Research on the possible health effects of EMF fields has been going on since the late 1970s. Institutions around the world have conducted thousands of studies. These studies have looked for relationships between EMF in our homes and workplaces and cancer or other adverse health effects, as well as biological effects in animals and on the cellular level. Numerous independent scientific panels have evaluated this large body of research. These panels are organized by reputable scientific organizations with the mandate to objectively evaluate health issues from exposures such as EMF and consist of scientists with knowledge in the relevant disciplines. These panels have weighed the evidence critically to come to a conclusion about whether the scientific research shows that exposure to EMF causes adverse health effects.

What are the Conclusions of These Scientific Panels?

Numerous national and international scientific agencies have convened groups of scientists to evaluate the research on the possible health effects associated with EMF. These agencies include the National Institute of Environmental Health Sciences (NIEHS), the International Agency for Research on Cancer (IARC), the former National Radiological Protection Board of Great Britain (NRPB), the Health Council of the Netherlands (HCN), the International Commission on Non-Ionizing Radiation Protection (ICNIRP), and the World Health Organization (WHO). The WHO, whose mandate is to provide leadership on global health matters, released an extensive review in June 2007, after more than 10 years of intensive study and consideration.

The conclusions of the WHO report can be summarized as follows:

- The research does not establish that exposure to EMF causes or contributes to any disease or illness.
- There are no substantive health issues related to electric fields at levels generally encountered by members of the public.
- While epidemiology studies have reported a weak statistical association between childhood leukemia and long-term exposures to magnetic fields greater than 3-4 mG, the association is not supported by the laboratory studies and has not been considered a causal relationship.
- The experimental animal studies as a whole do not show any adverse effects, including cancer, among animals exposed to high levels of magnetic fields.
- The experimental laboratory studies on cells and tissues have not confirmed any explanation as to how magnetic fields could cause disease.
- Because the epidemiology studies have limitations and the experimental studies provide little or no support for an association with cancer or mechanisms to cause cancer, the WHO did not conclude that magnetic fields cause childhood leukemia. Thus, considering all of the research together, the reviewers for the WHO did not conclude that magnetic fields cause any long-term, adverse health effects.

On its website the WHO states that "[b]ased 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." This conclusion is similar to those reached in recent reviews conducted by SCENIHR, a health agency of the European Union, in 2009 and 2013.

Should any Precautions Be Taken to Reduce my Exposure to EMF?

The WHO stated that the scope of any actions we take to reduce EMF exposure, either personally or as a society, should be proportional to the strength of the science. This means that because the research on EMF does not clearly show any adverse health effects, then actions to reduce exposure should be very low in cost and should not compromise the health, social, and economic benefits of electricity to our society.

Where Can I Find More Information on This Topic?

National Cancer Institute

World Health Organization
http://www.who.int/peh-emf/about/en/
What are Electric and Magnetic Fields?

A field describes the influence of an object in its surrounding space. For example, a temperature field surrounds a warm object, such as a space heater. Electric and magnetic fields (EMF) surround any object that generates, transmits, or uses electricity, including appliances, wiring, office equipment, generators, batteries, and any other electrical devices. Electric fields are the result of the electric potential (or voltage) on these objects, and magnetic fields are the result of the flow of current through these objects. There are also natural sources of magnetic fields, including the earth, whose static magnetic field is used for compass navigation, and our own bodies, which produce electric and magnetic fields as a result of the normal electrical activity of our heart, nerves, and brain. Just like a temperature field, electric and magnetic fields can be measured and their levels depend on, among other things:

- Properties of the source of the field (voltage, current, configuration, etc.)
- Distance from the source of the field

Both electric and magnetic fields decrease with distance from the source of the field. Electric field levels are also affected by nearby objects, such as buildings and trees, which can block the fields. Therefore, distribution or transmission lines usually have little effect on levels of electric fields inside nearby homes.

Magnetic Fields Decrease With Increasing Distance

Because electricity is used to do so many things in our daily lives, from lighting, heating and cooling our homes to powering our refrigerators and computers, magnetic fields are found throughout our daily environments. Our daily exposure depends on where we spend time and the sources we encounter in those locations. As an example, the magnetic field level encountered by a person traveling, working, and sleeping over a typical 48-hour period was measured. The magnetic field was measured with a device called a gaussmeter and reported in units called milligauss (mG).

<table>
<thead>
<tr>
<th>Distance from Source</th>
<th>Magnetic Field Level (mG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>160 mG</td>
</tr>
<tr>
<td>1'</td>
<td>20 mG</td>
</tr>
<tr>
<td>2'</td>
<td>10 mG</td>
</tr>
<tr>
<td>4'</td>
<td>1 mG</td>
</tr>
</tbody>
</table>

Magnetic Field Levels Encountered in a Typical Day

Measurements taken by Exponent engineers using standard measurement techniques. The numbers represent the median magnetic field, i.e., half of the appliances tested had higher levels and half had lower levels than those shown in the figure. The range of magnetic field levels encountered by a person traveling, working, and sleeping over a typical 48-hour period was measured. The magnetic field was measured with a device called a gaussmeter and reported in units called milligauss (mG).

<table>
<thead>
<tr>
<th>Distance from Source</th>
<th>Magnetic Field Level (mG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>168 mG (peak exposure)</td>
</tr>
<tr>
<td>1'</td>
<td>1.02 mG</td>
</tr>
<tr>
<td>2'</td>
<td>0.6 – 2 mG</td>
</tr>
<tr>
<td>4'</td>
<td>0.3 – 1 mG</td>
</tr>
</tbody>
</table>

Magnetic Fields are Found Everywhere

Electric fields are also affected by nearby objects, such as buildings and trees, which can block the fields. Therefore, distribution or transmission lines usually have little effect on levels of electric fields inside nearby homes.
Magnetic Fields are Found Everywhere

Magnetic and Electric Fields

Electric and magnetic fields (EMFs) are omnipresent in our daily lives. These fields are produced by various sources, such as electrical devices, appliances, wiring, office equipment, generators, and batteries. In our homes, electric currents flowing on water pipes generate magnetic fields indoors that are electrical in nature. Magnetic fields are the result of electric potential (or voltage) on conductors. These fields surround any object that generates, transmits, or uses electricity. Electric fields are typically created by the normal electrical activity of our bodies, while magnetic fields can result from the flow of current through wires.

Properties of Magnetic Fields

Magnetic fields are influenced by several factors, including the source of the field (voltage, current, configuration, etc.), the distance from the source, the type of source, and the material of the objects through which the field travels. Electric fields are also affected by nearby objects, such as buildings and trees, which can block the fields.

Exposure to Magnetic Fields

Magnetic fields encountered by a person traveling, working, and sleeping over a typical 48-hour period were measured. The magnetic field was measured with a device called a gaussmeter and reported in units called milligauss (mG). The magnetic field level encountered by a person traveling, working, and sleeping over a typical 48-hour period was approximately 1 mG. Exposure to much higher levels was common, but brief. As you can see, we are exposed to magnetic fields throughout the day at varying intensities.

Magnetic Field Levels in Our Homes

In our homes, magnetic fields are generated from appliances, the wiring that powers these appliances, the distribution lines that deliver electricity to the home, and any electric currents flowing on water pipes. Research has shown that background magnetic field levels in US homes range from less than 1 mG to over several mG. The strongest sources of magnetic fields indoors are electrical appliances. The magnetic fields produced by household appliances vary greatly, as shown in the right.

Magnetic Field Levels Encountered in a Typical Day

In this example, the average magnetic field exposure over this 48-hour period was approximately 1 mG. Exposure to much higher levels were common, but brief. As you can see, we are exposed to magnetic fields throughout the day at varying intensities.

How do Scientists Determine Whether Something in the Environment Like EMF Poses a Health Risk?

To determine whether an exposure (like EMF) poses a health risk, scientists look at all of the available research. The “research” refers to studies that were conducted by scientists at academic universities and scientific institutions. The strengths and weaknesses of each study are evaluated. Then, all of the studies are evaluated together to arrive at a conclusion. This is referred to as a weight-of-evidence review.

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What are Electric and Magnetic Fields called a gaussmeter and reported in units called milligauss (mG).

Typical 48-hour period was measured. The magnetic field was measured with a device magnetic field level encountered by a person traveling, working, and sleeping over a we spend time and the sources we encounter in those locations. As an example, the magnetic fields indoors are electrical magnetic fields (EMF) surround any object that generates, transmits, or uses electricity, and cooling our homes to powering our refrigerators and computers, magnetic fields

Electric fields are also affected by nearby objects, such as buildings and trees, which produce electric and magnetic fields as a result of the normal electrical activity of our bodies. Just like a temperature field, electric and magnetic fields can vary greatly, as shown to the right.

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Each type of study can be thought of as a puzzle piece. When placed together, the information from all three study types gives us an understanding of possible health effects.

Three Different Types of Research are Considered in a Weight-of-Evidence Review

Epidemiology studies: Scientists conducting epidemiology studies observe human populations and characteristics about their lives. With regard to EMF, many epidemiology 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. This comparison is estimated using a statistical association (see "What is a Statistical Association?").

Animal studies: Scientists have exposed laboratory animals 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 a higher rate of disease compared to a group of animals with no exposure. The strength of animal studies is that scientists are able to control all aspects of the animals’ lives.

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 may not be the same as the behavior of the same cells in intact animals or humans.

What Is a Statistical Association?

A statistical association is a measure of how often a disease and an exposure occur together in epidemiology studies. If there is a statistical association between an exposure and a disease, such as EMF and cancer, it does not mean that the exposure causes the disease. All studies (including animal and cell studies) must be considered together in a weight-of-evidence review to make a conclusion about causation.
EMF and Health Research

Since the late 1970s, institutions around the world have conducted thousands of studies. These studies have looked for relationships between EMF in our homes and workplaces and cancer or other adverse health effects, as well as biological effects in animals and on the cellular level. Numerous independent scientific panels have evaluated this large body of research. These panels are organized by reputable scientific organizations with the mandate to objectively evaluate health issues from exposures such as EMF and consist of scientists with knowledge in the relevant disciplines. These panels have weighed the evidence critically to come to a conclusion about whether the scientific research shows that exposure to EMF causes adverse health effects.

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Where Can I Find More Information on This Topic?

National Cancer Institute
http://www.cancer.gov/cancertopics/factsheet/Risk/magnetic-fields

World Health Organization
http://www.who.int/peh-emf/about/en/

This brochure was prepared by epidemiologists and biological scientists in the Health Sciences practice of Exponent, Inc., a leading engineering and scientific consulting firm.

Prepared by Exponent for Delmarva Power © June 2014.