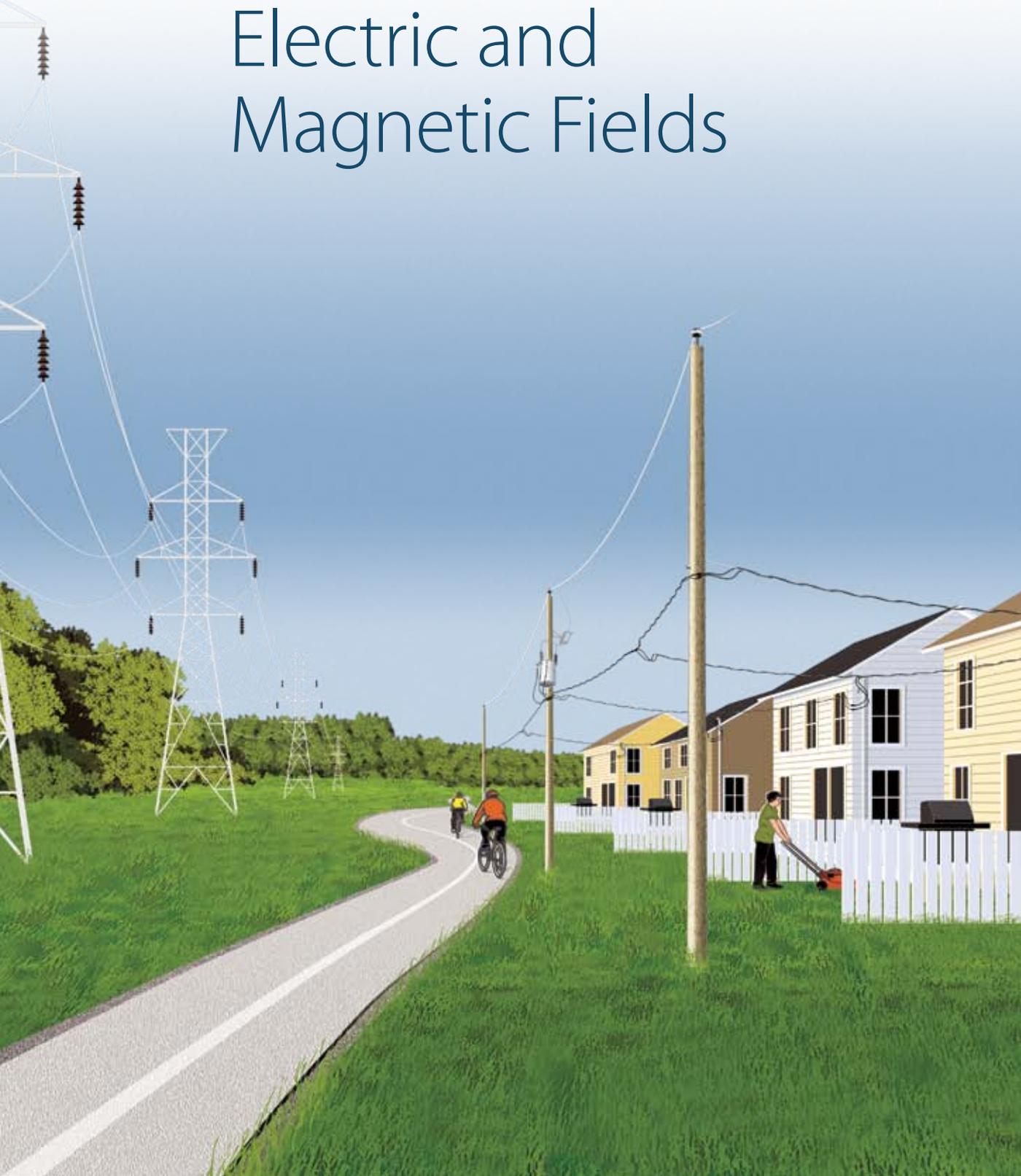


THE POWER SYSTEM AND HEALTH

# Electric and Magnetic Fields





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## ABBREVIATIONS AND SYMBOLS

<b>EMFs</b>	electric and magnetic fields
<b>ELF</b>	extremely low-frequency
<b>HVPL</b>	high-voltage power line
<b>kV</b>	kilovolt (unit for measuring the voltage carried by an HVPL; 1 kV = 1,000 volts)
<b>μT</b>	microtesla (unit of measurement used for magnetic fields; 1 μT = 1 millionth of a tesla)
<b>V/m</b>	volts per metre (unit of measurement used for electric fields)

## **ELECTRIC AND MAGNETIC FIELDS: REASSURING NEWS**

*It's hard to imagine a world without electricity. And yet, wherever electricity is used, electrical circuits and appliances produce electric and magnetic fields (EMFs). Although these fields are generally so weak as to be imperceptible, their potential effect on the human body has been the subject of extensive studies for the past 40 years. This research has resulted in numerous reports.*

*But what is an electric or magnetic field? How strong are the fields we are exposed to in our everyday lives? And most important, what do we know about their effects on the human body and on our health? What is the opinion of public health authorities, both here and around the world? In this brochure, we will attempt to provide some answers.*

*Today, electric and magnetic fields are much better understood and documented than they were a few years ago. As we will see, despite the large number of studies and their increasing quality, researchers have been unable to show that EMFs have any effect on human health, either in the workplace or at home. That's reassuring news indeed.*

*A hypothesis first put forward in 1979 linking childhood leukemia to extremely low-frequency magnetic fields in the home has never been confirmed by extensive experiments or epidemiological research. It is most likely a false alarm.*

*We hope you will find this brochure useful and informative.*

*Dr. Michel Plante*

*Direction – Santé et sécurité*

*Hydro-Québec*



# Electric and magnetic fields

EMFs are all around us, occurring naturally in every atom of matter. The surface of the Earth is covered with a natural electric field, created by electrical charges in the upper atmosphere. Similarly, a powerful electric field is required to keep the cells of living organisms alive.

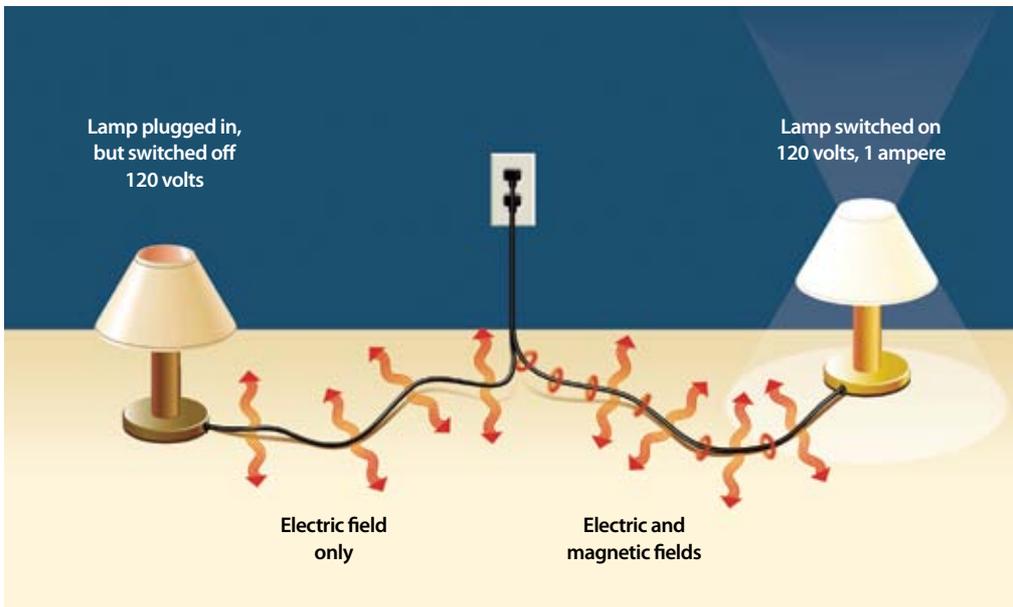
The Earth is also surrounded by a magnetic field that can be detected with a compass. This magnetic field is generated by electrical currents produced by molten matter in the Earth's core.

The electrical activity in the Earth's core is fairly consistent in intensity, resulting in direct current. The electricity that is produced by Hydro-Québec generating stations and used to power appliances and other devices is different. The electrons that move to create the electrical current change direction regularly at a rate of 60 times per second. This is what we call a 60-hertz alternating current, which produces alternating EMFs.

## WHAT IS AN ELECTRIC OR MAGNETIC FIELD?

All uses of electricity generate an electric field and a magnetic field. The field is strongest near the source, becoming weaker with distance. The notion of a “field” also applies to other physical phenomena present in our everyday environment.

Although the analogy is not scientifically exact, you could compare an EMF to the heat coming from a campfire. The temperature is very high near the fire, dropping quickly as you move away. At a certain distance, depending on the size of the fire, you will no longer feel any heat from it.



An **electric field** is related to voltage (measured in volts) and is generated by the **presence** of electric charges (electrons). It is measured in **volts per metre (V/m)**. The higher the voltage supplied to an appliance, the stronger the resulting electric field. The cord of an appliance plugged into a socket will generate an electric field, even if the appliance is not switched on. The strength of an electric field can be substantially reduced by the presence of anything that acts as a screen, such as trees, fences and buildings.

A **magnetic field** is generated by electric current (measured in amperes); that is, by the **movement** of electrons. As soon as an appliance is turned on, it produces a magnetic field. When it is turned off, the magnetic field disappears. Unlike electric fields, magnetic fields are not reduced by trees, fences or buildings; the field passes easily through these barriers. The strength of a magnetic field is measured in teslas, although we generally use a much smaller unit such as the **microtesla ( $\mu\text{T}$ )**.



# What factors contribute to my exposure to EMFs?

**We are all exposed to EMFs produced by electrical appliances, the household circuits that power them, and the transmission and distribution lines that bring electricity into our homes. The time we spend close to such equipment considerably influences our exposure to EMFs.**

We have seen that all electrical equipment produces an electric and a magnetic field when in operation.

The electrical energy that we use at home is provided at a low voltage, resulting in an electric field that is only a few volts per metre. The place where the electric field is strongest on the ground is directly under high-voltage lines, where the conductors are closest to the ground. There is also a natural electric field in the air, which gets stronger just before and during a storm.

Ambient magnetic fields in Québec homes are very weak and rarely exceed 1  $\mu\text{T}$ . However, their strength can differ substantially from one home to another. At our latitude, the Earth's magnetic field is around 50  $\mu\text{T}$ .

Many ordinary electrical appliances produce a magnetic field of tens or even hundreds of microteslas. Some specialized equipment used in hospitals produces significantly stronger magnetic fields—about 1 tesla in the case of magnetic resonance imaging (MRI) scanners. However, the strength of the field decreases considerably as you move away from the source. When an appliance is used for a short period of time, it doesn't contribute much to your overall exposure. As for transmission lines, the magnetic field in houses located right on the edge of the right-of-way<sup>1</sup> is generally stronger than in houses farther away.

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1. Strip of land set aside for use as a power line corridor.



## IN OUR HOMES

Many factors contribute to the ambient field in your home: use of electrical appliances, the amount of current circulating in the ground wire of your electrical distribution panel, power consumption in your neighborhood, the distance between your house and the next and between your house and the power distribution system, etc.

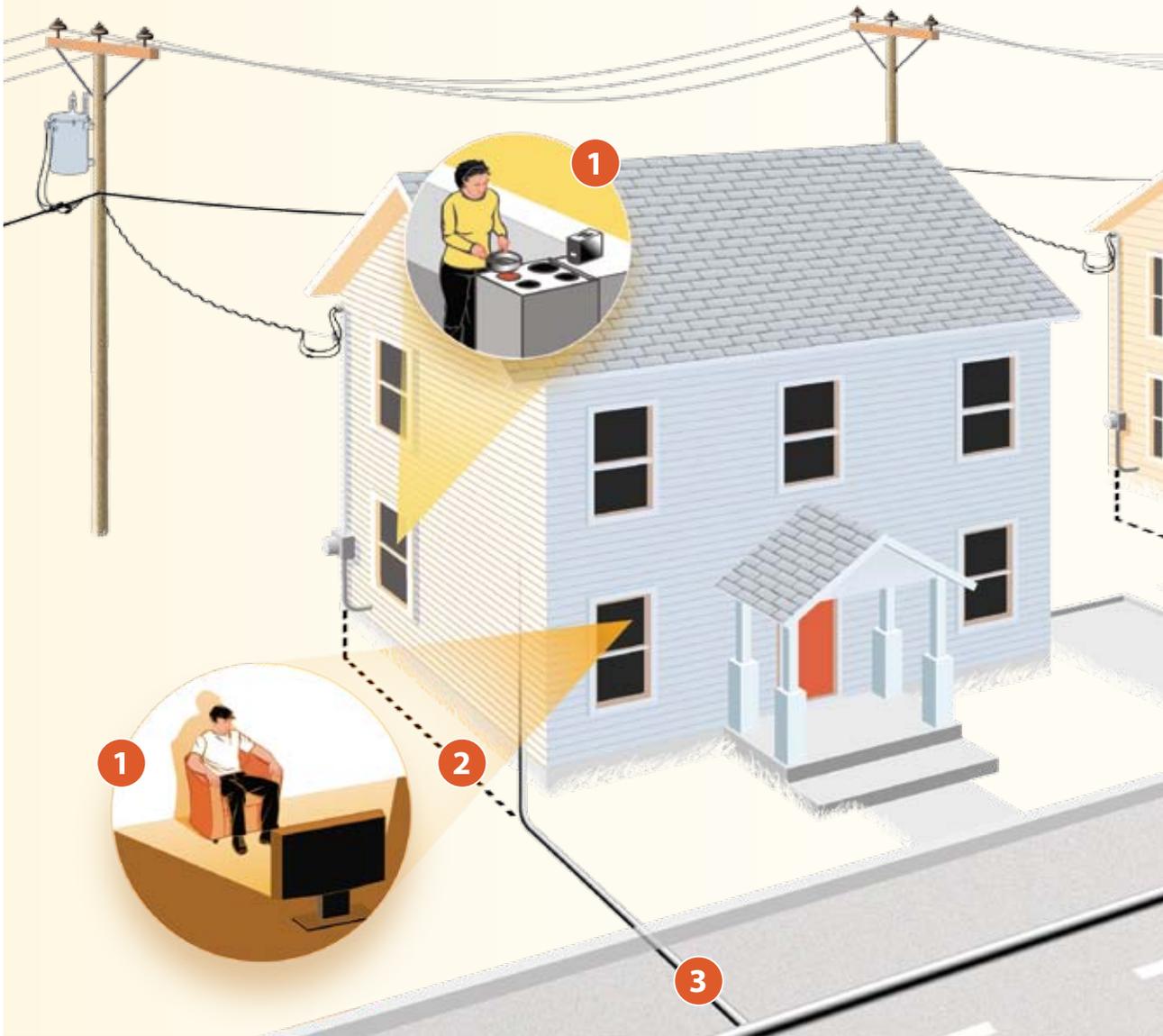
The electrical field changes very little; it is weak enough to be imperceptible. The walls and roof of your home make for an effective screen that reduces the electric field produced by outside equipment—for example, by power lines.

In nearly every home, magnetic field strength varies according to a cycle, which is determined by your power usage and that of your neighbors.

The magnetic field generally peaks between 6 p.m. and 8 p.m., and is at its weakest when people are asleep and most activity has ceased. This rule of thumb usually holds true for your immediate neighbors and for the entire area. In addition to a daily cycle, there are also seasonal variations.

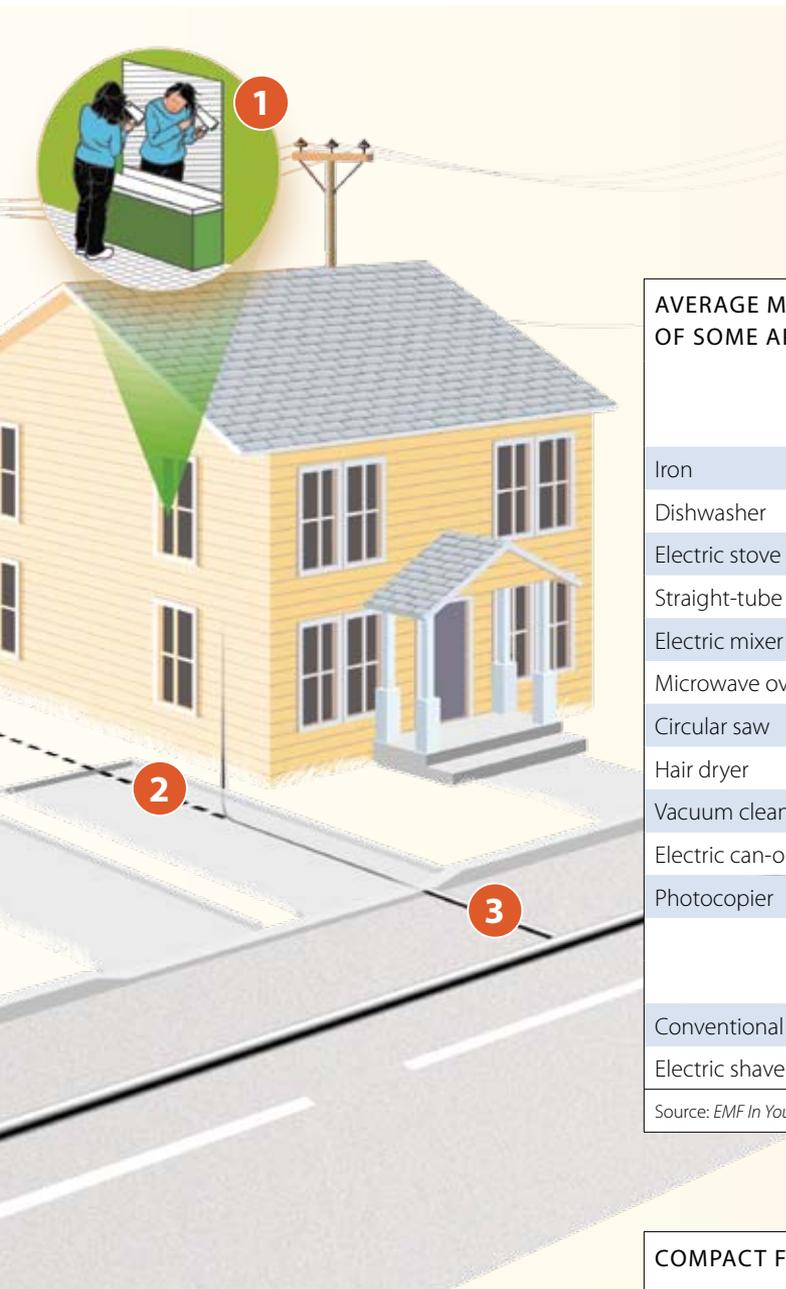
The table on page 7 gives you an idea of average magnetic fields for some common electrical appliances. As you can see, some devices generate stronger magnetic fields than others. The drop in field strength with distance is much more pronounced in the case of common electrical appliances than in the case of power lines. In fact, the magnetic field has generally dropped to ambient levels by the time you have moved one or two metres away from most working electrical appliances (two or three metres in the case of your home's electrical service entrance).

## EMFs IN OUR HOMES



Your exposure to the magnetic field of an **appliance that is turned on** 1 is determined by how close you are to it, and for how long. Some people may be frequently exposed to a very intense magnetic field for a short time, while others may be exposed to a weak field for longer periods.

Your **distribution panel** 2 is usually grounded to your home's water main to protect occupants from electric shock or electrocution in the event of an appliance malfunction.



### AVERAGE MAGNETIC FIELDS OF SOME APPLIANCES ( $\mu\text{T}$ )

	Distance from source		
	15 cm	30 cm	1.2 m
Iron	0.8	0.1	–
Dishwasher	2.0	1.0	–
Electric stove element	3.0	0.8	–
Straight-tube fluorescent light	4.0	0.6	–
Electric mixer	10.0	1.0	–
Microwave oven	20.0	1.0	0.2
Circular saw	20.0	4.0	–
Hair dryer	30.0	0.1	–
Vacuum cleaner	30.0	6.0	0.1
Electric can-opener	60.0	15.0	0.2
Photocopier	90.0	20.0	1.0
	1 cm	Avg. entire body	
Conventional electric blanket	10.0	1.5	–
Electric shaver	800.0	–	–

Source: *EMF In Your Environment*, Environmental Protection Agency, U.S.A., 1992.

### COMPACT FLUORESCENTS<sup>a</sup> ( $\mu\text{T}$ )

	Distance from source	
	15 cm	30 cm
Sylvania 13 W	0.04	–
Sylvania 14 W	0.04	–
Sylvania 23 W	0.09	–
Globe 13 W	0.11	–
Philips 13 W	0.03	–
General Electric 15 W	0.01	–

a) Measurements taken in August 2009 at Hydro-Québec's research institute.

Because the houses on your street probably have their **grounding systems connected to the water supply system** 3, you could say that they are all on the same electrical circuit. In fact, a number of studies have shown that the current in the grounding system is the main factor contributing to the ambient magnetic field in our homes.

## NEAR THE DISTRIBUTION SYSTEM

The power distribution system is the primary source of EMFs outside the home, because it brings electricity into your neighborhood, right to where you live. The electric fields produced by distribution lines don't vary much because in most cases, they carry a relatively stable voltage of 14 or 25 kV. The walls of your house screen inhabitants from outside power lines. Consequently, these lines contribute very little to the electric field inside the home.

Magnetic fields measured near power lines vary according to season, power demand and the technical characteristics of the lines (for example, pole height). Even underground distribution lines produce EMFs, since the magnetic field passes through matter and is not diminished by earth, rock or concrete.

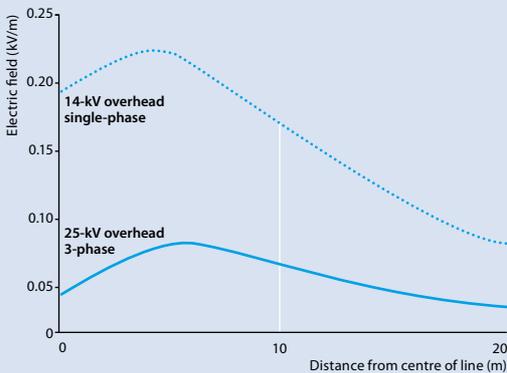


### THE TRANSFORMER MYTH

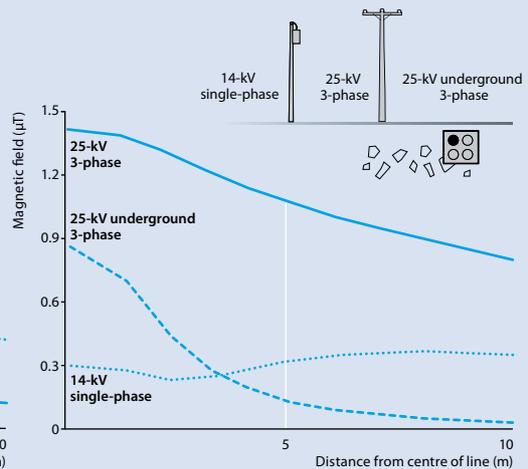
Since transformers are often perceived as a source of strong magnetic fields, measurements were taken close to distribution transformers. It was found that most of these units do not contribute to a power line's magnetic field past a distance of about 2 m. The reason? To increase the transformer's efficiency, it is designed to concentrate the magnetic field right in its core.

When distribution lines are underground, pad-mounted transformers are used. These are the green cabinets you see sitting on concrete bases. At a distance of 1 m, the magnetic field produced by a pad-mounted transformer drops to the ambient level produced by the underground line supplying it.

**ELECTRIC FIELD PRODUCED BY DISTRIBUTION LINES (kV/m)**



**MAGNETIC FIELD PRODUCED BY DISTRIBUTION LINES (µT)**



Note: The magnetic field values shown here are based on numbers that are higher than the provincial averages, to better represent the reality of densely populated urban centres. Fields can vary according to the technical characteristics of each line: pole height, normal variations in line current, conductor or cable configuration, etc.

## NEAR HIGH-VOLTAGE LINES

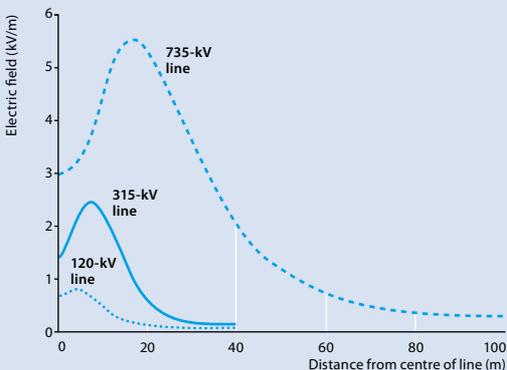
The electric field produced by a transmission line, like that of a distribution line, changes very little because of the line's stable voltage. Trees, fences and buildings reduce these electric fields. As for the magnetic field, since its strength depends not only on the intensity of the electric current but also on the distance from the source, the magnetic field generated by a high-voltage power line (HVPL) is usually stronger directly beneath the line and drops sharply as you move away. Note that only the wires that conduct the electric current produce EMFs; the towers do not produce a magnetic field because there is no current flowing in them.

Beyond a distance of about 100 m from an HVPL right-of-way, the magnetic field strength generally falls to the level of the ambient field produced by other sources in the environment. Houses built along the edge of a right-of-way will tend to have a higher magnetic field than those farther away.

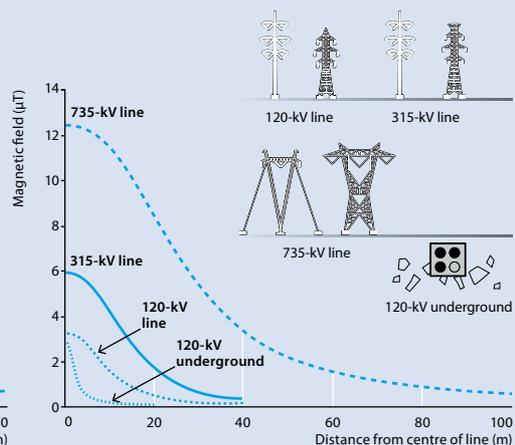
Since Quebecers use more electricity in winter than in summer—mainly to heat their homes—the current carried on HVPLs varies considerably from season to season. The magnetic fields of HVPLs will therefore be at their strongest during the coldest weeks of the year and at their minimum during the summer months.

The diagram below gives an idea of the average magnetic field values obtained near typical HVPLs under normal operating conditions.

**ELECTRIC FIELD PRODUCED  
BY HIGH-VOLTAGE LINES (kV/m)**



**MAGNETIC FIELD PRODUCED  
BY HIGH-VOLTAGE LINES (μT)**



Note: The magnetic field values shown above are based on average currents measured in most lines of each type. Fields may vary according to the technical characteristics of each line: pole height, normal variations in line current, conductor or cable configuration, etc.

## NEAR SUBSTATIONS

At most urban substations, the magnetic field measured at the fence does not exceed the ambient level. On the whole, the equipment within the substation yard contributes very little to the magnetic field measured outside the substation.

The lines leading into and out of the substation account for most of the EMFs measured there.



### WHAT IS THE CRACKLING NOISE SOMETIMES HEARD UNDER A HIGH-VOLTAGE LINE?

The noise is caused by a phenomenon called the **corona effect**. Very close to the conductors, the electric field is extremely strong, generating a cloud of tiny electric discharges in the air around the conductors. This is a localized phenomenon and does not extend any further than a few centimetres from the conductors. The corona effect is more pronounced in poor weather and can make a faint but audible noise. It can also cause radio interference if you drive a car under the line.



# What do we know about the effects of EMFs on health?

For nearly 40 years now, scientists have been investigating the possible effects of EMFs on human health. Hundreds of epidemiological studies have been conducted on various groups, including electric utility workers and the general public. In addition, numerous laboratory studies have been conducted regarding the effects of electric and magnetic fields on living animal and human cells.



The extraordinary number of studies—over 200 of which have been devoted to cancer—has allowed for excellent documentation of how harmless EMFs are, at the exposure levels found in our homes and workplaces. Most notably, no data have been found linking residential-level magnetic fields with childhood leukemia. In view of the number and quality of experimental studies conducted with no confirmation of any causal relationship between the two, we can no longer reasonably entertain this hypothesis. It was very probably a false alarm.

The presence of a 60-Hz EMF—that is, a field with extremely low frequency—causes the electrical charges within the body to move and alternate at the same frequency: 60 oscillations per second. This produces little electric currents within the body that disappear as soon as the person is no longer exposed to the field. These microcurrents do not accumulate within the body. They are generally imperceptible since they are not strong enough to excite nerve and muscle tissue. They are even weaker than the natural currents produced by your heart and brain. For example, under the influence of a magnetic field of 0.15  $\mu\text{T}$ , the microcurrents produced in your body are about 5,000 times weaker than your body's natural currents.

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*"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 low levels found in Canadian homes and schools, including those located just outside the boundaries of power line corridors."*

Source: Health Canada Web site, April 2011.

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## MAGNETIC FIELDS

The first effects of 60-Hz magnetic fields on humans do not appear until the level reaches 10,000  $\mu\text{T}$ , a very high intensity that has only been achieved in laboratory situations. Exposure to such a field produces microcurrents in the retina that are then sent to the brain via the nervous system, which gives us the impression of seeing flashes of light called *magnetophosphenes*. These flashes are not painful, nor do they damage eyesight. The phenomenon ceases as soon as exposure to the field ends.

As for the threat of cancer, experiments have been conducted on isolated cells and tissues, as well as long-term studies on animals at exposure levels 25,000 times higher than the average levels in the home. None of these experiments have indicated that 60-Hz magnetic fields have carcinogenic properties. While the findings of epidemiological studies are not as clear-cut, the most extensive ones have not shown any link between residential or workplace exposure to magnetic fields and the risk of cancer. And as regards childhood leukemia, studies based on actual measured magnetic fields in homes have not established any causal relationship.

60-Hz magnetic fields have no effect on pregnancy or fetal development, according to experimental studies on isolated cells and tissues as well as long-term studies on animals at exposure levels 25,000 higher than average residential levels.

In addition, none of the epidemiological studies could establish a link between exposure to 60-Hz magnetic fields and a higher risk of cardiovascular disorders, depression, suicide, amyotrophic lateral sclerosis, multiple sclerosis, Alzheimer's disease or Parkinson's disease.

### **HYPERSENSITIVITY TO EMFs**

*“Electromagnetic hypersensitivity (EHS) is characterized by a variety of non-specific symptoms that differ from individual to individual. These symptoms are certainly real and can vary widely in their severity. Whatever its cause, EHS can be a disabling problem for the affected individual. EHS has no clear diagnostic criteria and there is no scientific basis to linking EHS symptoms to EMF exposure. Further, EHS is not a medical diagnosis, nor is it clear that it represents a single medical problem.”*

Source: World Health Organization Web site

## ELECTRIC FIELDS

### EXPLANATION OF MICROSHOCKS

When your body is exposed to an electric field, it becomes charged with static electricity, just like when you drag your feet across a carpet in dry weather. Electric charges build up on your body's surface. Then, when you touch an object, there is a small electric discharge that allows your body to get rid of the excess electric charge. These microshocks can be startling. If the field is stronger than 5,000 V/m, they are often unpleasant. In fields over 10,000 V/m, they can be painful. And yet microshocks are not dangerous per se because they last such a short time (a few millionths of a second) and because the excess charge that causes them is right at the skin's surface and not in your internal organs.

Most people feel the first effects of electric fields only at levels rarely reached in daily life. For 60-Hz alternating currents, the field is imperceptible until it reaches a level of 3,000 V/m, where it may produce a tingling sensation or unpleasant microshocks. At 10,000 V/m, the tingling sensation is nearly constant. The microshocks may be painful, but are not dangerous. This is the level at which you can feel a current flowing through your body if you touch a large metal object such as a car. At 20,000 V/m, the microshocks are sufficiently unpleasant to warrant wearing a safety suit, like those worn by employees who work on high-voltage power lines.

Experimental studies on animals have not reported any serious effects at electric field levels of 30,000 V/m, which is 3 to 30 times the ambient levels measured in residential settings. In humans, acute or long-term exposure to electric fields has no adverse effect on health.

### FLUORESCENT TUBES UNDER HVPLs: AN AMAZING BUT HARMLESS PHENOMENON

When a person holds a fluorescent tube by one end under a high-voltage power line, it emits a weak light. Why does this happen?

The line's electric field creates a weak electric current, measured in millionths of an ampere. The gas inside the tube, excited by the current, gives off light.

A similar phenomenon can be observed when a fluorescent tube is held close to a car alternator. The phenomenon has no effect on living organisms.

None of the epidemiological studies on the risk of cancer in children or adults exposed to electric fields have indicated a causal relationship. Those that looked at the effects of EMFs on reproduction do not contain any electric field exposure data. However, according to studies using electric field exposure levels estimated on the basis of the proximity, size and number of power line conductors close to residential areas, electric fields do not appear to have any effect on reproduction. Very few studies have looked at the effects of electric fields on neurodegenerative diseases. These studies did not find any difference between electric utility workers—who are likely to have the greatest exposure to strong electric fields—and workers in other industrial sectors as to the frequency of amyotrophic lateral sclerosis, multiple sclerosis, Alzheimer's disease or Parkinson's disease.



**You're riding your bike under a high-voltage power line and you suddenly feel a prickle as you touch your handlebars or the frame of your bike...**

The balance has just been restored between your body's electrical charge and that of your bike's metal parts. An HVPL's electric field creates a charge in your body, and a different charge in the metal of your bike. When you touch the metal parts, these electrical charges are instantly brought to the same level, producing a small discharge that may be unpleasant but is not harmful. To avoid the discharge, just touch the metal of your handlebars as you near the power line, and maintain contact as you pass under the line. Your bike and your body are then considered, for electrical purposes, to be a single unit, allowing you to avoid the shock!

### **EXPLANATION OF THE TINGLING SENSATION ON THE SKIN**

When your body is exposed to an electric field, it builds up static electricity. The electric charges accumulate only at the surface of your skin and hair. At field levels of 1,000 V/m, the charge is strong enough to make your hair move. This phenomenon can be felt by very sensitive people when the weather is dry and there is no wind. However, the electricity remains on the surface of your skin and poses no danger to your health. Under a high-voltage line, your body becomes electrically charged.

For example, in an electric field of 10,000 V/m, the human body's electric charge is a few thousand volts, enough to make the hairs on your skin vibrate. It is similar to the effect of a Van de Graaff generator, which can produce several hundred thousand volts of electricity, making your hair stand on end. The spectacular effects of this machine can be observed at some interpretation centres, including Hydro-Québec's Électricium.

## OPINIONS OF SOME IMPORTANT ORGANIZATIONS

### Health Canada (2010)

"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 (ELF). [...] The International Agency for Research on Cancer (IARC) has evaluated the scientific data and has classified ELF magnetic fields as being 'possibly carcinogenic' to humans. [...] To put this into context, it is important to understand that [this

classification is also applied to coffee, gasoline engine exhaust and pickled vegetables, and is often used for agents that require further study. 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. [...] You do not need to take action regarding daily exposure 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."

### World Health Organization (WHO) (2007)

"[The WHO] concluded that there are no substantive health issues related to [extremely low-frequency (ELF)] electric fields at levels generally encountered by members of the public. [...] In 2002, the IARC published a monograph classifying ELF magnetic fields as 'possibly carcinogenic to humans'.<sup>1</sup> 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 leukemia associated with average exposure to residential power-frequency magnetic field above 0.3 to 0.4  $\mu$ T. [The WHO] 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 possible selection bias. In addition, there are no accepted biophysical mechanisms that would suggest that low-level exposures are involved in cancer development. [...] Additionally, animal studies have been largely negative. [...] A number of other adverse effects have been studied for possible association with ELF magnetic field exposure. These include other childhood

cancers, cancer in adults, depression, suicide, cardiovascular disorders, reproductive dysfunction, developmental disorders, immunological modifications, neurobehavioural effects and neurodegenerative disease. [...] The WHO [...] concluded that scientific evidence supporting an association between ELF magnetic field exposure and all of these health effects is much weaker than for childhood leukemia. In some instances (i.e., for cardiovascular disease or breast cancer), the evidence suggests that these fields do not cause them. [...] Regarding long-term effects, given the weakness of the evidence for a link between exposure to ELF magnetic fields and childhood leukemia, the benefits of exposure reduction on health are unclear."

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1. Editor's note: The IARC also classifies pickled vegetables, the practice of carpentry, and coffee in this group. They are not classified as confirmed carcinogens, nor as probable carcinogens.

## European Commission (2009)

"The few new epidemiological and animal studies that have addressed ELF exposure and cancer do not change the previous assessment that ELF magnetic fields are a possible carcinogen and might contribute to an increase in childhood leukemia. At present, *in vitro* studies did not provide a mechanistic explanation of this epidemiological finding. No new studies support a causal relationship between ELF fields and self-reported symptoms. New epidemiological studies indicate a possible increase in Alzheimer's disease arising from exposure to ELF fields. (...) Recent animal studies provided an indication for effects on the nervous system at flux densities from 0.1-1.0 mT. However, there are

still inconsistencies in the data, and no definite conclusions can be drawn concerning human health effects. Very few recent *in vitro* studies have investigated effects from ELF fields on diseases other than cancer and those available have very little relevance. (...) It is notable that *in vivo* and *in vitro* studies show effects at exposure levels (from 0.10 mT and above) to ELF fields that are considerably higher than the levels encountered in the epidemiological studies ( $\mu$ T-levels) which showed an association between exposure and diseases such as childhood leukemia and Alzheimer's disease."

## International Commission on Non-Ionizing Radiation Protection (ICNIRP) (2010)

"A considerable number of epidemiological reports [...] indicated that long term exposure to 50-60 Hz magnetic fields, orders of magnitude below the limits of the 1998 ICNIRP exposure guidelines, might be associated with cancer. In general, the initially observed associations between 50-60 Hz magnetic fields and various cancers were not confirmed in studies designed to see whether the initial findings could be replicated. However, for childhood leukemia the situation is different. The research that followed the first study has suggested that there may be a weak association between the higher levels of exposure to residential 50-60 Hz magnetic fields and childhood leukemia risk, although it is unclear whether it is causal: a combination of selection bias, some degree of confounding and chance could explain the results. Two pooled analyses (Ahlbom et al 2000; Greenland et al 2000) indicate that an excess risk may exist for average exposures exceeding 0.3-0.4  $\mu$ T, although the authors of those analyses cautioned strongly that their results cannot be interpreted as showing a causal relationship between magnetic fields and childhood leukemia. [...] In contrast to the epidemiological evidence [...], the animal cancer data, particularly those from large-scale lifetime studies, are almost universally negative. The data from cellular studies are generally supportive of the animal studies, though more equivocal. It is the view of ICNIRP that the currently

existing scientific evidence that prolonged exposure to low frequency magnetic fields is causally related with an increased risk of childhood leukemia is too weak to form the basis for exposure guidelines. In particular, if the relationship is not causal, then no benefit to health will accrue from reducing exposure."

## ARE THERE EMF EXPOSURE STANDARDS?

No regulation limiting public exposure to 60-Hz EMFs has been adopted under Québec's *Environment Quality Act*, although the Québec government is keeping a close watch on technological developments in the field. A committee to monitor studies on the health effects of high-voltage lines, reporting to the public health branch of the Ministère de la Santé et des Services sociaux, announced its position on EMFs and public health in 2000. It did not recommend any exposure limits or minimum distances from power facilities.

As Health Canada states on its Web site, at this time there are no Canadian standards for public or worker exposure to 60-Hz EMFs. However, for the past ten years, the department has been tracking research in this area in cooperation with the WHO.

Internationally, two influential scientific organizations recommend limits on human exposure to EMFs. These are the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Institute of Electrical and Electronics Engineers (IEEE). ICNIRP's mission is to analyze the risks of non-ionizing radiation on human health. In cooperation with the WHO, it formulates recommendations on exposure limits for workers and the general public. The IEEE is an international professional association that is responsible for developing safety standards, among other things. To come into effect in a given country or jurisdiction, recommendations from either organization must be adopted as a regulation or law.

EMF measurements conducted in Québec show that **outside** high-voltage line rights-of-way, the public is not exposed to field levels exceeding the limits recommended by ICNIRP or IEEE. However, the recommended electric field levels may sometimes be exceeded **within** the rights-of-way of some lines. This can occur when a person stands directly under the wires at their lowest point, midway between two towers. However, such situations do not pose any danger for human health, according to the International Agency for Research on Cancer.

### EXPOSURE LIMITS TO 60-HZ ELECTRIC FIELDS

	ICNIRP (kV/m)	IEEE (kV/m)
Workers	8.3	20
Public	4.2	5 <sup>a</sup>

a) 10 kV/m under high-voltage lines.

### EXPOSURE LIMITS TO 60-HZ MAGNETIC FIELDS

	ICNIRP (μT)	IEEE (μT)
Workers	1,000	2,710
Public	200	904

## WEB SITES FOR MORE INFORMATION

### **HYDRO-QUÉBEC**

[www.hydroquebec.com/sustainable-development/champs/index.html](http://www.hydroquebec.com/sustainable-development/champs/index.html)

### **HEALTH CANADA**

[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)

### **FEDERAL-PROVINCIAL-TERRITORIAL RADIATION PROTECTION COMMITTEE (HEALTH CANADA)**

[www.hc-sc.gc.ca/ewh-semt/radiation/fpt-radprotect/emf-cem-eng.php](http://www.hc-sc.gc.ca/ewh-semt/radiation/fpt-radprotect/emf-cem-eng.php)

### **WORLD HEALTH ORGANIZATION**

[www.who.int/peh-emf/en/index.html](http://www.who.int/peh-emf/en/index.html)

### **EUROPEAN COMMISSION**

[ec.europa.eu/health/opinions2/en/electromagnetic-fields/index.htm](http://ec.europa.eu/health/opinions2/en/electromagnetic-fields/index.htm)

### **NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES**

[www.niehs.nih.gov/health/topics/agents/emf/](http://www.niehs.nih.gov/health/topics/agents/emf/)

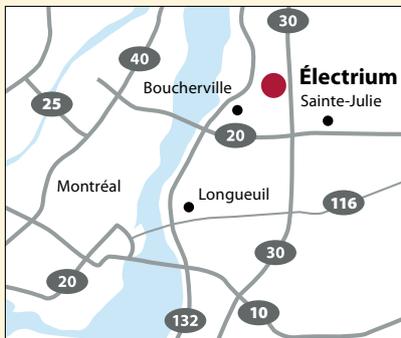
### **HEALTH PROTECTION AGENCY**

[www.hpa.org.uk/webw/HPAweb&Page&HPAwebAutoListName/Page/1158934607698?p=1158934607698](http://www.hpa.org.uk/webw/HPAweb&Page&HPAwebAutoListName/Page/1158934607698?p=1158934607698)

### **INTERNATIONAL COMMISSION ON NON-IONIZING RADIATION PROTECTION**

[www.icnirp.de/](http://www.icnirp.de/)

## TO FIND OUT MORE ABOUT EMFs



### Contact the Électrium

2001, rue Michael-Faraday  
Sainte-Julie (Québec)  
Telephone: 1 800 267-4558 or 450 652-8977  
(Montréal area)

Web site: [www.hydroquebec.com/visit/monteregie/electrium.html](http://www.hydroquebec.com/visit/monteregie/electrium.html)

### Visit the Électrium

Located on Montréal's south shore, 20 minutes from downtown Montréal.

From Highway 30, take Exit 128 and follow the blue signs.

### Hours

September to May:  
Monday to Friday, 9:30 a.m. to 4:00 p.m., and Sunday, 1:00 p.m. to 4:00 p.m.

June to August: daily, from 9:30 a.m. to 4:00 p.m.

### Free guided tours

Reservations required for groups.



[www.hydroquebec.com](http://www.hydroquebec.com)

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Legal deposit – 4th quarter 2011  
5th edition, November 2011

Bibliothèque nationale du Québec  
Library and Archives Canada  
ISBN 978-2-550-63332-7  
ISBN 978-2-550-63334-1 (PDF)

2011G226A

*Ce document est également publié en français.*

