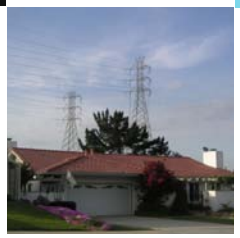
EPRI | ELECTRIC POWER RESEARCH INSTITUTE

January 2012

EMF and Your Health

Contents



Electric and magnetic fields (EMF) are present whenever and wherever electricity is generated, transmitted and used. Given electricity's unique and growing role in modern life – to light our homes, refrigerate our food, heal, diagnose, entertain, and communicate – one important question is whether exposure to EMF can have harmful health effects.

To answer this question, hundreds of scientific studies have been carried out around the world over the last 30-plus years. Conducted at universities and research institutions, these studies have used a variety of approaches to explore the potential health effects of EMF. Some have looked at patterns of disease in human populations, some at the effects of EMF exposure on laboratory animals, and still others at biological mechanisms that might plausibly link EMF to various diseases.

The World Health Organization (WHO) has weighed the full body of evidence from all these studies and classified EMF as "possibly carcinogenic," primarily because of observations made in human populations that show an association between magnetic field exposures and childhood leukemia. The association is weak and not supported by laboratory research, but it does show up in studies time and again, so causation cannot be ruled out. Ongoing research is trying to resolve this uncertainty.

This brochure has been developed to help explain the complex issue of EMF to the general public. It covers the physical nature of electric and magnetic fields, the health research and its findings, our everyday exposures to EMF, and the conclusions reached by scientific panels and policy makers, alike.

The brochure was produced by the Electric Power Research Institute (EPRI), a non-profit institution that has been involved in research on the health effects of EMF for more than 30 years. EPRI's EMF program continues to fund independent research at universities and other research institutions, all of which publish their findings in peer-reviewed scientific journals.

EMF Around You

WHAT ARE ELECTRIC AND MAGNETIC FIELDS?

Electric and magnetic fields are part of both the natural and manmade environments, and are often described as invisible lines of force. As shown in Figure 1, these fields are part of the electromagnetic spectrum, which is arrayed by the frequency of the field, or the number of times the field completes a full cycle (oscillates), every second. Near the low end of the spectrum are fields that arise from the use of electricity in the home. They have frequencies of 50 cycles per second in Europe and 60 cycles per second in North America, or 50 and 60 Hertz (Hz). At the high end of the spectrum is ionizing radiation, such as x-rays and gamma rays, with frequencies in the range of a billion-billion cycles per second. In the middle of the electromagnetic spectrum (millions to billions of cycles per second), are the radio-frequency fields we use everyday for TV, radio, and cell and cordless phones, and microwave ovens.

Ionizing radiation, such as x-rays, has enough energy to damage cells, and its use in medicine and nuclear energy is carefully managed. Radio-frequency exposures interact with people by depositing thermal energy in the body, which can result in the heating of tissue. At the frequencies our electric power systems operate, exposures cannot directly damage cells or produce tissue heating. This brochure focuses on the potential health effects of these extremely low frequency (50 or 60 Hz) fields.

Electricity use produces two types of fields–electric fields and magnetic fields. Electric fields arise from a voltage, which is analogous to the water pressure in a hose, whereas magnetic fields arise when the electric current begins to flow, analogous to opening the nozzle of the hose. Electric fields are easily shielded by objects and materials, such as houses, trees, wood, even skin. However, magnetic fields are not easily shielded and pass through most objects. Both can interact with living bodies, inducing electrical forces within those bodies. This is not so foreign as it might sound, since all living things rely upon electricity to run virtually all processes of life. There is a small voltage across the membrane of every cell in the human body that regulates the internal operations of the cell, acts as a traffic cop regulating what passes in and out of the cell, and sends impulses along the nerves to the brain, organs and extremities. The additional

electrical activity "induced" in the body by outside sources, such as power lines, home wiring, appliances, and equipment, are typically a small fraction of those that regulate the body.

Health-related research over the years has shifted away from electric fields to magnetic fields. The reason is that a large body of research supported by the Department of Energy (DOE) and EPRI, among others, did not uncover hazards associated with electric field exposure at the levels encountered in everyday activity. Exposure at very high levels can potentially be harmful, so standards have been established (see page 18). Health concerns are now focused on magnetic fields.

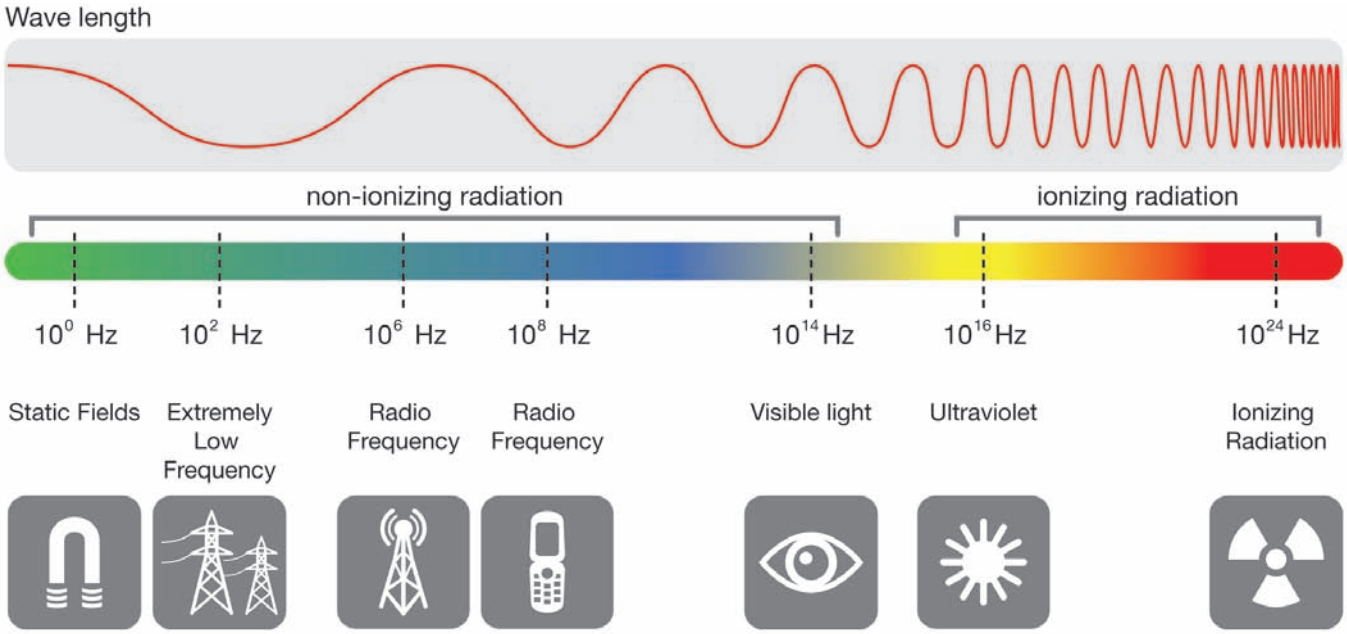


Figure 1 – The electromagnetic spectrum arrays fields by their frequency, ranging from zero (static field) and the very low, with frequencies in the hundreds of cycles per second, to the very high, with frequencies of trillion-billion cycles per second or more. Visible light sits in the middle of the spectrum.

TYPICAL SOURCES OF EMF EXPOSURE

From this point on in the brochure, our discussion focuses on the power frequency magnetic fields (50 or 60 Hz) associated with the transmission, distribution, and use of electricity, as shown in Figure 2. The unit of measure in the United States for magnetic field intensity is the "Gauss," and most of the fields experienced in daily life are in the milligauss range

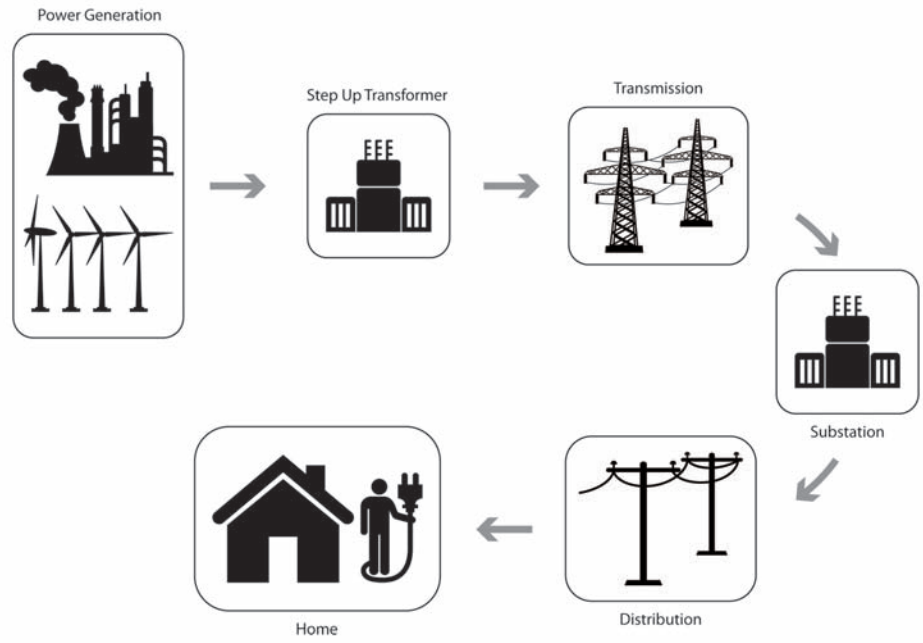


Figure 2 – Keeping the lights on requires an instantaneous flow of electricity from the power station through the transmission and distribution lines directly into the home. Voltage is stepped up or down by transformers to move electricity more efficiently.

OCCUPATIONAL STUDIES

Occupational studies can offer a useful opportunity to examine environmental EMF exposures at higher levels than occur in residential settings. Many occupational studies of electrical workers and others exposed to higher magnetic fields have examined both cancer and other diseases. Overall, the occupational studies do not support the link between magnetic fields exposure and any form of cancer.

(mG = 1/1000 G). The international unit is the "Tesla," which is a multiple of the Gauss, where for example, 10 mG = 1 microtesla.

Most human exposure to EMF from electric power sources (50 or 60 Hz) occurs during daily activities at home, at work and school. This includes exposure to low-level fields from power lines and house wiring, as well as appliances running on electricity. (Note: Exposure to fields from *wireless* communications, such as cell phones, occurs at much higher, megahertz frequencies, and is not covered by this brochure). As shown in Figure 3, magnetic fields from transmission lines fall off rapidly with distance from the lines.

Distribution lines are generally located closer to homes. They also produce magnetic fields but usually at lower levels. Magnetic fields are the result of electrical current, and this flow can fluctuate during the day as demand for power goes up and down. According to the 2002 report of the National Institute of Environmental Health (NIEHS) and the Department of Energy (DOE), "Magnetic fields directly beneath overhead

distribution lines typically range from 10 to 20 mG for main feeders and less than 10 mG for laterals. Peak EMF levels, however, can vary considerably depending on the amount of current carried by the line. Peak magnetic field levels as high as 70 mG have been measured directly below overhead distribution lines, and as high as 40 mG above underground lines."

ANIMALS AND PLANTS

Research on how animals and plants might be affected by exposure to EMF has been conducted since the 1970's. EMF exposure has not been shown to have any consistent detectable, adverse effects on plant growth or animal health. A separate issue is sometimes raised about potential harm to farm animals from "stray voltages." Stray voltage is a general term used to describe the small voltages that may exist at contact locations where they would not be expected nor desired. These voltages may result from the operation of electricity delivery and utilization systems both on and off a farm. Stray voltages may be enhanced by various abnormal and correctible situations, such as poor insulation or wiring errors. Bees in commercial hives with metallic components under or very close to transmission lines may be adversely affected if situated in electric fields high enough to produce conditions prone to shocks within the hives. These effects can be mitigated by shielding and grounding.

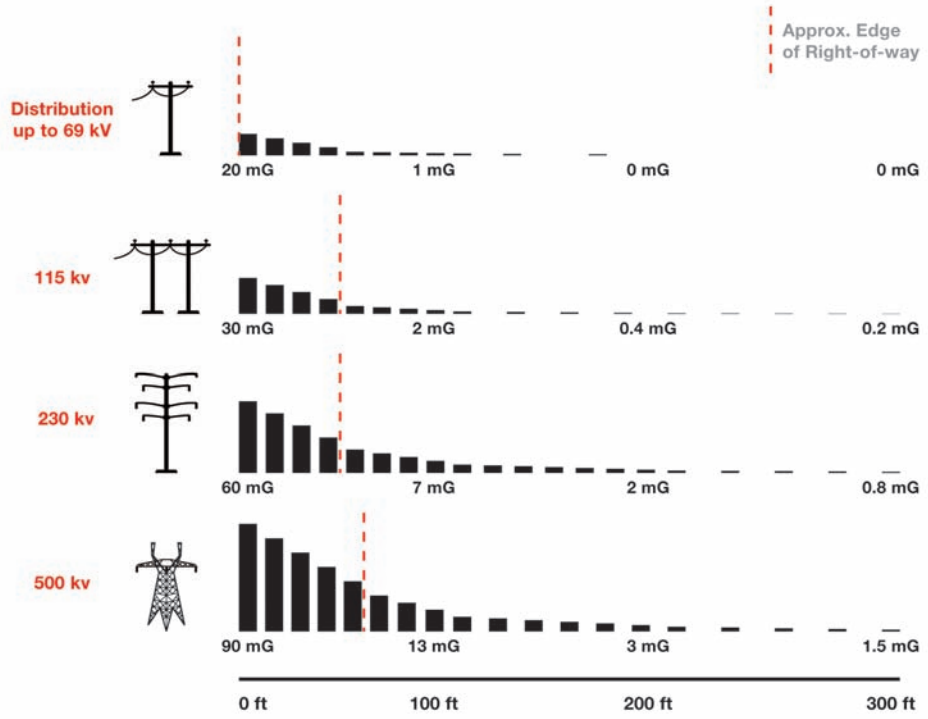


Figure 3 – Magnetic field intensity falls off rapidly with distance for both distribution and transmission lines. The field intensity varies over the day depending upon how much current is flowing through the line, or the design of the line. Source: BPA, 1993 and PG&E, 2008.

HOW EXPOSURE TO FIELDS VARY THROUGHOUT A DAY

A person's exposure changes over time and space, as people move from location to location in everyday life, from home to school or work, as well as when coming closer to appliances or other sources of exposure. Typical exposures throughout the day are shown in Figure 4. An individual may experience momentary peaks while getting dressed (e.g. using a hairdryer), traveling in a vehicle under power lines, and at home during dinner.

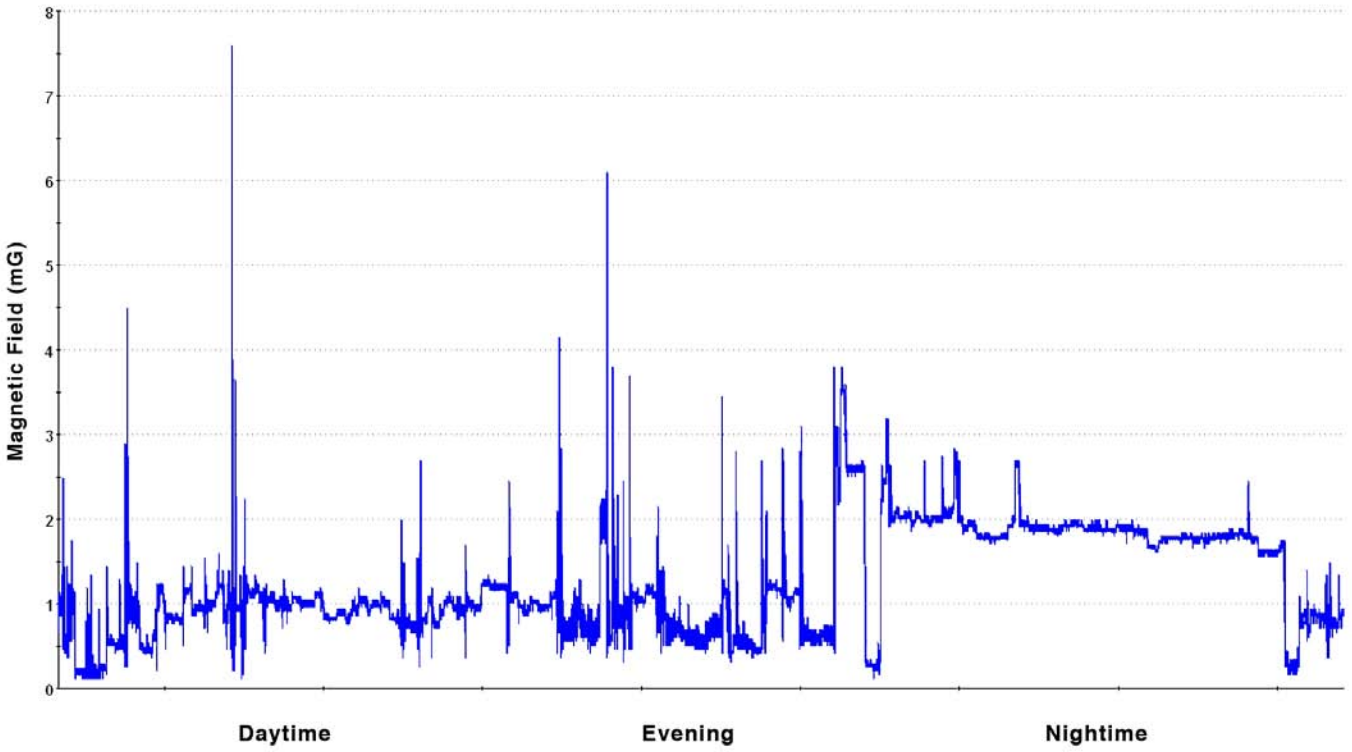


Figure 4 – Fields vary throughout the day. Averages can be quite low but there can be brief spikes as people move around or engage in different activities.

EXPOSURES AND TYPICAL LEVELS

Exposures to EMF in homes vary, depending on the location and type of home, and on how much time a person spends near to sources of EMF, including household appliances and wiring in the walls. In the United States, as shown in Figure 5, about 6% of homes have average exposure levels above 3 mG. One key study found that 3% of California schools are estimated to have average exposure above 3 mG.

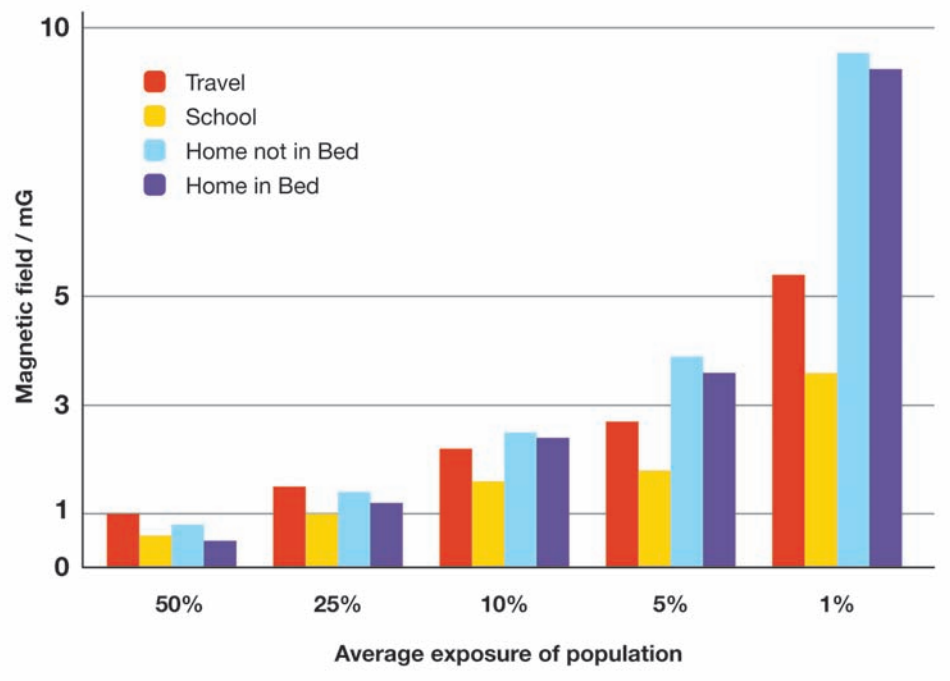


Figure 5 – Average fields found in United States homes, schools and transportation are typically below 3 mG. About 6% of homes show average exposures above 3 mG. Source: EMF Rapid, 1998.

PACEMAKERS AND OTHER MEDICAL DEVICES

Pacemakers and defibrillators are the most commonly implanted medical devices that may be affected by high EMF. Other devices that could possibly be affected by EMF exposure include cochlear implants and neurostimulators. High levels of exposure may cause interference with the operation of these devices through their sensing electrodes. The sensitivity of these devices depends on manufacturer, design, and how they are used by a patient. Metallic case shielding, internal circuits, filters and bipolar sensing have contributed to improved immunity to interference, and in practice, interference is very rare. Concerned individuals should consult their doctor.

Electric fields are produced by household appliances whenever they are plugged in, whether operating or not, while magnetic fields occur only when the appliances are turned on. Both types of fields fall close to background levels within a few feet of the appliance. As shown in Table 1, short-term exposures from some of the appliances that are used close to the body can be quite high. Some hairdryers inches from the head, for example, can produce fields as high as 700 mG. Fields from computer monitors and TVs are quite low overall.

Appliances		Magnetic Field (mG)	
		1.0 foot	User Distance
	AC Adapter	0 – 7.5	0 – 0.8
	Baby Monitor	0 – 2	0 – 15
	Compact Flourescent Bulb	0 – 0.1	0 – 0.6
	Digital Clock	0 – 8	0 – 8
	Dimmer Switch	0 – 0.8	0 – 0.8
	Electric Stove	1 – 5	0 – 20
	Gaming Console	0 – 0.5	0 – 0.6
	Hairdryer	0 – 70	1 – 700
	Laptop Computer	0	0 – 0.1
	LCD TV	0 – 2.5	0 – 0.6
	Microwave	1 – 200	0 – 300
	Plasma TV	1.4 – 2.2	0 – 0.1
	Portable Heater	1 – 40	5 – 150

Table 1 – Exposure to 50 or 60 Hz magnetic fields from electric appliances can vary greatly depending upon how close it is to the body. Intensity falls off dramatically with distance. Source: Zaffanella, 1992, NIEHS, 2002, and EPRI, 2010.

Potential Health Effects

There are a couple of guiding principles in health research. First, a single study is almost never definitive. Drawing scientific conclusions requires that the same or similar results be seen by different investigators. The second guiding principle is that different scientific approaches are useful in getting to the answer. When different approaches arrive at the same conclusion, scientists have greater confidence in the results. When judgments are rendered on whether a specific exposure causes a particular disease, expert scientific panels look at the full "weight of evidence" from all of these different studies before they make the call.

There are three basic approaches that can be thought of as forming a three-legged stool of evidence. The three legs are human studies, animal studies, and "mechanistic studies," which involve finding the underlying chain of physical and biological causation. But why use three approaches instead of one? It is very difficult to *directly* measure the impact of a substance on a human population, so *indirect* measures – the three legs – are used. These indirect measures all have strengths and weaknesses, but together, like a jigsaw puzzle, they can provide a more complete picture. When all three legs support the "weight of evidence," the results are considered solid. When one leg supports one conclusion but the other two legs don't, the stool is wobbly. The uncertainty this creates must be factored into the conclusion reached by expert scientific panels.

Studies involving groups of human beings carry more weight in the health research community than studies involving animals or cells in isolation. The most commonly used approach with humans involves comparing a group of people with a given disease (e.g. children with leukemia) with a comparable group *without* the disease, then estimating the historical exposure of both groups to the agent under study. The researchers look for patterns and associations between exposure and disease. This field of science, called *epidemiology*, uses sophisticated statistical techniques to tease out one possible cause of the disease from all the other possibilities. If researchers find a robust association, they then try to establish the nature and level of the risk.

LEUKEMIAS

Leukemias include a variety of cancers that arise in the bone marrow where blood cells are formed. Leukemias represent less than 4% of all cancer cases in adults but are the most common form of cancer in children. For children age 4 and under the incidence is approximately 6 per 100,000 per year, and decreases to 2 per 100,000 per year past the age of 10. Genetic factors may play a role, but the only known causes are ionizing radiation, benzene, and other chemicals and drugs that suppress bone marrow function, and human T-cell leukemia virus.

[Source: NIEHS 2002, page 18]

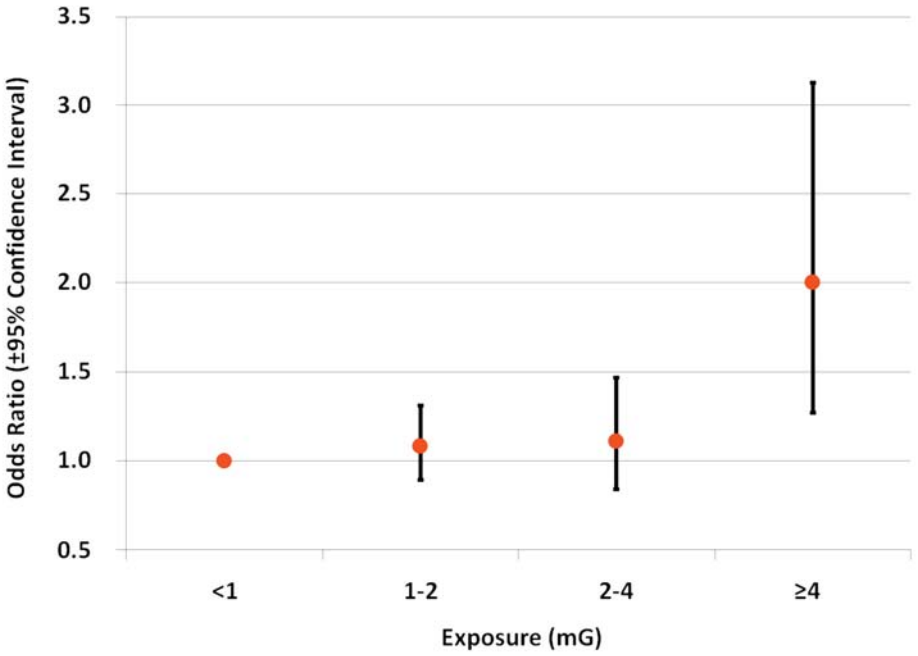


Figure 6 – Results of one pooled analysis of childhood leukemia studies shows the risk of leukemia is increased by a factor of 2 with average exposure levels greater than 4 mG, but found no indication of risk increase below that level. A pooled analysis combines data from different studies into one data set for statistical analyses. Source: Ahlbom, 2000

OTHER THEORIES

Although living near power lines increases exposure to the EMF, there are other factors to consider. According to one theory, interaction between electric fields and airborne pollutants close to high voltage power lines may increase the risk of some health effects. Another theory is that magnetic fields are associated with small voltages in house plumbing systems, which could cause small, imperceptible currents to flow through the bone marrow of children when bathing. These theories are being investigated and thus remain unconfirmed.

If an association is strong, it is more likely that the association does, in fact, denote the cause. For example, the association between smoking and lung cancer is very strong. Epidemiological studies showed more than ten times greater risk for smokers than for non-smokers. If the association is weak, it is possible that the agent is not the *direct cause* of the disease. It could mean that the factor occurs together with some other factor, not measured in the study, that actually causes the disease. In such cases, the association measured may be misleading.

Scores of epidemiological studies, all over the world, have looked at potential health effects in relation to EMF and turned up mixed results. The most consistent finding is an association between magnetic fields and childhood leukemia. Studies that combine or "pool" the data from different studies found the risk of childhood leukemia is increased by a factor of 1.5 to 2 with average exposure levels greater than 3-4 mG, but found no indication of increased risk below the 3-4 mG level. Figure 6 shows the results from one of these pooled analyses (Ahlbom, 2000) where the

risk of leukemia is increased by a factor of 2 with exposure levels greater than 4 mG.

The second scientific approach involves animal studies where laboratory animals, such as mice and rats, are exposed to the agent in question, and often at much higher levels than everyday human exposure. To date, dozens of highly controlled laboratory studies on EMF have been carried out, exposing rodents intermittently and continuously to doses as high as 10 G for as long as two years. These levels are much higher than average residential exposures. The results have been consistently negative, showing no contribution of EMF exposure to the development of cancer. Efforts to extrapolate these results to human beings can be questioned, and future research may use laboratory animals that are genetically engineered to be better models for leukemia research. But one fact stands out: according to the International Agency for Research on Cancer (IARC), *"All known human carcinogens that have been studied adequately for carcinogenicity in experimental animals have produced positive results in one or more animal species."* So, all in all, the second leg of the evidence stool does not support the findings of the first leg.

The third leg of evidence involves more detailed examination of the basic science in an effort to find a plausible biological explanation of how EMF could initiate or promote cancer or some other disease or health outcome. Thus far, a biological mechanism for typical EMF exposures has not been identified despite years of laboratory research. This may be because the energy levels involved are too low to have an effect on DNA. Thus, the third leg of the stool remains shaky, unable to support a coherent picture of how EMF might cause health effects.

The inconsistency in these results has led to classification of magnetic fields as "possibly carcinogenic" by IARC in 2001, and reaffirmed by the World Health Organization (WHO) in 2007. The classification does *not* mean a causal relationship has been established. What it does mean is that an association has been observed that is considered to be scientifically credible, but that chance, methodological bias or some other cause cannot be excluded as an explanation. Table 2 gives examples from the almost 1000 agents evaluated by IARC to date. Extremely low frequency (ELF) magnetic fields are in the same category as lead, chloroform, gasoline engine exhaust, coffee, and pickled vegetables.

IARC Classification	Examples of Agents
Carcinogenic to humans (107) (Usually based on strong evidence of carcinogenicity in humans)	Asbestos Alcoholic beverages Benzene Radon gas Solar radiation Tobacco (smoke and smokeless) X- and gamma-radiation
Probably carcinogenic to humans (59) (Usually based on strong evidence of carcinogenicity in animals)	Biomass smoke indoors Diesel engine exhaust Polychlorinated biphenyls (PCBs) Shift work
Possibly carcinogenic to humans (267) (Usually based on evidence in humans which is considered credible but for which other explanations could not be ruled out)	Chloroform Coffee ELF magnetic fields Gasoline engine exhaust Lead Pickled vegetables Radiofrequency fields
Not classifiable (508)	Tea Hair coloring products (personal use of) Polyvinyl chloride Printing inks Saccharin Static electric and magnetic fields
Probably not carcinogenic to humans (1)	Caprolactam

Table 2 – Examples of IARC classification of different exposures evaluated for their carcinogenicity to humans. To date, 267 out of 942 have been classified as being "possibly carcinogenic to human beings," including extremely low-frequency (ELF) magnetic fields. Source: http://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf, November 2011.

OTHER HEALTH OUTCOMES

In addition to childhood leukemia, many other chronic diseases have been investigated for possible connection to EMF exposure. Results to date have largely ruled out an association of EMF with breast cancer, and heart (cardiovascular) disease. Evidence of an association with childhood brain tumors and adult cancers remains weak. Occupational studies of men and women who have higher exposures at work than at home also do not support the link between magnetic fields and cancer, and research has found no links of EMF with cancer clusters (see sidebars). In addition to childhood leukemia, areas still under investigation include neurodegenerative diseases, such as Alzheimer's, and pregnancy outcomes, such as miscarriage. Each disease or outcome is being evaluated systematically using a rigorous scientific approach that takes into account the overall weight and quality of evidence.

CANCER CLUSTERS

When several cancers occur close in time and space – that is, in a cluster, such as in a given school – people seek a reason, and at times EMF has been thought to be a possible culprit. Most often, upon further investigation, no actual cancer cluster is identified. The perception of a cluster arises partly because people do not always understand how common cancer is. In industrialized countries, one in 2-3 people will develop some type of cancer during their lifetimes. Cancer clusters can and do occur by chance, but distinguishing a chance occurrence from an occurrence with a common cause is difficult. As a result, cancer cluster investigations are rarely productive, and none have linked a cancer cluster to magnetic field exposure.

International EMF Reviews

WHY SCIENTIFIC REVIEW IS IMPORTANT AND HOW IT IS DONE

Organizations that evaluate health research are required to review the entire body of scientific evidence. To do so, they form committees of respected, and well-published experts who evaluate all relevant studies. This requires committee members to look at different lines of scientific inquiry, evaluate the strengths and weaknesses of each, evaluate the scientific relevance of different studies, and the quality of the work. Studies that gather data on long-term human health effects are given more weight by these organizations. Animal studies and mechanistic studies are given less weight, but play an important role as check and balance in the scientific review process.

Not surprisingly, given all the complexities, answers are rarely definitive. No single study ever proves the existence or absence of an effect, which means that science works by the accumulation and evaluation of evidence. That is why the most useful conclusions on the state of EMF knowledge are provided by these scientific panels, usually chosen to provide a range of independent scientific viewpoints and expertise. They work together to develop a balanced consensus. Several such panels have comprehensively evaluated the EMF research literature and their conclusions are cited on the next page. It should be acknowledged that other, less authoritative, organizations have reached conclusions that differ.

National Institute of Environmental Health Sciences (NIEHS) 1999:

"The NIEHS believes that the probability that ELF-EMF exposure is truly a health hazard is currently small. The weak epidemiological associations and lack of any laboratory support for these associations provide only marginal scientific support that exposure to this agent is causing any degree of harm."

"The National Toxicology Program [in the United States] routinely examines environmental exposures to determine the degree to which they constitute a human cancer risk and produces the "Report on Carcinogens" listing agents that are 'known human carcinogens' or 'reasonably anticipated to be human carcinogens.' It is our opinion that based on evidence to date, ELF-EMF exposure would not be listed in the "Report on Carcinogens" as an agent reasonably anticipated to be a human carcinogen."

World Health Organization (WHO) 2007:

"On balance, the evidence [of an association between EMF exposure and childhood leukemia] is not strong enough to be considered causal, but sufficiently strong to remain a concern."

"The scientific evidence supporting a linkage between ELF magnetic fields and any of these [other] diseases is much weaker than for childhood leukemia and in some cases (for example, for cardiovascular disease or breast cancer) the evidence is sufficient to give confidence that magnetic fields do not cause the disease."

European Union's Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) 2009:

"The few, new epidemiological and animal studies that have addressed ELF exposure and cancer do not change the previous assessment that ELF magnetic fields are a possible carcinogen and might contribute to an increase in childhood leukemia. At present, in vitro studies did not provide a mechanistic explanation of this epidemiological finding."

Health Canada 2010:

"There is no conclusive evidence of any harm caused by exposures [to EMF] at levels found in Canadian homes and schools, including those located just outside the boundaries of power line corridors."

Standards and Policies

ESTABLISHING EXPOSURE STANDARDS AND GUIDELINES

There are two main organizations that set EMF exposure guidelines for the general public: the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the IEEE, a professional engineering organization formerly known as Institute of Electrical and Electronic Engineers. ICNIRP and IEEE consider all relevant scientific studies, provide an overall assessment of an adequate level of safe exposure, and then add an additional margin of safety in their standard setting process.

In terms of EMF, they found that there is not enough evidence to support guidelines for long-term exposure to low levels of EMF. The guidelines that do exist are based on limiting the *acute* effects of EMF on the body's nervous system. For magnetic fields, undesirable acute effects, such as nerve stimulation, are created only at field levels much higher than average household exposure. For magnetic fields, the current ICNIRP exposure guideline for the general public at power frequencies (50 or 60 Hz) is 2000 mG.

In addition, electric fields can produce direct effects on the body, such as small electric discharge or causing hairs to vibrate. Everyone is familiar with the phenomenon of touching a doorknob and feeling a small discharge or "microshock." Because it is concentrated on a small area of the skin it can be painful, but it is not usually regarded as harmful. Thresholds for these acute effects of electric fields are typically 5-10 kilovolts per meter (kV/m) for direct perception, and a few kV/m for microshocks. Such electric fields are rarely encountered outside of power line corridors.

NATIONAL POLICIES AND PRECAUTIONARY LIMITS

Health standard setting authorities in the United States and Canada have chosen not to establish national limits on EMF exposure. A few states and a few countries have developed precaution based exposure limits, but many adopt the limits published by ICNIRP or IEEE. Exposures to magnetic fields from power lines, as well as most other ordinary exposures, are well below the prescribed limits.

Some countries, states, and municipalities set limits lower than ICNIRP,

introduce limits based on distance from electric utility facilities, or take precautionary measures that reduce exposure without providing specific guidelines or limits. Regulators in California, for example, initiated a policy for application of low- or no-cost mitigation measures and set cost and performance guidelines.

After its most recent comprehensive evaluation of scientific literature on EMF, the World Health Organization recommended that given the "weakness" of the scientific evidence to date, any expenditures related to reducing EMF exposures should involve "little or no cost." Using a different kind of design during construction of certain types of transmission lines, for example, can reduce fields by about half at a distance of 100 ft, as shown in Figure 7. However, there is no scientific consensus on the application and value of precautionary measures to reduce EMF exposure.

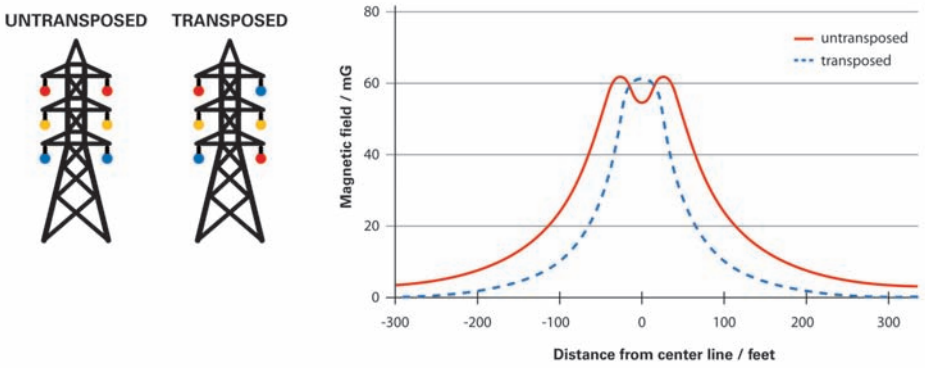


Figure 7– Exposures can be reduced by advanced transmission line design. In this case, exposures are reduced as much as half at a distance of 100 feet. Source: National Grid, 2010.

ELECTROMAGNETIC HYPERSENSITIVITY (EHS)

Some individuals experience a wide range of nonspecific symptoms such as headaches and sleep disturbance that can be quite debilitating, which they ascribe to EMF exposure. Further, some of these individuals believe that they can sense the presence of high fields, which trigger their symptoms. The consensus of the scientific community is that while some of these individuals clearly have health conditions, their symptoms are not related to EMF. This conclusion is based mostly on carefully conducted tests in the laboratory in which individuals self-identified as EHS cannot reliably detect the presence of fields, and their symptoms cannot be attributed to EMF. Several studies have indicated that the observed effects may be caused by an expectation that something harmful is going to happen.

WHAT CAN I DO TO REDUCE MY EXPOSURE?

Concerned individuals can reduce their exposure by learning about sources of EMF in their home and environment and by increasing distance to such sources, or by reducing the time of exposure. Such measures might include moving a bedside clock radio across the room, not using a hair dryer, or moving a child's bed away from EMF exposure sources. The reader can refer to the section of this brochure on Exposures and Typical Levels to learn more about typical exposure levels in many environments.

ONGOING RESEARCH

Much of the research over the years in the United States has been funded by EPRI and various United States government programs. The largest evaluation was undertaken in the early 1990's by the National Institute of Environmental Health (NIEHS) and the Department of Energy (DOE), with input from a wide range of public and private agencies, including EPRI. This evaluation, known as the Electric and Magnetic Fields Research and Public Information Dissemination (EMF RAPID) Program, was a six year project with the goal of providing scientific evidence on whether exposure to power-frequency fields involves a potential risk to human health. In 1999, at the conclusion of EMF RAPID, the NIEHS reported to Congress that the overall scientific evidence for human health risk from EMF exposure is weak.

While much of the government funding has ended since the conclusion of the EMF RAPID Program, EPRI's EMF program continues to fund high quality independent research that is conducted at leading universities and research institutions.

The current EPRI program aims to reduce uncertainty about the observed epidemiologic association between residential magnetic fields and childhood leukemia. Other issues addressed by the EPRI program include pregnancy outcomes and neurodegenerative diseases, such as dementia, Alzheimer's, and ALS (Lou Gehrig disease). EPRI will continue to address this important issue through rigorous research and publish results in the peer-reviewed scientific literature.

FURTHER READING

IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Non-ionizing radiation, Part 1: Static and extremely low-frequency (ELF) electric and magnetic fields. Lyon, IARC, 2002 (Monographs on the Evaluation of Carcinogenic Risks to Humans, 80).

ICNIRP – "Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz - 100 kHz)." Health Phys 99(6):818-836; 2010

IEEE Standards Coordinating Committee 28. IEEE standard for safety levels with respect to human exposure to electromagnetic fields, 0-3 kHz. New York, NY, IEEE - The Institute of Electrical and Electronics Engineers, 2002 (IEEE Std C95.6-2002).

National Institute of Environmental Health Sciences (NIEHS) (1999). NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields. NIH Publication No. 99-4493. Research Triangle Park, NC, USA: National Institute of Environmental Health Sciences, National Institutes of Health.

National Institute of Environmental Health Sciences (NIEHS)/DOE EMF Rapid Program (2002). "Electric and Magnetic Fields Associated with the Use of Electric Power: Questions and Answers." Research Triangle Park, NC, USA.

WHO - World Health Organization. Extremely low frequency fields. Environmental Health Criteria, Vol. 238. Geneva, World Health Organization, 2007.

USEFUL WEB LINKS

IEEE Committee on Man and Radiation web page
http://ewh.ieee.org/soc/embs/comar/

International Commission on Non-Ionizing Radiation Protection
http://www.icnirp.de/documents/FactSheetLF.pdf

National Cancer Institute Factsheet Magnetic Field Exposure and Cancer: Questions and Answers
http://www.cancer.gov/cancertopics/factsheet/Risk/magnetic-fields

NIEHS/DOE EMF RAPID Program June 2002, Elecric and Magnetic Fields Associated with the Use of Electric Power, Questions and Answers
http://www.niehs.nih.gov/health/docs/emf-02.pdf

World Health Organization web page on Electromagnetic Fields
http://www.who.int/peh-emf/en/
http://www.who.int/mediacentre/factsheets/fs322/en/index.html

World Health Organization Database of Worldwide EMF Standards
http://www.who.int/docstore/peh-emf/EMFStandards/who-0102/Worldmap5.htm

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