkin saw as possibly the biggest risk issue in the UK as one that threatened the way industry operated, if "communication continues to be led by the media and activists, with inaccurate reporting of scientific research going on un rebutted". She concluded that the way ahead was to support "the WHO and other independent research frameworks providing clear, accurate and consistent information to consumers in order that they can be reassured by responsible action and make informed decisions".⁹ The overall message in her presentation was that the primary risk to be assessed and managed was the risk to industry of having to make changes to their operations as a result of public concerns. Assessing whether or not public concerns are justified was apparently not part of the task.

⁸ Amount of awareness of possible risk, level of scientific consensus over extent of risk, equity of risk, detectability, dread disease vs. not dreaded, nature of risk (man made or natural), and individual choice/control over risk.

⁹ J. Larkin, 'Evaluating Response Options', EMF Risk Perception and Communication, Proceedings of the International Seminar on EMF Risk Perception and Communication, WHO, Ottawa, Ontario, Canada, Aug. 3-Sep. 1, 1998, pp. 137-150.

William Leiss from the School of Policy Studies, Queen's University, Kingston, Ontario, Canada, and Greg Paoli from Decisionalysis Risk Consultants, also from Ontario, made the point in their presentation at the Seminar that concerned members of the public were effectively using the Internet to educate themselves on the science to become effective advocates. This is also briefly examined in Chapter 4 of this thesis where the Australian public was able to effectively tap into Internet resources to gain a credible knowledge of the various RF/MW (and ELF) risk assessments, start up newsletters, and in several cases write books on the topic. According to Leiss and Paoli, "individual members of the public who do not necessarily have scientific expertise, but who have concerns about risk issues, have begun using Internet resources to gather information, establish contact with like-minded people everywhere on the globe, obtain guidance on how to ask questions of experts, and prepare themselves to become skilled intervenors in risk controversies". They were of the opinion that Internet based resources, in spite of weaknesses in the medium, were vital new aids for the empowerment of the public and were part of the proper functioning of legitimate democratic decision-making processes. They laid out basic principles to facilitate dialogue between expert risk assessors and the informed public on risk issues, principles that he felt were not being properly applied to reduce conflicts. They argued that three points must be clearly communicated to the public by both industry and government, whom he referred to as risk promoters:¹⁰

- The excess (increased) risk in every involuntary exposure
- The level of uncertainty in expert risk assessments
- The rationale for inequitably distributed exposure.

In a democratic society Leiss and Paoli argued the risk promoters have the duty to do so.¹¹

¹⁰ Risk Promoters refer to both industry and governments which jointly introduce new technologies.

¹¹ W. Leiss, G. Paoli, 'The Internet as a Public Information resource with a case study on a Canadian controversy about radio-frequency fields', EMF Risk Perception and Communication, Proceedings of the International Seminar on EMF Risk Perception and Communication, WHO, Ottawa, Ontario, Canada, Aug. 3-Sep. 1, 1998, pp. 151-192.

In relation to the communication of uncertainties, in his presentation at the EMF Seminar, William Bailey from Bailey Research Associates stated that acknowledgement of uncertainties to the public was necessary and that risk communication should be at the start of the risk assessment process. He saw an inevitable conflict between the scientists who were aware of the uncertainty in the scientific data, and the public and regulators who typically wanted risk assessments and guidance to reflect a total lack of uncertainty over risk. The problem was that scientists (including industry technical experts) were concerned that any acknowledgement of uncertainty would increase public concerns and result in criticism over their assessments. Bailey argued that such beliefs should not allow scientists to mislead other stakeholders, including the public. Thorough documentation and a transparent evaluation of the scientific data were essential to having risk assessment support an effective risk communication. As for the safety factors in the ICNIRP powerfrequency standards (10 for occupational and 50 for public exposure) Bailey questioned the justification of ICNIRP for the stricter public safety factor if exposures below the occupational limits were without effect. He mentioned that ICNIRP needed to explain its rationale for the extra public exposure safety factor.¹²

Daniel Wartenberg, from the Environmental and Occupational Health Sciences Institute, Piscataway, New Jersey gave a review of the scientific approach to inferring risk, based on weight of evidence, meta-analysis and quantitative risk assessment. He explained that weight of evidence is a careful and systematic review of the scientific literature, including *in-vitro*, *in-vivo* and epidemiological evidence. However, he pointed out that there is a subjective side to this evaluation based on reviewers' judgements of the quality, relevance and importance of the data. Judgement is guided by various accepted criteria but there is concern that there may be a focus on particular studies or specific issues that do not represent the whole body of evidence. [Relevant here is Chapter 3 of this thesis where the

¹² W.H. Bailey, 'Principles of Risk Assessment with Application to Current EMF Risk Communication Issues', EMF Risk Perception and Communication, Proceedings of the International Seminar on EMF Risk Perception and Communication, WHO, Ottawa, Ontario, Canada, Aug. 3–Sep. 1, 1998, pp. 193-211.

subjective nature of the weight of evidence approach taken by the IEEE RF standard setting committee is examined.] Wartenberg then covered meta-analysis, the systematic review of a body of epidemiological literature with statistical methods applied to summarize the quantitative findings of individual studies or find consistent patterns which also may be areas of disagreement in the results. He then covered the basic outline of qualitative risk assessment, the topic of this chapter, and concluded with a brief outline of how these methods could be applied to the EMF powerfrequency controversy.¹³

Caron Chess, from the Center for Environmental Communication, Rutgers University focused on the need for research on public participation in the risk assessment process. There has been little systematic research in this area (as of 1998) and what little research that was available either used vastly differing criteria or was done before the mid-1980s. Chess' main point was that for public participation to be effective, it must be based on solid research not a collection of assumptions. She examined the pros and cons of a number of different forms of public participation, with an emphasis on public meetings and citizen's advisory councils (CACs).¹⁴

The final presentation of the seminar was given by Richard Woodley, webmaster for the Internet based *Bridlewood Electromagnetic Fields Information Service*. Woodley's presentation was from the activist's viewpoint. Woodley offered the opinion that the EMF issue was one of politics, where evidence of EMF health hazards was being suppressed by the White House, and agencies downplaying or contradicting findings that are contained in the studies. He concluded with the remark that the public deserved better than this.¹⁵

¹³ D. Wartenberg, 'How Dangerous Is It Really? Some Approaches for Inferring Risk', EMF Risk Perception and Communication, Proceedings of the International Seminar on EMF Risk Perception and Communication, WHO, Ottawa, Ontario, Canada, Aug. 3–Sep. 1, 1998, pp. 213-227.

¹⁴ C. Chess, 'Public Participation: Guiding Practice With Research', EMF Risk Perception and Communication, Proceedings of the International Seminar on EMF Risk Perception and Communication, WHO, Ottawa, Ontario, Canada, Aug. 3–Sep. 1, 1998, pp.193-227.

¹⁵ R. Woodley, 'The Politics of EMFs- An Activist's Viewpoint', EMF Risk Perception and Communication, Proceedings of the International Seminar on EMF Risk Perception and Communication, WHO, Ottawa, Ontario, Canada, Aug. 3–Sep. 1, 1998, pp. 309-310.

Appendix 3

Summaries of the negative 'no' votes from the Australian TE/7 committee

1). John Hunter, Commonwealth Science and Industrial Research Organisation (CSIRO)

John Hunter opposed the adoption of the draft standard because it departed from the original 1985 standard, particularly with the increase in exposure levels and averaging times. He stated that there was a high level of controversy and uncertainty, making the level of potential risk to human health unknown. Hunter said that with this level of uncertainty it was advisable to set exposure levels far below levels known to cause adverse effects as is technically, economically, and socially feasible. With this, CSIRO saw no evidence being presented to suggest that the industry would be hindered if the levels in the 1895 standard were re-instated.¹

2). Roger Matthews, Local Government New Zealand

Roger Matthews considered that both the "basic restrictions" and "Derived Reference Levels" were difficult to determine, leaving local governments and other agencies with a standard what could not be enforced. Of special concern was Clause 10(b), having to do with "the primacy of the industry's business interests over neighbours interests, cost minimisation – to the industry, and appropriateness". This was defined by the industry itself – meaning that the industry could disregard the clause if it chose to. There was also no requirement for industry to show that best practice was followed to minimise exposure levels to the public and this should be addressed in the standard. Matthews also pointed out that the most of the submissions to TE/7 requested a precautionary approach and in response the committee had weakened it, therefore there was not a

¹ J. Hunter, CSIRO, CSIRO Ballet Draft (TE/7) WP ID Number 17067. cdr. doc, Mar. 02, 1999.

reasonable balance between the needs of industry and the interests of the community.²

3). Dan Dwyer, Communications, Electrical and Plumbers Union (CEPU)

Dan Dwyer saw the ICNIRP guidelines as providing nothing more than a “cooking standard”, as it only regulated the amount of heating that could be applied to the human body. Dwyer disagreed with assertions that ICNIRP’s standard was international and unassailable. He saw it as a controversial standard that suited industry. There was an acknowledgment that while industry may need massively increased exposures for its various technologies, giving enormous profits to the industry, this had to be balanced against a risk to public safety. Dwyer saw a number of studies reporting adverse findings being criticised as mere anecdotal evidence in a manner similar to what happened in the tobacco and asbestos scandals. Since the 1985 standard Dwyer saw all the research as being aimed at justifying an exploitation of the basic restriction (a rise in temperature of one degree) to the limit, with little effort at replicating previous studies. He considered such an approach was inconsistent with a precautionary approach. Dwyer mentioned that the draft had contained a statement on a precautionary approach which the public supported, but that the wording was later amended to end up merely as “feel good” statements put into the standard to reassure the public. This Dwyer felt was deceitful and misleading to the public. Some other points that he was concerned about were that Table 2 of the draft standard showed that while the whole body should not be heated above the level of 0.4 W/kg, it allowed the head exposure to be increased 25 times to 10.0 W/kg. This gave very significant temperature rise in parts of the head and brain which was a big bonus for the mobile phone industry. Another concern was that the increase in averaging times from the previous 60 seconds to 6 minutes was not consistent with the precautionary approach.

² C. Singley, R. Matthews, LGNZ, Ballot for the TE/7 Committee, DR 98627 – Human Exposure to Electromagnetic Fields, Mar. 1999.

Dwyer considered ICNIRP's stated standard of proof as set so high (dismissive) as to be inconsistent with public safety. He said that when there is any doubt the public should be fully informed and precautionary action taken.

The Vienna Resolution was suggested by Dwyer as a model for defining bioeffects. He recommended that instead of using the terms "athermal", "nonthermal" or "microthermal" effects, the term "low intensity biological effects" was more appropriate.

Dwyer said that the entire RF standard setting process was fundamentally flawed as the wrong people were making the decisions over public health. He felt that a political decision was needed, which he defined as "When it comes to public safety, if there is any risk, then the public should be firstly informed, then protected!" (by the government).

In conclusion Dwyer stated:

ICNIRP may take a conservative approach. A conservative decision would be the best approach for a professional research body with a reputation to protect! It is clear that any study that finds a link between RF radiation and a health risk will be severely criticised by the RF manufacturers/telecoms. This does nothing for your reputation, let alone your ability to bet more funds to replicate your findings.³

4). Sue Pennicuik, Australian Council of Trade Unions (ACTU)

Sue Pennicuik supported the reasons for its no vote as being the same as those expressed in Dwyer's CEPU submission (above).⁴

5). John Lincoln, The Australian Consumers Federation (ACF-1)

³ D. Dwyer, TOA, TE/7 Ballot TE/7-0090, Mar. 3, 1999.

⁴ S. Pennicuik, ACTU, Reasons For Negative Vote, D99030, Mar. 1999.

John Lincoln did not agree to the adoption of the ICNIRP guidelines as they were essentially flawed by the omission of some studies and the incorrect interpretation of others. The submissions by Neil Cherry and myself were mentioned as ones that could have formed a sensible debate in the committee but they were ignored. Lincoln felt that an increase in exposure levels without a meaningful precautionary approach would result in the proliferation of RF technology which had not been proven safe.

Lincoln mentioned Dr. John Holt's submission that explained that while the whole body average SAR rate of 4 W/kg was based on healthy bodies, it failed to consider the fact that diseased tissue absorbs more energy than does healthy tissue. He mentioned that this submission was ignored by the committee as well.

Lincoln took special note that, while public submissions were almost totally ignored by the committee, industry submissions received considerable attention. This was inconsistent with Standards Australia's stance of impartiality and was unjustifiable, in Lincoln's opinion.

As for a precautionary approach, Lincoln saw it as being "completely and utterly confounded so that the draft standard ignores all reference to precaution, despite strong community support for the principle" Lincoln added, "To exclude a precautionary approach mocks the notion of public health protection and utterly discounts community concerns."

Lincoln took issue with how the large number of public submissions that indicated an enormous public concerns about the effects of low level (non-thermal) radiation were in no way addressed in the final draft. Lincoln considered that such concerns could have been addressed with a precautionary approach. He considered that the standard dismissed non-thermal effects on the basis that "causation has not been shown". He explained that to wait for causation to be established was inappropriate in the case of RF as the latency period can be 20 + years. He stated that "when it comes to protecting the community public health, a responsible public health standard would not take such a risk". Furthermore, Lincoln noted

that the wording in the Foreword put public health subservient to the needs of industry. He also wondered why increasing the averaging time to 6 minutes from 60 seconds was so important to industry. Lincoln concluded:

I cannot in all conscience endorse a document that reflects so little regard for community opinion and community health. The Document must admit to being what it is: a performance standard based on thermal levels of RF only and must not pretend to be a Standard that protects public health at all levels of exposure.⁵

6). Don Maisch, The Australian Consumers Federation (ACF-2)

In justifying my no-vote to the proposed standard, I mentioned my previous submissions on the importance of a precautionary approach to be incorporated into the standard before voting in the affirmative. I pointed out that the draft that was agreed upon at the earlier Wellington NZ meeting, and which was circulated for public comment, did have elements of a precautionary approach. However the final wording in the Foreword and particularly Section 10(d) of the final draft was a significant departure from the concept of a precautionary approach as formulated at the Wellington meeting. In fact any reference to “Precautionary Approach” had been deleted in the final version.

I mentioned the New Zealand Shirley school decision (Chapter 5) and how the judge had erred in his ruling that “A precautionary approach is already implicit in the Act “ (ICNIRP). This was because even though the guidelines could be said to have a precautionary approach for thermal effects, it did not address a precautionary approach for possible low-level adverse biological effects. This is what the public submissions to TE/7 were overwhelmingly concerned about.

I saw an apparent bias on behalf of the judge in the Shirley decision where he accused the expert testimony of some of the witnesses as being biased but

⁵ J. Lincoln, ACF, Reasons For Negative Vote, Mar. 1999.

uncritically accepted the industry's evidence as correct in its interpretation of the science. For instance Judge Jackson stated that ICNIRP accurately portrays the general scientific view of the research and he referred to the discredited Robinette et al 1980 study. I pointed out that if the judge displayed the same level of critical examination with the ICNIRP Guidelines he would have found that ICNIRP made many significant errors in its evaluation of the epidemiological evidence. As my previous submissions to TE/7 asserted, the ICNIRP Guidelines apparently were incapable of dealing objectively with data on population exposures to RF/MW especially in light of the three epidemiological studies that were referred to on page 11 of the guidelines. This apparent bias in the ICNIRP guidelines was the main reason that I considered that a strong precautionary approach was necessary in relation to possible adverse effects from prolonged RF exposure at intensities insufficient to cause heating. In addition I called for a thorough and independent analysis of the ICNIRP document before it was accepted by the committee.

I considered the final draft as a big step backwards when compared to the original 1985 Standard, where it stated in the Foreword:

It has been demonstrated that low-level, long-term exposure can induce a variety of effects in the nervous, haematopoietic and immune systems of small animals. Such exposure may influence the susceptibility of such animals to other influencing factors. Thermal influences seem inadequate to account for these and other effects.

I concluded that the final result was a "homoeopathic dose of Precautionary Approach", which had been diluted to the extent that virtually nothing was left of the original intent. Therefore as a public /consumer representative I could not justify any vote except the no option.⁶

⁶ D. Maisch, ACF, Final Vote, Mar. 3, 1999, <http://www.emfacts.com/papers/submissions.html>

7). Jim Leigh, The National Occupational Health and Safety Commission (NOHSC),

Jim Leigh saw the reliance on 1998 ICNIRP guidelines as unsatisfactory when compared to the 1998 U.S. National Institute of Environmental Health Sciences (NIEHS) evaluation that followed the International Agency for Research on Cancer (IARC) cancer classification of extremely low frequency (ELF) EMF as an IARC class 2B carcinogen. He thought that TE/7 should wait until the formal IARC evaluation of RF exposures, scheduled for June of 2003. In the meanwhile the Interim standard could apply.

Leigh also thought it inappropriate for TE/7, composed as it was, to be trying to set a health based standard and giving public assurances (of safety) would be wrong. It was also wrong to be so concerned about giving legal protection to the creators of RF when they have such a strong voice in the process. He concluded that he “was concerned with the almost arrogant dismissal of much of the public comment and the failure to consider the Vienna Resolution of October 1998.”⁷

8). Ivan Beale, Adopt Radiation Controls (ARC), New Zealand.

Ivan Beale wrote that in its final form, the draft standard followed the philosophy used in both the IEEE and ICNIRP standards in that maximum permissible exposure levels are related to the well-established adverse effects associated with whole-body heating. Even though there is general agreement that the draft standard does provide adequate protection from adverse effects related to whole-body heating, it failed to consider findings from recent research that found adverse effects at levels far below the maximum permissible levels. Beale pointed out that he and other committee members had consistently argued for a standard that took into consideration the evidence of adverse effects at levels below the basic restriction of 4W/Kg. Details of this evidence, as well as references for precautionary principles and the principles of acceptable risk, had been presented

⁷ J. Leigh, NOHSC, Reasons For Negative Vote, March 1999.

to the committee. Beale pointed out that both he and Roger Matthews had presented papers to the committee dealing with these issues and why the draft standard did not serve the public health protection needs of the community. As the final draft standard did not reflect these arguments he could not support it.

Beale said that he would support the draft standard if it was clearly stated what the standard provided protection against and not pretend to provide adequate protection from all practically adverse effects. Beale concluded that:

In my view, the only honest alternative is to produce a standard that specifies maximum permissible exposure levels for effects associated with whole-body heating at exposure levels above 4 W/Kg, and make it clear that this is not intended to provide protection from other effects. These must be handled using some precautionary principle such as Prudent Avoidance.⁸

Beale made the point that the justification for the standard's dismissal of non-thermal effects was encapsulated in a sentence in the Foreword where it stated: "There is no conclusive evidence of any harmful effects to people exposed to the threshold value of 4 W/Kg". However, he considered that the validity of that sentence rested upon a definition of what "conclusive evidence" constituted but nowhere in the standard was that defined. Beale said that public health protection needed to go beyond "conclusive evidence" to "indicative evidence", especially when the scientific data on RF bioeffects is so limited. This is even more so with modulated RF where there has been almost no research on the effects of exposure to these fields. He stated that "[t]o indicate, as the draft standard does, that we have anything more than a very vague idea of the biological role of low-frequency modulations is as dishonest as it is dangerous".⁹

⁸ I. Beale, ARCENZ, Comments on revised draft TE/007-0050-520 and additional reasons for my negative vote, Mar. 1999.

⁹ *ibid.*

Beale concluded:

In my view, the only honest alternative is to produce a standard that specifies maximum permissible exposure levels for effects associated with whole-body heating at exposure levels above 4 W/Kg, and make it clear that this is not intended to provide protection from other effects. These must be handled using some precautionary principle such as Prudent Avoidance.¹⁰

¹⁰ *ibid.*

Appendix 4

Australian/New Zealand public resource documents

1) The 1991 book by retired CSIRO scientist, Les Dalton, *“Radiation Exposures: The hidden story of the health hazards behind official ‘safety’ standards”*, written for the general public, served as a basic primer in both ionizing and non-ionizing radiation health issues.¹

2) The January 1994 report by CSIRO scientists A. Doull & C. Curtain, titled *“A Case for Reducing Human Exposure Limits Based on Low Level, Non Thermal Biological Effects”* was made widely available to the concerned public by activist groups in Sydney and Adelaide. In addition the offices of the Australian Democrats in Hobart and Melbourne widely distributed copies. For the public this report gave a general overview on the history of RF standard setting internationally and in Australia, examined the thermal vs. non-thermal controversy and called for reducing the exposure limits.²

3) A June 1994 CSIRO report prepared by Stan Barnett was titled *“CSIRO Report on the Status of Research on the Biological Effects and Safety of Electromagnetic Radiation: Telecommunications Frequencies”*. Unlike the ICNIRP guidelines which dismissed chronic low level exposures as beyond the scope of the guidelines, and therefore addressed thermal acute effects only, the CSIRO report, which reviewed the important studies on RF exposure, concluded that a high level of uncertainty existed in the RF literature leading to an inability to address the issue of chronic environmental level exposures to RF. The report concluded that there was insufficient reliable scientific evidence on which to base sound conclusions about the safety of RF/MW radiation exposures in telecommunications. The report stated: “...because of its equivocal nature, the database for RF emissions has

¹ L. Dalton, *Radiation Exposures: The hidden story of the health hazards behind official ‘safety’ standards*, Scribe Publications, 1991.

² A. Doull, C. Curtain, *A Case For Reducing Human Exposure Limits Based On Low Level, Non Thermal Biological Effects*, Unpublished, 1994.

limited value. It may be dangerous to make general statements on safety based on lack of evidence of harmful effects when so little relevant research has been carried out.”³ Though this report was finalised by June 1994 it was only released in the form of six copies deposited in the Parliamentary library and languished there until March of 1995 when Senator Robert Bell and the magazine *Communications Day* received an anonymous letter about the report’s existence. Bell’s office requested two copies from Spectrum Management Agency (which later arrived marked confidential) and thereafter widely publicised the report’s existence.⁴ At about the same time investigative journalist Stewart Fist received a digital copy of the report and placed the entire report on his web site.⁵

According to Betty Venables, the convener of Sydney based Electromagnetic Radiation Alliance of Australia (EMRAA), the Report was the public’s first concise and comprehensive document on the RFR health issue. On advising the NSW Local Government Association of the availability of the CSIRO Report the President, Peter Woods, issued instructions for every local Council in NSW to receive a copy. According to Venables, the public concern regarding RFR exposure and the potential health threat was therefore based not on fear and ignorance but on reliable information regarding the state of the science, which they were obliged to seek out in the interest of family health.⁶

4) In October 1994, Senator Bell tabled in the Senate a report titled, *(Non-ionizing) Electromagnetic Fields and Human Health: Are current standards safe?*. This report critically examined the basis for the power frequency exposure guidelines and called for exposure standards to reflect the epidemiological evidence for chronic low level health effects at levels far lower than the standard limits.⁷

³ S. Barnett, Report on the Status of Research on the Biological Effects and Safety of Electromagnetic Radiation: Telecommunications Frequencies, CSIRO Division of Radiophysics, June 1994.

⁴ As reported in D. Maisch, ‘Fields of Conflict: The EMF Health Hazard Controversy’(self published), p. 57-58, Aug., 1995.

⁵ Correspondence with Stewart Fist, Aug. 30, 2005.

⁶ Correspondence with Betty Venables, convener of the The Electromagnetic Radiation Alliance of Australia (EMRAA) Sutherland Shire Environment Centre, Sutherland, NSW. July 27, 2003.

⁷ D. Maisch, (Non-ionizing) Electromagnetic Fields and Human Health: Are current standards safe?, Senate Hansard, Oct. 1994.

5) In April of 1995, Dr. Neil Cherry, from Lincoln University, New Zealand, widely circulated a report: *“Potential and Actual Adverse Effects of Cell Site Microwave Radiation”* This report consisted of his own review of the RF literature which highlighted shortcomings in the ICNIRP guidelines, as well as detailing possible adverse effects from mobile phone base stations at levels far below those set by ICNIRP.⁸ This report was followed by several later versions, all critical of ICNIRP guidelines.

6) In August 1995, I self published *Fields of Conflict: The EMF health hazard controversy*. This update of my October 1994 Senate paper was widely distributed in Australia by the Office of Senator Bell.⁹

7) In April 1996 Senator Bell tabled in the Senate a background report titled, *“Mobile Phones and Their Transmitter Base Stations: The Evidence For Health Hazards - A local Government and Community Resource Document”* This report was the result of an approximately six month search of literature relevant to health effects from telecommunications technology.¹⁰

⁸ N. Cherry, *Potential and Actual Adverse Effects of Cell Site Microwave Radiation*, (self published), 17 Apr. 1995.

⁹ Maisch, 1995.

¹⁰ D. Maisch, *‘Mobile Phones and Their Transmitter Base Stations: The Evidence For Health Hazards*, Australian Senate Hansard, Apr. 1996.

Glossary

ACA: The Australian Communications Authority. Now the Australian Communications and Media Authority with responsibilities for the regulation of broadcast, internet, radio-communication and telecommunications technology.

ACRS: The Advisory Committee on Reactor Safeguards advises the U.S. Nuclear Regulatory Commission on reactor safety studies, facility license applications, hazards of proposed facilities and the adequacy of proposed reactor safety standards.

ACTU: The Australian Council of Trade Unions is the peak body representing the Australian trade union movement.

AEC: The Atomic Energy Commission was established by the U.S. Congress in 1946-1947 to fulfil the dual roles of promoting the civilian uses of nuclear energy technology and regulation of that technology. As a result of these conflicting roles the regulatory function was transferred to the Nuclear Regulatory Commission in 1974 and the developmental function transferred to another organization which later became the Department of Energy.

AFRL: The Air Force Research Laboratory (U.S.) was created in October 1997 as a consolidation of four Air Force laboratory facilities with a research and development mission to improve the nation's war-fighting technologies.

AGNIR: The Advisory Group on Non-Ionizing Radiation was established by the U.K.'s NRPB in 1990 to review the scientific literature on the human biological effects of non-ionising radiation to advise on research priorities. Reconstituted in 1999 as an independent advisory group it now advises the Health Protection Agency on radiation, chemical and environmental hazards.

AIEE: The American Institute of Electrical Engineers was a U.S. based organization of electrical engineers from 1884 to 1963 when it merged with the Institute of Radio Engineers to form the IEEE.

ALARA: As Low As Reasonably Achievable is a fundamental principle in radiation protection with the aim of reducing radiation exposure (both for ionizing and non-ionizing radiation) but taking economic and social factors into account.

AMTA: The Australian Mobile Telecommunications Association is the peak industry body representing Australia's mobile telecommunications industry.

ANSI: American National Standards Institute is an industry standards body that promotes and facilitates voluntary consensus standards and assessment systems to aid global competitiveness of the American business sector while helping to assure the safety and health of consumers and the protection of the environment.

AOARD: The Asian Office of Aerospace Research and Development. A foreign detachment of the U.S. Air Force Office of Scientific Research.

ARC: Adopt Radiation Controls was a New Zealand based public interest group opposed to the adoption of the ICNIRP RF Guidelines for the nation.

ARPANSA: The Australian Radiation Protection and Nuclear Safety Agency is a federal government organization with the responsibility for protecting the health and safety of people, and the environment, from the harmful effects of ionising and non-ionising radiation.

ARRL: The American Radio Relay League represents the interests of amateur radio enthusiasts before U.S. regulatory bodies and provides technical advice and assistance to amateur radio operators in the U.S.

ASA: The American Standards Association was reorganized in 1966 to become the United States of America Standards Institute (USASI), renamed in 1969 as ANSI.

CAG: The Carcinogen Assessment Group formed by the U.S. EPA in order to centralize its in-house expertise on cancer.

CDRH: Center for Devices and Radiological Health within the U.S. FDA is responsible for ensuring the safety and effectiveness of medical devices and eliminating unnecessary human exposure to man-made radiation from medical, occupational and consumer products and educating industry on the relevant policies and regulations.

CENELEC: The European Committee for Electrotechnical Standardisation comprised of the National Electrotechnical Committees of 30 European countries and 8 National Committees from neighbouring countries. The business orientated organization works to further European harmonization of standards, creating standards requested by the market and harmonized standards in support of European legislation. It focuses on increasing market potential and encourages technological development and guarantees the safety and health of consumers and workers.

CEPU: The Communications, Electrical and Plumbing Union (Australia) represents the interests of the workers of three essential industries, the electrical, communications and plumbing sectors.

CFA: The Consumers Federation of Australia is the national peak body for consumer groups in the nation.

COMAR: The IEEE Committee On Man And Radiation a group of experts on health and safety issues related to electromagnetic fields, from powerline through microwave frequency ranges.

COST: The European Cooperation in the Field of Scientific and Technical Research that supports co-operation among scientists and researchers across Europe. The organization now has 35 member countries and enables scientists to collaborate in a wide spectrum of activities in research and technology.

CPSU: The Community and Public Sector Union (Australia) represents workers from the public sector, telecommunications, call centres, employment services, commercial broadcasting, the aviation industry and the science and research sectors.

CSIRO: The Commonwealth Science and Industrial Research Organisation is Australia's national science agency with more than 50 sites throughout Australia and overseas.

CTIA: The Cellular Telecommunications Industry Association (U.S.) represents all sectors of wireless communications – cellular, personal communication services and enhanced specialized mobile radio. They represent service providers, manufacturers, wireless data and internet companies and other sectors of the wireless industry.

CWD: The Compensating Wage Differential: The acceptance of a higher wage in exchange for a higher occupational risk of injury.

DARPA: The Defense Advanced Research Projects Agency is the central research and development office for the U.S. Department of Defense (DoD). DARPA's mission is to maintain the technological superiority of the U.S. military and prevent technological surprise from harming national security.

Daubert ruling: The U.S. Supreme Court issued a directive on June 28, 1993 relating to how federal judges should decide whether to allow expert testimony into the courtroom. It directed judges to act as scientific “gatekeepers” by examining the scientific method underlying expert evidence and to admit, in their opinion, only that evidence that was both “relevant and reliable.”

Diathermy: A now disused therapeutic treatment that used radiofrequency radiation to selectively heat tissue, such as muscles as it was thought to induce relaxation and aid healing.

DoD: The U.S. Department of Defense.

EC: The European Commission is the executive branch of the European Union. The body is responsible for proposing legislation, implementing decisions, upholding the Union's treaties and the general day-to-day running of the Union.

EEPA: The Electromagnetic Energy Policy Board (U.S.).

EHC: Environmental Health Criteria are WHO monographs that provide international, critical reviews on the health effects of electromagnetic fields/ radiation, chemicals and biological agents on human health and the environment.

Electromagnetic Spectrum: A way of organizing electromagnetic fields on the basis of their frequency of oscillations expressed in cycles per second, or Hertz (Hz). The higher the frequency, the shorter the distance between one wave and the next, and the greater the amount of energy in the field. The non-ionizing range extends from 0 Hertz to visible light at trillions of Hertz. Frequencies above light are considered to be ionizing and include X-rays and cosmic rays. The EM spectrum is divided into regions based on frequency and usage. See also Extremely low frequency, Radio frequency, and Microwave.

ELF: Extremely low frequency electromagnetic fields are in the portion of the electromagnetic spectrum extending from above zero to 3000 Hertz. This includes the 60-cycle power frequency in the United States and the 50-cycle in Europe and Australia.

EME: Electromagnetic Energy in the non-ionizing part of the electromagnetic spectrum, usually referring to radiofrequency radiations.

EMF: Electromagnetic Fields in the non-ionizing part of the electromagnetic spectrum usually referring to power frequency or extremely low frequency emissions.

EMR: Electromagnetic radiation: referring to radio frequency emissions. See EME.

EMRAA: The Electromagnetic Radiation Alliance of Australia. A Sydney based public interest activist group.

EOARD: The European Office of Aerospace Research and Development, a detachment of the U.S. Air Force Office of Scientific Research.

EPA: The Environmental Protection Agency is America’s peak government agency for environmental science, research, education and environment pollution risk assessment efforts. Their mission is to protect human health and the environment.

EPRI: The Electric Power Research Institute: the U.S. power industry’s research and development organization relating to the generation, delivery and use of electricity for the benefit of the public.

ESAA: The Electrical Supply Association of Australia is the peak industrial organization to promote the interests of the Australian power generating industry.

EU: The European Union is the economic and political union of 27 member states, located primarily in Europe.

FCC: The Federal Communications Commission a U.S. government agency regulates interstate and international communications by radio, television, wire, satellite and cable.

FDA: The Food and Drug Administration (U.S.) is an agency within the Department of Health and Human Services that is responsible for protecting the public health by assuring the safety, efficacy, and security of human and veterinary drugs, biological products, medical devices, the nation's food supply, cosmetics, and products that emit radiation.

FRE: The Federal Rules of Evidence (1975) govern the introduction of evidence in U.S. Federal Court proceedings, both civil and criminal. They do not apply to suits in state courts but are closely modeled in state provisions.

Frequency: The rate at which a periodic electromagnetic waveform repeats itself in time at one position in space. Frequency is measured in cycles-per-second or Hertz (Hz). The electric power frequency, depending on country is either 50 or 60 Hz. The radiofrequency and microwave frequency band ranges from approximately 3 kilohertz (kHz) to 300 gigahertz (GHz).

FOIA: The Freedom of Information Act.

Frye test: A U.S. legal precedent originating from 1923 regarding the admissibility of scientific examinations or experiments in legal proceedings.

GAO: The Government Accountability Office is an investigative arm of the U.S. Congress that audits and evaluates government programs and activities.

GATT: The General Agreement on Tariffs and Trade negotiated new trade agreements that all countries would enter into. It ran from 1947 to 1994, when it was replaced by the World Trade Organization.

GBR: Ground Based Radar is the primary fire control radar system , providing surveillance, acquisition, tracking, discrimination, fire control support and kill assessment for the U.S. National Missile Defense system.

Gigahertz: An electromagnetic frequency of billions of cycles per second.

GM: Genetic modification/manipulation referring to genetic engineering, recombinant DNA technology, and gene splicing.

HPS: The Health Physics Society is the U.S. society of specialists working in radiation safety issues. Founded in 1956 it established IRPA in 1964.

Hz: Hertz – see Frequency.

HCRA: The Harvard Center for Risk Analysis is a predominantly industry funded organization that promotes its version of risk analysis for addressing environmental risks to while addressing industry concerns.

HFT: High frequency transients are very brief high frequency voltage spikes of either positive or negative polarity in mains power electrical power wiring caused by switching (such as electric motors starting) causing interruptions to the current flow. Characterised as packing a lot of power into a very brief time frame, such as in micro-seconds.

IAC: The International Advisory Committee established to provide oversight to IEMFP.

IARC: The International Agency on Research on Cancer, a WHO agency that coordinates and conducts research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control, including disseminating information through publications, meetings, courses, and fellowships.

ICES: The International Committee on Electromagnetic Safety, formerly IEEE's SCC-28 standards committee, operates under the IEEE standards board to develop exposure standards for the frequency range 0 – 300GHz and has a membership representing 26 nations.

ICNIRP: The International Commission on Non-Ionizing Radiation Protection is non-government organization authorized by WHO to deal with non-ionizing radiation protection and recommend exposure standards to national governments.

IEC: The International Electrotechnical Commission. Founded in London in 1906 the organization is an international standards and conformity assessment body for all fields of electrotechnology including capacitors and resistors, semiconductor devices, electrical equipment in medical practice and maritime navigation and telecommunications.

IEEE: The Institute of Electrical and Electronics Engineers is a leading industry trade organisation formed in 1963 with the merger of the American Institute of Electrical Engineers and the Institute of Radio Engineers. It aims for the advancement of electrical and electronic technology including aerospace, computers, electrical power, biomedical and telecommunications and also sets standards over that technology.

IEGMP: The Independent Expert Group on Mobile Phones (U.K.) was established in 1999 and issued a report in May 2000 on its assessment of the scientific literature on the risks to health from mobile phone technology.

IEMFP: The International EMF Project. Under the auspices of the WHO its objective is to conduct risk assessments on the health and environmental effects of exposure to static and time-varying electric and magnetic fields in the frequency range 0 - 300 GHz. It recommends to national governments the exposure guidelines promulgated by ICNIRP with which it is closely allied.

ILGRA: The Interdepartmental Liaison Group on Risk Assessment (now defunct) was a committee of senior policy makers established to draft a uniform approach to risk for the U.K. government's policy on risk assessment.

INIRC: The International Non-Ionizing Radiation Committee was formerly a working group within IRPA formed in 1974 to examine the problems of health protection for non-ionizing radiation. It was renamed INIRC at the IRPA Congress in Paris in 1977. It was superseded by ICNIRP in 1992.

Ionizing Radiation: Electromagnetic radiation with sufficient energy to overcome the bonds of electrons in atoms or molecules. The released electrons then become ions. Usually referred to as radioactivity, it has a far shorter wavelength and consequently higher frequency than visible light. This type of radiation includes X rays and gamma rays.

ILO: The International Labour Organization is a United Nations agency to improve opportunities for women and men to obtain decent and productive work in conditions of freedom, equity, security and human dignity. Its main aims are to promote rights at work, encourage decent employment opportunities, enhance social protection and strengthen dialogue in handling work-related issues.

IRCG: The Geneva based International Risk Governance Council made up of a self-proclaimed independent group of government, industry and academic professionals with the aim of promoting their methodology on risk regulation.

IRIS: The Integrated Risk Information System is the risk analysis system used by the EPA for its risk assessment process.

IRPA: The International Radiation Protection Agency was established in 1964 as an international initiative of the Health Physics Society (U.S.). IRPA is the international forum of national radiation protection organizations with the aim of providing and improving protection from the hazards of radiation in order to facilitate the safe use radiological technology, including scientific, medical, engineering, nuclear and radio-communications. IRPA encourages the establishment of universally acceptable radiation protection standards or recommendations through the international bodies concerned (i.e. IEEE C95.1 and the ICNIRP Guidelines).

MW: Microwave frequency fields are in the upper part of the radiofrequency spectrum (see RF). It ranges from approximately 0.3 Ghz to 300 Ghz. As with all of the RF spectrum, in health protection standard setting the main biological effect of exposure to prevent is an increase in tissue temperature at high exposure levels (see SAR).

NAB: The National Association of Broadcasters is a U.S. trade association that advocates on behalf of more than 8,300 free, local radio, broadcast and television stations and represents their interests before Congress, the Federal Communications Commission and the Courts.

NATO: The North Atlantic Treaty Organization is a military alliance of 26 nations from North America and Europe following the goals of the North Atlantic Treaty signed in April 1949.

NAS: The National Academy of Sciences is a U.S. society of scholars engaged in scientific and engineering research to further science and technology for the betterment of society. NAS includes the National Research Council, the National Academy of Engineering, and the Institute of Medicine. Collectively, the four organizations are known as the National Academies.

NCRP: The National Council on Radiation Protection and Measurements is a U.S. congressionally chartered committee with the mission to formulate and widely disseminate information, guidance and recommendations on radiation protection and measurements which represent the consensus of leading scientific thinking. This includes the responsibility to facilitate and stimulate cooperation among organizations concerned with the scientific and related aspects of radiation protection and measurements.

NEPA: The National Environmental Policy Act (1969) established in the U.S. a national environmental policy to provide for the establishment of a Council on Environmental Quality that would work towards a better understanding of ecological systems and natural resources and promote actions to prevent or eliminate damage to the environment for the betterment of humanity. The Act established procedural requirements for all federal government agencies to prepare Environmental Assessments and Environmental Impact Statements.

NIH: The National Institutes of Health is a part of the U.S. Department of Health and Human Services and is the primary Federal agency for conducting and supporting medical research.

NIOSH: The National Institute for Occupational Safety and Health (U.S.) in the Department of Health and Human Services (DHHS) at the Centers for Disease Control and Prevention (CDC) is the federal agency with the mission to prevent work related illnesses and injuries.

NMD: The National Missile Defense program is a U.S. Department of Defense (DoD) program to develop a national missile defence system consisting of a global network of inter-working radar and missile systems to detect and destroy rogue missiles. In 2008 it was DoD's biggest budget program at \$8.8 billion for that year alone.

NOHSC: The National Occupational Health and Safety Commission (Australia) is a statutory body, with government, employer and employee representatives to lead and coordinate national efforts to prevent workplace death, injury and disease in the nation.

Non-thermal effects: Effects on biological tissue resulting from low-level and usually prolonged radiofrequency/microwave exposures of insufficient power to increase tissue temperature. As there may be subtle thermal reactions on cells not easily detectable the term "low-intensity" effects has been used as a replacement term.

Non-Ionizing Radiation: Electromagnetic radiation of insufficient energy to knock electrons from their orbit around atoms or molecules (see ionising radiation). This encompasses the entire frequency range from ELF to and including RF and MW frequencies.

NRC: The National Research Council (U.S.) was established in 1916 and functions under the auspices of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The NRC provides political leaders, policy makers, and the public with expert advice based on its assessment of the scientific evidence. Projects are funded by federal agencies, foundations, other governmental and private sources, and the institution's endowment. Committees are made up of scientists, engineers, and other professionals who volunteer their time without compensation.

NRC: The Nuclear Regulatory Commission (U.S.) was created by Congress in 1974 to regulate the use radioactive materials for civilian purposes and ensure that people and the environment were protected.

NRPB: The National Radiological Protection Board (U.K.) is an independent body that has responsibility for advising UK government departments and others on standards of protection for exposure to ionising and non-ionising radiation, which includes electric and magnetic fields.

NSB: The National Science Board (U.S.) serves as an independent body of advisors to both the President and Congress on broad national policy issues related to science and engineering research and education.

NSF: The National Science Foundation is an independent US government agency responsible for promoting science and engineering through research programs and education projects. The NSF is the major source of federal backing for research conducted by academic institutions excluding medical research.

NTIA: The National Telecommunications and Information Administration (U.S.) is the President's principal adviser on telecommunications and information policy.

OECD: The Organization for Economic Co-operation and Development, with a membership of 30 countries, aims to promote the global market economy, support member's economic growth, improve living standards and maintain member's financial stability.

OMB: The Office of Management and Budget (U.S.) is the largest office within the Executive Office of the President and oversees the activities of federal agencies for adherence to presidential policy. OMB gives advice to the Federal Administration on a range of topics relating to federal policy, management, legislative, regulatory, and budgetary issues.

OIRA: The Office of Information and Regulatory Affairs (U.S.) is located within OMB and conducts economic analysis and related analyses on issues related to government policy. It reviews draft regulations and collections of information under the Paperwork Reduction Act and develops and oversees the implementation of government-wide policies in the areas of information technology, information policy, privacy, and statistical policy.

OSHA: The Occupational Safety and Health Administration (U.S.) is the main federal agency charged with setting and enforcing occupational safety and health standards.

Paradigm (scientific): A general viewpoint that dictates a specific way of interpreting scientific data and how and which phenomena are to be described and researched.

PCIA: The Personal Communications Industry Association (U.S.) is a trade organization representing and promoting the telecommunications sector by providing the sector with expertise and support to address regulatory, marketplace and technical issues.

PCS: Personal Communications Service is a wireless phone service similar to cellular telephone service but emphasizing personal service and extended mobility.

Power frequency: The frequency of mains electrical power, either 50 or 60 hertz depending on country. Power frequency fields have wavelengths of more than 3,100 miles (5,000 km) and consequently have very low energy levels that do not cause heating or ionization, though they do create weak electric currents in conducting objects, including people and animals.

Precautionary Principle: A widely used moral and political guideline used in environmental decision-making where a high degree of scientific uncertainty exists. The two main formulations of the precautionary principle are as follows:

Article 15 of the Rio Declaration of 1992: "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

Wingspread Statement of 1998: "When an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."

Precautionary Approach: Similar to the precautionary principle but used specific to RF standard setting in the Australian standard setting TE/7 Committee (Chapter 5) this was meant to address in the RF standard the possibility of RF health hazards at exposure levels below the thermal threshold.

Risk assessment (in the regulatory setting): the scientific and technical quantitative evaluation of risks to health and wellbeing consisting of four steps: hazard identification, hazard characterization, exposure assessment and risk characterization.

RF: The Radiofrequency part of the electromagnetic spectrum that ranges from approximately 30 kHz to 300 GHz. In health protection standard setting the main biological effect of RF exposure to prevent is an excessive increase in tissue temperature at high exposure levels (see SAR).

RFAWG: The Radiofrequency Interagency Work Group (U.S.) is a joint federal government agency group with the responsibility for different aspects of RF safety and work to ensure coordinated efforts at the federal level. The agencies in this group are the FCC, NIOSH, EPA, OSHA and NTIA.

RNCNIRP: The Russian National Commission on Non-Ionizing Radiation Protection is the national agency with the responsibility for protecting the health and safety of Russian citizens, and the environment, from the harmful effects of ionising and non-ionising radiation.

SAA: The Standards Association of Australia, forerunner to Standards Australia.

SAR: The Specific absorption rate is a time derived compliance measurement expressed in watts per kilogram (W/kg) of the rate of energy absorption (or dissipation) in a volume mass of biological tissue (either 1 or 10 grams). This is essentially a calculation of the heat absorbed by tissue based on mathematical and artificial head models (for mobile phone compliance testing). SAR is the unit used in RF standards/guidelines to designate the threshold limits where adverse biological effects (heating) have been proven to occur when the human body is exposed to an RF field.

Sound Science: See TASSC.

TASSC: The Advancement of Sound Science Coalition was set up in 1993 by APCO (a public relations firm) and funded by the tobacco company Philip Morris in order to attempt to discredit a 1992 EPA study that found second-hand tobacco smoke was a Class-A carcinogen. TASSC also expanded its operation to attract other industries concerned about regulation of their activities. It developed the term “sound science” to demote science that discounted evidence of industrial hazards to health and the term “junk science” to denote research that was inimical to industry interests.

Thermal Effects: Well established adverse biological damage in tissue from short-term acute RF exposures of sufficient intensity to cause internal heating. RF standards are designed to limit such heating.

TIP: The Telecommunications and Industrial Physics division (now defunct) in CSIRO was the Division with the responsibility of researching non-ionizing radiation issues.

TMD: Theater Missile Defense systems (U.S.) are designed to counter battlefield threats from missiles with ranges of hundreds of kilometres.

QRA: Quantitative risk assessment, see risk assessment.

UEWR: Upgraded Early Warning Radar refers to technologically improved phased-array surveillance radars used to detect and track ballistic missiles targeted at the U.S.

UHSG: The Utility Health Sciences Group is an industry group representing the interests of U.S. power industry specific to the EMF health hazards issue.

UMDC: The United Missile Defense Company is a U.S. corporate joint venture established to develop the NMD program.

UNEP: The United Nations Environmental Program coordinates United Nations environmental activities, assisting developing countries in implementing environmentally sound policies and encourages sustainable development through sound environmental practices.

VOCs: Volatile organic chemicals are of predominantly industrial origins with an organic structure containing hydrogen, oxygen, and carbon which readily volatilise, or evaporate into the air. Due to their low water solubility, environmental persistence, and widespread industrial use, they are commonly found in the environment.

WHO: The World Health Organisation is the directing and coordinating authority for global health issues within the United Nations. It makes recommendations to determine the health research agenda as well as recommending health standards (also see IEMFP).

WOE: Weight of Evidence is the term used to refer to a collection of published scientific, legal and policy-making literature. Originally introduced in the 1990s to improve the risk assessment of Superfund toxic disposal sites in the U.S.

WTO: The World Trade Organization was established in 1995 as a replacement for GATT as an international organization designed to supervise and facilitate international trade. The organization deals with the rules of trade between nations and negotiates and implements new trade agreements. It also has the responsibility of enforcing member nation's adherence to all the WTO agreements. WTO membership requires member states to conform to the ICNIRP Guidelines.

XBR: X-Band Radar is an essential part of the U.S. NMD Program that conducts tracking, discrimination, and kill assessments of incoming ballistic missiles at the early phases of a missile's trajectory. It operates at 8 – 12 GHz and uses advanced radar signal processing technology to achieve a high degree of target resolution to discriminate against targets.

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