

FAQs Regarding Alternating Current (AC) Electric and Magnetic Fields (EMF)

In North America, AC transmission lines operate at a frequency of 60 cycles per second, or hertz (Hz), and EMF from transmission lines is included in the extremely low frequency (ELF) band of the EMF spectrum (below 3 kHz). ELF EMF is found virtually everywhere electricity is used in our society, including around household wiring, electrical appliances and transmission lines.

AltaLink recognizes that people may have concerns about exposure to ELF EMF, and takes those concerns seriously. AltaLink provides information about the status of ELF EMF health research from unbiased independent sources. AltaLink participates in the Electricity Canada EMF Task Group and also takes measurements of fields near our facilities.

What have national and international organizations concluded?

Research into possible adverse health effects from exposure to EMF has been undertaken extensively for more than 45 years. National agencies, such as Health Canada and the National Institute of Environmental Health Sciences (NIEHS) in the United States have reviewed this research and concluded there are no known adverse health effects to humans from low-level exposure to ELF EMF. Health Canada (HC) states “You don’t need to take precautions to protect yourself from these kinds of exposures.”

International organizations around the world, such as the International Agency for Research on Cancer (IARC) and the World Health Organization (WHO), among other agencies responsible for public health, have convened multi-disciplinary groups of scientists to review the research. These organizations have concluded there is insufficient evidence to support a cause and effect relationship between low-level ELF EMF exposure and any adverse health outcome. The WHO has concluded, based on a review of the scientific literature, that “current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields.” As ongoing research continues to confirm this finding there is greater scientific certainty that there are no adverse health effects.

What standards or guidelines apply to ELF electric and magnetic fields?

There are no national or provincial limits for ELF EMF in Canada. Two independent international scientific organizations, the International Commission on Non-ionizing Radiation Protection (ICNIRP) and the International Committee on Electromagnetic Safety (ICES)¹, have conducted reviews of the scientific literature. They have developed exposure guidelines to protect workers and the general public from known short-term or immediate (acute) biological effects such as interfering with the electric signals used by your brain and nervous system. These effects can result from direct exposure to high levels of ELF EMF, which are much higher than those typically found in everyday environments. Health Canada references the ICNIRP guidelines and state the guidelines help ensure that exposures to ELF EMF do not create electric currents that are stronger than the ones made naturally in your body. Health Canada states “Extremely low frequency EMF exposures in Canadian homes, schools and offices are far below the limits recommended in the ICNIRP guidelines.” AltaLink adds that exposures from AltaLink transmission lines are also below the limits in the ICNIRP guidelines.

¹ Institute of Electrical and Electronics Engineers (IEEE) committee



For the general public, the short-term electric field exposure guidelines range between 4.2 and 10 kilovolts per metre (kV/m); magnetic field exposure guidelines range between 2,000 and 9,040 milligauss (mG).

These organizations did not find a scientific basis to develop exposure guidelines for prolonged exposure to ELF EMF. For this reason, no low-level, long-term guidelines have been developed, the short-term guidelines continue to apply regardless of the duration of the exposure.

Do transmission lines or substations generate audible noise?

Sometimes audible noise can be heard from high-voltage transmission lines and is made up of a crackle and a lower frequency hum. The noise may be more noticeable in rainy or foggy conditions than in fair weather; however, noise from wind, rain, traffic or industrial sources often masks the low levels of audible noise generated by transmission lines. Substation transformers produce a low frequency hum that might be heard close to the substation and transformer cooling fans create noise when they are operating. AltaLink designs and ensures its transmission lines and substations comply with the Alberta Utilities Commission Rule 012 for noise control.

Will wireless communications reception be affected by a transmission line?

AltaLink's facilities are designed and operated to minimize levels of radio frequency interference (RFI) and to meet the Innovation, Science, and Economic Development (ISED) Canada interference regulations. AM and CB radio reception might be affected, particularly when directly under a transmission line. The type of radio, antenna and distance from the radio station can affect whether interference occurs. Higher frequency radio signals, such as FM, cellular phone and wireless internet, operate above the typical range of potentially affected frequencies and should not experience reception problems as a result of a transmission line. Contact AltaLink to investigate if your service provider suggests a transmission line is affecting your service.

Will television reception be affected by a transmission line?

Reception of cable TV and satellite TV signals are unaffected by RFI from transmission facilities. Digital TV signal frequencies are above the general range of potentially affected frequencies and should not experience reception problems as a result of a transmission line. If you think you might be experiencing poor television reception as a result of a transmission line, please call us. Although we cannot do anything about poor reception you had before the transmission line was built, if interference occurs after a line is built, the problem can often be solved by changing or relocating the TV antenna.

Will a Global Positioning System (GPS) receiver be affected by a transmission line?

RFI from transmission facilities on GPS equipment is unlikely. The signals sent to GPS receivers from satellites have frequencies much higher than the range of frequencies potentially affected by RFI from transmission lines. Research has shown transmission lines do not cause errors or malfunctions for modern GPS equipment. Contact AltaLink if you believe your GPS receiver is being affected by AltaLink's facilities.

How are nearby metal buildings and wire fences affected by a transmission line?

Electrical charges will not normally accumulate on buildings close to transmission lines because appropriate grounding already exists. AltaLink will help ensure that metal buildings, fences (including electric fences) and other structures close to its facilities are properly grounded to avoid the build-up of an electrical charge and possible nuisance shocks. Let us know if you are planning to put up a new building, fence or gate near an existing transmission



line, and we will advise you on how to ground the new structure and ensure it will not block access to the right-of-way.

Will my cardiac pacemaker be affected by a transmission line?

AltaLink is not aware of any cases of confirmed interference to pacemakers by transmission lines, however, experimental studies have reported that strong electric and magnetic fields have the potential to affect the function of a pacemaker if the fields exceed a pacemaker's immunity level. Pacemakers are designed to minimize the effect of interference from any source. Even though a change in function may be noted, it does not mean that a patient is at risk. Magnetic field levels directly under a transmission line are a fraction of a pacemaker's immunity level to magnetic fields. Electric field levels under some transmission lines may be comparable to the pacemaker's electric field immunity level. While electric fields may affect some models of pacemakers, this would be most likely directly under AC transmission lines operating at 500 kV since electric field levels drop rapidly with distance and are shielded by many materials.

In addition, most modern pacemakers are designed to filter out electrical interference or revert to a safe mode of steady pacing (called asynchronous pacing) if interference becomes too great. Your doctor will be able to identify if interference has occurred by reviewing the telemetry data on your next visit. If you have a concern about potential interference from exposure to an electric field, contact your doctor. AltaLink will work together with your doctor to help you determine if your device is immune to electric fields from a transmission line.

Can a transmission line be a source of stray voltage?

Stray voltage can cause behavioural problems in livestock if they experience a voltage across two points of their body. This is different than a nuisance shock from an ungrounded metallic object that is in close proximity to a transmission line. AltaLink will mitigate nuisance shocks through our common grounding practices.

Stray voltage problems are primarily related to distribution systems and on-farm wiring, both of which rely on the earth as a path for some of their current to flow. In these circuits, unbalanced loading on electrical panels, the use of distribution system neutrals and/or wiring problems can cause a current to flow into the earth (ground) at the load service point. Transmission lines might influence stray voltages only where long sections of on-farm wiring or distribution lines are built very near and parallel to the transmission lines, causing currents to be induced onto the neutrals of these facilities. Contact your electricity service provider if you suspect stray voltage is an issue on your property.

Is there a difference between AC and Direct Current (DC) transmission lines?

Yes. The vast majority of AltaLink's transmission lines are AC, in fact the majority of the lines in Alberta and Canada are AC, however DC lines also exist. Since AC and DC transmission lines differ in frequency, the EMF produced also differs in frequency. For AC equipment, the polarity of the voltage and current changes direction at 60 Hz, producing ELF EMF that changes direction at that frequency. For DC equipment, the polarity of the voltage and current remains constant (0 Hz), producing static fields that do not change direction. AC and DC fields behave differently. Only AC fields are capable of inducing currents and voltages in conductive objects such as fences, buildings and humans. High electric fields at the surface of transmission line conductors can ionize the air, causing an effect called corona which is the cause of any potential audible noise or RFI near transmission lines. Corona effects such as audible noise and RFI can occur near both AC and DC lines. While corona effects on AC lines are usually higher during wet conditions, corona effects on DC lines are generally higher during fair weather.



Where can I find further information about AC EMF?

Further sources of information about AC electric and magnetic fields include:

- AltaLink's brochure; 'A DIALOGUE ON ELECTRIC AND MAGNETIC FIELDS'
- Handouts published by health organizations such as those attached from WHO and HC
- Peer-reviewed scientific literature published in health science and electrical engineering journals

Websites of EMF Information from the WHO, HC and other health organizations:

- AltaLink's Website (AML) – Electric and Magnetic Fields (EMF)**
<http://www.altalink.ca/emf>
- Health Canada (HC) – “Power lines and electrical products: Extremely low frequency electric and magnetic fields:** <https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/everyday-things-emit-radiation/power-lines-electrical-appliances.html> https://www.hc-sc.gc.ca/hl-vs/alt_formats/pdf/iyh-vsv/environ/magnet-eng.pdf
- Federal Provincial Territorial Radiation Protection Committee (FPTRPC) – Report and Response Statements** <https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/understanding/federal-provincial-territorial-radiation-protection-committee.html#a3>
https://www.hydroone.com/poweroutagesandsafety/_corporatehealthandsafety_/EMFs/Health_Effects_and_Exposure_Guidelines_ELF_EMF.pdf
https://www.hydroone.com/poweroutagesandsafety/_corporatehealthandsafety_/EMFs/Position_Statement_for_General_Public.pdf
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https://www.hydroone.com/poweroutagesandsafety/_corporatehealthandsafety_/EMFs/Response_Statement_to_Public_Concerns_Regarding_EMFs_from_Electrical_Power_Tx_and_Dx_Lines.pdf
- World Health Organization (WHO) – Summary of EMF Background and Fact Sheets**
<http://www.who.int/peh-emf/about/WhatisEMF/en/>
<https://www.who.int/teams/environment-climate-change-and-health/radiation-and-health/non-ionizing/exposure-to-extremely-low-frequency-field>
<https://www.who.int/publications/i/item/9789241572385>
<https://www.who.int/initiatives/the-international-emf-project>
- National Institute of Environmental Health Sciences (NIEHS) – EMF RAPID Questions and Answers**
http://www.niehs.nih.gov/health/materials/electric_and_magnetic_fields_associated_with_the_use_of_electric_power_questions_and_answers_english_508.pdf
- International Commission on Non-Ionizing Radiation Protection (ICNIRP)**
<http://www.icnirp.org/en/applications/power-lines/power-lines.html>

- g) Electricity Canada (EC)**
<https://www.electricity.ca/knowledge-centre/the-grid/transmission/there-has-been-great-public-interest-in-the-risks-associated-with-electric-magnetic-fields-emfs/>
- h) BC Center for Disease Control (BCCDC) – RIN #1 Power Frequency Electric and Magnetic Fields**
<http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/EH/RPS/RIN01-ELF.pdf>
- i) National Cancer Institute (NCI) - Magnetic Field Exposure and Cancer: Questions and Answers** <http://www.cancer.gov/cancertopics/factsheet/Risk/magnetic-fields>
- j) Public Health England (PHE) - Electric and Magnetic Fields**
<http://www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/ElectromagneticFields>
- k) Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR)**
https://health.ec.europa.eu/publications/potential-health-effects-exposure-electromagnetic-fields-emf_en
- l) Swedish Radiation Safety Authority (SSM)**
<https://www.stralsakerhetsmyndigheten.se/en/areas/magnetic-fields-and-wireless-technology/magnetic-fields/>
- m) The European Health Risk Assessment Network on Electromagnetic Fields (EFHRAN)**
<https://sfrp.asso.fr/wp-content/uploads/2023/07/11-EFHRAN-oct-2012-revision-de-juillet-2010.pdf>





[Canada.ca](#) > [Health](#) > [Health risks and safety](#) > [Radiation and your health](#) > [Everyday things that emit radiation](#)

Power lines and electrical products: Extremely low frequency electric and magnetic fields

Power lines and electrical products emit extremely low frequency electric and magnetic fields (EMF). Learn about the safety of power lines and electrical products.

On this page

- [About extremely low frequency EMF](#)
- [Sources of extremely low frequency EMF](#)
- [Power lines and your home](#)
- [Recommended human exposure limits](#)
- [What we do to keep you safe from extremely low frequency EMFs](#)

About extremely low frequency EMF

Extremely low frequency electromagnetic fields (EMF) are invisible waves that travel through space and exert force on charged particles.

Extremely low frequency EMF:

- consist of electric fields and magnetic fields
- is in the frequency range of 1 Hertz (Hz) to 3 kilohertz (kHz) of the electromagnetic spectrum

An electric field is created whenever you plug a wire from an electrical product, like a lamp, into an outlet. When you turn the lamp on, the flow of current, known as alternating current (AC) forms a magnetic field. Together, the electric and magnetic field radiates out like a wave and are known as electromagnetic fields or EMF.

In Canada, the electricity that is distributed to our homes and other buildings is AC with a frequency of 60 Hz. This is considered extremely low frequency EMF.

Sources of extremely low frequency EMF

Electrical products create extremely low frequency EMF when they are plugged into a wall outlet and are turned on (drawing a current). Common sources of extremely low frequency EMF are:

- household wiring
- electrical appliances and household electrical products
- power lines, transformer boxes and electrical substations

Power lines and your home

Power lines that distribute electricity around your home emit extremely low frequency EMF. These fields are strongest at their source. This means you are exposed to stronger extremely low EMFs when you are close to a source such as:

- right beside a transformer box
- directly under a high voltage power line

As you move away, your level of exposure rapidly decreases. When you are inside your home, the electric fields from transformer boxes and high voltage power lines are often weaker than the fields from household electrical appliances.

Recommended human exposure limits

The potential health effects of extremely low frequency EMF has been studied extensively. While some people are concerned that long term exposure to extremely low frequency EMF may cause cancer, the scientific evidence does not support such claims.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has issued [guidelines for limiting exposure to extremely low frequency EMF](#). These guidelines help ensure that exposures to extremely low frequency EMF do not create electric currents that are stronger than the ones made naturally in your body. The electric signals used by your brain and nervous system make it possible for you to move, think and feel.

Extremely low frequency EMF exposures in Canadian homes, schools and offices are far below the limits recommended in the ICNIRP guidelines. You don't need to take precautions to protect yourself from these kinds of exposures.

Exposure to extremely low frequency EMF is not the same as electrical shock. Electrical shock can happen when an electrical product is used incorrectly. Learn [how to use electrical products safely](#).

What we do to keep you safe from extremely low frequency EMFs

To protect your health and safety, Health Canada:

- monitors the science on electromagnetic fields
- conducts research on potential health effects from electromagnetic fields
- contributes to the World Health Organization's International EMF Project

We do not regulate the delivery of electricity in Canada. For questions about power lines, transformer stations or other electrical infrastructure near your home, school or office you can contact:

- your local electricity provider
- your local public health office
- your municipal, provincial or territorial government

Related links

- [About radiation](#)
- [International EMF Project](#)
- [International Agency for Research on Cancer](#)
- [Radiofrequency electromagnetic fields \(EMF\)](#)
- [World Health Organization: Extremely low frequency fields](#)
- [International Commission on Non-Ionizing Radiation Protection](#)

Date modified:

2022-11-01



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Electric and Magnetic Fields

Updated: November 2012

Original: November 2001

IT'S YOUR HEALTH

Electric and Magnetic Fields from Power Lines and Electrical Appliances

THE ISSUE

Some people are concerned that daily exposure to electric and magnetic fields (EMFs) may cause health problems.



ELECTRICITY AND ELECTRIC AND MAGNETIC FIELDS (EMFS)

Electricity delivered through power lines is important in today's society. It is used to light homes, prepare food, run computers and operate other household appliances, such as TVs and radios. In Canada, appliances that plug into a wall socket use electric power that flows back and forth at a frequency of 60 cycles per second (60 hertz). The frequency used with the distribution of electricity from power lines and electrical appliances is different than the frequencies used for [Wi-Fi](#), [cell phones](#), and [smart meters](#).

Every time you use electricity and electrical appliances, you are exposed to electric and magnetic fields (EMFs) at extremely low frequencies (ELFs). The term "extremely low" is described as any frequency below 300 hertz. EMFs produced by the transmission and use of electricity belong to this category.

EMFs are invisible forces that surround electrical equipment, power cords, and wires that carry electricity, including outdoor power lines.

- *Electric Fields:* These are formed whenever a wire is plugged into an outlet, even when the appliance is not turned on. The higher the voltage, the stronger the electric field.
- *Magnetic Fields:* These are formed when electric current is flowing within a device or wire. The greater the current, the stronger the magnetic field.

EMFs can occur separately or together. For example, when you plug the power cord for a lamp into a wall socket, it creates an electric field along the cord. When you turn the lamp on, the flow of current through the cord creates a magnetic field. Meanwhile, the electric field is still present.

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POWER LINES AND YOUR HOME

EMFs are strongest when close to their source. As you move away from the source, the strength of the fields fades rapidly. This means you are exposed to stronger EMFs when standing close to a source (e.g., right beside a transformer box or under a high voltage power line), and you are exposed to weaker fields as you move away.

When you are inside your home, the magnetic fields from high voltage power lines and transformer boxes are often weaker than those from household electrical appliances.

Electric fields can be shielded using materials such as metal. Things like buildings and trees—and even the ground when power lines are buried—can block electric fields.

CANADIANS EXPOSURE TO EMFS AT EXTREMELY LOW FREQUENCIES (ELFS)

On a daily basis, most Canadians are exposed to EMFs generated by household wiring, lighting, and any electrical appliance that plugs into the wall, including hair dryers, vacuum cleaners and toasters. In the workplace, common sources of EMFs include computers, air purifiers, photocopiers, fax machines, fluorescent lights, electric heaters, and electric tools in machine shops, such as drills, power saws, lathes and welding machines.

EXPOSURE IN CANADIAN HOMES, SCHOOLS AND OFFICES PRESENT NO KNOWN HEALTH RISKS

There have been many studies on the possible health effects from exposure to EMFs at ELFs. While it is known that EMFs can cause weak electric currents to flow through the human body, the



intensity of these currents is too low to cause any known health effects. Some studies have suggested a possible link between exposure to ELF magnetic fields and certain types of childhood cancer, but at present this association is not established.

The [International Agency for Research on Cancer \(IARC\)](#) has classified ELF magnetic fields as “possibly carcinogenic to humans”. The IARC classification of ELF magnetic fields reflects the fact that some limited evidence exists that ELF magnetic fields might be a risk factor for childhood leukemia. However, the vast majority of scientific research to date does not support a link between ELF magnetic field exposure and human cancers. At present, the evidence of a possible link between ELF magnetic field exposure and cancer risk is far from conclusive and more research is needed to clarify this “possible” link.

Health Canada is in agreement with both the World Health Organization and IARC that additional research in this area is warranted.

REDUCE YOUR RISK

Health Canada does not consider that any precautionary measures are needed regarding daily exposures to EMFs at ELFs. 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.

THE GOVERNMENT OF CANADA'S ROLE

Health Canada, along with the World Health Organization, monitors scientific research on EMFs and human health as part of its mission to help Canadians maintain and improve their health.

International exposure guidelines for exposure to EMFs at ELFs have been established by the [International Commission on Non-Ionizing Radiation Protection \(ICNIRP\)](#). These guidelines are not based on a consideration of risks related to cancer. Rather, the point of the guidelines is to make sure that exposures to EMFs do not cause electric currents or fields in the body that are stronger than the ones produced naturally by the brain, nerves and heart. EMF exposures in Canadian homes, schools and offices are far below these guidelines.

FOR MORE INFORMATION

- Health Canada’s [Electric and magnetic fields](#) at: www.hc-sc.gc.ca/ewh-semt/radiation/cons/electri-magnet/index-eng.php
- The World Health Organization – Electromagnetic fields and public health:
 - [Exposure to extremely low frequency fields](#) at: www.who.int/mediacentre/factsheets/fs322/en/index.html
 - [Extremely low frequency](#) at: www.who.int/docstore/peh-mf/publications/facts_press/efact/efs205.html
 - [Extremely low frequency fields and cancer](#) at: www.who.int/docstore/peh-emf/publications/facts_press/efact/efs263.html



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Electric and Magnetic Fields

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Original: November 2001

IT'S YOUR HEALTH



FOR INDUSTRY AND PROFESSIONALS

- The International Agency for Research on Cancer (IARC) *Volume 80 – Non-ionizing Radiation, Part 1: Static and Extremely Low-Frequency (ELF) Electric and Magnetic Fields* at: <http://monographs.iarc.fr/ENG/Monographs/vol80/volume80.pdf>
- IARC Carcinogen classifications at: <http://monographs.iarc.fr/ENG/Classification/index.php>

RELATED RESOURCES

- Health Canada, *It's Your Health*:
 - Safety of Wi-Fi Equipment at: www.hc-sc.gc.ca/hl-vs/iyh-vsv/prod/wifi-eng.php
 - Safety of Cell Phones and Cell Phone Towers at: www.hc-sc.gc.ca/hl-vs/iyh-vsv/prod/cell-eng.php
- For safety information about food, health and consumer products, visit the [Healthy Canadians](http://www.healthycanadians.gc.ca) website at: www.healthycanadians.gc.ca
- For more articles on health and safety issues go to the *It's Your Health* web section at: www.health.gc.ca/iyh

You can also call toll free at
1-866-225-0709 or TTY at
1-800-267-1245*

Updated: November 2012
Original: November 2001

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Catalogue: H13-7/70-2012E-PDF
ISBN: 978-1-100-21395-8

Canada



Fact sheet N°322
June 2007

Electromagnetic fields and public health

Exposure to extremely low frequency fields

The use of electricity has become an integral part of everyday life. Whenever electricity flows, both electric and magnetic fields exist close to the lines that carry electricity, and close to appliances. Since the late 1970s, questions have been raised whether exposure to these extremely low frequency (ELF) electric and magnetic fields (EMF) produces adverse health consequences. Since then, much research has been done, successfully resolving important issues and narrowing the focus of future research.

In 1996, the World Health Organization (WHO) established the International Electromagnetic Fields Project to investigate potential health risks associated with technologies emitting EMF. A WHO Task Group recently concluded a review of the health implications of ELF fields (WHO, 2007).

This Fact Sheet is based on the findings of that Task Group and updates recent reviews on the health effects of ELF EMF published in 2002 by the International Agency for Research on Cancer (IARC), established under the auspices of WHO, and by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in 2003.

ELF field sources and residential exposures

Electric and magnetic fields exist wherever electric current flows - in power lines and cables, residential wiring and electrical appliances. **Electric** fields arise from electric charges, are measured in volts per metre (V/m) and are shielded by common materials, such as wood and metal. **Magnetic** fields arise from the motion of electric charges (i.e. a current), are expressed in tesla (T), or more commonly in millitesla (mT) or microtesla (μ T). In some countries another unit called the gauss, (G), is commonly used (10,000 G = 1 T). These fields are not shielded by most common materials, and pass easily through them. Both types of fields are strongest close to the source and diminish with distance.

Most electric power operates at a frequency of 50 or 60 cycles per second, or hertz (Hz). Close to certain appliances, the magnetic field values can be of the order of a few hundred microtesla. Underneath power lines, magnetic fields can be about 20 μ T and electric fields can be several thousand volts per metre. However, average residential power-frequency magnetic fields in homes are much lower - about 0.07 μ T in Europe and 0.11 μ T in North America. Mean values of the electric field in the home are up to several tens of volts per metre.

Task group evaluation

In October 2005, WHO convened a Task Group of scientific experts to assess any risks to health that might exist from exposure to ELF electric and magnetic fields in the frequency range >0 to 100,000 Hz (100 kHz). While IARC examined the evidence regarding cancer in 2002, this Task Group reviewed evidence for a number of health effects, and updated the evidence regarding cancer. The conclusions and recommendations of the Task Group are presented in a WHO Environmental Health Criteria (EHC) monograph (WHO, 2007).

Following a standard health risk assessment process, the Task Group concluded that there are no substantive health issues related to ELF electric fields at levels generally encountered by members of the public. Thus the remainder of this fact sheet addresses predominantly the effects of exposure to ELF magnetic fields.

Short-term effects

There are established biological effects from acute exposure at high levels (well above 100 μT) that are explained by recognized biophysical mechanisms. External ELF magnetic fields induce electric fields and currents in the body which, at very high field strengths, cause nerve and muscle stimulation and changes in nerve cell excitability in the central nervous system.

Potential long-term effects

Much of the scientific research examining long-term risks from ELF magnetic field exposure has focused on childhood leukaemia. In 2002, IARC published a monograph classifying ELF magnetic fields as "possibly carcinogenic to humans". This classification is used to denote an agent for which there is limited evidence of carcinogenicity in humans and less than sufficient evidence for carcinogenicity in experimental animals (other examples include coffee and welding fumes). This classification was based on pooled analyses of epidemiological studies demonstrating a consistent pattern of a two-fold increase in childhood leukaemia associated with average exposure to residential power-frequency magnetic field above 0.3 to 0.4 μT . The Task Group concluded that additional studies since then do not alter the status of this classification.

However, the epidemiological evidence is weakened by methodological problems, such as potential selection bias. In addition, there are no accepted biophysical mechanisms that would suggest that low-level exposures are involved in cancer development. Thus, if there were any effects from exposures to these low-level fields, it would have to be through a biological mechanism that is as yet unknown. Additionally, animal studies have been largely negative. Thus, on balance, the evidence related to childhood leukaemia is not strong enough to be considered causal.

Childhood leukaemia is a comparatively rare disease with a total annual number of new cases estimated to be 49,000 worldwide in 2000. Average magnetic field exposures above 0.3 μT in homes are rare: it is estimated that only between 1% and 4% of children live in such conditions. If the association between magnetic fields and childhood leukaemia is causal, the number of cases worldwide that might be attributable to magnetic field exposure is estimated to range from

100 to 2400 cases per year, based on values for the year 2000, representing 0.2 to 4.95% of the total incidence for that year. Thus, if ELF magnetic fields actually do increase the risk of the disease, when considered in a global context, the impact on public health of ELF EMF exposure would be limited.

A number of other adverse health effects have been studied for possible association with ELF magnetic field exposure. These include other childhood cancers, cancers in adults, depression, suicide, cardiovascular disorders, reproductive dysfunction, developmental disorders, immunological modifications, neurobehavioural effects and neurodegenerative disease. The WHO Task Group concluded that scientific evidence supporting an association between ELF magnetic field exposure and all of these health effects is much weaker than for childhood leukaemia. In some instances (i.e. for cardiovascular disease or breast cancer) the evidence suggests that these fields do not cause them.

International exposure guidelines

Health effects related to short-term, high-level exposure have been established and form the basis of two international exposure limit guidelines (ICNIRP, 1998; IEEE, 2002). At present, these bodies consider the scientific evidence related to possible health effects from long-term, low-level exposure to ELF fields insufficient to justify lowering these quantitative exposure limits.

WHO's guidance

For high-level short-term exposures to EMF, adverse health effects have been scientifically established (ICNIRP, 2003). International exposure guidelines designed to protect workers and the public from these effects should be adopted by policy makers. EMF protection programs should include exposure measurements from sources where exposures might be expected to exceed limit values.

Regarding long-term effects, given the weakness of the evidence for a link between exposure to ELF magnetic fields and childhood leukaemia, the benefits of exposure reduction on health are unclear. In view of this situation, the following recommendations are given:

- Government and industry should monitor science and promote research programmes to further reduce the uncertainty of the scientific evidence on the health effects of ELF field exposure. Through the ELF risk assessment process, gaps in knowledge have been identified and these form the basis of a new research agenda.
- Member States are encouraged to establish effective and open communication programmes with all stakeholders to enable informed decision-making. These may include improving coordination and consultation among industry, local government, and citizens in the planning process for ELF EMF-emitting facilities.
- When constructing new facilities and designing new equipment, including appliances, low-cost ways of reducing exposures may be explored. Appropriate exposure reduction measures will vary from one country to another. However, policies based on the adoption of arbitrary low exposure limits are not warranted.

Further reading

WHO - World Health Organization. Extremely low frequency fields. Environmental Health Criteria, Vol. 238. Geneva, World Health Organization, 2007.

IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Non-ionizing radiation, Part 1: Static and extremely low-frequency (ELF) electric and magnetic fields. Lyon, IARC, 2002 (Monographs on the Evaluation of Carcinogenic Risks to Humans, 80).

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Federal-Provincial-Territorial Radiation Protection Committee – Canada

Response Statement to Public Concerns Regarding Electric and Magnetic Fields (EMFs) from Electrical Power Transmission and Distribution Lines

- Issued on November 8, 2008 -

The Federal-Provincial-Territorial Radiation Protection Committee (FPTRPC) is aware of public concerns about possible health risks from exposure to EMFs in living and school environments, arising from electrical power lines located nearby. The FPTRPC developed both a Position Statement* on the health effects of EMFs and a Response Statement† concerning childhood leukemia, to help address these issues.

Public concerns appear to arise from periodic media reports and from dubious Internet websites which contain inaccurate, unsubstantiated, controversial or contradictory statements regarding EMF-health issues. Concerns may result in public opposition to the proposed construction of new high-voltage power lines or upgrades of existing ones. Opposition to such proposals is often influenced by factors other than health issues (e.g. aesthetics). In addition, some individuals and organizations are promoting precaution by advising the public to limit their time spent near power lines or to avoid being near lines.

Like household electrical appliances, power lines emit power-frequency EMFs. The intensity of the EMFs from such lines depends on wiring and tower configurations, as well as the line voltage, the current being carried and distance from the lines. EMFs from power lines and electrical appliances diminish rapidly with increasing distance. For magnetic fields, the contribution from power lines to the levels in most homes and other buildings is very small to negligible when compared to the fields in close proximity to operating electrical appliances and building wiring.

During the past three decades, a large number of scientific studies have been carried out throughout the world. These studies include laboratory investigations with biological organisms, and epidemiological analyses that examine the possible link between ill health and EMF exposure. The conclusion by the majority of experts in this subject area is that, while some epidemiological studies suggest a weak statistical link between EMFs and certain types of cancer, other epidemiological studies and the bulk of laboratory studies do not substantiate this link. Based on the weak epidemiological evidence from childhood leukaemia studies, the International Agency for Research on Cancer has classified power-frequency magnetic fields as “possibly carcinogenic to humans” (the same classification applied to, for example, coffee and pickled vegetables).

International EMF exposure guidelines based on established findings have been developed in order to protect against immediate (acute) effects on nervous system

functions. Science-based guidelines for protection against possible health effects such as cancer that may result from long-term (chronic) exposure have not been established. Given the lack of convincing scientific evidence on such effects, there are no national guidelines in Canada limiting exposure of the public to power-frequency EMFs.

Public concern over the EMF-health issues has led to recent demands for power line regulators to apply the Precautionary Principle (PP) to proposed construction of new high-voltage power lines or to the upgrade of existing ones. PP is a public policy approach for risk management of possible but unproven adverse health effects. The extent of PP approaches range from monitoring scientific developments and providing information to stronger measures such as action for lowering exposures. Any precautionary measures to be taken should be proportional to the level of risk and its associated uncertainty, the severity of the health outcome and the level of societal benefit. In the context of power-frequency EMFs, health risks to the public from such exposures have not been established; therefore, it is the opinion of FPTRPC that any precautionary measures applied to power lines should favour low cost or no cost options.

Most power lines and electrical facilities in Canada fall within provincial jurisdictions. The federal government involvement is for authorization of the construction and operation of international power lines and designated inter-provincial lines coming under federal jurisdiction. On request, the federal government participates in environmental assessment reviews for the proposed construction of new high-voltage power lines or upgrade of existing ones by providing expert information or knowledge. The possible effects of EMFs on human health are one of several environmental issues considered when conducting these reviews.

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.

* Position Statement for the General Public on the Health Effects of Power-frequency (60 Hz) Electric and Magnetic Fields; issued by the Federal Provincial Territorial Radiation Protection Committee – January 20, 2005

† Response Statement to the Issue of Power-Frequency Magnetic Fields and Childhood Leukemia – Issued on January 20, 2005.