

A curate's egg: Queensland's Guidelines for managing 50 Hz magnetic fields in office buildings

The origin of the phrase a curate's egg is from the cartoon True Humility, printed in the British satirical magazine Punch on 9th November 1895. The phrase is used to describe something which is partly good but which is ruined by its bad part, and, as a result, is now rather lost.

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Background

In 2013 the Queensland Government released its *Guidelines for the Management of 50 Hz Magnetic Fields in Office Buildings Owned and Managed by the Queensland Department of Housing and Public Works*. These guidelines are the current government policy for workers' exposure to 50 Hz mains power frequency magnetic fields in government offices.

The guidelines present a valid methodology for the measurement of magnetic fields in office buildings and are very useful in that regard.

However, the "target" level of 5 μ T [5 microTesla or 50 milliGauss (mG)]¹ as a supposedly reasonable, or acceptable level for a worker's exposure is far from adequate and gives a disingenuous assurance of safety that is not justified in our considered opinion.

As part of its rationale for the Queensland Guidelines the authors reference the limits recommended in the *Interim guidelines on limits to exposure to 50/60 Hz electric and magnetic fields (1989)*, set by the National Health and Medical Research Council (NH&MRC). The NH&MRC's recommended magnetic field limits are 1000 mG for public exposures (over a 24 hour period) and 5000 mG for occupational exposures.

On the surface of it, the Queensland's Guidelines seem quite precautionary in relation to that of the much higher interim limits set by the NH&MRC. However, what is not mentioned is the significant limitation of the NH&MRC limits, which are irrelevant to the actual exposures people may receive in the workplace. This is because the NH&MRC limits are only meant to provide protection against immediate harm, such as electrostimulation, at very high levels of exposure. Dr. Keith Lokan from the Australian Radiation Laboratory (ARL), explained this in 1991 in a conference paper published in *Radiation Protection in Australia*. To quote, discussing the NH&MRC interim limits:

One thing which we have done, though it has little direct bearing on the issue of chronic low level exposure, is to adopt the (above) recommendations on field limits. These limits represent plausible field values, below which immediate adverse health effects are unlikely, and as such serve a useful purpose. They are not intended to provide protection against possible cancer induction by continued exposure at the lower field levels implicated in the studies...²

¹ As many of the references cited in this paper were originally in milliGauss units (mG) all magnetic field measurements will be given in mG .

² Lokan, K., 'Risk Perception and Regulation- What Should the Regulator Do?' *Radiation Protection in Australia* , vol. 9, no.4, 1991, pp. 134-136.

This significant limitation on the NH&MRC interim guidelines is also admitted in an earlier relevant Queensland government discussion paper of Sept 2008:

*...the NH&MRC limits are based entirely around acute effects. As such, they cannot be said to guarantee safety from potential chronic effects such as cancer.*³

However, the same discussion paper then suggests the risk of possible chronic health hazards from electromagnetic fields lies “in the domain of psychological wellbeing” and that “the state of scientific evidence regarding the chronic effects of EMF exposure is best summarized as one of conjecture, contradictions and uncertainty”. In the Summary of Recommendations it is stated: “it appears that in the case of the psychological hazard, there are adequate grounds for action. This action should be composed of a risk communication and precautionary action component”.⁴

Thus, it would appear that the recommended 50 mG (5 μ T) limit in the 2013 “Guidelines for the Management of 50 Hz Magnetic Fields” are more based on addressing “psychological wellbeing”. That is, giving concerned workers the impression that 50 mG is an acceptable level for prolonged exposure in the workplace. The authors of this paper strongly disagree with that assessment.

A suitable guideline?

Setting a power-frequency magnetic field guideline limit which addresses possible long-term environmental level exposures has been a contentious issue for over 40 years, with strong industry influence in setting exposure standards / guidelines. The power industry’s position is that exposure standards can only be set to protect against immediate and obvious biological damage from high level exposure. Setting limits based on this concept has been the industry’s viewpoint from the very beginning of power frequency electromagnetic standard setting in the 1970s. This has resulted in exposure limits set so high that they are not a barrier to any possible future technological developments.

For example, the current guidelines set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP): 2000 mG for residential and 10,000 mG for workplace exposures are still based on only providing protection against immediate harm from high-level exposures. Other possible health endpoints such as cancer and immune system effects are deemed to lie outside standard / guideline considerations. ICNIRP claims to be free of industry influence but, on examination, industry involvement is endemic in the processes used to set environmental health criteria for power frequency EMFs.^{5,6}

³ Discussion Paper: Management of Electric and Magnetic Fields in Queensland Government Offices, September 2008, <http://www.hpw.qld.gov.au/SiteCollectionDocuments/MagneticFieldMgtDP.pdf>

⁴ *ibid.*

⁵ Maisch, D., “Conflict of Interest & Bias in Health Advisory Committees: A case study of the WHO’s Electromagnetic Field (EMF) Task Group”, *J. Aust. Coll. Nutr. & Env. Med.* Vol. 25 No. 1 (April 2006) pages 15-17. http://www.emfacts.com/download/who_conflict.pdf

⁶ Slesin L. “WHO Welcomes Electric Utility Industry To Key EMF Meeting, Bars the Press”, *Microwave News*, Sept. 22, 2005. <http://microwavenews.com/news/who-welcomes-electric-utility-industry-key-emf-meeting-bars-press>

The 2012 BioInitiative report

In contrast to the NH&MRC interim guidelines and those of ICNIRP, the 2012 BioInitiative report, written by 14 well-known scientists who reviewed the scientific literature, called for the creation of biologically based exposure standards. As for the biological effects of power-frequency magnetic fields they stated the following in part:

With 42 epidemiological studies published to date power frequency EMFs (magnetic fields) are among the most comprehensively studied environmental factors. Except ionizing radiation no other environmental factor has been as firmly established to increase the risk of childhood leukemia.

Sufficient evidence from epidemiological studies of an increased risk from exposure to EMF (power frequency magnetic fields) that cannot be attributed to chance, bias or confounding....

There is no other risk factor identified so far for which such unlikely conditions have been put forward to postpone or deny the necessity to take steps towards exposure reduction. As one step in the direction of precaution, measures should be implemented to guarantee that exposure due to transmission and distribution lines is below an average of about 1 mG. This value is arbitrary at present and only supported by the fact that in many studies this level has been chosen as a reference.⁷

The Bioinitiative report also examined the evidence that power frequency magnetic fields may influence breast cancer through an effect on melatonin production, a natural hormone known to suppress breast cancer cells. They found that 11 of the 13 epidemiological studies (residential and occupational) provided positive evidence that prolonged exposure to power frequency magnetic fields in the order of 12 mG can suppress melatonin production.⁸ The authors referred to this as a “relatively high” level.

A historical perspective on what Level is ‘acceptable’: The NCRP draft ELF review (1995)

The U.S. National Council on Radiation Protection and Measurements (NCRP), a U.S. congressionally chartered organization, was contracted by the Environmental Protection Agency (EPA) in 1983 to conduct a review of the biological effects of Extremely Low Frequency (ELF) EMFs. In early 1995 the draft of the 800 page NCRP report was leaked to the New York-based publication, Microwave News, which published the report's findings in August 1995. The final report was supposed to be approved and to be publicly available in early 1996, but final approval of the draft has never been acted upon. It is important to note, however, that the membership of the NCRP Committee was made up of expert scientists and the draft recommendations reflected their consensus evaluation of the scientific literature in relation to the potential hazards of long term, low level ELF magnetic fields. Committee membership included power industry engineers, epidemiologists, public health specialists as well as molecular and cellular biologists in order to include a wide range of societal interests.

Based on their review, the draft report endorsed a 2 mG exposure limit which would have immediately affected new day-care centres, schools and playgrounds, as well as

⁷ BioInitiative 2012, <http://www.bioinitiative.org/conclusions/>

⁸ *ibid.*

new transmission lines near existing housing. A somewhat more flexible policy was applied to new housing and offices. For existing facilities, the committee recommended a more gradual approach, with stronger restrictions phased in over time if the evidence of a health risk continued to grow.

The NCRP Committee's Conclusions:

In arriving at the proposed guidelines, the committee has considered available laboratory studies on bioeffects and epidemiological reports of health hazards from electric and magnetic field exposure. In key areas of bioelectromagnetic research, findings are sufficiently consistent and form a sufficiently coherent picture to suggest plausible connections between ELF EMF exposures and disruption of normal biological processes, in ways meriting detailed examination of potential implications in human health.

From studies on humans the committee cited evidence for a link between EMF's and:

- *childhood and adult cancer, including leukaemia and brain cancer;*
- *teratological effects and other reproductive anomalies;*
- *neuroendocrine and autonomic responses which, separately or collectively, may have pathophysiological implications;*
- *neurochemical, physiological, behavioural and chronobiological responses with implications for development of the nervous system.*

From laboratory studies the committee noted that EMFs:

- *affect cell growth regulation in animal and tissue models in a manner consistent with tumour formation;*
- *increase tumour incidence and decrease tumour latencies in animals;*
- *alter gene transcriptional processes, the natural defense response of Tlymphocytes and other cellular processes related to the development and control of cancers;*
- *affect neuroendocrine and psychosexual responses.*

In relation to the effect of low-level EMFs on melatonin and breast cancer, the committee concluded:

There has been a strong focus on ELF field actions in the pineal gland, relating to the pineal hormone, melatonin, and on a broad series of regulatory functions mediated by this hormone. Melatonin plays a key role in controlling the 24-hour daily biological rhythm. Disturbance of the normal diurnal melatonin rhythm is associated with altered estrogen receptor formation in the breast, a line of experimental evidence now under study, or possible links between ELF field exposure and human breast cancer. Further, melatonin has general properties as a free radical scavenger, with the possibility of a preventative role in oxidative stress, recognized as a basic factor in a broad spectrum of human degenerative disorders, including coronary artery disease, Parkinson's and Alzheimer's diseases, and aging.

The committee stated that the evidence pointed to human health hazards in common exposures to EMFs, particularly magnetic fields exceeding 2 mG.

There is an implication that a significant proportion of the world's population may be subjected to a low level of risk, but a risk factor with significant societal consequences, by reason of its pervasive nature and the serious consequences for affected individuals.

In their interim exposure guideline recommendations the NCRP concluded that while the laboratory and epidemiological findings were unable to establish well-defined thresholds for safety guidelines, it appeared prudent and responsible to set limits on “permissible future exposures”.

Therefore the NCRP committee called for “interim exposure guides” that would offer guidance on how to limit exposures. The NCRP committee recommended an “As Low As Reasonably Achievable” (ALARA) policy that over a three year period, ambient exposures in existing homes, schools and offices would be reduced to 10 mG. After six years, there would be an option to establish a guideline of 5 mG. At 10 years a goal of 2 mG would be considered, depending upon the scientific evidence at the time. As for future construction, the report recommended a 2 mG exposure limit for schools and for new transmission lines near existing housing, with somewhat less strict guidelines for new housing and offices.⁹

Committee member Dr. David Carpenter from the School of Public Health at the State University of New York, Albany, said of the committee’s recommendations:

*In almost any other type of environmental exposures, if the evidence were as strong as the association between EMFs and cancer, there would be extensive government regulation. The major reason that many members of the committee were unwilling to set more rigorous standards was that it would be horrendously expensive and unrealistic to enforce them.*¹⁰

In July 1995 the NCRP committee Chairman, Ross Adey, stated in reference to setting exposure standards based solely on preventing immediate biological damage from acute exposure levels:

*The laboratory evidence for athermal effects of both ELF and RF/MW fields now constitutes a major body of scientific literature in peer-reviewed journals. It is my personal view that to continue to ignore this work in the course of standard setting is irresponsible to the point of being a public scandal.*¹¹

Our interest in commenting on the Queensland 50 Hz guidelines

In 2006 we were asked by the Royal Australian Institute of Architects, due to our previous work in the area, to write a paper for their journal, *The BDP Environment Design Guide*. The title of our paper, “Electromagnetic Fields in the Built Environment – Design for Minimal Radiation Exposure”, made the following points:

- Sufficient evidence now exists to suggest that a contributing factor to consider in assessing indoor environment quality is the prolonged and excessive exposure to electromagnetic fields (EMFs) in buildings.
- Where scientific inquiry is inconclusive it is appropriate to adopt the ‘precautionary principle’.
- The impact of external power-line generated magnetic fields to indoor levels is considered to be minimal in terms of potential exposure and was therefore not

⁹ Draft report of NCRP Scientific Committee 89-3 on Extremely Low Frequency Electric and Magnetic Fields

¹⁰ Slesin L., “Draft NCRP Report Seeks Strong Action To Curb EMFs Committee Cites 2 mG Limit as Goal”, *Microwave News*, Vol. XV No. 4, July/August 1995, <http://microwavenews.com/news/backissues/j-a95issue.pdf>

¹¹ E-mail correspondence with Dr. Ross Adey, July 7, 1997.

detailed in this paper. Radiofrequency and microwave electromagnetic radiation (EMR) were also not covered in this paper.

- It is possible to address potential exposure at the building design stage to significantly reduce and minimize occupant exposure at relatively little cost during planning and design.¹²

Although a target exposure level was not recommended in the paper, we pointed out that average magnetic field levels in homes and office spaces were usually less than 2 mG. Specifically examined was a Victorian Workcare compensation case where a number of employees independently reported similar ill-health symptoms (such as Chronic Fatigue Syndrome: CFS) while working in an area immediately above an electrical substation. Initial spot measurements found widely fluctuating magnetic fields in the office up to 187 mG. Average room readings over the substation at the time of our survey were in the order of **31mG**. In comparison, other areas in the building averaged 0.7 to 1.5 mG. After remedial work was carried out, the levels above the substation averaged 7.4 mG¹³

Interestingly, if the Queensland 50 Hz guideline average level of 5 μ T (50 mG) was applied at time of survey the level of 31 mG would erroneously be considered as acceptable – but perhaps not to the people who worked there.

Our CFS magnetic field study

In a study carried out in 1998 by the authors of this paper, the residential magnetic field exposures of a group of 49 subjects suffering from symptoms that were medically diagnosed as CFS was conducted. All subjects were exposed to varying strength magnetic fields in their home environment. The subjects were divided into two groups: those experiencing prolonged exposure of 2 mG or more (Group A) and those with exposure to less than 2 mG (Group B).

The exposure levels in Group A averaged 7.1mG. The sources of exposure were identified and reduced to below 2 mG, whereas Group B's existing low exposure levels, averaging 0.67mG, were left unchanged. Both groups were monitored for six months for any changes in health status. At the end of six months, Group A had a significant improvement in health, including improved sleep, compared to Group B, thus indicating prolonged nighttime magnetic field exposures of around 7 mG may be a factor in both CFS and compromised sleep.^{14, 15}

All these levels are far below what the Queensland 50 Hz Guidelines would consider acceptable.

¹² Maisch, D., Podd, J., Rapley B., Electromagnetic Fields in the Built Environment – Design for Minimal Radiation Exposure, BDP Environment Design Guide, Aug. 2006. <http://www.emfacts.com/download/gen76.pdf>

¹³ Maisch, D., 1999, The Ross House Electrical Substation Workcare Compensation Case: Chronic Fatigue Syndrome (CFS) Symptoms Attributed to Exposure to Electromagnetic Fields (EMF) Due to Close Proximity to an Electrical Substation, Melbourne Victoria, (Report to Workcare Victoria, compiled) http://www.emfacts.com/download/The_Ross_House_Electrical_Substation.pdf

¹⁴ Maisch, D., Podd, J., Rapley, B., “Changes in Health Status in a Group of CFS and CF Patients Following Removal of @ Excessive 50 Hz Magnetic Field Exposure”, JACNEM, Vol. 21, No. 1; April 2002. http://www.emfacts.com/download/cfs_changes.pdf

¹⁵ Podd, J., Maisch, D., “Reducing EMF exposure improves sleep and reduces CFS symptoms”, Poster presentation at the 2nd International Workshop on "Biological effects of Electromagnetic fields", 7-11 October 2002, Rhodes, Greece, <http://www.emfacts.com/download/Reducing50.pdf>

Pseudo-iron deficiency in a French population

In 2000, an unusual blood condition, termed “pseudo-iron deficiency” was repeatedly being found by clinicians in a French hospital. Upon investigation, the condition was only found in residents living near twin 400 kilovolt transmission lines and who had prolonged exposures of around 2 mG. The symptoms reported by the hospital were the same as symptoms reported in the above-mentioned CFS study.

Interestingly, similar findings were reported in a later 2008 survey of similar 400 kV transmission lines in France. Taken together the French research strongly indicates adverse immune system effects in humans living within 100 metres of high voltage lines and with measured magnetic fields down to a 2 mG level.

The lead author, Eric Hachulla, concluded:

We speculate that EMFs may modify iron metabolism in populations subjected to 2 mG or more with a high bone marrow incorporation of the iron (that would explain the low iron level) and a rapid utilization for the metabolism of hemoglobin, sometimes with non-incorporation of ^{59}Fe in the liver.¹⁶

Concluding recommendations

It is our considered opinion that the 50 mG (5 μT) magnetic field recommendation as published in “Guidelines for the Management of 50 Hz Magnetic Fields in Office Buildings Owned and Managed by the Queensland Department of Housing and Public Works” is inadequate. It is disingenuous to rely upon guidelines which only address immediate high-intensity magnetic field exposures, giving the impression that such guidelines provides adequate safety to workers.

Taking a wider understanding of the available research, which is not limited by official standards/guidelines, a strong precautionary approach is called for. As for what magnetic field level would be an adequate precautionary measure we would suggest a 2 mG precautionary recommendation for the reasons we have briefly examined in this paper.

¹⁶ Hachulla E., et.al., “Pseudo-iron deficiency in a French population living near high-voltage transmission lines: a dilemma for clinicians” *Eur J Intern Med.* 2000 Dec;11(6):351-2. Also see: http://www.emfacts.com/download/pid_france.pdf

Biography

Don Maisch has been involved in the issue of health impacts of electromagnetic fields (EMF) since the early 1990's when he was a science writer for Australian Senator Robert Bell. He has served on government and industry EMF standard setting committees on behalf of the Consumers Federation of Australia. He is a member of the Australasian College of Nutritional and Environmental Medicine, a training College offering postgraduate education for health professionals. In 2010 he received his PhD from the University of Wollongong, New South Wales, Australia. His thesis examined the historical development of Western radiofrequency and microwave exposure standards and how vested interests have influenced those standards. He has published a number of papers on the health effects of electromagnetic radiation as well as numerous submissions. These are available online at <http://www.emfacts.com/papers/>

John Podd obtained his PhD in psychoacoustics from Victoria University of Wellington (New Zealand) in 1983. Since then he has lectured and researched in the School of Psychology, Massey University (New Zealand). His interest since the mid 90's has been in the effects of electromagnetic fields on biological systems (especially on human behaviour), and he has authored a number of publications and conference papers on the topic. He is a member of both the Bioelectromagnetics Society and the Association of Psychological Science (United States), and reviews papers for the BIOELECTROMAGNETICS journal.

Bruce Rapley received his PhD in 2013 from Massey University, Palmerston North, New Zealand. Thesis title: Sound in the military environment : detection, measurement and perception: a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, Massey University, Palmerston North campus, Institute of Food, Nutrition and Human Health. His professional interests include environmental noise measurement, bio-electromagnetics and product development and management.

APPENDIX A