

RESEARCHERS HAVE STUDIED ELECTRIC AND MAGNETIC FIELDS (EMF) OVER THE PAST FOUR DECADES. THESE FIELDS ARE GENERATED BY EVERYTHING ELECTRICAL FROM POWER LINES AND HOUSE WIRING TO PERSONAL COMPUTERS AND HOUSEHOLD APPLIANCES.



Ameren appreciates your interest in this scientific topic and hopes you find this brochure useful. We have provided information from respected scientific organizations to answer questions previously asked by customers regarding EMF. These organizations include the National Institute of Environmental Health Sciences (NIEHS), the World Health Organization (WHO), the International Commission on Non-Ionizing Radiation Protection (ICNIRP), and the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), a scientific committee of the European Commission. SCENIHR's responsibility is "to continuously monitor new scientific evidence that may influence the assessment of risks to human health in the area of electromagnetic fields . . . and to provide regular updates to the Commission."

If you need additional information on EMF, please visit the websites of these agencies provided below, or call our EMF information line at **314.554.2402**.

WHAT IS EMF?

Electric and magnetic fields are generated by anything that uses or conducts electricity — not just power lines.

EMF consists of two components:

- Electric fields are created by the voltage of electricity in a wire (similar to water "pressure" in a hose) — the higher the voltage, the stronger the electric field. Electric fields are produced on any energized conductor regardless of whether current is flowing.
- Magnetic fields exist only when current is flowing (similar to water moving through a hose) — the greater the current, the stronger the magnetic field.

This brochure focuses on magnetic fields because the World Health Organization states that "there are no substantive health issues related to ELF electric fields at levels generally encountered

by members of the public." And, most of the questions we receive from customers relate to magnetic fields.

HOW ARE MAGNETIC FIELDS MEASURED?

The intensity of magnetic fields is measured with an instrument called a gauss meter. Exposure is greater when a person is close to a source. Magnetic fields decline substantially with distance from the source. Field intensity is typically recorded in milligauss (one-thousandth of a gauss). Measurements are merely a snapshot of values at a given time and are valid only for that moment. Values can change dramatically depending upon the amount of electricity flowing through power lines or appliances at any given time.

Magnetic fields close to electrical appliances can be much stronger than those from other sources, including magnetic fields directly under power lines. Appliance fields decrease in strength with distance more quickly than do power line fields.¹ See table in this brochure of typical magnetic field levels from appliances compiled by NIEHS.

ARE THERE EXPOSURE STANDARDS FOR MAGNETIC FIELDS?

In the United States, there is no federal standard limiting public exposure to power frequency magnetic fields.¹ Two states have set standards for magnetic fields for new transmission lines — Florida and New York.¹

STATE TRANSMISSION LINE STANDARDS AND GUIDELINES

State	Maximum Line Load Edge R.O.W.*
Florida	≤ 200 mG ^{a, b, c}
New York	≤ 200 mG

* R.O.W. = right-of-way
(or in the Florida standard, certain additional areas adjoining the right-of-way).

^a 150 mG for 69-230 kV lines

^b 200 mG for 230-500 kV lines

^c 250 mG for >500 kV lines

TYPICAL MAGNETIC FIELD LEVELS FROM HOUSEHOLD SOURCES* (in milligauss, mG)

Distance from Source	6 in.	1 ft.	2 ft.	4 ft.	Distance from Source	6 in.	1 ft.	2 ft.	4 ft.
Blenders					Hair Dryers				
**Lowest	30	5	—	—	**Lowest	1	—	—	—
Median	70	10	2	—	Median	300	1	—	—
Highest	100	20	3	—	Highest	700	70	10	1
Power Saws					Video Display Terminals (PCs with color monitors)				
Lowest	50	9	1	—	Lowest	7	2	1	—
Median	200	40	5	—	Median	14	5	2	—
Highest	1,000	300	40	4	Highest	20	6	3	—
Vacuum Cleaners					Refrigerators				
Lowest	100	20	4	—	Lowest	—	—	—	—
Median	300	60	10	1	Median	2	2	1	—
Highest	700	200	50	10	Highest	40	20	10	10
Microwave Ovens					Fluorescent Lights				
Lowest	100	1	1	—	Lowest	20	—	—	—
Median	200	4	10	2	Median	40	6	2	—
Highest	300	200	30	20	Highest	100	30	8	4

The dash (—) in the above table means that the magnetic field measurement at this distance from the operating appliance could not be distinguished from the background measurements taken before the appliance had been turned on.

* From EMF in Electric and Magnetic Fields Associated with the Use of Electric Power, National Institute of Environmental Health Sciences (June 2002).

** Refers to the lowest, median and highest readings of all appliances measured in each category.

TYPICAL MAGNETIC FIELDS PRODUCED BY AMEREN TRANSMISSION LINES¹ (in milligauss, mG)

Type of Transmission Life	Maximum on Right-of-Way	Distance from the Center of the Right-of-Way					
		50 ft	75 ft	100 ft.	200 ft.	300 ft.	400 ft.
138/161 Kilovolts (kV)							
Single power line ² on two wooden poles	45-160	15-55	5-30	5-15	1-5	0-2	0-1
Single power line ² on one steel pole	25-105	10-35	5-20	3-11	1-3	0-2	0-1
Two power lines ² on steel towers or steel poles	10-85	5-55	3-35	2-23	0-7	0-3	0-2
345 Kilovolts (kV)							
Single power line ³ on two wooden poles	72-240	40-130	25-75	15-50	4-13	2-6	1-4
Single power line ³ on one steel pole	60-160	30-90	20-55	12-35	3-10	2-5	1-3
Two power lines ³ on steel towers or steel poles	55-155	45-120	30-80	20-55	5-16	2-7	1-4
Combination 345kV and 138kV⁴	35-180	10-145	10-90	8-55	3-13	1-6	1-3

¹ The values shown in this table are typical for normal system peak operating conditions and do not reflect abnormal circumstances that rarely occur for a short period of time.

² A single 138/161 kV transmission line consists of three large wires and one or two small wires to protect the line from lightning damage.

³ A single 345 kV transmission line consists of three sets of two large wires and one or two small wires to protect the line from lightning damage.

⁴ Values in this table should not be added or subtracted to calculate different combinations of line configurations because the field from each wire affects the fields from other wires and are not necessarily cumulative.



Two organizations have developed exposure guidelines for exposure of workers and the general public — ICNIRP⁵ and ICES.⁶

INTERNATIONAL EXPOSURE GUIDELINES FOR THE GENERAL PUBLIC AND WORKERS— REFERENCE LEVELS IN mG*

	Public	Workers
ICNIRP (2010)	2,000	10,000
ICES (2002/2005)	9,040	27,100

*higher exposures are allowed if Basic Restrictions are met

The public exposure levels in the table above are not exceeded under or near Ameren transmission lines. It is important to understand that a guideline limit is not a precise delineation between safety and hazard and the levels at which adverse effects might occur are far higher than these protective limits.

DOES BURYING POWER LINES REDUCE EMF?

Burying lines does not eliminate exposure. While electric fields are easily shielded by the earth, trees, fences and buildings, magnetic fields are not. At street level, the magnetic field strength from underground power lines depends on the number of cables, the spacing of the cables, the amount of current flowing through the lines and the distance you are from them.

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 distribution lines.¹ The magnetic fields from transmission lines typically will be higher than distribution lines but can diminish to similar levels at the edges of rights-of-way.

Do people living near high voltage power lines have much greater exposures to magnetic fields than others?

The exposure of people living in the vicinity of high voltage power lines differs little from others in the population.² Unlike some chemicals, electric and magnetic fields do not accumulate in the body.

HEALTH EFFECTS

How Do Scientists Study and Evaluate Health Effects?

Scientists typically conduct three types of studies to evaluate potential health effects of exposure to any physical, chemical or biological agent. These are epidemiologic studies (i.e., studies of disease occurrence in human populations), laboratory studies of animals, and laboratory studies of cells and tissues. Potential health effects of EMF from power lines and other sources have been studied worldwide in these scientific areas for about four decades. As the WHO stated, “scientific knowledge in this area is now more extensive than for most chemicals.” To draw conclusions, scientists evaluate the available evidence from all studies in the three main areas. Reliable scientific conclusions cannot be drawn from an individual study or a selected group of studies.

What have health agencies concluded from their reviews of research on EMF and health? The World Health Organization has “concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields”.² The conclusions of other agencies that have conducted comprehensive reviews of the research are similar (ICNIRP, 2010⁵; SCENIHR, 2015).⁷

How Do You Interpret Results of Epidemiologic Studies?

Results of epidemiologic studies have to be interpreted together with other types of studies. Epidemiologic studies alone typically cannot establish a clear cause and effect relationship, mainly because they detect only statistical associations between exposure and disease. A statistical association, in itself, does not establish or prove that the disease is caused by the exposure. The case for a cause-and-effect link is strengthened if there is a consistent and strong association between exposure and effect, a clear dose-response relationship, a credible biological explanation, support provided by relevant animal studies, and

above all consistency between studies. These factors have generally been absent in studies involving magnetic fields and cancer. This is one of the strongest reasons why health and scientific agencies have not concluded that weak magnetic fields have any effects on health.²

Is there a link between EMF exposure and cancer? Despite more than four decades of research to determine whether elevated EMF exposure, principally to magnetic fields, is related to an increase risk of cancer, the available scientific evidence does not confirm a cause and effect relationship.^{1,5,7}

Epidemiologic studies of magnetic fields have provided no consistent evidence for an association with any of the investigated adult cancers and with most cancers of children. Extremely low frequency (ELF) magnetic fields were classified by the International Agency for Research on Cancer (IARC) as possibly carcinogenic to humans based on limited evidence from some of the epidemiologic studies of childhood leukemia and based on inadequate evidence from laboratory animal studies showing no association between exposure to magnetic fields and cancer development. “Possibly carcinogenic to humans” is a classification used by IARC to denote an agent for which there is limited evidence of carcinogenicity in humans and less than sufficient evidence for carcinogenicity in experimental animals. This classification falls below both the “carcinogenic” and “probably carcinogenic” classifications. A cause and effect relationship has not been established because chance and various sources of potential unintentional error in the epidemiologic studies are possible explanations for the statistical associations reported in epidemiologic studies.³

Furthermore, analyses of a few cancer clusters by national and state health epidemiologists have been reported; none have supported the idea that magnetic fields are a contributor to cancer clusters.³

Does EMF affect the development of neurodegenerative diseases? In the past two decades, scientists have extensively studied whether exposure to magnetic fields may be associated with the development of neurodegenerative diseases, such as dementia, Alzheimer’s disease, or Lou Gehrig’s disease, or amyotrophic lateral sclerosis (ALS). Epidemiologic studies to date have not shown consistent associations with any of these diseases, and laboratory studies have not identified any potential biological mechanisms that may explain a potential relationship with these diseases.

Does EMF affect pacemakers or other medical devices?

Implanted medical devices are required to be immune to interference from electric and magnetic fields across a wide range of frequencies. Fields on transmission line rights-of-way would typically be too low to produce harmful interference (European Committee for Electrotechnical Standardization, 2010).^{1,8} If you are concerned about EMF exposure effects on pacemakers, implantable defibrillators or other implanted electronic medical devices you should consult your doctor.

What are the effects of EMF on farm animals? Studies performed to date have found little evidence of EMF effects on fauna at levels below international guideline levels. In particular, there were no adverse effects found on cattle grazing below power lines.⁴

What are the effects on crops and other plants? Field studies of 50-60 Hz exposure to plants and crops have shown no effects at the levels normally found in the environment, nor even at field levels directly under power lines operating at voltages up to 765 kV.⁴

Do power lines affect the reception of GPS signals used to guide farm equipment? Right up close to a tower, there might be some degradation in GPS performance if the tower blocks the signal, just as there can be some degradation close to buildings and trees. The frequency and strength of EMF from power lines, however, are too low to interfere with GPS signals.

FOR MORE INFORMATION

EMF RESOURCES

[World Health Organization \(2017, 2007\)](#)

[who.int/peh-emf/publications/facts/fs322/en/#](https://www.who.int/peh-emf/publications/facts/fs322/en/#)

[who.int/peh-emf/en/](https://www.who.int/peh-emf/en/)

[ICNIRP \(2017\)](#)

[icnirp.org/en/applications/power-lines/index.html](https://www.icnirp.org/en/applications/power-lines/index.html)

[European Commission – SCENIHR \(2015\)](#)

ec.europa.eu/health/scientific_committees/emerging/docs/scenih_r_o_041.pdf

[National Institute of Environmental Health Sciences \(2002\)](#)

niehs.nih.gov/health/materials/electric_and_magnetic_fields_associated_with_the_use_of_electric_power_questions_and_answers_english_508.pdf

REFERENCES

- ¹ The National Institute of Environmental Health Sciences (NIEHS) — EMF Electric and Magnetic Fields Associated with The Use of Electric Power June 2002. niehs.nih.gov/health/topics/agents/emf/index.cfm.
- ² The World Health Organization (WHO) - What is EMF; Establishing a Dialogue on Risks from Electromagnetic Fields — 2002. [who.int/peh-emf/publications/en/EMF_Risk_ALL.pdf](https://www.who.int/peh-emf/publications/en/EMF_Risk_ALL.pdf)
- ³ For example, U.S. National Cancer institute. Long Island Breast Cancer Study Project <https://epi.grants.cancer.gov/past-initiatives/LIBCSP/>. NCI reports “No consistent evidence for an association between any source of non-ionizing EMF and cancer has been found.” [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).
- ⁴ Electromagnetic Fields and Public Health Effects of EMF on the Environment — February 2005; [who.int/peh-emf/about/WhatisEMF/en](https://www.who.int/peh-emf/about/WhatisEMF/en).
- ⁵ International Commission on Non-ionizing Radiation Protection (ICNIRP). Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). Health Phys 99: 818-836, 2010. [icnirp.org/cms/upload/publications/ICNIRPLFgdl.pdf](https://www.icnirp.org/cms/upload/publications/ICNIRPLFgdl.pdf)
- ⁶ International Committee on Electromagnetic Safety (ICES). IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields 0 to 3 kHz. Piscataway, NJ: IEEE, 2002, Reaffirmed 2005. [ieeexplore.ieee.org/document/1046043/](https://www.ieeeexplore.ieee.org/document/1046043/)
- ⁷ Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) for the Directorate-General for Health & Consumers of the European Commission. Opinion on Potential Health Effects of Exposure to Electromagnetic Fields (EMF). Brussels, Belgium: Scientific Committee on Emerging and Newly Identified Health Risks, 2015. ec.europa.eu/health/scientific_committees/emerging/docs/scenih_r_o_041.pdf.
- ⁸ European Committee for Electrotechnical Standardization (CENELEC). Procedure for the assessment of the exposure to electromagnetic fields of workers bearing active implantable medical devices - Part 1: General Std. EN 50527-1:2016 (E). shop.bsigroup.com/ProductDetail/?pid=00000000030321268.

The links listed above are provided for your reference only. Neither Ameren nor its subsidiaries have any control over these websites, nor are they responsible for the contents of these websites. Ameren and its subsidiaries make no representation or warranty regarding these websites or the contents or materials on such websites.

ANSWERING
YOUR QUESTIONS ABOUT

Electric & Magnetic Fields

