

SUBMISSION ON TRANSPOWER'S NOTICES OF REQUIREMENT AND APPLICATIONS FOR RESOURCE CONSENTS

Section 145 of the Resource Management Act 1991

RECEIVED ON

- 4 OCT 2007

0823

To: Minister for the Environment
Freeport Grid Upgrade Submissions
PO Box 4405
Hamilton East
HAMILTON 3247

OR Email: tpcallin@mfe.govt.nz
Fax: 04 439 7700

[If you are emailing or faxing your submission, please make it for the attention of "Grid Upgrade Submissions"]

This submission relates to the notices of requirement and/or applications for resource consent, lodged by Transpower New Zealand Ltd for the North Island Grid Upgrade Project, and identified on the next page.

CLOSING DATE FOR SUBMISSIONS: 5 OCTOBER 2007

Title: Mr

My/Our Full Name(s): Martin Gledhill on behalf of the Ministry of Health

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Please tick the relevant boxes on the next page to identify whether you are making a submission on all notices of requirement and applications for resource consents or just some of them (please identify).

Please also indicate on the back of this form (✓) whether you support, oppose, or are neutral in relation to the notice(s) of requirement and applications for resource consents. If you are making a submission only on parts of a notice of requirement or application for resource consents, please note this when specifying the reasons for your submission.

The reasons for my/our submission are:

See attached

If you are attaching further information tick (✓) for yes

Please use more pages if you need to.

I/we seek the following decision from the Board of Inquiry (provide precise details including the nature of any conditions sought):

See attached

Please use more pages if you need to.

Use a clear tick in the appropriate box below (✓)

I/we wish to be heard in support of my/our submission (to speak at the public hearing).

I/we DO NOT wish to be heard and hereby make my/our submission in writing only.

Signature(s):

Date:

(Signature of submitter, or person authorised to sign on their behalf is required. Note signature is not required for electronic (email) submissions. If this is a joint submission by two or more individuals, each individual's signature is required.)



Ministry for the
Environment
Māori: Mātahi

Use the tick boxes below to indicate the called-in notices of requirement and applications for resource consents that your submission concerns. Use a clear tick in the appropriate box or boxes (✓).

I/we make my/our submission concerning all notices of requirements and applications for resource consents below.

OR

My/our submission only concerns the notices of requirement and applications for resource consents that I/we have ticked below.

	Support	Oppose	Neutral
Manukau City Council			
Pakuranga Substation Notice of Requirement. Reference No. 27619			✓
Otahuhu Substation Notice of Requirement. Reference No. 27619			✓
Brownhill Substation Notice of Requirement. Reference No. 27619			✓
Underground Cable – Pakuranga to Brownhill Notice of Requirement. Reference No. 27619			✓
Underground Cable – Otahuhu to Brownhill Notice of Requirement. Reference No. 27619			✓
Overhead Line Notice of Requirement. Reference No. 27619			✓
Franklin District Council			
Overhead Line Notice of Requirement. Reference No. L07089			✓
Waikato District Council			
Overhead Line Notice of Requirement. Reference No. DES0011/07			✓
Matamata-Piako District Council			
Overhead Line Notice of Requirement. Reference No. RMR200621			✓
Waipa District Council			
Overhead Line Notice of Requirement. Reference No. DN/0006/07			✓
South Waikato District Council			
Overhead Line Notice of Requirement. Reference No. 240/021			✓
Taupo District Council			
Overhead Line Notice of Requirement. Reference No. RM070209			✓
Whakamaru and Whakamaru North Substation Notice of Requirement. Reference No. RM070209			✓
Auckland Regional Council – Resource Consents			
<i>Pakuranga to Brownhill Underground Cable Resource Consents</i>			
Application 34102: Land Use Consent for earthworks			
Application 34370: Discharge of Contaminants to land from ancillary activities that produce wastewater or washwater			
Application 34372: Works in the Bed of a Watercourse			
Application 34373: Diversion of Surface Water			
<i>Overhead Line and Brownhill Substation Resource Consents</i>			✓
Application 34711: Land Use Consent for earthworks			
Application 34712: Discharge of Contaminants to land			
Environment Waikato – Resource Consents			
<i>Overhead Line and Whakamaru North Substation Resource Consents</i>			✓
Application 116902: Land Use Consent for vegetation clearance and earthworks			
Application 116903: Discharge Permit for the composting of vegetation			
Application 116904: Land Use Consent for the drilling of tower foundation below the water table			
Application 116905: Discharge Permit for the discharge of site water and drilling fluids from drilling activities into surface water.			

NOTE: A copy of this submission form must be sent as soon as possible at:

North Island Grid Upgrade Project, Transpower Freepost 182915, PO Box 1021, Wellington
or email submissions@transpower.co.nz or fax 04 819 7624.

I/we make my/our submission concerning all notices of requirements and applications for resource consents below.

Reasons for submission

The Ministry of Health (MoH) is aware that health concerns are likely to be a major concern to other submitters on these applications. The possibility that exposure to low frequency electric and magnetic fields* produced by the voltages and currents on electrical equipment might cause adverse health effects has been the subject of much research over the past twenty-five years. While some research suggests the possibility of adverse effects being associated with long term exposures to the highest levels to which the public might be exposed, other research does not suggest that such exposures could have any effects.

The Ministry of Health has followed the progress of that research and recommends strict compliance with exposure guidelines recommended by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). These guidelines are based on a review of the health effects research. ICNIRP is an independent scientific body recognised by the World Health Organisation for its expertise in this area. In addition, in recognition of the fact that adverse effects at levels which comply with the ICNIRP guidelines cannot be entirely discounted the Ministry recommends taking no or low cost measures to reduce exposures. Some background material on these recommendations is included in an annexe to this submission.

Decision sought from the Board of Inquiry

The Ministry of Health neither supports nor opposes the application, but considers that provided the exposures from the line comply with exposure guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), and Transpower can demonstrate that it has taken reasonable low or no cost measures (for example, in the design of the line and choice of route) to reduce exposures, the application should not be turned down on the grounds that exposures may endanger health. The Ministry of Health would also note that an adequate and safe supply of electricity is essential to maintain modern infrastructure, the economy and thus protect public health.

The Ministry would not normally recommend a condition requiring measurements for this type of application. However, we do recognise that measurements can increase confidence that the calculated field levels presented in the application are correct, and also by providing information on exposures in areas which are not covered by the calculations presented in the application. Therefore, the Board may wish to consider whether a measurement condition should be imposed and if so, seeking opinions from other submitters on the extent of such measurements, bearing in mind that measurements only reflect the conditions at the time of measurement (current, amount of sag on the line etc) and that magnetic fields in particular will vary over the course of the day and of the seasons.

* Some background information on low frequency electric and magnetic fields is presented in Appendix A to the annex of this submission.

Annexe Background material on MoH recommendations

- 1 Much research has been undertaken to investigate whether long or short term exposure to extremely low frequency (ELF) electric and magnetic fields (EMF) causes adverse health effects. This work has involved laboratory studies of isolated cell cultures and animals, and epidemiological studies of large human populations.
- 2 It is clear that exposures to very strong electric or magnetic fields may interfere with the nervous system. The fields produce weak electric fields in the body which in turn induce weak electric currents. The most sensitive indicator of an effect appears to be the production of magnetophosphenes (faint flickering sensations in the retina). These acute effects have been demonstrated experimentally and explained theoretically.
- 3 A lot of work has been carried out over the past twenty-five years to determine whether there are health effects associated with long term exposure to ELF EMF too weak to produce the established acute effects. In particular, much of the research has investigated whether exposures to ELF magnetic fields may affect the incidence of cancer, especially childhood leukemia.
- 4 Many reviews of all this work have been carried out over the years, including reports by (amongst others) the US National Institute of Environmental Health Sciences¹, the British National Radiological Protection Board^{2,3,4}, the Health Council of the Netherlands^{5,6,7}, the International Agency for Research on Cancer⁸, the Swedish Radiation Protection Authority⁹ and ICNIRP¹⁰. Although the major focus of the research and reviews has been possible effects of exposure to ELF magnetic fields on cancer, other outcomes such as effects on pregnancy, neurodegenerative diseases (Alzheimer's disease, amyotrophic lateral sclerosis (ALS) etc) and cardiovascular disease have also been investigated.
- 5 These reviews conclude that while there is a weak but relatively consistent association (correlation) between exposure to relatively strong ELF magnetic fields* and an increased risk of childhood leukemia, there is considerable doubt whether the association is due to a real cause and effect relationship, or whether it is due to other factors. Reasons for the doubt are:
 - At these exposure levels, laboratory evidence does not suggest that there could be any effects, and there is no known physical mechanism which could produce any interactions.
 - It is recognised that artefacts of the epidemiological study methods could account for some of the apparent association.
- 6 While there is some evidence of an association between employment in electrical occupations and ALS, it is felt that this is more likely to be due to

* "Relatively strong" means time-average exposures greater than 0.4 μ T. While this level may appear to be well within the range of commonly encountered exposures indicated in Appendix A, in practice very few people have average exposures greater than this.

risk of electric shocks, rather than ELF fields, and there is no persuasive evidence of other health effects being caused by ELF fields.

Exposure guidelines

- 7 In order to protect against adverse effects of exposure to ELF EMF, the MoH recommends the use of exposure Guidelines published by ICNIRP. ICNIRP is an independent scientific organisation responsible for providing guidance and advice on the health hazards of non-ionizing radiation (NIR), and was established to advance NIR protection for people and the environment. It is a formally recognised non-governmental organisation in NIR for the WHO and International Labour Office.
- 8 The ICNIRP proposals are based on a careful examination of the research data on the health effects of exposure to ELF EMF, and include margins for safety. They were first proposed in 1990, and reconfirmed in 1993 and 1998¹¹ after consideration of more recent research results. The ICNIRP guidelines have been adopted by a number of overseas health bodies.
- 9 In their guidelines, ICNIRP recognise the need to reconcile a number of differing expert opinions. The validity of scientific reports has to be considered, and extrapolations made from animal experiments to effects on humans. They note that:
- “The restrictions in these guidelines were based on scientific data alone; currently available knowledge, however, indicates that these restrictions provide an adequate level of protection from exposure to time-varying EMF (electric, magnetic and electromagnetic fields).”
- 10 The ICNIRP guidelines set fundamental exposure limits in terms of a *basic restriction* on electrical currents induced in the body by ELF fields. As induced currents are difficult to measure or calculate, ICNIRP also provide equivalent *reference levels* in terms of the more easily measured electric and magnetic field strengths. Provided field strengths are below the reference levels, induced currents will comply with the basic restriction. If exposures exceed the reference level, this does not necessarily mean that the basic restriction is being exceeded, but a more careful evaluation is required.
- 11 The ICNIRP guidelines applying at 50 Hz (the frequency of the fields from all equipment carrying or using mains electricity, including transmission lines) are summarised in the table below:

Exposure characteristics	Basic restriction Induced current density (mA/m ²)	Reference levels	
		Electric field strength (kV/m)	Magnetic flux density Microtesla
<i>Occupational</i>	10	10	500
<i>General public</i>	2	5	100

Note: all values are rms (root-mean-square, a kind of average)

12 For exposures of the general public, the ICNIRP reference levels for 50 Hz magnetic and electric fields are 100 μ T and 5 kV/m (5,000 V/m) respectively. These limits are for exposures of unlimited duration, and apply to both children and adults. The reference levels refer to the spatially averaged field strength over the body. For occupational exposures, the reference levels are 500 μ T and 10 kV/m.

13 ICNIRP considered the epidemiological data suggesting possible associations with childhood leukemia when preparing their Guidelines, and commented:

“It is the view of ICNIRP that the results from the epidemiological research on EMF field exposure and cancer, including childhood leukemia, are not strong enough in the absence of support from experimental research to form a scientific basis for setting exposure guidelines.”

14 ICNIRP has reviewed the data again since publishing its Guidelines¹⁰. While ICNIRP still recognises the associations which have been found in epidemiology studies, it also notes the factors which could have affected the apparent association, and comments that the results are:

“difficult to interpret in the absence of a known biological mechanism or reproducible experimental support of carcinogenesis”.

Prudent avoidance

15 The concept of "prudent avoidance" has been advocated as a means to control exposures to ELF fields, if there is any doubt that they are harmless. *Prudent avoidance* was an approach proposed by Dr M Granger Morgan and colleagues in the late 1980's, and can be simply defined as “*The idea of avoiding human exposure to power-frequency electric and magnetic fields when it can be done at modest cost and little inconvenience*”¹².

16 Put another way, "Prudent avoidance" suggests taking reasonable low or no cost measures to minimise exposure to ELF fields, both from existing sources and new installations. For example, an individual may choose to turn off an electric blanket at night (a prudent measure from the point of view of electrical safety as well). A manufacturer may alter the design of the blanket to reduce the level of fields around it. There are simple engineering and design techniques which can be adopted to reduce fields from transmission lines, and if there is a choice of routes for a line, then that resulting in lowest exposures to nearby houses and other occupied buildings should be selected, all other things being equal.

17 The MoH encourages the voluntary adoption of such low or no cost measures to reduce or avoid exposures. This is consistent with Ministry recommendations for other agents.

18 In the context of transmission lines, the following low/no cost options could be considered:

- Where there are options for route selection, choosing the one which avoids or reduces exposures, all other things being equal
- Arranging the conductors on pylons so as to maximise self-cancellation of the fields from the different phases of the circuit
- Considering design changes over limited areas (eg compact tower designs) to reduce exposures
- Considering the possibility of preventing new housing or other development immediately beneath and in the vicinity of the lines the line (for example, by obtaining an easement).

In some situations, these measures might bring other advantages, such as permitting easier access for maintenance, and improving the electrical transmission characteristics of the line.

Continuing MoH review of research

- 19 The Group Manager of the National Radiation Laboratory (a specialist unit of the MoH) chairs the Interagency Advisory Committee on the Health Effects of Non-Ionising Fields. The terms of reference and membership of this Committee are presented in Appendix B of this annex. In essence, the role of the Committee is to review work published on the health effects of non-ionising fields (including the ELF EMF produced around transmission lines and other electrical equipment) and advise the Director-General of Health. Should there be reasonable suspicion of health hazards, this is to be brought to the attention of Ministers.
- 20 The Interagency Committee published a Report to Ministers in November 2004¹³ endorsing the use of the ICNIRP Guidelines and the "prudent avoidance" approach set out above. In the six-monthly meetings held since publication of that Report, the Committee has not seen the need to change these recommendations.

Status of MoH recommendations

- 21 The MoH recommendations on controlling exposures to ELF EMF are advisory. Situations in which exposures might exceed the ICNIRP limits are rare, and the consequences of conceivable overexposure of insufficient gravity to merit regulation. The Ministry considers that the evidence for possible health risks caused by exposures below the ICNIRP limits does not warrant enforcing lower limits or a prudent avoidance approach under health regulations. (For example, one of the key papers on childhood leukemia was the meta-analysis published by Ahlbom *et al* in 2000¹⁴. The analysis included a New Zealand study¹⁵ and found that none of 86 cases of childhood leukemia reported over a four year period were associated with exposure to time averaged fields greater than 0.4 μ T. While this does not prove that there is no health risk, it does give an idea of the magnitude of any risk which may exist.)

Recent review by the WHO

- 22 In 1996 the WHO established its International EMF Project. One of the goals of the project is to publish authoritative health risk assessments in the WHO Environmental Health Risk Criteria (EHC) series.
- 23 The health risk assessment on ELF EMF was published in June 2007¹⁶. The assessment was prepared by a Task Group convened by the WHO in 2005. The process for drafting and finalising the assessment, copied from the publication (Preamble, pages xiii – xiv), is presented in Appendix C. The key elements are:
- The composition of the Task Group responsible for preparing the assessment covers the required range of scientific disciplines, and balances the range of opinions of the science, gender and geographical distribution
 - The Task Group reaches agreements by consensus
 - Task Group members inform WHO if an actual or potential conflict of interest could be perceived in their work, and sign a conflict of interest statement.

WHO health risk assessment

- 24 The principal conclusions on health risks (section 1.1.11) are summarised below and reproduced in full in Appendix D.
- There are established acute effects of exposure to ELF EMF, and compliance with existing international guidelines provides adequate protection.
 - Epidemiological studies suggest an increased risk of childhood leukemia for chronic exposures greater than 0.3 – 0.4 μT . Some aspects of the methodology of these studies introduce uncertainties in the hazard assessment. Laboratory evidence and mechanistic studies do not support a causal relationship, but the evidence is sufficiently strong to remain a concern.
 - If the relationship is causal, the global impact on public health, if any, is limited and uncertain.
 - Scientific data suggesting a linkage with other diseases (other childhood and adult cancers, depression, suicide, reproductive problems, developmental and immunological disorders, and neurological disease) is much weaker, and in some cases (eg cardiovascular disease, breast cancer) sufficient to rule out a causal relationship.
- 25 The principal protective measures recommended (section 1.1.12) are summarised below and reproduced in full in Appendix E.

- Exposure limits such as those recommended by ICNIRP should be implemented to protect against the established acute effects of exposure to ELF EMF.
- In view of the conclusions on childhood leukaemia, the use of precautionary approaches is reasonable and warranted but exposure limits should not be reduced arbitrarily in the name of precaution.
- Precautionary approaches should not compromise the health, social and economic benefits of electric power. Given the weakness of the link between exposures to ELF fields and childhood leukaemia, and the limited impact on public health if the relationship is causal, the benefits of exposure reductions are unclear, so the cost of precautionary measures should be very low.
- Very low cost measures should be implemented when constructing new facilities and designing new equipment.
- When contemplating changes to existing ELF sources, ELF field reduction should be considered alongside safety, reliability and economic aspects.

26 At a recent workshop organised by the WHO just after the release of the EHC review, the chair of the Task Group spoke about the great deal of thought that had gone into their recommendations on exposure limits and what form of precautionary approach was justified. The Task Group had carefully considered the possibility of reducing exposure limits in response to the childhood leukemia findings, but felt that this could not be justified. Nor could they justify any other reduction to existing limits.

MoH recommendations in relation to the WHO findings

27 The MoH considers that the WHO review largely supports the approach recommended by the Ministry, especially in regard to transmission lines. The current NPS process being undertaken by MfE presents a good opportunity to give practical effect to these recommendations.

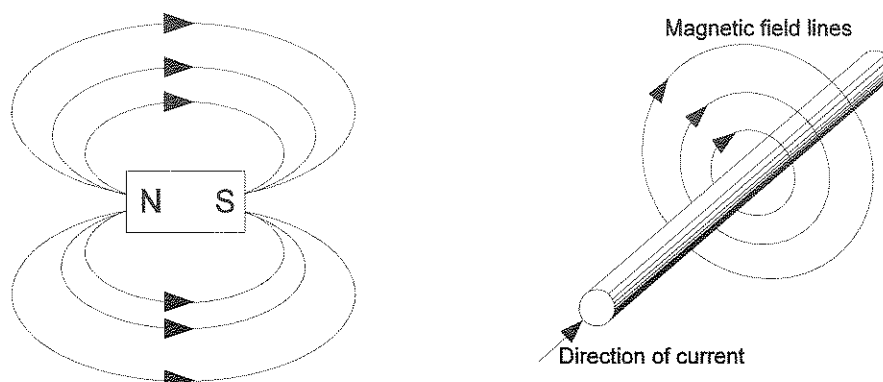
Appendix A Origin and nature of ELF EMF

Magnetic fields

A field is a concept used to explain how one body can influence or exert a force on another body that is some distance from it. A magnet, for example, attracts an iron nail even though the two objects may be separated by several centimetres. To explain this, we say that the magnet is surrounded by a magnetic field. The magnetic field has the property that it attracts anything made of iron.

A field is often represented by “lines of force”, whose number or density indicate the strength of the field. Around a magnet, the strength and shape of the magnetic field can be visualised by sprinkling iron filings over a piece of paper and holding the paper over the magnet. The filings align themselves in a pattern indicating the shape and direction of the field.

A wire carrying electric current generates a magnetic field around the wire. This field is exactly the same in its nature and properties to the magnetic field around a bar magnet, except that the “lines of force” form circular loops around the wire. The strength of the field decreases with increasing distance from the wire.



Magnetic field lines around a bar magnet (left) and a current-carrying wire (right)

If the wire carries an alternating current (ie, one which undergoes regular changes in its direction), then the magnetic field around the wire also undergoes regular changes in direction at the same frequency. Current in cables or equipment carrying mains electricity oscillates at a frequency of 50 Hz (ie, 50 times per second) and hence gives rise to a magnetic field that also oscillates at 50 Hz. This frequency is in a range commonly referred to as extremely low frequency (ELF).

ELF magnetic fields are found around any cables or appliances carrying mains electricity. If the current passes through a coil, as in a transformer or electric motor, the field lines are concentrated and a much stronger field is produced. However, the strength of the field falls off very quickly with distance, in inverse proportion to the square or cube of the distance. Magnetic fields are not shielded by most materials: special alloys or grades of steel are needed to provide effective shielding.

Magnetic field measurement results are reported in units of microtesla (μT), the unit of magnetic flux density in the SI (International System) of units. In some literature

on the subject, an older unit, the milligauss, is sometimes used. There is a factor of ten difference between these two units: 1 microtesla = 10 milligauss, 0.1 microtesla = 1 milligauss etc.

Typical ELF magnetic field levels found in various locations are summarised in the table below.

Location	Typical magnetic fields (μ T)
Beneath high voltage power lines (66 kV - 220 kV)	0.3 - 5
30 metres from high voltage line	0.1 - 1.2
Beneath low voltage street lines	0.15 - 2
Along central city streets (no overhead lines)	0.05 - 0.8
Background in houses, offices	0.05 - 0.15
50 cm in front of visual display unit	0.05 - 0.25
Close to appliances	0.05 - 7
1 metre from appliances	0.005 - 1
Near electric range	0.5 - 2.2

Electric fields

The voltage on a conductor or appliance creates an electric field. Electric fields are created by electric charges. Most people are familiar with the static electric charges created by walking across certain types of carpet when the humidity is very low, or by rubbing synthetic clothing.

Like the electric current, the voltage on a conductor or electrical appliance carrying mains current is not constant but alternates 50 times (cycles) every second. Therefore the electric field also alternates, and the equipment is surrounded by an alternating electric field.

As with magnetic fields, electric fields can be represented by "lines of force". Electric field lines are easily distorted by many materials, even those that are normally thought of as poor conductors. Because of this, electric fields are easily shielded. Trees or shrubs near a transmission line, for example, considerably reduce the electric field strength at ground level. The electric fields are also shielded by buildings and the strength inside a building near a transmission line is much lower than that outside the building. For this reason electric fields inside the dwelling were not measured.

Electric field measurement results are reported in units of volts per metre or kilovolts per metre (kV/m), the unit of electric field strength in the SI (International System) of units.

Typical ELF electric fields encountered in different situations are tabulated below.

Location	Typical electric fields (kV/m)
Beneath high voltage power lines (66 kV - 220 kV)	0.3 - 4
30 metres from high voltage line	0.01 - 0.1
Beneath low voltage street lines	0.01 - 0.08
Background in houses, offices	0.003 - 0.02
30 cm from appliances	0.006 - 0.9
1 metre from appliances	0.001 - 0.01

Appendix B Interagency Advisory Committee on the Health Effects of Non-Ionising Fields

The Interagency Committee on the Health Effects of Non-Ionising Fields (the Committee) will provide the Director General of Health with high quality, independent scientific and technical advice on any potential health effects from exposures to extremely low or radiofrequency fields including:

- the quality and completeness of information on which findings and recommendations have been made
- assessment and review of the impact of research and information published locally and overseas, on policies, guidelines and advice promulgated by the Ministry of Health, Ministry for the Environment or Ministry of Economic Development
- other technical, scientific and epidemiological matters in relation to the extremely low or radio frequency fields as may be required.

The Committee will report to the Director General of Health, with copies of meeting notes provided to the Chief Executives of the Ministry for the Environment and the Ministry for Economic Development. Should there be reasonable suspicion of health hazards, or other issues of significance, these will be brought to the attention of joint Ministers. Annual and/or occasional reports will also be provided to joint Ministers.

Composition of the Committee

The membership of the Committee will include representatives from the following agencies, organisations, and sectors:

- Ministry of Health (including the National Radiation Laboratory)
- Ministry of Economic Development (including Energy and Communications)
- Ministry for the Environment
- Occupational Safety and Health Service of the Department of Labour
- public health service
- local government (Local Government New Zealand)
- academics/scientists: up to two representatives
- consumers
- electrical industry (transmission and supply): up to two representatives
- telecommunications industry: up to two representatives.

The Ministry of Health will provide the Chair and secretarial support for the Committee.

Media Policy

In carrying their functions as members of the Committee, no member shall make media statements of any kind on behalf of the Committee or about the proceedings of the Committee unless requested to do so by the Director General of Health. If members wish to discuss media issues, they should contact the Ministry of Health's Corporate Communications Unit in the first instance (tel. 04 496 2008, pager 026 112 413).

Appendix C Process for producing WHO ELF EMF EHC monograph

“The general procedures that result in the publication of this EHC monograph are discussed below.

A first draft, prepared by consultants or staff from a RAD [Radiation and Environmental Health Unit of the WHO] Collaborating Centre, is based initially on data provided from reference databases such as Medline and PubMed and on IARC and ICNIRP reviews. The draft document, when received by RAD, may require an initial review by a small panel of experts to determine its scientific quality and objectivity. Once the document is acceptable as a first draft, it is distributed, in its unedited form, to well over 150 EHC contact points throughout the world who are asked to comment on its completeness and accuracy and, where necessary, provide additional material. The contact points, usually designated by governments, may be Collaborating Centres, or individual scientists known for their particular expertise. Generally some months are allowed before the comments are considered by the author(s). A second draft incorporating comments received and approved by the Coordinator (RAD), is then distributed to Task Group members, who carry out the peer review, at least six weeks before their meeting.

The Task Group members serve as individual scientists, not as representatives of their organization. Their function is to evaluate the accuracy, significance and relevance of the information in the document and to assess the health and environmental risks from exposure to the part of the electromagnetic spectrum being addressed. A summary and recommendations for further research and improved safety aspects are also required. The composition of the Task Group is dictated by the range of expertise required for the subject of the meeting (epidemiology, biological and physical sciences, medicine and public health) and by the need for a balance in the range of opinions on the science, gender and geographical distribution.

The membership of the WHO Task Groups is approved by the Assistant Director General of the Cluster on Sustainable Development and Health Environments. These Task Groups are the highest level committees within WHO for conducting health risk assessments.

Task Groups conduct a critical and thorough review of an advanced draft of the ELF EHC monograph and assess any risks to health from exposure to both electric and magnetic fields, reach agreements by consensus, and make final conclusions and recommendations that cannot be altered after the Task Group meeting.

The World Health Organization recognizes the important role played by non-governmental organizations (NGOs). Representatives from relevant national and international associations may be invited to join the Task Group as observers. While observers may provide a valuable contribution to the process, they can only speak at the invitation of the Chairperson. Observers do not participate in the final evaluation; this is the sole responsibility of the Task Group members. When the Task Group considers it to be appropriate, it may meet *in camera*.

All individuals who as authors, consultants or advisers participate in the preparation of the EHC monograph must, in addition to serving in their personal capacity as scientists, inform WHO if at any time a conflict of interest, whether actual or

potential, could be perceived in their work. They are required to sign a conflict of interest statement. Such a procedure ensures the transparency and probity of the process.

When the Task Group has completed its review and the Coordinator (RAD) is satisfied as to the scientific consistency and completeness of the document, it then goes for language editing, reference checking, and preparation of camera-ready copy. After approval by the Director, Department of Protection of the Human Environment (PHE), the monograph is submitted to the WHO Office of Publications for printing. At this time a copy of the final draft is sent to the Chairperson and Rapporteur of the Task Group to check the proofs.”

Appendix D WHO ELF EMF health risk assessment (section 1.1.11)

“According to the WHO Constitution, health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. A risk assessment is a conceptual framework for a structured review of information relevant to estimating health or environmental outcomes. The health risk assessment can be used as an input to risk management that encompasses all the activities needed to reach decisions on whether an exposure requires any specific action(s) and the undertaking of these actions.

In the evaluation of human health risks, sound human data, whenever available, are generally more informative than animal data. Animal and in vitro studies can support evidence from human studies, fill data gaps left in the evidence from human studies or be used to make a decision about risks when human studies are inadequate or absent.

All studies, with either positive or negative effects, need to be evaluated and judged on their own merit and then all together in a weight-of-evidence approach. It is important to determine to what extent a set of evidence changes the probability that exposure causes an outcome. The evidence for an effect is generally strengthened if the results from different types of studies (epidemiology and laboratory) point to the same conclusion and/or when multiple studies of the same type show the same result.

Acute effects

Acute biological effects have been established for exposure to ELF electric and magnetic fields in the frequency range up to 100 kHz that may have adverse consequences on health. Therefore, exposure limits are needed. International guidelines exist that have addressed this issue. Compliance with these guidelines provides adequate protection for acute effects.

Chronic effects

Scientific evidence suggesting that everyday, chronic low-intensity (above 0.3–0.4 μT) power-frequency magnetic field exposure poses a health risk is based on epidemiological studies demonstrating a consistent pattern of increased risk for childhood leukaemia. Uncertainties in the hazard assessment include the role that control selection bias and exposure misclassification might have on the observed relationship between magnetic fields and childhood leukaemia. In addition, virtually all of the laboratory evidence and the mechanistic evidence fail to support a relationship between low-level ELF magnetic fields and changes in biological function or disease status. Thus, on balance, the evidence is not strong enough to be considered causal, but sufficiently strong to remain a concern.

Although a causal relationship between magnetic field exposure and childhood leukaemia has not been established, the possible public health impact has been calculated assuming causality in order to provide a potentially useful input into policy. However, these calculations are highly dependent on the exposure distributions and other assumptions, and are therefore very imprecise. Assuming that the association is causal, the number of cases of childhood leukaemia worldwide that might be attributable to exposure can be estimated to range from 100 to 2400 cases per year. However, this represents 0.2 to 4.9% of the total annual incidence of

leukaemia cases, estimated to be 49 000 worldwide in 2000. Thus, in a global context, the impact on public health, if any, would be limited and uncertain.

A number of other diseases have been investigated for possible association with ELF magnetic field exposure. These include cancers in both children and adults, depression, suicide, reproductive dysfunction, developmental disorders, immunological modifications and neurological disease. The scientific evidence supporting a linkage between ELF magnetic fields and any of these diseases is much weaker than for childhood leukaemia and in some cases (for example, for cardiovascular disease or breast cancer) the evidence is sufficient to give confidence that magnetic fields do not cause the disease.”

Appendix E WHO recommended protective measures (section 1.1.12)

It is essential that exposure limits be implemented in order to protect against the established adverse effects of exposure to ELF electric and magnetic fields. These exposure limits should be based on a thorough examination of all the relevant scientific evidence.

Only the acute effects have been established and there are two international exposure limit guidelines (ICNIRP, 1998a; IEEE, 2002) designed to protect against these effects.

As well as these established acute effects, there are uncertainties about the existence of chronic effects, because of the limited evidence for a link between exposure to ELF magnetic fields and childhood leukaemia. Therefore the use of precautionary approaches is warranted. However, it is not recommended that the limit values in exposure guidelines be reduced to some arbitrary level in the name of precaution. 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.

Implementing other suitable precautionary procedures to reduce exposure is reasonable and warranted. However, electric power brings obvious health, social and economic benefits, and precautionary approaches should not compromise these benefits. Furthermore, given both the weakness of the evidence for a link between exposure to ELF magnetic fields and childhood leukaemia, and the limited impact on public health if there is a link, the benefits of exposure reduction on health are unclear. Thus the costs of precautionary measures should be very low. The costs of implementing exposure reductions will vary from one country to another, making it very difficult to provide a general recommendation for balancing the costs against the potential risk from ELF fields.

In view of the above, the following recommendations are given.

- Policy-makers should establish guidelines for ELF field exposure for both the general public and workers. The best source of guidance for both exposure levels and the principles of scientific review are the international guidelines.
- Policy-makers should establish an ELF EMF protection programme that includes measurements of fields from all sources to ensure that the exposure limits are not exceeded either for the general public or workers.
- Provided that the health, social and economic benefits of electric power are not compromised, implementing very low-cost precautionary procedures to reduce exposure is reasonable and warranted.
- Policy-makers, community planners and manufacturers should implement very low-cost measures when constructing new facilities and designing new equipment including appliances.
- Changes to engineering practice to reduce ELF exposure from equipment or devices should be considered, provided that they yield other additional benefits, such as greater safety, or little or no cost.

- When changes to existing ELF sources are contemplated, ELF field reduction should be considered alongside safety, reliability and economic aspects.
- Local authorities should enforce wiring regulations to reduce unintentional ground currents when building new or rewiring existing facilities, while maintaining safety. Proactive measures to identify violations or existing problems in wiring would be expensive and unlikely to be justified.
- National authorities should implement an effective and open communication strategy to enable informed decision-making by all stakeholders; this should include information on how individuals can reduce their own exposure.
- Local authorities should improve planning of ELF EMF-emitting facilities, including better consultation between industry, local government, and citizens when siting major ELF EMF-emitting sources.
- Government and industry should promote research programmes to reduce the uncertainty of the scientific evidence on the health effects of ELF field exposure.

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