



Electric and Magnetic Fields (EMF): the Basics

Staying informed about EMF research efforts conducted by objective, third-party sources is important to Great River Energy. We recognize that people living or working near power lines may have questions about EMF and we have employees who work on power lines and substations every day.

EMF exists wherever electricity is produced or used, and EMF surrounds any electrical appliance or wire that is conducting electricity. Everyone is exposed to these fields. You are exposed at home when you turn on a lamp, e-mail a friend, or use an electric oven or microwave to cook your dinner. In all likelihood, you're surrounded by EMF from electrical equipment in your workplace, too.

What are electric and magnetic fields?

These terms are often used interchangeably, and both electric and magnetic fields from power lines and electromagnetic fields may be abbreviated as EMF. The voltage on an electrical wire is caused by electric charges that can exert forces on other nearby charges. This force is called an electric field (E). When charges move, they produce an electric current that can exert forces on other electric currents. This force is called a magnetic field (M).

What creates electric and magnetic fields?

Electric fields are created by voltage – the higher the voltage, the stronger the field. Anytime an electrical appliance is plugged in, even if it isn't on, an electric field is created in its vicinity. But these fields are easily blocked by walls, trees, and even your clothes and skin, and the farther away you move from the source of the electric field, the weaker it becomes. Moving even a few feet away from an appliance makes a big difference in the strength of the field that you're exposed to. Electric fields are measured in kilovolts per meter (kV/m).

Magnetic fields, measured in milliGauss (mG), are produced by electric current and only exist when an electric appliance is turned on – the higher the current, the greater the magnetic field. As with electric fields, the strength of a magnetic field dissipates rapidly as you move away from its source. However, unlike electric fields that are easily blocked by



We are all exposed to EMF everyday from appliances and anything that uses, generates or distributes electricity. When you are operating a common vacuum cleaner or standing within six inches, you may be exposed to a magnetic field of 300 mG. See Figure 1.

ordinary materials, magnetic fields are not decreased by walls, clothes or other barriers.

Typically EMF research focuses on magnetic fields and not electric fields because electric fields are easily blocked.

How can I measure my EMF exposure?

You can monitor your daily exposure to magnetic fields by wearing a personal exposure meter (called a magnetometer or gaussmeter) or by keeping one close to you. This is the most accurate way to measure your true exposure to magnetic fields during the course of your normal activities. Other meters can be put in a location – like your kitchen or home office – to measure typical EMF levels in that spot. This type of measurement isn't an accurate measure of personal exposure, however, because it doesn't take into account your distance from the source of the fields or the amount of time you might spend in that place. Most utilities offer a free measurement service to customers for their homes or businesses. Contact your local electric service provider.

Figure 1. Typical 60 Hz magnetic field levels

	Magnetic field 6 inches from appliance (mG)	Magnetic field 2 feet away (mG)
Electric shaver	100	–
Vacuum cleaner	300	10
Electric oven	9	–
Dishwasher	20	4
Microwave oven	200	10
Hair dryer	300	–
Computers	14	2
Fluorescent lights	40	2
Copy machines	90	7
Garbage disposals	80	2

Source: National Institute of Environmental Health Sciences / National Institutes of Health: EMF Associated with the Use of Electric Power

What produces EMF at home and at work?

Anything that generates, distributes or uses electricity creates electric and magnetic fields. See Figure 1 above.

What are typical exposures at home?

Exposure levels vary from individual to individual and from home to home, but a study by the U.S. Department of Energy puts the background levels of power line magnetic fields in the typical U.S. home at between 0.5 mG and 4 mG with an average of 0.9 mG. Levels rise the closer you get to the source of the field. It is not unusual for people to be exposed to greater magnetic fields at work than at their home. See Figure 1.

What EMF levels are found near transmission lines?

All transmission lines produce EMF. The fields are the strongest directly under the lines and drop dramatically the farther away you move. See graphs at right. Contact your local utility for EMF information about a particular transmission line near you.

Do underground lines reduce EMF levels?

Because magnetic fields are unaffected by ordinary materials, burying power lines won't keep the fields from passing through the ground. Compared to overhead lines, underground lines are significantly more expensive to install, more difficult to repair and can have greater environmental

impacts. Since current research results provide no conclusive connection between EMF exposure and adverse health outcomes, burying lines isn't a reasonable alternative.

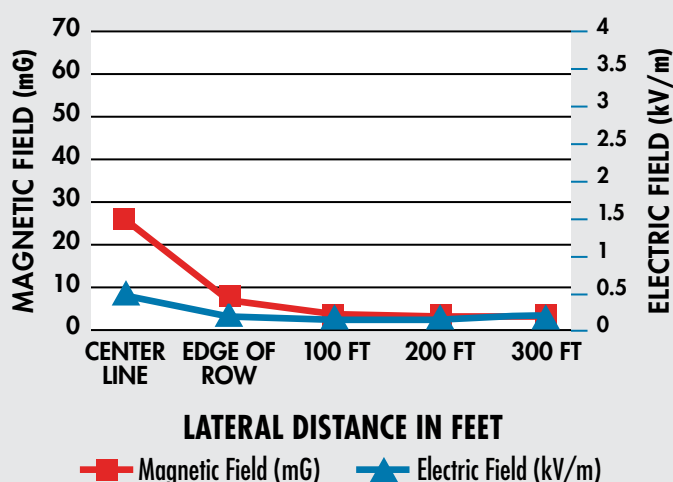
Are there state or federal standards for EMF?

We build transmission lines to industry standards. There are no state or federal standards limiting residential or occupational EMF exposure.

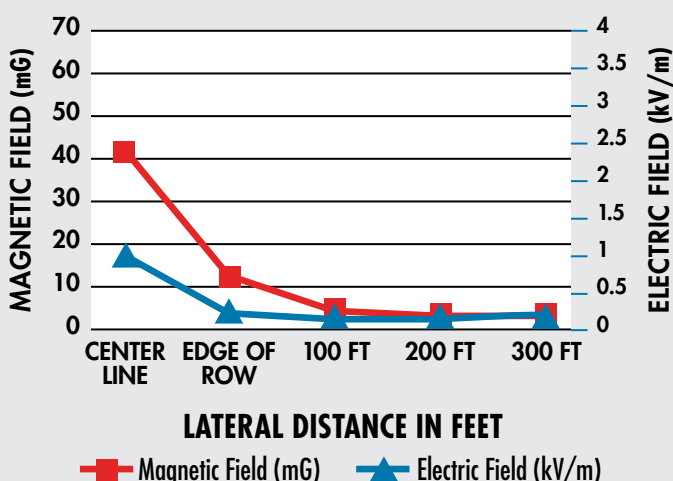
Does power line EMF affect my health?

This issue has been studied for more than 30 years by government and scientific institutions all over the world. The balance of scientific evidence indicates that exposure to EMF

Typical EMF Levels for a 69-kV Transmission Line



Typical EMF Levels for a 115-kV Transmission Line



does not cause adverse health outcomes (see Sources and Useful Links). The 2002 Minnesota Department of Health White Paper on Electric and Magnetic Field Policy and Mitigation Options states (page 36):

“The Minnesota Department of Health concludes that the current body of evidence is insufficient to establish a cause and effect relationship between EMF and adverse health effects.” The entire report is available at greatriverenergy.com/wp-content/uploads/2022/04/mndohwhitepaperemf.pdf

Does EMF interfere with pacemakers or other medical devices?

High levels of power line EMF can interfere with a pacemaker’s ability to sense normal electrical activity in the heart. Most often, the electric circuitry in a pacemaker might detect the interference of an external field and direct the pacemaker to operate at a steady, safe mode. This isn’t considered hazardous and is actually a life-preserving default mode. There have been cases with dual-chamber pacemakers triggering inappropriate pacing before the life-preserving mode takes over. The American Conference of Governmental Industrial Hygienists (ACGIH) issued guidelines for EMF exposure for workers with pacemakers or implantable defibrillators. Maximum safe exposure for workers with these medical devices at 60 Hz (the frequency of most transmission lines) is 1,000 mG for magnetic fields and 1 kV/m for electric fields. Nonelectronic metallic implants (artificial limbs, screws, pins, etc.) can be affected by high magnetic fields like those produced by MRI devices but are generally unaffected by the fields produced by most sources.

How can I reduce my exposure to EMF?

Remember, your exposure is determined by the strength of the magnetic fields given off by things around you, your distance from the source and how much time you spend in the field. Standing back – even an arm’s length away – from appliances that are in use is a simple first step. Some suggestions:

- Move motor-driven electric clocks or other electrical devices away from your bed.

- Be aware that motorized appliances (e.g., hair dryers, shavers, fans, vacuum cleaners, air conditioners) produce magnetic fields.
- Stand away from operating appliances that use a lot of electricity.
- Sit a few feet away from the TV and at least an arm’s length from the computer screen. Liquid crystal or plasma displays (LCDs), however, produce very low levels of EMF compared to the older cathode-ray tube (CRT) displays.
- Turn off appliances, like computer monitors, when you’re not using them.

Sources and useful links

- **Wisconsin Public Service Commission** white paper on EMF: psc.wi.gov/Documents/Brochures/EMF.pdf
- **National Institute of Environmental Health Sciences** booklet, EMF: Electric and Magnetic Fields Associated with the Use of Electric Power. Find it and other links at niehs.nih.gov/health/topics/agents/emf/
- **Minnesota Department of Health** – Minnesota Interagency Working Group on EMF Issues: A White Paper on Electric and Magnetic Field Policy and Mitigation Options. Find it at apps.commerce.state.mn.us/eera/web/project-file?legacyPath=/opt/documents/EMF%20White%20Paper%20-%20MN%20Workgroup%20Sep%202002.pdf
- **Western Area Power Administration:** Electric and Magnetic Fields: Facts. Find it at wapa.gov/wp-content/uploads/2023/04/EMFbook-1.pdf
- **World Health Organization Fact Sheet:** Electromagnetic fields and public health. Find it at who.int/news-room/questions-and-answers/item/radiation-electromagnetic-fields
- **American Cancer Society:** Information about non-ionizing radiation and power lines. Find it at cancer.org/cancer/risk-prevention/radiation-exposure/extremely-low-frequency-radiation.html



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