

## The Imprudence of "Prudent Avoidance"

David Hafemeister

In 1988, shortly before he died, Andrei Sakharov commented on the fate of the earth. Interestingly enough, rather than comment on the hydrogen bombs that he co-invented, he stated: "... in fact, I am now inclined to regard the many-faceted ecological threat to our environment as our most serious long-term problem " (1). Because I agree with this very long-term assessment, it is troubling to me to see environmental funds and political capital wasted on false threats. In particular, I am concerned that the quasi-legalistic concept of "prudent avoidance" is being used to chase the phantom risk of cancer caused by extremely low frequency (ELF) electromagnetic fields (EMF) from power lines. This needless chase costs some one to three billion dollars per year (2,3) and unnecessarily frightens the public with "electrophobia." The burden of these fiscal and emotional costs placed on the American public are incommensurate with the risk, if any, being mitigated. This outcome is not a use of science for the public good.

### What is prudent avoidance?

In the absence of any firm scientifically demonstrated connection between ELF/EMF and cancer, the concept of "prudent avoidance" has been invoked by many utility commissions (at least eleven by recent count) as a basis for promulgating regulations. Granger Morgan (4) defines "prudent avoidance" as "exercising sound judgment in practical matters. It means being cautious, sensible, not rash in conduct." Morgan continues, prudent avoidance "is to try to keep people out of fields when that can be done at modest cost...but not to go off the deep end with expensive controls which may not be beneficial."

Prudent avoidance, as thus defined, might seem reasonable if one understood the nature and severity of the risk, which is not the case for the alleged EMF health hazard. From there Morgan moves towards suggesting the arbitrary spending of money without measurable benefits: "Utilities and utility regulators must consider both distribution systems and transmission systems. Activities that may warrant consideration at the distribution level include: paying greater attention to population distributions around facilities; incorporating more consideration of exposure management in maintenance and facility upgrade policies...making selected use of undergrounding..." At this point "prudent avoidance" becomes imprudent because it leads to an open-ended, unbounded approach to risk mitigation. It stimulates a fearful public to use the threat of litigation to force utilities and school boards to take steps to mitigate a phantom effect. These institutions have little incentive to risk litigation, as long as the costs of compliance will be covered by rate payers or tax payers.

Morgan's approach appears to be driven by his statement that "there is some significant chance that fields pose a modest public health risk, and not much chance that the risk to any one of us will be very big." (4) Morgan seems to have placed great reliance on the very questionable work of Wertheimer and Leeper (5) when Morgan stated in 1992 that "a series of epidemiological studies, including studies of childhood leukemia by Nancy Wertheimer and Ed Leeper....have provided a growing basis for concern."

By now there have been at least 13 studies on childhood leukemia. These studies been examined by Washburn et al, and they find "no significant relation between combined relative risk estimates and 15 indicators of epidemiological quality. Assessment of EMF exposure in the primary studies was found to be imperfect and imprecise." (6)

In addition, Morgan has failed to examine the epidemiology risk factors by type of cancer, an approach that shows glaring inconsistencies. Because of the great impact of his writings, it would be useful for Morgan to update his analysis to determine what benefits have been gained by the annual spending of some \$1-3 billion.

Philosophically, Morgan alludes (4) to Thomas Kuhn's Structures Of Scientific Revolutions by stating that "paradigm shifts" are affecting "scientific thinking about biological effects from electric and magnetic fields." It is premature to talk of paradigm shifts when the preponderance of the data does not demonstrate that there is a connection between cancer and these fields. Morgan is concerned that public perceptions may drive regulations rather than scientific fact. However, I conclude that it is his own papers that have strongly pushed the EMF-risk process away from science and toward irrationality. I agree with the critics of "prudent avoidance" who have called it "the abandonment of science," "the triumph of fear of the unknown over reason," and "being so vague as to be useless." (4) Prudent avoidance is a delight for plaintiff lawyers since it is essentially a conclusion that the danger is probable.

A General Accounting Office (GAO) report (7) acknowledges this misuse of science by concluding: "Regulators in at least eleven states that we contacted have adopted practices for mitigating exposure to EMFs.... Some commercial utilities have also adopted prudent avoidance or other 'low cost/no cost' policies to address the public's concerns about EMFs. Such policies are not based on scientific knowledge about health effects of exposure to EMFs."

### The cost of mitigation

One of Morgan's co-authors, Keith Florig, commented in 1992: "...it seems likely that the total economic costs of the [EMF mitigation] activities described above now exceed \$1 billion annually, with the promise of growing costs in the years to come.... If we were to value the reduction of a unit of EMF risk at comparable levels, the most that we could justify spending on EMF mitigation would be something in the neighborhood of \$10 billion per year.... Recent examples include a town that moved several blocks of distribution lines underground at a cost of \$20,000 per exposed person; a utility that rerouted an existing line around a school at a cost of \$8.6 million; a new office complex that incorporated EMF exposure in its design at a cost of \$100-200 per worker; and a number of firms that have installed ferrous shielding on office walls and floors to reduce magnetic field exposures from nearby power handling equipment at costs ranging up to \$400 per square meter of office space." (2)

The GAO study (7) estimates the following costs for EMF mitigation, which would not reduce the EMF from appliances from within the home:

- \$90,000/mile for delta design above-ground transmission lines to reduce magnetic fields by 45%,
- \$2 million/mile to bury transmission lines in fluid-filled steel pipes to reduce magnetic fields by 99%,
- \$1 billion to limit magnetic fields to 10 milligauss at edges of rights-of-way for planned new transmission lines,
- \$3-9 billion to reduce magnetic fields at homes where grounding systems are the dominant source,
- \$200 billion to bury transmission lines nationwide near homes with fields greater than 1milligauss,
- \$250 billion to reduce average exposure to less than 2 milligauss from all transmission and distribution lines.

Allan Bromley, President Bush's Science Advisor, recently commented on an EMF study done by the Office of Science and Technology Policy: "It is safe, however, to conclude that the EMF risk issue will continue to be contentious and of immense potential economic importance; the current best estimate is that prior to 1993 it has cost the American public more than \$23 billion to respond to public worries about EMF ...particularly in connection with the placement of high-voltage power lines." (3)

Recently a law suit was filed against Houston Light and Power and the Electric Power Research Institute (EPRI) on behalf of eleven families with children suffering from cancer. The suit charges both the power company and EPRI with "fraudulent concealment of the carcinogenic nature of the fields that secretly and silently invaded their homes." To avoid such litigation and the associated unfavorable publicity, other institutions have decided to give in, rather than fight. For example, the San Diego Gas and Electric Company canceled a power plant upgrade and compromised on a 69-kilovolt line. Hawaiian Electric Industries, Inc., spent nearly \$5 million to reroute and reconfigure power lines. In the Mill Valley School District, four classrooms, a day care center, and a part of the playground located near power lines have been closed. The policy of prudent avoidance added about \$500,000 to the construction costs of the World Bank Building, and this approach is now considered to be a model in this area. The California Public Utility Commission has required the utilities to spend up to 4% of the cost of electrical projects to mitigate EMF. Thus, we see that the advocates of "prudent avoidance" are willing to spend large sums for mitigation efforts with no clear assessment of any benefits to be gained.

### Evidence bearing on EMF effects

The scientific literature and the reports of review panels show no consistent, significant link between cancer and the EMF from power lines (8). This literature includes epidemiological studies, research on biological systems, and the analyses of theoretical mechanisms. This negative result is consistent with the implications of arguments which have been advanced that there can be no such link. The preponderance of the epidemiological and biophysical/biological research findings have failed to substantiate those studies that have reported specific adverse health effects from the exposure to 60-Hz EMFs. It is always possible that some minor carcinogenic connection might be found, but the present data do not establish that connection. To justify expenditures on mitigation, there should be some consistent, meaningful combination of the following factors:

- a plausible coupling mechanism at the cellular level exists,
- evidence that the coupling must produce consistent biochemical changes,
- indications that the biochemical changes must be detrimental,
- meaningful epidemiology data that determine the degree of danger, and finally,
- application of upper-bound mitigation costs for EMF that are comparable to the mitigation costs for other dangers in society.

*Epidemiology.* The scientific panels that have reviewed the EMF epidemiology data have found them inconsistent and inconclusive (8). It is necessary when comparing the data to separate the results by cancer type. For example, consider the recent case of three studies of electrical workers and a recent study on non-electrical workers in Sweden (8). The 1993 California study reported no association of EMF with either leukemia or brain cancer. The 1993 Canadian-French study reported an association with leukemia, and astrocytoma, out of the 32 cancer types studied, but this study suffers from problems of internal inconsistencies. The 1995 Savitz/Loomis study reported no association of EMF with leukemia, but they reported an association with brain cancer. The 1993 Swedish study reported an association with leukemia, but not with brain cancer. Thus, these four "best studies" report very contradictory results. It is very difficult to determine statistically relative risk factors of less than two for rare modes of death because of the many confounding factors such as economic status and chemical pollutants.

*Biology and Biophysics Experiments.* The scientific review panels, the review articles, and the research papers that we have reviewed (8) do not claim a causal link between EMF and cancer. In addition, the review panels and review articles have pointed out that there is a continuing problem with replicating the experimental results on cells and animals.

*Theoretical Mechanisms.* No plausible biophysical mechanism for the systematic initiation or promotion of cancer by these extremely weak EMF's has been identified (8). The lack of epidemiological evidence and experimental evidence establishing a link between EMF and cancer is consistent with the biophysical calculations that rule out the carcinogenic effects because the thermal noise fields are larger than the fields from EMF. Since quantum mechanics, thermal noise fluctuations, and cancer promotion are all statistical effects, it is difficult to derive a proof that is a necessary and sufficient condition to preclude all cancer promotion. However, these fundamental calculations are a significant guide to conclude that the EMF-cancer link, if any, should be extremely difficult to detect because its magnitude is, at most, very small.

*Journalism.* The number of newspaper stories on EMF rose from 233 in 1992 to 548 in 1993. The number of magazine stories rose from 101 in 1992 to 216 in 1993. The writings of Paul Brodeur, such as *Currents Of Death*, have been followed with headlines such as "is my electric blanket killing me: chilling possibility that a power that has improved life could also destroy it; warning: Electricity can be hazardous to your health." Even when an article is even-handed, its caption at the top read: "Steps to Protect Yourself from Danger -- Real and Potential." It is my conclusion that science and the relative risk methodology are often undercut by the quality of journalism in a free and fear-prone society.

The statement issued by the Council of the American Physical Society (reprinted below in the Comment section) addresses these concerns in more general terms.

1. A. Sakharov, *Memoirs* (Knopf, New York, 1990), 409.
2. H. Florig, *Science* Vol. 257, 468-9, 488, 490, 492 (1992).
3. D. A. Bromley, *The President's Scientists* (Yale Univ. Press, 1994).
4. G. Morgan, *Physics and Society* October 1990, 10; *Public Utility Fortnightly* 15 March 1992.
5. N. Wertheimer and E. Leeper, *Am. J. Epidemiology* Vol. 109, 273 (1979).
6. E. Washburn et al, *Cancer Causes and Control* Vol. 5, 299-309 (1994).
7. General Accounting Office, *Electromagnetic Fields* (GAO/RCED-94-115, Washington DC, June 1994).
8. D. Hafemeister, "Background Paper on Power Line Fields and Public Health," (<http://www.calpoly.edu/~dhafemei>), 8 May 1995.

---

The author is with the Physics Department at California Polytechnic State University, San Luis Obispo, CA 93407.  
arnd@physics.wm.edu