

Understanding electric and magnetic fields

SDG&E® is committed to providing safe and reliable service for its customers, and a safe work place for its employees.

What is EMF?

Electric and magnetic fields (EMF) are invisible lines of force that are present wherever electricity flows—around appliances and power lines, and in offices, schools and homes. Electric fields are created by voltage and are shielded by most materials, such as lead, soil and concrete. Magnetic fields are created by current and are not shielded by most materials. Both electric and magnetic field strengths diminish with distance.

These fields are low energy, extremely low frequency fields. They are not to be confused with high energy or ionizing radiation such as x-rays and gamma rays.

Why is EMF a concern?

Concerns have been raised about a possible link between exposure to EMF and adverse health conditions. Some EMF studies have reported a weak association between estimates of exposure to magnetic fields and certain types of cancer. However, other studies have reported no effects. Laboratory experiments have shown that exposure levels typically well above those normally found in residences can produce cellular responses, but there is little or no evidence that these responses constitute a health risk.

Research

Over the past 35 years, hundreds of epidemiology and laboratory studies on the subject of EMF have been conducted throughout the world, with results that are often hard to interpret and sometimes conflicting.

- **Epidemiological studies** look for associations between the exposure of a group of people to an agent (possible risk factor) and the occurrence of disease in that group. Epidemiology deals with people in their natural environment, so exposures cannot be controlled or limited to the factors being studied. Thus, epidemiology addresses associations with disease outcomes; generally, it does not establish whether a particular agent causes disease.
- **Laboratory studies** make use of controlled conditions to attempt to assess effects from exposure to electric and magnetic fields on cells, tissue cultures, and animals. Most of the laboratory studies have involved exposures which are hundreds to thousands of times higher than those typically found in residential backgrounds and some occupational settings.



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Did you know?

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Continued on back

► What conclusions have the experts drawn?

To assess potential health risks from an environmental agent such as power frequency EMF, numerous internationally recognized scientific organizations and independent regulatory advisory groups have conducted scientific reviews, bringing together experts from a variety of disciplines to review the full body of research on this complex issue. Without exception, these major reviews have reported that the body of data, as large as it is, does not

demonstrate that exposure to power-frequency magnetic fields causes cancer or other health risks, although the possibility cannot be dismissed. The weakness of the reported associations, the lack of consistency and the severe limitations in exposure assessment in the epidemiology studies together with the lack of support from laboratory studies were key considerations in the findings of the scientific reviews. Most reviews recommend further research, and, appropriately, research is ongoing worldwide.

Conclusions from recent expert panel reviews

- **World Health Organization (WHO),** *Extremely Low Frequency Fields, Environmental Health Criteria Monograph No. 238* [June 2007]:

"Given the weakness of the evidence for a link between exposure to extremely low frequency [which, includes power frequency] magnetic fields and childhood leukemia and the limited potential impact on public health, the benefits of exposure reduction on health are unclear and thus the cost of reducing exposure should be very low."

The report classifies EMF as a "possible" cause of cancer because they found that some statistical studies provide "limited" evidence of an association between EMF and childhood leukemia, but that controlled laboratory studies do not provide support for that association. The evidence does not warrant a classification of EMF as a "probable" or "known" carcinogen because "virtually all" of the experimental evidence fails to support a causal association for childhood leukemia. For all other childhood and adult diseases, the WHO finds there is "inadequate" evidence for a classification of even "possible."

- **National Radiological Protection Board (NRPB),** *Review of the Scientific Evidence for Limiting Exposure to Electromagnetic Fields (0-300 GHz)* [U.K., 2004]:

"It is concluded that currently the results of these [epidemiological and experimental] studies on EMFs and health, taken individually or as collectively reviewed by expert groups, are insufficient either to make a conclusive judgment on causality or to quantify appropriate exposure restrictions."

- **Health Council of the Netherlands,** *Electromagnetic Fields Annual Update 2003* [January, 2004]:

"The [Health Council of the Netherlands] Committee, like the IARC itself, points out that there is no evidence to support the existence of a causal relationship here. Nor has research yet uncovered any evidence that a causal relationship might exist. Nevertheless, new suggestions for possible mechanisms ... are regularly put forward. However, none of these hypotheses can presently explain how ELF magnetic fields exposure might lead to cancer. Is this statement by the IARC sufficient reason to recommend that steps be taken to, for example, limit children's long-term exposure to ELF magnetic fields? Since the conclusion of the IARC is not different from that of the Committee, it adheres to its previously expressed view that, on the basis of the current level of knowledge, there is no reason to take such action."

- **California Department of Health Services,** *EMF Risk Evaluation Report* [June, 2002]:

As with previous scientific data reviews, the CDHS report did not conclusively associate or find direct causation of disease or cancer as a result of exposure to EMFs. However, counter to all other reviews, the three CDHS epidemiologists who wrote the report stated that:

"...to one degree or another..." they "...were inclined to believe that EMFs can cause some degree of increased risk of childhood leukemia, adult brain cancer, Lou Gehrig's Disease, and miscarriage."

The opinions expressed by the CDHS reviewers are controversial and have been criticized by members of the Department's own Science Advisory Panel of experts.

Have state or federal exposure standards been established?

There are no California or Federal standards regulating environmental levels of magnetic field exposure for workers or the general public. The panels of experts charged with recommending exposure limits for electric and/or magnetic fields have concluded that no meaningful experimental data exist on which to base standards or limits to which the public is exposed.

California, Federal and international EMF activities

The California Department of Health Services (CDHS) EMF Program

From 1993 to 2002, the California Department of Health Services (CDHS) managed the California EMF Program of research and information that was established by the 1993 California Public Utilities Commission (CPUC) Decision 93-11-013 and funded by the utility customers. The goal of the program was to assess the potential health effects from exposure to electric and magnetic fields and report the findings to the CPUC. In October 2002, the CDHS issued its final EMF Risk Evaluation report. Fundamentally, it agrees with other national and international agency evaluations in

that all of the reports find that an EMF health risk has not been scientifically demonstrated, although the possibility of a small risk cannot be ruled out.

The California Public Utilities Commission (CPUC)

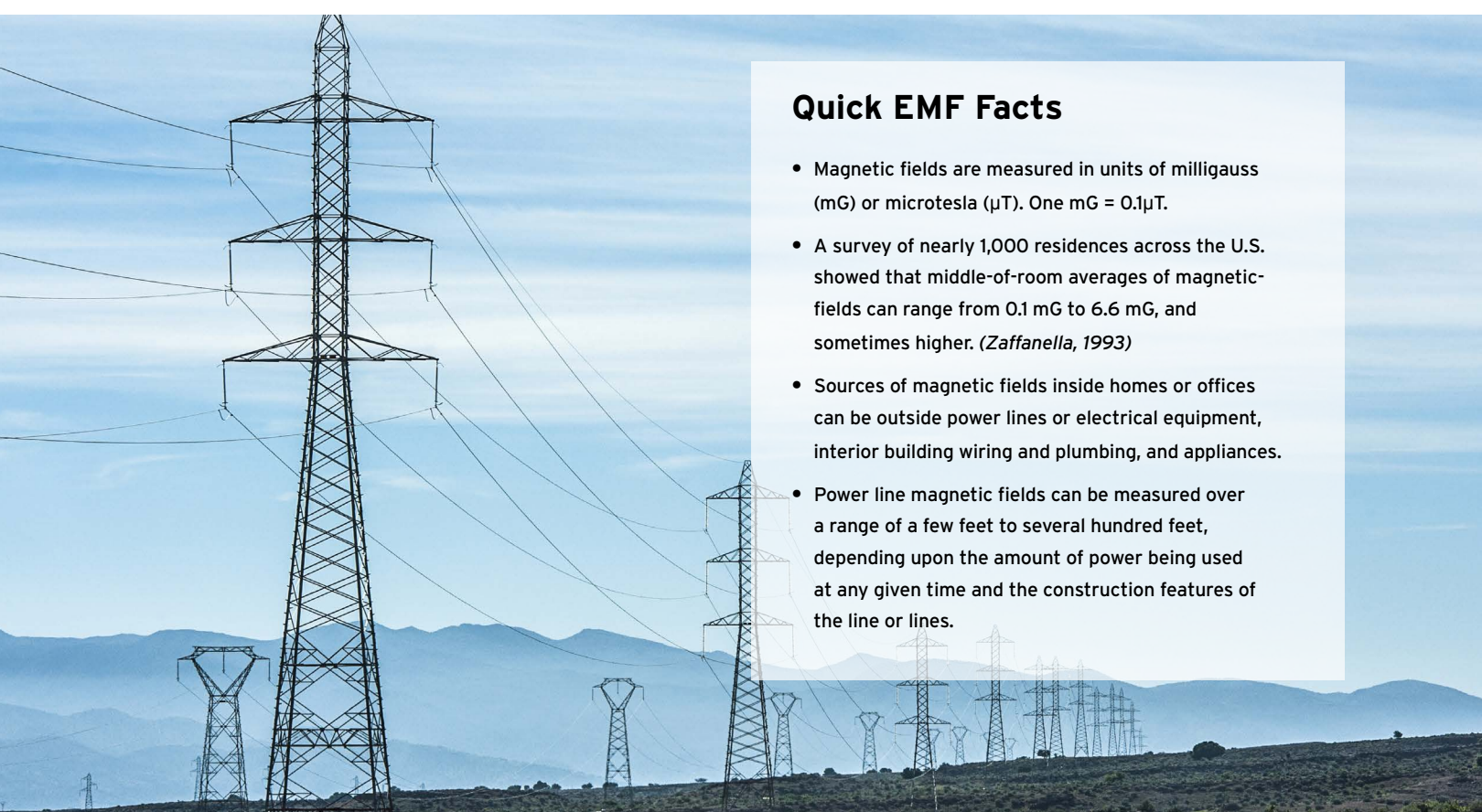
1993: The CPUC's 1993 EMF Decision 93-11-013 recognized that research had "not concluded that an EMF health hazard actually exists" and that "it is not appropriate to adopt any specific numerical standard in association with EMFs." Acknowledging public concern, the CPUC directed California's regulated electric utilities to:

- Take no-cost and low-cost steps to reduce EMF levels for new and upgraded transmission or substation projects.
- Develop EMF design guidelines for implementing the no-cost and low-cost steps.
- Implement uniform residential and workplace EMF measurement programs.
- Provide credible, meaningful, consistent, and timely EMF information to electric utility customers, employees, and the public.

Decision 93-11-013 can be downloaded online at <http://ftp.cpuc.ca.gov/gopher-data/environ/d9311013.doc>

Quick EMF Facts

- Magnetic fields are measured in units of milligauss (mG) or microtesla (μT). One mG = $0.1\mu\text{T}$.
- A survey of nearly 1,000 residences across the U.S. showed that middle-of-room averages of magnetic fields can range from 0.1 mG to 6.6 mG, and sometimes higher. (*Zaffanella, 1993*)
- Sources of magnetic fields inside homes or offices can be outside power lines or electrical equipment, interior building wiring and plumbing, and appliances.
- Power line magnetic fields can be measured over a range of a few feet to several hundred feet, depending upon the amount of power being used at any given time and the construction features of the line or lines.



2006: In January, the CPUC updated its EMF policy in Decision 06-01-042. The CPUC reaffirmed that health risks have not been demonstrated and that numeric exposure limits are inappropriate, and directed the utilities to continue to use no-cost and low-cost mitigation measures. Decision 06-01-042 can be viewed online at: https://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/53181.PDF

U.S. Federal EMF activities

The U.S. Federal Government's \$45-million EMF Research And Public Information Dissemination (RAPID) Program, managed by the National Institute of Environmental Health Sciences (NIEHS), submitted its final report to the U.S. Congress in 1999, concluding that: "[t]he scientific evidence suggesting that EMF exposures pose any health risk is weak;" and that "EMF exposures cannot be recognized as entirely safe because of weak scientific evidence that exposures may pose a leukemia hazard."

NIEHS also suggested "that the power industry should continue its current practice of siting power lines to reduce exposures and continue emphasis on educating both the public and providers of electricity about ways to reduce exposure;" and "... passive regulatory action is warranted such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures."

The international EMF project

The World Health Organization's (WHO) International EMF Project collaborates with a number of international agencies and organizations. WHO is pooling resources and knowledge concerning possible effects of exposure to EMF and making a concerted effort to identify gaps in knowledge, recommend focused research, conduct improved health risk assessments, and work toward international consensus and resolution on EMF health concerns. In June 2007, the International EMF Project published its report, Extremely Low Frequency Fields, Environmental Health Criteria Monograph No. 238. The report is consistent with the conclusions of the California Public Utilities Commission's (CPUC) review of EMF research and policy. The document can be viewed at: <https://www.who.int/publications/m/item/the-international-emf-project--progress-report-2015-2016>

What is SDG&E doing?

SDG&E is committed to providing safe and reliable service for its customers, and a safe work place for its employees. We recognize and share the concerns of our customers and employees over the possibility that electric and/or magnetic fields might adversely affect health. Until research and the scientific community provide greater direction, SDG&E's commitment includes the following measures:

- Maintain an EMF Center staffed with informed representatives available to talk with customers about EMF issues, and provide free magnetic field measurements on request.
- Provide objective EMF health literature to the public.
- Support, fund and monitor EMF research and participate in discussion forums and regulatory proceedings to remain current on all EMF-related issues.
- Implement low-cost and no-cost measures, where appropriate, to reduce fields associated with new and upgraded construction projects, in accordance with the rules of the CPUC decisions.



Magnetic field measurements

MAGNETIC FIELDS AT HOME

(Measurements are in milligauss.)

		1.2" away	12" away	36" away
Microwave Oven		750 to 2,000	40 to 80	3 to 8
Clothes Washer		8 to 400	2 to 30	0.1 to 2
Electric Range		60 to 2,000	4 to 40	0.1 to 1
Compact Fluorescent Bulb		0 to 32.8	0 to 0.1	0
Hair Dryer		60 to 20,000	1 to 70	0.1 to 3
LCD/Plasma TV		1.1 to 73.6	0 to 2.5	0 to 2.2

Source: Adapted from Gauger 1985 & EPRI Appliance Measurement Study 2010.

MAGNETIC FIELDS OUTSIDE

(Maximum values may be lower for some California utilities.)

Distribution Lines		1 to 80 milligauss under the line
Transmission Lines		1 to 300 milligauss at the edge of the right-of-way



Additional resources

To request a more detailed EMF information packet or free home or business magnetic field measurements, call SDG&E at 1-800-411-7343, or for more information or to submit an online request, visit <https://www.sdge.com/emf>

CPUC EMF Policy Page

<https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/permitting-and-environmental-review/electric-magnetic-fields>

Health Protection Agency (UK)

<https://www.gov.uk/government/publications/electric-and-magnetic-fields-health-effects-of-exposure>

National Cancer Institute

<https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation/electromagnetic-fields-fact-sheet>

U.S. Federal RAPID EMF Q&A

https://www.niehs.nih.gov/health/materials/electric_and_magnetic_fields_associated_with_the_use_of_electric_power_questions_and_answers_english_508.pdf

WHO International EMF Project

www.who.int/publications/m/item/the-international-emf-project--progress-report-2015-2016

