

Discussion Paper

Management of Electric and Magnetic Fields in Queensland Government Offices

Contents

1. Executive Summary	1
2. Background	2
3. EMF and Human Health	3
4. Responding to Uncertainty	4
5. Testing	9
6. Summary of Recommendations	11
7. Key Terms and Acronyms	12
8. References	14
Appendix A: Table of Factors Relevant to EMF Mitigation Action/Inaction (WHO 2007, 368-370)	16
Appendix B: Table of Factors (II) Relevant to EMF mitigation action/inaction (NHMRC 2006, 146)	18
Attachments	19
Findings from EMF testing in the Buildings containing substations in the DPW portfolio	20
Further Reading	21
Author and contributors	22

1. Executive Summary

A group of Queensland Government office workers have expressed concern over the hazard posed by continuous exposure to low-level, electric and magnetic fields (EMF) in the workplace. As the risks associated with this hazard are the subject of scientific uncertainty, the appropriate workplace health and safety response is not initially clear. As the responsible body, the Queensland Department of Public Works (DPW) must decide how to respond to this uncertainty in a way that is measured, justified and acceptable to the relevant stakeholders. This paper intends to aid to this process by reviewing a range of relevant EMF literature, and discussing its application to the issue at hand.

1.1 Content and Findings of this Paper

- A summary of the state of scientific evidence on the matter of EMF exposure and human health: *EMF are regarded by the World Health Organization (2007) as a “possible human carcinogen.” However, the evidence for this remains tenuous, and uncertainty prevails.*
- A presentation of differing views on risk mitigation in uncertain contexts (precautionary action): *On the one hand, there is an argument that uncertainty does not justify inaction, while on the other, theorists warn that chasing “phantom threats” leads to unnecessary resource wastage.*
- A discussion of the different demands and implications of the physical and psychological sides of the EMF hazard as it applies to the Queensland State Government: *While EMF exposure provides uncertain ground for precautionary action in the area of physical health, in the domain of psychological wellbeing, the risks are more certain, and the case for action more robust.*

- A presentation of international policy examples and risk communication norms to guide the form and scale of precautionary action: *Of these, the norms established by the policies of Prudent Avoidance and the Hierarchy of Control seem the most appropriate. It is important for the DPW to embed any precautionary steps in a risk communication framework, this involves establishing a dialogue with the stakeholders to formulate action multilaterally.*
- A discussion of testing in light of both its limits and potential: *In the Context of EMF exposure, testing cannot yet function as a guarantor of safety from chronic disease. However, it remains useful as an informant of precautionary action and a fulfillment of workplace health and safety obligations.*

2. Background

Over the period of 2004 to 2008, six public servants working on the ground floor of Queensland Government building Mineral House were diagnosed with different forms of cancer. In May of 2008, these staff raised concern that the cases represented a cancer cluster, the cause of which was suspected to be exposure to electric and magnetic fields (EMF), emitted by the electrical substation below.

A Queensland Health epidemiological investigation into the matter found that the cases were not sufficiently numerous or homogenous to represent a statistically significant deviation from the norm. However, the report emphasised the limits of epidemiological studies when dealing with small sample sizes (Qld Health 2008).

As part of its investigation, Queensland Health (2008) also measured the magnetic flux density on the first five floors of occupied areas at Mineral House. The highest reading recorded was 1.5 μT , and was found directly above the substation. This is well below the 100 μT exposure limit established by National Health and Medical Research Council of Australia (NHMRC) (1989). However, it is above typical exposures for Queensland office workers of 0.06-0.2 μT (Qld Health 2008, 7).

It is important to note that the NHMRC limit does not relate to the chronic effects of EMF exposure. As the connection between illness and long term exposure to low levels of EMF remains uncertain, the NHMRC limits are based entirely around acute effects. As such, they cannot be said to guarantee safety from potential chronic effects such as cancer. The matter of the chronic effects of EMF exposure is subject to significant scientific conjecture and it may be some years before research provides clear guidance on what constitutes a safe level, or indeed, what the dangers are (WHO 2007).

In 1999, shielding was installed in the basement of Mineral House to reduce EMF levels in the building. The stated reason for this was the flicker of computer screens caused by EMF. Improvements in screen technology rule out the use of this justification today. Measurements of EMF levels in occupied areas before these works found nothing in excess of 5.8 μT .

As the World Health Organization (WHO) (1946, 1) defines “health” as “a state of complete physical, psychological and social well-being,” the Queensland Health report’s negative findings in regard to a physical threat do not preclude the consideration of a health hazard posed by staff concern itself. Therefore, the issue is two-fold: encompassing a potential, yet unproven, physical hazard as well as a possible psychological hazard. The Queensland Workplace Health and Safety Act (1995, 29) states that an employer has an obligation to provide and maintain “a safe and healthy work environment.” Specifically, an employer is obliged to “Properly manage exposure to risks by identifying hazards...to assess risks that may result because of the hazards...to decide on appropriate control measures to prevent, or minimise the level of the risks... to implement control measures...[and] monitor the effectiveness of measures” (Qld Parliament 1995, 28).

Mineral House is one of sixteen office buildings in the Queensland Government portfolio managed by the Department of Public Works containing electrical substations.

In light of these factors, and the absence of an established specific management approach:

- The Department of Public Works (DPW) is developing guidelines for the management of EMF exposure in its office buildings in order to mitigate possible impacts on staff wellbeing and safety.
- The Chair of the DPW's Health and Safety Committee has made a commitment to review and assess the EMF levels annually across these 16 buildings. Dr Tee Tang of the Queensland University of Technology has been contracted to develop a testing methodology for this purpose.
- The Department of Public Works Technology and Development Division has formed a "Peer Review Group" comprising a number of experts and stakeholders, to contribute to and oversee the managerial response.
- This paper intends to aid to these measures by reviewing a range of relevant EMF literature, and discussing its application to the issue at hand. The paper also gives recommendations with a view to assisting the DPW develop its position on EMF exposure in the workplace. Furthermore, it is hoped that this paper may act as a foundation for the peer review group discussion.

3. EMF and Human Health

When considering the effect of EMF on human health it is necessary to distinguish between acute and chronic effects (See: Section 8). The most recent and comprehensive reviews (WHO 2007, IARC 2002, UNEP/WHO/IRPA 1987) on the subject conclude that:

- Human exposure to EMF has demonstrated acute effects and uncertain chronic effects.
- The acute effects of ventricular fibrillation and extrasystoles have been observed at levels of EMF above 500 μ T, the highest level recorded at Mineral House is 0.3% of this (UNEP/WHO/IRPA 1987).
- The only observed chronic effect is an increase in childhood leukaemia associated with prolonged exposure to EMF levels of 0.3-0.5 μ T. However, the International Association for Cancer Research (2001) as well as the World Health Organization (2007) deemed evidence for this association to "limited," as no study surveyed had convincingly ruled out chance, bias or confounding as a cause of this association.
- In light of this, EMFs are classified as a "Possible Human Carcinogen." (WHO/IARC 2007, 11)¹
- Regarding other diseases, no research has demonstrated a credible statistical connection. This conclusion covers cancers in children and adults, depression, suicide, reproductive dysfunction, developmental disorders, immunological modifications and neurological disease. Regarding cardiovascular disease and breast cancer, the World Health Organization (2007, 12) goes so far as to say, "The evidence is sufficient to give confidence that magnetic fields do not cause [these diseases]."
- Laboratory (*in vitro*) research has been unable to produce a plausible biophysical mechanism by which continuous exposure to low levels of EMF could lead to disease, though, it has not ruled out the existence of one (WHO 2007, 11).
- While associations have been observed between *magnetic* fields and cancer (childhood leukemia), there is no evidence to suggest a similar risk connected to *electric* fields (WHO 2007, 12).

The state of scientific evidence regarding the chronic effects of EMF exposure is perhaps best summarised as one of conjecture, contradictions and uncertainty. As such, EMF resides largely in the space between proven safety and proven danger. The World Health Organization (2007, 14) has strongly emphasized the need for further research, particularly in the area of cancer. However, this will take time.

¹ To put this in context, it is interesting to note that the WHO (2002) also places coffee, gasoline fumes and welding fumes in this category.

4. Responding to Uncertainty

4.1 The Precaution Debate

A conservative reading of the EMF and health evidence suggests members of staff may be facing a possible, albeit unproven, hazard, the risks of which are unknown. This status renders a simple quantitative risk management approach inappropriate, and presents a difficult decision in choosing how to respond to uncertainty.

- The Department of Public Works must decide whether or not to support precautionary approach given the opportunity cost of doing so. The opportunity cost could include action on other, more certain or harmful hazards (see: Figure 1).

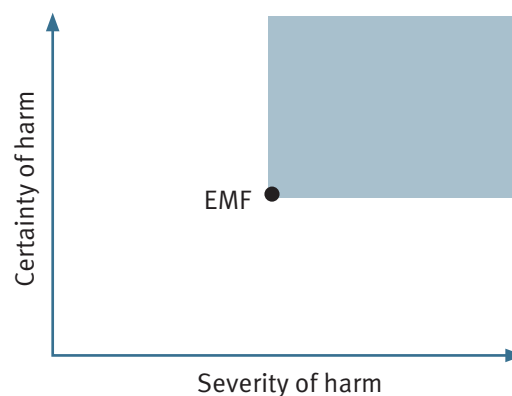


Figure 1. The EMF Hazard in Context (Adapted from Kheifets et al 2001, 7).

The shaded area represents hazards of an arguably higher priority than continuous, low-level EMF exposure. It is important that the topical nature of the EMF threat does not let it draw mitigation efforts away from more certain or severe hazards (in physical health terms).

4.1.1 The Precautionary Principle

The contrary opinions relevant to this decision are captured in the debate over the precautionary principle. The precautionary principle is, in essence, a recommendation to consider action to avoid a possible harm even if it is not certain to occur. In this way, it is a rebuttal of the notion that a lack of evidence should prohibit action (Kheifets et al 2001, 2). The precautionary principle has gained legitimacy in recent times through its endorsement by the United Nations (1992, 3) and the European Union (2000, 3).

In application, the precautionary principle varies dramatically in its response. In some agreements, it is said to represent the idea that scientific uncertainty should not preclude mitigating action. In others, it is said to represent the notion that uncertainty itself is justification for action: that activities of uncertain harm should be prohibited until their safety can be proven (Stewart 2002).

As EMF is a “possible human carcinogen” (IARC/WHO 2007, 11), whose safety remains contentious, it meets the traditional criteria for the precautionary principle to be applied.

4.1.2 Criticism of the Precautionary Principle

While few would dispute the ideal of precaution, many critics suggest that, in the context of EMF exposure, the precautionary principle can lead to irrational outcomes that draw scarce resources away from areas of greater need. As argued by Sakharov (1990, 409),

“[The precautionary principle] is being used to chase the phantom risk of cancer caused by extremely low frequency electric and magnetic fields from power lines. This needless chase costs [American utilities] some one to three billion dollars per year, and unnecessarily frightens the public with ‘electrophobia.’”

Hafemeister (1995) argues that, in the context of EMF exposure, the precautionary principle is not a response to the risk of disease. Instead, it is a reaction to the risk of future litigation from a fearful public. As organisations would rather pay the relatively small cost of precautionary action rather than face the many disadvantages of lawsuits, the precautionary principle has been widely accepted. However, in adopting the precautionary principle, Hafemeister (1995) argues, these organisations have legitimised the mitigation of a “phantom effect,” fanning the flames of public fear and unscientific policy making.

In short, critics of the precautionary principle in the EMF context see it as a fear-based and reactionary approach, rather than one grounded in informed scientific rationality. They argue that this type of policy making can draw resources away from other, more legitimate hazards. While popular opinion and international norms seem to be leaning ever more toward the side of precaution on environmental issues, in the context of continuous low level EMF exposure, the precaution debate remains very much open.

4.1.3 Discussion

To best apply this debate to the DPW situation, it is useful to split the EMF issue into two hazards; the first being the threat to the physical health of workers posed by exposure to low levels of EMF, and the second being the threat to the psychological health of workers caused by concern over the issue and the threat to the relationship between DPW management and staff.

4.1.3.1 Physical Hazard

In response to the threat to physical health, there are equally valid arguments for both action and inaction (as detailed in Section: 5).

Whether the DPW exercises precaution or instead focuses its resources on more apparent threats (see: figure 1), sound justification can be claimed. Therefore, the response to the physical hazard posed by EMF remains an arbitrary choice of the DPW.² This report can only recommend that the DPW follows a transparent logic in this decision, particularly in light of the dangers of making a decision that appears naive or ill-considered:

The decision could appear to be naive if it failed to weigh the opportunity costs of one approach over another. This applies to both precautionary action and inaction. As an example of the former, precautionary action could appear naive if it fails to take into account how the same resources could be used on a hazard of greater severity or certainty (see: figure 1). Conversely, if inaction is favoured, this could appear naive if it lacked consideration of the costs of the threat potentially manifesting in the future.

The DPW’s decision risks appearing reactionary if it takes mitigating action on a physical health threat, not because it is a threat of high priority (see figure 1), but because it is a subject of staff concern. This is not to say that staff concern does not warrant action in and of itself, rather that taking physical action on the grounds of a psychological concern, without labelling it as such, is a dangerous conflation that threatens to undermine the logic of the DPW’s response.

² Appendix A, sourced from the World Health Organization’s EMF Environmental Health Criteria (2007 368-370) provides a number of factors that could contribute to an action vs inaction cost-benefit model.

4.1.3.2 Psychological Hazard

In response to the psychological aspects of the EMF hazard the DPW is facing a more certain risk, therefore the case for action over inaction is clearer.

This hazard has several dimensions. Firstly, anxiety over the issue threatens staff health. Secondly, the issue threatens to undermine the positive relationship between staff and management. Thirdly, the current lack of closure on the issue serves to draw staff away from productive tasks, and taxes wider government resources. The substantial and growing nature of these costs is confirmed by senior DPW Management (Ball 2008). Furthermore, the issue may be creating a sense of inequality for staff. Levels at Mineral House (and presumably other parts of the DPW's office portfolio), are above the norm for Queensland office workers (0.06 to 0.2 μ T) (Qld Health 2008, 7). As a result, staff may feel they are at a disadvantage working in the buildings concerned, and this could lead to lower morale and perhaps lower staff retention.

The psychological nature of this hazard demands that this tangible response is embedded within a risk communication framework to ensure its acceptance. This framework is discussed in Section 4.3.

4.2 Specific Guidance for Precautionary Action

If the decision to take precautionary action is made, the next step is to look for guidance on what the appropriate level and type of action will be. Internationally, there is a number of existing precautionary EMF policy approaches that can provide some guidance.

4.2.1 Prudent Avoidance

One such approach is prudent avoidance. This is defined as “taking steps to lower human exposure to EMF by redirecting facilities and redesigning electrical systems and appliances at low to modest costs” (Nair, Morgan & Florig, 1989 cited in WHO 2007). This approach is most commonly applied by electrical utilities and takes the form of routing new power lines away from residences and schools. Prudent avoidance has been voluntarily adopted by the peak organisation of Australian electricity suppliers, the Energy Supply Association of Australia (citation). A voluntary prudent avoidance clause also accompanies the Australian National Health and Medical Research Council's (NHMRC) (2006) guideline exposure limits for EMF.

Different uses of the prudent avoidance principle carry different definitions of what represents “a low to moderate cost.” The NHMRC's (2008, 144) guidelines do not give quantitative advice, merely stating that actions that “can be readily achieved without undue inconvenience and at reasonable expense... are likely to be justified.” Although the NHMRC does give some guidance for forming a cost benefit analysis of precautionary action in the context of EMF (see Appendix B). The Swedish National Policy on EMF (1998, 5) is more specific. It relates acceptable prudent avoidance costs to pre-existing public health standards that stipulate acceptable levels of spending related to the number of deaths/cases of illness averted. A more simple measure is found in Californian EMF policy (cited in Kheifets et al 2001), where prudent avoidance is defined as steps that do not exceed 4% of the total project cost.

A concept known as the “Hierarchy of Control” provides specific guidance on the relative effectiveness of different measures and is endorsed by the Queensland Workplace Health and Safety Act (1995, 28). The order is as follows (“1” representing the most effective measure):

1. Elimination of the hazard
2. Substitution of the hazard with one of lesser risk
3. Isolation of the hazard from anyone who may be at risk
4. Minimisation of the risk by engineering means (for example, changes in design)
5. Minimisation of the risk by administrative means (for example, changes in working hours)
6. Utilisation of personal protective equipment.

(Qld Parliament 1995, 28)

The financial restrictions of prudent avoidance generally rule out measures 1 through 3. This leaves engineering solutions as the highest priority, however when dealing with *existing* buildings (rather than those in construction) the opportunities to make low-cost engineering changes are limited. Therefore, prudent avoidance in the DPW context, would most likely take the form of administrative measures, for example, rearranging office space to ensure areas closer to EMF sources are occupied for shorter periods, thus reducing overall exposure levels for workers.

In these matters it is useful to consider the concepts of economies of scope and scale. What is an unreasonable expense for one building may become reasonable when costs are spread over sixteen buildings (the number of State Government's office buildings housing electrical sub-stations). Furthermore, an action that comes at too great a cost to be justified on the grounds of reducing EMF exposure, may find justification when combined with the mitigation of other hazards. For example, it may not be feasible to enforce a walk in the park for staff solely to limit accumulative EMF exposure; however, the same policy could become viable when combined with the agenda to reduce inactivity/obesity.

The DPW's proposed annual testing regime will be useful for directing any prudent avoidance measures to those areas of greatest need, and for monitoring the effectiveness of such measures.

4.2.2 Precautionary Emission Control

This policy, implemented in Switzerland, is used to reduce EMF exposure by keeping the emission levels from EMF sources as low as "technically and operationally feasible" (Swiss Federal Council, 1999). In doing so, this policy cleaves the concepts of human health and economic/technological feasibility, with the former being assigned to exposure limits, and the latter to emission standards. This policy is potentially relevant to the DPW, and a dialogue with substation owners on this topic could be initiated.

4.2.3 Passive Regulatory Action

This recommendation, introduced in the USA, advocates educating the public on ways to reduce personal exposure, rather than setting up tangible avoidance measures (NIEHS, 1999 cited in WHO 2007). In the DPW context, an educational measure such as this may be a useful supplement. However, it seems undesirable as a central part of policy, as it may be perceived as weak or inadequate by staff. This perception would not be unreasonable as personal avoidance/protection is regarded as a last resort in exposure mitigation (Qld Parliament 1995, 28).

4.3 Inappropriate Precautionary policies

4.3.1 Precautionary Exposure Limits

This policy involves setting arbitrary exposure limits informed by precautionary rules of thumb rather than demonstrated health connections. This policy is endorsed by the Italian Government (cited in WHO 2007, 365), who set an "Attention Value" of 10 μT for specific locations such as children's playgrounds, residential dwellings and school premises. This limit was derived by dividing the International Committee Non-Ionising Radiation Protection standard by ten. The Italian Government also sets a "Quality Goal" of 3 μT (derived in the same fashion) that applies to new EMF sources and new residential dwellings. There is no evidence of acute effects at these levels, nor is there any evidence from epidemiological studies of leukaemia to suggest that an exposure of 3 μT is safer than an exposure of 10 or 100 μT (WHO 2007, 365).

The World Health Organization (2007), the NHMRC (2006), and a number of other authors (Gibbs 1991; Sahl and Dolan 1996) are strongly critical of this approach. The World Health Organization (2007, 365) states that:

"Such practice undermines the scientific foundation on which the limits are based and is likely to be an expensive, and not necessarily effective, way of providing protection."

The response to uncertainty is certainly not to create any sense of false certainty through arbitrary exposure limits, and the WHO rightly points out that such practice will waste resources that could be better spent on avoidance measures.

4.3.2 “As Low As Reasonably Achievable” Principle (ALARA)

On the surface, the ALARA standard (common to the mitigation of ionising-radiation) may appear to set a useful precedent to follow in the response to EMF. The ALARA principles specify that radiation levels should be kept as low as is technically feasible and economically viable (Matthews 1993, 491). However, it is inappropriate to apply ALARA to the EMF issue. Unlike EMF, ionising radiation has demonstrated health impacts at low levels and this informs the ALARA principle. Therefore, to apply ALARA to the EMF issue could confuse the logic of the response by implying that there was a proven danger where there is not. The prudent avoidance principle is more appropriate in the EMF context and has similar outcomes.

4.4 Risk Communication

- The goal of risk communication, in this context, is to create the conditions under which stakeholders have reason for confidence in the DPW’s response, and, as a consequence, feel a level of personal acceptance of the risk.

According to the World Health Organization (2002), risk communication involves an open and meaningful dialogue between all the relevant parties (stakeholders) throughout a risk management response.

The primary stakeholders in this situation are:

- The affected Queensland Government staff
- The Department of Public Works
- The Owners of the Electrical Substations concerned.

The potential benefits of a dialogue are that:

- By contributing to the process, members of staff are more likely feel a sense of ownership of the eventual response and this may increase its acceptance. This ownership may also allow staff to feel that their exposure to this hazard is consensual and under their control. These are two major factors that affect levels of risk perception. (WHO 1998).
- Staff and management are able to jointly clarify the nature of their responsibilities to each other in this context.
- The DPW is better able to tailor responses to the needs of other stakeholders. Conversely, a dialogue allows the DPW to promote the precautionary measures that it finds most viable (in the case that these are not initially popular).
- By decentralising the decision making process the, DPW shares out its responsibility for the response’s success or failure. This is particularly relevant in the context of scientific uncertainty. If the DPW acts unilaterally, it effectively assumes responsibility for the uncertainty and the risks taken in response. If all the stakeholders jointly acknowledge the limited evidence base, and work together to respond to it, the uncertainty underlying future outcomes will be more widely acceptable, and the responsibility shared.
- By involving substation owners, staff members will have reason to hold confidence in the successful implementation of emission based controls. Furthermore, measures that aren’t favored by substation owners can be identified and redesigned to ensure the sustainability and fairness of the overall response.

For the risk communication process to be a success, a number of factors must be in place (WHO 2002).

- The DPW must be willing share power over the response by incorporating the contributions of other stakeholders. Participation must be meaningful, not merely symbolic. The formulation of a peer review group involving representatives from staff and substation owners demonstrates such willingness.
- It is vital to actively share relevant information among stakeholders if everyone is to approach the problem together. The DPW has so far been proactive in this regard, promoting the availability of all documentation. The establishment of a consensus on the evidence surrounding the carcinogenicity of EMF is of particular importance in this situation. This paper and its accompanying bibliography can hopefully be a helpful resource in this regard.
- Representation of stakeholders should accurately and democratically reflect the views of the group. Furthermore, the content and decisions of the dialogue should be effectively disseminated to the members represented.

4.5 Responding to Uncertainty: Recommendations

- The hazard of exposure to EMF and the case for precautionary action should be analysed in its physical and psychological dimensions. For each, the benefits of precautionary action need to be weighed against the opportunity cost (mitigation of other hazards).
- It appears that in the case of the psychological hazard, there are adequate grounds for action. This action should comprise both a risk communication and precautionary action component.
- The best guidance for the form and scale of this precautionary action is provided by the policies of Prudent Avoidance, the Hierarchy of Control and Precautionary Emission Control.
- The limited opportunities associated with existing structures demand creativity and the maximising of economies of scale and scope to make prudent avoidance measures viable.
- The DPW should avoid unilateralism in the characterisation of the hazard, the formulation of the response and the evaluation of its implementation. Instead the DPW should maintain a meaningful dialogue between stakeholders in order to promote a consensus solution that garners feelings of consent and acceptance.

5. Testing

5.1 The role of testing (in this context)

- It is vital to note that in the area of chronic effects, no safe exposure limits exist. Therefore, testing will not guarantee safety from chronic effects of EMF exposure. The relationship between exposure levels and chronic effects remain uncertain (WHO 2007).

Testing is primarily useful in determining the distribution of EMF in Queensland Government Offices to inform and streamline avoidance measures. Regular testing also monitors the continuing effectiveness of these prudent avoidance measures. This is an employer's obligation as stipulated in the Queensland Workplace Health and Safety Act (Qld Parliament 1995: 29).

5.2 Principles of rigorous radiation testing

- If the principles of rigorous testing are embodied, not only will precautionary measures be well informed, but staff will have reason for confidence in the thoroughness of management's response.

A review of Australian and International EMF testing protocols (Karipidis 2002; IEEE 1993; ENA 2008; Kühn et al 2006; SVIVA, n.d.) reveals a number of principles that the DPW's testing methodology should seek to embody.

5.2.1 Instrument selection and calibration

The meter used to measure EMFs should be calibrated at the appropriate range (50-60Hz). Calibration of the instrument should be checked by the use of a portable calibration coil before each measurement session.

5.2.2 Comprehensiveness

A mapping technique should be used to ensure comprehensive coverage.

5.2.3 Seeking the “worst-case exposure position”

The testing method should specifically seek out the “worst-case exposure position” (Kuhn et al 2006: 11). This includes measuring areas nearest to substations as well as areas near and around switchboards, cabling, indoor transformers rooms, boosters, distribution cabinets and other electricity cabinets. This matter should also be considered diurnally; measurements should be taken at the time of day when power use is at its highest.

5.2.4 Unstructured component

An optional part of the testing method is the inclusion of an unstructured component. This is where the measurer asks staff if they have any areas of interest that they would like measured.

5.2.5 Transparency of Method and Repeatability

The testing method should provide simple and clear instructions to future qualified testing personnel, outlining where and how measurements are to be made and how results should be recorded. The method should also provide a “standardised measurement format” that allows for the comparison of data collected by different individuals at different locations and at different times.

5.3.6 Presentation of results

Results should be presented in such a way that they are easily understood.

5.3.7 Availability of data

The availability of both raw and summary data should be made clear to staff. However, a disclaimer concerning the fact that these levels provide no indication of risk of chronic disease should be included.

5.3.8 Establishment of a database

A database of results in standardised format should be established for quick reference and comparison.

6. Summary of Recommendations

- The hazard of EMF and the case for precautionary action should be analysed in its physical and psychological components. For each, the benefits of precautionary action need to be weighed against opportunity cost.
- 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.
- The best guidance for the form and scale of this precautionary action is provided by the policies of Prudent Avoidance, the Hierarchy of Control and Precautionary Emission Control.
- The limited opportunities associated with existing structures demand creativity and the maximising of economies of scale and scope to make prudent avoidance measures viable.
- The DPW should not act unilaterally when formulating avoidance responses. It should instead engage all stakeholders in a risk communication dialogue.
- Testing should be understood as an informant of avoidance measures, rather than a guarantor of safety from chronic disease.
- The rigour of testing should be compared against the principles summarised in section 6.2. Test results should be made available, but with a disclaimer regarding their inadequacy as a guarantor of safety.

7. Key Terms and Acronyms

Carcinogen

A substance capable of causing cancer (Oxford 2008).

Continuous Exposure

Continuous exposure has many definitions but these generally involve uninterrupted exposure for several hours a day over a period of weeks to years (ARPNSA 2006, 51)

Chronic and Acute Health Effects

A chronic health effect refers to an illness which develops slowly and has a long-lasting course. An acute effect is of a short duration and follows a single dose or short exposure (Oxford 2008).

Confounding

Confounding is a source of error in statistics that results in the appearance of a casual relationship between two variables when, in fact, there isn't one.

The Queensland Department of Public Works (DPW)

The Department of Public Works is responsible for the management of technical matters concerning Queensland Government Buildings.

Economy of Scale

A reduction in cost per unit resulting from an increased scale of production, for example the lower cost per unit when buying in bulk (Earl and Wakely 2005).

Economy of Scope

A reduction in cost per unit resulting from performing two or more functions jointly. For example, by combining the newspaper and milk delivery services, both are completed at lower cost than would be expected if they were completed independently (Earl and Wakely 2005).

Electrical Substation

A set of equipment that reduces the voltage of electricity to a level suitable for consumers (Oxford 2008).

Extrasystoles

A short sequence of extra heartbeats (Oxford 2008).

Extremely Low Frequency Electric and Magnetic Field (EMF)

An (often incorrectly labeled as an “electromagnetic” field) is the combination of electric and magnetic forces that surround any electrical device.

This report deals with electric and magnetic fields in the range of 50-60 Hz. These fall into the category of “extremely low frequency” which distinguishes them from higher frequency, ionising fields that can mutate genes (NIEHS 2002).

Hazard and Risk

A hazard is a source of potential damage, harm or adverse health effects.

Risk is the chance or probability that a person will be harmed or experience an adverse health effects if exposed to a hazard. (Matthews 1993)

Mineral House

Mineral House is a Queensland Government Building, where staff reported a suspected cancer cluster in early 2008 (Qld Health 2008).

MicroTesla (μT)

A unit for measuring magnetic field strength (magnetic flux density) (NIEHS 2002).

Opportunity Cost

Opportunity cost is the cost associated with the lost benefits of the next-best foregone alternative. In this case, opportunity cost may be represented by the lost opportunity to allocate resources to a hazard other than EMF (Earl and Wakely 2005).

Precautionary Principle

The Precautionary Principle is a policy of giving consideration to the mitigation of a hazard even if it is not certain to occur (Kheifets et al 2001).

Prudent Avoidance

Prudent Avoidance is an application of the precautionary principle to the issue of EMF. Prudent avoidance is defined as taking steps to lower human exposure to EMF by redirecting facilities and redesigning electrical systems and appliances at low to modest costs (Nair et al 1989 cited in WHO 2007).

Utility

A Utility is an organization that maintains the infrastructure for a public service, and may provide the services themselves (Oxford 2008). The utilities in this paper concern electricity.

Ventricular Fibrillation

A potentially fatal, uncoordinated series of very rapid, ineffective contractions of the heart chambers (WHO 2007).

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Appendix A:

Table of Factors Relevant to EMF Mitigation Action/Inaction (WHO 2007, 368-370)

Table 87. Factors relevant to the analysis of each policy option ^a

Option	Relevant factors in considering benefits	Relevant factors in considering costs
Do nothing	<p>Childhood leukaemia is a relatively rare disease, and only a small proportion of the population is exposed to levels mentioned in epidemiological studies (i.e. estimated time-weighted average above 0.3 or 0.4 μT).</p> <p>There are many uncertainties regarding the effectiveness of policies, which could be reduced with scientific progress.</p> <p>When the only available options are costly it may be more appropriate not to take formal action. Allows for the adaptation of policy as evidence emerges.</p>	<p>No possibility of reducing burden of disease. No progress towards removal of uncertainties and better knowledge in future.</p> <p>Undermines trust in authorities. Concerned citizens may take matters into their own hands.</p>
Research	<p>Reduces uncertainty and facilitates better decision-making.</p> <p>Contributes to the scientific base.</p> <p>Helps in developing solutions.</p>	<p>Diversion of resources from higher priority areas.</p> <p>May delay actions awaiting research results.</p>
Communication	<p>A knowledgeable public</p> <ul style="list-style-type: none"> - can better evaluate the acceptability of different levels of ELF risks - can reduce public concern due to misperceived ELF risks - can increase trust in those providing the information. <p>A knowledgeable public and workers</p> <ul style="list-style-type: none"> - can be involved in the decision-making process regarding ELF sources - can make informed decisions on what appliances to purchase or how to place them so as to minimize exposure - can influence market forces to design sources in order to minimize exposure (e.g. electric blankets). 	<p>Possibility of giving rise to unjustified alarm or concern.</p> <p>May have limited effectiveness where the understanding of exposure is difficult or where exposure is involuntary and hard to avoid.</p>
Mitigation	<p>Changes to planning of new facilities</p> <p>Reassessment of the need for new facilities.</p> <p>Avoid unnecessary exposure by comparing different planning scenarios so as to minimize exposure.</p> <p>Use of best available technology.</p> <p>Lower cost since options are dealt with in planning stage of new installations.</p>	<p>Requires alternative technical designs be presented for the construction of new facilities.</p> <p>Costs may include sterilization of land, devaluation of property, and compensation payments.</p> <p>Possibility of setting a precedent for future projects regardless of future circumstances.</p>

Table 87. Continued

Option		Relevant factors in considering benefits	Relevant factors in considering costs
Mitigation	Engineering changes of existing facilities	Reduction of exposure by taking protective measures such as installing shielding, changing wiring practices in houses and in distribution or transmission systems (split phasing, raising ground clearances, undergrounding etc.).	<p>A significant part of the cost may be in identifying the instances rather than remediation.</p> <p>Changes introduced to existing installations involve a higher cost.</p> <p>Costs may include sterilization of land, devaluation of property and compensation payments.</p>
	Engineering changes to appliances	Reduction of exposure to magnetic fields.	Increased cost (or increased size or weight) of appliances.
National standards	Exposure limits	May increase public confidence in the authority's action to protect health.	May undermine science-based guidelines.
			May give false sense of security.
			May hinder incentives for further reduction of undue exposure.
			Cost of compliance.
			Difficult to move towards less stringent standards if justified by new scientific evidence.

^a With the exception of the first option, all the options are evaluated in relation to "doing nothing" rather than adopting international guidelines.

Appendix B:

Table of Factors (II) Relevant to EMF mitigation action/inaction (NHMRC 2006, 146)

Options	Details	Factors for consideration
Do Nothing	Take no formal action; maintain the status quo	Has no effect on disease, no progress in reducing uncertainty and increasing knowledge.
Research	Enhanced research to remove uncertainties in the science. Further research on sources and distribution of exposure to allow more informed decision making.	Funding for large scale research is difficult. But small targeted studies are possible. Knowledge of exposure distribution important in this context
Communication	Increased provision of information to make it easier for members of the public to adopt individual precautionary approaches if that is their choice	This is a low cost option and should be made use of. However, without knowledge of high localised sources this may not result in significant changes to annual exposure.
Engineering measures	Enforcement of existing approved wiring practices in distribution systems and buildings to reduce magnetic fields Changes to distribution wiring practices to reduce ground currents Optimisation of engineering design of distribution or transmission systems Changes to design of domestic appliances to reduce magnetic fields	An important approach for new construction and in some cases may be cost-effective for existing buildings Cost of detection could be as high as the cost of mitigation Large variation in costs for changes such as rephasing, bundling and undergrounding. Cost will be a factor but could be presented as a consumer choice with appropriate information. This approach may not decrease average exposure
Planning measures	Changes to planning procedures to minimise exposures from high-voltage overhead lines	Some quite low-cost options are available.
Exposure limits	A precautionary approach is about reducing exposure but not about changing the exposure limits.	

Attachments

- [Measurement Findings](#)
- [Further Reading](#)
- [Author and Contributors](#)

Findings from EMF testing in the Buildings containing substations in the DPW portfolio

	Building	Max reading and location in occupied area
1	80 Ann Street - Primary Industries Building	2.9 μ T in the Library at Level 0. Small area with reading over 1.
2	33 Charlotte Street	2.6 μ T in an office, on its wall adjoining electrical riser room at Level 14. Workstation furniture against the wall is a concern.
3	147-163 Charlotte Street, Queensland Health	6.9 μ T in an office, on its wall adjoining electrical riser room at Level 17. Areas near those walls at every floor are areas of concern.
4	30 Mary Street – Education House Building	0.1 μ T at Level 1
5	61 Mary Street	2.2 μ T in vacant office in Basement 1. 1.3 μ T at security reception, Ground floor. No concern for other areas.
6	160 Mary Street – Forestry House	7 μ T on the wall of Conference room adjoining the plant room at Level 3. Reading falls rapidly to below 1 about 1.5 to 2m away.
7	317 Edward Street – RailCentre 1C	3.8 μ T in an office, on its wall adjoining electrical riser room at Ground Level. Readings fall rapidly to less than 0.5 away from the wall.
8	317 Edward Street – RailCentre 1D	1.14 μ T at the wall inside Q Build maintenance office near the electrical room at Basement 3
9	371 Vulture Street – Go Print Building	1.0 μ T, in the Bureau & Prep 1.2 μ T in the factory floor (printing and binding)
10	411 Vulture Street – Gabba Towers	3 μ T at the entry door of private tenancy office facing the lift lobby at Level 1. Readings near the perimeter wall adjoining the lift lobby at Level 0 and 1 are about 1 μ T.
11	Vulture and Main Streets – LandCentre Building	1.08 μ T in Level 2 office above main switch room. Reading of about 1 over a small area.
12	41 George Street – Mineral House	1.5 μ T in Ground Level office, State Government Security.
13	63 George Street	1.46 μ T at Ground Level, almost directly above major cable route below. . Reading of about 1 over a small area
14	80 George Street – (A Side)	1.36 μ T at Level 3, conference / meeting room
15	80 George Street – (B Side)	1.3 μ T at Level 3. Reading of about 1 over a small area
16	100 George Street – Executive Building	0.2 μ T in Level 4 office area
17	102 George Street – Executive Building Annexe	0.1 μ T in Level 1 office area
18	111 George Street	3.86 μ T measured in a small office room, on its wall adjoining electrical riser room at Level 25. Rapidly falls below 1 away from the wall.
19	75 William Street – Neville Bonner	0.8 μ T at Level 2, almost directly above major cable route below

Further Reading

EMF and Human Health

World Health Organisation. 2007. ***Extremely Low Frequency Fields. Environmental Health Criteria Monograph No.238***. Geneva: World Health Organisation.

This report is the most up to date, authoritative review of scientific findings on the effects of EMF exposure on human health. The report concludes that human exposure to EMF has “demonstrated acute effects and uncertain chronic effects.” The conclusion regarding chronic effects is extremely relevant to the role EMF testing, as it means that test results cannot be used as guarantors of safety from chronic disease.

The Precautionary Approach and EMF

Sahl, Jack and Michael Dolan. 1996. ‘**An Evaluation of Precaution-based Approaches as EMF Policy Tools in Community Environments.**’ *Environmental Health Perspectives* 104(9)

This article presents arguments for and against the use of precautionary approaches in regard to EMF exposure. The article shows that a precautionary policy response can reconcile these views by staying within certain bounds. Firstly, policy should be of a moderate scale in relation to the evidence that does exist. Secondly, precaution should not be used to replace scientific policy making, it should instead be an interim measure of appropriate scale and form.

Specific Guidance for Precautionary Action

World Health Organisation. 2007. ***Extremely Low Frequency Fields. Environmental Health Criteria Monograph No.238***. Geneva: World Health Organisation. (pp 363-365)

The latter sections of this report succinctly summarise international precautionary EMF policy examples. The report is highly complimentary of the Prudent Avoidance Approach and damming of the use of arbitrary, non-scientific, numerical standards.

Risk Communication

WHO. World Health Organisation. 2002. ***Establishing a Dialogue on Risks from Electromagnetic Fields***. Geneva: World Health Organisation.

This document specifically guides policy makers in the area of risk communication as it relates to EMF exposure. It focuses on moving managers from a unilateral risk management to a collaborative process involving all the stake holders. There is also an emphasis on how specifically to present risk information during this process.

Testing

IEEE. Institute of Electrical and Electronics Engineers. 1993. ‘**A protocol for spot measurements of residential power frequency magnetic fields Power Delivery.**’ *IEEE Transactions* 8(3): 386 - 1394

This document sets out a number of relevant principals concerning effective and reliable EMF testing procedure.

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