

EMF and Health

What is EMF?

EMF is an abbreviation for “electric and magnetic fields” and also for “electromagnetic fields.” Power lines, appliances, and home wiring all produce electric and magnetic fields.

Is EMF “radiation” like medical X-rays or ultraviolet sunlight?

Radiation from medical X-rays and from the ultraviolet part of sunlight is strong enough to damage DNA, but EMF from power lines, appliances, and home wiring is not.

What are the EMF levels from common sources?

Please see the chart to the right.

Table 1: Common Sources of Magnetic Fields (mG)

Sources*	Distance from Source	
	6 Inches (mG)	24 Inches (mG)
Microwave Ovens	100 - 300	1 - 30
Dishwashers	10 - 100	2 - 7
Refrigerators	Ambient - 40	Ambient - 10
Fluorescent Lights	20 - 100	Ambient - 8
Copy Machines	4 - 200	1 - 13
Drills	100 - 200	3 - 6
Power Saws	50 - 1,000	1 - 40

*Different makes and models of appliances, tools, or fixtures will produce different levels of magnetic fields. These are generally accepted ranges.
Source: National Institutes of Health - National Institute of Environmental Health Sciences

Table 2: Typical US Magnetic Field Levels Associated with Overhead Transmission Lines

EPRI-EMF	Nominal Voltage Class (kV)	Right-of-Way Width (ROW)(ft.)	Value	Maximum within ROW	At Edge of ROW	Distance from Edge of ROW (ft.)		
						100	200	300
	138	100	E Field (kV/m)	2.5	0.2	0.1	0.03	0.01
			M Field (mG)	34.8	16.8	2.7	1	0.5
	230	130	E Field (kV/m)	3.2	0.2	0.1	0.04	0.02
			M Field (mG)	47.7	21.3	4.6	1.8	0.9
	345	150	E Field (kV/m)	5.6	0.6	0.2	0.1	0.1
			M Field (mG)	77.7	43.7	11	4.5	2.3
	500	130	E Field (kV/m)	5.9	2.9	0.3	0.1	0.05
			M Field (mG)	121.8	49.8	10.7	4.2	2.2
	765	200	E Field (kV/m)	8.4	4.4	0.7	0.2	0.1
			M Field (mG)	217	82.5	23.6	10.9	6.3

NOTE: These values are for general information and not for a specific line.
Source: Electric and magnetic fields are representative values provided by American Electric Power.

Electric and magnetic fields (EMF) are invisible lines of force that occur in nature and wherever electricity flows, such as through electric lines, electric appliances and motors. Electric fields are produced by the presence of voltage or an electrical charge. They are measured in volts per meter, such that the higher the voltage, the greater the electric field. Magnetic fields result from current or the flow of electricity in a wire. Field strength increases as the current increases. Magnetic fields are measured in units called gauss and are typically reported in thousandths of a gauss, or milligauss (mG).

***A lamp that is plugged in produces an electric field even while it is turned off.
However, it will produce a magnetic field only when it is turned on.***

Electric and magnetic fields are present in and around the earth. The magnetic field on the earth (the force that causes a compass to always point north) averages about 500 mG. Thunderstorms also produce EMF.

Alternating current (AC) magnetic fields are associated with power lines and appliances and may cause electrical charges to move in objects that conduct electricity.

Static or direct current (DC) magnetic fields, such as the magnetic field of the earth, do not cause electrical charges to flow in stationary objects.

Objects – including trees, shrubs and buildings – can block electric fields. Magnetic fields, however, are not easily blocked and can pass through most objects.

The strength of both fields declines rapidly as the distance from their source increases.

The Health Effects of EMF

Questions about health effects from EMF exposure first arose in the 1960s and 1970s with the use of higher transmission voltages in the U.S.

Scientists have researched whether exposure to low frequency electric and magnetic fields from power lines and electric appliances poses a risk to human health. Initial research focused on electric fields because higher voltages produce higher electric fields. Overall, studies of electric fields found no evidence of biological changes that could lead to health effects.

EMF research began to focus on magnetic fields when an epidemiological study [Wertheimer and Leeper, 1979] suggested that magnetic fields from power lines in Denver might be linked to childhood cancers. A subsequent study [Savitz, 1988] found statistical results generally consistent with the Denver study.

Since then, many epidemiological studies have focused on the possible role of magnetic fields in cancer and other diseases. To date, while some statistical associations have been reported, no actual health effects have been demonstrated.

The issue is extremely complex; consequently, definitive answers have not been simple or easy to obtain, despite the fact that the topic has been researched for decades.

Types of EMF Research

Laboratory or basic science studies look at effects of EMF on cells and tissues of humans and animals. Epidemiological studies use statistics to determine whether an association exists between a disease and an external factor such as EMF exposure.

Exposure assessment studies look at sources and amounts of EMF exposure.

AEP and EMF

AEP has sponsored and continues to sponsor research through its membership in the Electric Power Research Institute (EPRI), the research organization for the electric utility industry.

AEP itself does not actively conduct research on the health effects of EMF. And, while the company will conduct measurements upon request, interpretation of measured levels is not possible, as no level of exposure has been determined to be unsafe.

AEP takes any health and safety issue very seriously. Therefore, it routinely monitors scientific and technical developments and public policy related to EMF as part of its ongoing effort to provide a safe environment for employees and the public.

For Further Information

To link to third-party websites where you can read the latest information on studies of the potential health effects of EMF exposure, please visit one of the following AEP-affiliated websites:

AEPOhio.com/go/EMF

Appalachianpower.com/go/EMF

AEPTexas.com/go/EMF

Kentuckypower.com/go/EMF

Indianamichiganpower.com/go/EMF

PSOklahoma.com/go/EMF

SWEPCO.com/go/EMF



EMF and Health

What is EMF? “EMF” is an abbreviation for “electric and magnetic fields” and also for “electromagnetic fields.” Power lines, appliances, and home wiring all produce electric and magnetic fields. “EMF” is also commonly used to refer to just “magnetic fields.” Some people are concerned about whether magnetic fields cause adverse health effects. In the information below, “EMF” refers to magnetic fields.

What are the EMF levels from common sources?

Examples of EMF Sources* (in milligauss)	
Coffee makers	7
Toasters	10
Distribution line upper level of typical average	20
Dishwashers	20
500 kV transmission line typical average at edge of right-of-way	30
Distribution line typical maximum above underground line	40
Laptop on lap	18-60
Distribution line typical maximum under overhead line	70
Blenders	70
500 kV transmission line typical average under the line	87
Hair dryers	300
Vacuum cleaners	300

* People typically change activities and locations during a day, so we are exposed to a variety of sources of EMF and a wide range of field levels. In the table above, field levels are taken from the U.S. National Institute of Environmental Health Sciences (NIEHS), Electric and Magnetic Fields Associated with the Use of Electric Power, EMF Questions & Answers, pages 33-35 (median level at 6 inches from appliances), page 36 (distribution lines), and page 37 (transmission lines). As noted by NIEHS, field levels of transmission lines can approximately double during peak loads, which occur about 1% of the time. Laptop on lap: Bellieni, C. V., et al. (2012), Arch Environ Occup Health 67(1): 31-36.

Is EMF “radiation” like medical X-rays or ultraviolet sunlight? No. Radiation from medical X-rays and from the ultraviolet part of sunlight is strong enough to damage DNA, but EMF from power lines, appliances, and home wiring is not. (See page 3 for more information.)

What does the World Health Organization say about whether EMF causes health effects? The World Health Organization says on its website:

"Despite extensive research, to date there is no evidence to conclude that exposure to low level electromagnetic fields is harmful to human health."

<https://www.who.int/news-room/q-a-detail/radiation-electromagnetic-fields> ("Radiation: Electromagnetic fields – Biological effects or health effects? What is a health hazard? – Key Points")

Are there any EMF exposure guidelines? Yes. Two international expert groups have issued exposure guidelines based on avoiding very high levels of exposure that can produce short-term biological responses, such as the perception of a faint flickering of light or a tingling on the skin. The international expert groups are the Institute of Electrical and Electronics Engineers (IEEE) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

Both groups of experts have concluded that no adverse health effects occur at EMF levels below their exposure guidelines.

EMF levels under a typical 500 kV high voltage transmission line are 95% below the strictest guideline.

Typical EMF Levels from Power Lines* <i>compared to</i> EMF Exposure Guidelines (in milligauss)	
IEEE exposure standard for general public	9,040
ICNIRP exposure guideline for general public	2,000
500 kV transmission line typical average under the line	87
Distribution line typical maximum under overhead line	70
Distribution line typical maximum above underground line	40
500 kV transmission line typical average at edge of right-of-way	30
Distribution line upper level of typical average	20

* All power line levels above are taken from U.S. National Institute of Environmental Health Sciences (NIEHS), Electric and Magnetic Fields Associated with the Use of Electric Power, EMF Questions & Answers, pages 36 and 37. As noted by NIEHS, field levels of transmission lines can approximately double during peak loads which occur about 1% of the time.

How much research has been done on EMF and health?

EMF-Health Effects Research Totals * <u>more than</u>		
45 years	2,900 studies	\$490 million spent

* Repacholi M, "Concern that 'EMF' magnetic fields from power lines cause cancer." Sci Total Environ (2012), doi:10.1016/j.scitotenv.2012.03.030, page 3.

How does EMF from power lines compare to “radiation” from sources such as medical X-rays and ultraviolet sunlight?

EMF can be confused with radiation like medical X-rays and ultraviolet sunlight because the term “radiation” is often used to refer to two very different things.

“Radiation” is a scientific term that simply describes how energy travels from a source. A rock tossed into a pond is a source of energy where it lands and causes ripples that “radiate” out in circles - that is “radiation.” TV and radio broadcast towers, power lines, appliances, and home wiring all have fields that radiate out from the source.

The term “radiation,” however, is also used to refer to very different fields, such as those from medical X-rays or the ultraviolet part of sunlight. Exposure to fields from those sources can damage the DNA in cells, which can lead to cancer. A good example is overexposure to sunlight, which can lead to skin cancer. The damage occurs by a process called ionization, so those fields are categorized by science as “ionizing” radiation.

EMF from power lines, electrical appliances, and home wiring, however, is not strong enough to damage DNA, so it is not the same as radiation from medical X-rays or the ultraviolet part of sunlight. EMF, therefore, is categorized as “non-ionizing.”

The capability to damage DNA is determined by the “frequency” of the source. Frequency is measured in Hertz.

For a source to produce enough energy to damage DNA, it must be at a frequency of approximately ten thousand billion Hertz. EMF from the use of electricity is at a frequency of only 60 Hertz in Canada and the U.S.

Comparison of Field Frequencies			
Source of Field		Lowest Frequency Field of Source (Hertz)	
Ionizing Radiation			
		Medical X-rays	1,000,000,000,000,000,000
		Most ultraviolet sunlight	10,000,000,000,000,000
Non-ionizing Radiation			
		Visible light	100,000,000,000,000
		Radio broadcast at a low frequency	10,000
		Electricity	60

What conclusions have government health authorities reached about whether EMF causes health effects? Here are some examples taken from current websites (see links in the next section):

U.S. National Cancer Institute

“Numerous epidemiologic studies and comprehensive reviews of the scientific literature have evaluated possible associations between exposure to non-ionizing EMFs and risk of cancer in children... No consistent evidence for an association between any source of non-ionizing EMF and cancer has been found.”

Health Canada

“While some people are concerned that long term exposure to extremely low frequency EMF may cause cancer, the scientific evidence does not support such claims.”

Australian Radiation Protection and Nuclear Safety Agency

“There is no established scientific evidence that exposure to electric and magnetic fields found around the home, the office or near powerlines causes health effects.”

Where else can I find information about EMF and health? Here are some good places to start:

- World Health Organization website:
 - (1) What are electromagnetic fields?,
<https://www.who.int/news-room/q-a-detail/radiation-electromagnetic-fields>
 - (2) Environmental Health Criteria 238, Extremely Low Frequency Fields,
<https://www.who.int/publications/i/item/9789241572385>
- U.S. National Cancer Institute: Electromagnetic Fields and Cancer,
[https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation/electromagnetic-fields-fact sheet](https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation/electromagnetic-fields-fact-sheet)
- Health Canada: Power Lines and Electrical Products,
<https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/everyday-things-emit-radiation/power-lines-electrical-appliances.html>
- Australian Radiation Protection and Nuclear Safety Agency: Electricity and Health,
<https://www.arpsa.gov.au/understanding-radiation/radiation-sources/powerlines>