

June 1998

The Future of Electromagnetic Field Litigation

Michael C. Anibogu

Follow this and additional works at: <https://digitalcommons.pace.edu/pelr>

Recommended Citation

Michael C. Anibogu, *The Future of Electromagnetic Field Litigation*, 15 Pace Envtl. L. Rev. 527 (1998)

DOI: <https://doi.org/10.58948/0738-6206.1351>

Available at: <https://digitalcommons.pace.edu/pelr/vol15/iss2/8>

This Article is brought to you for free and open access by the School of Law at DigitalCommons@Pace. It has been accepted for inclusion in Pace Environmental Law Review by an authorized administrator of DigitalCommons@Pace. For more information, please contact dheller2@law.pace.edu.

ARTICLES

The Future of Electromagnetic Field Litigation

MICHAEL C. ANIBOGU*

I. Introduction

In October 1996, the Committee on the Possible Effects of Electromagnetic Fields on Biologic Systems (Committee) of the Natural Research Council (NRC) released its report (NRC Report) entitled the *Possible Health Effects of Exposure to Residential Electric and Magnetic Fields*.¹ The NRC Report concluded that “. . . the current body of evidence does not show that exposure to these fields presents a human health hazard.”² The Committee specifically reported that “. . . no conclusive and consistent evidence shows that exposure to electric and magnetic fields produces cancer, adverse

* The author is admitted in New York and Nigeria, and practices law in New York City. He is a graduate of the University of Nigeria and has earned a L.L.M. in Environmental Law from Pace University School of Law.

This article is dedicated to the memories of his father and other deceased members of his family. The author would like to take the opportunity to thank his wife Chinwe and son Kene, for their love, support and understanding; Professor M. Stuart Madden, for inspiring and supervising this work; Margaret Murray, Barbara Traub and Mary Ellen Messina, for helping with the research, Margaret and Luke Corcione, for managing the manuscript; and John Dolgetta, Managing Editor of Environmental Health Law Articles, and other associate members of the Pace Environmental Law Review for their excellent and impressive editorial work on the Article.

1. NATIONAL RESEARCH COUNCIL, COMMITTEE ON THE POSSIBLE EFFECTS OF ELECTROMAGNETIC FIELDS ON BIOLOGIC SYSTEMS, REPORT ON POSSIBLE HEALTH EFFECTS OF EXPOSURE TO RESIDENTIAL ELECTRIC AND MAGNETIC FIELDS (National Academy Press, 1997) [hereinafter, NRC REPORT].

2. *Id.* at 1. See *infra* Section IV and accompanying text (giving a full description of the structure of the National Research Council and its findings).

neurobehavioral effects, and reproductive and developmental effects.”³ Therefore, according to the Committee’s findings, the current evidence does not support the theory that EMFs cause adverse health effects.

On July 3, 1997, a team of researchers from the National Cancer Institute (NCI) and the Children’s Cancer Group (CCG),⁴ published its own report (NCI/CCG Report) which was the result of an eight year, fifty million dollar, power line research project. The NCI/CCG Report, entitled *Residential Exposure To Magnetic Fields And Acute Lymphoblastic Leukemia In Children*, was published in the *New England Journal of Medicine*.⁵ The NCI/CCG Report concluded that there is “. . . little support for the hypothesis that living in houses with high weighted average magnetic field level or in homes close to electrical transmission or distribution lines is related to Childhood ALL [Acute Lymphoblastic Leukemia].”⁶ The release of the NRC Report and the NCI/CCG Report were followed by a series of newspaper articles that discussed the issues concerning the future of electromagnetic field (EMF) litigation.⁷ Most of the articles predicted that the NRC’s findings would mean the end of EMF litigation.

However, because of the dynamics and the complexity of the electromagnetic field controversy and the unknown ef-

3. *Id.*

4. The Children’s Cancer Group is a nationwide collection of childhood leukemia experts and specialists from approximately a dozen of the nation’s leading medical institutions, that collectively treat about half of all of U.S. children with cancer. See Curt Suplee, *No Greater Cancer Risk Is Found In Children Living Near Power Lines; Federal Study Tries To Shed Light On High-Voltage Debate*, WASHINGTON POST, at A3 (July 3, 1997).

5. See Martha S. Linet, et. al., *Residential Exposure To Magnetic Fields And Acute Lymphoblastic Leukemia In Children*, 337 N. ENG. J. MED. 1 (1997) [hereinafter NCI/CCG Report].

6. *Id.* at 7. See *infra* Part IV.7 (for a more detailed discussion of the NCI/CCG Report).

7. See Warren E. Leary, *Panel Sees No Proof of Health Hazards from Power Lines*, N.Y. TIMES at A1 (Nov. 1, 1996); *Study Fails to Link Electric Fields with Human Disease*, REPORTER DISPATCH at B1 (Nov. 1, 1996); Max Boot, *The Mass Tort That Wasn’t*, WALL STREET J. at A19 (Nov. 6, 1996); Robert Park, *Power Line Paranoia*, N.Y. TIMES at A23 (Nov. 13, 1996); Gina Kolata, *Big Study Sees No Evidence Power Lines Cause Leukemia*, N.Y. TIMES, at A1 (July 3, 1997); Suplee, *supra* note 4, at A3.

fects of electromagnetic fields, it does not seem that any blanket prohibition can deter EMF lawsuits. Rather, this Article contends that two factors, (1) the NRC Report and (2) the 1993 United States Supreme Court decision in *Daubert v. Merrell Dow Pharmaceuticals Inc.*,⁸ will make it increasingly more difficult for plaintiffs to succeed in future EMF litigation in many jurisdictions. However, it does not mean that plaintiffs are barred from bringing such actions.

Part II of this Article discusses the science of electromagnetic fields and radiation. Part III examines the electromagnetic field debate and controversy. Part IV reviews key EMF studies and research. Part V discusses the congressional charge to the National Research Council to study the effects of EMF. Part VI explores the nature of EMF claims as toxic torts and analyzes the holding in *Daubert*. Part VII reviews case law on EMF litigation. Part VIII analyzes how the NRC Report and the holding in *Daubert* will impact future EMF litigation. Part IX attempts to forecast the future of EMF litigation.

II. The Science of Electromagnetic Fields & Radiations

A. Sources of Electric and Magnetic Fields

A basic knowledge of the science of electromagnetic fields and radiation is important because it will clarify the controversy surrounding EMFs and create an understanding of the electromagnetic environment. An understanding of EMFs is essential because the use of electricity is now so pervasive and extensive, and "the sources of exposure to electric and magnetic fields are everywhere."⁹ There are both natural and manmade sources of EMFs.

There are many natural sources that emit electric and magnetic radiation, and the fields produced by these sources

8. 509 U.S. 579 (1993).

9. NRC REPORT, *supra* note 1, at 17.

"appear throughout nature and in many living things."¹⁰ Natural electromagnetic sources include: the Earth, which produces strong magnetic fields arising from its rotation; atmospheric forces, which produce the electric fields that surround the Earth during thunderstorms; and certain ferrous minerals which are located in the Earth's core and have magnetic properties that give rise to magnetic fields.¹¹

Human and other animal body cells "maintain large natural electric fields across their outer membranes."¹² Some of these cells, "especially those in the nervous system, make use of complex electrochemical processes in their normal function."¹³ This explains why some animals, such as sharks, eels, and pigeons are able to "detect extremely weak low frequency (ELF) fields and use them for homing and finding prey."¹⁴

There are also anthropogenic sources that produce and emit EMFs. These are the sources which are at the center of the existing EMF controversy. Some of the manmade sources include:

power plants (generating stations), which produce electricity; high voltage transmission lines, which carry the electricity to major population centers; substations and their transformers, which reduce voltage to levels suitable for distribution within a population center; distribution lines (distribution primaries), which commonly carry power along residential streets; distribution transformers, which reduce the voltage to amounts suitable for use in homes; and distribution secondaries (service drops), which carry electricity to individual residences.¹⁵

Since electromagnetic fields are often associated with "power lines," it is necessary to point out that these transmission

10. See OFFICE OF TECHNOLOGY ASSESSMENT, U.S. CONGRESS, BIOLOGICAL EFFECTS OF POWER FREQUENCY ELECTRIC AND MAGNETIC FIELDS 1, 4 (1989) [hereinafter O.T.A. REPORT].

11. See O.T.A. REPORT, at 4.

12. *Id.* at 1.

13. *Id.* at 2.

14. *Id.*

15. NRC REPORT, *supra* note 1, at 12.

lines, distribution lines, and services drops are technically and collectively known as "power lines."¹⁶ Other sources of manmade electromagnetic fields arise from the electric power used to operate machinery, appliances, lighting and numerous other electrical devices that are used in homes and workplaces.¹⁷

The naturally occurring electromagnetic fields¹⁸ are at least 100 times more intense than the those produced by the common manmade fields.¹⁹ In spite of this difference in magnitude, the scientific explanation for all electromagnetic fields, whether manmade or natural, is the same. However, fields from manmade sources are sinusoidal, that is, they alternately change from positive to negative voltage in smooth variation, with a frequency of 60 cycles per second.²⁰

B. The Nature of Electric and Magnetic Fields

The electromagnetic environment is made up of two components: (1) an electric field and (2) a magnetic field.²¹ These two components are characterized by their wavelengths, expressed in meters, and their frequencies, expressed in hertz (Hz).²² The electric and magnetic components of the electromagnetic environment are interrelated but distinct.

The term "fields," when used in describing electrical phenomena, refers to a property of space around an electrical charge. Electric fields can be described as the space or region surrounding an electrical charge that is at rest or stationary. The electric field of a charged object is "a description of the

16. *Id.*

17. *Id.*

Thus, our modern life is pervaded by these manmade electromagnetic fields and radiations. People use electricity to cook food, do laundry and operate microwaves. Electricity is now part and parcel of our daily lives and as such, we encounter manmade electromagnetic fields daily.

18. Naturally occurring electromagnetic fields are also at times referred to as static electric fields. A static electric field is produced by electric charges whose magnitude and position do not change in time. *See* NRC REPORT, *supra* note 1, at 23.

19. *See* O.T.A. REPORT, *supra* note 10, at 1.

20. NRC REPORT, *supra* note 1, at 11 n.1.

21. *See id.* at 3.

22. *See id.* at 11 (1 Hz = 1 cycle per second).

electric force that object is capable of exerting on other charges brought into its vicinity."²³

Magnetic fields are created when the electrical charges creating electrical fields are in motion as electric currents.²⁴ The currents are "measures of the rate at which electrical charges flow in a power line or wire."²⁵ When the charges are in motion, the space or region around them constitutes magnetic fields. As the charges move they exert a magnetic force of attraction or repulsion on other charged objects found within the region or the surrounding fields. This magnetic attraction or repulsion is the magnetic force.²⁶

The common feature of both the electric field and the magnetic field is that they are both characterized by their frequency and strength, which is described in terms of the hertz (Hz).²⁷ As described earlier, one cycle per second is called a hertz (Hz).²⁸ The frequency of ordinary household currents in the United States is 60 cycles per second, otherwise known as 60-Hz. In Europe and the rest of the world it is 50 cycles per second (50-Hz).²⁹

One essential distinction is that an electric field can be created by a stationary charge while magnetic fields can only be produced by a charge in motion.³⁰ Also, electric fields begin on positive charges and end on negative charges, but magnetic fields do not have beginnings or ends but form closed, continuous loops of force around the source of the field.³¹ Another distinct feature is that electric fields are generally measured in volts per meter, whereas magnetic fields are measured in microtesla (μT) or milliGauss (mG).³² The strength or intensity of an electric field is proportional to its

23. O.T.A. REPORT, *supra* note 10, at 7.

24. NRC REPORT, *supra* note 1, at 22.

25. O.T.A. REPORT, *supra* note 10, at 4.

26. *See id.*

27. *See id.*; *see also* NRC REPORT, *supra* note 1, at 13.

28. *See* NRC REPORT, *supra* note 1, at 11 n.1 (indicating that the "hertz" is the internationally accepted unit of frequency).

29. *Id.* at 12 n.4.

30. *See id.*

31. *See id.*

32. *See* at 12 n.4 (1 μT = 10 mG).

voltage, whereas the strength of a magnetic field is proportional to its current.³³ For example, an electric appliance connected to an electric outlet will produce an electric field even when it is turned off.³⁴ The appliance will produce a magnetic field only when it is turned on and operating. Finally, at extremely low-frequencies, electric fields are easily attenuated or affected by objects in the environment, whereas magnetic fields are not so easily attenuated.³⁵

Most common objects, such as, trees, walls, buildings and other large structures can attenuate electric fields, that is, provide shielding from these fields. Magnetic fields are attenuated or shielded only by structures containing large amounts of ferrous materials or other special metals, such as metallic alloys.³⁶ Since magnetic fields are not so easily attenuated, they are generally assumed to be the possible source of many health hazards.³⁷

C. Sources of Exposure to Electric and Magnetic Fields

Electric and magnetic fields exist "wherever there is electric power."³⁸ Due to the fact that electricity is now such an indispensable part of modern life, and its use is so extensive and pervasive, "every person in modern society is unavoidably exposed to them."³⁹

Electric and magnetic fields are "associated with large and small power lines, wiring and lighting in homes and places of work, and all electrical appliances."⁴⁰ The fields are created by the electric charges that are generated and pumped into the power system by electric power generating stations.⁴¹ The electric fields arise from the amount of charge produced; magnetic fields are created by the motion of the

33. See O.T.A. REPORT, *supra* note 10, at 7-8.

34. See NRC REPORT, *supra* note 1, at 14.

35. See *id.* at 3.

36. *Id.* at 4, 13. See also O.T.A. REPORT, *supra* note 10, at 16.

37. See NRC REPORT, *supra* note 1, at 4.

38. O.T.A. REPORT, *supra* note 10, at 1.

39. NRC REPORT, *supra* note 1, at 18-19.

40. O.T.A. REPORT, *supra* note 10, at 1; see also NRC Report, *supra* note 1, at 13-14.

41. See NRC REPORT, *supra* note 1, at 12.

charge.⁴² The effects of exposure to different sources of electric and magnetic fields can vary, depending upon their frequency and strength.⁴³ The effects of fields generated by high-voltage transmission lines, operating at 60 Hz, might be quite different from those generated by high-frequency (mega- or giga hertz) devices.⁴⁴

D. Understanding Electromagnetic Energy

Although electric and magnetic fields are quite different in character,⁴⁵ they are intimately related to each other.⁴⁶ When they are united and taken together, they are "often referred to as electromagnetic fields."⁴⁷ Therefore, the term electromagnetic denotes the intimate relationship or co-existence, in time and space, of the two components - electric fields and magnetic fields.⁴⁸ The interrelationship of the two fields depends upon the source and the frequency of the respective fields. Usually the bonding of the two fields is directly proportional to the frequency of the fields components. Thus, at the low frequencies, usually encountered in the normal use of electric power use, the coupling or bonding between the two fields is extremely weak or minimal. Under this minimal coupling condition, the components are referred to as electric and magnetic fields, and "can be considered independent to an excellent approximation."⁴⁹ However, at higher-frequency fields, the electric and magnetic fields are substantially linked and are referred to as electromagnetic fields or EMFs.⁵⁰ It is the mutual interaction of the two fields that produces electromagnetic fields. Thus, the EMFs formed from this process assume their independent existence in space quite different from the component fields from which

42. *See id.*

43. *See* NRC REPORT, *supra* note 1, at 11.

44. *See id.*

45. *See* O.T.A REPORT, *supra* note 10, at 15.

46. *See id.* at 16.

47. *Id.* at 1. *See also* NRC REPORT, *supra* note 1, at 13 (indicating that generally "time-varying fields are described together as electromagnetic fields").

48. *Id.*

49. *Id.*

50. *Id.* at 15.

they were formed. They are characterized by their own wavelengths (expressed in meters) and their own frequencies (expressed in hertz).⁵¹ The frequencies and wavelengths are related to the velocity of light.⁵²

Different forms of electromagnetic energy have frequencies and wavelengths that expand over an enormous range. The full range of frequencies or wavelengths of natural and manmade EMFs are "described as the electromagnetic spectrum"(the "spectrum").⁵³ The spectrum ranges from extremely low frequencies (ELFs),⁵⁴ to extremely high frequencies.⁵⁵ Thus, the spectrum is used to classify different intensities of EMFs according to their relative strength, measured by their wavelengths and frequencies, and are represented on the spectrum in "a hierarchy of increasing electromagnetic energy."⁵⁶

The spectrum ranges from 0 Hz to above 10^{15} Hz, that is from the extremely low frequencies to high frequency, to very high frequency, represented or arranged on the spectrum in "a hierarchy of increasing electromagnetic energy."⁵⁷ At the extreme low end of the spectrum, is the ELF designation, usually associated with electric and magnetic fields and with household currents of 50-60 Hz or power lines. Next on the spectrum is the high frequency band with progressively higher frequencies and energy consisting of radio waves,⁵⁸ infrared radiation,⁵⁹ visible light,⁶⁰ and ultraviolet radiation.⁶¹ At the extreme high end of the spectrum, are the high frequencies and short wavelengths of energy, usually associated with x-rays⁶² and gamma rays.⁶³ The intensity of electro-

51. See NRC REPORT, *supra* note 1, at 11.

52. See *id.* at 12.

53. *Id.*

54. ELFs may range from three to 3kHz. See *id.* at 12 n.3.

55. Extremely high frequencies may reach a level above 10^{17} Hz. See *id.* at 12.

56. *Id.*

57. NRC REPORT, *supra* note 1, at 12.

58. Consisting of 10^6 to 10^{10} Hz. See *id.*

59. Consisting of 10^{12} to 10^{14} Hz. See *id.*

60. Consisting of 10^{14} Hz. See *id.*

61. Consisting of 10^{15} Hz. See *id.*

62. Consisting of 10^{16} to 10^{20} Hz. See *id.*

magnetic energy is directly related to the energy of its frequency, which is proportional to the corresponding wavelengths and the greater energy.

There are obvious differences in the frequencies and wavelengths of the various energy levels on the spectrum. Some of the fields on the spectrum are ionizing while others are not. Only electromagnetic energy or radiation with frequencies greater than approximately 10^{15} Hz is ionizing energy or radiation, capable of ionizing atoms and molecules.⁶⁴ Electromagnetic fields on the spectrum below the frequency range of 10^{15} Hz are known as non-ionizing because they lack the capacity or sufficient energy to produce ionization.⁶⁵ They may be non-ionizing ELF's or non-ionizing high frequency radiation.⁶⁶

The very high frequency fields or radiation above the frequency range of 10^{15} Hz, such as x-rays and gamma rays, are ionizing fields or radiation. High frequency fields ionize because they are capable of dislodging electrons from atoms or molecules or producing charged particles from the atoms and molecules with which they interact.⁶⁷ Therefore, this ionizing radiation is known as a source of "damage to biologic systems through the reactions of the products of ionization with critical cellular components."⁶⁸

Most equipment used for the generation, transmission and distribution of electric power worldwide generates ELF electric and magnetic fields within the common frequency range of 50-60 Hz.⁶⁹ Higher frequency EMFs are capable of traveling long distances away from their source. Such fields are known as electromagnetic waves or radiation.⁷⁰ Since the

63. Consisting of 10^{18} to 10^{25} Hz. *See id.* at 12.

64. *See id.* at 12.

65. "Ionization" is ability of EMFs to dislodge electrons from atoms or molecules, or to break molecular or chemical bonds directly. *Id.*

66. *See id.*

67. *See id.*

68. NRC REPORT, *supra* note 1, at 12.

69. *See id.*

70. *See* O.T.A REPORT, *supra* note 10, at 6.

extremely low-frequency fields are of the non-ionizing type it is technically inappropriate to refer to them as radiation.⁷¹

The ELF's, which measure 50 - 60 Hz, are the most commonly occurring phenomena of EMF emission and are not actually referred to as radiation. They have traditionally been held incapable of causing harm or posing threat to human health.⁷² Suspected health hazards or concerns, resulting from exposure to such fields are the basis of the EMF controversy.

III. The EMF Controversy and Debate

It is already known that exposure to non-ionizing, high frequency EMFs, will usually cause severe burns and serious thermal damage to body tissues, and that exposures to non-ionizing, extremely-low-frequency, can lead to burns, electrocution and electrical shocks. The scientific debate or question with regard to EMFs is whether or not there are potential adverse health effects or risks associated with exposure to non-ionizing, low-strength, low-frequency electric and magnetic fields 50 Hz - 60 Hz, usually associated with the generation, transmission and use of electric power in a residential setting. Simply put, the basic issue is whether exposure to such fields in our homes and workplaces, leads to athermal hazards, causes cancer, cause reproductive abnormalities or neurobiologic diseases. Some experts and scientists in this field believe that these EMFs can cause such adverse health effects. However, there are many who have contrary opinions. Ultimately, this is the basis of the EMF controversy.

A. The Genesis of the EMF Controversy

Public concern about exposure to electromagnetic fields focuses on four types of adverse health effects including: (1) cancerous (primarily childhood leukemia); (2) reproductive and developmental effects (primarily premature pregnancy termination); and (3) neurobiologic effects (primarily learn-

71. *See id.*

72. *See* NRC REPORT, *supra* note 1, at 7.

ing disabilities and behavioral modifications).⁷³ Of the three types of adverse effects, cancer and childhood leukemia have attracted the most public attention.⁷⁴

Since ancient times, electric and magnetic phenomena have been known and recognized by man.⁷⁵ Animals also recognized and used electric and magnetic phenomena.⁷⁶ However, the modern means to measure, generate, control and use electric and magnetic phenomena only became adequately understood by humankind in the last 200 years.⁷⁷ Society has become extremely dependant upon electricity in the past century dating back to the invention of the light bulb and has become a common source of energy used in all homes.⁷⁸ The controversy about electromagnetic fields can be better appreciated if discussed under three periods: Pre-1960; 1961 to 1990; and 1991 to present.

1. The EMF Controversy in the Period Prior to 1960.

Within this period, the main concerns about the generation, transmission and use of electricity were burns, shocks and electrocution. The concerns about possible adverse human health effects of electromagnetic fields were raised about 50 years ago, during the Second World War, by military personnel, who were exposed to relatively high strength, high frequency, non-ionizing radar systems, video screens and other radiative devices.⁷⁹ Since then, there has been sporadic claims of adverse health effects, associated with high frequency sources, such as radar units used by the police, antenna systems used by the military, cellular phones and microwave ovens.⁸⁰

73. See NRC REPORT, *supra* note 1, at 14.

74. See *id.* at 14.

75. See *id.* at 9.

76. See O.T.A. REPORT, *supra* note 10, at 2.

77. See NRC REPORT, *supra* 1, at 9.

78. See *id.* at 9.

79. See *id.* at 10.

80. See *id.*

2. The EMF Controversy in the Period Between 1961 and 1990.

Recent attention and concern about the possible adverse health effects of exposure to extremely-low-frequency EMFs of 60 Hz can be traced to studies conducted in the former Soviet Union in the 1960s and early 1970s. Those studies reported a link between electric fields and chronic disorders, such as headaches, tiredness, and nausea.⁸¹ The studies were conducted again in the west, but the results were not replicated. Western scientists shifted their attention to magnetic fields.⁸² Those Soviet studies and reports did not raise public interest or concern.

Drs. Nancy Wertheimer and Ed Leeper ignited the EMF controversy and sparked public concern about the EMF phenomena when they published a work entitled *Electrical Wiring Configurations and Childhood Cancer*⁸³ (Wertheimer/Leeper Report). The article reported epidemiologic data suggesting an association between the configuration of power lines near homes and the incidence of leukemia and other types of childhood cancer.⁸⁴

The Wertheimer/Leeper report was heavily criticized for two major reasons. First, it was criticized for its methodology. Due to budget constraints, the research was not conducted as a double blind study and was therefore, susceptible to the personal biases of the researchers.⁸⁵ The results were based on calculations of approximate EMF exposure, rather than actual measurements.⁸⁶ Second, the research was criticized for failing to look at additional risk factors, such as he-

81. See Chris Clark, *EMF: A Major Headache?*, 116 ENERGY ECONOMIST 2, 4 (1991) [hereinafter, *EMF: A Major Headache?*].

82. See *id.* at 5.

83. Drs. Nancy Wertheimer & Edward Leeper, *Electrical Wiring Configurations and Childhood Cancer*, 109 AM. J. OF EPIDEMIOLOGY 273 (1979).

84. *Id.* at 277.

85. See John Weiss, *The Power Line Controversy: Legal Responses to Potential Electromagnetic Field Health Hazards*, 15 COLUM. J. ENVTL. L. 359, 365 (1990).

86. See Winfred Conkling, *Shocking Charges: How Electromagnetic Fields Affect Health*, 12 AM. HEALTH 50, 52 (May, 1993).

redity and exposure to x-rays,⁸⁷ and for not adequately ruling out other possible external factors, such as cigarette smoke or socio-economic influences.⁸⁸ Dr. Wertheimer admitted that her EMF research methodology was flawed. As a plaintiff witness in *State of Wisconsin v. Weinberger*,⁸⁹ she testified that her research on the subject was "merely exploratory" and candidly conceded that it suffered from several "methodological weaknesses."⁹⁰ Despite the many flaws and admitted methodological weaknesses of the Wertheimer/Leeper Report, it received enormous publicity and generated great public anxiety about EMFs. It also sparked off governmental interest, both at the federal and state level. The scientific community found the results intriguing enough that other scientists and experts began to search for an EMF-cancer link.⁹¹ Some studies had similar results as the Wertheimer/Leeper Report, while others yielded mixed results.⁹²

There are also several studies that support the conclusions in the Wertheimer/Leeper Report. In 1986, a study conducted by Dr. Lennart Tomenius, a county medical officer in Stockholm, Sweden, found that there exists a "correlation between childhood cancer and proximity to power lines."⁹³ In 1987, a second study by Dr. David Savitz of the University of North Carolina, attempted to eliminate some of the flaws of the Wertheimer/Leeper report and indicated a "two-fold increase in the risk of cancer for children living near high-current lines."⁹⁴ In 1991, Dr. John Peters, of the University of Southern California, conducted another study which reported that "the risk of contracting leukemia was doubled among

87. *See id.*

88. *See Weiss, supra* note 85, at 374.

89. 745 F.2d 412 (7th Cir. 1984).

90. 745 F.2d at 422-423.

91. *See Clark, supra* note 81, at 5.

92. Greg LaBar, *Electromagnetic Fields: the Problem with Power*, 52 OCCUPATIONAL HAZARDS 90, 93 (Oct. 1990).

93. Lennart Tomenius, *50-Hz Electromagnetic Environment And The Incidence Of Childhood Tumors In Stockholm County*, 7 BIOELECTROMAGNETICS 191, 203 (1986).

94. Gary Taubes, *Fields of Fear: Health Effects of Electromagnetic Fields*, 274 ATLANTIC MONTHLY 94, 96 (Nov. 1994).

children living near high-current lines."⁹⁵ Finally, a 1992 Swedish study conducted by Anders Ahlbom, an epidemiologist, and Maria Feychting, a graduate student of the Karolinska Institute in Stockholm, was hailed as definitive and persuasive.⁹⁶ The study revealed that the "elevated relative risk" of leukemia in children "increase[d] with [the] level of exposure to magnetic fields."⁹⁷

However, other studies found there existed "no association between leukemia and estimated exposure to magnetic fields."⁹⁸ In the United States the "electricity industry took the subject seriously. Not because it has endorsed the scientific arguments, but because the U.S. public is worried."⁹⁹ Increased governmental action and intense media attention helped cause an upsurge in public concern about the potential risks of exposure to EMFs. Thus, while the Wertheimer/Leeper report initially ignited the controversy, it was ultimately inflamed by a combination of several events.

a. O.T.A. Report on the Biological Effects of Power Frequency Electric and Magnetic Fields.

The March 1989 O.T.A. Report on the *Biological Effects of Power Frequency Electric and Magnetic Fields*¹⁰⁰ "gave congressional acceptance to the view that EMFs on human health could not be dismissed as a possibility."¹⁰¹ Although the O.T.A. Report concluded that much of the evidence on the subject was "too weak to allow firm conclusions either way,"¹⁰² it did note that, "there are still legitimate reasons for concern."¹⁰³

95. *Id.*

96. See Conkling, *supra* note 86, at 53.

97. Maria Feychting and Anders Ahlbom, *Magnetic Fields And Concern In Children Living Close To Swedish High Voltage Power Lines*, 138 AM. J. EPIDEMIOLOGY 467, 478 (1983).

98. See LaBar, *supra* note 92, at 97.

99. See Clark, *supra* note 81, at 2.

100. See O.T.A. REPORT, *supra* note 10, at 1.

101. Clark, *supra* note 81, at 3.

102. O.T.A. REPORT, *supra* note 10, at 65.

103. *Id.* at 75.

The release of the O.T.A. Report was followed in late spring of 1989, by a three-part article in the New Yorker Magazine entitled the *Annals of Radiation*¹⁰⁴ written by Paul Brodeur. In the articles Brodeur asserted that the adverse health effects caused by both power lines and electrical appliances were real and that the government had long known of them and concealed such facts. His follow-up article in June 1990, entitled *Calamity on Meadow Street*, pointed to cancer clusters in three neighborhoods in Connecticut, North Carolina and California. Brodeur's assertions concerning EMFs were widely disputed by the utility industry and scientists alike. However, his findings attracted considerable media and public attention.¹⁰⁵

b. The Boeing Settlement that Bolstered the EMF Controversy

In August, 1990, Boeing, an airplane manufacturer, settled a personal injury lawsuit in state of Washington. The suit alleged that Boeing caused the plaintiff, a Boeing employee, to contract leukemia by exposing him to a form of EMF known as electromagnetic pulse radiation.¹⁰⁶ As a result of this settlement, the Robert Carl Strom Foundation, named after the plaintiff, was formed. The foundation brought together a ten-member group of lawyers known as the Electromagnetic Radiation Case Evaluation Team (EMRCET). The EMRCET was established in order to offer advice to citizen groups and individual plaintiffs about electromagnetic radiation.

104. Paul Brodeur, *The Annals of Radiation*, NEW YORKER MAGAZINE, June 12, 1989, at 51; Brodeur, *The Annals of Radiation*, NEW YORKER MAGAZINE, June 19, 1989, at 47; Brodeur, *The Annals of Radiation*, NEW YORKER MAGAZINE, June 19, 1989, at 58 (the article was published in the New Yorker as a three part series). See also Weiss, *supra* note 85, at 360 n.8.

105. See Clark, *supra* note 81, at 3.

106. One week before trial, Boeing agreed to settle the case and to pay the plaintiff and his family \$500,000, in a lump sum and annuities, and together with the co-defendant to pay \$200,000 to fund 10 years of independent medical monitoring for the other 700 others in the class, who would retain their right to seek compensation for any EMF-induced health effects. The company also announced that the alleged work practice had already been changed. See *id.*

c. The Initial EPA Studies On the EMF
Controversy

In October 1990, the EPA released its draft review on EMFs entitled *Evaluation of the Potential Carcinogenicity of Electromagnetic Fields*.¹⁰⁷ The release was controversial among scientists inside and outside of government because it suggested that there could be a "possible link" between cancer and EMFs.¹⁰⁸ It reported a "consistent pattern of response which suggests, but does not prove, a causal link" between exposure to EMF's and cancer.¹⁰⁹ The review concluded that "with our current understanding, we can identify 60-Hz magnetic fields from power lines and perhaps other sources in the home as a possible but not proven cause of cancer in humans."¹¹⁰

Soon after the release of the EPA report, it was leaked to the press that in the discussion of a first draft, an ascription of "probable human carcinogen" had been deleted and ultimately replaced by a "possible, but not proven, cause of cancer in humans."¹¹¹ There were allegations of cover-up and of top level political and industrial interference because of the billions of dollars at stake.¹¹² Although the EPA report stated that the draft "should not be construed as representing agency policy or position"¹¹³ the draft still had a great impact on the EMF controversy. It influenced the public debate on EMFs and inflamed the controversy by creating the erroneous impression of the "possibility" that EMFs could cause cancer.

107. *EPA Finding On Possible EMF-Cancer Link, Blasted By White House Panel*, UTIL. ENV'T REP., Sep. 23, 1991, at 1, available in 1991 WL 2465873 [hereinafter, *EPA Finding Blasted*].

108. *Id.*

109. *Id.*

110. *Id.*

111. *Id.*

112. *See id.*

113. *Id.*

3. The EMF Controversy in the Period from 1991 to the Present.

In August 1991, the Committee on Interagency Radiation Research and Policy Coordination (CIRRPC) criticized the EPA draft report as "unnecessarily alarming" and not "scientifically sound."¹¹⁴ The CIRRPC was established by Allen Romley, the White House Science Adviser, for the purpose of reviewing the controversial the EPA's report. The CIRRPC was comprised of representatives from numerous federal agencies who had an interest in radiation research. The panel concluded that the evidence presented in the EPA report "... does not provide a scientifically sound basis for linking cancer to exposures to electric and magnetic fields."¹¹⁵

The EMF controversy reached its peak in 1992. According to one writer, the issue reached its "media and public interest in zenith in November, 1992, with the Feychting-Ahlbom childhood cancer study."¹¹⁶ Congress enacted the Energy Policy Act¹¹⁷ which instituted an EMF research program, known as the National EMF Research and Public Information Dissemination (RAPID) program.¹¹⁸ Several reports were released that addressed major EMF studies and reviews in the U.S.¹¹⁹ Another development was the release of the controversial Swedish report which "bolstered evidence of a relationship between cancer and exposure to electromagnetic fields."¹²⁰

In December, 1992, Paul Brodeur released yet another article on the EMF controversy in the New Yorker Magazine. The article focuses on cases of cancer among staff and students of Slater School in Fresno, California and was highly critical of California health and utility officials. The article

114. *Id.*

115. *Id.*

116. Leonard S. Greenberger, *EMF: From The Outside Looking In*, 134 PUB. UTIL. FORTNIGHTLY, Jan. 1, 1996, at 15, available in 1996 WL 9280069.

117.

118. The RAPID program also created the EMF-infoline to disseminate to the public information about EMF.

119. See *infra* Section V (subsection entitled 1992 Studies).

120. *Swedish Studies Boosts Evidence of Link Between EMF and Cancer*, UTIL. ENV'T REP., Oct. 16, 1992, at 1, available in 1992 WL 2499352.

reviewed the past few years of federal activity and involvement with the EMF controversy and discussed the controversial Swedish EMF studies. Brodeur argued that utility companies and the Electric Power Research Institute (EPRI), which is funded by these companies, have deliberately steered research and information activities away from any link that may exist between power lines and adverse health effects.¹²¹

On April 5, 1993, the first electric and magnetic field personal injury case to be tried by a jury went to trial. In *Zuidema v. San Diego Gas & Electric*,¹²² the plaintiffs claimed that their daughter contracted a rare form of kidney cancer from exposure to SDG&E's power lines during her gestation and early childhood. They also claimed that the EMFs from the power lines rendered their house unsafe and unfit for residential use and forced them to sell it at a reduced price.¹²³ The case received a lot of publicity which heightened the EMF controversy.¹²⁴ Additionally, by early November 1993, there were several other lawsuits alleging personal injuries from electromagnetic fields pending throughout the country.¹²⁵

The EMF controversy in the United States has been less intense since 1993. Media interest and attention on the subject has been waning since that year. According to one writer, the EMF controversy "... has made a noticeable descent into relative obscurity, with virtually no major television stories since spring 1993."¹²⁶ The suggested reasons for the decline of media and public interest include: lack of pro-

121. *See id.*

122. *See* Craig T. Liljestrand, *EMFs And The Potential For Injury: Real Danger or Overreaction*, 62 DEF. COUNSEL J. 400, 405 (1995) (citing to *Zuidema v. San Diego Gas & Electric*, Civ. Case No. 638-22 (Cal. App. Dep't Super. Ct. 1993)).

123. *See id.*

124. *Landmark EMF-Related Personal Injury Case Goes To Trial: Precedent Expected*, UTIL. ENV'T REP., Apr. 16, 1993, at 1, available in 1993 WL 2444089.

125. James R. Pierobon, *EMF Litigation, Three East Coasts Lawsuits Go To Trial: Industry Braces For Shock Waves*, ELECTRIC WORLD, Dec. 1, 1993, at 96, 97.

126. *See* Greenberger, *supra* note 115, at 15.

vocative research results; the plaintiffs' loss of virtually all the personal injury EMF lawsuits that went to trial in 1993; and the Swedish government's change of policy, which diminished the value of the heralded Swedish studies.¹²⁷ In other countries the EMF controversy never achieved this heightened level. For example, in Europe, public concern and press coverage on EMF has been limited. The electricity industry in Europe remains convinced that there are no adverse effects from EMFs and power lines.¹²⁸

IV. The EMF Studies and Reports

The EMF controversy generated by intensive media coverage and attention ensured a steady flow of funding for further EMF research.¹²⁹ There are generally two types of EMF research: (1) biological studies and (2) epidemiological studies. Biological studies examine mechanisms that may explain alleged EMF effects.¹³⁰ Epidemiological studies focus on establishing whether an association exists between exposure to a putative disease-causing agent and disease occurrence in humans.¹³¹ Epidemiological studies are more important because virtually all existing evidence linking EMF to cancer comes from the science of epidemiology.¹³²

Biological studies usually involve laboratory experiments, using animal or human tissues and cell cultures, as well as tracking the current exposure of live animals and people.¹³³ The laboratory experiments attempt to demonstrate the effects of EMF exposure on living things, including single cells, group cells, organs and animals.¹³⁴ Epidemiological studies use statistics to chart association between death or disease and factors such as exposure to EMFs.¹³⁵ Generally, there are four contrasting types of epidemiological exposure

127. *Id.*

128. Clark, *supra* note 81, at 1.

129. See Taubes, *supra* note 94, at 101.

130. See Clark, *supra* note 81, at 1.

131. See NRC Report, *supra* note 1, at 2.

132. See Taubes, *supra* note 94, at 96.

133. See LaBar, *supra* note 92, at 94.

134. See *id.* at 96.

135. See Conklin, *supra* note 86, at 52.

assessment studies that have been condensed by EMF researches:

- (1) Hypothesis-generating studies, which use death-certificate information to examine the occurrence of disease in populations.
- (2) Cohort studies, which identify and select groups of individuals for study on the basis of some exposure of interest.
- (3) Case-control studies, which identify individuals who have disease of interest (cases) and individuals without the disease (controls).
- (4) Nested case-control studies, which combines some attributes of both cohort and case-control studies.¹³⁶

Over the past twenty years several biological and epidemiological EMF studies have been conducted around the world. None of the studies have categorically established or eliminated any connection between EMFs and adverse health effects.¹³⁷

A. The International Studies Regarding EMFs

1. The Australian Study

In 1991, a panel addressing EMF and health concerns was established by the Victorian Government of Australia to review the range of approaches that are taken in relation to power line fields and recommend appropriate action.¹³⁸ The panel reviewed the literature on health effects of exposure to low-frequency electric and magnetic fields. The panel released its report in 1992 and concluded that "the uncertainties in the data were so great as to preclude the possibility of establishing an association of risk with exposure."¹³⁹ The panel noted that such fields have not been proven scientifi-

136. Denise Warkentin, *Utilities Feel Weight of Burden Caused by EMF Fears*, ELEC. LIGHT AND POWER, Oct. 3, 1995, at 33, 34.

137. See *id.*

138. NRC REPORT, *supra* note 1, at 20.

139. *Id.*

cally to be harmful, but recommended adoption of a policy of prudent avoidance.¹⁴⁰

2. The British Study

In 1992, the British National Radiological Protection Board (NRPB or the Board) released its report entitled the *Biologic Effects of Non-ionizing EMF Radiation*.¹⁴¹ The report contained summaries of experimental investigations on EMFs. The Board assessed power frequency of electric and magnetic fields and the risk of cancer. It concluded in summary, that “no firm evidence of a carcinogenic hazard was found from exposure of paternal gonads, the fetus, children or adults to ELF electric and magnetic fields.”¹⁴² The Board’s follow-up reassessment of the issue in 1994 affirmed its 1992 conclusions.¹⁴³

3. The Canadian/French Study

In 1994, a joint French and Canadian study of electric utility workers was released. The joint research team studied more than 223,000 male workers at three facilities in Canada and France — Electricite de France, Hydro-Quebec and Ontario Hydro. The study relied on strict EMF exposure measurement protocol, rather than estimates of exposure based on job tenure.¹⁴⁴

After analyzing numerous cancer cases, the researchers found “only a slight risk of cancer associated with exposure to electromagnetic fields.”¹⁴⁵ They observed “no association between EMF exposure and male breast cancer, skin melanoma

140. *Id.*

141. *Id.*

142. *Id.*

143. *See id.* The Board was chaired by Sir Richard Doll, the famous Oxford University epidemiologist, who pioneered studies linking cigarette smoking to lung cancer. He called the evidence on EMF “much too weak to justify the conclusion that EMF can cause childhood or adult cancer.” *See Clark, supra note 81, at 5.*

144. *Only Slight Risk of Cancer Associated with EMF’s in New Occupational Study*, UTIL. ENV’T REP., Apr. 1, 1994, at 1, available in 1994 WL 2253599 [hereinafter *New Occupational Study*].

145. *Id.*

and prostate cancer.”¹⁴⁶ According to the study’s lead researcher, Dr. Gilles Theriault of McGill University, “definitive evidence” of an association between EMF and leukemia and brain cancer “has not been obtained.”¹⁴⁷

4. The Danish Study

In October 1993, researchers from the National Cancer Registry of Denmark released a report entitled *Residence Near High Voltage Facilities and the Risk of Cancer in Children*.¹⁴⁸ The research group studied the cases of all Danish children in whom leukemia, brain tumors or malignant lymphomas were diagnosed in the last twenty years. The group concluded that there was a “positive association” found between many types of childhood cancer and exposure to “magnetic fields from *high* [emphasis added] voltage installations.”¹⁴⁹ Therefore, the group concluded that although there may be a connection between EMFs and cancer, it exists for high voltage exposures, but no agreement had been reached with respect to low energy fields.¹⁵⁰

5. The Finnish Study

In October 1993, a Finnish study reported “no significant increase in the incidence of leukemia, lymphoma, or cancers overall in children exposed to residential magnetic fields from power transmission lines in Finland.”¹⁵¹ However, these researchers also warned that a relationship between risk of childhood cancer and exposure to “exceptionally high” EMFs should not be inferred from their findings.¹⁵² Ultimately, the study left open the possibility of a connection between higher levels of EMF exposure and cancer.

146. *Id.* at 2.

147. *Id.* at 1.

148. See Joergen Olsen, et. al., *Residence Near High Voltage Facilities And The Risk of Cancer In Children*, 307 BRIT. MED. J. 891, 895 (1993).

149. *Id.* at 895.

150. See *id.*

151. Pia K. Verkasalo, et. al., *Risk Of Cancer In Finnish Children Living Close To Power Lines*, 307 BRITISH MED. J. 895, 899 (1993)[hereinafter Verkasalo, *Risk of Cancer In Finnish Children*].

152. *Id.*

A second Finnish study conducted by researchers from the Department of Public Health and Helsinki University of Finland was published in October 1996. This second study entitled *Magnetic Fields of High Voltage Power Lines and Risk of Cancer in Finnish Adults: A Cohort Study*,¹⁵³ was the first nationwide study ever to be completed. The researchers used data from the Finnish Power Company records to estimate exposures to annual average magnetic fields over 20 years.¹⁵⁴ The researchers studied over 90% of all the power lines in Finland¹⁵⁵ utilizing data from a nationwide system of registers.¹⁵⁶ The information used for this study was extrapolated out of data files maintained by the Central Population Register and the Finnish Cancer Register which consisted of data for approximately 383,700 people.¹⁵⁷ The researchers screened approximately twenty types of cancer for an association with magnetic fields.¹⁵⁸ This exposure assessment of the study was based on calculations of the average annual magnetic fields separately for each of the years 1970-89 at buildings closer than 500 meters from 110 kv, 220 kv and 400 kv overhead power lines in Finland.¹⁵⁹

The researchers concluded that "extremely low-frequency magnetic fields of high voltage power lines at typical residential levels do not seem to be associated with an increase in cancer among adults."¹⁶⁰ The researchers stated that "[t]he results of the study suggest strongly that typical residential magnetic fields generated by high voltage power

153. Verkasalo, Pia K., et. al., *Magnetic Fields of High Voltage Power Lines and Risk of Cancer in Finish Adults: Nationwide cohort study*, 313 BRIT. MED. J. 1047 (1996) [hereinafter Verkasalo, *Cancer in Finnish Adults*].

154. *Id.*

155. *Id.* at 1048.

156. *Id.*

"A nationwide exposure register was created on personal exposures to 50 Hz magnetic fields from high voltage power lines over a period of 20 years (1970-1989) in Finland, which made it possible to investigate several types of cancer in one population based on cohort study." *Id.*

157. Verkasalo, *Cancer in Finnish Adults*, *supra* note 153, at 1048.

158. *Id.*

159. *Id.*

160. *Id.* at 1056.

lines are not related to cancer in adults.”¹⁶¹ However, this study does not dismiss that there may be an increase in health risks when there is exposure to higher EMF levels.¹⁶²

6. The Irish Study

In February 1996, scientists from the University of Bristol in Britain published their study of the health records of people living near power lines in Ireland over a twenty year period. The report concluded that there is “strong evidence that children exposed to EMFs suffer a higher risk of leukemia.”

According to the researchers, electromagnetic fields created by high-voltage power lines cause cancer, particularly in children, “by prompting the body to absorb higher than normal levels of radon.”¹⁶³ According to the group’s lead researcher, “radioactive radon gas particles collect around power lines, attracted by the electromagnetic fields”¹⁶⁴ The electromagnetic fields cause the particles to oscillate, which when inhaled, “have a greater chance of sticking in the lungs and causing problems.”¹⁶⁵ Ireland’s Electricity Supply Board is studying the report before it reacts to the findings of the study.

7. The Malaysian Study

In February 1996, the Malaysian Energy, Telecom and Post Minister, conducted a study assessing the risks of human exposure to EMFs in response to the growing public concern expressed by citizens living near power lines. The study was conducted by scientists and researchers from the ministry.

161. *Id.*

162. *Id.* at 1056-57.

163. See *U.K. Scientists Say EMF's Cause Cancer By Prompting Body To Absorb Radon*, UTIL. ENV'T REP., Feb. 16, 1996, at 1, available in 1996 WL 8716193.

The article describes radon as “a naturally occurring gas emitted by uranium. It is a carcinogen and usually exists in large volumes in homes.” *Id.*

164. *Id.*

165. See *id.*

In the report released in March 1996, the researchers concluded that there are no significant health risks [from EMF exposure], provided that country's state owned electric utility company "follows the recommendations of the International Radiation Protection Association (IRPA)."¹⁶⁶ The Malaysian Ministry stated that "residents living near high-voltage transmission lines are safe as long as they are not exposed to more than 1,000 milligauss (μG)/day, which the ministry said is IRPA's accepted guideline."¹⁶⁷ Ultimately, the ministry concluded that, based on previous studies conducted in other countries, "EMF exposure under IRPA guidelines is not shown to cause either cancer or birth defects."¹⁶⁸ The researchers recommended a proper buffer zone between transmission facilities and residents for safety purposes.¹⁶⁹

8. The Swedish Studies

The earliest significant Swedish study was that of a county medical officer in Stockholm, Sweden. The study surveyed over 2,000 homes located in close proximity to power lines. The study, published in 1986, found that "for all dwellings with any type of visible electrical construction, the number of tumor dwellings were significantly greater than expected."¹⁷⁰

However, the most notable of the Swedish studies were those reported in October 1992, by two groups of Swedish researchers. The two studies suggested a relationship existed "between cancer and exposure to electromagnetic fields."¹⁷¹ In one of the two studies, a group of researchers conducted an occupational study of worker exposure to EMFs in Sweden. The group analyzed 104 cases of chronic lymphocytic leukemia in men, according to their estimated EMF exposure in

166. *Malaysian Energy Ministry Review of Emf Studies Finds Standards Are Not Needed*, UTIL. ENV'T REP., Mar. 15, 1996, at 12, available in 1996 WL 8716260.

167. *Id.*

168. *Id.*

169. *Id.*

170. See Tomenius, *supra* note 93, at 203.

171. *Swedish Studies Boost Evidence*, *supra* note 120, at 1.

the workplace. The group found a that was a link between worker exposure to EMF and chronic lymphocytic leukemia. It also concluded that the risk of this form of leukemia increased with the magnitude of the EMFs.¹⁷²

The other Swedish study conducted an investigation of homes near transmission lines. It linked 39 cases of childhood leukemia, culled from more than 400,000 people, to EMF exposure related to power transmission lines.¹⁷³ The researchers reported that there existed "more support for an association between childhood leukemia than against it."¹⁷⁴ They took advantage of the Swedish massive public records system to calculate the risks from detailed historical data compiled by the government on patterns of electricity use over each power line. The report concluded that for "[l]eukemia in children and exposure defined from calculated historical fields, this study shows elevated estimated relative risks, which increase with level of exposure."¹⁷⁵ However, the report also found that "[f]or all cancers combined or for central nervous system tumors or lymphoma, there [was] no evidence . . . of an association with the calculated historical fields."¹⁷⁶

Both Swedish studies were the first to establish evidence of a dose-response relationship between EMFs and cancer.¹⁷⁷ The use of Sweden's public records and databases allowed the group to estimate accurately the strength of the EMFs to which the leukemia victims were exposed.¹⁷⁸ The group of studies conducted by the researchers was termed as being one of the "most ambitious and sophisticated efforts"¹⁷⁹ and described as one of "the most persuasive epidemiological studies . . ." ¹⁸⁰ ever completed. By 1994 the Swedish govern-

172. *Id.*

173. Richard Stone, *Polarized Debate: EMF's And Cancer*, 258 *SCIENCE* 1724, 1725 (Dec. 11, 1992).

174. Feychting & Ahlbom, *supra* note 97, at 480.

175. *Id.* at 478.

176. *Id.*

177. See Stone, *supra* note 169, at 1725.

178. See *id.*

179. See *Swedish Studies Boost Evidence*, *supra* note 120, at 2.

180. See Conkling, *supra* note 86, at 55.

ment started to shift interest in the studies on the ground that current research indicated magnetic field exposure did not "seem to be a public health problem."¹⁸¹

B. The United States Studies

1. The National Academy of Sciences Report (1977)

The National Academy of Sciences Report was one of the earliest significant reviews of EMFs in the U.S. It was commissioned by the U.S. Navy to study the biological and human health effects of extremely low frequency electromagnetic radiation. The report summarized the existing state of knowledge concerning biological effects of extremely low frequency electromagnetic radiation. It concluded that "[n]o generally-accepted adverse human or ecological effects due to such fields have been observed in humans, workplaces, communities or in the immediate vicinity of electric power transmission corridors"¹⁸²

2. The O.T.A. Report (1989)

The Office of Technology Assessment (O.T.A.) in 1989, published a 103-page background paper which was prepared by Carnegie Mellon University's Department of Engineering and Public Policy.¹⁸³ The paper concluded that much of the evidence on EMF was too weak to allow one to make a firm conclusion either way.¹⁸⁴ It noted that some of the evidence was consistent "with the hypothesis that ELF fields may play a role in cancer or tumor development" but observed that "none of these constitutes proof or even . . . a strong indication that it does."¹⁸⁵ The report called for more research on

181. *International Swedish Officials Favoring Prudent Avoidance Strategy For Utility*, UTIL. ENV'T REP., March 18, 1994, at 14, available in 1994 WL 2253651 [*International Swedish Officials*].

182. See Weinberger, 745 F.2d at 421.

The report was included in an EIS (Environmental Impact Assessment) prepared and filed by the Navy in connection with its "project seafarer," which was the subject of litigation in this case. *Id.*

183. See O.T.A. REPORT, *supra* note 10, at 67.

184. See *id.* at 65.

185. *Id.* at 68.

potential effects of power frequency of electric and magnetic fields on the central nervous system, and on the possibility of cancer promotion. It recommended a policy of prudent avoidance.¹⁸⁶

3. The 1989 California Study

In 1989 the California legislature directed the state's Public Utility Commission (PUC) and the State Department of Health (DHS) to prepare and submit a joint report to "(1) identify any cancer or other medical risks found by any study to be associated with power line electric and magnetic fields; and (2) list further 'high priority research projects' that need to be undertaken to identify such risks."¹⁸⁷ Acting pursuant to the legislative directive, the PUC and DHS released a joint report in September 15, 1989.¹⁸⁸ The report summarized the existing studies on EMFs and power lines and concluded that there was no compelling scientific evidence that electric and magnetic fields pose a significant health risk.¹⁸⁹

4. The CIRRPC/Oak Ridge Report (1992)

The Committee on Interagency Radiation Research and Policy Coordination (CIRRPC) consists of representatives of numerous federal agencies with an interest in radiation research, and is part of the White House Office of Science and Technology Policy.¹⁹⁰ The Oak Ridge Associated Universi-

186. *Id.* at 78.

The O.T.A. Report defined prudent avoidance as "avoiding exposure by formulating strategies that were prudent from the standpoint of cost and the best understanding of risks." NRC REPORT, *supra* note 1, at 18-19.

187. See *San Diego Gas and Electric Co. v. Covalt*, 926 P.2d at 688-89 (Cal. App. 1996) (the Supreme Court of California citing and explaining the purpose of the joint report issued by the California Public Utilities Commission and the California Department of Health Services entitled *Potential Health Effects of Electric and Magnetic Fields from Electric Power Facilities* (Sep. 15, 1989)).

188. See *Covalt*, 926 P.2d at 689.

189. *Id.*

190. See *Federal Report Aside, Movie and Brodeur Article Makes Utilities 'Bad Guys' On EMFs*, UTIL. ENV'T REP., Dec. 11, 1992, at 1, available in 1992 WL 2499214 [hereinafter *Federal Report Aside*]; see also *EPA Finding On Possible EMF-Cancer Link Blasted By White House Panel*, UTIL. ENV'T REP., Sep. 6, 1991, at 1, available in 1991 WL 2465873 [hereinafter *EPA Finding Blasted*].

ties, which assisted in compiling the report, is an association of higher educational institutions, mostly from the southeastern United States.¹⁹¹

In 1989, in response to media attention concerning EMFs, the U.S. Department of Labor and the White House requested a panel of the Oak Ridge Associated Universities, to review the existing literature on EMFs. The panel reviewed approximately 1,000 articles published in the past 15 years on the subject and released its report in 1992.¹⁹² The report has been described as "perhaps the most quoted of the national and international reviews of the possible health effects from exposure to power-frequency electric and magnetic fields."¹⁹³ The report established that there was "no convincing evidence in published literature to support the contention that exposures to extremely low-frequency electric and magnetic fields generated by sources, such as, household appliances, video display terminals, and local power lines are demonstrable health hazards."¹⁹⁴ Ultimately, the panel noted that the results of its review did not justify an expansion of the national research efforts to investigate the health effects of exposure to electric and magnetic fields. In summary, the report concluded that in "the broad scope of research needs in basic science and health research, any health concerns over exposures to ELF-EMF should not receive a high priority."¹⁹⁵

5. Other 1992 Studies on EMFs

In 1992 three researchers at the California Institute of Technology in Pasadena, reported that they identified "biological magnets" in the human brain.¹⁹⁶ They claimed that the biological magnets may have implications for understand-

191. See *Federal Report Aside*, *supra* note 190, at 1.

192. See *id.*

193. NRC REPORT, *supra* note 1, at 18.

194. *Id.* (quoting the report published by the Oak Ridge Associated Universities in 1992).

195. *Id.* at 19-20.

196. See *Electric and Magnetic Fields: Scientists Identify Brain 'Magnets' that Might Explain Effects of EMF*, UTIL ENV'T REP., May 29, 1992, at 6, available in 1992 WL 2500683 [hereinafter *Scientist Identify Brain 'Magnets'*].

ing the potential health effects from electric and magnetic fields, including transmission lines and electric appliances.¹⁹⁷ The group isolated microscopic crystals of the magnetic mineral magnetite from samples of brain tissue.¹⁹⁸ The group speculated that if the crystals are coupled to ion channels with human cells, EMF could be opening and closing the channels with unknown biological consequences.¹⁹⁹

There was also a study conducted by researchers in Colorado. After a year-long study and after evaluating over 11,000 published articles on EMFs, a consortium of researchers from three Colorado Universities concluded that "there was an absence of persuasive evidence to directly link health effects to electric and magnetic fields."²⁰⁰

In Connecticut, a panel of scientists from the Connecticut Academy of Sciences and Engineering analyzed the "potential health effects of 50-60 Hz electric power fields, which included fields from power lines and distribution facilities, and household and workplace wiring and appliances. The panel studied the affects of the intensity of the field, duration of exposures, and the current status of magnetic field testing and measurement methods."²⁰¹ Firm judgments about the adverse health effects of extremely low frequency (ELF) magnetic fields are impossible to make considering the state of current knowledge on the subject.²⁰²

6. EPRI Funded Studies Relating to EMFs

The Electric Power Research Institute (EPRI), the research arm of the United States Utility Industry, has been very active in EMF research. By 1994, the EPRI spent ap-

197. *Id.*

198. *Id.*

199. *See id.*

200. *EMF: P.S. Colorado-funded EMF study finds no strong Evidence of Health Effects*, UTIL. ENV'T REP., July 10, 1992, at 11, available in 1992 WL 2499592 [hereinafter *Colorado-Funded EMF Study*]; see also *EMF: Connecticut EMF Report; No Firm Judgment On Adverse Health Effects Is Possible*, UTIL. ENV'T REP., July 10, 1992, at 11, available in 1992 WL 2499593 [hereinafter *Connecticut EMF Report*].

201. *See Connecticut EMF Report*, *supra* note 200, at 11.

202. *See id.*

proximately \$60 million on EMF research in fifteen years and pledged to fund \$22 million of a \$60 million five-year federal EMF research program.²⁰³

a. The EPRI/MRI Melatonin Report (1994)

In 1994, the Midwest Research Institute (MRI) a not-for-profit research center in Kansas City, Missouri, released the report of an EPRI-funded study of the effects of EMF exposure on male melatonin level.²⁰⁴ The study suggested that the production of melatonin is suppressed by EMF exposure.²⁰⁵ The main purpose of the study was to learn whether EMF exposure affects production of melatonin. The study revealed that "melatonin production levels fell in men whose normal night-time melatonin production was low after they were exposed to 200 milliGauss (MG) of electromagnetic fields, but men with higher production levels showed no significant change."²⁰⁶ The study revealed that those men whose melatonin levels were most affected by exposure to bright light also "tended to be those who showed the greatest reduction during the exposure test."²⁰⁷

b. The EPRI/UNC Occupational Study (1995)

In 1995, researchers at the University of North Carolina (UNC) released the report of an occupational study funded by the EPRI. The study researched the impact of EMFs on utility workers. The researchers from UNC studied male workers employed at least six months between 1950 and 1986 by five U.S. utility companies which included approximately 138,905 men. The report stated that men in electric utility

203. See Mark T. Hoske, *EMF Communication May Be More Important Than Facts*, ELECT. LIGHT & POWER, July 1, 1994, at 2, 3.

204. *EMF EPRI Study: Some Male Melatonin Levels Affected After 200 MG of EMF Exposure*, UTIL. ENV'T REP., Apr. 29, 1994, at 8, available in 1994 WL 2253536 [hereinafter *EMF-EPRI Study*].

205. Melatonin is "a hormone considered to be a powerful anti-carcinogen . . . and helps control feelings, actions, and daily rhythms, and is thought to be produced at night." *Id.*

206. *EMF-EPRI Study*, *supra* note 201, at 9.

207. *Id.*

occupations appear to have "no increased risk for leukemia, but a slightly increased risk for brain cancer."²⁰⁸

The result of this study is inconsistent with previous occupational studies, such as the 1993 occupational study at Southern California Edison "which found no increased risk of brain cancer or leukemia from EMF exposure," and the Canadian/French study which found "no increased risk of brain cancer, but a slight association between EMF exposure and leukemia."²⁰⁹

c. EPRI Worker Analysis Report (1995)

In December 1995, the EPRI released the result of another occupational study conducted with researchers from the University of California at Berkeley. The study reexamined more than 50 previous studies and pooled the results of 29 of them for a new statistical analysis. The study found that "electrical workers are about 10% to 20% more likely to develop brain cancer than other workers."²¹⁰ It found no clear relationship between "the amount of exposure to EMFs and the level of risks."²¹¹ The researchers concluded that "the apparent lack of a clear pattern of exposure and risk substantially detracts from the hypothesis that measured magnetic fields in the work environment are responsible for the observed excess of risk."²¹²

7. The NCI/CCG Report 1997

The National Cancer Institute (NCI) report was the result of a comprehensive research/study project conducted by a team of scientists, specialists and investigators.²¹³ The eight-

208. H.A. Cavanaugh, *EMF Study: Good News And Bad News Utility Workers Have No Increased Risk For Leukemia . . . But A Slightly Higher Risk for Brain Cancer*, 209 *ELECTRICAL WORLD* 8 (Feb. 1995).

209. *Id.*

210. *EPRI Analysis Says Electrical Workers Have 10-20% More Risk Of Brain Cancer*, *UTIL. ENV'T REP.*, Jan. 5, 1996, at 1, available in 1996 WL 8716113 [hereinafter *EPRI Analysis*].

211. *Id.*

212. *Id.*

213. NCI/CCG Report, *supra* note 5, at 1 (the researchers and scientists were gathered from several institutions, such as, the division of Cancer Epidemiology

year, \$5 million project, was coordinated by the NCI.²¹⁴ It was financed in part by a grant from the NCI and by the University of Minnesota, Children's Cancer Research Fund.²¹⁵ The project involved about 1,250 participants from nine (9) states.²¹⁶ The purpose of the project was to "evaluate residential exposure to magnetic fields in a comprehensive case-control study of acute lymphoblastic leukemia (ALL) in childhood."²¹⁷ It has been described as "the largest U.S. attempt so far to investigate one of the most emotionally incendiary public health issues in American life."²¹⁸

The team's report noted that the results of some of the earlier investigations of "a possible link between childhood leukemia and residential exposures to magnetic fields at 50-60 Hz from nearby power lines" have been inconsistent.²¹⁹ It identified the shortcomings of the report: (1) inconsistent findings; (2) discrepancies between results based on proxy estimates and those based on direct magnetic field measurements; and (3) the absence of supportive laboratory evidence, or a plausible biologic mechanism of disease causation.²²⁰ The report also noted that the shortcomings "have resulted in uncertainties about the relation, if any, between childhood leukemia and exposure to magnetic fields."²²¹ According to the report, the project was motivated by "widespread concern and the limitations of previous studies."²²²

The report stated that the team designed its investigations to address some of the limitations and shortcomings of earlier studies, particularly the lengthy intervals (typically years or decades) between the diagnosis of ALL and mea-

and Genetics of the national Cancer Institute, the Children's Cancer Group, and the Division of Pediatric Epidemiology Clinical Research of the University of Minnesota School of Medicine).

214. Suplee, *supra* note 10, at A3.

215. NCI/CCG Report, *supra* note 5, at 7

216. *Id.* at 2 (the states include: Illinois, Indiana, Iowa, Michigan, Minnesota, New Jersey, Ohio, Pennsylvania and Wisconsin).

217. *Id.*

218. Suplee, *supra* note 4, at A3.

219. NCI/CCG Report, *supra* note 5, at 1

220. *Id.* at 1-2.

221. *Id.* at 2.

222. *Id.*

surements of magnetic fields.²²³ The team's investigators measured magnetic fields within 24 months after the date of diagnosis in the children with ALL.²²⁴

The team addressed other shortcomings of the previous studies which included fewer cases of childhood leukemia; measured fields driving a smaller proportion of the reference period or lacked standardized reference referral. For the evaluation of magnetic fields the previous studies evaluated fewer: (1) potential confounding variables ; (2) selected controls, who moved less frequently than the case patients; and (3) failed to blind data collecting in each residence evaluated. In this project, residential magnetic-field levels were measured at nearly four times the numbers of case patients and controls in the largest previous investigation.²²⁵

The report identified the project's strengths to include: "(i) the fact that magnetic field measurements covered more than 95% of the reference period for 77% of subjects and more than 90% of the reference period for 83% of subjects; (ii) the collection of the exposure data on a blinded basis; (iii) the personal-exposure studies to develop and evaluate the measurement protocol; (iv) the routine calibration of all magnetic field (Emedex) meters; (v) the lengthy initial training, retraining, and site visits of measurement staff; (vi) the independent re-diagraming of a substantial proportion of residences, which showed good concordance of assigned wire codes; and (vii) the regular view of all measurements, with detailed investigation of potential errors."²²⁶ The team made a strong effort to achieve a high rate of participation in the study, despite the obvious hardships for families of the participants. According to the report, up to 78% of eligible case patients and 63% of eligible controls participated in the project.²²⁷

A major limitation of the team's investigation was the absence of measurements for individual residences in the years

223. *Id.* at 6.

224. *Id.*

225. *Id.*

226. *Id.*

227. *Id.*

preceding the diagnosis of cancers.²²⁸ The selection of controls by random-digit dialing was another weakness of the project identified by the report, but it explained that the use of alternative control groups was not feasible.²²⁹

a. The Research Team's Methodology

According to the report, the team used a comprehensive "case-control" method to carry out its investigation.²³⁰ The team enrolled 638 children with acute lymphoblastic leukemia (ALL), who were under the age of fifteen years, and were registered with the Children's Cancer Group. These were the "cases" that were the subjects of the study. They then selected 620 eligible "controls" by random-digit telephone dialing and matched these controls individually to the cases, according to: the first eight digits of the telephone number, age, and race.²³¹

The team next subjected the "cases" and "controls" to an equal degree of study of residential exposure to magnetic fields generated by nearby power lines. In the subjects' current and former homes, investigating data collectors and technicians, blinded to or unaware of the subjects' health status, measured magnetic fields for twenty-four hours in each child's bedroom and for thirty seconds in three or four other rooms and outside the front door.²³² A computer algorithm assigned wire-code categories, based on the distance and con-

228. *Id.*

229. *Id.* The controls used in the project, were selected by random digit telephone dialing and were individually matched to the children with acute lymphoblastic leukemia according to the first eight digits of the telephone number, age and race. *See id.* at 2

230. *Id.* at 2, 6.

In a "case-control" method, researchers will usually identify or select a large number of persons, who have the disease in question-these are then classified as the "cases." The researchers will next select or identify an equally large number of persons of the same age, sex, race and general background, who do not have the disease- these are classified as the "controls." The researchers will then attempt to see if some factor or environmental agent is more common or prevalent in the disease "case" population than among the "controls" Suplee, *supra* note 4, at A3. *See also* O.T.A. REPORT, *supra* note 10, at 102.

231. *Id.* at 2

232. *Id.*

figuration of nearby power lines, to the subjects' main residences (for 416 case patients and 416 controls) and to those where the family had lived during the mother's pregnancy with the subject (for 230 case patients and 230 controls).²³³

b. The Team's Findings

The research team made several findings regarding EMFs. First, it found "no significant excess risk of childhood ALL associated with time-weighted average summary residential magnetic-field levels of 0.200 μT or greater, nor did [it] observe any significant dose response trends."²³⁴ The team also found that "there was a tendency for the risk of ALL to be higher among subjects with summary exposure levels of 0.300 μT or more, but the number of children with such high levels was small."²³⁵ The team further found that the "risk of ALL was not associated with high wire codes for either the subject's main residence or the mother's residence during pregnancy."²³⁶ It noted, that adjustments for socioeconomic, demographic or other potentially confounding variables had little effect on the risk.²³⁷

The team found that contrary to some earlier studies "no association existed between the highest wire code category and an elevated risk of childhood ALL."²³⁸ The team also found that there was "a significant correlation between the measured magnetic fields and wire codes."²³⁹ The team observed that the lack of association between childhood ALL and wire code categories "is particularly note worthy since public concern has been driven primarily by the excess risks

233. *Id.* at 1.

234. *Id.* at 5

235. *Id.*

236. *Id.*

237. *See id.*

238. *Id.* This was inconsistent with some earlier studies, such as, the Wertheimer & Leeper studies. *See generally* Wertheimer & Leeper, *supra* note 83.

239. NCI/CCG Report, *supra* note 5, at 5. This was consistent with the finding in some previous studies. *See generally* Barnes, et. al., *Use Of Wiring Configuration And Wire Codes For Estimating Externally Generated Electric And Magnetic Fields*, 10 BIOELECTROMAGNETICS 13 (1989).

linked with surrogate or historical estimates of magnetic-field exposure.”²⁴⁰

c. The Team’s Conclusions

The team concluded that its findings and results “provide little support for the hypothesis that living in homes with high time weighted average magnetic-field levels or in homes close to electrical transmission or distribution lines is related to the risk of childhood ALL.”²⁴¹ According to Dr. Martha Linet, a childhood cancer specialist, epidemiologist and leader of the team, the study was not ambiguous: “it found no dangers from magnetic fields induced by power lines.”²⁴²

Jerry Williams, the director of the radiology lab at John’s Hopkins Oncology Center, called this study, “the strongest study so far.”²⁴³ Writing his editorial opinion in the *New England Journal of Medicine*, Edward W. Campion, advocated an end to power line cancer research, which according to him, has “produced considerable paranoia, but little insight and no prevention.”²⁴⁴ He argues that “it is time to stop wasting our resources.”²⁴⁵

8. Expert Statements, Opinions And Comments

Several experts and various professional scientific bodies and associations have commented about the health effects of EMFs. In 1995 the American Physical Society²⁴⁶ released a statement declaring that

[t]he scientific literature and the reports of reviews by other panels show no consistent, significant link between

240. NCI/CCG Report, *supra* note 5, at 5.

241. *Id.* at 7

242. *See* Kolata, *supra* note 7, at A3.

243. Suplee, *supra* note 4 at A3

244. *See* Edward W. Campion, Editorial Opinion, *N. ENGL. J. MED.* 337 (1997). *See also* Suplee, *supra* note 4, at A3.

245. *Id.*

246. “The American Physical Society is a non-profit scientific and educational organization. It is the principal membership body of physicists in the U.S., representing over 43,000 physicists in academia, industry and government.” *Covalt*, 55 920 P.2d at 703 n.32.

cancer and power line fields. . . . While it is impossible to prove that no deleterious health effects occur from exposure to any environmental factor, it is necessary to demonstrate a consistent, significant, and causal relationship before one can conclude that such effects do occur. From this standpoint, the conjectures relating cancer to power line fields have not been significantly substantiated.²⁴⁷

The opinion of the American Physical Society indicates the difficulty in establishing the relationship between EMFs and the harmful health effects they may have individuals. In addition, the American Medical Association (AMA) adopted a policy statement in 1995 declaring that it "will continue to monitor developments and issues relating to the effects of electric and magnetic fields, even though no scientifically documented health risk has been associated with the usually occurring levels of electromagnetic fields"²⁴⁸

In September 1995, a group of experts consisting of seventeen prominent physicists, epidemiologists, biochemists, and physicians (included among them were six Nobel laureates) filed an amicus curie brief in *Covalt*.²⁴⁹ The brief stressed that there is no rational basis upon which to make a determination with regard to the adverse health effects of EMFs and further indicated that the fear of EMFs was based wholly on speculation and not based on scientific knowledge.²⁵⁰

In summary, there have been studies on the health effects caused by exposure to power lines and EMFs. However, none of the studies have categorically established or eliminated any connection between EMFs and adverse health risks.²⁵¹ In 1992, the California Consensus Group recognized

247. *Id.* (quoting the Council of American Physical Society, *Power Line Fields and Public Health* (April 1995)).

248. *Id.* (quoting American Medical Association, *AMA's Policy Compendium*, Policy No. 460.938 (1995)).

249. *See Covalt*, 55 P.2d at 703 n.33.

250. *See id.*

251. *Id.* at 691 (quoting the Report issued by the California EMF Consensus Group to Public Utilities Commission entitled *Issues and Recommendations for Interim Response and Policy Addressing Power Frequency Electric and Magnetic Fields* (1992)).

this fact, when it reported that "the scientific community has not concluded whether or not there is a health risk from electric and magnetic fields."²⁵² It is appropriate to end this section with reference to a report prepared by the Oak Ridge National Laboratory which stated that "[w]e do not know at this point whether EMF exposure from power frequency sources constitutes a health hazard. Therefore, we cannot determine levels of exposure which are 'safe' or 'unsafe.'"²⁵³

V. Congressional Charge to the National Research Council

Public concern about possible adverse health effects resulting from exposure to power lines and other extremely-low-frequency electric and magnetic fields, continues despite the fact that considerable research has been conducted on the subject. The problem is due in part to the inconclusive nature of most of the studies, and the fact that there is no generally accepted theory on how power lines and other sources that emit EMFs could have adverse health effects.

In response to this continued public concern, and in an attempt to put an end to the confusion regarding EMFs, Congress enacted a law designating the U.S. Department of Energy (DOE) as the lead agency for conducting further EMF research.²⁵⁴ Congress directed the DOE to enter into an agreement with the National Academy of Sciences (NAS) to conduct a review and evaluation of the possible health effects of electric and magnetic fields.²⁵⁵ Pursuant to the congressional directive, the DOE entered into an agreement with the

The Consensus Group consisted "of 17 persons representing various state agencies, utility companies, electric workers unions, and consumer organizations concerned about possible health effects of electric and magnetic fields in California." *Id.*

252. *Id.*

253. NAT. INST. ENV'T HEALTH SCIENCES AND U.S. DEPT. ENERGY, QUESTIONS AND ANSWERS ABOUT EMF, ELECTRIC AND MAGNETIC FIELDS ASSOCIATED WITH THE USE OF ELECTRIC POWER 1, 29 (Dec. 1995)[DOE/EE-0040] [hereinafter NIEHS & DOE Q&As].

254. *See* NIEHS & DOE Q&As, at 29.

255. *See* NRC Report, *supra* note 1, at 1.

NAS and asked the Academy to conduct the review.²⁵⁶ In response to the DOE's request, the Committee on Possible Effects of Electromagnetic Fields on Biologic Systems was convened by the Board of Radiation Effects Research of the National Research Council's Commission on Life Sciences. The National Research Council is an arm of the NAS.²⁵⁷

A. The Charge to the Committee

The committee was to evaluate the literature on the possible health effects of exposure to electric and magnetic fields and report to the Board on its findings. It was directed to "focus on electric and magnetic fields typical of household frequencies and on possible adverse health effects of cancer, reproductive and developmental abnormalities and neurobiologic dysfunctions, such as learning and behavioral disabilities."²⁵⁸ The Committee was "also asked to examine the scientific evidence to determine the effects of the electric and magnetic fields of household frequencies on biologic systems, to determine if sufficient data of adequate quality exists, and to perform a health risk assessment."²⁵⁹ Specifically, the DOE charged the committee to:

- Review and evaluate the existing scientific information on the potential effects of exposure to electric and magnetic fields, on cancer incidence, reproduction and development and learning and behavior.
- Focus on electric and magnetic fields frequencies and exposure modalities found in residential settings.
- Produce a report that contains a review of pertinent information on the effects of electric and magnetic fields, identification of research areas in which data are needed to better understand any potential health hazard, and recommendations for research in those area and strategies for implementing research that would enhance understanding. If data of appropriate quality are

256. Initiation of the research was made possible by a grant, Grant No. DE-FG01-92CE34100, between the DOE and NAS.

257. See NRC Report, *supra* note1, at 9-10.

258. *Id.* at 10.

259. *Id.* at 10.

available, include a health risk assessment of power-frequency electric- and magnetic-field exposures.²⁶⁰

B. The Workings of The Committee

The Committee on Possible Effects of Electromagnetic Fields on Biologic Systems worked on the project for almost three years. It reviewed residential exposure levels to electric and magnetic fields, evaluated the available epidemiologic studies, and examined laboratory investigations that used cells, isolated tissues, and animals.²⁶¹ The Committee held informational workshops to acquaint members with past studies on the subject. It also invited U.S. and international experts and scientists in the field to brief the committee about their work and the state of knowledge concerning effects of power lines and other EMFs. The committee, by process of re-analysis, assessed and evaluated data on the subject. It examined over 500 studies and literature on EMF, spanning well over 17 years. It engaged the services of outside bio-statisticians, to advise it on the strength of individual scientific papers and the significance of the body of evidence as a whole.²⁶² The committee synthesized its conclusions and findings based on the data it evaluated, and submitted the same to the Board. In October 1996, the National Research Council published and released the committee's conclusions and findings in a report entitled *Possible Health Effects of Exposure to Residential Electric and Magnetic Fields*.²⁶³

C. The Committee's Conclusions and Findings

The NRC Report concluded that "the current body of evidence does not show that exposure to these fields presents a human-health hazard."²⁶⁴ The Report further established that there was "no conclusive and consistent evidence shows

260. *Id.*

261. *See id.* at 1-2.

262. *See id.* at Section VII.

263. *See* NRC REPORT, *supra* note 1, at 1.

264. *Id.* at 2

that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects or reproductive and developmental effects.”²⁶⁵ Ultimately, the Committee found that there was no evidence existing that links EMFs and childhood leukemia.²⁶⁶ Therefore, in order to be able to appreciate the weight of the committee’s conclusions and findings and appreciate its possible future impact on the EMF controversy, it is helpful to have some knowledge of basic facts about the settings and functions of the Committee.

D. Basic Facts About The Functions And Settings of The NAS & NRC.²⁶⁷

The National Academy of Sciences (NAS), is a private, non-profit, self-perpetuating society of distinguished scholars, engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. The Academy received its charter from Congress in 1863. Upon the authority of that charter, the Academy has a congressional mandate to advise the federal government on scientific and technical matters.

The National Research Council was organized and set up by the National Academy of Sciences in 1916 to advise the federal government about science and technology. The governing board of the council was made up of members drawn from the National Academy of Sciences, the National Academy of Engineering and the Institute of Medicine.²⁶⁸ Operating under general policies determined by the National Academy of Sciences and the National Academy of Engineering, the National Research Council is the principal provider of services to the government.

265. *Id.*

266. *See id.*

267. *See id.*

268. The National Academy of Engineering was established in 1964 under the Charter of the NAS, as a parallel organization of outstanding engineers. It shares the NAS’s responsibility for advising the Federal Government. It is autonomous in its administration and in selecting its members. The Institute of Medicine was set up in 1970 by the National Academy of Sciences to secure the Services of eminent members of appropriate profession in examination of policy matters pertaining to the public. *See id.*

The Committee that worked on the EMF review and project, was approved by the governing board of the National Research Council. Members of the committee represented a wide range of disciplines. Their academic credentials included physics, engineering, chemistry, biology, and applied sciences such as, risk perception. Some of them were experts in cancer, reproductive and developmental effects and neurobiologic effects. Others had experience in epidemiology, risk and exposure assessments. Some of them worked on EMFs for a good part of their careers.²⁶⁹

VI. The Nature of EMF Litigation

There are basically two types of EMF litigation: property claims and personal injury claims. The typical EMF case involves plaintiffs, usually private persons suing for private remedies (money damages and/or injunctive relief), against electrical utility companies. The most frequent claim is that the plaintiffs have been exposed to EMFs emitted by the defendant's power line. As a consequence of such exposure, the plaintiffs have suffered injury to their persons or property. By the terms of such claims, EMF cases are toxic torts.

A. Features And Characteristics of Toxic Torts

Toxic torts "comprise harms to persons, property or to the environment, due to the toxicity of a product, a substance, or a process."²⁷⁰ Toxic torts have been defined as "civil actions asserting a demand for recovery of damages that arose from exposure to a chemical substance, emission or product, where that exposure allegedly caused physical and/or physiological harm."²⁷¹ Every toxic tort is "an exposure to a toxic substance," and the defining consequence is "an illness or other adverse human effect . . . which has a non-trivial and non-transitory effect upon persons."²⁷² The term toxic gener-

269. *See id.* at 7.

270. M. STUART MADDEN, *TOXIC TORTS DESKBOOK* 2 (1992).

271. 1 JAMES T. O'REILLY, 1 *TOXIC TORTS PRACTICE GUIDE* § 2.01 at 2-1 (2d ed. 1995).

272. *Id.*

ally refers to substances "that by inhalation, ingestion, dermal exposure or otherwise can cause personal physical injury or disease."²⁷³

B. Special Features of Toxic Tort Litigation

EMF cases fall under toxic tort litigation because electricity produced by power lines or EMF waves are created by cellular phones and other products. These products can be toxic and ultimately cause adverse health effects in people who live near, or use, or work with such products. Multiple theories can be applied when instituting an EMF lawsuit. One commentator stated that the a "myriad [of] liability theories [can] characterize toxic tort actions."²⁷⁴ Toxic tort plaintiffs can phrase their claims in terms of multiple theories or recovery such as nuisance, trespass, products liability, negligence, strict liability for abnormally dangerous activities and statutory strict liability.²⁷⁵

1. Long Latency Period

The most distinguishing feature of toxic torts is that they "almost always involve injury or damage that has a long latency period before harm manifests itself"²⁷⁶ In toxic torts, unlike other torts, the interval between exposure and toxic effect may be several years. The latency period is the "time between exposure and on-set of symptoms."²⁷⁷ There is always difficulty in establishing "a cause and effect relationship" in toxic tort cases.²⁷⁸ Such cases invariably present "complex questions of medical or scientific causation."²⁷⁹ Medical and/or scientific experts are usually needed to prosecute and sustain toxic tort cases because of the issue of latency period. Experts are needed to prepare and try the case

273. GERALD BOSTON & M. STUART MADDEN, *LAW OF ENVIRONMENTAL AND TOXIC TORTS* 1 (1992).

274. L. NEAL ELLIS, JR. & CHARLES D. CASE, *TOXIC TORT AND HAZARDOUS SUBSTANCE LITIGATION* 103 (1995).

275. BOSTON & MADDEN, *supra* note 273, at 1,6.

276. *Id.* at 7.

277. 1 O'REILLY, *supra* note 271, § 3.19 at 3-44 - 3-46.

278. *Id.*

279. BOSTON & MADDEN, *supra* note 273, at 7.

to establish the crucial "causal relationship between the toxin and the harm."²⁸⁰

2. Proof of Causation

In toxic tort cases causation is an intricate element of the claims. Causation has been defined as "some reasonable connection between the act or omission of the defendant and the damage which the plaintiff has suffered."²⁸¹ In order to sustain toxic tort claims, plaintiffs must prove that exposure to a toxic substance for which the defendant is responsible is capable of causing harm and did in fact cause harm to the plaintiff.²⁸²

In summary, to establish causation in toxic tort cases, plaintiffs must: (1) prove exposure to a toxic substance; (2) establish a link between the exposure and the defendant; and (3) prove that the toxic substance is capable of producing harm and that the exposure to the substance has in fact produced harm.²⁸³

C. The Use of Experts in Toxic Tort Cases

To be able to sustain toxic tort claims and prove all the elements of causation, plaintiffs must establish by "a preponderance of evidence" that their illnesses were caused by a toxic exposure for which the defendant was responsible.²⁸⁴

To establish exposure to a toxic substance, plaintiffs may need expert testimony because exposure varies according to the nature of the substance. The need for experts at this stage will depend on the nature of the toxic substance and the mode of exposure.²⁸⁵ To link the defendant to the exposure, plaintiffs must introduce expert scientific or medical evidence that "defendant's product or process was a substantial factor

280. MADDEN, *supra* note 270, at 5.

281. W. PAGE KEETON ET. AL, PROSSER AND KEETON ON THE LAW OF TORTS § 41 (5th ed. 1984); *see also* ELLIS & CASE, *supra* note 274, at 103.

282. ELLIS & CASE, *supra* note 274, at 107.

283. *See id.* at 105-109.

284. *See* BOSTON & MADDEN, *supra* note 273, at 8.

285. *See* ELLIS & CASE, *supra* note 274, at 107.

in plaintiffs' injury or loss."²⁸⁶ To establish medical causation one must show that exposure is capable of producing harm and that it in fact produced the plaintiffs harm or loss. Therefore, it is necessary that plaintiffs use expert scientific and medical testimony in order to establish this causation.²⁸⁷ Generally, expert testimony is required because courts will not take judicial notice of a substance's ability to cause harm.²⁸⁸

When medical and/or scientific experts are called to testify whether the exposure is capable of producing harm or whether it produced harm in the plaintiffs, their opinions must be made to "a reasonable degree of medical or scientific certainty."²⁸⁹ To successfully defend a toxic tort case, defendants will need experts to counter the plaintiffs' experts, to discredit the statistics upon which the plaintiffs' expert testimony are based, and to reach conflicting conclusions as to the toxic potential of the substance in issue.²⁹⁰

Thus, in toxic tort cases, both the plaintiffs and defendants must use experts to successfully prosecute or defend their positions respectively. This is implicit in the nature of such torts, due to the issue of the latency period and their scientific or medical novelty.²⁹¹ The type of experts to be used in each case and at each stage of the case will depend on the peculiar facts and circumstances of each case. Generally, physicists, environmental scientists, hydrologists and industrial hygienists may be used to establish exposure to toxic substance.²⁹² Some of the same experts may be used to link the exposure to the defendants. In order to establish medical causation the plaintiffs need to procure the testimony of epidemiologists,²⁹³ toxicologists²⁹⁴ and physicians.

286. MADDEN, *supra* note 270, at 6.

287. *See id.*; *see also* BOSTON & MADDEN, *supra* note 273, at 8.

288. *See* ELLIS & CASE, *supra* note 274, at 108 n.36.

289. *Id.* at 111; *see also* BOSTON & MADDEN, *supra* note 273, at 8.

290. *See* BOSTON & MADDEN, *supra* note 273, at 8.

291. *See* MADDEN, *supra* note 270, at 2.

292. *See* ELLIS & CASE, *supra* note 274, at 106.

293. Epidemiologists are experts, who use statistics generated from population-based studies to quantify the association between exposure to a substance and harm. *See id.* at 111.

D. Admissibility of Scientific Evidence in Toxic Tort Cases

The plaintiffs and defendants in toxic tort cases have one more crucial hurdle to cross after they have assembled and engaged their respective expert witnesses. The admissibility of such expert opinions is "a critical and controversial" issue in every toxic tort litigation.²⁹⁵ The issue is of great significance in federal courts and in all the other jurisdictions that apply the Federal Rules of Evidence or identical rules of evidence.

In toxic tort cases, like in all other cases where experts are used in litigation, the question of the standard for admitting scientific evidence or opinion is a major part of the proceedings. For years there has been great division among the courts and jurisdictions about the proper standard for the admission of expert testimony. Before the 1993 U.S. Supreme Court decision in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*²⁹⁶ many courts accepted and applied what has come to be known as the "Frye Standard" or "Frye Rule."

1. The Frye Standard

Under the "Frye Standard" enunciated by the U.S. Court of Appeals for the District of Columbia Circuit in *Frye v. United States*,²⁹⁷ the "general acceptance" test is the standard for admissibility of novel scientific evidence. The Frye decision predated the Federal Rules of Evidence and was accordingly based on the rules of common law. Under the Frye Standard expert opinion based on scientific technique was inadmissible unless the technique was "generally accepted" as reliable in the relevant scientific community.²⁹⁸ The U.S. Supreme Court in the *Daubert* case, rejected this "general ac-

294. Toxicologists study the capacity of toxic substances to produce harmful effects in living organisms. See Gerald Boston, A. *Mass Exposure Model of Toxic Causation*, 18 COLUM. J. ENV'T. L. 181 (1993); see also BOSTON & MADDEN, *supra* note 273, at 349.

295. See BOSTON & MADDEN, *supra* note 273, at 357.

296. 509 U.S. at 579.

297. 293 F. 1013 (D.C. Cir. 1923).

298. See *id.* at 1014.

ceptance" test on the ground that the rule in *Frye* has been superseded by the Federal Rules of Evidence.²⁹⁹

2. An analysis of *Daubert v. Merrell Dow Pharmaceuticals*

The U. S. Supreme Court in *Daubert* held that the Federal Rules of Evidence "occupy the field" on the issue of admissibility of expert testimony. The Court noted specifically that rule 702 which governs the admissibility of expert testimony, does not establish "general acceptance" as an absolute pre-requisite to admissibility of expert testimony.³⁰⁰

The Court held that under the Federal Rules of Evidence, the trial judge had the primary duty and responsibility to ensure that any and all scientific testimony or evidence admitted in the case is both "relevant and reliable."³⁰¹ The Court held that under Rule 702, a trial judge must first determine, whether or not a proposed expert or scientific testimony "will assist the trier of fact to understand the evidence or to determine a fact in issue."³⁰² According to the Court, expert testimony "which does not relate to any issue in the case is not relevant and . . . non-helpful."³⁰³ In the Court's opinion, the subject of an expert's testimony must be "scientific knowledge."³⁰⁴ The Court then went on to set out guidelines for judges faced with expert scientific testimony to follow.

First, the trial judge must determine at the outset, under Rule 104(a) of the Federal Rules of Evidence, whether the expert is proposing to testify to "scientific knowledge that will assist the trier of fact to understand or determine a fact in issue."³⁰⁵ According to the Court, for the judge to make this determination, he must make a preliminary assessment of whether "the methodology underlying the testimony is scientifically valid and whether that reasoning or methodology

299. See *Daubert*, 509 U.S. at 857.

300. See *id.* at 588. See also Fed. R. Evid. 702

301. See *Daubert*, 509 U.S. at 589.

302. *Id.*; see also Fed. R. Evid. 702.

303. *Id.* at 591.

304. See *id.* at 590.

305. *Id.* at 592. See also Fed. R. Evid. 104.

properly can be applied to the facts in issue.”³⁰⁶ Factors the judge should consider in making this determination, include: (1) whether the evidence can be, and has been, tested; (2) whether the evidence has been subjected to peer review and publication; and (3) in a case of a particular scientific technique, what the known or potential rate of error is and the existence and maintenance of standards controlling the technique’s operation.³⁰⁷

3. General Acceptance

The Court stated that even though “general acceptance” is not an absolute requirement for assessment of “reliability,” it can have a bearing “on the inquiry.”³⁰⁸ Second, the judge in assessing a proffer of expert scientific testimony, should in addition, be mindful of other applicable rules of Federal Rules of Evidence.³⁰⁹ According to the Supreme Court, the judge should be guided by the provisions of Rules: 703, 706 and 403. Rule 703 allows the judge to admit otherwise inadmissible hearsay evidence if it is customary for experts in the field to use such evidence to make inferences.³¹⁰ Federal Rule of Evidence 706 allows the judge, at his discretion, to procure the assistance of his own expert to help the court in understanding the issues.³¹¹ Rule 403 allows the judge to exclude relevant evidence “if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury”³¹² Also under Rule 403, the Court stressed that trial judges have more control than lay witnesses.³¹³ Therefore, the primary function of the judge is to determine the scientific validity of the proffered expert testimony based on its “evidentiary relevance and reliabil-

306. *Daubert*, 509 U.S. at 592-93.

307. *See id.* at 593-94.

308. *See id.* at 594.

309. *See id.* at 595

310. *See id.*; *see also* FED. R. EVID. 703.

311. *See Daubert*, 509 U.S. at 595; *see also* FED. R. EVID. 706

312. *Daubert*, 509 U.S. at 595; *see* FED. R. EVID. 403.

313. *See Daubert*, 509 U.S. at 595.

ity”³¹⁴ focusing “on principles and methodology, not on the conclusions that they generate.”³¹⁵

E. Conducting EMF Lawsuits

The concern in electromagnetic fields litigation is exposure to radiation from electromagnetic fields. Radiation from electromagnetic fields can be toxic if it is ionizing. Whether the non-ionizing radiation is also toxic is the subject of the EMF controversy. EMF plaintiffs may phrase their claims under multiple theories of nuisance, trespass, negligence, products liability, strict liability for abnormally dangerous activities, statutory strict liability and personal injury.³¹⁶ The plaintiffs may claim damages for Cancerphobia, enhanced risk of harm, medical monitoring costs, injunctive relief, and monetary awards.³¹⁷

An obstacle that plaintiffs must overcome in bringing EMF lawsuits is establishing causation. First, they must prove that exposure to radiation from electromagnetic fields exists. Secondly, they must establish that exposure to the defendant’s power lines, or other EMF generating products, was the proximate cause of the injury.³¹⁸ Finally, the plaintiffs must demonstrate by medical evidence or expert testimony that the defendant’s product was a substantial contributing factor in their injury.³¹⁹

In contrast, in order to defend EMF cases, defendants should argue: (1) that their product is not the source of the radiation; (2) that the radiation produced by their product or power line is not capable of producing any adverse harm; and (3) that the radiation from the power line or product did not cause the particular harm alleged by the plaintiffs.³²⁰ Like other toxic torts, both parties in EMF cases will need the services of experts in order to help in the preparation of their

314. *See id.* at 597.

315. *Id.* at 595.

316. *See* Madden, *supra* note 270, at 5.

317. *See Covalt*, 920 P.2d at 669.

318. *See* MADDEN, *supra* note 270, at 5.

319. *See id.* at 6.

320. *See generally* MADDEN, *supra* note 270, at 5-7.

cases and to provide testimony at the trial. At trial both defendants and plaintiffs will face the problem of admissibility of expert testimony and at that stage the decision in *Daubert* will become relevant.

VII. An Overview of EMF Caselaw

An overview of EMF case law will foster an appreciation of EMF litigation. EMF litigation may come in four different forms: (1) claims before regulatory or public utility commissions; (2) property-based EMF claims; (3) workers compensation claims; and (4) personal injury claims.³²¹ Notable regulatory or public utility commissions' decisions, include a 1991 Missouri Public Service Commission (MPSC) decision, in which the MPSC rejected a proposed 101-mile, 345 kv transmission line because of health hazards.³²²

The commission ruled that "on the basis of the evidence . . . , it cannot conclude that electromagnetic fields pose any palpable danger to human life, health or to the breeding potentials of dairy herds. Neither can the commission rightfully conclude that EMF emanations are harmless."³²³ It further added that "no scientific studies, expert testimony or other body of reliable evidence has been presented . . . which establishes a causative link between [EMFs] and negative or biologic effects."³²⁴ Finally, the commission concluded that in the light of the paucity of firm scientific data, it cannot order the utilities to ". . . adopt preventive or palliative measures to combat a phenomena which, on the basis of information now before the commission, may be relatively benign."³²⁵

Additionally, a Michigan Administrative Law Judge (ALJ), rejected arguments of citizen groups that construction of a 125-mile, 345 kilovolt transmission line could pose health

321. See Roland A. Giroux, *Daubert v. Merrell Dow: Is This What The EMF Doctor Ordered?* 12 PACE ENVTL. L. REV. 393, 430 (1994).

322. See Re St. Joseph Light and Power Co., No. EA-90-252, 1991 WL 498638, at *7 (Mo.P.S.C. Aug. 28, 1991).

323. *Id.*

324. *Id.*

325. *Id.*

threats from EMFs.³²⁶ He found that the documents referred to by the group "failed to establish that magnetic fields are the cause of, or contribute to, cancer and other illnesses."³²⁷ He concluded that "the evidence does not even show an association between the low-level magnetic field that would exist at the edge of the right-of-way and human illness."³²⁸

A. Claims Before Regulatory or Public Utility Commissions

These types of claims usually relate to attempts by utilities to construct new power lines or transmission lines or to upgrade existing ones. These claims constitute a good percentage of all EMF cases litigated in the United States. The proceedings usually involve interveners or citizen groups, attempting to stop or restrict the proposed construction or upgrading of the new power line or transmission facility. They are mainly in administrative proceedings conducted by ALJs or Public Utility Commissions (PUCs).

A 1993 decision by a California ALJ recommended that electrical utilities in California should not be required "to alter existing power lines to reduce exposure to electric and magnetic fields."³²⁹ The case involved a 2.5 year proceeding to determine the role of California state's regulators' role in the EMF debate and to determine what steps utilities should take. The ALJ rejected the proposals made by some environmental groups, which suggested that the California Public Utility Commission (CPUC) should get involved in basic research relating to whether EMFs constitute health

326. See *Electric and Magnetic Fields ALJ Rejects Health Threat Argument, Recommends Approving Consumers' Line*, UTIL. ENV'T REP., Oct. 16, 1992, at 1 available in 1992 WL 2499360 [hereinafter *ALJ Rejects Health Threat Argument*] (the decision referred to by the Michigan ALJ was for two cases and were consolidated under Index Numbers U-10059 and U-10061).

327. *Id.*

328. *Id.*

329. *California ALJ: Utilities Not Required to Alter Lines to Reduce EMF Exposure*, UTIL. ENV'T REP., July 23, 1993, at 1, available in 1993 WL 2443872 [hereinafter *California ALJ: Utilities*] (this California ALJ is part of the California Public Utilities Commission and the case is registered under Docket Number 191-01-012).

hazards.³³⁰ He ruled that there is "no realistic expectation that this research effort would reach any definite conclusions."³³¹ He added that "scientists have been unable to develop a consensus that there is a definite link between EMF and adverse health effects on humans after more than 30 years of research and thousands of studies."³³²

The ALJ stated that "utilities would be running the risk that public policy would be guided by perception rather than scientific analysis, resulting in the adoption of reactive and expensive policies."³³³ The judge recommended that "... the best response to EMF is to avoid unnecessary exposure to EMF, if such avoidance can be achieved at a cost which is reasonable in the light of the risk identified."³³⁴

In a 1993 decision by a Virginia State Corporation Commission Hearing examiner,³³⁵ which involved the issue of whether the Virginia Power Company should be permitted to build a 75-mile, 500-kv transmission line across part of south-central,³³⁶ the examiner found that there "simply is no evidence to prove that there is an association between electromagnetic fields and cancer."³³⁷ He rejected assertions by historical and environmental groups that EMFs emanating from the line would have adverse impact on the health of those who live near it.³³⁸ The examiner ruled that "while there is really no dispute among experts that EMFs have biological effects, there is no evidence that these effects are harmful."³³⁹ The ALJ also added that there is "no biological evidence associating exposure to EMF with cancer."³⁴⁰

330. *See id.*

331. *Id.*

332. *Id.*

333. *Id.*

334. *California ALJ: Utilities*, *supra* note 329, at 1-3.

335. *See Electric and Magnetic Fields: Virginia Hearing Examiner Backs Virginia Power 500-kv Line, Finding No EMF Cancer Link*, UTIL. ENV'T REP., Oct. 15, 1993, at 1 available in 1993 WL 2443716 (Virginia State Corporation Commission Case No. PUE 920058) [hereinafter *Virginia Hearing Examiner*].

336. *See id.* at 2.

337. *Id.*

338. *See id.*

339. *Id.* at 3.

340. *Virginia Hearing Examiner*, *supra* note 335, at 3-4.

B. Property-Based EMF Claims

1. Eminent Domain and Inverse Condemnation

Eminent domain and inverse condemnation actions usually involve governmental agencies or public entities. The two causes of action "implement the constitutional rule that private property may not be "taken or damaged . . . for public use without just compensation."³⁴¹ The main difference between the two causes of action is that in eminent domain claims "the focus is usually limited to the amount of compensation owed the property owner, under the 'just compensation' clause" of the Constitution.³⁴² In an inverse condemnation action "the property owner must first . . . [establish] that the public entity has, in fact, taken [or damaged] his or her property before he or she can reach the issue of 'just compensation.'"³⁴³ The *sine qua non* for cause of action for inverse condemnation is that defendant's conduct "must constitute permanent physical occupation of plaintiff's property amounting to exercise of dominion and control thereof."³⁴⁴

a. Eminent Domain Decisions

i. *Zappavigna v. New York Power Authority*.³⁴⁵

In *Zappavigna* the plaintiff, a landowner, was denied consequential damages for alleged decreased market value of his property, occasioned by the current public perception that exposure to high voltage power lines either poses or may pose health risks to those in the vicinity of such lines.³⁴⁶ The property in question was one of several over which the power authority had easements, acquired via eminent domain for its 207-mile Marcy South transmission line.³⁴⁷ The Appellate Division held that "there was no basis in scientific evidence

341. U.S. Const., 5th Amend.; See also *Covalt*, 13 Cal.4th 893, 939.

342. *Covalt*, 13 Cal.4th at 939-40.

343. *Id.* at 940.

344. *Reiss v. Consolidated Edison Company of New York*, 650 N.Y.S.2d 480, 482 (3d Dep't. 1996).

345. 588 N.Y.S.2d 585 (2d Dep't 1992).

346. See *id.* at 586.

347. See *id.*

for a fear of exposure to the fields emitted by power lines , and that high voltage power lines have no effect on property values.”³⁴⁸

ii. *San Diego Gas & Electric Co. v. Daley*.³⁴⁹

In *Daley* an electric utility exercised its eminent domain powers to condemn an easement for a new power transmission line across plaintiff's unimproved property.³⁵⁰ The sole issue before the court was the amount of compensation or severance damages required for the taking. The California Court of Appeals held that the severance damages could include “a diminution in the value of the remainder of the property assertedly caused by prospective buyers’ fear of electric and magnetic fields arising from the new transmission line, regardless of whether the fear was reasonable.”³⁵¹

iii. *Criscuola v. Power Authority of the State of New York*.³⁵²

The New York Court of Appeals in *Criscuola*, while formulating the condemnation award with regard to the plaintiff's remaining property, held that the plaintiff need not prove the reasonableness of the public fear.³⁵³ According to the court, it was sufficient to prove that public fear or perception, medically reasonable, existed in the market place, and this reduced the property's value.³⁵⁴

iv. *Borenkind v. Consolidated Edison Co. of New York*.³⁵⁵

In *Borenkind*, the plaintiffs claimed they sold property which was located near pre-existing high voltage power lines for less than the fair market value, due to public perception of

348. *Id.* at 587.

349. 253 Cal. Rptr. 144 (Cal. Ct. App. 1988).

350. *See Daley*, 253 Cal. Rptr. at 146.

351. *Id.* at 150-151.

352. 621 N.E.2d 1195 (N.Y. 1993).

353. *See Criscuola*, 621 N.E.2d at 1195.

354. *Id.*

355. 626 N.Y.S.2d 414 (Sup. Ct.1995).

health risks posed by transmission lines.³⁵⁶ They alleged a partial taking and contended that the defendant knew or should have known of the public perception and could have taken steps to protect plaintiffs' property from the impact of the perception.³⁵⁷ The trial judge dismissed plaintiffs' claim and held that the utility company was not liable for a taking "where there [was] no new, or for that matter, old taking or disseisin from these plaintiffs themselves."³⁵⁸ Here the court particularly noted that the plaintiffs could not have a claim especially when the power lines existed prior to the plaintiff purchase of the property.³⁵⁹

b. Inverse Condemnation Decisions

i. *Reiss v. Consolidated Edison Co.*³⁶⁰

In *Reiss v. Consolidated Edison Co.*, a New York Supreme Court held that "in order to sustain a cause of action for inverse condemnation, plaintiffs must allege and prove that defendant intruded onto [plaintiffs'] property and interfered with [their] property rights to such a degree that the conduct amounts to a constitutional taking."³⁶¹

In this case the plaintiffs, residential property owners in Pleasantville, New York, sold their property because they feared that EMFs emitted from the defendant's power lines might have been dangerous to the health of their child.³⁶² They sold their house at a reduced price and then brought an action against the defendant, an electrical utility company.³⁶³ The plaintiffs alleged that the reduced price for the property was due to public perception or fear of possible health hazards from power lines of the transmission facility that was located on the utility's easement. Alleging inverse con-

356. *See id.* at 415

357. *See id.*

358. *Id.* at 416.

359. *See id.* at 415

360. 650 N.Y.S. 2d 480 (3d Dep't 1996).

361. *Id.* at 481 (quoting *O'Brien v. City of Syracuse*, 429 N.E.2d 1158 (N.Y. 1981)).

362. *See id.*

363. *See id.*

demnation, the plaintiffs sought relief via a permanent injunction. The trial judge dismissed the plaintiffs' case, and they appealed.³⁶⁴

The Appellate Division affirmed the judgement of the trial court. It held that the plaintiffs have "failed to prove harm by reason of the existence of the EMFs."³⁶⁵ Specifically, the court noted that the plaintiffs "have offered no scientific proof that EMFs constitute a health hazard, thereby rendering their property unsafe and uninhabitable."³⁶⁶ The court concluded that "having failed to establish that the defendant harmed plaintiffs' property, plaintiffs are not entitled to reimbursement for the diminution in the value of their property."³⁶⁷

c. Nuisance and Negligence Claims

In *Borenkind*³⁶⁸ the trial court also ruled that the defendant utility company was not liable in nuisance and in negligence. On the issue of nuisance, the judge recognized that "a private nuisance claim could be made out when an otherwise authorized public use was unreasonably, negligently or dangerously carried out,"³⁶⁹ yet this was not the case here. The court further ruled that since electricity is "... imperceptible to the ordinary senses and there being evidence presented that science is unable to yet conclude whether or not harm from them results, the invasive quality of electrical and magnetic fields as a nuisance, even if shown to reach the plaintiffs' property is fatally impaired."³⁷⁰ Therefore, given the uncertainty of the present state of

364. See *id.*

On appeal, plaintiffs contended that the utility company invaded their property with a non-solid agent for the benefit of the general public causing substantial diminution in the value of their property, thus constituting a de facto "taking," for which they are entitled to compensation. See *id.* at 481.

365. *Reiss*, 650 N.Y.S.2d at 481.

366. *Id.*

367. *Id.*

368. See *Borenkind*, 626 N.Y.S.2d at 416.

369. *Id.*

370. *Id.*

knowledge regarding the effects of EMFs, the court disallowed plaintiffs' claim.

With regard to negligence, the court in *Borenkind* held that "no duty can be ascribed to defendant owing to the plaintiffs when a publicly sanctioned use is carried out in the legally required manner."³⁷¹ It added that the defendant was "under no duty to wage a public information campaign over the safety and impact on health from the localized emanations of power lines, indeed, . . . there appears to be no evidence of harm or otherwise."³⁷²

d. Trespass Claims

In *Jordan v. Georgia Power Co.*,³⁷³ the plaintiffs sued for damages arising from an alleged trespass of electromagnetic radiation onto their property. The plaintiffs contended that the damages were caused by EMFs from the defendant's power line next to their property. The trial court granted defendant's motion for summary judgment on the trespass claim.³⁷⁴ The judge concluded that EMFs "were not tangible as defined by law for the purpose of trespass determinations."³⁷⁵ He found that "there has been no physical injury to the real estate alleged."³⁷⁶ The plaintiffs appealed the ruling and the Court of Appeals affirmed.

The Court of Appeals ruled that the trial judge's grant of summary judgment was proper. It held that "the scientific evidence regarding whether EMFs cause harm of any kind is inconclusive; the invasive quality of these electric fields cannot presently constitute a trespass."³⁷⁷ The court left open the possibility that trespass cause of actions may become viable in the future, when it concluded "we do not close the door on the possibility that science may advance to a point at

371. *Id.*

372. *Id.*

373. 466 S.E.2d 601 (Ga. 1995).

374. *See id.* at 603.

375. *Id.*

376. *Id.*

377. *Id.* at 604.

which damage from EMFs is legally cognizable and a trespass action may lie."³⁷⁸

C. EMF Workers Compensation Claims

EMF-related workers compensation cases usually arise when a party alleges that he or she has suffered some personal harm or injury, due to occupational exposure to EMFs or power lines. *Pilisuk v. Seattle City Light*³⁷⁹ is one of the most notable EMF-related workers compensation cases in the country. In this case, the Washington State Workers Compensation Appeals Board upheld an earlier state agency decision, which ruled that EMFs did not cause a Seattle City Light worker's leukemia.³⁸⁰

The lawsuit was originally filed in 1991 by the widow of the deceased worker, Roberta Pilisuk. She claimed that she was entitled to worker's compensation benefits on behalf of her husband alleging that he died from an illness due to his employment at the Seattle City Light Utility Company.³⁸¹ The Washington State Department of Labor and Industries denied her claim in 1992. She then appealed to a state administrative law judge, who affirmed the state agency's decision.³⁸²

The judge ruled that "Mr. Pilisuk's leukemia was not naturally and proximately caused by his exposure to EMFs during the course of his employment at Seattle City Light."³⁸³ He added that "while the theory that EMF promotes or copromotes leukemia is plausible, it is not probable."³⁸⁴ The judge further stated that even if one assumes "that EMFs are capable of acting as a promoter, it is impossible to conclude that the exposure naturally and proximately caused

378. *Id.* at 606.

379. See Denise Warkentin, *Seattle City Light Wins EMF Lawsuit Brought By Worker*, ELEC. LIGHT AND POWER, Jan. 1, 1995, at 3 (construing *Pilisuk v. Seattle City Light*, Claim No. T-448239 (Wash. Bd. Indus. Ins. App. 1994)).

380. See *id.*

381. See *id.*

382. See *id.*

383. *Id.*

384. *Id.*

Mr. Pilisuk's leukemia."³⁸⁵ The judge concluded that "the preponderance of evidence suggests that EMF is neither an initiator nor a promoter of leukemia."³⁸⁶ The widow's further petition for review was dismissed by the state's Board of Industrial Insurance Appeal.³⁸⁷ The Board upheld the judge's decision.³⁸⁸

1. Cases Involving Electronic Products and EMFs

*Verb v. Motorola*³⁸⁹ is one of the most instructive EMF-related cellular phone cases. In this class action case, cellular phone users brought an action against various cellular phone manufacturers, including Motorola.³⁹⁰ The plaintiffs claimed that their cellular phones should have been accompanied by warnings that use of the phones may cause an increased health risk. In addition, plaintiffs alleged that the design of cellular phones causes an increase in health risks to the plaintiffs.³⁹¹ Plaintiffs under claims of warranty of fitness, negligence, strict liability, consumer fraud, and deceptive trade practices. Upon defendant's motion to dismiss, the trial court dismissed the class action.³⁹² The court held that the subject matter of the plaintiffs' action was pre-empted by federal law.³⁹³ The court also ruled that the plaintiffs did not allege a compensable injury.³⁹⁴ The plaintiffs appealed.

The Illinois Appellate Court partially affirmed. The court ruled that regulations of the Federal Communications Commission (FCC) did not pre-empt state action against the manufacturers, as ruled by the trial court. It found, however, that "the FDA does preempt a state's power over the issues in the case . . . because the FDA directly regulates electronic

385. *Id.* at 4.

386. *Id.*

387. *See id.*

388. *See id.*

389. 672 N.E.2d 1287 (Ill. Dist. Ct. App. 1996).

390. *See id.* at 1288.

391. *See id.* at 1289.

392. *See id.*

393. *See id.* at 1293.

394. *See id.* at 1296.

products that emit radiation with regard to public health."³⁹⁵ The court found that the Electronic Product Radiation Control Act³⁹⁶ authorized the FDA to "... prescribe performance standards for electronic products to control the emission of radiation from such products, if it determines that such standards are necessary for the protection of public health and safety"³⁹⁷ It found that under the Product Radiation Control Act "no state shall have the authority to act in conflict with that prescribed standard"³⁹⁸ once a FDA standard is in place.

The court ruled that the plaintiffs' future personal injury and damages claim "constitute conjecture and speculation."³⁹⁹ The court noted that the plaintiffs failed to plead specific facts and that any of the plaintiffs may "have discontinued the frequency of the use of their cellular telephones, or that the telephones have diminished in value."⁴⁰⁰ The court concluded that plaintiffs' complaint failed to state a cause of action "because plaintiffs' claims are all based upon mere theoretical possibilities of injury and/or damages."⁴⁰¹

In *Bendure v. Kuston Signals Inc.*,⁴⁰² the plaintiff, a police officer, alleged that exposure to EMFs from a hand-held traffic radar gun, manufactured by the defendants had caused his non-Hodgkins lymphoma. A California jury unanimously found for the defendants.⁴⁰³ The jury did not believe the plaintiff's injury was caused by exposure to EMFs from radar guns manufactured by the defendant.⁴⁰⁴

395. *Id.* at 1291.

The pre-emption doctrine provides that when Congress asserts power over a particular matter, no state has power over that matter. See *Kellerman v. MCI Telecommunications*, 493 N.E.2d 1045, 1049 (Ill. 1986).

396. Electronic Product Radiation Control Act, 21 U.S.C. § 260kk(a)(1) (1995).

397. *Motorola*, 672 N.E.2d at 1293.

398. *Id.*

399. *Id.* at 1295.

400. *Id.*

401. *Id.* at 1296.

402. See *Liljestrand*, *supra* note 122, at 405 (citing to *Bendure v. Kuston Signals Inc.*, Civ. No. C-91-1174 (N.D. Cal. 1993)).

403. See *id.*

404. See *id.*

2. Power Line Cases

Most EMF power line cases involve claims by plaintiffs that their illnesses were caused by exposure to EMFs from the defendants' power lines or high voltage transmission units in the neighborhood. There are many notable power lines cases in the country. One of the first EMF personal injury case was *Zuidema v. San Diego Gas and Electric Company*.⁴⁰⁵ In this case, the plaintiffs claimed that their daughter contracted a rare form of kidney cancer (a Wilms tumor) from exposure to defendant's power lines during her gestation and early childhood.⁴⁰⁶ They sought damages against the defendants in excess of one million dollars. The defendant argued that "no link has ever been shown between EMFs and cancer."⁴⁰⁷ They also contended that the plaintiffs' scientific evidence was based on "insupportable conclusions"⁴⁰⁸ about the child's disease. A California jury agreed with the defendants and rejected the plaintiffs' claims.

In another EMF case, *Jordan v. Georgia Power Company*,⁴⁰⁹ property owners brought action against electric utility and power supply corporation claiming damages arising from electromagnetic radiation on property allegedly caused by power lines located next to their property.⁴¹⁰ The plaintiffs alleged their development of non-Hodgkin's lymphoma was due to exposure from the power lines.⁴¹¹ The plaintiffs based their claims on trespass, nuisance, negligence, and inherently dangerous activity.⁴¹²

The Court of Appeals held that the trial judge committed a reversible error when he admitted the defendant's medical testimony, which stated there was a consensus in the scientific community regarding the adverse health effects of EMFs.

405. See Francis A. Citra, *Utilities Urged to Vigorously Defend EMF Actions*, 72 ELECT. LIGHT & POWER, Sep. 1, 1994, at 3; see also Roy A. Torres, *Cause Of Action For EMF Harm*, 5 Fordham Envtl. L. J. 403, 404-405 (1994).

406. See Citra, *supra* note 405, at 3.

407. *Id.* at 4.

408. *Id.*

409. 219 S.E.2d 601 (Ga. App. 1995)

410. See *Jordan*, 219 S.E.2d at 603.

411. See *id.*

412. See *id.*

The court ordered a limited re-trial, but upheld the trial judge's summary judgment and directed verdicts on the trespass and nuisance claims. The court ruled that "the scientific evidence regarding whether EMFs cause harm of any kind is inconclusive."⁴¹³ The court concluded that "the present state of science does not authorize recovery based on these facts."⁴¹⁴

a. *Glazer et. al., v. Florida Power & Light Co.*

In *Glazer v. Florida Power & Light Co.*,⁴¹⁵ a resident brought a claim of negligence and wrongful death, on behalf of himself and his late wife, against the defendant.⁴¹⁶ He sued the utility company after his wife died from chronic myelogenous leukemia (CML); he was also diagnosed with the same illness.⁴¹⁷ He alleged that both he and his wife contracted the illness as a result of continuous exposure to magnetic fields emanating from electric currents flowing through a water main and from utilities transformer and distribution lines.⁴¹⁸ The judge granted defendant's motion for summary judgment and the plaintiff appealed the decision.

On appeal, the Florida District Court of Appeals upheld the trial judge's decision. The court found that the plaintiff could cite "no scientific study or research," undertaken during the period he occupied his home "specifically examined the issue of whether magnetic fields emanating from plumbing lines may be linked to cancer."⁴¹⁹ According to the court, "in the absence of any study or research to put [the utility] on notice of possible adverse health effects from magnetic fields emanating from water plumbing lines . . . , we conclude that no duty to warn or investigate can be imposed upon the FPL, a utility company, as a matter of law."⁴²⁰

413. *Id.* at 606.

414. *Id.*

415. 689 So. 2d 308 (Fla. Dist. Ct. App. 1997).

416. *See Glazer*, 689 So.2d at 309.

417. *See id.*

418. *See id.* at 13.

419. *Id.*

420. *Id.*

b. *San Diego Gas and Electric Co. v. Covalt*

*Covalt*⁴²¹ encompasses and comprehensively deals with most of the common issues that arise in electromagnetic field litigation.⁴²² The plaintiffs in the case brought actions against SDG&E, a utility company, alleging that EMFs emanating from the utility's power lines had caused them emotional distress, made their home uninhabitable, and destroyed its market value.⁴²³ Their complaint alleged five causes of action for personal injury and three causes of action for property damage. Their personal injury action included claims for the following: (i) medical monitoring; (ii) intentional infliction of emotional distress; (iii) negligent infliction of emotional distress; (iv) strict product liability; and (v) negligent product liability.⁴²⁴ The property damage causes of action included claims for trespass, nuisance and inverse condemnation. The plaintiffs sought injunctive relief, and an order requiring SDG&E to "discontinue the emissions of electromagnetic radiation onto or adjacent to their property."⁴²⁵

The defendants brought a demurrer motion, asking the trial court to dismiss the action. They contended that the trial court lacked subject matter jurisdiction to hear the case and that the plaintiffs failed to state a cause of action on each count of their complaint.⁴²⁶ The trial judge overruled the demurrer, and the defendants filed a petition for a writ of prohibition in the California Court of Appeals.⁴²⁷

The court of appeals granted the defendants an alternative writ and stayed all proceedings.⁴²⁸ In dealing with the merits of the case, the court first dealt with the five personal injury causes of action in the complaint.⁴²⁹ It observed that the plaintiffs "did not allege that they have been physically

421. 920 P.2d 669 (Cal. 1996).

422. See *Covalt*, 920 P.2d at 678-79.

423. See *id.*

424. See *id.* at 679

425. *Id.*

426. See *id.*

427. See *id.*

428. See *id.*

429. See *id.* at 680.

harmed by the electric and magnetic fields arising from SDG&E's power lines, but only that they have experienced emotional distress because they fear that in the future they may contract cancer or other serious diseases as a result of their exposure to such fields."⁴³⁰ Relying on the rule in *Potter v. Firestone*,⁴³¹ the California Court of Appeals ruled that the plaintiffs failed to plead any facts that met the second leg of the Potter Rule, which required that "reliable medical or scientific opinion corroborate[] their belief that it is probable that they will in fact develop cancer in the future from exposure to electric and magnetic fields, arising from SDG&E power lines."⁴³² It concluded that the complaint failed to state a cause of action on the personal injury counts.⁴³³

The court ruled that the cause of action for medical monitoring cannot be brought as a separate cause "... because it is not a separate tort, but simply an item of damages that cannot be awarded until liability is established under a traditional tort theory."⁴³⁴ The court recognized the broad powers of the CPUC, and ruled that a judgment on any of the three property damage causes of action would "conflict with a general regulatory policy of the commission regarding power lines and magnetic fields."⁴³⁵ Ultimately, it held that the trial court lacked subject matter jurisdiction.

The Supreme Court of California, in dealing with the issue of jurisdiction recognized that the CPUC has broad con-

430. *Id.*

431. *Potter v. Firestone Tire & Rubber Co.*, 863 P.2d 795 (Cal. 1993). See also *Covalt*, 920 P.2d. at 680.

432. *Id.* (quoting *Potter v. Firestone Tire & Rubber Co.*, 863 P.2d at 824).

The rule in *Potter* states that:

[d]amages for fear of cancer may be recovered only if the plaintiff pleads and proves that (1) as a result of the defendants' negligent breach of a duty owed to the plaintiff, the plaintiff is exposed to a toxic substance, which threatens cancer; and (2) the plaintiff's fear stems from a knowledge corroborated by reliable medical or scientific opinion, that it is more likely than not that the plaintiff will develop the cancer in the future due to the toxic exposure.

Potter, 863 P.2d. at 824.

433. See *id.*

434. *Id.* at 680 n.18.

435. *Id.* at 681.

stitutional and statutory powers, which allows it to adopt policy on whether: "(1) electric and magnetic fields arising from power lines of regulated utilities are public health risks, and (2) what action, if any, utilities should take to minimize that risk."⁴³⁶ The court found that the CPUC has "exercised and is still exercising" this constitutional and statutory power.⁴³⁷ It recognized that the CPUC has, after reviewing the current scientific evidence, "determined that it is not sufficient at this time to establish that electric and magnetic fields are dangerous and on that basis, adopted a detailed interim policy on the subject . . ." and a "superior court determination that . . . the same evidence is sufficient to answer the question and that such fields are, in fact, dangerous would plainly undermine and interfere with that policy."⁴³⁸ On the issue of trespass, the court ruled that the plaintiffs "do not and cannot state facts sufficient to constitute a cause of action for trespass," under the substantive law of California.⁴³⁹ It observed that "electric and magnetic fields arising from power lines are wholly intangible phenomena . . . , unlike noise, odors or light, they cannot be directly perceived by the senses."⁴⁴⁰ It added that "such fields are an extremely low frequency, non-ionizing form of electromagnetic energy."⁴⁴¹ The court held that the plaintiffs failed to allege, as they were required to do, "that the electric and magnetic fields at issue . . . caused any physical damage to their property."⁴⁴² Relying on its past decision in *Wilson v. Interstate Steel Co.*,⁴⁴³ the court concluded that the plaintiffs proved no "physical dam-

436. *Id.* at 687.

437. *See id.* at 694.

438. *Id.* at 702-703.

439. *Id.* at 695.

440. *Id.*

441. *Id.*

442. *Id.*

443. 649 P.2d 922 (Cal. 1982). In *Wilson*, the court stated that "[n]oise alone, without any damage to the property will not support a tort action for trespass." *Id.* at 924. In addition the court noted "[a]ll intangible intrusions, such as, noise, odor or light alone are dealt with as nuisance cases not trespass. Succinctly stated, the rule is that actionable trespass may not be predicated upon non-damaging noise, odor or light." *Id.* at 924 (citing *Greater Westchester Homeowners Assn. v. City of Los Angeles*, 603 P.2d 1329 (Cal. 1979)).

age to their property and hence no cause of action for trespass"⁴⁴⁴

On the nuisance cause of action, the court stated that a trier of facts would be required to find that reasonable persons viewing the plaintiffs' case objectively would: (1) experience a substantial fear that the electromagnetic fields cause physical harm and (2) deem the invasion so serious that it outweighs the social utility of SDG&E's conduct.⁴⁴⁵ It ruled that the plaintiffs could not bring private nuisance action because, an award of damages on that basis "would interfere with the policy of the CPUC on electric and magnetic fields."⁴⁴⁶ It ruled further that such an award would be inconsistent with the CPUC's determination that electromagnetic fields present no health hazards.⁴⁴⁷

On the inverse condemnation cause of action, the court held that to succeed, the plaintiffs "must allege that the intrusion (to their property) has resulted in a burden on the property that is direct, substantial and peculiar to the property itself."⁴⁴⁸ It explained that a claim for inverse condemnation based on electric and magnetic fields is not governed by the traditional "physical intrusion cases, but by cases dealing with an intangible intrusion that does not physically damage the property."⁴⁴⁹ The court concluded that the plaintiffs are "unable to allege, . . . that the electric and magnetic fields in question caused a direct and substantial burden on their property."⁴⁵⁰

444. *Covalt*, 920 P.2d at 695.

445. *See id.*

446. *Id.*

447. *See id.* at 697.

448. *Id.* at 698.

449. *Id.* (quoting *Varjabedian v. City of Madera*, 572 P.2d 43 (Cal. 1977)).

450. *Id.*

VIII. How The NRC Report And The Decision in *Daubert* Can Impact Future EMF Litigation and Legislation

A. Legislation

1. Legislation at the Federal Level

Because of the high esteem enjoyed by the National Academy of Science and because of its preeminent position as the scientific adviser to the U.S. Government, the findings and conclusions embodied in the NRC Report may encourage EMF legislation at both the federal and state levels. At the federal level, Congress may enact legislation similar to the Electronic Product Radiation Act,⁴⁵¹ authorizing a federal agency, such as, the Department of Energy, to regulate all EMF emitting facilities in the country. Such an enactment may authorize the agency to set and prescribe national performance standards for public health and safety for such facilities. It may contain provisions prohibiting states from acting contrary to or in conflict with the national standards and giving courts very limited powers of judicial review over the agency's EMF policies and standards.

Once such legislation is in place and the designated agency establishes national EMF standards, then all the utility companies need to do to escape liability is to comply with the set standard. If such a utility company complies with the agency standards and regulations and gets its approval before it installs new power lines, or expands existing transmission facilities, it will be in a strong position to defeat plaintiffs' EMF claims. The utility will be in a strong position to successfully raise a preemption defense against such claims.

In *Verb v. Motorola*,⁴⁵² the defendants relied on the Electronic Products Radiation Act (EPRA), and successfully used a preemption defense to defeat plaintiffs' claim that EMFs from their cellular telephones caused them injury. An Illinois

451. See Electronic Product Radiation Control Act, 21 U.S.C. § 360kk(a)(1) (1995).

452. See *Motorola*, 284 N.E.2d at 1287.

Appellate Court found for the defendants, the cellular phone manufacturers. The court held that EPRA "does preempt a state's power over the issues in the case."⁴⁵³ The court found that under the Act, the FDA had the exclusive power, "to prescribe performance standards for electronic products to control the emission of electronic product radiation for the protection of the public health and safety."⁴⁵⁴ It ruled that any determination by the trial court as to whether the cellular phones were unsafe and what warning labels must be made "would require the court to establish standards of safety and warning, which would usurp the FDA's exclusive power to do so with Electronic products that emit radiation."⁴⁵⁵ The court dismissed the plaintiffs' claims on the grounds that they "were pre-empted by the FDA."⁴⁵⁶

2. Legislation at the State Level

At the state level, the NRC Report can also encourage states' legislators to enact legislation, making specified state agencies the exclusive authorities on EMF. A states's legislation, may for example, authorize its public utility commission to adopt a state policy on whether EMFs produced by power lines and high voltage transmission facilities of regulated utilities in the state are public health risks. Also, such legislation may authorize the agency to prescribe what action, if any, the utilities should take to minimize such risks. It may further give the agency comprehensive jurisdiction over questions of public health and safety arising from EMFs and electric utility operations in the state, with very limited judicial review powers to the courts.

In *Covalt*, the California Supreme Court addressed the issue relating to public utilities and the power of the state's PUC (CPUC) to regulate the industry.⁴⁵⁷ The court cited legislation that already exists relating to the any possible health risks that may exist in relation to the utilities industry. The

453. *Id.* at 1293.

454. *Id.*

455. *Id.* at 1294.

456. *Id.*

457. *See Covalt*, 920 P.2d at 699.

legislation is found in the California Constitution⁴⁵⁸ and sections 1759 and 2106 of the California Public Utilities Act.⁴⁵⁹ The court found that the CPUC had broad authority "to determine whether the service or equipment of any public utility (in the state), poses any danger to the health or safety of the public, and if so, to prescribe corrective measures and order them into effect."⁴⁶⁰ The court also found that the commission had broad powers to determine standards for the "design and siting of electric power lines"⁴⁶¹ and to prescribe standards for the installation and use of "appropriate safety or other devices,"⁴⁶² and to require every utility to do "any . . . act which the health or safety of . . . the public may demand."⁴⁶³

The court found that the commission had adopted a "policy on power line electric and magnetic fields."⁴⁶⁴ It dismissed the plaintiffs' claims for nuisance and negligence because awards of damages on them, "would impermissibly interfere with the commission's policy on power line electric and magnetic fields."⁴⁶⁵ It added that award of damages on the plaintiffs' claims would be inconsistent with the CPUC's conclusion, "that evidence did not support reasonable belief that such fields, presented substantial risk of physical harm."⁴⁶⁶ The court, holding that the trial court lacked jurisdiction, concluded that "unless and until evidence supports such belief, utilities need take no action to reduce field levels from existing power lines."⁴⁶⁷

B. Admissibility of Expert Testimony

The decision in *Daubert* and the NRC Report may impact future EMF litigation. *Daubert* established that to be admis-

458. See CAL. CONST. Art XII, § 5 (Amended 1910).

459. See Ann. Cal. Pub. Util. Code §§ 1759, 2106 (West 1996)

460. *Covalt*, 920 P.2d at 687.

461. *Id.*

462. *Id.*

463. *Id.*

464. *Id.* at 688.

465. *Id.* at 697.

466. *Id.*

467. *Id.*

sible, expert scientific testimony must be relevant and reliable, and help the trier of facts to determine the issues in the case. Under the *Daubert* standard, the trial judge should (a) make a preliminary assessment of whether “the methodology underlying the testimony is scientifically valid and whether that reasoning or methodology properly can be applied to the facts in issue”⁴⁶⁸ and (b) consider whether the evidence can be and has been tested, whether the evidence has been subjected to peer review and publication, whether the known or potential rate of error, and the existence and maintenance of standards controlling the technique’s operation and the general acceptance.⁴⁶⁹ Thus, using the *Daubert* guidelines, a trial judge may reject a plaintiff’s expert testimony on the basis of the following options: (1) flawed or invalid methodology, (2) lack of peer review, (3) known or potential rate of error, (4) general acceptance, and (5) relevancy.

1. Flawed or Invalid Methodology

Plaintiffs in EMF litigation invariably rely on epidemiological studies to establish a positive relationship between EMF exposure and cancer. Many of the notable epidemiological studies concerning the health risks of EMFs have been seriously criticized for their improper methodologies. A trial judge confronted with a proffer of such heavily criticized epidemiological study many simply reject it on the grounds that its methodology is flawed. In *Weinberger* one of the factors the trial judge considered in rejecting the much-touted Wertheimer and Leeper studies was the admitted flawed methodologies of those studies.⁴⁷⁰ However, the court did not refer to *Daubert* in reaching its decision.

2. Lack of Peer Review

Using the guidelines in *Daubert*, a trial judge may reject a party’s expert scientific testimony on the grounds that a study has not undergone peer review or been published. In

468. *Daubert*, 509 U.S. at 593.

469. *Id.* at 593-595.

470. *Id.*; see also *Weinberger*, 745 F.2d at 412.

1993, a California administrative law judge, rejected plaintiffs' attempt to tender into evidence the highly publicized Swedish EMF study.⁴⁷¹ Without citing *Daubert*, the judge ruled that the Swedish study has not yet undergone peer review or been published in a scientific journal.

3. Known or Potential Rate of Error

One major problem with epidemiological studies is that they are usually susceptible to errors and full of inconsistencies. Some of the errors identified with past epidemiological studies that linked EMF to cancers include, "possible bias in selection of controls, difficulty in quantization of field strength and exposure and the aberrant influence of confounding factors."⁴⁷² It has been suggested that one reason for the "frustrating contradictions" in epidemiological studies is that "epidemiological studies can be tricky to interpret"⁴⁷³ In an EMF trial, a defendant may simply refer to these known errors and inconsistencies and urge a judge not to admit a plaintiff's proffered epidemiological evidence. Relying on the guidelines in *Daubert*, the judge may exclude such evidence on the grounds of "known or potential rate of error."⁴⁷⁴

4. General Acceptance

According to the Supreme Court there is also another consideration to take into account and that is the notion of "general acceptance."⁴⁷⁵ The Supreme Court stated that "[w]idespread acceptance can be an important factor in ruling particular evidence admissible"⁴⁷⁶ It is important that the scientific community express an acceptance of the general scientific theory that is proffered at trial.⁴⁷⁷ If a relatively unknown technique has been able to gain only minimal sup-

471. See *California ALJ*, *supra* note 329, at 1.

472. See *Colorado EMF Report*, *supra* note 200, at 11.

473. See Conklin, *supra* note 89, at 53.

474. See *Daubert*, 509 U.S. at 594.

475. See *Daubert*, 509 U.S. at 595.

476. *Id.*

477. See *id.*

port then the probability that the particular evidence will be admitted at trial is much lower and will be viewed upon skeptically by the scientific community and the particular court.⁴⁷⁸

5. Relevancy

Almost all existing evidence linking EMF to cancer emerges from the science of epidemiology.⁴⁷⁹ In spite of the numerous studies conducted, no definitive evidence of an association between EMFs to adverse health risks has been documented. None of the studies have linked "leukemia or other cancers to the actual magnetic fields measured in the homes."⁴⁸⁰ Much of the studies that attempted to link EMF to cancer have been described as "much too weak to justify the conclusion."⁴⁸¹ The Oak Ridge Associated Universities in their report concluded that "epidemiologic findings of an association between electric and magnetic fields and childhood leukemia or other childhood or adult cancers are inconsistent and inconclusive."⁴⁸² According to this report, there is no compelling evidence "that these fields initiate cancer, promote cancer or influence tumor progression."⁴⁸³

The National Research Council made similar findings and conclusions. In its report, the NRC stated that "epidemiological evidence does not support possible association of magnetic fields with adult cancers, pregnancy outcome, neuro-behavioral disorders and childhood cancers other than leukemia."⁴⁸⁴ It concluded that "no conclusive and consistent evidence shows that exposure to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects or reproductive and developmental effects."⁴⁸⁵ Defendants in EMF litigation can use these findings and reports to support

478. *Id.*; see also *infra* Section 6 (discussing the concept of "general acceptance").

479. See Taubes, *supra* note 94, at 96.

480. *Id.* at 97

481. *Id.* at 96.

482. *Id.* at 95

483. *Id.*

484. See NRC REPORT, *supra* note 1, at 2-7.

485. *Id.* at 1-2.

an argument that the plaintiffs' proffered expert scientific testimony is inadmissible on grounds of relevancy. A trial court confronted with such an issue can rely on the guidelines in *Daubert* to exclude such evidence on the grounds that it is not relevant and that it will not aid the trier of facts in the case. It is important to point out that the holding in *Daubert* will only impact EMF cases in federal jurisdictions and in those jurisdictions that have adopted the Federal Rules of Evidence.

IX. Conclusion

So far the plaintiffs have lost most of the EMF cases that have gone to trial. Unfortunately, due to the present state of scientific knowledge on EMFs, plaintiffs in these cases will continue to lose these cases unless new scientific studies definitively link EMF exposure to adverse health risks or injury.⁴⁸⁶ As the Georgia Court of Appeal observed in the *Jordan* case, "the scientific evidence regarding whether EMF cause harm of any kind is inconclusive . . . the present state of science does not authorize recovery based on these facts."⁴⁸⁷ The NRC Report and the holding in *Daubert*, will make matters worse for the plaintiffs until new scientific facts and studies can make it possible for them to start winning.

486. See Liljestrand, *supra* note 122, at 404.

487. *Jordan*, 466 S.E.2d at 603