



# UNDERSTANDING ELECTRIC AND MAGNETIC FIELDS

**BC**hydro 

FOR GENERATIONS

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

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

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

**Glossary:** Look up definitions of technical terms. Terms in the glossary are bolded the first time they are used in the booklet.

**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 for additional details, 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 base our conclusions on the established research and findings of national and international health authorities. BC Hydro is guided specifically by the findings of Health Canada and the World Health Organization that EMF 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 questions. 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 up-to-date on 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](http://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

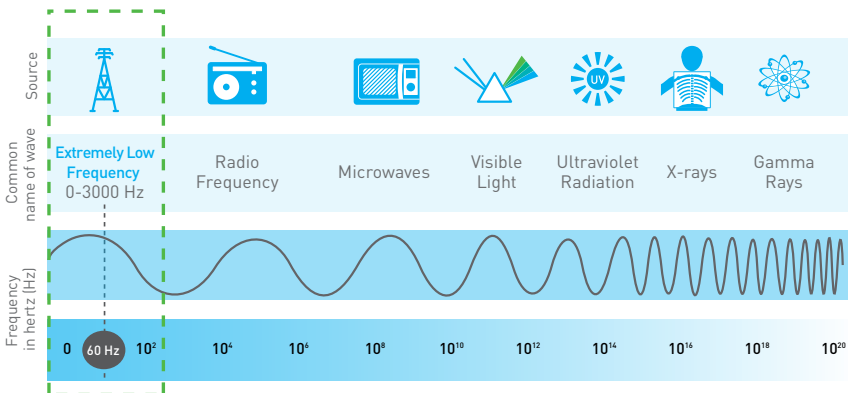
# WHAT ARE ELECTRIC & MAGNETIC FIELDS?

Electric and magnetic fields (EMF) are present everywhere that electricity flows. Electrical appliances, household wiring and power lines all produce EMF. 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). Electrical power 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



Source: Institute of Electrical and Electronics Engineers.

\***Helpful hint:** Terms in the glossary are bolded the first time they are used in the booklet. See glossary for more detailed definitions of terms.

**Note:** For more information related to radio frequency, see the resource section of this booklet.

# 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, such as a power line. An electric field is also present when an electrical appliance is plugged into an outlet even if it is not turned on. They 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 electrical 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   | Magnetic Fields   |
|---|---|
| Produced by voltage; present any time an appliance is plugged in even if it is turned off | Produced by current; only present when an appliance is plugged in and turned on |
| Measured in volts per metre or kilovolts per metre  | Measured in <b>gauss</b> or tesla   |
| Easily shielded by trees, buildings   | Not easily shielded   |

Strength decreases rapidly with distance from the source

# ELECTRIC FIELDS

## ELECTRIC FIELDS AND STARTLE 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.

Conductive objects, such as a vehicle, fence line or person, that are near electric fields can attract an electric charge. When a person touches that object he or she can experience 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.

Startle shocks are not harmful but understanding how and when they can occur will help to reduce surprise when experiencing one.

## 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](http://bchydro.com/emf).

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

# MAGNETIC FIELD STRENGTH

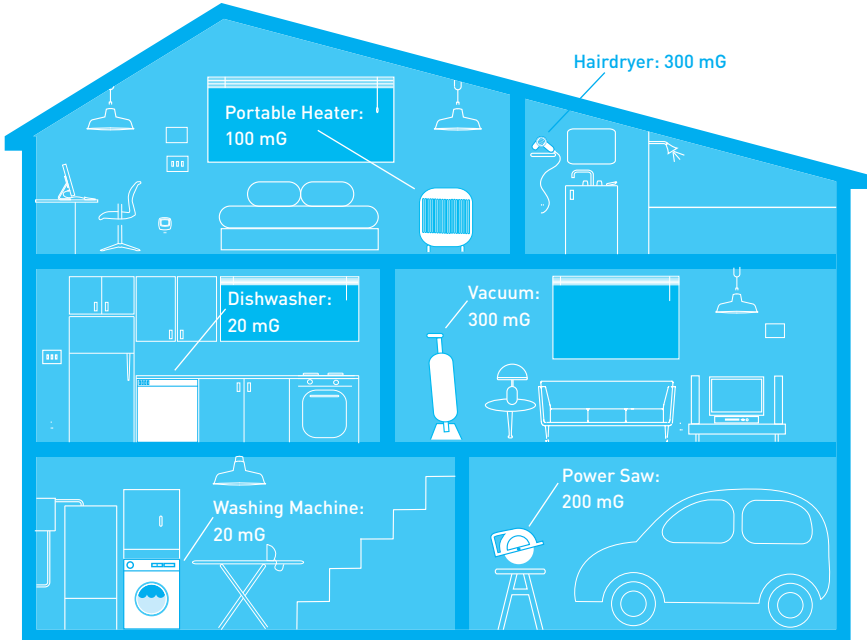
## Magnetic field strength:

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

The strength of magnetic fields near electrical appliances depends 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, magnetic field levels from appliances are often much higher than under power lines; however, the levels fade quickly as you move away from an appliance.

EMF is present everywhere that electricity flows. Magnetic fields are produced whenever an appliance is turned on. Magnetic fields close to electrical appliances are normally stronger than those from other sources, such as 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 sources

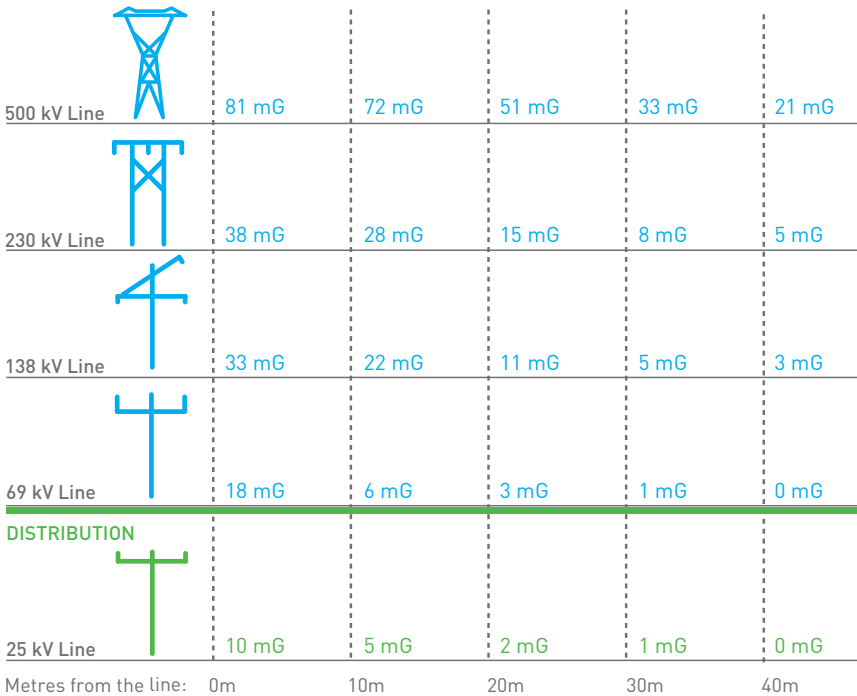
## Magnetic Field Strength (continued)

Just like appliances, the magnetic field levels from power lines depend on the current flowing in a line, the configuration of the wiring and a person's 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 than the summer.

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

## Typical Magnetic Field Levels Near Transmission & Distribution Lines

### TRANSMISSION



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.



## 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 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.

## 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, the intensity of these currents is too low to cause any known health effects.

(Health Canada, It's Your Health Fact Sheet on EMF, November 2012)

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, 2012)

The World Health Organization (WHO) has also looked at questions around EMF. In June 2007, WHO released a comprehensive report on possible health effects of exposure to extremely low frequency electric and magnetic fields. In this report, 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)

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 update in 2010, ICNIRP recommends a residential magnetic field exposure limit of 2,000 **milligauss (mG)** and an occupational exposure limit of 10,000 mG.

These voluntary guidelines were developed to address short-term exposure only. ICNIRP determined that evidence for health effects from long-term exposure is insufficient to establish exposure standards. ICNIRP continues to monitor the research in this area.

WHO endorses the guidelines established by ICNIRP. We look to established research and scientific experts like 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, electrical appliances, or power lines. Your 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 is strongest at the source and fades rapidly as you move away from the source.

### **Can you eliminate EMF by burying the lines underground?**

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

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

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

### **I received a shock when I touched my car that was parked near a power line — what causes that?**

This is called a “startle shock.” It may occur when conductive objects (including people) are located within a power line’s electric field and become electrically charged. When a person with a different level of induced charge contacts an object or another person, the charge is equalized (discharged) between the two bodies and the person may receive a startle shock. A startle shock will not harm the recipient but could cause surprise.

### **Can EMF cause radio or television interference?**

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

### **Why is EMF classified as a carcinogen?**

EMF is 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 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 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.

### **How does EMF affect me if I have an implanted medical device?**

The guidelines and exposure recommendations set out in this booklet are for the average population and cannot directly address the requirements of people with implanted medical devices such as heart pacemakers. For more information and advice about EMF, contact the device manufacturer and the clinician who implanted the device.

### **Is there a connection between EMF and electromagnetic hypersensitivity (EHS)?**

According to the World Health Organization, electromagnetic hypersensitivity (EHS) has no clear diagnostic criteria and there is no scientific basis to link EHS to EMF.

# RESOURCES

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

## **BC Hydro's EMF website**

This website is updated on an ongoing basis with new information. It also includes links to the resources listed below.

[bchydro.com/emf](http://bchydro.com/emf)

## **EMF and Health: Review and Update of the Scientific Research**

This report was prepared by an independent, technical and scientific research firm to assess the current status of research regarding the potential for health effects from exposure to EMF.

[bchydro.com/emf](http://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](http://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.

<http://www.bccdc.ca/healthenv/Radiation/ElectromagFields/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](http://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](http://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](http://www.electricity.ca/industry-issues/environmental/electric-and-magnetic-fields.php)

## **Radio Frequency & BC Hydro's Smart Meters**

This site includes information on radio frequency and BC Hydro's Smart Meters.

[http://www.bchydro.com/energy\\_in\\_bc/projects/smart\\_metering\\_infrastructure\\_program/faqs.html](http://www.bchydro.com/energy_in_bc/projects/smart_metering_infrastructure_program/faqs.html)

# 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 lives to try to determine and correlate their health events with exposure factors.

**Experimental studies:** Experimental studies involve exposing cells, tissues and 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 0-3000 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 discharge or shock that is noticeable 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.

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 with a pamphlet that explains how to take measurements. To borrow a kit, please contact us at 604 699 7678 or toll free at 1 866 647 3334.

## CONTACT US

For additional information please visit our website at [bchydro.com/emf](http://bchydro.com/emf) or contact us:

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