



UNDERSTANDING ELECTRIC AND MAGNETIC FIELDS

BC hydro 

FOR GENERATIONS

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WE ARE COMMITTED TO ADDRESSING THE PUBLIC'S CONCERNS IN AN OPEN AND BALANCED MANNER.

We are providing this booklet to explain EMF and to summarize for you what national and international health and scientific agencies have said about EMF and health.

To provide information about EMF and our commitments, we have included the following:

Glossary: Use this to look up the definitions of technical terms. Terms in the glossary are bolded the first time they are used in the booklet.

Resources: Refer to this list of resources for additional sources of information, including links to scientific studies and information from established health authorities.

Questions & Answers: Look at responses to some of the most frequently asked questions about EMF.

Contact information: Contact us for more information or to borrow a magnetic field measuring kit.

Resources: Refer to this list of resources for additional information, including links to scientific studies and information from established health authorities.

BC HYDRO & EMF

Electrical infrastructure, as well as electrical appliances, produce electric and magnetic fields (EMF). BC Hydro recognizes that there is public concern about EMF and possible health effects.

We are providing this booklet to explain EMF and to summarize for you what national and international health and scientific agencies have said about EMF and health.

We base our conclusions on the established research and the conclusions of national and international health authorities. BC Hydro is guided specifically by the findings of Health Canada and the World Health Organization that EMF exposure from power lines does not cause any adverse health effects.

The relationship between EMF and health effects is the subject of ongoing research and we realize that there continues to be concern about potential effects. BC Hydro takes all health and safety concerns seriously and therefore we will continue to:

- Communicate openly and provide balanced, accurate information about EMF
- Monitor scientific EMF research and keep abreast of relevant scientific, policy and regulatory developments. Links to scientific research sources on EMF are available in this booklet and on our website: bchydro.com/emf
- Adhere to all federal and provincial legislation and regulations and all regulatory requirements addressing EMF
- Take appropriate steps to reduce EMF levels in the design of new and upgraded electrical infrastructure

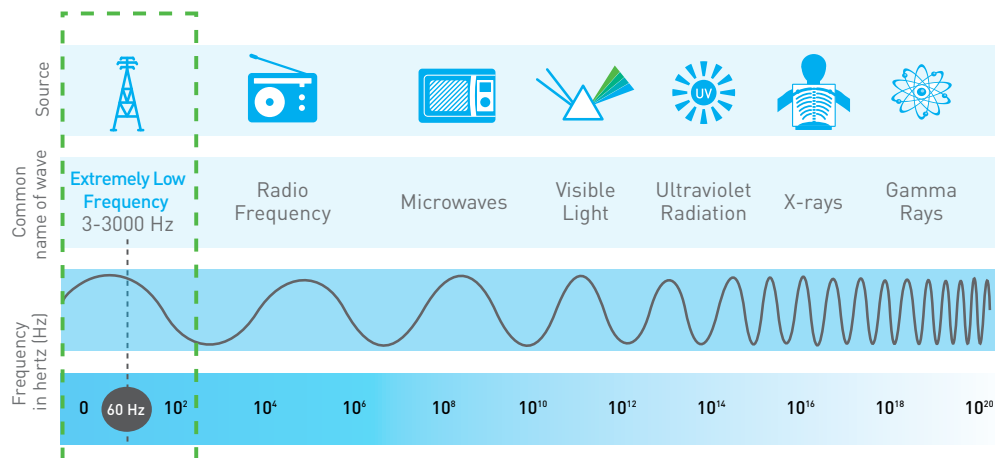
WHAT ARE ELECTRIC & MAGNETIC FIELDS?

Electric and magnetic fields (EMF) are present everywhere that electricity flows. Electrical appliances, household wiring and electrical power lines all produce electric and magnetic fields. These fields are part of a broad range of waves called the **electromagnetic spectrum**, which includes other waveforms such as radiowaves, microwaves, infrared rays and x-rays.

Different forms of electromagnetic energy are distinguished by their frequency, measured in hertz (Hz). Power frequency EMF has a frequency of 60 Hz. The power we use in North America uses alternating current (AC) and the power alternates back and forth 60 times each second. EMF from electricity is classified as “Extremely Low Frequency” (60 Hz), producing much less energy than other waveforms in the spectrum.

This diagram illustrates the different levels of energy that make up the electromagnetic spectrum. The energy of waveforms increases exponentially as you move from left to right in this diagram.

Frequencies of the Electromagnetic Spectrum and Common Sources



Helpful hint: please see glossary for a more detailed definition.

A COMPARISON OF ELECTRIC & MAGNETIC FIELDS

Although they are often referred to together as EMF, electric fields and magnetic fields are actually two distinct components of electricity.

Electric fields are produced by voltage in a wire. For example, an electric field is present when an electrical appliance is plugged into an outlet, even if it is not turned on. Electric fields can be blocked or shielded by objects such as buildings or trees.

Magnetic fields are produced when electric current is flowing, so they are only present when an electric appliance is turned on. As the flow of electricity – the current – increases, the magnetic fields increase. Magnetic fields pass through most objects and cannot be blocked as easily as electric fields.

Electric Fields

Produced by voltage, so present any time an appliance is plugged in, even if it is turned off

Measures in volts per metre or kilovolts per metre

Easily shielded by trees, buildings

Magnetic Fields

Produced by current, so only present when an appliance is plugged in and turned on

Measured in gauss or tesla

Not easily shielded

Strength decreases rapidly with distance from the source

ELECTRIC FIELDS

ELECTRIC FIELDS AND NUISANCE SHOCKS

Most of the interest regarding possible health effects is related to magnetic fields and not electric fields; however, people may notice the presence of electric fields when they are near power lines. Electric fields are produced by any object that carries voltage.

When conductive objects such as a vehicle, fence line or a person are near the electric fields, they can attract an electric charge, and when a person touches that object he or she can experience a shock called a **startle shock**. This is similar in effect to the small shock you might feel in your house after shuffling your feet on the carpet and touching a door handle.

A startle shock is not harmful but could be startling and individuals should be aware of the potential for startle shocks to prevent surprise.

ELECTRIC FIELDS AND HEALTH

In June 2007, the World Health Organization concluded that “*there are no substantive health concerns related to electric fields at levels generally encountered by the public.*” (WHO, Fact Sheet No. 322 Electromagnetic fields and public health, June 2007)

For more information about electric fields please visit our website at bchydro.com/emf

Most of the interest regarding possible health effects is related to magnetic fields; therefore the remainder of this booklet focuses on magnetic fields.

MAGNETIC FIELD STRENGTH

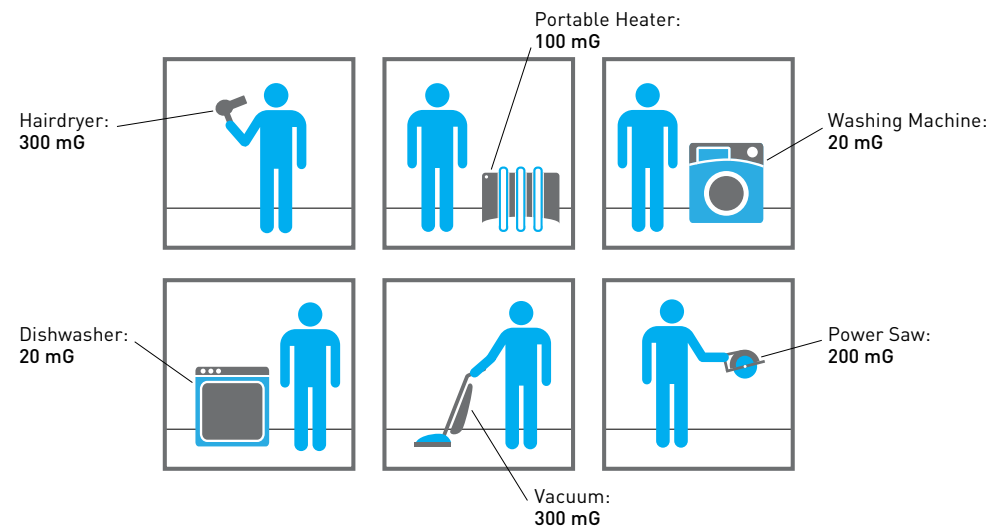
Magnetic field strength:

- Is directly related to the amount of current flowing, and
- Diminishes rapidly with distance from the electrical source.

Magnetic fields from appliances depend on the current flowing through the appliance, the configuration of the wiring within the appliance, and a person's distance from the appliance. Due to proximity, the magnetic fields experienced by users of appliances are often much higher than those experienced under power lines; however, the levels fade quickly as you move away from an appliance.

EMF are present everywhere that electricity flows and magnetic fields are produced whenever an appliance is turned on. Magnetic fields close to electrical appliances are often much stronger than those from other sources, such as magnetic fields under power lines, because you are much closer to appliances than power lines.

Typical Magnetic Field Levels in the Home



Source: EMF in your Environment, U.S. Protection Agency, 1992.

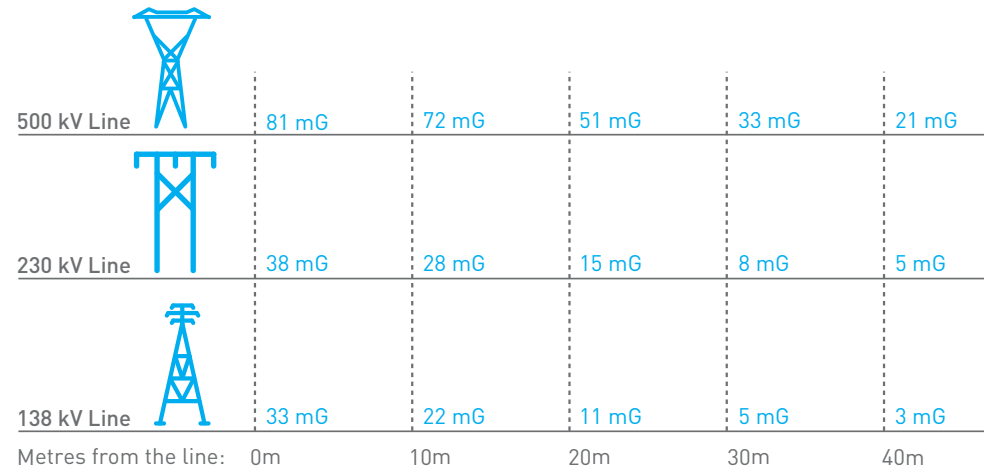
All measurements were taken 6 inches from the source

Magnetic Field Strength *(continued)*

Just like appliances, the magnetic field levels from power lines depend on the amount of current flowing on a line, the configuration of the wiring and the distance from the line. The current or electrical load on a transmission line will depend on how much electricity is being used at any given time. In British Columbia, variations in electrical load follow a fairly typical pattern, with morning and evening peaks, and larger loads in the winter months than during the summer.

Magnetic field levels diminish rapidly with distance, so as you move away from a power line the magnetic field strengths drop off.

Typical Magnetic Field Levels Near Transmission Lines



The levels in this diagram are average field levels and were calculated based on average energy load and average tower heights. These measurements are for general information only; for a specific transmission line, please contact BC Hydro at 604 623 4472.

If you are interested in measuring magnetic field levels in your home, magnetic field measuring equipment is available on loan from us. The Magnetic Field Measurement Kit includes a gauss meter, along with a pamphlet that explains how to take the measurements. To borrow a kit, please contact us at 604 623 4472 or toll free at 1 866 647 3334.

MAGNETIC FIELDS & HEALTH

The question of whether exposure to EMF, in particular magnetic fields, causes adverse health effects has been the subject of thousands of scientific studies over the last three decades.

The extensive health research and scientific knowledge surrounding EMF includes both **epidemiological studies** and **experimental studies** in animals, tissues and cells. These epidemiological studies and experimental studies provide pieces of the puzzle but no single study or even all the studies of just one type can give us the whole picture.

In epidemiological studies, researchers try to establish whether there is a statistical association between the exposures of certain groups of people and diseases they experience. Some epidemiological studies have suggested a weak association between exposure to magnetic fields and childhood leukemia. It is unclear, however, whether exposure to magnetic fields actually caused the disease. Some studies do not include magnetic field measurements when trying to determine an association and no epidemiological study has provided direct evidence that would permit drawing the conclusion that EMF is a cause of cancer or other adverse health effects.

Experimental studies involve exposing cells, tissues and/or animals to magnetic fields under controlled conditions. These studies allow researchers to closely control magnetic field exposure and provide information about any small scale biological changes that magnetic fields may cause. Experimental studies have not provided a basis to conclude that magnetic fields are the cause of any disease. Scientists at Health Canada have been at the forefront of experimental studies to assess whether magnetic fields might cause or promote the development of cancer, but in more than 10 years of research they have not found persuasive evidence for this hypothesis.

Magnetic Fields & Health *(continued)*

Many reputable health authorities such as the World Health Organization and Health Canada have conducted thorough reviews of all the different types of studies and research on EMF and health. These health authorities have examined the scientific **weight-of-evidence** and have determined that when all of the epidemiological and experimental studies are considered together, the consensus is that there is no **cause-effect relationship** between exposure to magnetic fields and human health.

We recognize that there are members of the public who remain concerned with the scientific findings to date, and therefore we will continue to monitor the scientific developments related to EMF as part of our ongoing commitment to EMF management.

GUIDELINES & EXPOSURE RECOMMENDATIONS

Health Canada has reviewed the current scientific findings regarding exposure to EMF and concluded:

“Research has shown that EMFs from electrical devices and power lines can cause weak electric currents to flow through the human body. However, these currents are much smaller than those produced naturally by your brain, nerves and heart, and are not associated with any known health risks.”

(Health Canada, It's Your Health Fact Sheet on EMF, January 2010)

As a result: *“You do not need to take action regarding daily exposures to electric and magnetic fields at extremely low frequencies. There is no conclusive evidence of any harm caused by exposures at levels found in Canadian homes and schools, including those located just outside the boundaries of power line corridors.”*

(Health Canada, 2010)

The World Health Organization (WHO) has also looked at the questions around EMF. In June 2007, the WHO released a comprehensive report on the possible health effects of exposure to extremely low frequency electric and magnetic fields. In this report, the WHO stated that *“the evidence related to childhood leukemia is not strong enough to be considered causal.”*

(WHO, Fact Sheet No. 322 Electromagnetic fields and public health, June 2007)

The WHO went on to recommend that governments and industry continue to monitor the science and promote research programs to address gaps in knowledge. We are committed to following this recommendation.

In 1998, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) developed voluntary exposure guidelines. ICNIRP is a formally recognized, international non-profit organization made up of independent scientific experts that are responsible for providing guidance and advice on non-ionizing radiation protection for people and the environment. In its guidelines, the ICNIRP recommends a residential magnetic field exposure limit of 833 milligauss (mG) and an occupational exposure limit of 4,200 mG.

These voluntary guidelines were developed to address short-term exposure only. ICNIRP determined that evidence for health effects from long-term exposure to power frequency magnetic fields is insufficient to justify establishing exposure standards. ICNIRP continues to monitor the research in this area, including a major review published in 2003.

The WHO endorses the guidelines established by ICNIRP. We look to established research and scientific experts like the WHO to provide guidance on health issues related to electrical infrastructure. Moving forward we will continue to follow their recommendations with regards to health concerns and the electricity system.

QUESTIONS & ANSWERS

Can I avoid exposure to EMF if I stay away from power lines?

No. EMF is found wherever there is electricity, whether in household wiring, electric appliances, or power lines. Your overall exposure is determined by how strong the field is at its source, how far you are from the source, and how long you remain near the source. EMF are strongest at the source and fade rapidly as you move away from the source.

Can you eliminate EMF by burying the lines underground?

No. The ground will shield the electric field, but the magnetic field will still pass through.

Sometimes I feel electricity in the air when I am under a transmission line. What is happening?

Electric fields exist around all wires that carry electricity. Electric fields can sometimes be noticeable directly under the high voltage transmission lines. This feeling can be discomforting (arm hair stimulation or tingling), but it is not unsafe or a health risk.

What causes a nuisance shock if I touch my car or other conductive object near the transmission lines?

This may occur when the conductive objects (including people) are located within the transmission line's electric field and become charged. When a person with a different level of induced charge contacts the object or another person, the charge is equalized (discharged) between the two bodies and the person may receive a nuisance shock. A nuisance shock will not harm the recipient but could be startling.

Can EMF cause radio or television interference?

Radio and television interference can be the result of various electrical appliances or devices. A transmission line can occasionally cause some interference with radio and television reception. Please contact us at 604 623 4472 if you are having reception problems and believe it is related to a nearby power line.

If BC Hydro believes EMF do not pose a health risk, why is EMF classified as a carcinogen?

EMF are classified as a "possible carcinogen", or 2B carcinogen, by the International Agency for Research on Cancer (IARC). This classification is the weakest of three categories used by IARC to classify potential carcinogens. Other everyday items in this category include coffee, gasoline engine exhaust and pickled vegetables. The 2B classification acknowledges that concerns have been raised from some epidemiological studies but conclusive evidence has not been found despite extensive and ongoing research.

How has BC Hydro taken precautions to reduce potential EMF risks?

Our approach is modeled after recommendations by the World Health Organization and that is to take reasonable precautionary measures. Examples of reasonable measures include open communication with the public, monitoring the science on EMF and the way we design our projects including conductor phase optimization, increasing ground clearances, and the position of the poles within the right-of-way.

Does BC Hydro have magnetic field measuring kits?

Yes, we loan magnetic field measuring equipment. The Magnetic Field Measurement Kit comes with a gauss meter and a DVD and booklet that explain how to take the measurements. To borrow a kit please contact us at 604 623 4472 or toll free at 1 866 647 3334.

TO LEARN MORE

If you would like to learn more about EMF, we recommend the following sources:

BC Hydro's EMF website

Find the sources below, and new information on an ongoing basis, at our links page on EMF.

bchydro.com/emf

EMF and Health: Review and Update of the Scientific Research

This report was prepared by Exponent to assess the current status of research regarding the potential for health effects from exposure to EMF. Exponent is a leading technical and scientific research firm that provides BC Hydro with a regular weight-of-evidence review on current EMF research.

bchydro.com/emf

Health Canada

This fact sheet contains basic information about EMF, typical Canadian exposures, and Health Canada's role.

It's Your Health Fact Sheet: Electric and Magnetic Fields at Extremely Low Frequencies

www.hc-sc.gc.ca/hl-vs/iyh-vsv/environ/magnet-eng.php

BC Centre for Disease Control

This site includes statements from experts, information on scientific studies, and resources for more information.

www.bccdc.ca/healthenv/Radiation/ElectromagRadiation/default.htm

World Health Organization

This site from the United Nations health agency provides links to EMF fact sheets, extensive research publications, and general information about EMF.

www.who.int/peh-emf/en

National Institute of Environmental Health Sciences

The US National Institute site provides information on research conclusions and results and overall information regarding EMF.

www.niehs.nih.gov/health/topics/agents/emf/index.cfm

Canadian Electricity Association

The Canadian Electricity Association (CEA) is the professional association of electrical companies across Canada. You can find information about the CEA's commitments to safety, and EMF research on the site.

www.electricity.ca/industry-issues/environmental/electric-and-magnetic-fields.php

GLOSSARY

Cause-effect relationship: A relationship between two variables where one factor directly causes or influences the other.

Electromagnetic spectrum: The group of electromagnetic waves starting from the waves with the longest wavelengths (and least energy), consists of extremely low frequency (such as power frequency EMF), radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, x-rays, and gamma radiation.

Epidemiological studies: Epidemiological studies look at patterns of disease occurrence in human populations and the factors that influence these patterns. These studies are observational in that they examine and analyze people in their normal daily life to try to determine and correlate their health events with exposure factors.

Experimental studies: Experimental studies involve exposing cells, tissues and/or animals to a specific agent, such as EMF, under carefully controlled conditions to determine if the agent is the cause of a disease.

Extremely low frequency (ELF) fields: Extremely low frequency refers to electromagnetic fields in the range of 0-300 Hz.

Field Strength: The strength of an electric field, measured in volts per metre (V/m) or of a magnetic field, measured in gauss (G) or milligauss (mG).

Gauss or milligauss: Magnetic fields are measured in units of gauss (G) or tesla (T). Gauss is the unit most commonly used in Canada, while tesla is more commonly used internationally. Most magnetic field levels related to electrical devices are only a fraction of a gauss so it is more common to measure magnetic levels in units of milligauss (mG). A milligauss is 1/1000 of a gauss.

Startle shock: A small electrical discharge or shock that is perceptible but not dangerous.

Weight-of-evidence review: A weight-of-evidence review critically evaluates the strength of the evidence for causality for a particular exposure and disease. It entails a comprehensive assessment of all relevant scientific research, in which each of the studies is critically evaluated, and more weight is given to studies of better quality.

CONTACT US

For additional information please visit our website at bchydro.com or contact our main office at:

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