What are EMF?

EMF refer to extremely low frequency (ELF) **E**lectric and **M**agnetic **F**ields associated with the delivery and use of electricity. EMF surround anything that generates, transmits, or uses electricity. These sources include power lines, the electrical wiring in our homes and buildings, and household electrical appliances. The strength of both electric fields and magnetic fields declines quickly as the distance from the source increases.

Electric fields are generated by voltage and are measured in units of kilovolts per meter (kV/m); devices operating at higher voltages produce higher electric fields. Magnetic fields are generated by the movement of electricity, known as a current, and are measured in units of milligauss (mG). Electric fields are blocked by everyday objects like trees, fences and buildings while magnetic fields are not blocked by these objects. Consistent with both public and scientific interest, magnetic fields and the related health research are the primary focus of this fact sheet.

Since electricity is such an integral part of our infrastructure and everyday life, people living in modern societies are surrounded by EMF. Our daily exposure depends on where we spend time and the sources we encounter in those locations. Indoors, the primary sources of EMF in most homes and buildings are the electrical wiring and the electrical appliances and equipment we use, such as vacuum cleaners, electric lamps, and hair dryers. Other residential EMF sources include nearby power lines and currents on water pipes. EMF levels from all of these sources diminish quickly with distance.

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Have scientists conducted much research on EMF and health?

Yes. Research evaluating whether EMF have the potential to cause adverse health effects has been on-going for close to 50 years. International and national scientific and health agencies have reviewed this body of research, including Health Canada, the World Health Organization (WHO), and the International Agency for Research on Cancer (IARC), among others. These agencies have weighed the evidence from all three study types (epidemiologic, animal, and laboratory studies). The conclusions of these reviews have been quite consistent in that the research does not confirm that EMF has any adverse effect on human health at the levels we are exposed to in our everyday lives.

Health Canada's conclusions are consistent with other scientific and health agencies, in that it too has not found reliable evidence for harmful effects of EMF at levels found in homes or communities. Health Canada states:

> *"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." (Health Canada, 2022)*

Do EMF harm wildlife?

In addition to research on human health, a substantial number of studies have been conducted to evaluate the potential effects of EMF exposure on the health of wildlife, including deer, elk, birds, and bees. Overall, the research does not conclude that EMF from transmission lines or the presence of power lines and structures results in adverse effects on the health, behavior, reproductive performance, or productivity of these animals.

This information was prepared by scientists and engineers at Exponent, Inc., an international scientific and engineering firm, to present a current summary of the status of EMF research as reflected in reviews by science and health organizations. This brochure is limited to the scientific literature reviewed and may not include all information in the public domain.

Prepared by Exponent for EPCOR Distribution & Transmission Inc.

Electric and Magnetic Fields and the City of Edmonton Transmission Reinforcement (CETR) Project

Exponent is a scientific and engineering firm whose professionals are experts in areas including epidemiology, electrical engineering, exposure assessment, biology, toxicology, and public health. The information in this brochure has been prepared for EPCOR Distribution & Transmission Inc. for the City of Edmonton Transmission Reinforcement (CETR) Project to provide an overview of current research on the electric and magnetic fields (EMF) associated with the use of electricity.

Are there EMF Exposure Standards and Guidelines?

In Canada, there are no national or provincial limits for extremely low frequency electric and magnetic fields. Health Canada has not concluded that EMF at the levels found in homes and communities are harmful to human health. As a result, Health Canada states there is no need for protective measures to limit exposure to ELF EMF as:

> *"Extremely low frequency EMF exposures in Canadian homes, schools and offices are far below the limits recommended in [international] guidelines. You don't need to take precautions to protect yourself from these kinds of exposures." (Health Canada, 2022)*

Guidelines for public and occupational exposure to ELF EMF have been set by two international scientific organizations based on their review of the relevant health research and review by other health and scientific agencies. These guideline limits were set to prevent the only known and established health effects of exposure, which are short-term effects, such as stimulation of nerves and muscles and annoyance by spark discharges, that occur at levels much higher than what is experienced in our everyday lives. Both organizations determined that the scientific evidence does not establish a causal relationship between ELF EMF and long-term health effects, including cancer or other diseases. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) recommends exposure limits for the general public of 2,000 mG for magnetic fields and 4.2 kV/m for electric fields. The International Committee for Electromagnetic Safety (ICES) recommends limits for the general public of 9,040 mG for magnetic fields and 5 kV/m for electric fields (10 kV/m on right-of-way [ROW]).

What EMF levels are projected for the Edmonton Transmission Reinforcement Project?

The City of Edmonton Transmission Reinforcement Project has proposed two types of transmission power lines: a 72 kilovolt (kV) double circuit transmission line and a 240 kV double circuit transmission power line. The Project electric fields are very low (about 1 kV/m or less) directly beneath the transmission line and decrease rapidly with distance to <0.5 kV/m or less.

Projected values of the **magnetic fields at varying distances from the centreline of structures** are shown in **Figure 1**.

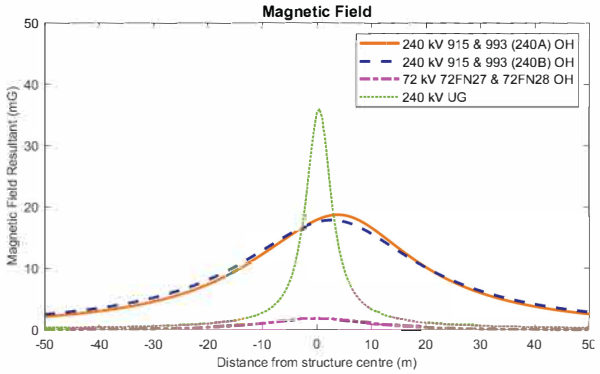

Figure 1. Calculated magnetic field profile for 240 kV and 72 kV overhead (OH) lines and 240 kV underground (UG) cables at 2032 projected average loading. Distances shown from centreline of the structures (0 m) at 1m above ground. The magnetic field values are highest near the centreline but diminish rapidly with distance. Calculations performed using computer algorithms developed by the U.S. Department of Energy.

Based on EPCOR Distribution & Transmission Inc. (EDTI)'s projected line loadings over the next 10 years, the calculated magnetic field for the 72 kV overhead line will vary little, ±0.1 mG for 2023-2033 at average loading, with the magnetic field calculated to be 1.3 mG at 7.5 m from the centreline for 2032 average loading. Over that same decade, the variation in the magnetic field for the 240 kV overhead lines also is calculated to be small (±2 mG), with the magnetic field calculated to be ≤13 mG at 15 m from the centreline for 2032 average loading. For limited periods of a few hours or days each year (< 30 hours in 2022), the loading and hence the magnetic fields on both lines can increase slightly, i.e., by 0.7 mG for the 72 kV lines at 7.5 m from centreline and by 1 mG for the 240 kV lines at 15 m from the centreline, for 2032 peak loading. For the 240 kV underground cables, although the maximum magnetic field at the centreline is higher than the 240 kV overhead lines (35 mG UG vs 19 mG OH), the magnetic field at 15 m and further from the centreline is calculated to be much lower for the underground lines than the overhead lines (1.8 mG UG vs 13 mG OH) for 2032 average loading. This occurs because the magnetic field from the 240 kV underground cable drops more rapidly with distance from the centreline, compared to the 240 kV overhead lines for 2032 average loading. During peak loading, the change in magnetic field from the underground cables, compared to average loading, is small (±0.1 mG at 15 m). **Both the electric and magnetic field levels calculated for the CETR project including at peak line loading are well below the exposure guideline levels recommended by ICNIRP and ICES for the general public.**

How does the scientific review process evaluate research?

The scientific process involves looking at all the evidence on a particular issue in a systematic and thorough manner. A single study is not sufficient to reach a scientific conclusion because every study has its own strengths and weaknesses that need to be considered when interpreting findings. When many studies are considered together, the strengths of some may be weaknesses in others and vice versa. Findings that are replicated by independent methods and researchers provide the most reliable data. Therefore, all of the studies are evaluated together to arrive at a conclusion. This is referred to as a weight-of-evidence review.

Three types of research studies are considered in a weight-of-evidence review:

Epidemiologic studies: . Scientists use statistical methods in epidemiologic studies to evaluate whether an exposure (e.g. physical, chemical, or biological) is associated with health outcomes observed in human populations in their normal daily lives. Regarding EMF, many epidemiologic studies have investigated whether people with a disease had a higher magnetic field exposure in the past, compared to people who do not have the disease.

Animal studies: Scientists have exposed laboratory animals under controlled conditions to magnetic field levels as high as 50,000 mG and as long as their entire lifetime. They then looked to see if these animals had higher rates of disease compared to a group of animals with no exposure.

Laboratory studies: Researchers expose cells or tissues to magnetic fields under controlled conditions and observe any changes that may occur. These studies can be used to investigate whether magnetic fields affect biological mechanisms related to diseases, such as cancer, at the cellular level. They usually have limited value, though, because the behavior of isolated cells and tissues may not be the same as the behavior of the same cells and tissues in intact animals or humans.

To determine whether an exposure (like EMF) poses a health risk, scientists look at the available data from all three study types. Epidemiologic, animal, and laboratory studies complement one another, as the limitations of one study type are addressed in another. Each type of study can be thought of as a puzzle piece; when placed together, the evidence from all three study types gives us an understanding of possible health effects. Taken together, epidemiologic, animal, and laboratory research studies on EMF do not support the conclusion that EMF causes harm to human health. (NIEHS, 1999; IARC, 2002)