

THE PRECAUTIONARY PRINCIPLE AND EMF

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✍ Abstract –

The precautionary principle, a recommendation to consider action to avoid a possible harm even if it is not certain to occur, is variously defined and interpreted. I will present a range of definitions with an emphasis on their requirements for strength of evidence of harm and for actions to be taken. I will describe the variety of approaches that have been adopted in developing policy to address the issue of possible health effects of electric and magnetic fields (EMF) in the face of scientific uncertainty. Further, I discuss specific aspects of scientific uncertainty regarding EMF health risks particularly relevant to the development of precautionary principle policy. I will define and discuss prudent avoidance and other unique features of applications of the precautionary principle to EMF. I will conclude with examples from EMF policy decisions of risk tradeoffs that need to be considered in developing any precautionary principle policy, and provide recommendations for better ways to define and implement the precautionary principle.

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✍ Introduction

The precautionary principle is one of many guides society can use when deciding whether to take action to protect people from possible harm. It is essentially a “better safe than sorry” approach suggesting that action should be taken to avoid harm even when it is not certain to occur.

All risks are to some degree uncertain, but the degree of uncertainty varies.

Clearly, when the harm associated with a risk is slight and its occurrence very uncertain, little or no action

should be taken. Conversely, when the harm is great and there is little uncertainty about its occurrence, significant action is called for. It is in the gray area where substantial harm is postulated but certainty about whether it will occur is low, or where the degree of harm is low but the certainty is high, that policymaking is more difficult and some decision rules are needed as a guide to action. The precautionary principle provides a framework that can help provide a basis for decisions about whether to take action and what action to take in uncertain situations, if it is supplemented by other decision rules and risk evaluation.

✍ Defining the Precautionary Principle

A wide variety of definitions and interpretations of the precautionary principle have been proposed. These definitions include three basic approaches:

1. *Where there are threats of serious or irreversible damage, uncertainty should not be a reason for postponing action to prevent that damage.*
2. *Where there are threats of serious or irreversible damage, precautionary measures should be taken even if cause-and-effect relationships are not clearly established.*
3. *Whenever an action or substance could cause irreparable/irreversible harm, even if that harm is not certain to occur, the action should be prevented and eliminated.*

Although each of the above definitions appears as a precautionary principle, important differences in the requirements for strength of evidence and actions to be taken make these approaches substantively different. Similarly, definitions of the precautionary principle imply a wide range of actions that should be taken once the strength of evidence requirement has been satisfied.

Another important difference in the various definitions of the precautionary principle lies in who bears the burden of proof. In some definitions, the burden of proof is shifted from the opponents of a possibly harmful action to its proponents (Wingspread, 1998). Finally, definitions of the precautionary principle reflect differing degrees of risk aversion.

On 2 February 2000, the European Commission approved an important communication on the Precautionary Principle providing guidelines for the application of the Principle. According to this communication, measures based on the precautionary principle should be

- ?? tailored to the chosen level of protection,
- ?? non-discriminatory in their application, i.e. they should treat comparable situations in a similar way,
- ?? consistent with similar measures already taken, i.e. they should be comparable in scope and nature to measures already taken in equivalent areas in which all scientific data are available,
- ?? based on an examination of the potential benefits and costs of action or lack of action (including, where appropriate and feasible, an economic cost/benefit analysis),
- ?? provisional in nature, i.e. subject to review in the light of new scientific data, and
- ?? capable of assigning responsibility for producing the scientific evidence necessary for a more comprehensive risk assessment.

In this definition, the Precautionary Principle is "risk-oriented", in that it requires an evaluation of risk research including cost-benefit considerations. It is clearly intended for use in drafting provisional responses to potentially serious health threats, until adequate data are available for more scientifically based responses.

✂✂ **The State of EMF Science**

The use of electricity has continued to grow throughout the industrialized world since the first public power station began operation over 100 years ago. Today, developing nations look to electricity as a primary means of creating jobs and improving the quality of life. Though electric power clearly benefits societies in countless ways, concern has been raised about the possible adverse health effects from electric and magnetic fields produced during its generation, delivery, and use. In the face of uncertainty, public concern about EMF, as well as the ubiquity of EMF exposure and thus the potential for an appreciable public health impact associated with even a small risk, has led to suggestions that the precautionary principle be adopted.

✂✂ **Scientific Uncertainty**

While the precautionary principle applies by definition to situations characterized by scientific uncertainty, its application to the EMF issue is especially problematic owing to several specific aspects of EMF science. EMF science involves not only uncertainty as to whether or not exposure is associated with increased risk, but additional uncertainties as well.

First is uncertainty about the magnitude and specificity of the risk.

Another important uncertainty is that it is at present unknown which aspect of exposure might be harmful.

The absence of a clearly elucidated, robust, and reproducible mechanism of interaction of EMF with biological systems and the plethora of field characteristics that could be relevant make avoidance strategies that fall short of avoiding EMF exposure entirely (which could be accomplished only by not using electricity at all) both difficult to formulate and potentially counterproductive.

✂✂ **Application of the Precautionary Principle to EMF**

Governments have responded to the EMF issue in very different ways. While most have not established any standards for EMF exposure, others have developed guidelines, set local limits, or adopted a policy of prudent avoidance.

✂✂ **EMF Guidelines and Limits**

A number of national and international organizations have formulated guidelines establishing limits for occupational and residential EMF exposure. These organizations include the International Radiation Protection Association/International Non-Ionizing Radiation Committee (IRPA/INIRC, 1990), the Comité Européen de Normalization Electrotechnique (CENELEC, 1995), the National Radiological Protection Board in the United Kingdom (NRPB, 1993), Deutsches Institut für Normung-Verband Deutscher Elektrotechniker (DIN/VDE, 1995), the American Conference of Governmental Industrial Hygienists (ACGIH, 1996), and the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998). Guidelines focus on prevention of acute neural and cardiac effects. Evidence of potential long-term effects such as cancer is considered insufficient for guideline formulation.

In the U.S., several state and local governments have adopted electric and magnetic field limits for transmission lines (Sahl and Murdock, 1997). These limits, established by regulations in some states (e.g., Florida) and by informal guidelines in others (e.g., Minnesota), are on the order of 10 kV/m within rights-of-way and 2 kV/m at the edge of rights-of-way for electric fields and around 200 mG for magnetic fields. Much more stringent limits for magnetic field exposure (on the order of 2–4 mG at the edge of rights-of-way) have been adopted in some local ordinances.

✂✂ **Prudent Avoidance**

More frequently than guidelines, governments have adopted "prudent avoidance," a concept introduced by M. Granger Morgan, H. Keith Florig, and Indira Nair at Carnegie Mellon University. In a 1989 U.S. Office of

Technology Assessment (OTA) report (Nair et al., 1989), they suggested prudent avoidance as a policy option. The report defined prudent avoidance as “taking steps to keep people out of fields both by rerouting facilities and redesigning electrical systems and appliances;” prudence was defined as “undertaking only those avoidance activities which carry modest costs.” Introduced as “an example of using incomplete science to make a reasoned judgment in the face of uncertainty,” prudent avoidance can be seen as an application of the precautionary principle, which calls for taking simple, easily achievable, low-cost measures to minimize exposure even in the absence of a demonstrable risk.

Since its introduction, prudent avoidance has been adopted in Australia, Sweden, and several U.S. states, including California, Colorado, Hawaii, New York, Ohio, Texas, and Wisconsin. Other states, such as Connecticut and Missouri, and the District of Columbia have rejected a policy of prudent avoidance because of insufficient evidence and lack of scientific consensus on the EMF issue.

In the U.S., prudent avoidance has been interpreted to mean everything from adopting the best available practices to implementing low-cost steps (defined in California as actions costing less than 4% of a project budget) in constructing new lines. Most recently, the National Institute of Environmental Health Sciences (NIEHS) report stated that “the NIEHS believes that there is weak evidence for possible health effects from ELF-EMF exposures, and until stronger evidence changes this opinion, inexpensive and safe reductions in exposure should be encouraged.” While noting that aggressive regulatory concern is not warranted, because the use of electricity and therefore exposure to ELF-EMF is ubiquitous, the report states that “passive regulatory action is warranted such as a continued emphasis on educating both the public and the community on means aimed at reducing exposures.”

Prudent Avoidance has not been formally adopted in the US for regulation of communications or commercial broadcasting facilities. However, government agencies have made recommendations to the telecommunications industry that could be considered as forms of Prudent Avoidance. In 1999 the U.S. Food and Drug Administration (FDA) urged the mobile phone industry to design phones that minimize user exposure to RF fields to levels necessary for the device's function.

In Prudent Avoidance, as implemented by various countries, prudent refers to expenditures, not an attitude to risk. It does not imply setting exposure limits at an arbitrarily low level, and requiring that they be achieved regardless of cost, but rather adopting measures to reduce public exposure to EMF at modest cost. There is no requirement for assessment of potential health benefits.

ALARA is an acronym for As Low As Reasonably Achievable. It is a policy used to minimize known risks, by keeping exposures as low as reasonably possible, taking into consideration costs, technology, benefits to public health and safety and other societal and economic concerns. ALARA today is mainly used in the context of ionizing radiation protection, where limits are not set on the basis of a threshold, but rather on the basis of "acceptable risk". Under these circumstances, it is reasonable to minimize risk that can be presumed to exist even at levels below recommended limits, on the grounds that what constitutes "acceptable risk" can vary widely among individuals.

The Precautionary Principle and EMF Policy: Specifics

Application of the precautionary principle to EMF policy has several unique and interesting aspects; among them are the use of everyday exposure levels as a benchmark, the distinction between new and existing electrical facilities, exposure to children, and the involuntary nature of the exposure. Several risk tradeoffs are also involved.

Since, as discussed above, it is presently unknown what, if any, levels or characteristics of exposure might be harmful, several applications of the precautionary principle have used existing EMF exposure levels as a benchmark (National Board of Occupational Safety and Health, 1996). Similarly, the New York Public Service Commission limits new construction to designs “that produce magnetic fields no stronger than those already common throughout the state” (Stilwell, 1996).

Limiting application of the precautionary principle to new facilities is common to most policies that have adopted it. Implicit in the focus on new facilities is consideration of costs, which are typically higher for retrofitting existing facilities than for modifying the design of new ones. Because the epidemiologic evidence for EMF effects has been strongest for childhood leukemia and because children are often afforded extra protection, some proponents of the precautionary principle have suggested that special consideration be given to schools and day-care facilities (as, for example, in Sweden). Formal policy analysis, which includes cost-effectiveness calculations, would also tend to give more weight to exposure to children because of the increase in potential lost years of life.

Tradeoffs to consider include the potential for risk offset, risk substitution, risk transfer, and risk transformation (Graham and Wiener, 1995), as well as benefits and costs.

Finally, voluntary and involuntary sources of exposure carry different risk perception implications (Slovic, 1987); if an exposure is viewed as involuntarily imposed,

perceived risk increases. Although the concept of prudent avoidance spans suggestions for personal or voluntary exposures as well as those perceived as involuntarily imposed, most of the so-far-adopted policies focus on exposures that are regarded as involuntary.

Another difficulty is the ubiquity of EMF exposure in modern society, at highly variable levels and over wide frequency ranges. It is therefore difficult to create cautionary policies that have consistency and equity. For example, typical urban environments contain a multitude of radiofrequency transmitters, ranging from low power communications transmitters to very high power broadcast transmitters. It is difficult to envision a consistent and equitable cautionary policy that would minimize radiofrequency EMF exposures from cellular telephone base stations given the presence of far higher powered sources in the same urban area. Indeed, attempts to implement a cautionary policy for cellular telephone masts have typically been done on a piecemeal basis, with no attention to other (much stronger) sources of RF energy in the environment.

It is possible to introduce cautionary policies without undermining science-based standards. In 1999, the New Zealand Government issued their RF exposure standards that follow the 1998 ICNIRP EMF guidelines. The Ministries of Health and Environment noted that it considered the basic restrictions and reference levels in its standard to "provide adequate protection". However, the Ministries noted that community concerns over RF exposure might be addressed by "...minimizing, as appropriate, RF exposure which is unnecessary or incidental to achievement of service objectives or process requirements, provided that this can be readily achieved at modest expense". This emphasis on reducing exposure at "modest expense" with no evidence of prospective health benefits or cost-benefit analysis, marks this policy as a form of prudent avoidance, not an application of the Precautionary Principle as outlined by the European Commission.

Discussion

As it has been implemented in EMF policy, the precautionary principle—or, more specifically, prudent avoidance—has been criticized as going too far and not far enough. Risks are always present in all aspects of our lives and there is always some uncertainty associated with those risks. We as individuals and as a society can and do make decisions under uncertainty. And while the possibility of risk does not in itself justify action, uncertainty does not in itself justify inaction. Rather, both a proposed precautionary action and its alternative (not taking that action) should be evaluated in terms of the probability of false-positive and false-negative errors and their consequences. When societal losses from false-negative errors are more compelling than losses from false-positive errors, precautionary action is justified.

The precautionary principle is vague and at best can provide a general framework. Additional decision rules are necessary as a guide to whether actions should, in fact, be taken in the face of uncertainty in a given situation and, if so, which action among competing alternatives should be chosen. Such guidance should be based on consideration of tradeoffs and cost-benefit analysis.

Both the benefits of electricity and other newer technologies such as mobile phones, as well as potentially enormous mitigation costs, easily justify the need for better scientific knowledge for more informed decisions.

Because it is unlikely that any one alternative will be preferred with respect to all of the objectives, defining objectives for decisions is vital, as is accepting that it will probably be necessary to make tradeoffs among those objectives. Other criteria will need to be developed and applied and might depend on the specifics of who is practicing the precautionary principle and in what setting. How prescriptive these criteria are will depend on whether an individual, an industry, or a government is applying the precautionary principle, as well as whether human health or the environment are to be protected.

Both science and judgment play a pivotal role in any evaluation of risk. Adoption of the precautionary principle does not eliminate, and perhaps increases, the need to reduce uncertainty. Any such policy should provide for means to monitor and refine the consequences of action, as decisions made in the face of uncertainty will not be right all the time.

References

Swedish Environmental Protection Act (1969) *International Digest of Health Legislation* 21 (1971), p. 180.

Von Moltke K, The Vorsorgeprinzip in West German Environmental Policy, in *Twelfth Report of the Royal Commission on Environmental Pollution*, Annex 3, p. 57. London: H.M. Stationery Office, 1987.

Department of the Environment Ministerial Declaration. Second Conference on the Protection of the North Sea, London. London: Department of the Environment of the United Kingdom, 1988.

Treaty of Maastricht *International Legal Materials* 31. 1992.

United Nations (1992a) United Nations Conference on Environment and Development: Convention on Biological Diversity, Preamble,

United Nations (1992b) United Nations Conference on Environment and Development: UN Framework Convention on Climate Change, Article 3 (3).

United Nations (1992c) United Nations Conference on Environment and Development: Rio Declaration on Environment and Development, LFNCD document A/CONF. 151/5/Rev. 1, June 13.

Australia: Intergovernmental Agreement on the Environment (1992). Available at: <http://www.environment.gov.au/psg/igu/pubs/igae.html>.
United Kingdom: Strategy on Sustainable Development (1994).

Bergen Declaration (1990). Ministerial Declaration on Sustainable Development in the [UN] ECE Region (Bergen/ Norway, 16 May 1990), article 7 In *Yearbook of International Law* 1, p. 429.

Convention on the Protection of the Marine Environment of the Baltic Sea Area (1992), article 3 (2).

Cameron J and Abouchar J, The precautionary principle: a fundamental principle of law and policy for the protection of the global environment, *Boston College International Comparative Law Review*, XIV 1, 1-27, 1991.

Rachel's Hazardous Waste News (1993), No. 339, May 27.

Wingspread Conference (1998) *Wingspread Statement on the Precautionary Principle*, Racine, WI: Wingspread Conference. Available at <http://www.wajones.org/wajones/wingcons.html>.

International Radiation Protection Association /International Non-Ionizing Radiation Committee (IRPA/INIRC) (1990) Interim guidelines on limits of exposure to 50/60-Hz electric and magnetic fields, *Health Physics* 58, 113-22.

Comité Européen de Normalisation Electrotechnique (CENELEC) (1995) *Human Exposure to Electromagnetic Fields, High Frequency (10 KHz to 300 Ghz)*, CENELEC Standard ENV 50166-2, January.

National Radiological Protection Board (NRPB) (1993) *Restrictions on Human Exposure to Static and Time Varying Electromagnetic Fields and Radiation: Scientific Basis and Recommendation for Implementation of the Board's Statement*, Documents of the NRPB 4, 8-69.

Deutsches Institut für Normung-Verband Deutscher Electrotechniker (DIN/VDE) (1995) *Safety in Electromagnetic Fields: Protecting People in the Frequency Range from 0 to 30 kHz*. Provisional Standard, DIN VDE Vol. 0848-4 A/3.

American Conference of Governmental Industrial Hygienists (ACGIH) (1996) *TLVs and BEIs: Threshold Limit Values for Chemical Substances and Physical Agents, Biological Exposure Indices*. Cincinnati, OH: ACGIH.

International Commission on Non-Ionizing Radiation Protection (1998) Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz), *Health Phys* 74, 494-522.

American Conference of Governmental Industrial Hygienists (ACGIH) (1998) *TLVs and BEIs: Threshold Limit Values for Chemical Substances and Physical Agents*. Cincinnati, Ohio: ACGIH.

Federal Government of Germany (1996) 26th Ordinance Implementing the Federal Emission Control Act (EMF Ordinance—26th BIm SchV) of 16 December 1996. *Federal Law Gazette* (BGB1) Ip. 1966. Bonn, Germany.

Swiss Federal Council (1999) Regulation on Protection Against Non-Ionizing Radiation. Available at <http://www.buwal.ch/recht/f/finkridx.htm>.

Sahl J D and Murdock B S, *Electric and Magnetic Fields and Human Health*, Second Edition, Irwindale, CA: Southern California Edison, 1997.

Nair I, Morgan M G and Florig H K, *Biological effects of power frequency electric and magnetic fields: Background paper*. Washington, DC: Office of Technology Assessment, Congress of the United States. Publ. No. OTA-BP-E-53,1989.

Gibbs H, *Inquiry into Community Needs and High Voltage Transmission Line Development*, Sydney, Australia: New South Wales Government, 1991.

Villa S, and Ljung L, *Magnetic fields and cancer* [Swedish], Stockholm, Sweden: National Electric and Safety Board, 1993.

National Board of Occupational Safety and Health, National Board of Housing, Building, and Planning, National Electrical Safety Board, National Board of Health and Welfare, Radiation Protection Institute (1996) Low-frequency electrical and magnetic fields: The precautionary principle for national authorities, *Guidance for Decision-Makers*, Stockholm: National Board of Occupational Safety and Health.

NIEHS (1999) *NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields*. Prepared in Response to the 1992 Energy Policy Act (PL 102-486, Section 2118). Report No. 99-4493. Research Triangle Park, N.C.: National Institute of Environmental Health Sciences, National Institutes of Health.

Stilwell J H, Walking the high wire: Practical possibilities for regulatory responses to the electromagnetic field quandary, *The Review of Litigation* 15, 141-168, 1996.

Slovic P, Perception of risk, *Science* 236, 280-285, 1987.

Electromagnetic Energy Policy Alliance (EEPA) Prudent avoidance: the abandonment of science. Official position of the Electromagnetic Energy Policy Alliance, *HPS Newsletter*, 21-24; October, 1991.

Keeny R L and von Winterfeldt D, Appraisal of the precautionary principle applied to electric and magnetic fields, *Journal of Risk Research* 3 (submitted), 1999.

Graham J D and Wiener J B, *Risk vs. Risk: Tradeoffs in Protecting Health and the Environment*, Cambridge, MA: Harvard University Press, 1995