World Health Organization

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Electromagnetic fields and public health
Static electric and magnetic fields

Technologies using static fields are increasingly being exploited in selected industries, such as medicine with magnetic resonance imaging (MRI), transportation systems that use direct current (DC) or static magnetic fields and high-energy physics research facilities. As the field strength of the static field increases, so does the potential for a variety of interactions with the body.

The International EMF Project of the World Health Organization (WHO) has recently reviewed the health implications of high static field exposure and highlighted the importance of public health protection for medical staff and patients (particularly children and pregnant women) and workers in industries producing high field magnets (Environmental Health Criteria, 2006).

SOURCES

Electric and magnetic fields are generated by phenomena such as the Earth's magnetic field, thunderstorms, and the use of electricity. When such fields do not vary with time they are referred to as static and have a frequency of 0 Hz.

In the atmosphere, static electric fields (also referred to as electrostatic fields) occur naturally, in fair weather, and especially under thunderclouds. Friction can also separate positive and negative charges and generate strong static electric fields. Their strength is measured in units of volt per metre, (V/m), or kilovolt per metre (kV/m). In daily life we may experience spark discharges with grounded objects or hair rising as a result of friction, for example from walking on a carpet. The use of DC electricity is another source of static electric fields, e.g. rail systems using DC, and televisions and computer screens with cathode ray tubes.

A static magnetic field is measured in units of ampere per metre, (A/m) but is usually expressed in terms of the corresponding magnetic induction measured in units of tesla, (T) or millitesla (mT).The natural geomagnetic field varies over the Earth's surface between about 0.035 - 0.07 mT and is perceived by certain animals that use it for orientation. Man-made static magnetic fields are generated wherever DC currents are used, such as in electric trains or industrial processes such as aluminium production and in gas welding. These can be more than 1000 times stronger than the Earth's natural magnetic field.

Recent technological innovations have led to the use of magnetic fields up to 100 000 times stronger than the Earth's magnetic field. They are used in research and in medical applications such as MRI that provides three-dimensional images of the brain and other soft tissues. In routine clinical systems, scanned patients and machine operators can be exposed to strong magnetic fields in the range of 0.2 - 3 T. In medical research applications, higher magnetic fields, up to about 10 T, are used for whole body patient scanning.

For static electric fields, few studies have been carried out. The results to date suggest that the only acute effects are associated with body hair movement and discomfort from spark discharges. Chronic or delayed effects of static electric fields have not been properly investigated.

HEALTH EFFECTS

For static magnetic fields, acute effects are only likely to occur when there is movement in the field, such as motion of a person or internal body movement, such as blood flow or heart beat. A person moving within a field above 2 T can experience sensations of vertigo and nausea, and sometimes a metallic taste in the mouth and perceptions of light flashes. Although only temporary, such effects may have a safety impact for workers executing delicate procedures (such as surgeons performing operations within MRI units).

Static magnetic fields exert forces on moving charges in the blood, such as ions, generating electrical fields and currents around the heart and major blood vessels that can slightly impede the flow of blood. Possible effects range from minor changes in heartbeat to an increase in the risk of abnormal heart rhythms (arrhythmia) that might be life-threatening (such as ventricular fibrillation). However, these types of acute effects are only likely within fields in excess of 8 T.

It is not possible to determine whether there are any long-term health consequences even from exposure in the millitesla range because, to date, there are no well-conducted epidemiological or long-term animal studies. Thus the carcinogenicity of static magnetic fields to humans is not at present classifiable (IARC, 2002).

INTERNATIONAL STANDARDS

Exposure to static magnetic fields has been addressed by the International Commission on Non-Ionizing Radiation Protection (see: www.icnirp.org). For occupational exposure, present limits are based on avoiding the sensations of vertigo and nausea induced by movement in a static magnetic field. The recommended limits are time-weighted average of 200 mT during the working day for occupational exposure, with a ceiling value of 2 T. A continuous exposure limit of 40 mT is given for the general public.

Static magnetic fields affect implanted metallic devices such as pacemakers present inside the body, and this could have direct adverse health consequences. It is suggested that wearers of cardiac pacemakers, ferromagnetic implants and implanted electronic devices should avoid locations where the field exceeds 0.5 mT. Also, care should be taken to prevent hazards from metal objects being suddenly attracted to magnets in field exceeds 3 mT.

WHO'S RESPONSE

WHO has been active in the evaluation of health issues raised by exposure to electromagnetic fields (EMF) in the frequency range from 0 to 300 GHz. The International Agency for Research on Cancer (IARC) evaluated the carcinogenicity of static fields in 2002, and the WHO International EMF Project has recently conducted a thorough health risk assessment of these fields (Environmental Health Criteria, 2006) where gaps in knowledge have been identified. This has resulted in a research agenda for the next few years to inform future health risk assessments (www.who.int/emf). WHO recommends a review of standards when new evidence from the scientific literature becomes available.

WHAT CAN NATIONAL AUTHORITIES DO?

While there are huge benefits to be gained from use of static magnetic fields, particularly in medicine, possible adverse health effects from exposure to them must be properly evaluated so that the true risks and benefits can be assessed. It will take some years for the required research to be completed. In the meantime, WHO recommends that national authorities set up programmes to protect both the public and workers from possible adverse effects of static fields. In the case of static electric fields, since the main effect is discomfort from electric discharges to the body, it is sufficient to provide information on exposure to large electric fields and how to avoid them.

In the case of static magnetic fields, because the level of information on possible long-term or delayed effects of exposure is currently insufficient, cost-effective precautionary measures may be justified to limit the exposure of workers and the public. WHO recommends that authorities take the following measures:

- Adopt international science-based standards to limit human exposure.
- Take protective measures for the industrial and scientific use of magnetic fields by keeping a distance from fields that may pose a significant risk, by enclosing the fields, or by applying administrative controls such as staff education programs.
- Consider licensing magnetic resonance imaging (MRI) units having field strengths exceeding 2 T, in order to ensure that protective measures are implemented.
- Fund research to fill the large gaps in knowledge regarding the safety of people.
- Fund MRI units and databases to collect health information on exposure of workers and patients.

REFERENCES FOR FURTHER READING

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- Electromagnetic fields

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