

Subject: ATTENTION!!!, Safe level of EMR is ZERO (Cherry)..
Date: Mon, 29 May 2000 18:51:12 -0500 (CDT)

.....Folks -- this is an HISTORIC announcement.....!!!

I appreciate that Dr. Cherry has chosen to share this with us.
Most of you will not be attending the meetings in Europe which he refers-to here..... Guru will.....

I dare-say that Dr. Cherry's statement below will cause some serious reverberations in the smug 'circle' of the INDUSTRY "science" defenders..... (The Moulders, Stuchlys, et al., whom many of you have sent me messages about, recently.....)

And, I predict that you will be referring to this proclamation for years to come into the future.....

Finally -- as at the Alamo -- the "line in the sand" has been drawn on the issue of EMR/health effects..... It has been drawn concisely, clearly and without the usual protective "spin" on behalf of the vested interests.....

The public, the legitimate and unbiased medical community, the regulators, and the governments can all read and easily understand what follows ... without any excuses to equivocate or dissemble the facts.....

(Press people. You ARE free to make use of this release..... You might also want to review guru's "Mission Statement" posted on the home page of the website..... It foretold such an event ... "perhaps sooner rather than later.....")

Cheerio.....

Roy Beavers (EMFguru) You gotta SHOWME -- I'm from Missouri....
roy@emfguru.com

.....It is better to light a single candle than to curse the darkness.....
NEW!!! Website... <http://emfguru.com>
.....People are more important than profits.....

----- Forwarded message -----

Date: Tue, 30 May 2000 10:01:49 +1200
From: "Cherry, Neil J" <CHERRY@kea.lincoln.ac.nz>
To: rbeavers@llion.org
Subject: Safe level of EMR is ZERO

Dear Roy,

I am about to leave for Europe where I am presenting the results of my latest research into low level health effects of EMR as requested by representatives at the European Parliament and our very good friends in Salzburg City Council.

The conclusion of my research is that:

A great deal of illness and death currently occurring in developed countries, can be associated with the progressively increased exposures to EMR, especially in the RF/MW range because this is much more biologically active and damaging than ELF fields, Bawin and Adey (1976), Vignati and Guiliani (1997). This is going to increase very significantly with the use of cell phones and the installation of cell sites.

My problem is that there is so much research that shows adverse biological and health effects, but there is a concerted campaign to ignore, discredit or attack the messengers. The studies are not generally known by authorities who trust bodies that appear to be reliable but who deliberately mis-quote and mis-represent the published research. This continues to delay measures to protect public health by retaining the strongly disproven assumption of tissue heating being the only effect.

Warm Regards to you and all on the list.

Neil Cherry

Potential and Actual Adverse Effects of Radiofrequency and Microwave Radiation at levels near and below $2 \mu\text{W}/\text{cm}^2$.

by

Dr Neil Cherry
Lincoln University
10/2/98

1. Background:

1.1 Introduction:

There is wide community concern about the possible or actual health effects of electromagnetic radiation. Most recently the concern has focused on the placement of cell sites (mobile phone base stations) in communities, close to residences, schools, preschools, hospitals and work places, for example. Strong claims by industry representatives and their consultants that there is no scientific evidence to justify the public's fears is scientifically demonstrably wrong.

This review cites a great deal of internationally published peer-reviewed scientific evidence from laboratories and universities around the world, sourced from reports from reputable institutions and in internationally published papers from peer-reviewed journals. This shows compelling evidence of athermal biological changes in cells and in animals which relate to brain function change, sleep disruption, chronic fatigue, reproductive problems and adverse health problems such as immune system impairment and cancers of many organs. Epidemiological studies have identified statistically significant increases of the incidence of most these symptoms and diseases associated with above average exposure to radio-frequency and microwave (RF/MW) exposure.

The Standards which are referred to and preferred by industry and military authorities are technical standards and not public health standards. The standards bodies in Australia and New Zealand are the Standards Associations. These are the bodies who are responsible for building and mechanical standards. When the Australian Government wished to set an RF/MW exposure standard they referred the matter to Standards Australia, who formed a committee of "stakeholders" who had an interest in the use of RF/MW technology. This included telecommunications and power industry representatives, government departments who deal with the radio spectrum, defence department personnel, along with the Australian Radiation Laboratory, C.S.I.R.O. and some scientists who had an interest in RF/MW, most of whom were consultants to the industry or the government in RF/MW matters. This is not a group which is totally independent of those who gain benefit from using the spectrum and is not a group working from the basis of public health research and protection.

Hence the standard, NZS 6609, is based on international standards and guidelines which are based on what is describes as "established health effect" which in the RF/MW range is only "tissue heating". Thus these standards ignore the highly probable health effects shown by the combination of laboratory, animal and epidemiological studies and hence is not a public health protection standard and should not be promoted and used as such.

There is more than enough research and published studies to show that adverse health effects are established to a high degree of probability by epidemiological studies, backed up by plausible biological mechanisms from laboratory and animal experiments, associate serious adverse health effects with chronic low level exposures to RF/MW radiation in occupational and residential situations where the mean exposure level is near or below $0.1 \mu\text{W}/\text{cm}^2$. This is 2000 times less than the guideline approved by the standards committee and over 100 times higher than the ambient exposure in rural New Zealand and Australia.

This is not the first review which shows that EMR at the occupational and residential levels of exposure with are on average significantly below the standards, which are based on heat avoidance, produce strongly associated adverse health effects. Two leading U.S. EMR researchers make similar conclusions and two highly eminent institutions also concur.

Frey (1994) states in his book "On the Nature of Electromagnetic Field Interactions with Biological Systems":

"First, I will detail some epidemiological and laboratory evidence indicating that em fields can promote cancer. Second, I will detail effects of electromagnetic fields have on neural and neuroendocrine systems. Then I will summarize the relevant information on how the neural and immune systems interact. With the foregoing as foundation, I will then integrate it all and spell out one means by which exogenous electromagnetic fields may promote cancer"

The biological mechanism presented involves the absorption of the em field at the cell membrane which perturbs the neurochemistry, with changes in dopamine, opiate and melatonin systems.

Cleary (1995), in the "Encyclopedia of energy Technology and the Environment" concludes in part:

"There is increasing evidence of possible health effects of environmental exposures to EMFs and EMR in the home and in the work place. Epidemiological evidence indicates possible associations of long-term exposure and cancer incidence, adverse reproductive outcomes, and behavioural and neurological changes."

The U.S. Environmental Protection Agency staff produced a review in 1990 which recommended that ELF be classified as a probable carcinogen and RF/MW as a possible carcinogen, Sibbison (1990).

In 1992 the European Parliament passed resolution B3-0280/92 which included in part:

"E: whereas the results of many in vivo and in vitro studies show increasingly clearly that the interaction mechanisms underlying such disorders and diseases [cancer, nervous disorders and circadian rhythm changes], centred mainly in the cell membrane, lead to disruption of melatonin secretions, ornithine decarboxylase activity and T-lymphocyte efficacy, testify to the probable role of non-ionizing radiation in promoting cancer,"

Some military and occupational groups are exposed to moderate to high exposures to RF/MW on occasions during their work. The prevailing international view is that the only effect of RF/MW is heating of tissue. It is also accepted that there is no scientific evidence that heating of tissue on a few degrees Celsius can cause cancer. Hence high military and occupational studies which find increased incidence of cancer cannot be dismissed on the grounds that their exposures are high. If it was true that high exposure groups were associated with high Risk Ratios for cancer, moderate exposure groups with moderate Risk Ratios and low exposure groups with low Risk Ratios then this would provide a form of gross dose-response relationship and would result in compelling evidence that RF/MW was probably or actually carcinogenic.

Using leukaemia as an example we might expect Polish Military personnel to be in a high exposure group, amateur radio operators to be moderately exposed group and residences of cities in the vicinity of TV and FM towers to be a low exposure group. The results of such studies are summarised in Table 1.

Table 1: A summary of epidemiological studies involving adult leukaemia mortality or incidence, ranked by probable RF/MW exposure category.

Study	Reference	Exposure Category	Leukaemia Type	Risk Ratio	95% Confidence Interval
Polish Military (Mortality)	Szmigielski et al., 1996	High	ALL	5.75	1.22-18.16
			CML	13.90	6.72-22.12
			CLL	3.68	1.45-5.18
			AML	8.62	3.54-13.67
			All Leuk.	6.31	3.12-14.32
Amateur Radio (Mortality)	Milham (1988)	Moderate/ High	AML	1.79	1.03-2.85
North Sydney TV/FM towers (Mortality)	Hocking et al.(1996)	Moderate	All Leuk.	1.17	0.96-1.43
			ALL+CLL	1.39	1.00-1.92
			AML+CML	1.01	0.82-1.24
			Other Leuk	1.57	1.01-2.46
UK TV/FM (Incidence)	Dolk et al. (1997b)	Low	Adult Leuk.	1.03	1.00-1.07

Note: ALL : Acute Lymphatic Leukemia; CLL: Chronic Lymphatic Leukaemia; AML Acute Myeloid Leukaemia; CML: Chronic Myeloid Leukaemia; and All Leuk.: All Adult Leukaemias.

By exposure ranking these studies a form of dose response relationship is found with increasing Risk Ratio with increasing exposure. This is referred to by Bradford Hill (1964) as a biological gradient which suggests a strong association between a disease agent (RF/MW) and disease (Leukaemia). Several other epidemiological studies have found statistically significant associations with RF/MW exposure and leukaemia, adding strength and consistency to this relationship. The Dolk et al. (1997b) study finds mean adult

leukaemia incidence varying with radial distance in a manner which is close to the likely exposure curve. This is a strong individual study's dose-response relationship.

This evidence more than is sufficient under the resource Management Act to establish a plausible biological mechanism and a potential adverse effect on the environment. Without the evidence presented above the Planning Tribunal in the MacIntyre/Bell South Case stated that the New Zealand Standard NZS 6609 as "not decisive" in RMA considerations where there is evidence of potential adverse health effects.

The Tribunal held that:

"we cannot avoid our duty to decide the resource consent application on the evidence by simply accepting the New Zealand Standard as decisive of the issue. The law does not give the standard that status. It is the Tribunal's duty to consider all the evidence and find whether or not there would be actual or potential effects on the environment of allowing the activity. we hold that compliance with the New Zealand Standard is not decisive of that question; and any challenge to the adequacy of the levels set in the standard is collateral to it."

It is important to note the context of this appeal. The applicant, BellSouth, was appealing the CCC imposition of a $50\mu\text{W}/\text{cm}^2$ exposure limit, seeking to have it changed to $200\mu\text{W}/\text{cm}^2$, the level in NZS 6609. The Tribunal clearly rejected this based on the evidence given, including evidence of potential adverse effects below $3\mu\text{W}/\text{cm}^2$ and the applicants willingness to reduce emissions to produce a public exposure of $1.6\mu\text{W}/\text{cm}^2$, and set the public exposure condition at the nearest dwellinghouse of $2\mu\text{W}/\text{cm}^2$.

Since this is the only legally and scientifically contested case about the health effects of cell sites in New Zealand it has the strongest precedent weight. Hence for the applicant and the CCC officers to recommend conditions based compliance with NZS 6609 is legally challengeable and inappropriate. It is a clear example of the way in which the officers' recommendations are ignoring legal and scientific evidence showing that under the RMA legal framework the standard has no status nor standing and the environment court has moved to a public exposure level of 1 % of the standard. The finding of the MacIntyre case also state that the level should be revised when there is new evidence. There is a host of new evidence which is summarised here.

1.2 Summary of Evidence:

In this report will give evidence which will show the following:

- That the New Zealand Standard is based on avoidance of heating effects and does not protect public health from adverse health effects linked to chronic extremely low level exposure to RF/MW radiation as indicated by biochemistry, animal studies and epidemiology.
- That the committee which sets the standard is comprised largely but not exclusively by pecuniary interested stakeholders who derive financial benefit from the production and usage of RF/MW radiation.

- That athermal biological effects have been identified which relate to adverse health effects.
- That biological effects identified for ELF exposures also apply to RF/MW which is pulsed or modulated at ELF frequencies with the difference that RF/MW has a far higher penetration into tissues than does ELF signals.
- That experiments on animals, which are normally used in chemical, cosmetic and drug tests of human safety, when used to test the safety of electromagnetic radiation show adverse health effects.
- That epidemiological studies of populations who are known to experience above average exposures to RF/MW radiation, form a strong and coherent set of evidence, which is consistent with the cellular changes and animal experiments, which shows that RF/MW radiation is a very highly probable or even an actual adverse health causal agent.
- That, given the above evidence which also shows that effects occur in residential populations at very low exposure levels, consistent with those experienced with hundreds of metres of cell phone base stations, that cell phone base stations should be located a considerable distance from residences, worksites, schools, preschools and hospitals.
- That given the health effect are real risks, the strong and supportable anxiety that such scientific information provides, the costs to the community and the health system cannot be offset against any additional costs which might be entailed in locating cell sites base stations away from homes and rural towns. These costs should be borne by the users and producers of the cell phone technology by requiring them to locate their base stations well away from public assess places where people spend more than 4 hours per day.
- Because of the results of epidemiological studies of public exposure then:

**The national standard for public exposure
should be set at $0.1 \mu\text{W}/\text{cm}^2$.**

1.3 Professional Scientific background:

My name is Neil James Cherry, I have the degrees of B.Sc. (Hons) and Ph.D. in Physics from the University of Canterbury. I am a member of a number of learned societies, including Fellow of the Royal Meteorological Society (F.R.Met.S.), member of in the Royal Society of N.Z. (M.R.S.N.Z.) and member of the International Society for Environmental Epidemiology (M.I.S.E.E.). I was Senior Lecturer in Agricultural Meteorology in the Department of Natural Resources Engineering at Lincoln University for 23 years and hence I am a professional biophysicist. I have 28 years of post graduate research experience, about 25 years of research into air pollution, including air pollution epidemiology and health effects. I teaching experience in undergraduate and graduate courses in environmental engineering, environmental physics, air pollution meteorology, modeling and health effects, atmospheric chemistry, environmental epidemiology, biometeorology and human biometeorology.

I have over 15 years research experience in human biometeorology and environmental epidemiology, and in studying the effects of the natural environment on human physiology, psychology and brain function. Repacholi (1993) (The WHO/IRPA/UNEP sponsored review) notes: "The biological effects of electromagnetic fields is multidisciplinary; it draws from physics, engineering, mathematics, biology, chemistry, medicine and environmental health". My academic qualifications, teaching and research experience, which include professional training, teaching, research in physics, engineering, mathematics, biology, chemistry and environmental health, provides a broad and sound foundation for researching the adverse health effects of EMR from an integrative, multi-disciplinary approach.

I have used my wide multi-disciplinary experience over about the last 4 years to review the published research of the effects of artificial electromagnetic radiation on human physiology, brain function and health. This included a recent international study tour to major universities and laboratories who are engaged in researching EMR effects. I have authored several widely internationally circulated reviews of the scientific literature on EMR health effects.

1.2 Planning and RMA background:

I am an elected member of Canterbury Regional Council and Chairperson of the Resource Planning Committee, with considerable experience in the use, interpretation and implementation of the Resource Management Act 1991, through academic study and lecturing, Resource Consent hearings, Environment Court hearings, and policy and plan development.

1.3 Independence of Evidence:

I bring a totally independent scientific and professional approach to this evidence, with no pecuniary interest in the subject. My professional base is Lincoln University. I have strong community support, shown by the large number of New Zealand, Australian, U.S., U.K. and Irish individuals, community groups and councils who have sought my reviews and my evidence at hearings, review panels, Inquiries, pension claims and insurance claims.

My interpretation of the research results is frequently at variance with scientific and expert evidence submitted by consultants engaged by industry and applicants for resource consents. Because of these differences I have taken great and careful pains to check and cross-check my information and interpretation with the authors of the papers and reports where possible and practical, and with other independent scientists, doctors and researchers in laboratories and universities and in private practice.

A totally independent public authority, the New Zealand Parliamentary Commissioner for the Environment, in her 1996 report "Public Authority Planning for cellphone transmission facilities", states:

"Scientific and technical information on the subject should be 'neutral'. Much of the technical and scientific expertise, however, resides in the companies and may not be perceived as neutral by the community. Local authorities need an independent source of advice in order to fulfill their responsibilities under the RMA. Where a public agency is seen to support the industry, local

authorities and the public may perceive that an agency is not truly independent and may distrust the information provided.”

I strive to provide totally independent, high quality, scientific advice with the primary emphasis on assessing the public health impacts and taking a public health protection approach as a matter of priority.

A valued colleague, an eminent epidemiologist and public health professional, Professor John Goldsmith, who was a member of our team of expert witnesses for the MacIntyre/BellSouth Planning Tribunal appeal, stated in the conclusions to one of his published reviews, Goldsmith (1995):

“There are strong political and economic reasons for wanting there to be no health effect of RF/MW exposure, just as there are strong public health reasons for more accurately portraying the risks. Those of us who intend to speak for public health must be ready for opposition that is nominally but not truly, scientific.

At present there seems to be little interest in or understanding of epidemiologic information among regulatory bodies that should provide protection. While we conduct epidemiologic studies as well as we possibly can, we who are concerned with health protection and careful identification of risks must also keep pressure in regulatory agencies to include epidemiologic thinking in their work.”

There is strong, and growing, epidemiologic evidence, with reinforcing and related animal and cell biological research, to show that chronic low-level exposure to RF/MW produces increased risk of adverse health effects in occupational groups and residential populations.

As the evidence for adverse health effects from EMR continues to mount year by year, experts on behalf of industrial clients still claim that there is no substantial evidence of effects below the thermal threshold, no evidence of a causal adverse effect and/or no proof of adverse effects. They also say that experiments need to be replicated and that more and more research is required. Enough evidence existed many years ago for the following two reviews to come to strong conclusions. The RMA requires only the establishment of a potential adverse effect in order to invoke section 5(2)(c) and Section 3(f), to avoid, remedy or mitigate any potential adverse effect.

1.4 New Zealand’s Law, The Resource Management Act 1991:

The Resource Management Act 1991 (RMA) regulates all construction and industrial and trade discharges of contaminants into the environment. A cell site requires a building resource consent from a territorial authority. If RF/MW radiation is recognized as an issue in a Regional Air Plan then the discharges into the environment can be controlled through rules in that Plan. The Canterbury Regional Council has legal advice that RF/MW is a contaminant under the RMA and therefore can be regulated through a regional air plan. Irrespective of this in deciding on any resource consent or district or regional rule, an assessment of the effects on the environment must be carried out according to the Fourth Schedule. Over-riding this is a general duty, Section 17, for every person to avoid,

remedy or mitigate any adverse effects of an activity on the environment, enforceable through an Enforcement Officer or the Environment Court. "Effects" include any potential effects of low potential probability which has a high potential impact, Section 3 (f).

The RMA threshold test is that it is more likely than not that there is a potential effect of low probability which has a high potential impact.

1.4.1 Definition of contaminant:

In relation to cell sites and the discharge of RF/MW into the environment, Section 2 of the RMA defines a "contaminant as "includes any substance (including gases, liquids, solids, and micro-organisms) or energy (excluding noise) or heat, that either by itself or in combination with the same, similar, or other substances, energy, or heat (b) When into air, changes or is likely to change the physical, chemical, or biological condition of the air into which it is discharged. RF/MW radiation is a form of energy which heats and changes the biological conditions of cells irradiated by it in the environment having passed into the air.

1.4.2 Purpose of the RMA, Sustainable Management, Adverse Effects:

The purpose of the RMA is to promote the sustainable management of natural and physical resources. This means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while -

- (a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
- (b) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
- (c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment.

where (Section 3) the definition of "Effect" includes -

- (a) Any positive or adverse effect; and
- (b) Any temporary or permanent effect; and
- (c) Any past, present, or future effect; and
- (d) Any cumulative effect which arises over time or in combination with other effects - regardless of the scale, intensity, duration, or frequency of the effect, and also includes -
- (e) Any potential effect of high probability; and
- (f) Any potential effect of low probability which has a high potential impact.

The definition of "Environment" in this Act, includes "Ecosystems and their constituent parts, including people and communities;..".

1.4.2.1 Cumulative potential effects:

The Resource Management Act directly recognizes cumulative effects and potential effects. The cumulative risk of cell damage from chronic low level exposure to the RF/MW radiation from a cell site, clearly conforms to the definition of a cumulative effect, **regardless of scale, intensity, duration and frequency** and a "potential effect of low probability which has a high potential impact", e.g. cancer, miscarriage, learning difficulties, sleep disruption or chronic fatigue syndrome.

1.4.2.2 Alternative sites - alternative receiving environments:

In giving guidance about the rules in plans about discharges into the environment the RMA states (Section 70 (2)) that, "Before a regional council includes in a regional plan a rule requiring the adoption of the best practicable option to prevent or minimise any actual or likely adverse effect on the environment of any discharge of a contaminant, the regional council shall be satisfied that, having regard to -

- (a) The nature of the discharge and the receiving environment; and
- (b) Other alternatives, including a rule requiring the observance of minimum standards of quality of the environment, -

the inclusion of that rule in the plan is the most efficient and effective means of preventing or minimising those adverse effects on the environment."

The Fourth Schedule lists the Matters that should be included in an assessment of effects on the environment, which includes: (f) Where the activity includes the discharge of any contaminant, a description of-

- (i) The nature of the discharge and the sensitivity of the proposed receiving environment to adverse effects; and
- (ii) Any possible alternative methods of discharge, including discharge into any other receiving environment:
- (g) A description of the mitigation measures (safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce the actual or potential effect:

1.4.3 Avoiding siting cell sites near sensitive receiving environments:

Cell sites radiate low levels of RF/MW radiation into the environment surrounding the site. Hence when considering the siting of cell sites the nature and sensitivity of the receiving environment is critical. Applicants for Resource Consents are required to investigate other receiving environments, i.e. alternative sites with less sensitivity to the effects of the discharge. The effect of the discharge is required to be prevented or minimised, including the consideration of less sensitive sites. Because of the epidemiological evidence of health effect risks, environments which include long term exposure of people, especially the young, the elderly, pregnant women and the sick, i.e. schools, preschools, hospitals, retirement homes and residences. In addition some work places involve vulnerable

people for 9 hours a day (8am to 5 pm) and hence could be considered as sensitive receiving environments.

2. New Zealand Court precedents which guide the scientific approach:

Three Planning Tribunal/Environment Court (The Court) cases are considered relevant to the consideration of the approach to scientific evidence and expert witnesses:

- Rodney District Council/Transpower (A85/94), a high voltage powerline appeal which relates to adverse health effects, plausible mechanisms, the balance of probabilities, and conflict of evidence as well as the role, approach and status of expert witnesses.
- MacIntyre/BellSouth (A15/96), a cellsite appeal based on adverse health effects, and focuses on Section 3(f) of the RMA 1991 and establishing a condition for public exposure under which there was no evidence of adverse effects, "even a potential effect of low probability and high potential impact". It also recognizes the need for a review in the light of new evidence. Scientifically contestable evidence was presented and tested under cross-examination.
- Beckenham/Telcom (W165/96) a cellsite appeal based on visual effects, but includes scientifically uncontested and legally unargued discussion of health effects where the Court considers that "the onus of proof is Telecom to persuade us on the balance of probabilities".

2.1 Rodney/Transpower Case: 20 September 1994 - 17 October 1994.

This case was about potential adverse health effects from a high tension powerline. The key finding relates to decisions made under situations of scientific uncertainty. It addresses issue relating to "plausible mechanisms", "balance of probabilities" and "scientific consensus" under conditions of a conflict of evidence. The decision (A85/94) states (p21):

"It is our duty to make findings about actual or potential effects of the proposed activity on the environment. To make our decision on a question on which there is a conflict of evidence, we have to be satisfied on the balance of probabilities, having regard to the gravity of the matter in question."

"We accept the validity of statements of Dr Repacholi that it is not possible for scientists to prove that exposure to electrical magnetic fields from high voltage transmission lines does not have adverse effects on health; and that an appropriate approach is that with open minds we carefully consider the evidence from studies that suggests that there is or is not an effect. Yet although we can accept that scientific knowledge about the potential adverse effects of the fields may be incomplete, it is our duty to make a decision now, on the present state of knowledge. It would be an abdication of that duty if we were to allow opponents of proposals to prevent them from proceeding on the basis that science might discover effects that had not yet been established. That is not to reject the precautionary approach, but there needs to be some plausible basis, not mere suspicion or innuendo, for adopting the approach."

This gives guidance on the application of the precautionary approach when applying the provisions of the RMA relating to potential adverse health effects that: **“there needs to be some plausible basis, not mere suspicion or innuendo, for adopting the approach.”**

2.1.1 Weight of expert evidence:

In order to establish a plausible mechanism scientific evidence must be presented. A plausible mechanism may be proposed by one side of a case and be attacked as implausible by the other. When there is conflict between experts about that evidence the status and plausibility of the experts becomes relevant.

2.1.2 Status of experts:

The Court notes that there is a “conflict of evidence” and set about resolving that conflict through ranking the quality of the experts and their evidence.

Three expert witnesses presented evidence. Dr Michael Repacholi and Dr Andrew McEwan presented evidence on behalf of the applicant and Dr Ivan Beale gave independent evidence. The decision is very instructive on the status of experts and the use and interpretation of expert scientific evidence in the Environmental Court.

The decision stated: “As a judicial body it would not be appropriate for us to weight suspicion, even when expressed by one who is qualified as an expert witness, against the opinions of even better qualified experts which are consistent with the consensus of the international scientific community.”

At that time none of these experts had published any fundamental research that they had carried out on the adverse health effects of powerlines, although Dr Beale was carrying out such a project at that time. Dr Beale’s project was given no weight by the Tribunal , assisted by comment from Dr McEwan, because it was not written up, not peer-reviewed and not published. On the other hand, while Drs Repacholi and McEwan had no relevant publications of their own. Their evidence was given weight because it was consistent with the claimed “consensus of the international scientific community” and that the exposures of the residents would be a small fraction of the allowed international guidelines.

A further reason for according the evidence of Drs Repacholi and Mc Ewan a higher status was because Dr Beale “did not produce the reports of the studies on which he relied, and did not refute his colleagues claims that they (the reports) were inconclusive because of methodological weaknesses”.

Dr Repacholi’s status is clear as the chairman of two highly significant international commissions but he has never published any basic scientific research on health effects of powerlines which was relevant in this case. The nature of this claimed “consensus of the international scientific community” needs to be viewed critically since so much emphasis is placed on it by the Court and the experts for the applicant.

2.1.3 International Scientific Consensus:

The applicant's case was that there was no evidence of adverse effects, neither through a biological mechanism, nor through epidemiological studies. Dr McEwan deposed that "there is no established interactive mechanism which explains how biological cells might be affected by external weak fields; that epidemiological studies show a lack of consistency and had not established any causal association between health effects and exposure to ELF magnetic fields." He further stated that the NRL recommends the use of the interim 1990 ICNIRP guidelines which were reviewed and confirmed by the commission in 1993. "Dr McEwan deposed that the guidelines had been based on careful examination of the research data on effects of exposure to ELF electric and magnetic fields, and include a margin of safety."

Expert "confirmation" of Dr McEwan's evidence is given by Dr Repacholi. Dr Repacholi "deposed that laboratory evidence does not support there being a link between exposure to 50/60 Hz fields and carcinogenesis or any form of cancer" and he says that epidemiological studies has not established an association between cancer and 50/60 Hz fields neither for workers nor for residents.

This appears to establish a very strong four-tier case for no adverse effects:

- No plausible biological mechanism.
- No epidemiological association of risk of an adverse health effect.
- International consensus that there are no biological mechanisms nor public health risks.
- Confirmation that public exposure falls within international guidelines.

In critically assessing this approach it is vital to note that very different approaches to assessment of evidence and levels of proof are being used. One seeks "Proof of an Effect" and another seeks "Evidence of Risk of an Effect".

2.1.4 Proof of an Effect Approach (Strong Proof):

This approach uses the terms of scientific proof and seeks a very high level of confidence that evidence of an effect is available. It requires that the research results referred to have to be highly reliable and repeated before identification of an adverse effect is made. The requirement is for strong links to be made and for proof of causation to be established before an adverse health effect is accepted. Thus only reliably proven adverse effects can be used to set guidelines and standards. Hence only thermal effects are used are used to set the international and national standards because they are the only effects accepted by the selected reviewers as scientifically proven.

2.1.5 Proof level used by applicant experts and international guidelines:

The "proof stance" an expert witness or a group of experts takes is revealed by the phrases and language used in their evidence.

The terms such as "not supporting there being a link" and "established" or "established any causal association", show that the high level of proof is being applied. Drs McEwan and Repacholi both use this strong proof language.

In reviewing the documents of the international bodies which set the EMR guidelines we find the same strong proof language. By applying such tests epidemiological evidence is almost entirely excluded from standards setting because by its nature it does not provide proof of causation.

Jammet (1990) outlines the criteria used by UNEP/WHO/IRPA/ and ICNIRP for limiting exposure to 50/60Hz fields:

“The limits recommended in these guidelines were developed primarily on established or predicted immediate health effects produced by currents induced in the body by external electric and magnetic fields.”

Epidemiological research was found to:

“provide some support for the findings of a previous study on childhood cancer and exposure to weak electric fields”

but

“To date, chronic low-level exposure to 50/60 Hz fields has not been established to increase risk of cancer.” (Strong proof language).

Given this rejection of the epidemiologic evidence the IRPA set public exposure limits at an induced current of 2 mA/m² which is equivalent to an electric field of E=5 kV/m or B=0.1 mT, which will avoid shocks and perception of the presence of the field. This is far above the levels in which children live who have been shown to have increased risk of leukaemia, for example, which is around 0.2 to 0.5 µT, or down to 500 times lower than the recommended standard.

Protecting workers from gross, immediate effects of induced currents is very different from protecting residents from chronic low level exposure when residing near high voltage power lines. The expert witnesses for the applicant, Dr Repacholi and Dr McEwan seek status and strength of argument by referring to the international consensus that there are no established effects and that international guidelines give levels of exposures under which there will be no proven adverse effects.

2.1.6 Level of Scientific proof used by the Court:

The Court appears to be unaware of the strong proof approach of these experts and in the UNEP/WHO/IRPA/ and ICNIRP guidelines. Dr Repacholi is the chair of the major international commissions and was chair of the Australasian EMR standards sub-committee, indicating the likelihood of consistency of the strong proof approach being applied locally and internationally.

In contrast, the legal guidance given by the Court in its interpretation of the Resource Management Act requires the adoption of the “evidence of risk” approach. The Court states that there must be “some plausible basis” for adopting a precautionary approach. Sections 5(2)(c) and 3(f) of the RMA 1991 apply and the court states that “we have to be satisfied on the balance of probabilities, having regard to the gravity of the matter in question. The possibility of adverse effects on the health of the people who may be exposed to electric and magnetic fields from high voltage power lines has sufficient gravity to deserve a higher standard of proof.”

This statement points to the “evidence of risk” approach because of the “gravity of the situation with respect to the health of the people”.

However, the Court was steered away from this to a strong proof approach advocated by the expert witnesses on behalf of the applicant and in the relative absence of presentation of evidence to the contrary. It is very difficult for the Court when International and National experts do not present the available evidence when it would be contrary to their client’s interests and no equivalent standing independent expert is sought and available to provide the total sweep of evidence available.

2.1.7 The Nature of the International Group setting the International Consensus and Guidelines:

The WHO 1993 review team was derived primarily from the International Radiation Protection Association (IRPA), which in 1992 formed an independent commission called the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Evidently three apparently separate and independent bodies, the IRPA, the ICNIRP and the WHO, contain primarily the same group of people, Table 2.

It is seen that there is a strong overlap in membership of international commissions which all involve national representatives and draw from a small pool of eminent scientists. The first eight members are on both commissions, giving a total scientific membership of the two commissions of 19 people, Table 2.

Table 2: Membership of three of the major international commissions which produce the “international consensus” on EMR health effects.

WHO 1993 Review Team	ICNIRP 1996 Commission
^a Dr M. Repacholi (Chairman)(Aust)	Dr M. Repacholi (Chairman) (Aust)
^a Prof. M. Grandolfo (Italy)	Prof. M. Grandolfo (Italy)
^a Prof. J. Bernhardt (Germany)	Prof. J. Bernhardt (Germany)
^a Dr L.A. Court (France)	Dr L.A. Court (France)
^a Dr A. McKinlay (Observer) (UK)	Dr A. McKinlay (UK)
Dr M. Swicord (USA)	Dr M. Swicord (USA)
^a Dr A.J. Stolwijk (USA)	Dr A.J. Stolwijk (USA)
^a Dr L.D. Szabo (Hungary)	Dr L.D. Szabo (Hungary)
Dr C.F. Blackman (USA)	Prof. A. Ahlbom (Sweden)
Dr R.D. Saunders (UK)	Dr. U. Bergqvist (Sweden)
^a Prof. M.G. Shandala (USSR)	Dr J.S. Cesarini (France)
^a Dr M.A. Stuchly (Canada)	Dr D.H. Sliney (USA)
Dr S. Szmigielski (Poland)	Dr T.S. Tenforde (USA)
	Dr H.P. Jammet (France)
^a Mme A. Duchene (Secretary)(France)	R. Matthes (Secretary) (Germany)
^a From the International Non-Ionizing Radiation Committee of the IRPA.	

Hence, the “international consensus” claimed is not as substantial as might initially be assumed. A broader group of scientists were involved in the U.S.E.P.A. 1990 report, 7 with the writing, 22 as reviewers and a further 9 who participated in a Peer Review

Workshop, totally 38 of the United States' top EMR researchers and environmental health experts.

2.1.8 Available Evidence was not presented to the Court:

Many available published papers were not presented to the court. For example, Perry et al. (1981) studied the incidence of suicide near powerlines in the West Midlands of England and found "a significant correlation between suicide locations and the measured power-frequency magnetic field strength. Significantly more suicides occurred at locations of high magnetic field strength." This result is consistent with depression which is associated with melatonin disruption in Seasonally Affective Disorder and studies presented here showing probable melatonin disruption with EMR exposure.

The Court can only deal with evidence which is placed before it. The eight of the most comprehensive research reviews of EMR health effects published to date are:

- 1981: The WHO review: "Environmental Health Criteria 16: Radiofrequency and Microwaves". Shore (1981)
- 1990: The U.S.E.P.A. review "Evaluation of the potential Carcinogenicity of Electromagnetic Fields"
- 1992 The Oak Ridge Associated Universities (ORAU) Review: "Health Effects of Low-Frequency Electric and Magnetic Fields".
- 1993: The WHO review: "Environmental Health Criteria 137: Electromagnetic Fields (300 Hz to 300 GHz)". Repacholi (1993).
- 1994: The Swedish review of ELF effects: "Exposure to extremely low frequency electromagnetic fields and the risk of malignant diseases - an evaluation of epidemiological and experimental findings." Hardell et al. (1994)
- 1994: C.S.I.R.O. Review: "Status of research on biological effects and safety of Electromagnetic Radiation: Telecommunications Frequencies". Barnett (1994)
- 1995: Encyclopedia of Energy Technology and Environment, Electromagnetic Fields, Health effects, Cleary (1995)
- 1997: The U.S. National Research Council report "Possible Health effects of Exposures to Residential Electric and Magnetic fields".

The second, third and fifth are relevant to ELF and were available for the Rodney hearing in September 1994 but only the third was referred to. The eighth is also about ELF effects but was not available for the Rodney case. The 1990 E.P.A. review includes the statement:

"In view of these laboratory studies (about EMR biological effects), there is reason to believe that the findings of carcinogenicity in humans is biologically plausible".

It concludes its epidemiological review with:

“In conclusion, after examination of the available epidemiologic data over the past 15 years, there is evidence of a positive association of exposure to magnetic fields with certain forms of site-specific cancer, namely leukemia, cancer of the CNS, and, to a lesser extent, lymphomas.”

This report originally recommended that ELF's be classified as a probable carcinogen and RF/MW as a possible carcinogen, Sibbinson (1990). This strongly conflicts with the evidence presented at the Rodney hearing which relied to some extent on the ORAU review.

The court recorded Dr McEwan's evidence as concluding:

“that there was no convincing evidence to support the contention that exposures to extremely low frequency electric and magnetic fields generated by sources such as power lines are demonstrable health hazards; that epidemiological findings of an association between electric and magnetic fields and childhood leukemia or other childhood or adult cancers are inconsistent and inconclusive; that no plausible biological mechanism had been presented that would explain causality; and that lack of epidemiological support was consistent with calculations of quantities based on Fundamental laws of physics for describing electric and magnetic fields which showed that the fields induced in the human body from external extremely low frequency sources are generally much weaker than intrinsic fields created by the normal activity of the body. They concluded that any assessment of a health risk associated with fields emitted by those sources would be speculative and seemingly unjustified. Having made subsequent reviews of more recent studies, the authors of those reports considered that the later results did not give sufficient ground to change their conclusions.

In summary, it was Dr McEwan's opinion that there is no established interactive mechanism which explains how biological cells might be affected by external weak fields; that epidemiological studies show a lack of consistency and had not established any causal association between health effects and exposure to extremely low frequency magnetic fields; and that while the evidence does not demonstrate a risk to health, if the risk does exist it would be very small.”

Plausible Biological Mechanism:

Dr McEwan ignores the evidence about melatonin reduction and calcium ion efflux and concludes: “that no plausible biological mechanism had been presented that would explain causality.” and “there is no established interactive mechanism”.

“Causality” and “established” are language from the “strong proof approach”. This is the approach adopted by the ORAU team and Dr McEwan. This approach is inappropriate in the RMA legal environment. Dr McEwan generally accurately reports the reviewers conclusions but in many cases the conclusions can be challenged. In chapter 2 of the review calcium ion efflux is dismissed as a biological mechanism because the fields associated with the observed effects are below the thermal threshold and the observed

thermal field voltage gradients of about 0.02 V/m at the cell level and an electric field gradient of 280 V/m across the cell membrane and the lack of a known physical coupling model.

Calcium ion efflux has been repeatedly observed in fields modulated at ELF frequencies at cell membrane exposure levels far below the thermal threshold, with non-linear responses being identified.

The icing on the cake for those taking a strong proof approach is their inability to accept an athermal biological effect when their physics calculations apparently show induced fields at cellular level which are less than the intrinsic fields of the cell membrane for example and hence are assumed not to be able to cause change. With ELF biological research it has been shown repeatably that the modulation is critical and the magnitude of the modulation can be very much smaller than a static field and still be detected and reacted to. For example Liburdy et al. (1993) found that melatonin reduces the growth rate of human breast cancer cells (MCF-7) in culture, but that 12 mG 60 Hz magnetic field completely blocks the protective effect of melatonin. They suggest a threshold between 2mG and 12 mG.

Changes in rodents' pineal melatonin are dismissed for similar physics-based reasons in Chapter 2, by Dr Bennett of the Department of Applied Physics, Yale University. However, the chapter on neurobehavioural effects, co-authored by a medical researcher from the University of Texas, Dr Russell Reiter, author of many papers on melatonin, is much more positive about EMF reductions in pineal melatonin in rodents. It includes the conclusion: **"Thus, at this stage, although pineal effects seem to have been documented in nonhuman mammals as a result of EMF exposure, in humans there is no evidence suggesting adverse health effects related to disturbance of pineal physiology."** **"However the positive data relating to EMF effects on pineal serotonin metabolism should not be ignored."**

The ORAU review reported several nonhuman mammals which showed melatonin reduction with electric, magnetic and combined electric and magnetic fields. Yellon (1991) who studied the effect of 60 Hz magnetic fields on Djungarian Hampsters, and found daytime levels of Pineal and Serum Melatonin were the same but exposed animals has a lower and later nocturnal pineal peak and a much lower serum melatonin concentration. In relation to this study, pVII-27, **"this finding makes a very strong argument for magnetic field effects on the circadian melatonin rhythm. Furthermore, the findings show that daytime exposures to such fields may have very significant consequences in terms of the subsequent night's melatonin rise."**

The review's final conclusions include the statement: "When considered collectively, however, the findings suggest either a direct or indirect interaction of fields with at least one aspect of pineal metabolism, namely the nocturnal conversion of serotonin to the primary pineal hormone, melatonin."

This and other statements within the ORAU report can be used to construct a "plausible biological mechanism" such as is required by the Court for the identification of a potential effect, but in a strong proof approach the possibility of melatonin reduction is as yet unproven in human beings and therefore is not part of a causal effect.

Epidemiological evidence:

Dr McEwan quoted the results of a review carried out by Dr Dockerty in Dunedin. Dr Dockerty reviewed 15 studies, only two of which reached the 95 % confidence level of statistical significance. Dr McEwan's primary source is the ORAU review carried out on behalf of the Department of Labour by an eleven member team from the Oak Ridge Associated Universities. They claim to have reviewed about 1000 journal articles which had been published in the past 15 years (to 1992). The total number cited which relate to biological effects is about 420 and to epidemiological effects is about 80.

A detailed reading of the ORAU report reveals considerable epidemiological and biological evidence of a potential effect but the conclusion the court recorded in relation to Dr McEwan's use of this review was expressed in "strong proof" language.

Of the 35 epidemiological studies cited on leukaemia, for example, 23 have rate ratios greater than 1.0 and eleven of these reach the 95 % confidence level. Of the 12 which have $RR \leq 1.0$, 8 have 40 or fewer exposed people with leukaemia.

Table 3 summarizes the integrated results of the occupational studies reviewed and clearly shows statistically significant Risk Ratios for proportional incidence and mortality and for Cohort studies. The case control studies were marginally non-significant. Notice that the review only covers papers published up to 1991.

Table 3: Summary analysis of occupational studies on EMFs and leukemia. (Extracted from ORAU Table V-14.)

Leukemia Type	Design (n = observed cases)	Summary RR (95% CI)	References*
All leukemia	Proportional mortality (n=618)	1.2 (1.1-1.2)	1,2,3,4,5,6,7
	Proportional incidence (n=148)	1.2 (1.0-1.4)	8,9
	Case-control	1.1 (0.9-1.3)	10,11,12,13,14,15,16
	Cohort (n=599)	1.1 (1.0-1.2)	17,18,19,20,21,22,23, 24,25,26,27,28
Acute myeloid	Proportional mortality (n=93)	1.2 (1.0-1.5)	2, 4, 7
	Proportional incidence (n=55)	1.5 (1.1-1.9)	8,9
	Case control	1.6 (1.2-2.0)	11,13,14,15,16,29,30,31
	Cohort (n = 128)	1.2 (1.0-1.5)	21,22,23,26

*References: (1) Peterson and Milham 1980; (2) McDowall 1983; (3) Calle and Savitz 1985; (4) Milham 1985a; (5) Milham 1985b; (6) Gallagher et al. 1990; (7) Robinson et al. 1991; (8) Wright et al. 1982; (9) Coleman et al. 1983; (10) Dubrow and Wegman 1984; (11) Gilman et al. 1985; (12) Stern et al. 1986; (13) Orams 1988; (14) Pearce et al. 1989; (15) Loomis and Savitz 1990; (16) Bastuji-Garin et al. 1990; (17) Wiklund et al. 1981; (18) Olin et al. 1985; (19) Blair et al. 1985; (20) Tornqvist et al. 1986; (21) Milham 1988a; (22) Linet et al. 1988; (23) Tornqvist et al. 1991; (24) Garland et al. 1990, (25) Juutilainen et al. 1988; (26) Juutilainen et al. 1990, (27) Tola et al. 1988; (28) Matanoski et al. 1989; (29) Flodin et al. 1986; (30) Loomis and Savitz 1989; (31) Cartwright et al. 1988.

If the Court had been shown this table then their conclusions could well have been different. In fact the data presented in the ORAU Table V-14 is consistent with the conclusions of the EPA 1990 review and Hardell (1995) with their greater number of reviewed papers.

In contrast, the Hardell review considered nearly 100 epidemiological studies, dozens of which achieved statistical significance, and hence the conclusions were drawn that cancers, particularly leukaemia, breast cancer, melanoma and nervous system tumours, are associated with ELF exposure. Similar conclusions were also found by the U.S. E.P.A. 1990 review.

Hardell et al. (1995) reviewed the scientific literature published up to July 1994 and concluded that there was:

- An increased risk of leukaemia in children and the existence of, or distance to, power lines in the vicinity of their residence.
- An increased risk of chronic lymphatic leukaemia and occupational exposure to low frequency electromagnetic fields.
- An increased risk of breast cancer, malignant melanoma of the skin, nervous system tumors, non-Hodgkin lymphoma, acute lymphatic leukaemia and acute myeloid leukaemia and certain occupations, involving design, manufacture, installation or maintenance of electronic or electric equipment.

The conclusions of the Swedish and U.S.E.P.A reviews are very different from those quoted at the Court hearing by the experts for the applicant, even though there is a great deal of published review material held in common. It is the difference in approach to the interpretation of the data which leads to the difference in conclusion. A "strong proof approach" finds many reasons to dismiss evidence of highly probable health effects because it does not constitute causal proof. The language used is very important. For example the use of the word "risk". Hardell et al. (1994) conclude from statistically significant epidemiological research that there is "increased risk of" many adverse health effects. On the other hand Dr McEwan used the absence of causal proof as evidence of no "demonstrated risk to health". For public health epidemiologists, final causal proof of an effect is not necessary for there to be an avoidable risk of an adverse health effect.

2.1.9 Plausible Mechanism:

The Court decision on the application of the RMA provides some guidance on a "plausible mechanism" which is required to establish a potential effect.

The fact that an available plausible biological mechanism was not presented to the Court by the expert witnesses shows the role of evidence in RMA decision making and the problem when the expert witnesses appearing are unaware of the most recent research or take a selective approach to it on behalf of their client.

Reiter (1994) published a review of the research on melatonin suppression by ELF electromagnetic fields and the relationship to the reported increased incidence of cancer. From papers and reports published up to 1993, hence they were available for the Rodney Hearing, Reiter concludes that animal experiments show that ELF suppresses nocturnal melatonin, melatonin is a potent free radical scavenger and so is a "potent oncostatic agent and it prevents both initiation and promotion of cancer." Reiter (1994) therefore states:

“Thus, if in fact artificial electromagnetic radiation increases the incidence of cancer in humans, a plausible mechanism could involve the reduction of melatonin which is the consequence of such exposures.”

Hence a plausible mechanism, melatonin reduction, was available, and a much larger set of epidemiological studies than cited by Dockerty, with statistically significant associations of ELF exposure with cancer incidence, was available, but was not presented by any of the expert witnesses. Hence the finding of no adverse health effects was made in the absence of the substantial body of evidence which was available but was not presented at that time.

2.1.10 Commentary:

Dr Beale has now completed and published his research in a highly reputable, international, peer-reviewed journal, and it does show statistically significant psychological and adverse health effects, with linear dose-response relationships for several health variables. Significant dose-response relationships, coupled to plausible mechanisms, are very close to being accepted as causal. Swedish studies, Feychting and Ahlbom (1993, 1995), identify linear dose-response ($p=0.005$) relationships for childhood leukaemia and magnetic field strength in relation to power line proximity.

Other internationally credible bodies had reviewed the international literature and concluded that there was strong evidence of adverse health effects associated with powerlines, contrary to the claimed “scientific consensus” deposed by Drs Repacholi and McEwan. These include a review team of U.S. EPA scientists, Sibbison (1990), the European Parliament (1992), Cleary (1994), and the Swedish reviews, Hardell et al. (1995), for example. Even the 1997 U.S. National Research Council (NRC) report “Possible health effects of exposure to residential electric and magnetic fields”, which was widely reported as a “no effects report”, had epidemiological findings which included the statement:

“These studies found the highest wire-code category is associated with a rate of childhood leukemia (a rare disease) that is about 1.5 times the expected rate.”

According to Dr Richard Luben, a member of the review panel, this conclusion survived the very high replicated study standard imposed by the review committee.

A scientifically comprehensive and objective presentation of studies available to the court in late 1994 would have more than satisfied the requirement to show a plausible biological mechanism and a potential adverse health effect from living near powerlines. The court was not presented with this data and made its findings accordingly. In giving its findings clear guidance is given about the nature and quality of the scientific evidence required. Subsequent publication of research results strengthens the conclusions which could have been drawn at the time of the hearing, that there are adverse health risks of living near powerlines.

The expert witnesses appearing for the applicant take a high proof approach, which in the RMA legal environment, effectively misled the Court into concluding that there were no plausible mechanisms and no risk of adverse health effects, when a more comprehensive approach based on seeking evidence of potential effects would have easily identified

reduced melatonin as a plausible mechanism for increased cancer, and there exists in epidemiological research evidence of a significant risk of leukaemia, especially acute myeloid leukaemia.

This case illustrates the way in which expert witnesses assist the applicant to construct a set of evidence which supports the granting of a Resource Consent. It is seen that this can involve careful selection of approaches and scientific studies which support the case. The Court appears to be unaware of the use of a strong proof approach being taken by witnesses for the applicant when the law under which the hearing is being held is a potential effects approach.

2.2 MacIntyre/BellSouth Case:

In New Zealand the Environment Court (as the Planning Tribunal) in 1995 heard the case of residents against BellSouth, and the decision is recorded as Decision A96/15 (MacIntyre Case), NZPT (1996). The decision of the Chief Planning Judge, His Honour Judge Sheppard, was based on the part of the New Zealand Standard NZS 6609 which advocates that exposure should be "as low as reasonably achievable" (ALARA), and on the application of the Precautionary Principle, in conjunction with Sections 5 and 3 of the Resource Management Act 1991 (RMA). The RMA requires that people "avoid, remedy or mitigate any adverse effects of an activity on the environment" (Section 5(2)(c)), including "any cumulative effect which arises over time or in combination with other effects - regardless of scale, intensity, duration, or frequency of the effect, (section 3(d)), and also includes" ... "any potential effect of low probability which has a high potential impact" (Section 3(f)).

The court finding summarises the case as:

"In this case, the applicant has asserted that there would not be an actual or potential effect on the environment from the radiation emitted from the cell phone transmitter; and it has adduced evidence tending to establish that. The appellants have challenged the applicant's assertion, and have adduced evidence which they claim will satisfy us that there is a potential of an effect of low probability but high impact on the environment from the health effects of radiation from the transmitter."

The Court further defined the word "potential" as an adjective of: "capable of coming into being or action" , "possible but not yet actual; capable of being or-becoming"

2.2.1 Expert evidence:

Dr Michael Repacholi, EMR Consultant to the World Health Organization, and Mr Martin Gledhill, Senior Scientist at the National Radiation Laboratory, presented scientific evidence on behalf of the applicant, BellSouth, while Dr Neil Cherry, Biophysicist at Lincoln University, Professor John Goldsmith, Head of Epidemiology, Ben Gurion University of the Negev, Israel, and Associate Professor Richard Luben, Medical Biochemist and Endocrinologist from University of California, Riverside, presented evidence for the residents in support of the appeal.

The evidence structure of the applicant was similar to that in the Rodney case. Mr Gledhill and Dr Repacholi both gave evidence that the cell site conformed to the national standard, NZS 6609, and to international guidelines.

Dr Repacholi gave detailed scientific evidence denying the existence of proven biological mechanisms and claiming that epidemiological evidence had not established adverse health effects. We can see the strong proof approach to scientific evidence by Dr Repacholi in this case. For example, in his evidence to the Planning Tribunal he stated:

Section 54.2: "To produce any adverse effect, RF exposure above a threshold must occur. This threshold level is the RF exposure needed to increase tissue temperature by at least 1°C. The low RF power levels from base transceiver stations cannot possibly cause this temperature rise."

Section 55: "The International (IRPA 1988) RF standard is based on reviews of scientific literature which indicate (WHO 1993 - Repacholi (1993)) that a threshold exposure of 4 W/kg is needed before any adverse health effect occurs. For the cellular telephone frequencies 800-955 MHz the current International standard recommends an exposure limit of 400-470 $\mu\text{W}/\text{cm}^2$ (0.08 W/kg) for the general public."

Section 54.4: "Exposure to RF fields has not been established to cause cancer."

Section 54.9: "SAR (W/kg) of 0.00016 has no effect, and this is the level from cellular telephone base stations."

Section 85: "On page 14 Dr Cherry suggests that a 2-3 fold increase in miscarriage occurred with a monthly mean microwave exposure of less than 1 $\mu\text{W}/\text{cm}^2$. This is patently absurd. Dr Cherry emits 0.3 $\mu\text{W}/\text{cm}^2$, does he suggest if 4 people are in a room they will cause miscarriages?"

Apart from the final item, these statements summarize the official position of most national government bodies and standards setting bodies. Apart from the last sentence of Section 54.2 and Section 55, all of these claims are able to be shown to be scientifically wrong. They stand in strong contrast the European Parliament resolution, which was passed after extensive hearings of expert testimony, and will be shown conclusively here to be wrong. Taking the last point first, for example.

2.2.1 Repacholi Claim of 0.3 $\mu\text{W}/\text{cm}^2$ of microwaves from Black body emissions:

Dr Repacholi's claim that people emit 0.3 $\mu\text{W}/\text{cm}^2$ of microwave radiation from Black body emissions so that 4 people would emit 1.2 $\mu\text{W}/\text{cm}^2$ of microwave radiation is in itself clearly wrong and patently absurd. Dr Repacholi knows well the background to this because he is referring to his edited review report, Repacholi (1993), which in turn refers to his own published paper, Repacholi (1983). These both note that the 0.3 $\mu\text{W}/\text{cm}^2$ is emitted by black bodies "when integrated up to 300 GHz". Over 0.22 $\mu\text{W}/\text{cm}^2$ of which is from above 100 GHz, which above the microwave radiation and is referred to as Extremely High Frequency (EHF) radiation and part of the Far Infrared portion of the spectrum. In the whole band from 100 to 1000 MHz the black body irradiance is only about 0.0092 pW/cm². (0.0000092 $\mu\text{W}/\text{cm}^2$).

Dr Repacholi's statement is also wrong because the number of people in a room makes very little difference to the total black body irradiance since the intensity varies as the

fourth power of the absolute temperature and the surfaces of the room will be at comparable absolute temperatures to people's skin and clothing surfaces.

Only under persistent cross-examination from John Fogarty Q.C. Dr Repacholi eventually reluctantly admitted that this claim was made "with tongue in cheek".

2.2.2 Dr Repacholi claimed the support of "Science":

Dr Repacholi claimed that "science" supported his position. When asked what he meant by "science" he referred to the WHO 1993 review. He acknowledged that he had chaired the review team and was the technical editor of the review. He claimed that the report represented official WHO policy. He was then asked to read the statement in the opening pages of the review which states:

"This report contains the collective views of an international group of experts and does not necessarily represent the decisions or the stated policy of the United Nations Environment Programme, the International radiation Protection Association, or the World Health Organization."

2.2.3 Characteristics of the Applicant's Case:

Thus the applicants case in MacIntyre was similar to the evidence presented in the Rodney case, an international scientific consensus was claimed for the position that there were no plausible mechanisms and no epidemiology proved (casually) that there were adverse health effects.

2.2.4 Residents Case:

The residents' case was based on establishing that there was at least one plausible biological mechanism that, according to Rodney, could be used to establish a potential adverse health effect. That there also existed cellular and animal experiments to give strong substance to the plausible biological mechanism and epidemiological studies which showed statistically significant associations with RF/MW radiation and adverse health effects. This would establish a potential adverse health effect from low level RF/MW radiation at levels well below the national guideline but exceeding levels of evidence required by RMA Section 3 (d), (e) and (f).

2.2.4.1 Overview of Scientific Evidence:

On behalf of the residents Dr Cherry gave the overview of the biological mechanisms and epidemiological studies showing statistically significant associations between cancer, brain changes and reproductive effects such as miscarriage from exposure to RF/MW radiation. He also summarised exposure data and showed that many experiments involved only a few hours per day and often only 5 days per week. Hence, if there was a cellular biological mechanism, the chances of which could lead to tumorigenic outcomes, a cumulative exposure characterised by the long term mean exposure was an appropriate measure to relate to a public exposure standard.

2.2.4.2 Biological Mechanisms for EMR effects:

Professor Luben gave detailed evidence on the biochemical changes observed in cellular systems with EMR exposure, including calcium ion efflux, signal transduction alteration, ornithine decarboxylase changes and the relevance of these to cancer. He concluded:

“Clearly, any environmental influence (e.g. electromagnetic fields) that modifies signal transduction pathways in normal cells could also influence the potentially tumorigenic pathways in susceptible cells, either by enhancing the likelihood of transformation by other tumorigenic stimuli or by acting in a directly tumorigenic manner. Thus, it is not necessary to hypothesize, as some have done, that EMF must cause genetic damage to cells in order to cause cancer or developmental abnormalities. Nor is it necessary to hypothesize that EMF must alter the expression of genes in cell directly (indeed, recent studies make this hypothesis seem rather unlikely). By influencing signal transduction pathways, which in turn regulate cell proliferation, cell differentiation, and even transformation to a cancer phenotype, EMF can potentially be involved in a host of disease processes without ever penetrating the cell membrane in any significant manner.”

Dr Luben referred to Byus (1994) that there was scientifically published evidence showing that athermal levels of RF/MW modulated at ELF frequencies had increased ODC in a significant and long-lasting fashion in cultured Reuber H35 rat hepatoma cells, following several other laboratories showing that ELF exposure had altered ODC concentrations in a wide range of biological media.

Hence plausible biological mechanisms have been identified, the primary one promoted by Dr Luben being altered signal transduction of cell regulation pathways which are potentially tumorigenic.

2.2.4.3 Epidemiological evidence of EMR effects:

Dr John Goldsmith referred to evidence of radar exposures being associated with testicular cancer, two previous studies which had been reported as “no effect” studies which he deposed both showed increases in cancer with radar exposure, namely, the U.S. Embassy in Moscow and the Korean War Study, a number of the epidemiological studies involving cancer and the U.S. Physiotherapist study associating early term spontaneous abortion with microwave exposure during diathermy. In addition he referred to measurements of changes to blood in microwave exposed people, including chromosome aberrations and somatic mutations. He related the blood changes to “a potential effect of high probability” and the data on cancer near broadcasting facilities and at the Moscow Embassy as “a potential effect of high probability which has a high potential impact.”

When asked in cross-examination whether epidemiological evidence on the adverse health effects of RF/MW could be described as a “weak link”, Professor Goldsmith replied (evidence transcript: p137, line 36):

“I disagree. I think when children die of cancer between 5 and 18 $\mu\text{W}/\text{cm}^2$ over a period of time - exposure is not weak. It is significant.”

Dr Goldsmith is referring to a 4 to 5-fold increase in childhood leukaemia in the U.S. Embassy in Moscow, the top floors of which were irradiated by a radar for several hours a

day, days a week and over several years. Dr Cherry pointed out to the Court that the mean exposure was in the range 1 to 2.4 $\mu\text{W}/\text{cm}^2$.

2.2.4 Treatment of the scientific evidence:

With high level scientific evidence and legal argument on both sides of the case, the Court gives detailed discussion of the legal and scientific evidence.

2.2.4.1 Status of the New Zealand Standard, NZS 6609:

The Court determined that compliance with the Standard is not decisive. They said that in the absence of challenge by another party resource consent proceedings are entitled to rely on compliance with the relevant New Zealand Standard. However, parties to a Resource Consent are not bound to accept that compliance "because New Zealand standards are not given particular status in law, parties must be free to assert that significant adverse effects on the environment would occur despite compliance with the standard. In this case the appellants assertion of environmental harm notwithstanding compliance with NZS 6609, "was supported by expert witnesses."

2.2.4.2 Status of scientific publications:

Referring to a U.S. Supreme Court Case, *Daubert v Merrill Dow Pharmaceuticals Inc.*, the decision, in which a lower court had rejected evidence because it hadn't yet been published in peer-review journals. The Supreme Court ruled:

"402. All relevant evidence is admissible, except as otherwise provided. ... Evidence which is not relevant is not admissible.

702. If scientific, technical or other specialized knowledge will assist the trier of fact to understand the evidence or to determine the fact of an 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."

In the RMA legal environment, when potential effects are considered on the basis of probative evidence:

"The Court [Supreme Court] noted that some propositions are too particular, too new, or of too limited interest to be published, but held that submission to the scrutiny of the scientific community is a component of 'good science', in part because it increases the likelihood that substantive flaws in methodology will be detected. So the fact of publication (or lack of it) in a peer-reviewed journal, while not decisive, is a relevant consideration on assessing the scientific validity of a particular technique or methodology on which an opinion is premised."

On the treatment of evidence and discretion in decision making, MacIntyre says:

"On the second issue, the Planning Tribunal is free to receive anything in evidence that it considers appropriate, and is not bound by the rules of law about evidence that apply to judicial proceedings. Even so, the basic

principles of evidence developed by the general courts provide a valuable guide for fact-finding by the Tribunal. It is our understanding that there are three requirements for us to make a finding on a question of fact. There needs to be material of probative value, ie, tending logically to show the existence of facts consistent with the finding. Also, the evidence must satisfy us of the fact (i.e. that there will or will not be such an effect) on the balance of probabilities and having regard to the gravity of the question; but , we are not to put either party to having to prove its assertion of fact beyond reasonable doubt. Further, the heart of a finding of fact is that we ourselves need to feel persuaded that it is correct.

We do not accept that the existence of a serious scientific hypothesis, or even one that is regarded as deserving priority for testing, is necessarily sufficient by itself to establish a potential effect, even a potential effect of low probability which has a high potential impact. Nor do we accept that the Tribunal should impose a threshold based on current scientific knowledge before taking notice of a scientific hypothesis. We hold that like any other evidence tending to establish a contested fact, the grounds for the hypothesis have to be exposed to testing (as discussed in Daubert's case) and scrutinised to determine whether they meet a basic threshold of reliability (as discussed in Mohan's case) to assist the Tribunal to weigh the evidence and make a finding one way or the other."

Application of the Precautionary Principle in the RMA:

"On the general precautionary principle, we note that a consent authority is entitled to have regard to any other matter not listed in section 104(1) which it considers relevant and reasonably necessary to determine the application; and that the definition in section 2(1) of the term "environment" extends to include people. The purpose of the Act is to promote the sustainable management of natural and physical resources. The term "sustainable management" is described by reference among other things to enabling people to provide for their health and safety.

There may be resource consent applications in which a consent authority may consider it relevant and reasonably necessary to have regard to the precautionary principle. In the context of the Resource Management Act the principle can apply to people and their health as well as for the rest of the natural and physical environment. So a consent authority may allow its discretionary judgment to grant or refuse consent to be influenced by the precautionary principle to the extent consistent with the statutory purpose of promoting the sustainable management of natural and physical resources and with judicial exercise of that discretion."

2.2.4.2 Nature of the appeal relating to exposure limits:

This appeal was base on a public exposure limit applied by the Christchurch City Council of $50 \mu\text{W}/\text{cm}^2$ being appealed by BellSouth who sought a limit of $200 \mu\text{W}/\text{cm}^2$ as provided for by NZS 6609. The Court's decision to set the public exposure condition at $2 \mu\text{W}/\text{cm}^2$ based on the evidence before it, shows a clear and strong departure from the New Zealand Standard and the Christchurch City Council's draft plan limit.

2.2.4.3 Court errors of fact and approach:

On page 37 of the findings the Court incorrectly implied that two studies which did show effects were no effects studies by claiming that Dr Silverman resiled from the Polish Military study which did show effects, when she resiled from the conclusions of the Korean War study which had incorrectly concluded that there were no effects.

The Court records the study of Dr M.C. Shandala and colleagues reporting stimulated changes to brains at microwave exposures of 10, 50 and 500 $\mu\text{W}/\text{cm}^2$. Even though it was pointed out (by Dr Cherry) that $10\mu\text{W}/\text{cm}^2$ for 7 hours per day averaged $2.9\mu\text{W}/\text{cm}^2$, the court concluded that "there was no evidence of health effects from exposures to radiation at or below $10 \mu\text{W}/\text{cm}^2$." The Court also incorrectly identified the Moscow Embassy exposures as estimates as not being below $10\mu\text{W}/\text{cm}^2$. Sliverman (1980) details the measurements. The peak ranges from $5\mu\text{W}/\text{cm}^2$ from 1953 to May 1975, $15\mu\text{W}/\text{cm}^2$ from June 1975 to Feb 1976 and no more than 1 from Feb 1976 onwards. These values were measured on the outside walls of the embassy. The radar signals were not continuous but varied with time of day and time of year.

From these readings the all-time estimate of their mean value is in the range 1 to $2.4\mu\text{W}/\text{cm}^2$ which is associated with a 5-fold increase of leukaemia in children. The Court received evidence of this mean range of exposure and the increase in childhood cancer. Hence there was evidence presented of adverse health effects below $3\mu\text{W}/\text{cm}^2$. This makes sense of the Court's decision to set the condition at $2\mu\text{W}/\text{cm}^2$ when the applicant had agreed that operating conditions would not generally exceed $1.2\mu\text{W}/\text{cm}^2$.

Hence it is incorrect and misleading to claim that the MacIntyre decision found that "there is no evidence of adverse health effects". There was evidence of adverse health effects below $3\mu\text{W}/\text{cm}^2$, from Shandala et al., the U.S. Physiotherapist study, Von Klitzing's study and from the U.S. Embassy in Moscow, which enabled the Court to set the public exposure level at $2\mu\text{W}/\text{cm}^2$ and say that with this condition there would be no known adverse health effects. The court is factually in error when it records that "there is no evidence of health effects from exposures at or below $10 \mu\text{W}/\text{cm}^2$."

An epidemiological methodological error found in the written decision relates to isolating studies rather than assessing the sweep of evidence. The Court decided to select only those studies it considered to be in the relevant narrow frequency and modulation range to be applicable to cell phone frequencies and modulations, rather than considering the wider question as to whether RF/MW could be considered to be carcinogenic, backed up by animal experiments and plausible biological mechanisms and a consistent pattern of epidemiological studies.

For example, the claim that the only radiation which is proven to be carcinogenic is ionizing radiation and that non-ionizing radiation cannot produce cancer, is disproven by noting that Ultraviolet radiation, which is non-ionizing, is shown to produce skin cancer.

The claim that photons of RF/MW radiation cannot initiate nor promote cancer because their energy is insufficient to break chemical bonds and hence cannot damage DNA and thus cannot produce a tumour, is at odds with the strong evidence of childhood leukaemia in association with proximity to high voltage powerlines and other cancers associated with occupational EMR exposures. Many researchers have asserted that there are many other

ways of initiating and promoting cancer than simply through damage to DNA. Research showing single and double strand DNA breakage in RF/MW fields implicates free radicals as the source of the damaged DNA, Lai and Singh (1997). Free radicals are also involved with DNA damage in the presence of ionizing radiation. Hence the biological mechanisms are very similar but for ionizing radiation the enhanced free radical concentration is a direct consequence of energy imparted by the quanta of ionizing radiation, whereas for non-ionizing radiation the reduction in the free radical scavenger melatonin results in enhanced concentrations of free radicals which have been produced by other processes, such as oxidative stress.

Evidence that studies had shown DNA breakage and chromosome aberrations in RF/MW exposure were presented to the Court. The melatonin mechanism was also presented but not with the compelling evidence of Reiter (1994) and Lai and Singh (1997).

It is inappropriate in public health effects to focus on only four studies and attempting to dismiss each one based on methodological weakness. Each study is part of a suite of studies which, taken together, form a strong set of evidence.

For example, the American physiotherapist epidemiological study followed two earlier studies from Sweden and Denmark which showed adverse pregnancy outcomes with those working with short-wave diathermy (Kallen et al. (1982) and Larsen et al. (1991)) and two rodent studies showing reproductive problems with low level microwave exposure, Il'chevich and Gorodetskaya (1976) and Chazan et al. (1983). Chromosome aberrations and melatonin involvement is recognised as causes of spontaneous miscarriage, Sandyk et al. (1992).

The Korean War Study can be compared with the Polish Military Study, Szmigielski et al. (1988 and 1996) and the U.S. Air Force Study, Garyson (1997), both of which found increases of cancer with RF/MW exposure. this gives at least three studies showing cancer increase with exposure to military radio and radar.

Von Klitzing's observations that human EEG's change with exposure to modulated microwaves is consistent with Adey (1981), Dumanskiy and Shandala (1974), Shandala et al. (1979) and Gvopzdkcova et al. in McRee (1970).

Residential cancer increases as found in the U.S. Embassy in Moscow were also found in North Sydney by Hocking et al. (1996), in Hawaii by Maskarinec and Cooper (1993) and in Wichita, Kansas by Lester and Moore (1982a), as well as in the U.K. by Dolk et al. (1997 a,b).

One of the principles of epidemiology, Hill (1965), is to seek consistency to determine if the effect has been "repeatably observed by different persons, in different places, circumstances and times". Another principle is to look for a "biological gradient" or dose-response relationship. Such a relationship is found in Dolk et al. (1997 a and b) which finds the adult leukaemia incidence peaks at some distance from TV and FM radio regional transmission towers, and then it decreases with distance in line with the decrease in exposure with distance.

Some of these papers were cited to the court in MacIntyre but the later published papers are included to demonstrate the approach and the strengthening of evidence over time.

2.2.5 The Decisions:

The Tribunal (A96/15) decided that a precautionary approach to the adverse health effects issue was warranted, p 49. In the next paragraph it states:

“However, this case focused on the possibility of adverse health effects from radiofrequency radiation, and after careful consideration of the evidence we have found that the transmissions would not have any actual or potential adverse effects on the public, not even a potential effect of low probability which has a high potential impact. This can be assured by the amended condition that we would substitute [2 $\mu\text{W}/\text{cm}^2$], and by the provisions of the Act that could be invoked if it should turn out, contrary to the evidence before us, that the transmissions have an adverse effect, including the ability to review the condition.”

The converse of this is that without a condition of $2\mu\text{W}/\text{cm}^2$, the finding of no actual nor potential adverse effect will not be assured. To underscore and strengthen this position the Tribunal stated the consent should be reviewed in the light of new evidence of adverse health effects near or below $2\mu\text{W}/\text{cm}^2$. The Resource Consent was granted with the following condition:

“3. That the incident power flux density of radiofrequency radiation emitted by the facility, measured at any dwellinghouse, is not to exceed 2 microwatts per square centimetre.”

Hence, while setting the Public Exposure Limit at $2\mu\text{W}/\text{cm}^2$, the decision requires the review of this condition if there is any new evidence. “New Evidence” includes re-evaluation and interpretation of the research presented to the original hearing if sound principles warrant that, as well as the results of studies not presented to the original hearing because of lack of awareness of them or access to them, or they were not published at that time. A great deal of new evidence is now available and will be presented in detail later.

2.3 Evidence of Risk of an effect approach:

Seeks sound scientific evidence of risk of an effect as a basis for risk reduction or risk avoidance through exposure reduction or minimization.

This approach seeks to identify evidence of risk of an effect in a sound scientific manner, not just reacting to suspicion of an effect. It looks for biochemical changes in cells which might indicate a possible effect, it views animal exposure experiments as providing indications that the cellular or molecular changes could have a human health effect since the effects are found in living mammal cells or organs. It looks at epidemiological studies which show statistically significant increases in incidence of disease in groups which are more highly exposed to a suspected disease agent, in which all identified confounding factors have been adequately dealt with, as evidence of risk of an effect.

The court decision in the MacIntyre case was seen and a win-win-win decision. The applicant was granted the resource consent. The residents obtained the strictest exposure condition in the western world and the scientists gained extensive guidance on the presentation and treatment of scientific evidence in an RMA legal environment.

2.4 The Beckenham Case:

Telecom and CCC Officers favor the Beckenham Decision (W165/96) of November 1996 for it reverts to the $200 \mu\text{W}/\text{cm}^2$ exposure level of the standard NZS 6609, rather than the MacIntyre case which sets a public exposure limit of $2 \mu\text{W}/\text{cm}^2$, based on probative scientific and legal evidence of potential adverse health effects as required by the RMA 1991.

Thus there was no contestable scientific evidence nor legal argument, and the Beckenham case has no standing in the issue of adverse health effects compared to MacIntyre which does.

The Beckenham was based on an appeal by Telecom NZ against the CCC decision to decline the consent based on visual impact. As it was explained in the MacIntyre case that if there was no challenge of the other party then a consent authority may treat the standard as setting an appropriate level of emissions. This is just what the court did. However the Court also has the discretion to set as lower public exposure level based on probative evidence, such as choosing to adopt the findings of the MacIntyre case. The Court chose not to do this. The findings include the statement:

“We agree with Mr Cooke-Willis that it is wrong in principle for the Court to set arbitrary limits on RF emissions from cell sites which are below those set by the relevant New Zealand Standard 6609: 1990, unless there is compelling evidence given in individual cases that the public interest requires such a course. There is no such evidence in this case.”

This implies that the Court accepted the Telecom evidence from Mr Cook-Willis and Dr Black, that the MacIntyre limits are arbitrary. This is demonstrably not the case. The limit of $2 \mu\text{W}/\text{cm}^2$ lies below four cases of scientific evidence presented showing effects below $3 \mu\text{W}/\text{cm}^2$ and the applicant’s agreement to operate at a maximum of about $1.2 \mu\text{W}/\text{cm}^2$.

In the Beckenham case in an agreed memorandum defining the issues counsel for the appellant and the respondent recorded the following matters as being agreed:

“Any actual or potential health or environmental effects of alleged or perceived effects of radiofrequency emissions from the appellant’s proposed cellular base station are not issues which either party intend to raise or give evidence on, in this proceeding. The respondent does not raise these issues in opposition to the appeal.”

Despite this agreement between Telecom and the CCC, the minister of the Colombo Street Baptist Church, Mr D.W. Haliday, appearing for the church and the Archer Home, “did not share the view taken by the respondent (CCC) on the matter of the possible health risk to adjoining residents which may result from the building of the facility. To the contrary he took the view that it is the responsibility of the appellant (Telecom) to prove to an acceptable standard that there is no health risk.” This was occasioned by Telecom seeking the confirmation of the public exposure guideline of NZS 6609 against the decision of the Court in the MacIntyre case of $2 \mu\text{W}/\text{cm}^2$.

Although Mr Haliday cited scientific evidence for possible health risk from that presented to the original resource consent hearing by Dr Neil Cherry and in articles and letters from

other professionals, he presented no professional legal nor scientific evidence by experts available for cross-examination. Hence the only expert witness evidence was provided by the appellant (Telecom).

The Court notes that, "It is only when the Court has decided that the evidence is sufficiently relevant and probative to be admitted to consideration that it is then enjoined to have regard to the matters raised in the sections of the Resource Management Act..."

The Court required the appellant (Telecom) to provide legal and scientific evidence based on the situation that "the onus of proof is [on] Telecom to persuade us on the balance of probabilities."

It appears that in the absence of professional adversarial evidence the Court relies on the appellant to show at the level of balance of probabilities, that there is no adverse effect, but where there is contestable legal argument and scientific evidence, as in MacIntyre, the Court is able to apply Section 3 (f) of the RMA.

In the Beckenham findings, referring to Dr Black's in summary of his evidence and expressing his view on the appropriate conditions, the findings record:

"Significantly, however, he concludes that it would be quite wrong in his view to set what he describes as pseudo standards which he is fearful is the approach being adopted by some councils in the light of the MacIntyre case."

Dr Black's statement is highly challengable. It misrepresents the court's decision in the MacIntyre case, but it reinforces Telecom's case which is arguing for the adoption of NZS 6609 in order to weaken the precedent effect of MacIntyre. Telecom was fearful of the court endorsing the findings of the MacIntyre case, which rejected the use of the public exposure guideline given in NZS 6609 and imposed an RMA probative evidence based condition at 1 % of the guideline based on RMA Section 3 (f).

In accepting Telecom's legal and scientific evidence in the Beckenham case the Court could have exercised a discretion to adopt the condition set in the MacIntyre case, a public exposure limit of $2 \mu\text{W}/\text{cm}^2$ at the nearest dwelling house. They chose not to, and decided in favour of Telecom's appeal to apply NZS 6609's $200 \mu\text{W}/\text{cm}^2$.

It therefore appears that the Court in the Beckenham case has accepted Telecom's incorrect and challengable interpretation of the MacIntyre case which led them to make their own highly challengable statement:

"We question the value of inviting this court to continue to entertain and make findings in respect of detailed technical and medical evidence in order to decide in each case whether or not a health hazard exists in relation to these facilities. We would have thought that by now the findings in cases such as MacIntyre and others v the Christchurch City Council Decision 15/96 dated 5/3/96 would have been sufficient, in the absence of any fresh evidence to allay concerns of residents about possible health hazards emanating from cell sites such as those proposed in this case."

In making this statement the Court reveals its misinterpretation of the MacIntyre decision. If the Court and Telecom had accepted the public exposure levels in the MacIntyre decision then health evidence would not have been necessary in the Beckenham case. New evidence in relation to the MacIntyre case was presented to the Resource Consent hearing panel on behalf of the residents by Dr Neil Cherry, but was not available to the Court because of Dr Cherry's absence overseas. The Court in exercising its discretion and by ruling in Telecoms favour and not choosing to confirm the MacIntyre decision, has exacerbated the problem of protecting public health from exposures from cell sites.

Telecom and CCC officers by the way in which they misrepresent the Beckenham and MacIntyre cases in relation to adverse health effects are misleading the hearing.

Only witnesses on behalf of Telecom presented evidence on health effects. Dr Black mounted an argument around the premise that there are no proven effects. For example the findings state:

“Dr David Black notes that the only known, and scientifically proven effect of RF emissions on the human body is that heating occurs at certain levels of exposure.”

Dr Black does acknowledge that:

“there is a significant body of research which is looking at the possibility that there may be biological effects other than those caused by heating” but he goes on to say “to date however no athermal effects have been confirmed to the standard of proof required in scientific debate. The research is unconfirmed and anyway does not infer adverse effect or hazard to health.”

With the assistance of legal advice from Telecom and CCC, and scientific advice from Telecom's witness, especially Dr Black who made some scientifically and legally challengeable statements concerning epidemiological evidence, biochemistry and the MacIntyre case, instead of accepting the evidence and findings of the MacIntyre case, the Court itself made a highly challengeable statement.

The evidence presented here challenges this statement. Some of the research findings in this report were presented in the MacIntyre, but none of it was presented to the Court in the Beckenham Case.

It is assumed by the Court that expert witnesses give objective evidence which is full and comprehensive to enable the court to come to an informed judgement.

I assert that in the Beckenham case, Dr Black's evidence is carefully crafted to meet the desires of the applicant. He does this by using high proof language and a selective quoting of scientific research. The following demonstrates this through an analysis of Dr Black's statements as quoted in Beckenham.

(a) Almost all of Dr Black's statements about health effects are cast as a personal opinion only or in high proof terms.

For example:

1. Dr Black: "To date however no athermal effects have been confirmed to the standard of scientific proof required for scientific debate. The research is unconfirmed and anyway does not infer any adverse effect of hazard to health."
2. Dr Black: "I am of the opinion that cancer from any level of RF is extremely unlikely. I could not even construct a hypothesis as to how cancer could conceivably be caused from these low levels of RF."
3. Dr Black: "There is no evidence to actually link rises in ODC (which is the enzyme in question) with cancer promotion".
4. Dr Black: "There is no coherent evidence that electromagnetic fields do actually affect cell membranes. Even if they might there is no reason to believe that this would pose a hazard to health."

Personal opinion: 2. "I am of the opinion", and "I could not even", 4. "there is no reason".

High Proof Language: 1. "have been confirmed to the standard of proof required in scientific debate". "The research is unconfirmed". 3. "Actually link". 4. "no coherent evidence .. do actually affect" and "would pose a hazard".

Comment 1: Calcium ion efflux is a well confirmed athermal effect of RF/MW exposure. The melatonin mechanism is a highly probable and therefore plausible mechanism for cancer, immune system impairment, spontaneous miscarriage, sleep, learning and memory disruption. Since there is statistically significant, multiple epidemiological evidence for all of these adverse health effects, and since there is a plausible mechanism and animal laboratory evidence, it is highly probable that RF/MW exposure increases the risk of, and incidence of these health effects. Dr Black has used a standard high proof approach to ignore or dismiss a mountain of evidence by implying that for there to be an adverse health effect there needs to be an established and proven athermal mechanism. Then he claims that there is no proven athermal effect therefore, he argues, there is no health hazard.

By moving away from the high proof environment to the potential effects environment we ask different questions and treat evidence in a different way. If we asked the question, is there evidence of an adverse health effect such as cancer from occupational or residential exposure to RF/MW radiation, based on internationally published, peer-reviewed research of statistically significant associations, sound exclusion of likely confounders and in some cases, dose-response relationships, the answer is YES !!!

That is, there is strong scientific evidence of a highly probable risk of a health hazard.

If we further ask if there have been controlled animal laboratory experiments which have shown health effects consistent with the epidemiological studies, the answer is YES !!!

If we further ask, have there been laboratory in vitro studies showing that cell lines change their behaviour in ways which are consistent with the above evidence, the answer to this is also, YES !!!

Comment 2: To avoid the many epidemiological studies which find statistically significant increased incidence of cancer or mortality of cancer for those exposed to RF/MW Dr Black refers only to his own opinion not the large published scientific studies. The fact

that Dr Black cannot conceivably construct a hypothesis of how cancer can be caused he ignores many published papers which do provide such hypothesis including Reiter (1994), Adey (1989, 1990, 1993a, 1993b), Luben (1995), Szmigielski et al. (1988), McLauchlin (1992), and Cleary (1994).

Comment 3: There is a great deal of evidence making a highly probable link, reported by Luben in MacIntyre, but the term used, which is high proof, "Actually link" is pedantically correct. This stands in strong contract to Professor Richard Luben's evidence in MacIntyre, and Dr Luben is a well recognised EMR researcher and past president of the Bioelectromagnetics Society. He stated:

"The activity of ODC is believed to represent a measure of the rapidity of cell division; higher ODC levels are associated with more rapidly proliferating cells. This rapid proliferation of cells is a characteristic of cancer. Agents which stimulate ODC activity in some cells are known as tumor promoting agents. Byus and colleagues (Byus et al. , 1987) reported that three different cell lines, human lymphoma cells (CEM), mouse myeloma cells (P3), and rat hepatoma (Reuber H35) cells exhibited increases of 50 to 300% in ODC activity when exposed to sinusoidal 60 Hz electric fields at 10 mV/cm (1 V/m). Increases in ODC were detected as low as 0.1 V/m in Reuber H35 cells. The investigators interpreted these results as indicative of and EMF effect on the cell membrane, resulting in a signal transduction effect on ODC activation by mechanisms not directly investigated in these studies."

Comment: Dr Luben's evidence, based on extensive published research, identifies the cell membrane as a primary point of interaction between ELF and RF and the cell. Professor Luben is backed up by a large array of scientific research. The well know calcium ion efflux observations relate to cell membrane induced effects by ELF and ELF modulated RF/MW. Adey (1990) reviews and summarizes Cell membrane transductive coupling and concludes the **"Both low-frequency fields and radiofrequency fields with low frequency modulation can act separately and synergistically with chemical cancer promoters at cell membranes."** This confirms the cancer promotion and co-promotion effects of EMR and the site of activity as the cell membrane.

Comment 4: Calcium ion efflux occurs through the cell membrane. There is a high number of replicated studies of the calcium ion efflux from cells. This is a well confirmed athermal effect of modulated RF/MW radiation, related to modulation frequency not the exposure level, even down to SAR level of 0.00015 W/kg, Schwartz et al. 1990. Repacholi (1993) stated: "This field-induced effect is of interest because it occurs at SARs too low to implicate heating, and because calcium ions play a prominent role in the transductive coupling of many cell membrane-mediated responses." Hence Dr Black is factually wrong in claiming that there are no confirmed athermal biological effects except heating. There are several others but this serves to illustrate the problem.

The calcium ion concentrations in cells is related to the fidelity of DNA replication, the cyclic AMP signal transduction pathway which regulates cell energy supplies, the protein kinase C activity which is fundamental for cell regulation, Adey (1990). Walieczech (1992) states in his review "Based on these findings it is proposed that membrane mediated Ca^{2+} signalling processes are involved in the mediation of field effects on the immune system." The immune system produces killer cells which attack cancer cells (target cells) in an

attempt to eliminate them. These killer cells are T-lymphocytes and the act of killing the target cells is called cytotoxicity. Inhibition of cytotoxicity of T-lymphocytes was reduced by up to 20 % by a sinusoidally modulated 450 MHz field (1.5 mW/cm²), Lyle et al. (1983). Quan et al. (1992) showed that microwave heating of human breast milk eliminated a large proportion of the immunoglobulin factors for fighting E-coli bacteria, by up to a factor of 18 compared to conventional heating to 95 °C.

Dr Black’s carefully worded statements can all be justified in the context of a high proof approach, but in the RMA potential effects legal environment they are incorrect and mislead the court.

It is my experience as a Regional Councillor that in none of the Resource Consent Hearings I have sat on over the past 5 years has a lawyer nor an expert witness for the applicant knowingly given evidence which was likely to lead to the consent being declined. The applicant prepares a case to the best of their ability and resources with the purpose of gaining the resource consent. None of our Regional councillors and none of our Investigating officer staff can recall a case to counter this.

Hence our experience and the compelling logic of the situation suggests that it is self evident that legal council, planner and expert witness evidence on behalf of an applicant will be aimed at obtaining the resource consent, whether it is at the initial hearing stage or in the Environment Court.

This makes good sense of the Court’s evidence requirements as set out above in the three cases reviewed. The courts have exercised discretion and judgement based on their interpretation of the evidence presented and the legal advice given.

What has become clear also in every case the expert evidence on behalf of the applicant was based on a strong proof approach. In writing up the decisions and findings only in the MacIntyre case is the potential effects environment of RMA decision making properly recognised. However, in every case no comment was made and no indication was given that the court recognised and rejected the strong proof approach.

2.5 Comparative use of evidence for levels of legal or scientific proof:

In presenting scientific evidence in the RMA legal framework, it is important to note where the Section 3 (f) potential effect level lies compared to other levels of evidence and scientific proof, Table 4.

100 %	Scientific Proof, Causation established. (NZS 6609)
99%	Multiple epidemiologic studies with dose response relationships,
↑	plausible biological mechanisms and animal experiments.
95 %	Multiple epidemiologic studies, one with dose response
↑	relationship, plausible biological mechanisms and animal
90 %	experiments.
	Highly Probable (Beyond Reasonable Doubt)

	Dose response relationship with significant risk ratio and plausible mechanism, with animal experiments.
↑	Animal experiment(s).
	Multiple epidemiologic studies with statistically significant risk ratios and a plausible biological mechanism.
51 %	Probable (Balance of probabilities, more likely than not)
50 %	
↑	Requires two or three studies with risk ratios which are significant at the 95 % confidence level.
5 %	
↑	Potential effect of low probability and high potential impact. Section 3(f) standard.
1 %	
0.000001 %	Potential effect, regardless of scale. Plausible mechanism

The MacIntyre Case is the only EMR case with competitive scientific evidence and legal argument and hence is based on Section 3 (f) and demonstrates the fundamental difference between the "strong proof" approach in the Rodney case, the lack of competitive probative evidence in the Beckenham case and the "evidence of risk" approach taken in the MacIntyre case.

3. Significant National and International Reviews:

3.1 European Parliament Resolution:

After extensive hearings, involving dozens of expert witnesses from around the world, the European Parliament on 19 March 1992 adopted resolution B3-0280/92, which included the following statement:

"Thus in the frequency range 100 kHz to 300 GHz, 50 years ago it was scarcely possible to measure 10 pW/cm² on the ground in our countries. Today, depending on the location, values one million to one thousand million times higher are recorded because of the explosion of telecommunications."

and the following clauses:

- A. having regard to the significant increase, in the environment, of power density of non-ionizing electromagnetic radiation in the various frequency ranges, associated with technological development over the last few decades,
- B. having regard to the precautionary principle included in Article 130r of the Treaty establishing the European Community and the ALARA principle (a-slow-as-reasonably-achievable), according to which it is necessary, in this case to minimize exposure to electromagnetic radiation,

- C. whereas such radiation interacts with matter by non-thermal mechanisms and whereas, as regards radiofrequencies and microwaves, these are therefore added to the purely thermal interaction mechanisms,
- D. whereas, according to an increasing number of epidemiological and experimental studies, even slight exposure to non-ionizing electromagnetic fields increases the risks of cancer, can be accompanied by nervous disorders and disruption of the circadian rhythms and seems capable of affecting developing organisms,
- E. whereas the results of many in vivo and in vitro studies show increasing clearly the interaction mechanisms underlying such disorders and illnesses, centred mainly in cell membrane, lead to disruption of melatonin secretions, ornithine decarboxylase activity and T-lymphocyte efficacy, testifying to the probable role of non-ionizing radiation in promoting cancer,
- F. whereas synergy phenomena must be expected between non-ionizing radiation and other physical agents, ...

The conclusions of the European Parliament strongly accept the adverse effects of EMR and more than fulfill the legal requirements of Section 3 of the RMA for the definition of an adverse health effect. In presenting new evidence, evidence not present to the European Parliament, conclusions beyond those of the New Zealand Environment Court and the European Parliament can be drawn that adverse health effects occur below $2\mu\text{W}/\text{cm}^2$, and over 1000 times below the Australian/ New Zealand guideline of $200\mu\text{W}/\text{cm}^2$.

3.2 U.S. E.P.A. Reviews and draft recommendations:

The United States Environmental Protection Agency (U.S.E.P.A.) Health Effects Laboratory has a responsibility to study a wide range of toxic health studies including ELF and radiofrequency radiation health effects. A major review of RF/MW biological effects was published in 1984, Elder and Cahill (1984). In 1990 a scientific team of U.S. Environmental Protection Agency research staff produced a review of the then available literature. This was peer reviewed internally and externally. It recommended that:

- a) ELF radiation be classified as a "probable human carcinogen", and
- b) RF/MW be classified as a "possible human carcinogen".

The publication of this result was strongly opposed by the White House and the U.S. Air Force on the grounds of public alarm and national security, Sibbison (1990). In 1996, after years and years of delays, the review was left unpublished because of EPA budget cuts, much to the disappointment of the review team leader, Dr Robert McGaughy and the lead epidemiologist, Dr Doreen Hill, who both remarked that the evidence is now much stronger, Microwave News Jan/Feb 1996.

The recommendations were based in the E.P.A.'s public health protection mandate but the classifications were not made for political reasons. If the revised, stronger recommendations would have been published last year and history would have been made. The U.S. E.P.A. would have classified both ELF and RF/MW as highly probable human carcinogens. Even the U.S. Air Force now allows papers to be published linking

exposure to RF/MW and ELF to increased brain tumours in U.S. Air Force staff, Grayson (1996).

Hence the U.S. E.P.A. recommendations, consistent with the European Parliament recommendations, add significant weight to the evidence of an adverse health effect from public exposure to RF/MW radiation.

3.3 World Health Organization Reviews:

3.3.1 WHO 1981 Review:

In 1981 the World Health Organisation (WHO) issued a report "Environmental Health Criteria 16: Radiofrequency and Microwaves", Shore (1981). The human effects in the 1981 report rely heavily on the USSR and Eastern Europe studies with the exception of the Korean War Study, Robinette and Silverman (1977). The USSR and Polish studies showed that microwaves exposure under 10 mW/cm² produced "marked disturbance in cardiac rhythm, expressed by variability or pronounced bradycardia" and "a higher incidence of changes in the nervous and cardiovascular systems in the exposed group". The initial findings of the Korean War Study in 1977 were "no significant differences were found between the 2 groups".

The 1981 WHO report in part concludes:

"Effects have been reported at power densities too low to produce biologically significant heating."

and

"The general population includes persons of different ages (infants, small children, young adults and senior citizens) and different states of health, including pregnant women. The possible greater susceptibility of the developing fetus to microwave/RF exposure may deserve special consideration. Exposure of the general population should be kept as low as possible and limits should generally be lower than for occupational exposure. In view of the fact that data are still required to clarify interaction mechanisms and determine threshold levels for effects, it is recommended that microwave and RF exposure of occupationally exposed workers and the general population should be kept as low as readily achievable."

The 1981 WHO report, if coupled with the Precautionary Principle would have led the central and local government to adopt policies for the siting of radio and TV transmitters and cell sites away from places where children and women of child-bearing age would reside and/or work.

Between 1980 and 1992 there was a large volume of research published substantiating the concerns expressed in the 1981 report. Many published papers reported repeated studies on non-thermal effects such as calcium ion efflux, cell cycle changes, DNA breakage and chromosome aberrations. Several long-term rodent studies observed increased cancer and reproductive effects, and many epidemiological studies associated RF/MW exposure with increases in cancer, birth defects and miscarriage, for example. Some of these studies are reviewed in the 1993 WHO report, Repacholi (1993).

3.3.2 WHO 1993 Review:

The evidence of athermal effects has progressed from "Effects have been reported" in the WHO 1981 review to "A substantial body of data exists describing in vitro biological responses to amplitude modulated RF at SARs too low to involve any response to heating." in WHO1993 review (p 20 &154), Repacholi (1993). Thus clearly recognizes the increased evidence of athermal effects which might well be biological mechanisms explaining and strengthening the epidemiological studies results. Several western epidemiological studies in the 1993 review report increased cancers with RF exposure and the report states: "However there are studies indicating an increase in cancer in RF field-exposed populations." (p 167).

Despite the recognition of stronger evidence, the 1993 WHO review's recommendations are weaker in terms of public health protection and moving more towards a high proof approach. This the 1993 WHO report emphasizes uncertainty, recommends carrying out more research and delays recommending precautionary risk avoidance, concluding:

"There is increasing concern about the possibility that RF exposure may play a role in the causation or promotion of cancer, specifically of the blood forming organs or in the CNS. Similar uncertainties surround possible effects on reproduction, such as increased rates of spontaneous abortion and of congenital malformations.

Effects of RF exposure on CNS function, with resulting changes in cognitive function are also surrounded by uncertainties. In view of the potential importance of these interactions and the disruptive effects of the uncertainty on society, a high priority should be placed on research in this area. It is important that research efforts be coordinated to clarify rather than increase the level of uncertainty. Research on possible mechanisms, such as weak field interactions, should be closely coordinated with appropriately designed animal toxicology studies and with human epidemiology."

It should also be noted that several of the studies used in the 1993 review which are reported to show there are no cancer effects, actually do show increased risks of cancer with exposure to RF fields.

- Early results of the health effect of staff and children in United States Embassy in Moscow which is irradiated by a radar for many years showed no significant incidence of cancer, Lilienfield et al. (1978) but mutations in blood and increased cancer is reported in Goldsmith (1995).
- The cancer study in Wichita Kansas which showed a dose-response relation of cancer for populations exposed to no radar, one radar and two radars by Lester and Moore (1982a) was ignored even though it was in the same journal as Lester and Moore (1982b) which showed that county cancer rates were higher in counties which has air force bases which the authors related to the existence of radars. The 1993 WHO review team uses Polson and Merritt (1985) to claim contradictory findings, whereas in fact Lester (1985) accepts the criticism from Polson and Merritt that some cities in another county might be closer to a radar in a neighbouring county, re-evaluates the study by apply this correction.

This concludes: "Thus the 91 counties that contained cities nearest each of the 91 Air Force bases were found to have higher incidences of cancer than the control counties. This strengthens the possibility of an association between some factor associated with AFBs - our original hypothesis was microwave radiation - and cancer incidence because we now explicitly recognize the use of county containing the city nearest the base. ..."

Since all of these papers were available and quoted by the review team, the failure to quote the conclusions of Lester (1985) raises the question of the possible bias approach of the review team towards the "no effect" stance.

- Analysis of the Korean War Study data, used in the 1993 WHO review as a "no effect" study, reveals that the identified high exposure group compared to the identified low exposure group has malignant neoplasms of 8.2 and 5.0 per 1000, with a risk ratio of RR = 1.66 (95% CI: 1.06-2.60).

The review team also ignores several other studies which do show increased cancer with exposure to RF/MW including Lin et al. (1985), Maskarinac et al. (1983), De Guire et al. (1987), Thomas et al. (1987), Preston-Martin et al. (1989), Johnson and Spitz (1989), Savitz and Chen (1990), Garland et al. (1990) and Tornqvist et al. (1991), for example.

In considering mutagenic effects the review claims that "In general, no changes in mutation rate has been observed, except in cases where substantial temperatures may also have occurred." The WHO review reports only one exception, Yee (1982). This ignores Heller and Teixeira-Pinto (1959) [which was cited in the 1981 review], Sagripanti and Swicord (1986) and Garaj-Vrhovac et al. (1991,1992), all of which report athermal condition increased incidence of chromosome aberrations with exposure to RF/MW radiation. Even though it was denied for many years, blood samples were taken from the staff of the U.S. Embassy in Moscow and these were shown to have increased mutations, Goldsmith (1995). This was clearly an athermal effect with peak external wall exposures of $15 \mu\text{W}/\text{cm}^2$, mean external wall, upper floor exposes less than $2.4 \mu\text{W}/\text{cm}^2$ and mean indoor, all floors expose of less than $0.1 \mu\text{W}/\text{cm}^2$.

At a recent seminar involving international experts I asked if there was any scientific evidence showing that high temperatures and excess heat can cause cancer. The unanimous answer was "no". There are no known scientific studies shown that high temperatures, which wont kill an organism, has caused cancer, broken DNA or mutations.

Hence the WHO review team incorrectly interpreted the studies they used which they claimed to show no effects when the data published in the studies actually showed increased cancer incidence. They claimed contradictory findings when none actually existed and they ignored many studies which showed human cancer increased effects and chromosome aberration increases with RF/MW exposure, and where studies showed mutations they claimed that these were caused by heating. This adds considerable weight to the impression that there was a "no effect" and "strong proof" bias in the review team approach.

The strong proof (No effect) approach was revealed by the chairman of the review team, Dr Michael Repacholi in his evidence on behalf of BellSouth in the Planning Tribunal hearing in 1995 when he stated: "To produce any adverse effect, RF exposure above a threshold must occur. This threshold level is the RF exposure needed to increase

tissue temperature by at least 1°C.” This clearly ignores the epidemiologic evidence of cancer associated risk with RF exposure with life-time mean RF/MW exposures around and much less than 1 to 5 $\mu\text{W}/\text{cm}^2$.

There is extremely strong official government, military and industry pressure not to acknowledge the possibility or probability of adverse health effects from RF/MW radiation because of the clear and expensive implications of meaningful public health risk avoidance and legal liability. This pressure is reported by Sibbinson (1990).

The continuing WHO EMR program under Dr Repacholi's leadership is under continual criticism for

3.4 Electromagnetic fields , Health effects, Encyclopedia of Energy Technology and the Environment, Cleary (1995):

Professor Cleary summarizes the scientific literature on EMR and health effects. He includes a discussion of interaction mechanisms, including hormonal alterations:

“Hormonal alterations have been reported to occur in laboratory animals exposed to ELF fields. Specifically, exposure affected biorhythms resulting in the suppression of the normal nocturnal increase in melatonin [Wilson et al. (1983,1986)]. This finding is potentially significant due to the interaction of melatonin with other hormones. reduction in plasma melatonin concentrations causes increased levels of circulating steroid hormones such as estrogen and testosterone as well as increased prolactin release by the pituitary gland [Reiter et al. (1990)]. Such hormonal alterations increase the rate of proliferation of breast tissue and suppress the immunological system, effects consistent with increased breast cancer risk [Stephens (1987)].”

After reviewing epidemiological, animal and in vitro studies he came to the following conclusions:

Epidemiological:

“Epidemiological studies, although quite limited in number, provide evidence of an association of long term exposure to RF/microwave and lower frequency EMFs and cancer incidence. Although a number of different cancers have been reported to result from such exposure, leukemia and brain cancer appear to be the most prevalent.”

Animal:

“Animal studies have also provided evidence that low-intensity EMR alters brain neurochemistry under conditions not involving tissue heating. Effects of microwave exposure on: (1) actions of various psychoactive drugs, (2) the activity of the cholinergic systems of the brain, and (3) on neural mechanisms in the rat, were investigated by Lai (1992). Neurological alterations were induced in specific parts of the rat brain by 45 minute exposures to 2450 MHz EMR at SARs of 0.6 W/kg. It was concluded that alterations of levels of endogenous opiates were responsible for the

observed EMR effects and that the effects depend upon the exposure parameters, Lai (1992). The results of these studies are of interest since they provide evidence that low-intensity EMR can alter brain function which is consistent with numerous reports of behavioral, neurological and neuroendocrine alterations in humans due to EMR exposure.”

In Vitro:

“In summary, in vitro studies of the effects of low-intensity RF and microwave radiation indicate dose rate dependent increases in neoplastic transformation frequency and proliferation. In view of limitations on the extrapolation of in vitro results to in vivo responses, these results cannot be related directly to cancer incidence in human populations exposed to such radiation. However, these results are not inconsistent with the hypothesis that human exposure to RF or microwave radiation, under presently not well-defined conditions, may affect cancer incidence.”

CONCLUSIONS

“There is increasing evidence of possible health effects of environmental exposures to EMFs and EMR in the home and in the work place. Epidemiological evidence indicates possible associations of long-term exposure and cancer incidence, adverse reproductive outcomes, and behavioral and neurological changes. Inherent limitations on exposure assessment, common to epidemiological studies, provide imprecise knowledge regarding time- or exposure intensity thresholds for these effects, thus making risk assessment difficult at this time. Whereas the results of animal experimentation and cellular studies of ELF EMFs and EMR effects are generally consistent with results of epidemiological studies, they provide insufficient data for meaningful risk assessment.

The greatest impediment to understanding the effects of EMFs and EMR on living systems is the limited knowledge of interaction mechanisms. One consequence is that research in this area has been treated with scepticism that has, together with other factors, resulted in serious limitations on research support. In view of the diverse nature of the physical properties of electromagnetic fields reviewed here, as well as the great variety of reported effects in living systems, the large gaps in our understanding are perhaps not surprising. The potential magnitude of exposure-related health effects in industrial societies indicates that these uncertainties must be resolved.”

Dr Cleary’s review gives conclusions which support the U.S.E.P.A. review team’s classification of ELF and RF/MW as probable and possible carcinogens and the probable causes of other adverse health effects.

3.5 Conclusions about reviews:

These national and international reviews provide more than sufficient evidence of a potential adverse health effect from RF/MW exposure to satisfy the section 3(f) level of proof. The material below provides an even more comprehensive review to strengthen this conclusion.

4. Levels of proof:

4.1 The Strong Proof Approach:

International and National EMR standards are based on established effects, the only one of which the bodies which set the standards will reconise is heating of tissue. This is a "strong proof" approach.

The "strong proof" approach is characterized above by Goldsmith (1995) by its rejection of epidemiologic information. The academic and professional roots of radiation standards committee members is Biophysics and Health Physics relating to ionizing radiation health studies. The history of investigations concerning cancer effects from ionizing radiation reveal an initial reluctance among the scientists involved to accept that radioactive material which produces ionizing radiation was actually carcinogenic. Later it was recognized that the products of radioactive decay can ionize atoms, producing ions and free radicals which can damage DNA, cause chromosome aberrations and hence is mutagenic and carcinogenic. Scientists with this background and associated training have been a strong proponents of the strong proof approach in relation to the potential health effect of EMR. This largely relates to a conviction that unless radiation and ionize molecules it cannot cause cancer.

The nub of the basic difference of opinion between the two polarized sides of experts in this debate related to the existence of athermal effects which would provide a plausible mechanism to support epidemiological evidence of public health effects, in the absence of ionization. Those on national and international standards setting commissions and committees, and those presenting evidence on behalf of telecommunications companies and power companies take a strong proof approach and claim that the only proven adverse effects are heating and that athermal effects and public health effects are unproven and therefore cannot be used in standards setting nor Resource Consent decisions.

The strong proof approach is dominant in Government Radiation Laboratories, such as the New Zealand National Radiation Laboratory (NRL), Australian Radiation Laboratory (ARL) and the U.K.'s National Radiation Protection Board (NRPB). From these national bodies the representative take the strong proof approach into the IRPA, WHO and ICNIRP.

4.2 Evidence of athermal effects and health risks:

There is a well established "Public Health" approach, Hill (1965) and Goldsmith (1996), which is not generally applied in relation to standards setting for electromagnetic radiation, which is more dominated by a "strong proof" approach.

4.2.1 The Bradford-Hill 'viewpoints':

The 'classic' public health approach is outlined by Sir Austin Bradford-Hill in his presidential address to the then newly formed Royal Society section on Occupational Medicine on 14th January 1965. He was addressing the question of how much and what kind of evidence of epidemiological association was necessary to point to causation, as well as what level or type of association was of itself sufficient for prudent avoidance to be taken to reduce or eliminate the potential or probable risk. In his introduction he states:

“But with the aims of occupational, and almost synonymously preventative, medicine in mind the decisive question is whether the frequency of an undesirable event B will be influenced by a change in an environmental feature A. How such a change exerts an influence may call for a great deal of research. However, before deducing ‘causation’ and taking action we shall not invariably have to sit around awaiting the results of that research. The whole chain may have to be unravelled or a few links may suffice. It will depend on the circumstances.”

Sir Austin outlines his factors or criteria as:

(1) Strength of Association:

He gives the example of an enormous increase of scrotal cancer amongst chimney sweeps on one hand and the less than doubling of coronary thrombosis amongst smokers compared with non-smokers. He addresses the problem of confounders with the smoking group, refers a single occupational group, doctors, which showed increases the rates of lung cancer with increased cigarette usage concluding that the increasing ratios of incidence are “far more informative” than absolute differences in death rates.

Sir Austin finally refers to John Snow’s analysis of the 1854 cholera epidemic when the death rate from a sewage contaminated water source was 71 in 10,000 compared to a nearby water source which was sewage free, which was 5 per 10,000.

He concludes this section saying “In thus putting emphasis on strength of an association we must, nevertheless, look to the obverse of the coin. We must not be too ready to dismiss a cause-and-effect hypothesis merely on the grounds that the observed association appears to be slight. There are many occasions in medicine when this is in truth so.”

(2) Consistency of the observed association:

This raises the question has the association been repeatedly observed by different persons, in different places, circumstances and times? This is to sort out those chance associations from real rare hazards. He says “Whether chance is the explanation or whether a true hazard has been revealed may sometimes be answered only by repetition of the circumstances and observations.” He points to a paradox that “The different results of a different enquiry certainly cannot be held to refute the original evidence; yet the same results from precisely the same form of enquiry will not invariably strengthen the original evidence. I would myself put a good deal of weight upon similar results reached in quite different ways, e.g. prospectively and retrospectively.

Once again looking at the obverse of the coin, there will be occasions when repetition is absent or impossible and yet we should not hesitate to draw conclusions.”

Sir Austin illustrated the obverse by referring to an example involving Sir Richard Doll’s study of nasal cancers among certain workers and pensioners from a particular chemical industry, and later only those working with a particular chemical process. The nasal cancer rate was 10 times expected but no causal agent was known for several decades. Sir Austin states:

“No causal agent of these neoplasms has been identified. Until recently no animal experimentation had given any clue or any support to this wholly statistical evidence. Yet I wonder if any of us would hesitate to accept it as proof of a grave industrial hazard.”

(3) Specificity:

If the association is limited to specific workers and to specific sites and types of disease and there is no association between the work and other modes of dying, then clearly that is a strong argument in favour of causation.

He immediately warns, however, not to over-emphasize the importance of the characteristic, as even in the example he uses, there is a cause and effect relationship with two sites of cancer and how milk can be the source of a wide range of sicknesses. The actual example used is smoking and lung cancer which is raised by a factor of 9 to 10 in smokers compared to non-smokers. Sir Austin notes that there is specificity and a specificity in the magnitude of the association.

As with all other factors, he points to the obverse, that diseases may have more than one cause, indeed single causes he decides are not frequent. He then concludes:

“In short, if specificity exists we may be able to draw conclusions without hesitation; if it is not apparent, we are not thereby necessarily left sitting irresolutely on the fence.”

(4) Temporality:

The exposure to a disease causing agent must occur before the disease occurs, otherwise the agent cannot be associated with the disease. It can be more subtle, such as does a particular diet cause a disease or does the onset of the disease lead to a change in diet?

(5) Biological gradient:

“If the association is one which can reveal a biological gradient, or dose-response curve, then we should look most carefully at such evidence.”

Sir Austin again refers to smokers concluding:

“The clear dose-response curve admits of a simple explanation and obviously puts the case in a clear light.” “Often the difficulty is to secure some satisfactory quantitative measure of the environment which would permit us to explore this dose-response. But we should invariably seek it.”

(6) Plausibility:

“It will be helpful if the causation we suspect is biologically plausible. But this is a feature I am convinced we cannot demand. What is biologically plausible depends upon biological knowledge of the day.” “In short, the

association we observe may be a one new to science or medicine and we must not dismiss it too light-heartedly as just too odd.”

(7) Coherence:

“On the other hand the cause-and-effect interpretation of our data should not seriously conflict with the generally known facts of the natural history and biology of the disease.”

The examples used refer to smoking and cholera. Laboratory evidence of cancer of the skin of laboratory animals in cigarette smoke and the lack of a biological agent in the case of cholera from sewage contaminated water. Sir Austin is here giving the obverse that the lack of a plausible agent to give coherence to the result did not weaken the epidemiological case for cholera hazard.

(8) Experiment:

Sir Austin notes that occasionally it is possible and desirable to experiment when a health effects is suspected from exposure to a possible disease agent because of an epidemiological association. By removing the suspected disease agent, if the association disappears than the cause-and-effect relationship is greatly strengthened but is the disease association continues the association is significantly weakened.

(9) Analogy:

In some circumstances parallel effects can be compared by analogy.

Bradford Hill’s closing comments:

“Here are nine different viewpoints from all of which we should study association before we cry causation. What I do not believe - and this has been suggested - is that we can usefully lay down some hard and fast rules of evidence that must be obeyed before we accept cause and effect. None of my nine viewpoints can bring indisputable evidence for or against the cause-and-effect hypothesis and not can be required as a sine qua non. What they can do, with greater or less strength, is to help us to make up our minds on the fundamental question - is there any other answer equally, or more, likely than cause and effect?”

Sir Austin does not require that all of the nine viewpoints to be satisfied, as some have suggested, rather he argues against this. He goes so far as to say that none of them are essential conditions (sine qua non). A judgement is required in each case and the viewpoints are valuable tools to assist in an assessment of the significance or otherwise of a set of studies. Bradford-Hill’s approach is strongly at odds with the reductionist approach used by the Court in the MacIntyre case. It is consistent with the approach advocated by Professor Goldsmith and most other public health professionals.

4.2.2 Goldsmith on Epidemiology and EMR:

Eminent international epidemiologist, Professor John Goldsmith has rightly criticized IRPA EMR standards because of their failure to take into account the epidemiological findings of adverse public health effects, Goldsmith (1992): His abstract states:

“In standard setting there is a tendency to use data from experimental studies in preference to findings from epidemiological studies. Yet the epidemiological studies are usually the first and at times the only source of data on such critical effects as cancer, reproductive failure, and chronic cardiac and cardiovascular disease in exposed humans.

A critique of the protection offered by current and proposed standards for ionizing and non-ionizing radiation illustrates some of the problems. Similar problems occur with water and air pollutants and with occupational exposures of many types. The following sorts of problems were noted:

- (a) Consideration of both thermal and non-thermal effects especially of non-ionizing radiation.**
- (b) Interpretation of non-significant results as equivalent to no effect.**
- (c) Accepting author's interpretation of a study, rather than examining its data independently for evidence of hazard.**
- (d) Discounting data on unanticipated effects because of poor fit to preconceptions.**
- (e) Dependence on threshold assumptions and demonstration of dose response relationships.**
- (f) Choice of insensitive epidemiological indicators and procedures.**
- (g) Consideration of each study separately, rather than giving weight to the conjunction of evidence from all available studies.**

These problems may be minimized by greater involvement of epidemiologists and their professional organizations in decisions about public health protection.”

Dr Goldsmith concludes:

“Existing standards (IRPA, and Tables 2 and 3), lacking appropriate use of epidemiological data, are not sufficient to provide a reasonable level of protection against long-term cancer hazards or against symptomatic, or physiological effects of R.F. radiation. This is in part because of the failure to evaluate currently available epidemiological information. Omission of critical studies occurs, as well as acceptance of a superficial conclusion concerning the meaning of the studies which were cited. The standards do provide a reasonable level of protection against thermal effects.

These remarks are also applicable to the recently published Israeli guidelines which propose to reduce the standards shown in Table 3 by 2/3 for new exposures. They are, in our opinion, a step in the right direction. However, due to the present lack of inclusion of current data on athermal (behavioral and chronic disease) effects, these guidelines cannot be considered an adequate basis for protection of the health of populations in the 1990s.

In conclusion, in setting health protection guidelines it is reasonable to expect that examples be given in which data on symptoms, carcinogenic hazards, and biological indices have been incorporated. When such data are available and are not used, the level of health protection may be insufficient.

Hence it is clear, from the standards documents themselves, from members of the standards setting bodies and from criticisms by epidemiologists, that RF/MW standards do not incorporate epidemiological findings and thus do not protect public health from adverse health effects.

The alternative, epidemiologically-based view holds that there is sufficient evidence of athermal effects to establish highly plausible biological mechanisms for cancer, brain and sleep disturbance, immune system impairment and reproductive effects, and sufficient animal and epidemiological evidence to require the setting of public and occupational exposures at much lower levels across the whole EMR spectrum.

5. Standards Setting:

5.1 History of Approaches:

Since RF/MW radiation is non-ionizing it is the widely held presumption in the Health Physics profession and in the Government Radiation Laboratories, for example, that RF/MW radiation is not mutagenic and carcinogenic because quanta of RF/MW lack the energy to ionize atom nor to break chemical bonds. This conviction lay behind the Tri-Service program in the United States, Steneck and Cook (1980) and is widely held in official government, military and industrial sectors today. With this assumption being widely adopted, the Tri-Service Program undertook extensive in-depth research in an attempt to determine the limits of the thermal effects which could be born by service personnel without thermal injury.

Michaelson (1971) summarizes the Tri-Service Program and the pioneering work of Professor Herman. Michaelson shows the extensive mathematical lengths which were taken to calculate the thermal effects of RF/MW exposure, especially by Schwan and his group at the University of Pennsylvania.

Dr Alan Frey, Frey (1988), in his outline of the historical development of research on low intensity non-ionizing radiation, points out that most of the research done during the 1960's and 1970's was irrelevant to his topic since the Department of Defense sponsors who determined what would be done were interested only in high power levels relevant to thermoregulation.

This was based to a significant extent on the notions about the nervous system function which Professor Schwan had developed. Schwan set up a mathematical model of the nerve's axon membrane, and assumed that this was a reasonable representation of the

nervous system, Schwan (1969). His calculations with the model indicated that at field strengths that are "not thermally significant", the induced potentials across the nerve membrane are many orders of magnitude smaller than the nerve resting potential. He stated that such induced fields applied to the resting potential of the axon cannot excite the nerves, and essentially, on the basis of this, he concluded that the nervous system could not be influenced by low intensity RF radiation.

For example, Schwan and Foster (1980) conclude:

"The considerations above do not suggest any weak nonthermal mechanism by which biological systems could react to low-intensity microwave fields."

Dr Frey points out that he had identified two primary faults in Prof Schwan's model. One was that the model was unrealistic. Nerves function, and the resting potential, is only one extreme of the continuum of potentials of the axon. Schwan ignored most of the nerve cell, including the most important part, when he considered only the axon in his model. Further, nerves interact with each other (see the dendritic cell in Figure 16). The points of interaction on the synapses are the most sensitive to disturbance, not the axon. Thus Schwan's model, based on the resting potential of the axon, did not conform to reality.

Secondly, Schwan assumed that we had a good understanding of the nervous system at the time he developed his model. What we have learnt since then shows how complex it is. Cellular biochemistry has identified and quantified many processes in cells, including nerve cells, many of which are altered by very small and subtle EMR induced signals, through such processes as gap junction changes, ionic balance and signal transduction. Frey (1971) showed that by changing one of Schwan's model parameters to a more realistic value, and then re-doing his calculations, leads to the conclusion that the nervous system would be affected by low level RF radiation.

Frey's work in 1971 has been vindicated by many studies but those studies and Frey (1971) have been totally ignored by those favouring a thermal view. More sophisticated models are now in use with considerable experimental verification. These are outlined by Adey (1981, 1991) for example. Prof Adey concludes:

"To claim that there are no nonthermal mechanisms for the interaction of weak RF/MW signals with human and animal organs and cells is simply not scientifically credible."

5.2 Setting the U.S. Standard C 95.1: Avoiding thermal hazard.

It is totally clear that the U.S. and subsequent standards are based on thermal effects. The U.S. safety standard C95.1 was set at 10 mW/cm² after a large number of experiments involving quite intense short-term exposure at this or somewhat higher levels, e.g. 50 to 200 mW/cm², with no apparent irreversible effects, Steneck and Cook (1980). They also report that a letter from the Raytheon Company to Senator Warren G. Magnuson, dated 31 August 1967, contended that:

"The Tri-Service program had led to 'three basic conclusions': the biological effects involved were (i) thermal, (ii) non-cumulative, and (iii) of little concern

since 'man has a built-in alarm system coupled to his threshold of pain that protects him from thermal injury.'

Steneck and Cook (1980) note:

"In the push to set the standard, there can be no doubt that possible evidence against its safety was ignored and that research which might have clarified certain details was not undertaken."

Steneck and Cook also note that: **"few animal studies involving long-term exposure to low-level radiation were undertaken."**

In setting up one of the rare long-term animal exposure studies, Guy et al. (1980) note that:

"Although there are more than 5000 published articles in the literature pertaining to the biological effects of electromagnetic radiation, the question of whether long-term low-level radio-frequency radiation exposure is hazardous to health remains highly controversial."

5.3 IRPA Standards - protection from thermal hazards:

The exposure standard of 10 mW/cm² is associated with a Specific Absorption Rate (SAR) of 4 W/kg which is referred to in Dr Repacholi's evidence, Section 1.6.2. Repacholi (1990) states:

"The international (IRPA, 1988) and most Western Standards are accepted, on the basis of reviews of all appropriate scientific literature, a threshold RF exposure of 4 W/kg as necessary under normal environmental conditions to produce behavioural changes in animals. Standards have generally required that limits of RF absorption be set that do not allow more than one tenth of the threshold SAR value (that is 0.4 W/kg) to be exceeded."

Gandhi (1990) states that the observed highest rates of temperature rise in human subjects is given by 0.0045 x SAR (W/kg) in °C/min. An SAR of 4 W/kg will raise the temperature of a human body by about 1°C in 1 hour. For workers to avoid significant heating a safety factor of 10 is used giving an occupational exposure limit of 0.4 W/kg. Localized heating can occur in human bodies exposed to RF/MW radiation, especially in places such as the head, ankles and testes. Jammet (1988) says:

"The 'hot spot' range, extending from about 400 MHz up to 2000 MHz or even 3000 MHz, where significant localized energy absorption can be expected at incident power densities of 100 W/m² (10,000 μW/cm²). The size of hot spots ranges from several centimeters at 915 MHz to about 1 centimeter at 3000 MHz. Hot spots are caused by resonance or quasioptical focusing of incident fields. The former mechanism prevails at lower frequencies, the latter at higher ones (Foster et al. (1978) and Schwan (1982)). For the human head, the hot spot range extends from 300 MHz to 2000 MHz (Foster et al. 1978)."