

# **Transmission Lines - Electric and Magnetic Fields (EMF)**

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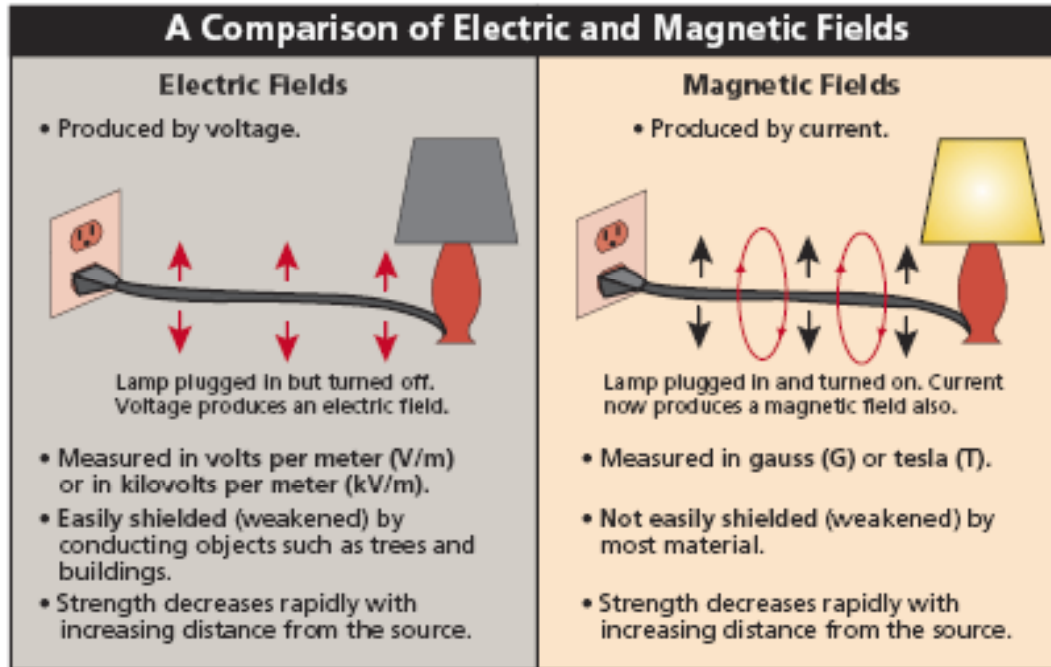
Florida DEP - Siting

**Q: What are electric and magnetic fields?**

**A: Electric and magnetic fields (EMF) are invisible lines of force that surround any electrical device.** Power lines, electrical wiring, and electrical equipment all produce EMF.

Electric fields are produced by voltage and increase in strength as the voltage increases. The electric field strength is measured in units of volts per meter (V/m).

Magnetic fields result from the flow of current through wires or electrical devices and increase in strength as the current increases. Magnetic fields are measured in units of gauss (G) or tesla (T).

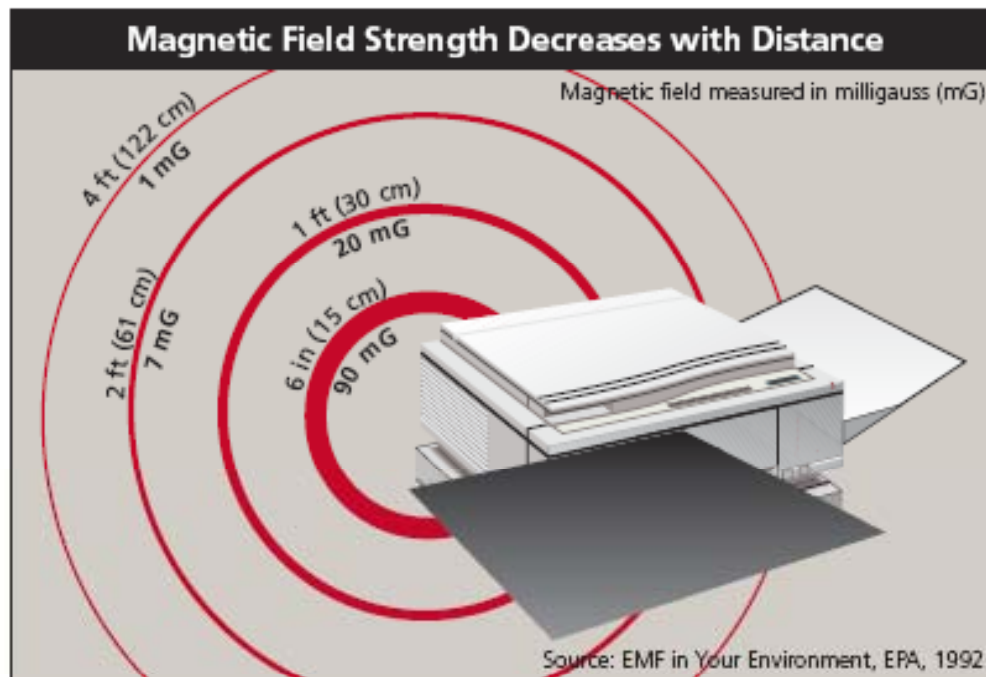


An appliance that is plugged in and therefore connected to a source of electricity has an electric field even when the appliance is turned off. To produce a magnetic field, the appliance must be plugged in and turned on so that the current is flowing.

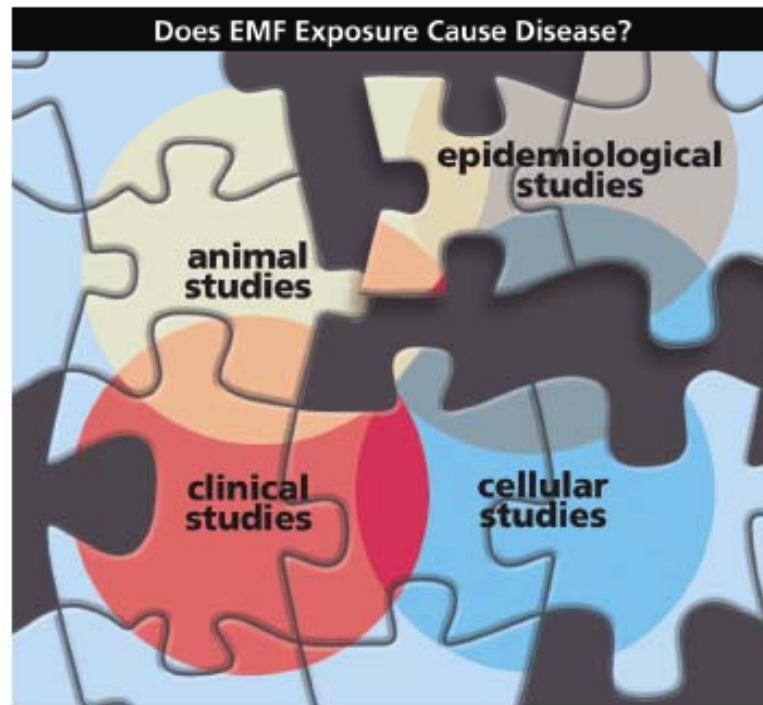
**Electric fields** are shielded or weakened by materials that conduct electricity—even materials that conduct poorly, including trees, buildings, and human skin.

**Magnetic fields**, however, pass through most materials and are therefore more difficult to shield.

Both electric fields and magnetic fields decrease rapidly as the distance from the source increases.



You cannot see a magnetic field, but this illustration represents how the strength of the magnetic field can diminish just 1–2 feet (30–61 centimeters) from the source. This magnetic field is a 60-Hz power-frequency field.



Laboratory studies and human studies provide pieces of the puzzle, but no single study can give us the whole picture.

Even though electrical equipment, appliances, and power lines produce both electric and magnetic fields, most recent research has focused on potential health effects of magnetic field exposure. This is because some epidemiological studies have reported an increased cancer risk associated with estimates of magnetic field exposure. No similar associations have been reported for electric fields; many of the studies examining biological effects of electric fields were essentially negative.

**Q: So what about magnetic field data?**

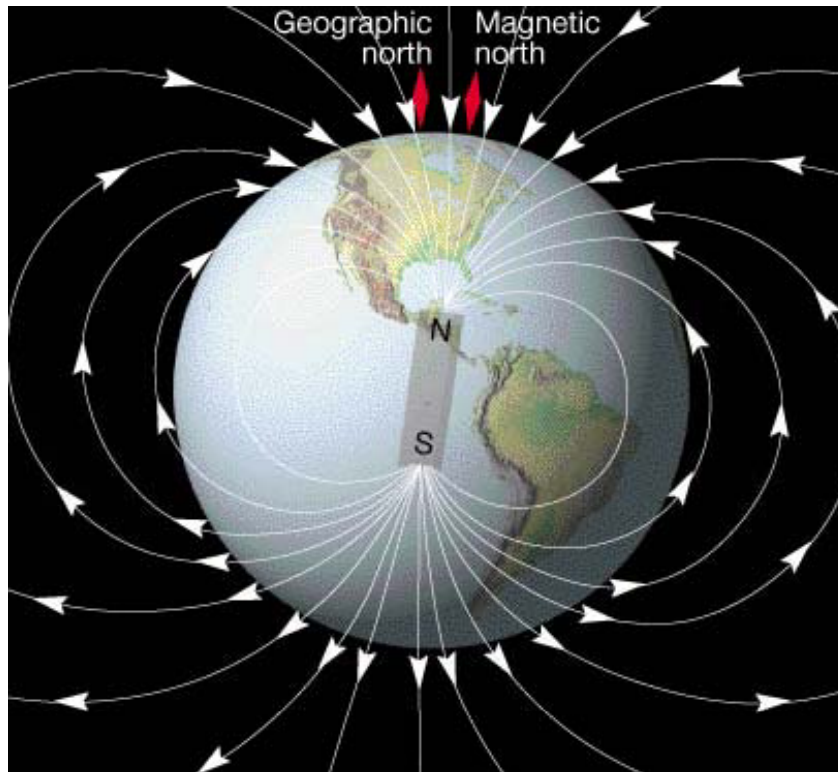
**A:** After reviewing all the data, the U.S. National Institute of Environmental Health Sciences (NIEHS) concluded in 1999 that the evidence correlating EMF to childhood leukemia was weak, but that it was still sufficient to warrant limited concern. The NIEHS rationale was that no individual epidemiological study provided convincing evidence linking magnetic field exposure with childhood leukemia, but the overall pattern of results for some methods of measuring exposure suggested a weak association between increasing exposure to EMF and increasing risk of childhood leukemia.

**Association**

In epidemiology, a positive association between an exposure (such as EMF) and a disease is not necessarily proof that the exposure caused the disease. However, the more often the exposure and disease occur together, the stronger the association, and the stronger is the possibility that the exposure may increase the risk of the disease.

**Q: Wait a minute.... doesn't the earth produce EMF?**

**A: Yes.** The earth produces EMF, mainly in the form of static fields, similar to the fields generated by DC electricity. The earth's magnetic field of about **500 mG** is thought to be produced by electric currents flowing deep within the earth's core.



**Q: Have clusters of cancer or other adverse health effects been linked to EMF exposure?**

**A : There have been no proven instances of cancer clusters linked with EMF exposure.**

An unusually large number of cancers, miscarriages, or other adverse health effects that occur in one area or over one period of time is called a “cluster.” Sometimes clusters provide an early warning of a health hazard.

**Q: Have cancer rates increased along with the increased use of electricity and the related EMF exposure?**

**A: Not necessarily.**

Although the use of electricity has increased greatly over the years, EMF exposures may not have increased. Changes in building wiring codes and in the design of electrical appliances have in some cases resulted in lower magnetic field levels. Rates for various types of cancer have shown both increases and decreases through the years, due in part to improved prevention, diagnosis, reporting, and treatment.



**Q: Is there a link between EMF exposure in electrical occupations and cancer?**

**A: Various studies have been completed in the USA, Canada, and Europe:**

**California**

A 1993 study of 36,000 California electric utility workers reported no strong, consistent evidence of an association between magnetic fields and any type of cancer.

**Canada/France**

A 1994 study of more than 200,000 utility workers in 3 utility companies in Canada and France reported no significant association between all leukemias combined and cumulative exposure to magnetic fields. There was a slight, but not statistically significant, increase in brain cancer. The researchers concluded that the study did not provide clear-cut evidence that magnetic field exposures caused leukemia or brain cancer.

**North Carolina**

Results of a 1995 study involving more than 138,000 utility workers at 5 electric utilities in the United States did not support an association between occupational magnetic field exposure and leukemia, but suggested a link to brain cancer.

**Denmark**

In 1997 a study of workers employed in all Danish utility companies reported a small, but statistically significant, excess risk for all cancers combined and for lung cancer. No excess risk was observed for leukemia, brain cancers, or breast cancer.

**United Kingdom**

A 1997 study among electrical workers in the United Kingdom did not find an excess risk for brain cancer. An extension of this work reported in 2001 also found no increased risk for brain cancer.

So, the studies are not consistent.....



**Q: Have there been any long-term, continuous exposure studies done to connect EMF with leukemia?**

**A : There have been five long-term, continuous exposure studies done on mice and rats.**

In summary, the studies found no effect.

Animal Leukemia Studies: Long-Term, Continuous Exposure Studies, Two or More Years in Length			
First author	Sex/species	Exposure/animal numbers	Results
Babbitt (U.S.)	Female mice	14,000 mG, 190 or 380 mice per group. Some groups treated with ionizing radiation.	No effect
Boorman (U.S.)	Male and female rats	20 to 10,000 mG, 100 per group	No effect
McCormick (U.S.)	Male and female mice	20 to 10,000 mG, 100 per group	No effect
Mandeville (Canada)	Female rats	20 to 20,000 mG, 50 per group <i>In utero</i> exposure	No effect
Yasui (Japan)	Male and female rats	5,000 to 50,000 mG, 50 per group	No effect

10 milligauss (mG) = 1 microtesla ( $\mu$ T) = 0.001 millitesla (mT)

**Q: So, if the findings are not consistent, what kind of guidelines exist to provide protection for the general public?**

**A :** Two organizations have developed voluntary guidelines for EMF exposure. One of these organizations (The International Commission on Non-Ionizing Radiation Protection, or ICNIRP) has established reference levels (guidelines) which are recognized by the USA's National Institute of Environmental Health Science (NIEHS) and the World Health Organization (WHO). Exposure below these reference levels is considered to be safe.

**Table 4.** Reference levels for general public exposure to time-varying electric and magnetic fields (unperturbed rms values)

Frequency range	E-field strength (V m <sup>-1</sup> )	H-field strength (A m <sup>-1</sup> )	B-field (μT)
1 – 10 Hz	10 000	$4 \times 10^4 / f^2$	$5 \times 10^4 / f^2$
0.01 – 0.025	10 000	4/f	5/f
0.025 – 0.1 kHz	250/f	4/f	5/f
0.1 – 0. kHz	250/f	40	50
0.4 – 1 kHz	250/f	16/f	2/f
1-3 kHz	250/f	16	20
3 – 100 kHz	87	16	20

Note:

- *f* in Hz or kHz, as indicated in the frequency range column.
- See separate sections below for advice on non sinusoidal and multiple frequency exposure
- For purposes of demonstrating compliance with the basic restrictions, the reference levels for the electric and magnetic fields should be considered additively.

**Q: How does that table translate into providing protection from EMF?**

**A :** The applicable row on the table for 60 Hz (the frequency of electricity in the USA) is the row with a frequency range of 0.025 – 0.1 kHz.

The calculations for Electric Field strength (in Volts/meter) for frequency (f) of 60Hz (0.060 kHz) are as follows:  $250/0.06 = 4166$  Volts/Meter. This equates to **4.16 KV/m.**

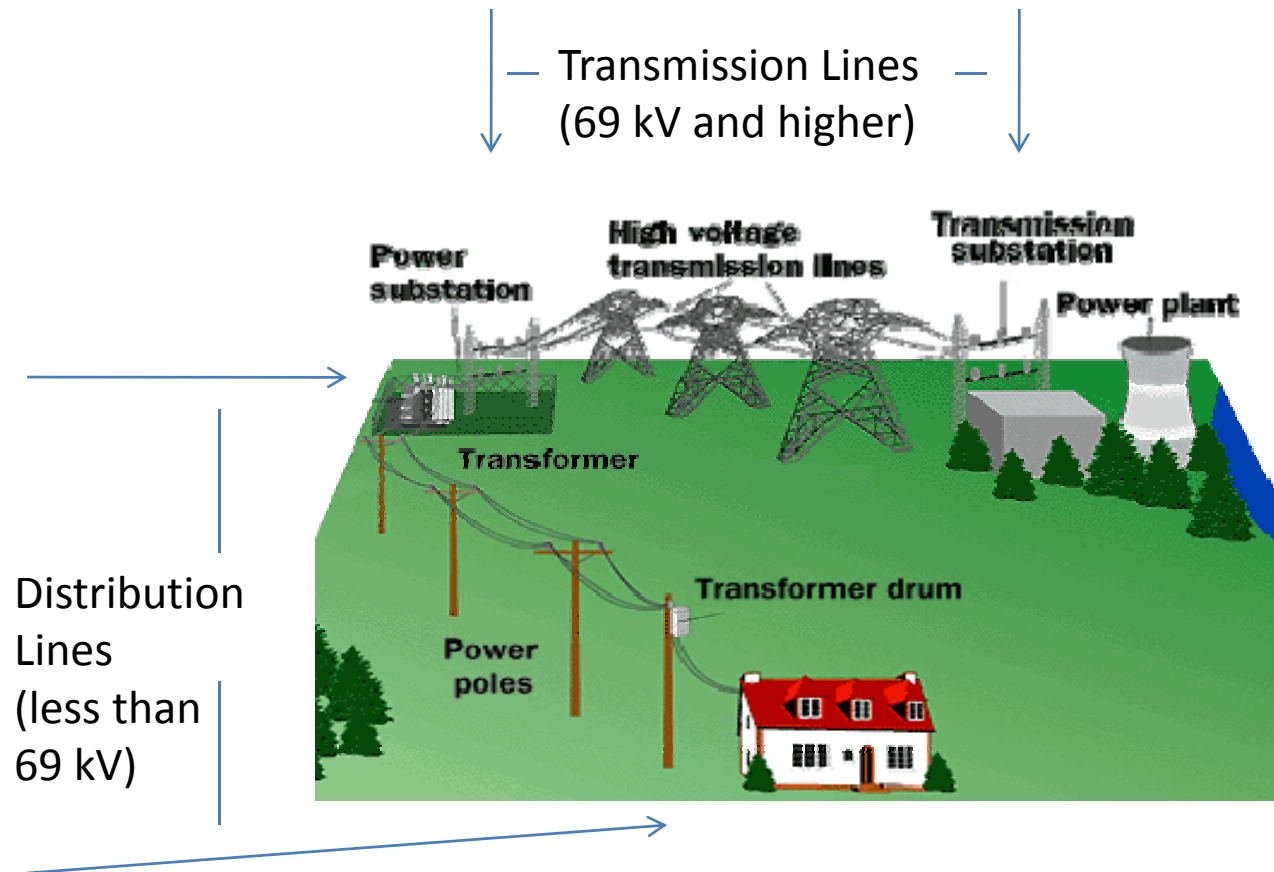
The calculations for Magnetic Field strength (in microTeslas) for a frequency of 0.060 kHz are as follows:  $5/0.06 = 83.33$  microTeslas. This equates to **833.3 milliGauss.**

**Q: How does the magnetic field guideline of 833 milliGauss compare to typical appliances?**

**A : Based upon this guideline, use of typical household appliances can be considered as safe:**

Appliance	Magnetic Field at 6''	Magnetic Field at 1'
Can Opener	600 mG	150 mG
Vacuum Cleaner	300 mG	60 mG
Hair dryer	300 mG	1 mG
Microwave	200 mG	40 mG
Electric Shaver	100 mG	20 mG
Mixer	100 mG	10 mG
Copy Machine	90 mG	20 mG
Garbage Disposal	80 mG	10 mG
Blender	70 mG	10 mG
Fluorescent Light	40 mG	6 mG
Electric Range	30 mG	8 mG
Battery Chargers	30 mG	3 mG
Washing Machine	20 mG	7 mG
Analog Clock	15 mG	2 mG

Q: So household appliances are safe... What about transmission lines?

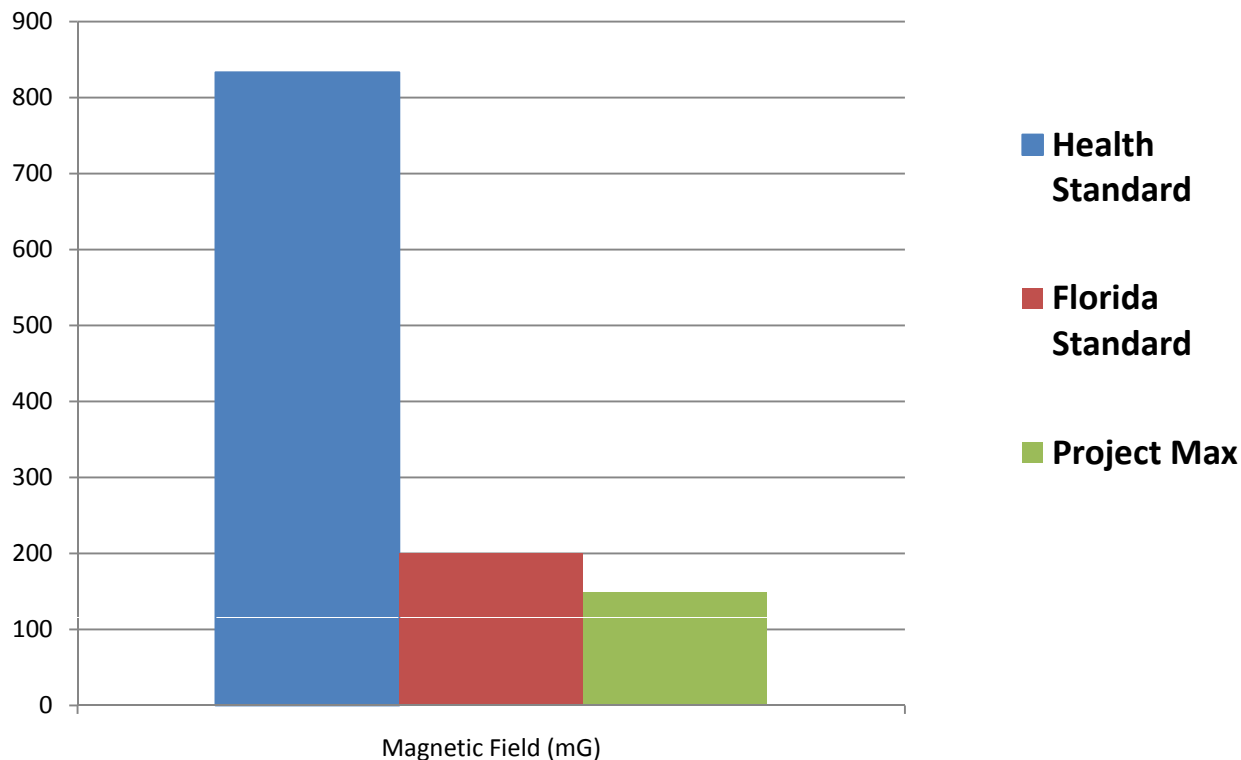


From: Brain, Marshall. "How Power Grids Work." 01 April 2000. HowStuffWorks.com

**Q: How does the 833 milliGauss recognized protective guideline for magnetic fields compare to state and federal requirements on transmission lines?**

**A :** There are NO federal standards for transmission line EMF. Furthermore, Florida is one of only a handful of state's to have formally established standards. Florida's standards for transmission lines are set to define the width of the Right-Of-Way, which must be procured by the utility. For transmission lines in the 250kV to 500kv range, the standard is 2.0 kV/m and 200 milliGauss, meaning that the EMF cannot exceed these values at the edge of the Right-Of-Way.

The chart below summarizes how the highest magnetic field from this project's transmission lines compares with the recognized protective guideline from ICNIRP as well as Florida's standard.



## Questions?

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References - Much of the material herein was obtained from:

**“Results of EMF Research - EMF Questions & Answers Booklet”,  
National Institute of Environmental Health Sciences  
(<http://www.niehs.nih.gov/health/docs/emf-02.pdf>)**

and

**“Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and  
Electromagnetic Fields”  
International Commission on Non-Ionizing Radiation Protection  
(<http://www.icnirp.de/documents/emfgdl.pdf>)**