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# Electric and Magnetic Fields



On a daily basis, most of us are exposed to electric and magnetic fields (EMF) generated by household wiring, lighting, computers and other electrical appliances, such as hair dryers, coffee makers, televisions and power tools.

Since the 1970s, scientists have been researching possible human health effects of EMF, particularly certain cancers including brain cancer, lymphoma, breast cancer and leukemia. This extensive research has not proven a link between health risks and EMF.

Canadian electric utilities are committed to supporting EMF research to resolve ongoing questions, as well as to providing educational materials and facilitating magnetic field measurement for the public and employees.

## What are electric and magnetic fields?

Power frequency (also referred to as extremely low frequency or ELF) electric and magnetic fields are present everywhere that electricity flows. All electrical wires – and the lighting, appliances and other electrical devices they supply – are sources of electric and magnetic fields. Although they are often referred to together as EMF, electric fields and magnetic fields are actually distinct components of electricity (See “Electric vs. Magnetic Fields” sidebar). Most of the interest regarding possible health effects is related to magnetic fields. So usually, when the term EMF level is used, it is the magnetic field strength that is being referred to or measured.

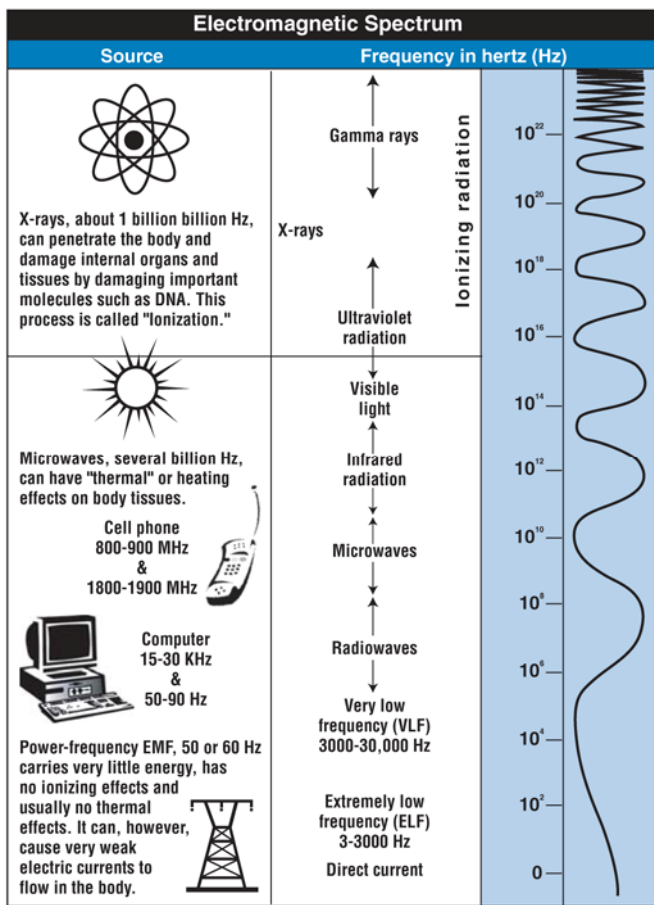
X-rays, visible light, radio waves, microwaves and power frequency EMF are all forms of electromagnetic energy making up an electromagnetic spectrum. On the next page there is a chart of the electromagnetic spectrum. As the chart shows, one property that distinguishes different forms of electromagnetic energy is the frequency, measured in hertz (Hz). These frequencies are plotted on the right side of the spectrum chart. At the lowest end is static or direct current (DC) electricity with a frequency of 0 Hz. At the upper end (above  $10^{16}$  Hz - that's 10,000,000,000 MHz) is ionizing radiation produced by ultraviolet, X-ray and gamma ray radiation.

## Electric vs. Magnetic Fields

Electric fields are produced by voltage or electric charge. An electric field is present, for example, when an appliance is plugged into an outlet, even if it is not turned on. Electric fields are measured in Volts per metre (V/m); the higher the voltage, the greater the electric field.

Magnetic fields are created by the flow of current in a wire or an appliance. As a result, they are only present in an appliance when it is switched on. As the flow (current) increases, so does the strength of the field.

In North America, magnetic fields in electrical wiring are most commonly measured in milligauss or mG (one thousand milligauss equal 1 gauss). Elsewhere magnetic fields are measured in microtesla or  $\mu$ T (one thousand  $\mu$ T equal 1 mT, one million  $\mu$ T equal 1 tesla). One  $\mu$ T equals 10 mG



The wavy line at the right illustrates the concept that the higher the frequency, the more rapidly the field varies. The fields do not vary at 0 Hz (direct current) and vary trillions of times per second near the top of the spectrum. Note that  $10^3$  means  $10 \times 10 \times 10$  or 10,000 Hz. 1 kilohertz (kHz) = 1,000 Hz. 1 megahertz (MHz) = 1,000,000 Hz.

Courtesy of NIEHS booklet EMF Questions and Answers at: (<http://www.niehs.nih.gov/health/docs/emf-02.pdf>)

Power frequency EMF has a frequency of 60 Hz. It is at the lower end of the spectrum near DC electricity and well below the microwave or RF (radio frequency) radiation emitted by cellular phones and radio broadcast transmitters. As noted on the chart, unlike x-rays and gamma rays, power frequency EMFs have little energy and no ionizing or thermal effects on the body.

### Exposure and guidelines

Both electric and magnetic fields are strongest at the source – whether it is a power line or an appliance such as a hair dryer, dishwasher or microwave oven – and decrease rapidly when you move away from the source. Magnetic field exposure from power lines depends primarily on the current the wires carry and an individual's distance from the lines. And while electric fields are easily shielded by trees, fences and other building materials, magnetic fields pass through most objects.

In Canada, there are no guidelines or standards on acceptable levels of residential EMF exposure. Health Canada's It's Your Health fact sheet on EMF states, "Health Canada does not consider guidelines for the Canadian Public necessary because scientific evidence is not strong enough to conclude that exposures cause health problems." Health

Canada also states, "You do not need to take action regarding typical daily exposures to electric and magnetic fields at extremely low frequencies." (Health Canada, January 2010) (See the sidebar for other information on EMF standards)

### Research

Scientists around the world have been researching possible human health effects of EMF since the 1970s. There are two main types of research which make up the body of scientific knowledge around EMF: epidemiological studies and laboratory studies. These epidemiological studies and laboratory studies provide pieces of the puzzle but no single study can give us the whole picture.

### Epidemiological Studies

In epidemiological studies, researchers try to establish whether there is a statistical association (mathematical link) between selected groups of people with certain types of exposure and certain kinds of disease. The stronger the statistical association, the greater the probability that the particular exposure may cause the disease. However, epidemiological studies cannot establish a cause and effect relationship because other possible causes that could explain the statistical relationship cannot be ruled out. Some epidemiological studies have suggested a possible statistical association between exposure to magnetic fields and some diseases, including childhood leukemia.

### Laboratory Studies

Laboratory studies involve exposing cells, tissues, humans and/or animals to EMF under controlled conditions. These studies allow researchers to closely control EMF exposure and provide information about any small scale biological changes that EMFs may cause.

Laboratory studies have not confirmed that magnetic fields are the cause of any disease.

### Conclusions to date

In light of the evidence and research to date, a number of conclusions have been drawn by international research organizations on the health risks associated with EMF:

- Health Canada's 2010 It's Your Health fact sheet on EMF states:

"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.

There have been many studies about the effects of exposure to electric and magnetic fields at extremely low frequencies. Scientists at Health Canada are aware that some studies have suggested a possible link between exposure to ELF fields and certain types of childhood cancer" but Health Canada goes on to conclude that. "In summary, when all of the studies are evaluated together, the evidence suggesting that EMFs may contribute to an increased risk of cancer is very weak."

- Following a 10-year review of scientific research on effects from exposure to electromagnetic fields, the World Health Organization's International EMF Project states:

"In the area of biological effects and medical applications of non-ionizing radiation approximately 25,000 articles have been published over the past 30 years. Despite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals. Based on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields. However, some gaps in knowledge about biological effects exist and need further research."

- The Federal-Provincial-Territorial Radiation Protection Committee (FPTRPC), organized under Health Canada's Radiation Protection Bureau, issued a Position Statement in January, 2005 stating that adverse health effects from exposure to power frequency EMFs at levels normally encountered in homes, schools and offices have not been established.

And in November 2008, the FTRPC issued a Response Statement to Public Concerns regarding Electric and Magnetic Fields (EMFs) from Electrical Power Transmission and Distribution Lines which concluded "In summary, it is the opinion of the Federal-Provincial-Territorial Radiation Protection Committee that there is insufficient scientific evidence showing exposure to EMFs from power lines can cause adverse health effects such as cancer. Therefore, a warning to the public to avoid living near or spending time in proximity to power lines is not required."

- A 1999 report by the U.S. National Institute of Environmental Health Sciences (NIEHS) following a seven-year EMF research programme concluded:

"The NIEHS believes that the probability that EMF exposure is truly a health hazard is currently small. The weak epidemiological associations and lack of any laboratory support for these associations provide only marginal scientific support that exposure to this agent is causing any degree of harm"

- The World Health Organization International Agency for Research on Cancer (IARC) has classified power frequency EMF as a 2B carcinogen – a possible carcinogen based on unanswered questions of the statistical association between magnetic field exposure and childhood leukemia. IARC found no consistent evidence that childhood EMF exposures are associated with other types of cancers or that adult EMF exposures are associated with increased risk of any kind of cancer. Other 2B Possible Carcinogens include coffee, pickled vegetables and gasoline engine exhaust.

The Canadian electricity industry continues to support scientific research on EMF and possible long-term effects on people. CEA member companies also work to communicate accurate and up-to-date information to the public and employees about EMF.

For more Canadian electricity industry information on EMF, please visit our website at <http://www.electricity.ca/emf.php>

## EMF Exposure Guidelines

In the absence of sufficient data to allow a long-term EMF exposure guideline to be established, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Institute of Electrical and Electronics Engineers (IEEE) have proposed exposure guidelines which protect workers and the general public from well-documented immediate biological effects that can result from direct exposure to fields well above those typically found in living environments. These immediate biological effects could include: stimulation of nerves and muscles, functional changes in the nervous system, hair stimulation and other tissues, shocks, burns, and elevated tissue temperatures.

Typical Canadian exposures fall well below these international guidelines.

- The International Commission on Non-Ionizing Radiation Protection (ICNIRP) published "Guidelines for Limiting Exposure to Time Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)" in April 1998. It is available at <http://www.icnirp.de/documents/emfgdl.pdf>.
- The Institute of Electrical and Electronics Engineers, Inc. (IEEE) produced "C95.6-2002 IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields 0 to 3 kHz 2002". This technical document is available for purchase at [http://standards.ieee.org/reading/ieee/std\\_public/description/emc/C95.6-2002\\_desc.html](http://standards.ieee.org/reading/ieee/std_public/description/emc/C95.6-2002_desc.html)
- The Health Canada summary "Extremely Low Frequency: Health Effects and Exposure Guidelines Related to Extremely Low Frequency Electric and Magnetic Fields – An Overview" is available at <http://www.labour.gov.sk.ca/radiation/>

### What are Canadian utilities doing?

## To Learn More

For more information on EMF, contact your local electricity provider.

To find out more about what Health Canada has to say on EMF you can visit: <http://www.hc-sc.gc.ca/hl-vs/iyh-vs/environ/magnet-eng.php>

The FPTRPC, a joint committee of federal and provincial agencies has prepared statements on EMF and health effects: Extremely Low Frequency: Position Statement for the General Public on the Health Effects of Power-Frequency (60 Hz) Electric and Magnetic Fields available at: <http://www.labour.gov.sk.ca/radiation> and Response Statement to Public Concerns Regarding EMF from Electrical Power Transmission & Distribution Lines (Nov. 8, 2008): <http://www.hc-sc.gc.ca/ewh-semt/radiation/fpt-radprotect/emf-cem-eng.php>

The Electric and Magnetic Fields Research and Public Information Dissemination (EMF RAPID) Programme, led by the U.S. National Institute of Environmental Health Sciences (NIEHS), has produced an informative booklet, available online at: <http://www.niehs.nih.gov/health/docs/emf-02.pdf>

The World Health Organization (WHO) is conducting its International EMF Project to evaluate EMF research and risks: <http://www.who.int/entity/peh-emf/project/en>

## What Lies Ahead for EMF Research and Policy

EMF research is on-going, and from time to time health agencies and organizations, such as Health Canada and the World Health Organization, review the new studies and confirm or update their position statements on EMF.

As well, these agencies are looking to “precaution-based policies” to possibly guide their actions on EMF and other issues. Precaution-based policies are intended to address issues where there is some basis for concern, but no scientific certainty of a cause and effect relationship.

Generally a precaution-based policy requires that there is enough evidence to do a risk analysis or a cost/benefit analysis when considering policy options. It is not intended to be a replacement for scientific understanding. The Government of Canada document on precaution is available at: <http://www.pco-bcp.gc.ca/docs/information/publications/precaution/precaution-eng.pdf>.

The World Health organization website also contains information of precaution.