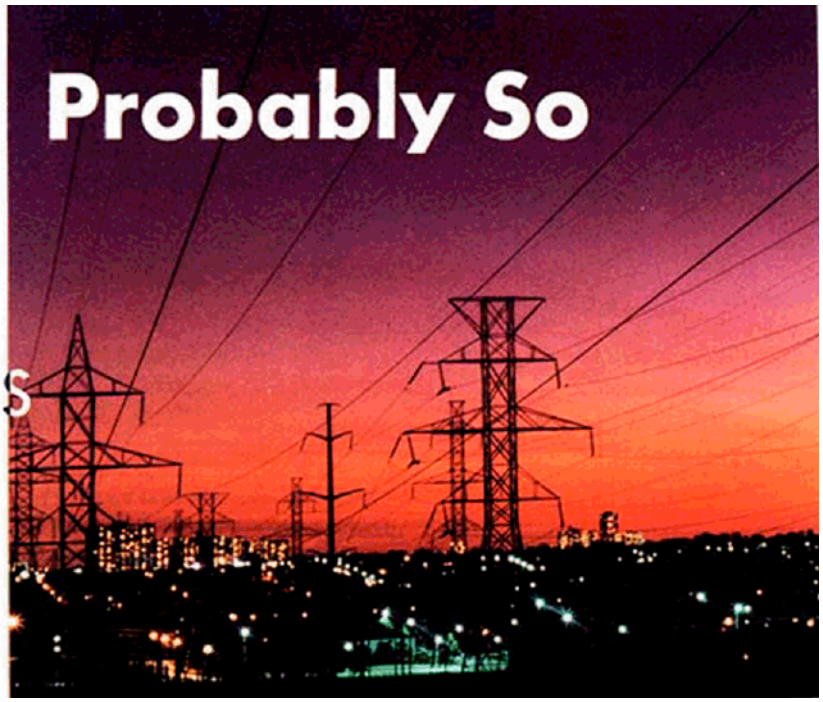
Are Power Lines Hazardous to Health?



by ANDREW A. MARINO

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Editor's note: Last fall Ontario Hydro hosted a symposium, sponsored by major utility organizations in the United States and Canada, on the health effects of electric and magnetic fields. The symposium was divided into time segments: state of scientific knowledge; current U.S., Canadian and foreign regulatory perspectives and legal case studies; and utility communication programs.

Three of the following articles were written by symposium participants. The first two present different views on the effects of electromagnetic fields on health. The other article deals with utility responsibilities and communication on this subject.

The collected symposium papers are available as a syllabus from Ontario Hydro, Suite H8D4. 700 University Ave., Toronto, Ontario, M5G 1X6, for $45 (U.S.) or $55 (Canadian).

THE BEST DATA for evaluating power line-related health risks would come from laboratory studies of human beings, but there are serious ethical and legal problems with such studies. The invasive nature of measurement techniques routinely employed for animals renders most human studies unthinkable.

Furthermore, study of the biological effects of chronic exposure of human subjects to simulated power line fields is risky, and consequently it is unlikely to be approved by institutional review boards. We must rely primarily on animal studies to provide relevant information regarding the cause and nature of any health risk.

The choice of an animal experiment involves issues of experimental design and interpretation of data. Not every experiment that involves power-frequency fields is useful for evaluating potential health risks of power lines. If, as an example, one studied large, old rats caged in cramped conditions, the possibility of observing a neuroendocrine response would be minimized because of both the confounding presence of the cage stress and the use of an animal population having a reduced ability to respond to any environmental factor. Such a study would therefore be useless for evaluating a health risk whose basis was a neuroendocrine response.

It is normally not practical to do an animal study to determine whether electromagnetic fields (or any agent) cause chronic disease such as cancer or heart disease. Animal studies can reveal the existence of physiological effects. (A neuroendocrine response, altered brain waves and depressed serum enzyme levels are examples.) The relationship of animal data to human disease is usually a matter of judgment, not demonstrable fact. Thus the philosophy and credibility of the individual making the judgment are important factors in the evaluation.

Animal Changes Noted

Electromagnetic fields have affected tissue in the brains of rabbits and altered brain-wave activity of rats, the behavior of trained rats, and the innate orienta-

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tional ability of birds. Rabbits, rats and mice exhibited functional alterations in their immune systems following exposure to electromagnetic fields.

Rats continuously exposed to fields for 30 days exhibited lower average serum levels of a hormone known to mediate the body's acute response to stress. In another study, a similar effect persisted in rats for four months. Exposure to fields delayed fracture healing in rats, altered growth rate in rats and monkeys, produced skeletal abnormalities in chick eggs and promoted cancer in rats.

In human subjects, changes in electromagnetic environment have altered serum triglyceride levels and reaction time, and decreased performance on standardized tests.

In some animal studies no effects were found, but I know of none regarding which it can be plausibly asserted that the null findings amount to evidence that no effects exist. Industry-designed studies have simply not provided relevant scientific data.

Animal Studies Interpreted

The literature of electromagnetic-field-induced changes in laboratory animals can be summarized this way:

In some studies no effects were found, but I know of none regarding which it can be plausibly asserted that the null findings amount to evidence that no effects exist.

• Exposure to fields can alter the metabolism of all body systems, including the nervous, endocrine, cardiovascular, hematological, immune and reproductive system.

• An organism's response to a field is determined by a combination of factors including its physiological history, genetic predisposition, and the totality of prevailing environmental conditions.

• Field-induced biological effects in animals are adaptive or compensatory because the fields present the organism with an environmental factor to which it must accommodate.

The animal studies have established that the electromagnetic field can be a biological stressor capable of eliciting an adaptive response.

Stress and Disease Related

Mindful that study of electromagnetic fields on humans is more limited than animal studies, what can we say about clinical signs that will occur in exposed human beings, and why?

The idea here is simple, and it accommodates all the animal and human data produced so far. If an individual is subjected to either psychological or physical stress—bereavement, trauma and poor diet are examples—he is more prone to disease than would otherwise be the case.

Virtually any disease may be developed, depending on other factors in the individual's genetic history or environment. Put another way, the ability to adapt to stressors is finite. Addition of any stressor tends to diminish the subject's ability to cope—a condition manifested clinically as a disease. Power line fields are stressors. Thus they tax adaptive capacity; this characteristic links them with human disease.

Since 1979, some 25 studies have appeared in the literature linking exposure to electromagnetic fields to cancer. The frequency of cancer increased when the electromagnetic field was added to the environment, and therefore the electric field was a risk factor for the disease.

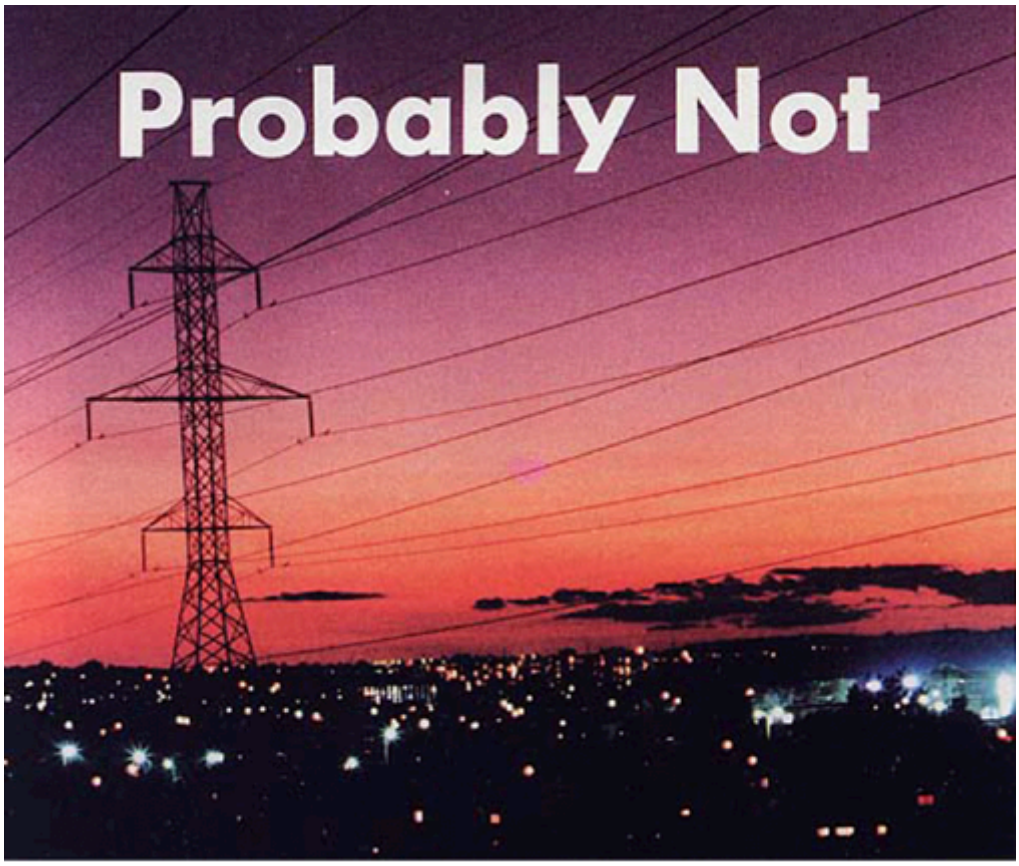
Epidemiological correlation between fields in the environment and cancer emerged because our society maintains adequate statistical records regarding cancer incidence. The studies do not mean that cancer, as opposed to other diseases, is a more likely manifestation in the chronically exposed population. Electromagnetic fields have been linked with suicide, polycythemia, nervous-system disorders, sexual dysfunction and fetal development. The field is a potentiating factor for all diseases because it is one of a milieu of neurogenic and somatic stressors.

Electromagnetism Pervasive

In summary, environmental electromagnetic energy from high-voltage power lines and other sources is pervasively present in the environment. Numerous laboratory studies with animals, and some human beings, have shown that such energy is a biological stressor in the sense that it can elicit an adaptive response from the exposed individual.

As with any stressor, chronic application is inimical to well-being because it taxes adaptive capacity. Chronic stress due to field exposure is a risk factor for disease, as has been shown in appropriately controlled epidemiological studies.

The environment used to conduct electrical energy along a power line is simply not suitable for human habitation. It is an energy highway, and it ought to be dedicated to that purpose.∗



By H.B. GRAVES

A consultant and former professor of biology at Pennsylvania State University, Graves was chairman of the American Institute of Biological Science's Committee on Biological and Human Health Effects of Extremely Low-Frequency Electromagnetic Fields.

He is presently employed full-time by a Washington-based law firm that specializes in representing power companies.

IN 1983, FLORIDA gave its Department of Environmental Regulation (DER) responsibility over public health issues regarding electric and magnetic fields from transmission lines of 230 kV or greater. Lack of DER staff expertise and finances to address the issue, and utility concerns that there be an informed basis for rulemaking decisions in this area, led to an arrangement whereby the Florida Electric Power Coordinating Committee funded a Science Advisory Commission to review the transmission line health issues. The State Department of Environmental Regulation and U.S. Department of Energy (DOE) monitored the commission's efforts to assure the final report's quality and independence.

The members of the Florida commission, of which I was chairman, were chosen in consultation with and approval of senior DER and power coordinating committee staff, and after consultation with DOE representatives. Selection criteria included impartiality plus expertise and experience in animal and human biology, including epidemiology, psychology, statistics, medicine, physics, electrical engineering and risk analysis.

The commission's primary tasks were to review and interpret the science and engineering issues, outline the options available to the state, and outline the decision processes that the state should go through to choose an appropriate course of action regarding 60-Hz electric and magnetic field exposure guidelines. Commission members emphasized that there were limits to the kinds of advice and recommendations it could appropriately make. Some of the judgments did not revolve around scientific and technical questions, but around values and political judgments outside their expertise and authority.

The commission identified the following alternative decisions that the state of Florida could reach concerning public health problems:

• A public health problem definitely does exist;

• It is likely that a public health problem exists;

• It is not likely that a public health problem exists, but some ambiguities in the currently available science warrant monitoring the problem from time to time; or

• A public health problem definitely does not exist.

The commission recommended the third alternative. After careful review and discussion of available scientific evidence, the commission unanimously agreed on the following:

1. It is unlikely that human exposure to 60-Hz electric and magnetic fields can lead to public health problems.

2. There is not presently sufficient evidence to allow a scientifically based choice of a measure of exposure to electric and magnetic fields that could be used as the basis for a program of exposure control. Hence, a scientifically based program of 60-Hz field exposure reduction is not now possible, and any program of 60-Hz exposure reduction undertaken would have to be based upon other considerations.

3. A value-based strategy which would keep transmission line exposures

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comparable to those from other common sources is a value decision, not a scientific decision, and as such lay outside the domain of the Commission's expertise and authority.

4. Because of ambiguities in the available science and the large volume of research in progress, the state should monitor new developments in this area. However, if Florida made an initial decision that public health problems are unlikely, reopening the area for further consideration would not be justified unless a significant new body of experimental evidence became available.

5. Although there are no documented cases of serious injury or death arising from 60-Hz electric field interference with the operation of a cardiac pace-maker, improbable circumstances could arise in which such exposure could lead to serious injury or death. Thus concerned parties in Florida should urge the Food and Drug Administration (FDA) to revise pacemaker testing and performance criteria so as to include circumstances representative of transmission line induced currents and appliance leakage currents.

(In response, the FDA said, "We do not believe we should institute, at the present, any overall changes in performance requirements or labeling policy for pacemakers coming to the market...the pacemaker's performance characteristics are considered by physicians in selecting the appropriate pace-maker for a given patient.")

A technician measures electrical field strength beneath a transmission line near Toronto, Ontario. Photo by Ontario Hydro

There is not, in fact, persuasive scientific evidence that such adverse effects exist.

6. With the exception of honey bees, exposure of agricultural crops and animals and natural ecosystems to 60-Hz electric and magnetic fields gives rise to no biologically significant consequences. Beehives in electric fields of more than a few kV/m have an electric potential drop along materials inside the hive, so bees can get a shock as they move about. The problem is easily managed by screening and informing beekeepers of potential problems and the solutions.

7. To protect public safety and to help avoid potential nuisance problems, Florida utilities should adhere to the National Electrical Safety Code or to an equivalent state code.

8. Since the controversy surrounding possible long-term health effects of electric and magnetic fields is only one aspect of transmission line siting which contributes to public confusion and regulatory uncertainty, the DER should consider development of a variety of "good neighbor" policies. They include transmission line electrical effects guidelines which describe acceptable calculation methods and standardized transmission line conditions, including acceptable edge of right-of-way corona-generated audible noise levels; electromagnetic radio and television interference levels; radio and television interference mitigation procedures; standard conditions for calculating and reporting electric and magnetic fields; grounding policy to keep shocks below a specified level for fences and other conducting objects; and field criteria to limit nuisance shocks in special use areas such as parking lots.

The commission noted that most of the options listed went beyond questions of safety and public health and that a "no guideline" option was acceptable in many cases. The guidelines would simply minimize the obtrusiveness of the presence of transmission lines, minimize unusual or objectionable effects, minimize nuisances, and help delineate real issues.

The commission report explained why risk-management strategies such as limiting electric field strength at the edge of the right-of-way cannot be based on scientific evidence of adverse health effects because there is not, in fact, persuasive scientific evidence that such adverse effects exist. ∗