ELECTRIC AND MAGNETIC FIELDS: INVISIBLE RISKS? by Leonard A. Sagan, M.D. (Electric Power Research Institute, 1996).

POSSIBLE HEALTH EFFECTS OF EXPOSURE TO RESIDENTIAL ELECTRIC AND MAGNETIC FIELDS by National Research Council (National Academy Press, 1996).

Reviewed by
*David Zachary Kaufman**

I. INTRODUCTION

Fears of electric power lines and related fears of Electric and Magnetic Fields (EMF) are long-standing, as is the propensity to sue over those fears. Cases addressing electric power line concerns date before World War I.[1] In addition, EMF and its potential for both good and bad has been a staple of science fiction for over 60 years. In the science-fiction novellette *Waldo, Inc.* (still in print), R.A. Heinlein postulated that "beamed power" caused people to become weaker and that the utility industry conspired to prevent people from finding out. More recently, scientists and laypersons have become increasingly concerned about residential EMF exposures from sources such as cellular phones, water beds, electric shavers, electric blankets, and appliances. Some epidemiological studies of EMF's health effects indicate a possible link between EMFs and some forms of cancer, especially childhood leukemia.[2] The scientific evidence has not been confirmed and is hotly debated in the scientific community, which is unable to either explain the results or conclusively confirm or refute them. At the same time the public has become increasingly apprehensive of EMF exposure, partly due to a series of books and articles by Paul Brodeur and other journalists which argue that utilities cover up scientific findings that EMFs, cancer, and other maladies (including reproductive maladies) are linked. Although a number of lawsuits against utilities have been filed alleging EMFs caused the plaintiffs' illnesses; none appear to have been successful.[3]

As a result of the public's concern, the electric utility industry, the U.S. Department of Energy, and the U.S. Congress have attempted to educate the public about EMFs with respect to what is known, what is knowable,

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* Mr. Kaufman is a sole practitioner in Washington D.C. and Virginia specializing in environmental law. Mr. Kaufman is also an Adjunct Professor of Environmental Law at George Mason University School of Law in Virginia. In addition to his J.D., Mr. Kaufman holds a Ph.D. in Economics.

1. *See, e.g.,* Alabama Power Co. v. Keystone Lime Co., 67 So. 833 (Ala. 1914); Wadsworth Land Co. v. Charlotte Elec. Co., 88 S.E. 439 (N.C. 1915).

2. *See, e.g.,* Nancy Wertheimer & Ed Leeper, *Electrical Wiring Configurations and Childhood Cancer*, 109 AM. J. EPIDEMIOLOGY 273 (1979); Rene Verreault et al., *Use of Electric Blankets and Risk of Testicular Cancer*, 131 AM. J. EPIDEMIOLOGY 759 (1990); David Savitz & Dana Loomis, *Magnetic Field Exposure in Relation to Leukemia and Brain Cancer Mortality Among Electric Utility Workers*, 141 AM. J. EPIDEMIOLOGY 123 (1995).

3. *See, e.g.,* San Diego Gas and Elec. Co. v. Super. Ct. of Orange County, 920 P.2d 669 (Cal. 1996).

what is unknown, and what additional work needs to be done (where known). The two books reviewed here are the result of these continuing efforts. Both are very good, well worth reading, and share the same conclusion:

> [T]he conclusion of the committee is that the current body of evidence does not show that exposure to these [EMF] fields presents a human-health hazard. Specifically, no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects, or reproductive and developmental effects.[4]

However, a weak statistical association between "wire codes" and childhood leukemia has been identified, the causation of which remains unidentified.[5]

Dr. Sagan's book was released with very little fanfare, which is unfortunate because it is an excellent book. In contrast, the NRC Report was released to the public with tremendous—and slightly misleading—fanfare. The opening line in the NRC's press release is "No clear, convincing evidence exists to show that residential exposures to electric and magnetic fields (EMFs) are a threat to human health, ..." Lawyers who read this will immediately note the burden of proof issue inferred, an issue the NRC Report itself does not address. Worse, the sentence is not precisely accurate. A more accurate description of the NRC's conclusions are stated in the Report: "EMFs do not appear to cause cancer, neurological, reproductive, or other adverse health effects, but there is statistical correlation between power lines and childhood leukemia." An even more accurate description of its findings is in the NRC's Report Executive Summary: "no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects, or reproductive and developmental effects."[6]

I recommend the reader, if pressed to choose only one of these two books, choose Dr. Sagan's book. Furthermore, for the reader who wishes to delve more deeply, Dr. Sagan's book should be read first. Dr. Sagan's book is an invaluable aid to understanding the NRC's discussion and conclusions. Because I recommend this sequence, the books will be reviewed in that order.

II. ELECTRIC AND MAGNETIC FIELDS: INVISIBLE RISKS?

Dr. Sagan's book, *Electric and Magnetic Fields: Invisible Risks?*, was published by the Electric Power Research Institute (EPRI), an organization funded by the electric industry and an advocate for its positions. Dr. Sagan is a retired EPRI employee. His book is intended for non-scientists, especially policy makers, business persons, attorneys, and secondarily interested laypersons. Dr. Sagan's book explains and clarifies scientific and risk-related concepts. Although EPRI's sponsorship of the study risks a

4. NATIONAL RESEARCH COUNCIL, POSSIBLE HEALTH EFFECTS OF EXPOSURE TO RESIDENTIAL ELECTRIC AND MAGNETIC FIELDS, Executive Summary at 1 (1996) [hereinafter NRC Report].

5. *Id.* at 2.

6. *Id.* at 1.

perception of lack of objectivity, Dr. Sagan and EPRI appear to be very conscious that their work will be carefully scrutinized for that reason. As a result, the book reflects a serious and successful effort to demonstrate the integrity and accuracy of its findings.

While all of the chapters are helpful, some are better than others. The best and most informative chapters were 3, 6, and 8. In chapter 3, "EMF Exposure Assessment," the book sets out scientific fundamentals of electric and magnetic field exposure (the two are different) in easy-to-understand language. The chapter then discusses problems in assessing exposure after discovering a health impact and explains why scientists frequently use surrogates—which may or may not work well—for EMF exposure: it is difficult, if not impossible, to accurately measure historical exposure to EMF. A thorough understanding of this chapter is especially useful in understanding the NRC's critical assessment of some of the studies evaluated.

As good as chapter 3 is, chapter 6, "Risk Assessment," is better. It provides a clear description of "risk assessment," its limitations, and the factors that go into conducting a risk assessment. Without this information the reader is unable to compare risks, *e.g.*, between EMF and driving a car or smoking a cigarette. Even more important, the information in chapter 6 is critical to a proper understanding of the NRC Report (discussed below).

Equally informative—and equally important to a proper understanding of the NRC Report—is chapter 8, "Epidemiology." This chapter gives the reader a wonderful guide to the different ways of measuring and evaluating risk. Chapter 8 also explains clearly potential problems with epidemiology and the factors that confound the studies. Finally, chapter 8 shows why epidemiology cannot "clear" a potential risk factor—a fact of considerable importance to both plaintiff and defense counsel.

In sum, I recommend this book unreservedly to any person interested in understanding the foundation science behind the EMF controversy and its limits.

III. Possible Health Effects of Exposure to Residential Electric and Magnetic Fields

Congress directed the Department of Energy (DOE) to investigate whether routine exposure to EMF found in residences can cause cancer and other health effects, and required DOE to fund a research project by the National Research Council on the subject.[7] Three years later that project produced *Possible Health Effects of Exposure to Residential Electric and Magnetic Fields*. The intended audience is the sophisticated layperson, congressional staff and other scientists. The scientists who made up the Committee preparing this report were very experienced, and some had previously worked on EMF issues. This was a deliberate decision by the National Research Council, because it was concerned—that if all the Com-

7. Energy and Water Development Appropriations Act of 1992, Pub. L. No. 102-104, 105 Stat. 510 (1992).

mittee's members had significant experience with EMF issues, they would be perceived as being unduly influenced by the electric utility industry or the DOE. It is not clear to me that the NRC will succeed in its attempt to avoid allegations of a failure of objectivity, but they have tried very hard to achieve that goal.

No new research was funded by Congress; this report was intended to summarize all the data available to date and, if possible, end the debate over EMFs' safety. It will fail because

> Scientist [sic] often can be precise in pinpointing the cause and the remedy for a well-defined disease . . . . The situation for power-frequency electric and magnetic fields and their effects on biologic systems is quite different. There is no widely accepted understanding of how extremely low-frequency electric and magnetic fields, such as those associated with the distribution and use of electric power, could cause a disease or whether it causes a disease. Considerable research has been conducted in this area, . . . but given the lack of a specific disease end point to track or a well-accepted theory of how the fields might affect biologic systems, the data are discordant; they have been gathered using different exposure conditions and have resulted in conflicting observations of different effects or no effects.[8]

The problems described in this paragraph explain much of the controversy surrounding the EMF issue. We expect science to answer our questions and concerns and, when it can't, public complaints and conspiracy theories rage. Today scientists don't have a theory that can explain how EMFs could affect us. Therefore, it is hard for scientists to conduct research that can validate or refute the theory that EMFs can have an adverse affect upon human health and well-being. The data is discordant—it is different, inconsistent, and does not agree with itself. All of us who work in and around this subject area hoped that the NRC Report would settle some of these issues, but it didn't. It does, however, put a scientific imprimatur on the confusion and explains why the facts are subject to multiple interpretations.

The NRC Report does some things very well. Although much of the report shows unfortunate signs of having been "written by committee," it is fair, balanced, and well-presented. Nowhere is this better done than where it counts most—the Executive Summary and the Summary and Conclusion section of each chapter. All interested persons should read them—even if (as unfortunately occurs some times) the rest of the chapter is too technical or too confusing for easy comprehension. On the other hand, the chapter on epidemiology is excellent; it is well balanced and carefully sets out the issues and difficulties involved while explaining the scientifically supportable conclusions and limits on those conclusions. This chapter ties in nicely with Dr. Sagan's chapter on the same subject. Together these two chapters help the lay reader understand why, in the absence of a coherent theory, epidemiology is key to determining how EMFs affect us—if they do.

For example, the Report compares the different epidemiological studies and evaluates them before concluding that "the number of well-

8. NRC Report, *supra* note 4, at vii.

designed studies supportive of [a positive] association is not sufficient to conclude that any of the associations are actually present."[9] The Report attributes this conclusion to the fact that

> [t]he application of epidemiologic data to determination of causality is particularly problematic. A mistaken inference that a given exposure causes a specific disease can result from a number of potential errors or misinterpretations. Conversely, even when a true causal relationship is present, it will not always be discerned easily. Ultimately, causal inference is enhanced when a number of noncausal explanations have been carefully postulated, tested, and refuted.[10]

Thus, a fair-minded reader would conclude that the present evidence, and even theory, is insufficient now to underlie corporate liability for allegations of ill effects attributable to EMF. However, the reader might conclude that new evidence and/or future advances in our theoretical understanding of EMF's effect on biological mechanisms might reopen the issue.

I recommend the NRC Report to the dedicated reader—it is full of useful information and contains the scientific basis for many legal arguments counsel for both plaintiff and defense will want to master. It is more difficult to read and absorb than Dr. Sagan's book, but is well worth the effort if one is trying to master the science of EMF.

IV. CONCLUSION

These books are extremely useful to the lawyer interested in the subject—whether on behalf of plaintiff or defendant. They are full of useful information and will hopefully do much to inform the world about these issues. Unfortunately, they will not set the issues to rest; only time and more scientific research can do that.[11]

9. NRC Report, *supra* note 4, at 115.

10. NRC Report, *supra* note 4, at 114.

11. Also noted: In April 1997 Public Utilities Reports (Arlington, Va.) will publish ELECTRIC UTILITY RESTRUCTURING: A GUIDE TO THE COMPETITIVE ERA, by Peter Fox-Penner. The publisher, which has a solid track record in energy-related publications, touts that it will be a both non-technical and comprehensive guide to the technology of electric supply now and in the future, the workings of the deregulated market, and the pricing and regulation for new programs. It will be available for $59.00 (soft-cover, 500 pages) at 1-800-368-5001.