

ELECTROMAGNETIC FIELDS AND PUBLIC HEALTH

THE PRESENT EVIDENCE

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Electromagnetic fields (EMF) occur in nature and thus have always been present on earth. However, during the twentieth century, environmental exposure to man-made sources of EMF steadily increased due to electricity demand, ever-advancing wireless technologies and changes in work practices and social behaviour. Everyone is exposed to a complex mix of electric and magnetic fields at many different frequencies, at home and at work.

Potential health effects of man-made EMF have been a topic of scientific interest since the late 1800s, and have received particular attention during the last 30 years. EMF can be broadly divided into *static* and *low-frequency* electric and magnetic fields, where the common sources include

power lines, household electrical appliances and computers, and *high-frequency* or radiofrequency fields, for which the main sources are radar, radio and television broadcast facilities, mobile telephones and their base stations, induction heaters and anti-theft devices.

Unlike ionizing radiation (such as gamma rays given off by radioactive materials, cosmic rays and X-rays) found in the upper part of the electromagnetic spectrum, EMF are much too weak to break the bonds that hold molecules in cells together and, therefore, cannot produce ionization. This is why EMF are



FIGURE 1. THE ELECTROMAGNETIC SPECTRUM

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called 'non-ionizing radiations' (NIR). *Figure 1* displays the relative position of NIR in the wider electromagnetic spectrum. Infrared, visible, ultraviolet and ionizing radiation will not be considered further in this handbook.

WHAT HAPPENS WHEN YOU ARE EXPOSED TO ELECTROMAGNETIC FIELDS?

Electrical currents exist naturally in the human body and are an essential part of normal bodily functions. All nerves relay their signals by transmitting electric impulses. Most biochemical reactions, from those associated with digestion to those involved in brain activity, involve electrical processes.

The effects of *external* exposure to EMF on the human body and its cells depend mainly on the EMF *frequency* and *magnitude* or strength. The frequency simply describes the number of oscillations or cycles per second. At low frequencies, EMF passes through the

body while at radio frequencies the fields are partially absorbed and penetrate only a short depth into the tissue.

Low-frequency electric fields influence the distribution of electric charges at the surface of conducting tissues and cause electric current to flow in the body (Fig. 2A). *Low-frequency magnetic fields* induce circulating currents within the human body (Fig. 2B). The strength of these induced currents depends on the intensity of the outside magnetic field and the size of the loop through which the current flows. When sufficiently large, these currents can cause stimulation of nerves and muscles.

At *radiofrequencies* (RF), the fields only penetrate a short distance into the body. The energy of these fields is absorbed and transformed into the movement of molecules. Friction between rapidly moving molecules results in a temperature rise. This effect is used

in domestic applications such as warming up food in microwave ovens, and in many industrial applications such as plastic welding

or metal heating. The levels of RF fields to which people are normally exposed in our living environment are much lower than those needed to produce significant heating.

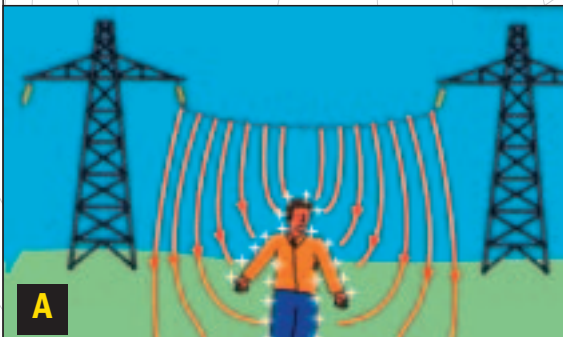


FIGURE 2. A Electric fields do not penetrate the body significantly but they do build up a charge on its surface, while **B** exposure to magnetic fields causes circulating currents to flow in the body.

BIOLOGICAL EFFECTS AND HEALTH EFFECTS

Biological effects are measurable responses of organisms or cells to a stimulus or to a change in the environment. Such responses, e.g. increased heart rate after drinking coffee or falling asleep in a stuffy room, are not necessarily harmful to health. Reacting to changes in the environment is a normal part of life. However, the body might not possess adequate compensation mechanisms to mitigate all environmental changes or stresses. Prolonged environmental exposure, even if minor, may constitute a health hazard if it results in stress. In humans, an adverse *health effect* results from a biological effect that causes detectable impairment in the health or well-being of exposed individuals.

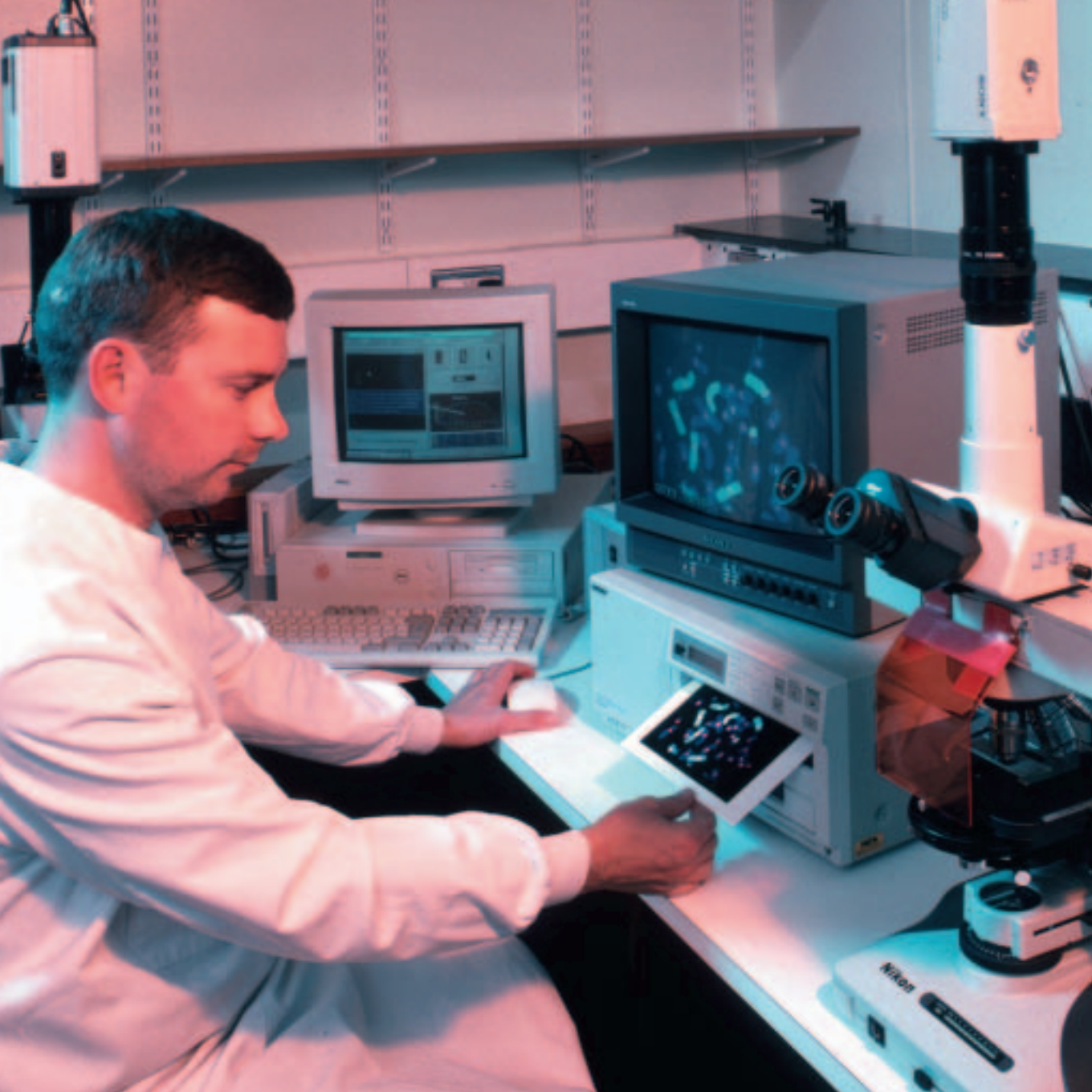
Complying with exposure limits recommended in national and international guidelines helps to control risks from exposures to EMFs that may be harmful to human health. The present debate is centred on whether long-term, low level exposure below the exposure limits can cause adverse health effects or influence people's well being.

carcinogenicity of *static and extremely low frequency (ELF) electric and magnetic fields*. Using the standard IARC classification that weighs human, animal and laboratory evidence, ELF magnetic fields were classified as *possibly carcinogenic to humans* based on epidemiological studies of childhood leukaemia. An example of a well-known agent classified in the same category is coffee, which may increase risk of kidney cancer, while at the same time be protective against bowel cancer. "Possibly carcinogenic to humans" is a classification 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. Evidence for all other cancers in children and adults, as well as other types of exposures (i.e. static fields and ELF electric fields) was considered inadequate to classify either due to insufficient or inconsistent scientific information. While the classification of ELF

CONCLUSIONS FROM SCIENTIFIC RESEARCH

LOW-FREQUENCY FIELDS

Scientific knowledge about the health effects of EMF is substantial and is based on a large number of epidemiological, animal and in-vitro studies. Many health outcomes ranging from reproductive defects to cardiovascular and neurodegenerative diseases have been examined, but the most consistent evidence to date concerns childhood leukemia. In 2001, an expert scientific working group of WHO's International Agency for Research on Cancer (IARC) reviewed studies related to the



magnetic fields as possibly carcinogenic to humans has been made by IARC, it remains possible that there are other explanations for the observed association between exposure to ELF magnetic fields and childhood leukaemia.

HIGH-FREQUENCY FIELDS

Concerning radiofrequency fields, the balance of evidence to date suggests that exposure to low level *RF* fields (such as those emitted by mobile phones and their base stations) does not cause adverse health effects. Some scientists have reported minor effects of mobile phone use, including changes in brain activity, reaction times, and sleep patterns. In so far as these effects have been confirmed, they appear to lie within the normal bounds of human variation.

Presently, research efforts are concentrated on whether *long-term, low level* RF exposure, even at levels too low to cause significant temperature elevation, can cause adverse

health effects. Several recent epidemiological studies of mobile phone users found no convincing evidence of increased brain cancer risk. However, the technology is too recent to rule out possible long-term effects. Mobile phone handsets and base stations present quite different exposure situations. RF exposure is far higher for mobile phone users than for those living near cellular base stations. Apart from infrequent signals used to maintain links with nearby base stations, handsets transmit RF energy only while a call is being made. However, base stations are continuously transmitting signals, although the levels to which the public are exposed are extremely small, even if they live nearby.

Given the widespread use of technology, the degree of scientific uncertainty, and the levels of public apprehension, rigorous scientific studies and clear communication with the public are needed.