

If, when and how - PP for EMF.

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1. The problem

Public concerns about EMF exposure conflict with the views of industry and government, in some countries at least, perhaps reflecting different perceptions of national needs and public safety. Balance, proportionality and personal choice are likely to be key considerations.

The Electricity Supply Industry (ESI) and Communications Industry (CI) are vital elements of a modern economy, bringing essential public benefits. In the UK, privatisation of the ESI and liberalisation of the CI have brought substantial benefits to the taxpayer and consumer, and their continued success is an important political objective.

As a side effect they create public exposure to (different) EMF, with uncertain implications and rational public concern. Exposures from both sources include (a) voluntary exposure under some direct personal control (consumer choice, internal house wiring, appliances), (b) occupational exposures in the ESI and CI industries and in other workplaces and (c) imposed (largely chronic and involuntary) exposure in residences, schools and public places.

Those real and measurable exposures may be of the order of 1000 times greater than naturally occurring background levels in the same frequency band. On the other hand, to put it in a different perspective, taking time out from writing this on a cold winter night, I sat up to a fine log fire and felt perhaps 1000 W/m² of EMF on my face. Very nice! Much more than CI exposures, but a different frequency range and just for a few minutes.

The essence of the conflict is that, on the one hand, people, particularly children, have uncertain but potentially fatal risks imposed on them for commercial and political reasons, while on the other hand, it would be unfair and against the public interest to burden the ESI and CI with disproportionate liability and cost on account of unproven possibilities of numerically small risks.

Can these positions be reconciled? As a start, extreme positions, such as denial or dismissal of potential effects or demands for 100% safety, should be avoided.

There are other issues with powerlines and base stations, notably visual impact and property devaluation. Such issues can interact with health, for example through the stress of financial impact, damage to quality of life, and a sense of injustice at an uncompensated imposition. This paper considers only health effects from EMF.

2. Risk

The ideas of “risk” and in turn “cause” are at the root of precaution. Technical definitions sometimes obscure the artificial nature of these concepts, and provide for the denial of technical “risk” when in ordinary language people would think there is a risk.

Following common usage and dictionary definitions [1],

let risk mean a reasoned possibility of harm.

Here risk is a possibility, a concept not a number. More technical definitions express risk as a probability or a likelihood, i.e. a number [2, 3], and so may restrict application to cases where the probability can be evaluated, or to cases where a cause has been firmly established. In business risk analysis “risk” may refer to the possibility, while likelihood is a separate factor alongside impact.

In the present case there is the question of a causal effect between the exposure and the harm. The idea of cause is itself intrinsically imprecise and uncertain [4]. So we have the (mere) possibility of a causal effect. If the possibility of causal effect is reasoned, then there is a risk of a causal effect, and hence a risk of a risk (of harm), which is still a risk, even if the cause is not firmly established.

Some official bodies accept that there is a possibility that powerline EMFs cause cancer, but do not accept there is an established causal effect. That has been enough to escape precautionary policy, and to treat the risk as a phantom or myth..

Conventionally, agreeing a causal effect depends on (e.g. using the Bradford Hill guidelines) establishing both a statistical association and a plausible mechanism. Different interpretations of “plausible” now arise [1]. Bradford Hill [5] says:

*“It will be helpful if the causation we suspect is biologically plausible, though this is a feature we cannot demand. What is biologically plausible depends upon the biological knowledge of the day. Thus there was no biological knowledge to support (or to refute) Pott’s observation in the 18th Century of the excess of cancer in chimney sweeps. ... (passage omitted) ...
In other words, the association recorded may be one new to science or medicine and must not therefore be too readily dismissed as implausible or even impossible.”*

What is needed here is a graduated assessment of causation, as outlined in 1995 [4], rather than a yes/no approach. This is where the California Department of Health tackles the job [6]. They introduce a “degree of certainty” of causation by EMFs, called “degree of confidence in causality” in an earlier draft. Some EMF risks are rated above 50%, or more likely than not.

Risks where cause is not established have been called uncertain hazards [7], phantom risk [8, 9] and virtual risk [10]. This class of possible risks, as some of the other names suggest, tends to be treated by the public authorities as suspect. California is an exception, bringing a rigour to the assessment. Lessons from the BSE-CJD affair in the UK show the failure of political dismissal, and call for a more inclusive approach.

Recognising the importance of historical failures to respond to uncertain hazards, an EU report [11] sets out 12 “late lessons”. The first is “respond to ignorance as well as uncertainty”, with its accompanying definitions and analysis. The EU report is a rich resource.

3. Key issues for EMF

Some key issues seem to be overlooked, or misinterpreted, not least by the NRPB in the UK. In contrast the Stewart Report [12] on mobile phones, structurally more independent than NRPB standing committees, was more aware.

Independence itself is a general issue and there are different levels of independence [1]. Advisory groups and vetting processes inevitably suffer pressures of political, funding, commercial and career interests. The BSE affair in the UK, along with many other examples, encourages a public presumption of fallibility and spin towards official statements. Some steps can be taken to improve independence of scientific advisory bodies, for example in their method and periods of appointment and their accountability.

The issue of human variability is described by Alasdair Philips [13], noting Strachan's description of modern epidemiology as "*safety for the susceptible*" in his Bradford Hill Memorial Lecture 2001. Apart from protection, there is a detection issue. Data for predisposed groups would yield stronger results. General population studies may dilute real effects to insignificance.

Important uncertainties in EMF work seem to be taken to diminish the results. But they may be diluting the results and concealing stronger results. For example, using "wrong" exposure metrics (e.g. TWA, MMF) may lead to under-stated results. Other measures (e.g. E, nocturnal MF) may, if reflecting real mechanisms, yield stronger results. Searching among many independent metrics increases the probability of a chance result, but that can be corrected statistically.

The issue of information physics goes beyond the very limited approach (to non-ionising fields) which considers only energy effects, either through induced macroscopic currents and thermal effects, or through the quantum-energetic direct-hit effect on DNA at the molecular level. On the other hand information effects relate only to the energy required to store, transmit or interfere with information, which may be very low in terms of, for example, cell signalling or release of radicals from a weakly bonded caged configuration. The term "signal effects" may also be used [8].

To have an information effect, a field only needs to be detectable. Powerline fields are readily detectable at 100 metres by a pocket instrument. Detection of mobile phone radiation is their *raison d'être*. It is a fallacy to suppose that only by harmful quantum energy or harmful thermal energy can illness be caused. Information effects on immune system, on hormone production, on oxidation control can have ill effects, including cancer, for example by disrupting inhibitors.

Among potential mechanisms, the melatonin hypothesis offers interesting possibilities which seem to have been rather lightly dismissed in connection with EMF. Henshaw [14] has browsed the pineal and melatonin literature and found many relevant papers not cited in EMF surveys. Appendix 1 lists a few of them and a chain of hypotheses which they support, leading to a:

plausible summative hypothesis: that exposure to power-frequency EMF at levels well below those consistent with thermal effects, and at levels of environmental exposure, can have biological effects on humans, and these biological effects can lead to ill health, through mechanisms which are necessarily information- and control-based rather than essentially energetic.

Issues of risk communication and risk perception have attracted attention, showing the lack of systematic assessment of uncertainty and credibility of cause [15].

4. Precaution in principle

Stewart [12] refers to EU and WHO sources and quotes a ruling of the European Court of Justice which concluded: “*Where there is uncertainty as to the existence or extent of risks to human health, the Commission may take protective measures without having to wait until the reality or seriousness of those risks becomes apparent.*” Note the reference to “existence or extent”. A key principle is that the measures should be proportionate to the risk, though Adams & Thompson [10] refer to *Edwards v. NCB* 1949 sanctioning “gross disproportion” of measures above risk.

A UK approach is reflected in a written Parliamentary response [16] in 1994 to Mr Alex Carlisle’s question “To ask the SoS for Health if she will make it her policy to encourage the enactment of a prudent avoidance policy with regard to electrical powerline work ...”: Mr Sackville: “.... On the basis of present evidence, the two bodies [NRPB and COMARE] have not recommended the adoption of a policy of prudent avoidance. ...”

The NRPB had not then considered precautionary policy for powerline EMF, and still has not, though the Stewart report did (later) for mobile phones. Nevertheless, ministers have dismissed precaution on the basis that “NRPB does not recommend” it. Further, this has been used to block any discretion on the part of local authorities. The main test comes with planning applications to build new houses under existing powerlines. Local authorities attempting to adopt a precautionary policy have been faced with National Grid’s legal team objecting at public inquiries, with the effect that suggestion of a health problem and a precautionary approach is expunged.

A test policy: “**other things being equal, exposure will be avoided**” has been vigorously resisted by the NGC in this country and the ESB in Ireland, when I have put it at inquiries. I had put a similar question to Sir Richard Doll at a conference in 1995, with reference to hypothetical powerlines to be built near a school, and he indicated he would support such a precautionary policy. He also mentioned the Chinese wall he observes between scientific advice and policy consideration.

5. Practical options

Returning to the categories of (a) voluntary, (b) occupational and (c) imposed exposures, responses may differ. The role of government will be to regulate imposed and occupational exposures and to promote fair information and consumer choice on voluntary exposure.

A free market offers some solutions. VDUs (VDTs) provide an example [17]: “The VDTs of today have EMFs 10- 100 fold lower than those of the 80s without the regulating authorities having issued any regulations and without any substantial increase in costs.”

Simply by promoting information and voluntary precaution, and acknowledging uncertain hazards, governments may be able to solve many problems by market forces, without catastrophe. The mobile phone industry is unlikely to collapse under such gentle voluntary moves. People are very resilient to small risks when they bring desired benefits.

The EU principle of internalising the cost of environmental damage at the planning stage of projects would guide developers in choosing options. In turn, this may depend on compensation for imposed exposures. It will be helpful if the EC, WHO and NIEHS can give a lead on the question of compensation for imposed uncertain hazards; clearly they are unwelcome even if not proved.

Then there is the difficult distinction of new and pre-existing developments: can there be compensation for one without the other?

The NCRP Scientific Committee 89-3 chaired by Professor Ross Adey, after nine years on the ELF EMF problem produced a draft report [18] in 1995. It addresses the question of precaution and makes recommendations. The report was blocked in its formal approval stages which included political and industrial interests. It is worth re-visiting however.

Four options were considered for the existing ELF EM environment:

Option 1. No recommendation.

Option 2. Exposure guideline of 0.2 μT and 10 V/m.

Option 3. Exposure guideline of 1 μT and 100 V/m.

Option 4. The ALARA concept (as low as reasonably achievable).

The conclusion was to adopt Option 4 allowing an ALARA guideline to be progressively implemented over a ten year period.

For future developments, the NCRP Committee recommended that

(1) new schools etc. should not be built where ambient fields exceed 0.2 μT ,

(2) new housing should not be built under existing HV lines or where ambient fields exceed 0.2 μT for longer than two hours daily,

(3) new powerlines would not be built where they would produce fields exceeding 0.2 μT in existing houses,

(4) in new offices etc. aim to reduce intermittent and ambient fields to 0.2 μT .

More recently the Swiss Ordinance [19] is intended to protect the public from “harmful or undesirable” NIR, from 0 to 300 GHz. It distinguishes between:

- stationary installations and appliances (restricting the former only);
- old and new installations;
- sensitive use locations (e.g. playgrounds, regularly occupied rooms) and other locations;
- precautionary controls (specified with a limit of 1 μT for certain installations including new powerlines, otherwise “as low as is technically and operationally feasible and financially viable”) and stringent controls (for proven harm).

Time-limited modernisation requirements apply to old installations with transitional provisions. Appendix 1, para. 15 provides for authorised exemption provided phase assignment is optimised.

It would be helpful to learn of the Swiss experience since the Ordinance came into effect on 1.2.00 and in particular what proportion of installations have been granted exemption.

Proportionality for uncertain hazards may incline towards guidelines rather than firm limits, in the first instance at least. Guidelines could be used as a basis for requiring good reasons for, rather than prohibiting, exceeding the exposures, and they could be incorporated in national planning guidance. But then exceeding the guidelines invites compensation.

The prospect of people choosing to live under powerlines, even if the authorities agreed there was a health risk, should not be ignored. There are many benefits from staying in the same house, such as community and schooling, which may lead people to prefer to take the small risk, as has happened where houses have natural radon levels presenting a risk. The introduction of formal guidance is however likely to have an effect on prices of highly exposed houses.

The cost of burying all National Grid's 4,000 route km in England and Wales would be some £40 billion. This is not contemplated. The cost of full implementation of guidelines such as those above might be of the order of £4 billion over ten years in the UK. That compares with roughly half a billion pounds annual profit of National Grid and with a turnover of the electricity market in England and Wales of the order of £15 billion or wholesale value around £5 billion per year. Full implementation would add to the price of electricity significantly, but not impossibly. These things would need considering against the damage to industrial competitiveness and impact on the community, and they would be major considerations.

Stather [20] gives an indicative cost-benefit analysis, with exposure reduction measures valued from £200,000 to tens of millions of pounds per case of leukaemia avoided. That is based on a relative risk of 2.7 as then found in the association with residential exposures to ELF fields above 0.2 μ T. This takes no account of benefits other than reduced risk of cancer. These are typical rates of investment in risk reduction and compare with NRPB's theoretical evaluation for occupational exposure to (ionising) radiation of £100,000 to £1.7m per nominal life saved (1987 values).

6. Conclusions: if, when and how.

Can we answer “no” to “if”? The question applies of course to fields below ICNIRP levels and thermal effects. In the UK the answer is “no” for ELF fields, with a mild and passive element of precaution recommended for mobile phones in the Stewart Report, but government departments are considering the position.

The evidence continues to grow and to be disputed. For ELF there is a persistent and robust unexplained epidemiological association with childhood leukaemia, and growing evidence of information-effect potential mechanisms. Official advisory bodies acknowledge a “possible human carcinogen”.

Dispute about the level of uncertainty and the size of risk does not remove the possibility nor escape the applicability of definitions of precautionary policy. In the face of uncertainty, to say “we don't know” is not enough. The question of precaution demands a response yes or no, but it can be tempered by proportionality. To be silent will not resolve the conflict.

Evidence and definitions seem to require an answer “yes”. Bodies like the EC, WHO and NIEHS would seem to have a duty to answer “yes” to “if”, but would not be expected to agree on fine details of “when” and “how”. On the other hand, international agreement might moderate any negative impact on economic competitiveness.

My recommendations are to be very open about information, to accept the appropriateness of precaution, to let the free market work to balance the issues where practicable, to learn from the Swiss experience, to adopt precautionary guidelines in careful stages and to introduce measures for compensation for imposed exposures exceeding the guidelines.

As for specific guideline levels and thresholds (part of the “when”) and regulations (part of the “how”), the Swiss model is commendable. They have done the preparation, and now provide a free trial for others to monitor.

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Appendix 1: Melatonin

Over the past three months, Denis Henshaw has forwarded to me academic papers (listed below, and many more before those), some dating back to the 1990s and some very recent, many not included in EMF reviews, supporting the following hypotheses among others.

1. Exposure to power frequency emf well below levels of thermal effects can suppress melatonin in humans.

Research includes both animals and humans. Exposure levels are relevant to human environmental exposure, e.g. 1 μ T for occupational exposure. Experiments on hamsters at 86 μ T indicate an effect within the pineal gland, noting speculation about whether the observed effects on melatonin levels may otherwise be via optical sensing or reaction mechanisms.

2. Melatonin can have a protective effect against human miscarriage.

Administered doses of melatonin were associated with decreased luteinising hormone (LH) which in turn was associated with miscarriage in women.

3. Melatonin can be protective against gamma radiation.

Pre-treatment doses of melatonin in mice and in blood samples of human volunteers showed significant protective effects against gamma radiation.

4. Melatonin can be an effective anti-oxidant and an immune enhancing agent.

“Even at physiological concentrations, melatonin detoxifies free radicals and reduces oxidative damage.” (In vivo and in vitro animal-based experiments.)

5. Physiological melatonin concentrations vary between organs by orders of magnitude, a base level being the picomolar or low nanomolar range. Higher levels, called pharmacological, can occur physiologically in some organs.

6. Geomagnetic disturbances can be associated both with depressed melatonin and with certain illnesses (depression, SAD); the association is enhanced in combination with power-frequency exposure.

While these hypotheses do not constitute a conclusive mechanism for ill-health effects of exposure to powerline fields, notably childhood leukaemia with its persistent epidemiological statistics, and bearing in mind that melatonin is not the only possibility of an information mechanism, and that different mechanisms may combine as causal factors, the hypotheses would seem together to provide a

plausible summative hypothesis: that exposure to power-frequency emf at levels well below those consistent with thermal effects, and at levels of environmental exposure, can have biological effects on humans, and these biological effects can lead to ill health, through mechanisms which are necessarily information- and control-based rather than essentially energetic.

The above hypotheses are drawn from just those recently forwarded papers. Henshaw [14] gives more references supporting similar hypotheses relating to melatonin and EMF. Much more can be seen at <<http://www.electric-fields.bris.ac.uk>>.

Papers considered in Appendix 1.

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