

Gray Davis  
Governor  
State of California

Grantland Johnson  
Secretary  
Health and Human Services Agency

Diana M. Bontá, R.N., Dr.P.H.  
Director

Department of Health Services

# SHORT FACTSHEET ON EMF

The use of electricity is taken for granted, but people are still concerned about whether powerlines and appliances are safe or unsafe. Here are answers to some common questions about electric and magnetic fields. See also our Web site at <http://www.dhs.ca.gov/ps/deodc/ehib/>.

## What are electric and magnetic fields and why are people concerned about them?

Electric and magnetic fields are a basic force of nature (like gravity), generated by electricity. They are found almost everywhere. Electric and magnetic fields are found in nature, where they are created by such things as lightning and static electricity. Man-made fields are found wherever people use electricity, such as near powerlines and electrical appliances. Like sound, electric and magnetic fields are made of a mixture of components and so can be described in many different ways. Both have wave-like properties such as strength and “frequency” (how often they cycle back and forth). Sound can be loud (strong) or soft (weak), high or low pitched (different frequencies), suddenly loud or constant in tone, and pure or jarring. Similarly, electric and magnetic fields are a mixture of components. They can be strong or weak, have a high or low frequency, have sudden increases in strength (“transients”) or a constant strength, and consist of one pure frequency or several (called “harmonics”). For example, the *strength* of a field can be weak and constant, as in most nighttime home environments, or it can be strong and vary from high to low every few seconds, as from an electric blanket set on high.

Powerlines and wiring in buildings and appliances generate 50 and 60 Hertz fields, sometimes referred to as “power frequency” fields. Hertz is the unit for measuring the frequency of fields in the number of wave cycles each second. The lower the frequency of a field, the lower its energy. Power frequency fields are low frequency fields and have low energy levels. Microwave and x-ray fields are high frequency fields and have high energy levels.

Early scientific studies found a link between increased rates of cancer and closeness to certain kinds of powerlines that can cause strong magnetic fields. Over the last two decades concern about the health effects of electric and magnetic fields has increased.

## Where does EMF come from?

We are exposed to EMF from many sources, including high voltage transmission lines (usually on metal towers) carrying electricity from generating plants to communities, and distribution lines (usually on wooden telephone poles) that bring electricity to our homes, schools and workplaces. We are also exposed to magnetic fields from wiring in buildings and from all our electric appliances, like TV sets, radios, hair dryers, electric blankets and electric tools.

Most of the fields we experience in a day come from sources other than powerlines, such as wiring and appliances in homes or workplaces. The strength of both electric and magnetic fields decreases as you move away from their source, just as the heat from a campfire decreases with distance. For both electric and magnetic fields strength decreases more quickly with distance from “point” sources like appliances than from “line”

**CALIFORNIA ELECTRIC AND MAGNETIC FIELDS PROGRAM**

A project of the California Department of Health Services and the Public Health Institute

sources such as powerlines. For example, the magnetic field is down to “background levels” (the naturally occurring amounts) at 3 or 4 feet away from an appliance (*table 1*). It reaches background levels around 60 to 200 feet from a distribution line and about 300 to 1000 feet from a transmission line.

In spite of these similarities, electric fields and magnetic fields have somewhat different properties and possibly different ways of influencing our bodies. Electric fields can be shielded or weakened by

Table 1. Examples of magnetic fields at particular distances from appliance surfaces.

	MILLIGAUSS (mG)	
	at 1 foot	at 3 feet
aquarium pump	0.35-18.21	0.01-1.17
band saw	0.51-14.24	0.05-0.75
can opener	7.19-163.02	1.30-6.44
clock	0.34-13.18	0.03-0.68
clothes iron	1.66-2.93	0.25-0.37
coffee machine	0.09-7.30	0-0.61
computer monitor	0.20-134.7	0.01-9.37
copier	0.05-18.38	0-2.39
desktop light	32.81	1.21
dishwasher	4.98-8.91	0.84-1.63
drill press	0.21-33.33	0.03-8.35
fax machine	0.16	0.03
food processor	6.19	0.35
garbage disposal	2.72-7.79	0.19-1.51
hairdryer	0.1-70	0.1-2.8*
microwave oven	0.59-54.33	0.11-4.66
mixer	0.49-41.21	0.09-3.93
portable heater	0.11-19.60	0-1.38
printer	0.74-43.11	0.18-2.45
portable fan	0.04-85.64	0.03-3.12
radio	0.43-4.07	0.03-0.98
range	0.60-35.93	0.05-2.83
refrigerator	0.12-2.99	0.01-0.60
scanner	2.18-26.91	0.09-3.48
sewing machine	3.79-7.70	0.35-0.45
tape player	0.13-6.01	0.01-1.66
television	1.80-12.99	0.07-1.11
toaster	0.29-4.63	0.01-0.47
vacuum	7.06-22.62	0.51-1.28
VCR	0.19-4.63	0.01-0.41
vending machine	0.46-5.05	0.02-0.59

L. Zaffanella, School Exposure Assessment Survey, California EMF Program, interim results, Nov. 1997.

trees, buildings and even human skin, but magnetic fields are not so easily blocked. Most recent studies have focused on the health effects of magnetic fields

because they are not readily shielded and are easier to measure than electric fields.

## What kind of scientific studies have been done?

Nobody knows for sure whether exposure to 50 and 60 Hertz fields is a health risk. Three kinds of studies have been done to explore this:

- 1) laboratory studies that expose human or animal cells or organs to fields, looking for biological changes
- 2) laboratory studies that expose animals to fields, looking for changes in body function, chemistry, behavior or general health
- 3) “epidemiological” studies that observe people’s health and evaluate whether groups that have high or unusual EMF exposure have a greater chance for developing a disease like cancer than groups with “normal” or usual exposures

## What do these studies show?

First, *these studies do not show a clear pattern of health hazards*. Some but not all animal and cell studies have shown biological changes linked with *magnetic field* exposure. However, it is not clear whether these biological changes would be the same in humans. Second, it is not clear which component (frequency, strength, harmonics, etc.) of magnetic field exposure might be hazardous.

Concern about possible health hazards from electric power use is supported by results of some scientific studies, but the evidence they provide is still incomplete and inconclusive and even, in some cases, contradictory. A good deal of research is underway to help resolve these questions and uncertainties. Most but not all epidemiological studies show an association between leukemia (a type of cancer) and an “indirect” estimate of high magnetic field exposure such as living very near a type of powerline that could cause of high magnetic fields or working where there is high electrical exposure. These estimates may not really represent a person’s true exposure at the critical time period when they may have started developing an illness. Also, these studies show that some estimates of magnetic field exposure might be *related* to cancer, but this does not necessarily mean

that magnetic fields *cause* cancer. Indirect ways of estimating exposure may unintentionally include other risk factors like chemicals used at work or living in a particular neighborhood.

## How would magnetic field measurements taken in my house compare to others?

The California Department of Health Services measured the strength of magnetic fields in the bedroom, family room, and kitchen and at the front door of some San Francisco Bay Area houses. Any appliances or electrical devices that were on at the time were left on. As shown in *table 2*, about half of the houses had an average magnetic field level below 0.71 milligauss (mG, the basic unit for measuring magnetic field strength), and 90% of homes had levels below 1.58 mG.

These are measures of the average strength of the 60 Hertz frequency magnetic field at a particular day and time. Field strengths vary with time, day and season depending on electricity use. For example,

Table 2. Distribution of average magnetic field strength of San Francisco Bay Area homes.

homes below average field strength	736 homes measured <sup>1</sup>
10%	0.43 mG
25%	0.54 mG
50%	0.71 mG
75%	0.98 mG
90%	1.58 mG

<sup>1</sup>Lee, G., California Exposure Assessment study (preliminary findings). California EMF Program. 1996.

dinnertime readings are often higher than the middle of the night because appliances are in use. The other magnetic field components (like harmonics of other frequencies and short bursts of stronger fields called transients) are not included in these measurements, so they do not describe other aspects of the fields or other frequencies. Also, the field strength may change over time or distance depending on the location and type of its source.

Fairly simple measurements made by a trained technician can show the main indoor or outdoor sources of elevated magnetic fields in a home. Many utility companies and several private businesses can take these measurements. Taking measurements at different distances from powerlines can help show

if the lines are sources for elevated magnetic fields inside a home. Turning off the house's main power switch will rule out sources caused by power use inside. In most cases it is possible to find and correct the source of elevated fields if they are due to faulty wiring, grounding problems or choice of lighting fixtures.

## What are current government initiatives on EMF?

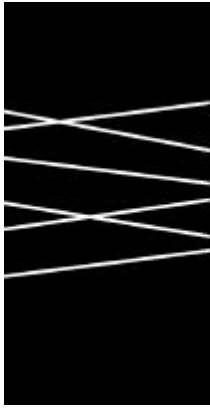
### *The State of California*

The California Department of Education enacted regulations that require minimum distances between a *new school* and the edge of a transmission line "right-of-way," or the area immediately surrounding lines that utility companies need to access the lines for maintenance and repairs. The setback distances are 100 feet for 50-133 kV lines, 150 feet for 220-230 kV lines, and 350 feet for 500-550 kV lines. These distances were not based on specific biological evidence, but on the known fact that the strength of electric fields from powerlines drops to near background levels at the specified distances, given that no other major sources are present.

In 1993, the California Public Utilities Commission (CPUC) authorized the state's investor-owned utilities to carry out "no and low cost EMF avoidance and measures" in construction of new and upgraded utility projects. The CPUC also established our California EMF research, education, and technical assistance program under the guidance of the Department of Health Services. This program will provide information to assist those responsible for making public policy. However, at present the state of California has no formal rules or guidelines, but advocates "no and low cost" of EMF. This means minimizing EMF exposure when it is easy and inexpensive to do so. Right now there is not enough evidence to justify making regulations governing EMF.

### *The Federal Government*

At the Federal level, the Federal Energy Policy Act of 1992 included a five-year program of electric and magnetic field (EMF) Research and Public Information Dissemination (EMF-RAPID). The EMF-RAPID Program asked these questions: Does exposure to EMF produced by power generation, trans-



mission, and use of electric energy pose a risk to human health? If so, how significant is the risk, who is at risk, and how can the risk be reduced?

In 1998, a working group of experts gathered by the EMF-RAPID Program met to review the research that has been done on the possible health risks associated with EMF. This group reviewed the studies that have been done on the subject, and then voted on whether they believed that exposure to EMF might be a health risk. They then published a report describing their findings. A majority of the scientists on this working group voted that the epidemiology studies of childhood leukemia provide enough evidence to classify EMF as a “possible human carcinogen.” This means that, based on the evidence, these researchers believe that it is possible that EMF causes cancer, but they are not sure. They also decided that they did not have enough evidence to determine whether EMF exposure might cause other diseases.

The EMF-RAPID Program released its final report to Congress in 1999. This report explains the program’s findings, including the results of its working group and many research projects. The final report states that “the NIEHS believes that there is weak evidence for possible health effects from [power frequency] ELF-EMF exposures, and until stronger evidence changes this opinion, inexpensive and safe reductions should be encouraged.” (page 38) For more information on the EMF-RAPID program, or to look at these reports, contact the EMF-RAPID Program, National Institute of Environmental Health Sciences, National Institutes of Health, P.O. Box 12233, Research Triangle Park, North Carolina 27709, or visit their Web site at <http://www.niehs.nih.gov/emfrapid>. When ordering a copy of the final report, refer to the NIH publication number 99-4493.

## Conclusion

Until we have more information, some communities and individuals are adopting the “no and low cost” avoidance strategy. It’s easy to move an electric clock a few feet away from a bedside table, and it’s simple to sit further away from the computer monitor. Table 1 above shows how quickly EMF decreases as you move away from an appliance. It almost disappears at distances of 3 to 5 feet. It is possible to take measurements in your home to identify sources of EMF, including faulty electrical wiring that can produce elevated magnetic fields and electrical shock. In California, the Public Utilities Commission requires investor-owned utilities to provide magnetic field measurements at no charge to their customers.

Contact us for a more detailed long factsheet. Please send us your questions and comments, too.

## **CALIFORNIA ELECTRIC AND MAGNETIC FIELDS PROGRAM**

A project of the California Department of Health Services and the Public Health Institute

(510) 622-4500 fax (510) 622-4505  
Elihu Harris State Office Building  
1515 Clay St., 17<sup>th</sup> Floor  
Oakland, CA 94612  
<http://www.dhs.ca.gov/ps/deodc/ehib/>