Public Service Commission of WISCONSIN

Electric & Magnetic Fields (EMF)

Introduction

The Public Service Commission of Wisconsin (PSC or Commission) prepared this informational guide about electromagnetic fields (EMF) to help in understanding of transmission line safety and regulation.

Utilities and transmission companies build and/or upgrade transmission lines to carry electricity over long distances. Before they undertake new construction projects, they must apply for PSC approval and the application must include information on EMF to inform the Commission's determination of whether a project is in the public interest.

About Electromagnetic Fields

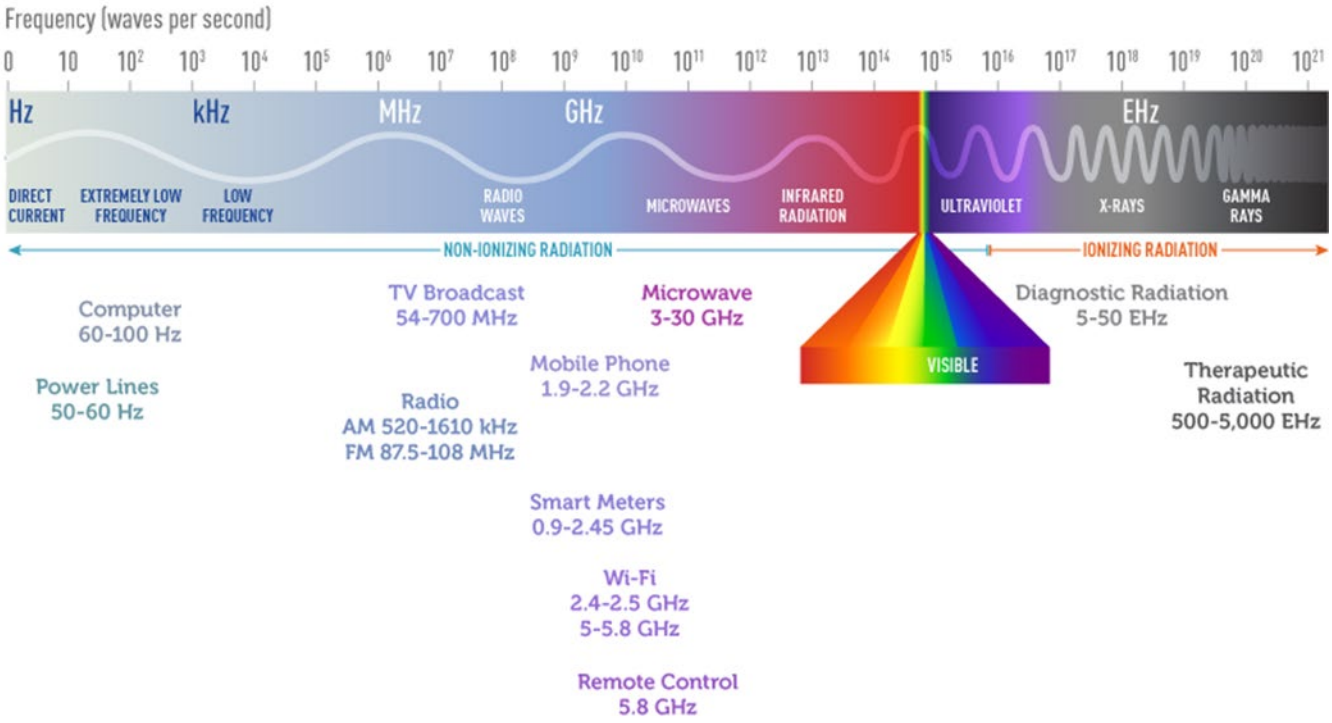
Electricity produces electric and magnetic fields. These fields are a line of force that are often combined and called **electromagnetic fields** (EMF). **Electric fields** are created with any device or wire that is connected to a source of electricity, even when current (or the rate of flow of electric charge) is not flowing, or the device is not turned on. **Magnetic fields** are created only when there is an electric current flowing. A magnetic field is proportional to the current flow through an electric line; this means that as the current increases, so does the magnetic field.

The strength of electric and magnetic fields decreases significantly as distance from the source increases. Electric fields, including those from high-voltage transmission lines, are easily shielded by common objects such as trees, fences, and walls. Magnetic fields can more easily pass through non-metallic objects, but drop in strength quickly as distance increases.

Magnetic fields are part of the **electromagnetic spectrum**, which includes the range of radiation types from low to high frequencies. Radiation is energy that travels and spreads evenly as it moves away from a source. Visible light that comes from a lamp and radio waves that come from a radio station are examples of two types of electromagnetic radiation.

Only the highest frequencies of electromagnetic radiation, like gamma rays, are ionizing and can break apart DNA, which can lead to negative health impacts, such as cancer. Magnetic fields generated by electric lines are non-ionizing and fall in the extremely-low-frequency (ELF) range of the electromagnetic spectrum. Unlike ionizing radiation, magnetic fields from ELF radiation, including from electric lines and other sources such as appliances, cannot break apart molecular bonds in DNA. The image below from the National Cancer Institute represents the electromagnetic spectrum and different electrical devices.

Figure 1 Electromagnetic Spectrum[1]



Common Levels of Magnetic Fields

Any device that uses electric current creates a magnetic field. The common measurement unit of magnetic fields is in milligauss (mG), which is equal to one-thousandth of a Gauss (G). Electric appliances such as computers and refrigerators, and the wiring that runs through walls and ceilings in homes, produce magnetic fields when current is flowing. Many of these devices (e.g. microwave oven, dishwasher,

[1] National Cancer Institute at the National Institute of Health, *Electromagnetic Fields and Cancer*, <https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation/electromagnetic-fields-fact-sheet>, accessed July 14, 2025.

hairdryer) emit a greater magnetic field at short distances in comparison to what overhead high-voltage transmission lines emit at the centerline under the wires. Typical household background environmental or ambient magnetic field levels are most often around one to three mG. Table 1 below shows some common household devices and estimated magnetic field levels. For example, dishwashers emit a magnetic field range of 10 to 100 mG at a distance of six inches, but those levels drop to 2 to 7 mG at 24 inches away. Similarly, on average, a 230 kilovolt (kV) transmission line may emit a field of 20 mG at 50 feet from the centerline (directly under the wires) but deplete to ambient levels at 300 feet from the centerline.

Table 1 Common Sources of Magnetic Fields (mG)

	Distance From Source	
Sources*	**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
Vacuum cleaners	100 - 700	4 - 50
Drills	100 - 200	3 - 6
Transmission Lines**	**50 feet (mG)**	**300 feet (mG)**
115 kV	7 – 14	0.2 – 0.4
230 kV	20 - 40	0.8 – 1.6
500 kV	29 – 62	1.4 – 3.0

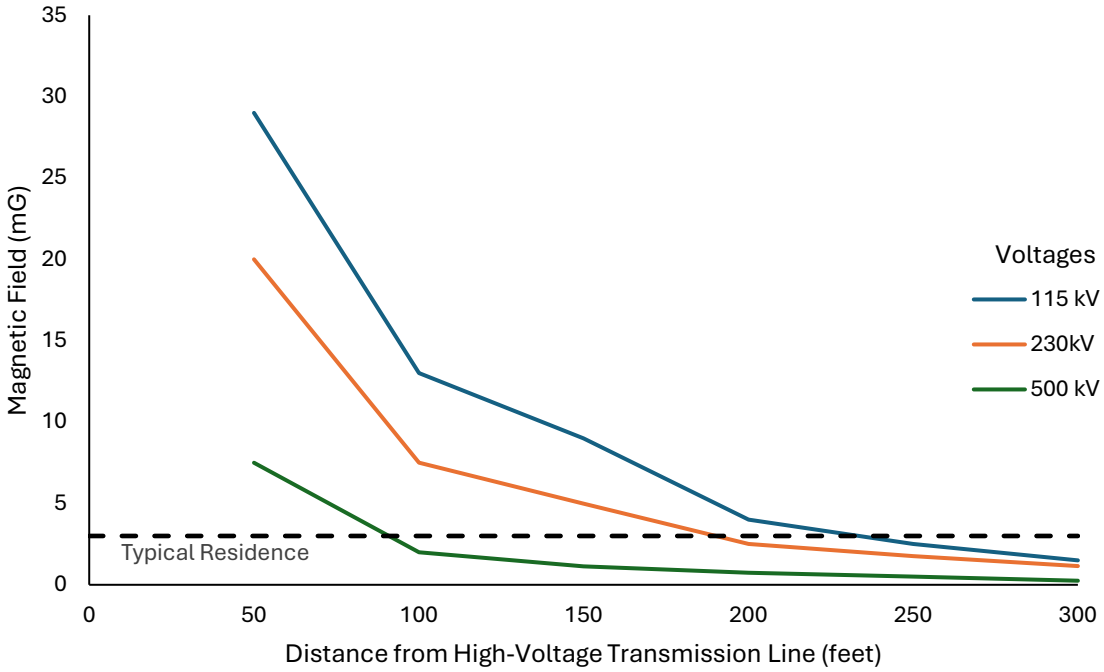
*Different makes and models of appliances, tools, or fixtures will produce different levels of magnetic fields. These are generally accepted ranges.

** NOTE: These values are for general information and not for a specific line.

Since magnetic field levels in the vicinity of transmission lines are dependent on the flow of electric current through them, those levels can change throughout the day as electrical demand increases and decreases. For overhead transmission lines, the magnetic fields typically range from about five to 150 mG, depending on the amount of current flowing, the separation of the conductors (wires), and distance from the lines. In general, at a distance of about 300 feet from a transmission line, measured magnetic

fields are similar to typical ambient background levels found in most homes. Figure 2 depicts the magnetic fields of different transmission line voltages at increasing distances from the centerline. The dashed line on the figure represents the ambient magnetic field levels of a typical single-family household residence.

Figure 2 Magnetic Field Strength and Distances from Overhead Transmission Lines[2]



EMF Safety

EMF has been heavily researched and studied to understand if human health effects exist. Research including epidemiological (field) studies and laboratory studies have been done to study the effects of non-ionizing ELF radiation at different levels, from low levels in residences to higher levels that may be experienced by line workers. To date, studies have been unable to identify any plausible biological mechanism by which EMF exposure might cause any human disease, and scientists have come to a consensus that EMF is not responsible for human disease. According to the National Cancer Institute, there is no mechanism identified that would explain how EMF could cause cancer. No published power-frequency exposure study has shown a statistically

[2] Data interpreted from Medical College of Wisconsin website by John Moulder, *Power Lines and Cancer FAQs,* archived at <http://large.stanford.edu/publications/crime/references/moulder/moulder.pdf>, accessed on July 14, 2025.

significant dose-response relationship between measured magnetic fields and cancer rates or between distances from transmission lines and cancer rates.

The following organizations and websites contain detailed information about EMF and transmission lines along with links to published research.

- International Commission on Non-Ionizing Radiation Protection https://www.icnirp.org/en/applications/power-lines/index.html
- National Cancer Institute (NCI) http://www.cancer.gov/cancertopics/factsheet/Risk/magnetic-fields
- National Institute of Environmental Health Sciences (NIEHS) http://www.niehs.nih.gov/health/topics/agents/emf/
- US EPA https://www.epa.gov/radtown/electric-and-magnetic-fields-power-lines
- World Health Organization (WHO) http://www.who.int/peh-emf/en/

Review and Regulation of EMF

The PSC actively monitors EMF research and its potential for causing human health effects. Consideration of magnetic field exposure is a regular part of the review process for electric utility construction cases. Transmission line and substation construction applications must contain several types of information that relate to magnetic fields and must adhere to current guidelines regarding exposure.

A utility must provide estimates of magnetic fields that would be generated by a proposed transmission line. The estimates are specific to the proposed voltage, line configuration, and peak power flows during the first year of operation and after ten years of operation. In its application, a utility must report the number and type of buildings within 300 feet of a proposed centerline, including schools, hospitals, and daycare centers.

Commission staff check and verify the utility's calculations of the estimated magnetic fields. This information is then available to the public and the Commission when it makes a decision about a proposed project and routing options.

In the US, there are no federal standards limiting occupational or residential exposure to EMF from power lines. Limits established by national and international professional organizations are well beyond the range of magnetic fields typically generated by transmission lines. In 2019, the Institute of Electrical and Electronics Engineers (IEEE) published a public exposure guideline of 9,040 mG for head and torso exposure (at 20-

751 Hz).[3] In 2010, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) revised its reference levels for public exposure to magnetic fields in the 60 Hz range and recommended that magnetic fields not exceed 2,000 mG[4]. As discussed, this level is far higher than that produced by the high-voltage transmission lines reviewed by the Commission.

Additional information about the Transmission Line Review Process is available at https://psc.wi.gov/SiteAssets/TransmissionLineReviewProcess.pdf

Public Service Commission of Wisconsin
P.O. Box 7854
Madison, WI 53707-7854

Telephone: 608-266-5481
Toll free: 888-816-3831
Consumer affairs: 608-266-2001 / 800-225-7729
TTY: 608-267-1479 / 800-251-8345
Fax: 608-266-3957

Website: psc.wi.gov

[3] Institute of Electrical and Electronics Engineers (IEEE), *C95.1-2019 IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields 0 to 300 GHz,*. New York, IEEE, 2019 <https://www.sandiegocounty.gov/content/dam/sdc/pds/ceqa/Soitec-Documents/Final-EIR-Files/references/rtcref/ch9.0/RTCrefappx/2014-12-19_IEEE2002.pdf>, accessed on July 14, 2025.

[4] International Commission on Non-Ionizing Radiation Protection (ICNIRP), *Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz - 100 kHz)*. Health Physics, Vol. 99, No. 6, November 2010, p. 3, <https://www.icnirp.org/cms/upload/publications/ICNIRPLFgdl.pdf>, accessed July 14, 2025.