



**BC Transmission**  
CORPORATION

# Understanding Electric and Magnetic Fields



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## About BCTC

BC Transmission Corporation (BCTC) is the provincial Crown corporation that plans, builds, operates and maintains British Columbia's publicly owned electrical transmission system. Once a part of BC Hydro, BCTC was established in 2003 as an independent Crown corporation with a sole focus on transmission.

BCTC operates more than 18,000 kilometres of transmission lines that are supported by more than 20,500 steel towers and 75,000 wood poles. Transmission lines carry electricity from generation facilities, like BC Hydro dams, to almost 300 substations around the province. From these substations, BC Hydro delivers electricity directly to BC's homes and businesses.

BCTC is committed to operating the electricity transmission system in a safe manner to ensure that British Columbians continue to enjoy the benefits of reliable electricity supply.

# BC Transmission Corporation & EMF

BCTC plans, builds, operates and maintains British Columbia's publicly owned electrical transmission system. This system moves high-voltage electricity throughout the province from where it is produced to where it is used in communities, homes and businesses.

Electricity transmission as well as electrical appliances produce electric and magnetic fields (EMF). BCTC recognizes that there is public concern about EMF and possible health effects.

Based on the established research and the conclusions of national and international health authorities, BCTC is guided by the findings of Health Canada and the World Health Organization that EMF exposure from power lines does not cause any adverse health effects.

However, the relationship between EMF and health effects is the subject of ongoing research and BCTC realizes that there continues to be concern about potential health effects. We take these 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 BCTC's website: [www.bctc.com/community/electric\\_magnetic\\_fields/](http://www.bctc.com/community/electric_magnetic_fields/)
- 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 transmission facilities

## We are committed to addressing the public's concerns in an open and balanced matter.

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 more information on these topics and BCTC's 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.

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

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

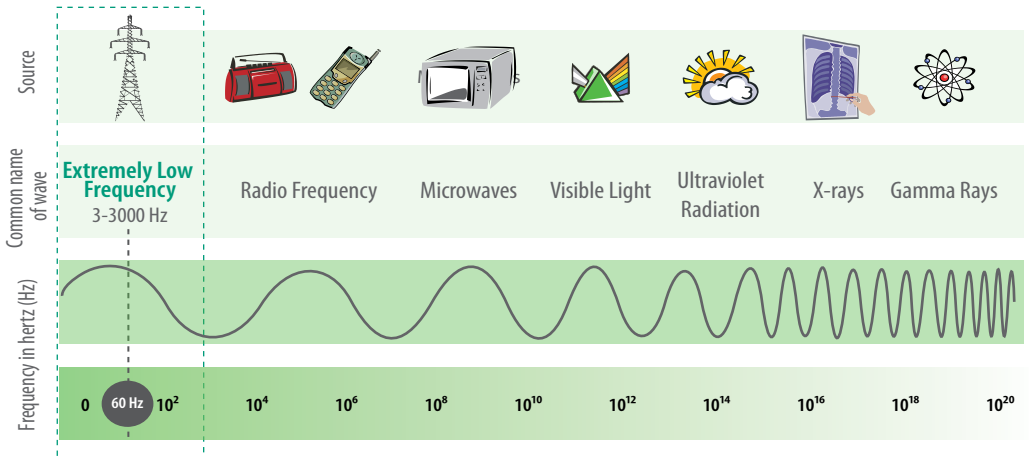
**Contact Information:** Contact us for more information or to borrow a magnetic field measuring kit.

# 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.

FREQUENCIES OF THE ELECTROMAGNETIC SPECTRUM AND COMMON SOURCES



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

# 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 electric 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	Magnetic Fields
Produced by <b>voltage</b> , so present any time an appliance is plugged in, even if it is turned off	Produced by <b>current</b> , so only present when an appliance is plugged in and turned on
Measured in <b>volts per metre</b> or <b>kilovolts per metre</b>	Measured in <b>gauss</b> or <b>tesla</b>
<b>Easily shielded</b> by trees, buildings	<b>Not easily shielded</b>

**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 startling shock called a **nuisance 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 nuisance shock is not harmful but could be startling and individuals should be aware of the potential for nuisance shocks to prevent being startled.

## 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 [www.bctc.com](http://www.bctc.com).

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

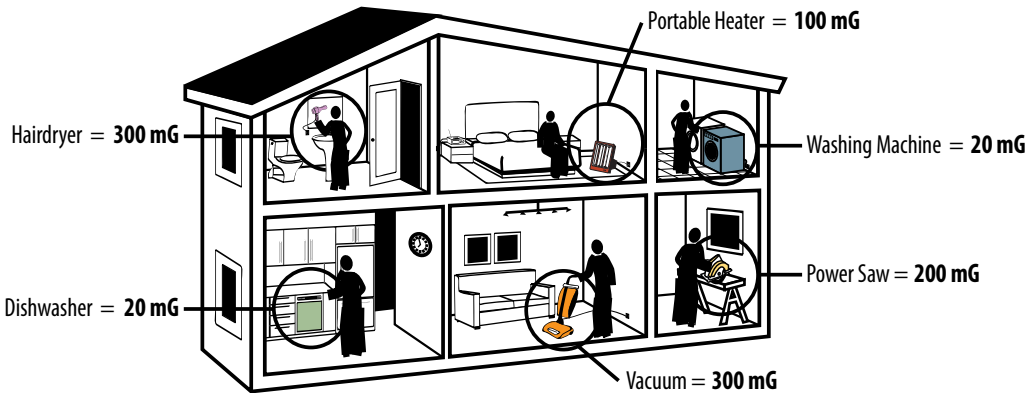
Magnetic **field strength**:

- 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.

## TYPICAL MAGNETIC FIELD LEVELS IN THE HOME

\*All measurements were taken 6 inches from the source



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

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.

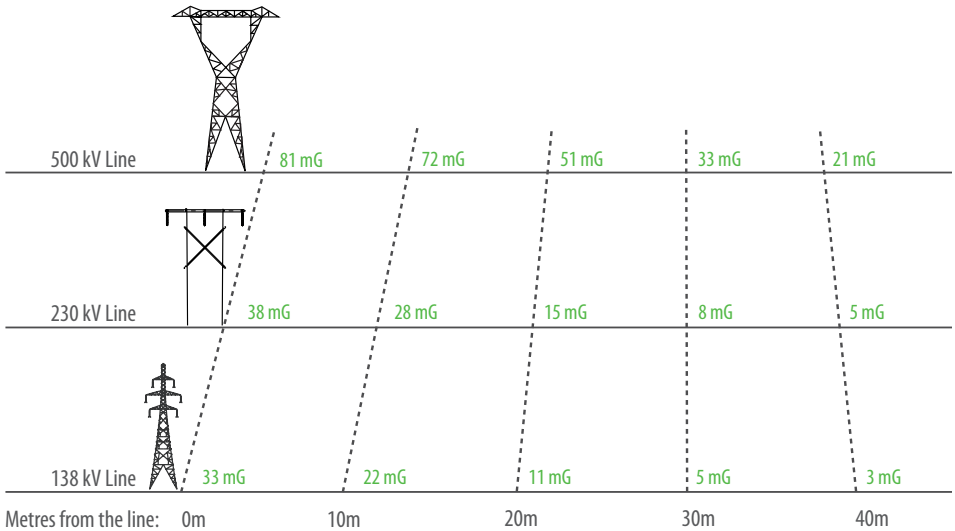
# Magnetic Field Strength

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 BCTC at **604.699.7456**.

If you are interested in measuring magnetic field levels in your home, magnetic field measuring equipment is available on loan from BCTC and BC Hydro. The Magnetic Field Measurement Kit includes a gauss meter, along with a booklet that explains how to take the measurements. To borrow a kit, please contact us at **604.699.7456** 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.

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.

BCTC recognizes that there are members of the public who remain concerned with the scientific findings to date, and therefore BCTC 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:

*"You do not need to take action regarding typical daily exposures to electric and magnetic fields at extremely low frequencies. There is no conclusive evidence of any harm caused by exposures at levels normally found in Canadian living and working environments."*

(Health Canada, It's Your Health Fact Sheet on EMF, April 2004)

*As a result: "Health Canada does not consider guidelines necessary because the scientific evidence is not strong enough to conclude that typical exposures cause health problems."*

(Health Canada, 2004)

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 the gaps in knowledge. BCTC is 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. BCTC looks to established research and scientific experts like the WHO to provide guidance on health issues related to electrical transmission. Moving forward BCTC will continue to follow their recommendations with regards to health concerns and the transmission 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 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 BCTC at **604.699.7456** if you are having reception problems and believe it is related to a nearby transmission line.

# Questions & Answers

## **If BCTC 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 BCTC taken precautions to reduce potential EMF risks?**

BCTC’s 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 BCTC have magnetic field measuring kits?**

Yes, magnetic field measuring equipment is available on loan from BCTC and BC Hydro. 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 **604.699.7456** 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:

### **BCTC's EMF website**

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

[www.bctc.com/community/electric\\_magnetic\\_fields/](http://www.bctc.com/community/electric_magnetic_fields/)

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

This report was prepared by Exponent for BCTC, 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 BCTC with a regular weight-of-evidence review on current EMF research.

[www.bctc.com/community/electric\\_magnetic\\_fields/links.htm](http://www.bctc.com/community/electric_magnetic_fields/links.htm)

### **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.

[www.bccdc.ca/healthenv/Radiation/ElectromagRadiation/default.htm](http://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](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)

# 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.

## Nuisance 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 [www.bctc.com](http://www.bctc.com)  
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