
Electromagnetic fields – EMF

apropos

Electrosmog

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The phenomenon	<p>The earth is surrounded by a natural electromagnetic field which is influenced by energy eruptions from the sun. With the spread of modern technology, the earth's natural electromagnetic field is being more and more severely affected and even changed by man-made fields from power distribution lines, communication facilities, and electrical installations and equipment (electromog).</p>
Effects on technological systems	<p>Every power line, every telephone line, every radio and television station and receiver, every piece of electrical equipment generates an electromagnetic field and emits electromagnetic radiation as long as it is in operation. The electromagnetic fields and radiation associated with power engineering and communications applications are known to cause interference with electrical and electronic systems.</p>
EMC	<p>EMC stands for electromagnetic compatibility and refers to the extent to which electrical and electronic systems are able to operate without mutual interference. EMC is assured by technical standards, for instance by limits on the maximum interference power which such systems are allowed to emit to the environment or the minimum interference power which they must be able to absorb without detriment to their proper functioning and reliability.</p> <p>The following examples may serve to illustrate the need for these technical standards. In 1984 a Tornado fighter plane crashed near Munich when its electronic control system malfunctioned due to interference from powerful radio transmitters in the vicinity. And in Japan a number of workers were injured by industrial robots which went out of control presumably due to electromagnetic radiation.</p>
Effects on humans, animals and plants	<p>Although electromagnetic radiation was known to have adverse effects on technological systems, it was long thought that this radiation posed no danger to humans, animals and plants.</p> <p>In recent years, however, more and more scientists are voicing more and more doubts. It is thought that electromagnetic radiation may have an adverse effect on health. Research is under way worldwide to investigate the effects of electromagnetic radiation on living organisms.</p> <p>Among the public at large, the result of these doubts has been a feeling of uncertainty, culminating in fears of health impairments. These fears have even given rise to a number of court cases. In Germany, construction had to be stopped on a number of telecommunications towers when local interest groups lodged objections on the grounds that such installations constituted a health hazard. One electric power utility in the US was sued because a high-voltage transmission line passed over a school house. Also in the US, manufacturers of mobile telephones have been taken to court on the suspicion that the electromagnetic radiation emitted by these devices has caused brain tumors in some users.</p>
Definitions Electric field	<p>An electric field is the three-dimensional space around an electrically charged body (e.g. an electron) which exerts a force on other charged bodies. An electric field is present for example in any household appliance to which an electric voltage is applied, even if it is not actually in operation.</p>
Magnetic field	<p>The three-dimensional space between a magnetic north and a magnetic south pole within which magnetic forces can be shown to act.</p>

Electromagnetic field	If current flows in an electric field, a magnetic field is generated. This is referred to as an electromagnetic field. Such a field is built up for instance when a household appliance is put into operation. Most everyday power supply systems deliver alternating current and voltages. These produce alternating electromagnetic fields.
Low-frequency alternating field	A field in which the current alternates 3 to 3000 times per second is known as a low-frequency field. The unit of measurement is the hertz: this designates the frequency of a cyclic process with a period of 1 second. Commonly encountered low-frequency alternating fields are, for example, railway motive power lines with a frequency of 16 $\frac{2}{3}$ hertz, electric power lines and domestic appliances with a frequency of 50 hertz, and television sets and personal computers with 3000 hertz.
High-frequency alternating field	A field in which the current oscillates several million to several billion times per second is known as a high-frequency field. Such fields are generated for instance by microwave ovens and medical apparatus.
Field strength	The strength of an electromagnetic field is designated by the electric component of the field, expressed in volts per metre (V/m), and by the magnetic component of the field, expressed in microtesla (millionths of the unit for magnetic field strength). The field strength diminishes rapidly with increasing distance from the source of the field.
Electromagnetic radiation	An intentional or unintentional modification of electrical fields which propagate with the speed of light along electrical conductors, optical wave guides or through empty space. One intentional use of electromagnetic radiation is for radio and television transmissions.

Health impacts
High-frequency fields

The thermal (heating) effect of high-frequency fields and radiation on tissue is well known and is utilised for instance in microwave appliances. This same thermal effect is known to cause damage to temperature-sensitive organs such as the cornea in the eye.

Nowadays, we are all constantly exposed to high-frequency fields and radiation. For this reason, standards and limits have been established to prevent this radiation damaging public health. In Germany, the limit has been set at 10% of the energy conversion level in the body, equivalent to a radiation power of 0.1 watt per kg body weight. Thus, a person of 70 kg body weight may be subjected to a maximum continuous exposure of no more than 7 watts.

Low-frequency fields

Scientific opinions differ as to the impact of low-frequency fields and radiation not associated with thermal effects. Low-frequency radiation could trigger reactions unknown to classical physics in biological systems.

Numerous experiments performed on groups of persons, animals and plants exposed to electromagnetic radiation produced findings that could be indicative of biological effects. For example, influences on cells and cell membranes, on cell division, on biological cycles, on the immune system, and on the behaviour and growth of cancer cells have been identified.

One Swedish study performed in October 1992 puts the risk of leukaemia for children living less than 50 metres from a high voltage transmission line at almost three times the average.

There are also some mechanisms which have not yet been adequately researched. For example, living beings appear to have a kind of "frequency and power window", within which they tend to absorb and are particularly sensitive to electromagnetic radiation. Another important factor may be synergetic mechanisms, in which the effects of electromagnetic radiation combine with the effects of other harmful influences (e.g. heavy-metal pollution).

In many of these cases, a positive hazard to health cannot be identified. In other cases, at no such hazards exist.

Limits	<p>Various national and international limits have been established and recommendations made to rule out health hazards due to low-frequency fields and radiation.</p> <p>The international limits and recommendations lie in the range of 3000 to 20,000 V/m for the electric field component and 100 to 5000 microtesla for the magnetic field component.</p> <p>The International Radiological Protection Association (IRPA) recommends limits of 5000 V/m and 160 microtesla, and the World Health Organisation (WHO) recommends 100 microtesla for the magnetic field component.</p> <p>German industrial standards (DIN 0848) prescribe limits of 20,000 V/m for the electric field component and 5000 microtesla for the magnetic field component. The German authorities, by contrast, recommend 2000 to 4000 V/m for the electric field component and 20 to 100 microtesla for the magnetic field component. They also recommend avoiding any unnecessary exposure to radiation even below these limits. In an international comparison, the statutory limits (DIN) for both components are very high in Germany.</p>
Everyday exposure to electromagnetic radiation	<p>The following examples give some indication of the scale of radiation exposure involved in the use of some everyday electrical equipment and devices. The values are given both for the electric and the magnetic field components of the radiation.</p>
Magnetic field components	<p>Electric shavers give a reading of 0.28 microtesla at a distance of 30 cm, table lamps give 0.05 to 0.25 microtesla, radio alarm clocks 0.25 microtesla, television sets 4 microtesla, electric cookers 20 microtesla, hot-air fans 40 microtesla, while 400 microtesla can be measured below high-voltage transmission lines. All these values are considerably lower than the prescribed limits and recommendations.</p>
Electric field components	<p>Coffee makers give a reading of 50 V/m at a distance of 30 cm, refrigerators 60 V/m, electric irons 100 V/m, while 6000 V/m can be measured under 380 kV overhead power lines. All these values, except for those measured beneath the overhead power lines, are significantly below the prescribed limits and recommendations.</p> <p>The field strength of 6000 V/m measured beneath the overhead power lines is below the DIN limit (20,000 V/m) but above the international (IRPA) limit (5000 V/m) and above the German national radiological protection authority limit (2000 to 4000 V/m).</p>
Biological effects	<p>In terms of purely physical limits, everyday exposure to electromagnetic radiation would appear not to constitute a hazard, with the exception of radiation from high-voltage transmission lines. On the other hand, doubts have been raised as to the validity of the limits themselves, because these are based only on the physical effects of electromagnetic radiation and make no allowance for its biological effects, if these are known at all.</p> <p>These biological effects may, however, be quite significant, as they have been observed in experimental studies of low-frequency alternating electromagnetic fields of field strength far below the recommended limits.</p> <p>Numerous statistical surveys, which, however, are disputed in scientific circles for a variety of reasons, indicate that long-term exposure to magnetic fields of 0.1 to 0.3 microtesla at a frequency of 50 hertz constitutes an enhanced cancer risk. At any rate, biological reactions have been scientifically demonstrated in test persons subjected to the said exposures.</p>

- The generation of electromagnetic radiation by overhead power lines, transformers, transmitters, but also by inadequately or incorrectly screened electrical equipment can cause interference in instrumentation, control and signalling facilities. Malfunctioning of machine controls, control systems, alarm systems or monitoring systems may ensue and lead to bodily injury, damage to property and financial losses. For example, malfunctions in heart pacemakers have been caused by electromagnetic radiation from microwave equipment and by anti-shoplifting devices in department stores.
- Potential health hazard due to malfunctioning of medical equipment which uses electromagnetic radiation for the examination or treatment of patients (e.g. nuclear resonance tomographs).
- Adequate protection of communication and data processing networks and systems against electromagnetic radiation (in this context especially lightning) which could cause damage to or destruction of the systems themselves and loss of data with enormous reconstruction costs, if reconstruction is possible at all.
- Official recommendations concerning health hazards from modern mobile communication equipment, especially recommended distances required as a function of transmission power between the mobile radio unit antenna and the user in order to rule out health hazards. The operating manual should contain instructions on proper use of the hand unit.
- High hazard potential to air traffic due to electromagnetic interference with electronic flight equipment. Airlines are banning the use of mobile phones, computer games, laptops and CD players on board because incidents involving interference with navigation and radio systems have already occurred.
- Unquantifiable third party liability risks due to the rising number of systems and equipment emitting electromagnetic radiation, since legal precedent is tending more and more towards the view that compliance with official requirements and regulations is not itself enough to rule out detriment to health.

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