Electrosmog in the environment

Swiss Agency for the Environment, Forests and Landscape SAEFL

Electricity supply systems, electrical appliances and a wide range of transmitters for various wireless applications generate non-ionising radiation (commonly referred to as “electrosmog”) that can be harmful to our health, depending on its intensity. With its Ordinance relating to Protection from Non-Ionising Radiation, the Federal Council introduced a legal instrument to protect the population against the harmful effects of electrosmog.

This brochure describes the main sources of electro-smog, assesses the associated risks, identifies existing gaps in research and suggests ways in which we can reduce our own level of exposure.

Swiss Agency for the Environment, Forests and Landscape SAEFL, June 2005

Electrosmog in the environment

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Precautions in the interest of public health

The countless options that have been opened up to us through the development of modern information and communications technology have fundamentally altered our daily life in the course of the past ten years or so. The rapid growth of mobile telephony and the Internet are just two obvious examples.

We are now using ever more electrical appliances and wireless devices at home, in the office and when we are on the move, but there is a negative side to this trend too, namely the increasing pollution of our environment in the form of non-ionising radiation. In February 2000 the Federal Council issued its Ordinance relating to Protection from Non-Ionising Radiation as an instrument to protect the population against the harmful effects of electrosmog. It stipulates exposure limit values for supply installations such as power lines, mobile phone antennae and wireless transmitters in order to protect the population against scientifically acknowledged harmful effects. In addition it contains stringent regulations governing facilities installed close to locations occupied by people for lengthy periods of time. Here, in applying the precautionary principle, exposure is limited to even lower values.

The relative complexity of non-ionising radiation and its biological effects, our lack of the necessary sensory organs for perceiving radiation, the continued existence of gaps in research and uncertainties relating to health risks give rise to a variety of speculations and fears, and with this brochure the Swiss Agency for the Environment, Forests and Landscape wants to counter these by providing some factual information. For example, it presents up-to-date findings concerning the impacts of non-ionising radiation on our health in as objective a manner as possible. We have also attempted to give a visual form to the invisible radiation that is ever-present in our environment, and thus to render it more tangible.

But this brochure also addresses the aspect of personal responsibility – for electrosmog is often home-made. In many homes, the main sources of non-ionising radiation are not external supply systems, but rather our own electrical appliances. And here, state legislation has its limitations in protecting us. It is therefore up to each of us to act in our own interest and make careful use of the many options provided by modern-day technology.

Philippe Roch
Director of the Swiss Agency for the Environment, Forests and Landscape

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Power supply

Electric and magnetic fields are unavoidable by-products of electricity transmission and use. The highest levels of exposure occur in the immediate vicinity of high-voltage power lines and transformer stations.

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Electrical appliances in the home

In most residential dwellings, electrosmog is home-made. Here we ourselves are able to considerably reduce our level of exposure by taking basic measures. For example, we should avoid placing electrical appliances that run constantly, e.g. clock radios, in places where people spend lengthy periods of time.

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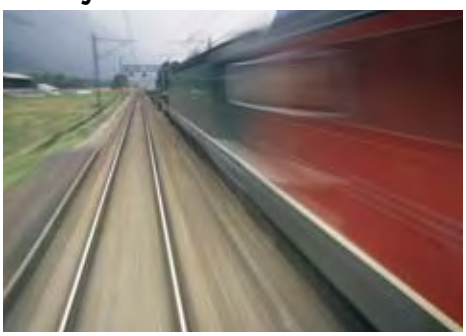
Railway lines



Magnetic fields along railway lines fluctuate considerably. Accelerating or braking locomotives increase the current and thus intensify the magnetic fields. Exposure levels are higher on heavily frequented stretches.

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Mobile telephony

Thousands of base stations in Switzerland secure the almost nation-wide availability of mobile phone services. On the other hand, the numerous antennae give rise to an increase in high-frequency radiation throughout the country.

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Broadcasting, point-to-point microwave links, amateur radio

High-power transmitters for radio and TV programmes are usually placed at elevated locations. Since there are normally no residential dwellings within the critical range, it is usually no problem for them to comply with the installation limit value.

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Wireless devices in buildings

Wireless devices such as cordless phones, cordless headphones, baby monitors, WLAN stations, etc., are also being used in residential dwellings to an ever increasing extent. Although their transmitting power is often relatively low, these devices can dominate the indoor exposure to high-frequency radiation.

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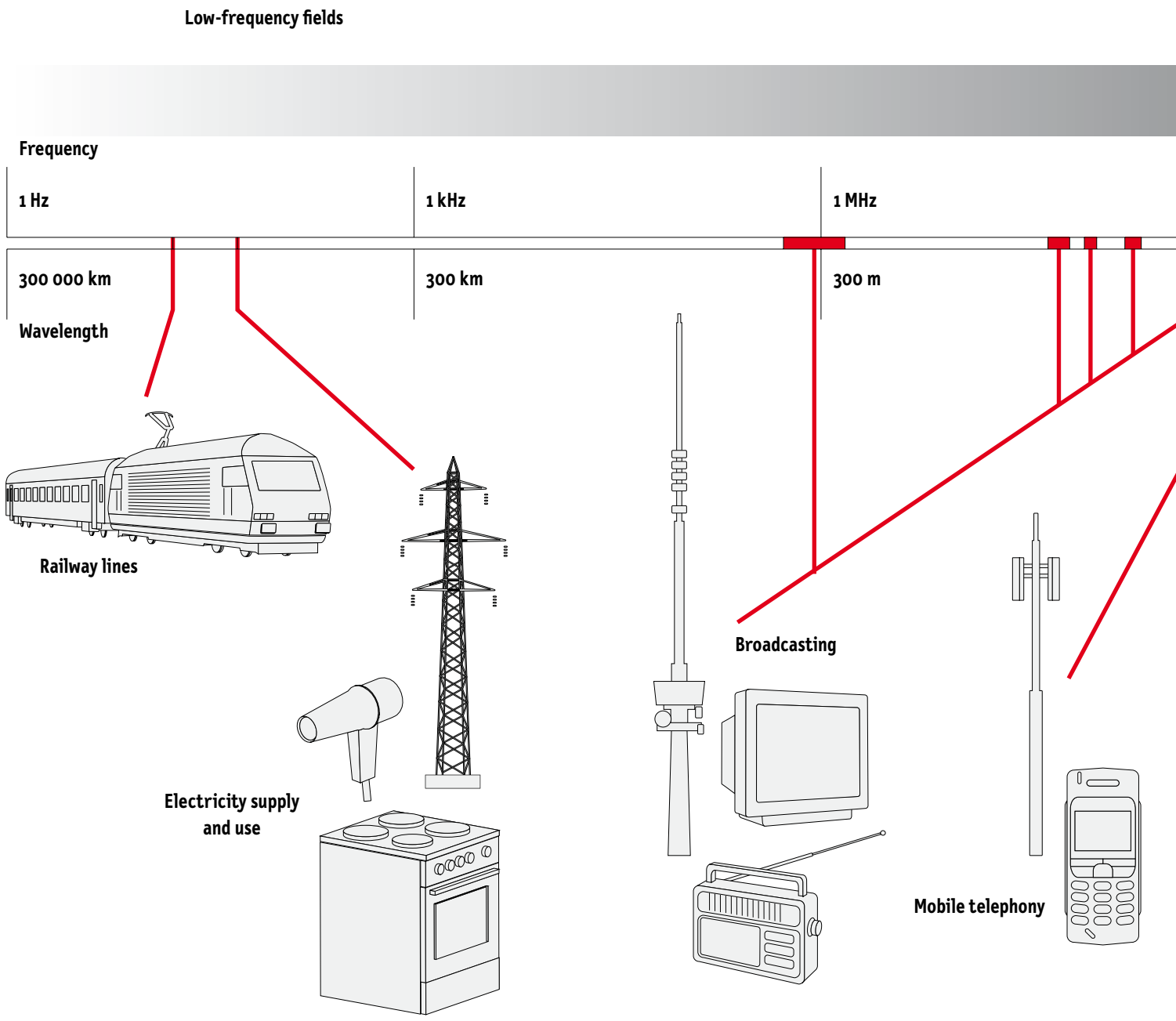
Electromagnetic spectrum



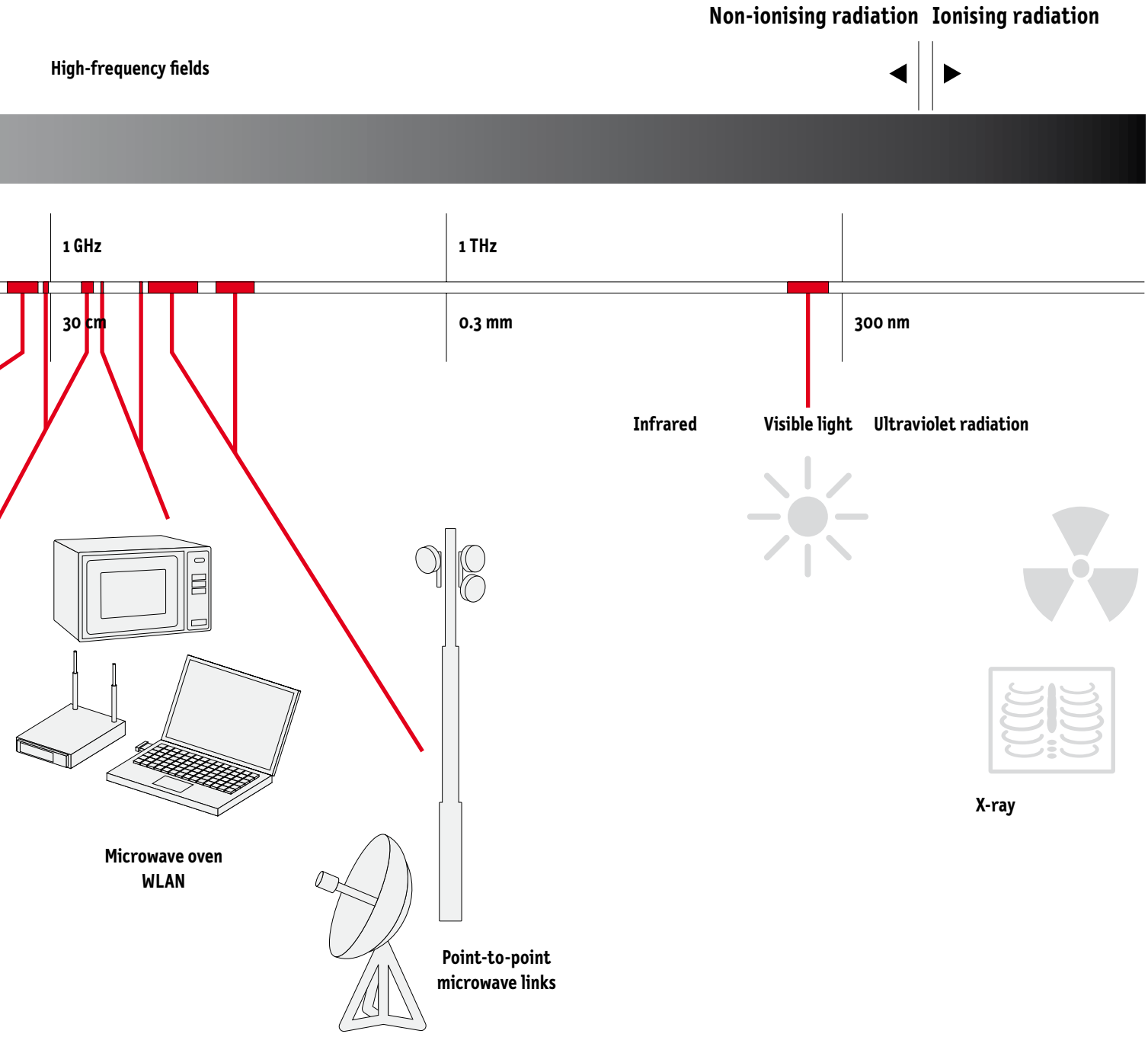
The diagram here shows an overview of the entire electromagnetic spectrum. Electromagnetic radiation occurs in our natural environment and is also generated artificially in a variety of forms, e.g. electric and magnetic fields from high-voltage power lines, radiation from mobile phone base stations and radio transmitters, visible light, x-rays. In physical terms, these types of radiation are distinguished by their frequency, i.e. the number of oscillations per second. Depending on their frequency they have different radiation properties and different effects on human beings.

Division of frequency spectrum

The frequency spectrum of electromagnetic radiation is broadly divided into non-ionising and ionising radiation. Non-ionising radiation is divided into low-frequency and high-frequency radiation, infrared radiation, visible light and ultraviolet radiation. Artificially produced low-frequency and high-frequency radiation are also referred to as “electrosmog”.

Low-frequency fields

The low-frequency range includes electric and magnetic fields from railway contact lines, high-voltage power lines and electrical household appliances. Since the railway power supply has a frequency of 16.7 oscillations per second, the fields it produces also have a frequency of 16.7 hertz (Hz). By comparison, the public power supply has a frequency of 50 Hz.



High-frequency radiation

We speak of high-frequency radiation when oscillations are 30,000 per second or more. Here, electric and magnetic fields are coupled and can propagate in the form of a wave. This is used for the wireless transmission of information. Specific examples include transmitters and receivers for radio and television, mobile telephony, point-to-point microwave links and radar. Such equipment uses frequencies ranging from several hundred kilohertz for medium-wave radio to several billion hertz (gigahertz) for point-to-point transmission, while heat radiation (infrared) and visible light have even higher frequencies. Although these are no longer described as "electrosmog", they nonetheless belong to the category of non-ionising radiation.

Ionising radiation

The transition to ionising radiation occurs in the ultraviolet radiation range. Ionising radiation includes x-rays and gamma radiation. By contrast with non-ionising radiation, ionising radiation possesses sufficient energy to directly alter the basic constituents of living organisms (atoms and molecules).

The negative impacts of intensive non-ionising radiation on our health have been scientifically established and are undisputed, but with the exception of workplace accidents, people are never exposed to such high levels of radiation. However, biological effects also occur at levels well below internationally recommended hazard thresholds. Since scientists are unable to indicate how harmful these effects are, it is advisable to take certain precautions.

Is electrosmog a health hazard?

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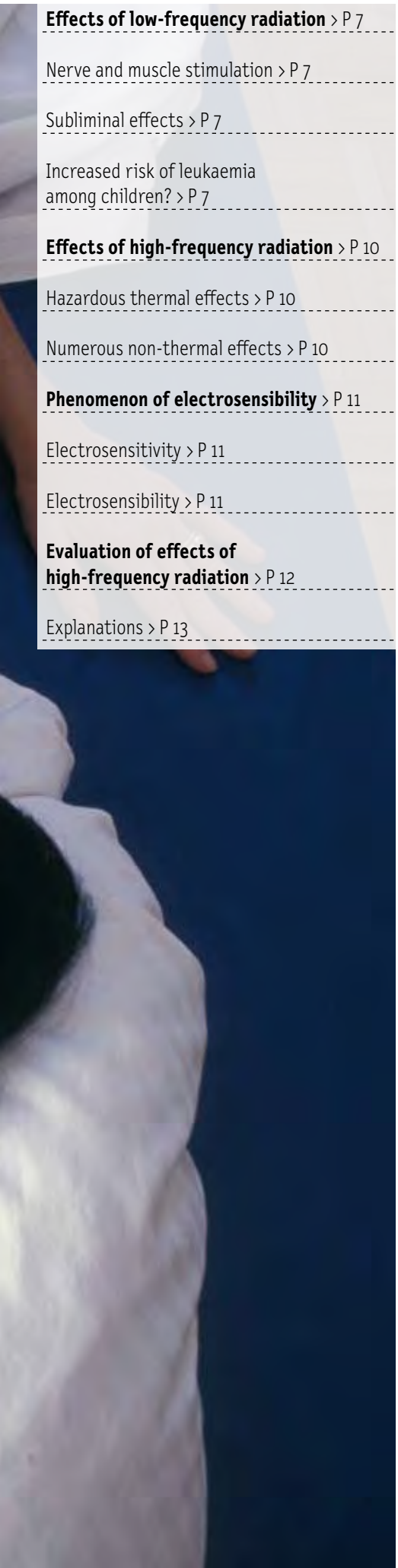


Effects of low-frequency radiation

Unlike many animals (such as birds and fish), human beings do not possess any sensory organs for electric or magnetic fields. The most we can do is perceive them indirectly. For example, some people experience a tingling sensation on their skin when standing directly beneath high-voltage power lines. Here the alternating electric field causes body hairs to vibrate, and this is perceived as a tingling sensation. While this effect may be perceived as an annoyance, it does not represent any danger to health.

Nerve and muscle stimulation

More intensive electric and magnetic fields are known to be harmful to our health, though we are not normally exposed to these in daily life. For example, extremely intensive magnetic fields over 10,000 microtesla (μT) can cause nerve and muscle cells to malfunction. Such powerful magnetic fields generate electric currents in the human organism that trigger undesirable nerve excitations and muscle contractions. And if the heart is exposed to extreme magnetic fields of more than 100,000 μT, this can cause cramping of the heart muscle – a condition that is life-threatening.
These effects on nerves and muscles are referred to as stimulation effects. They have been scientifically established and form the basis for defining international hazard thresholds. If these limits are not exceeded, no nerve or muscle cell malfunctions are triggered by low-frequency fields.

Subliminal effects

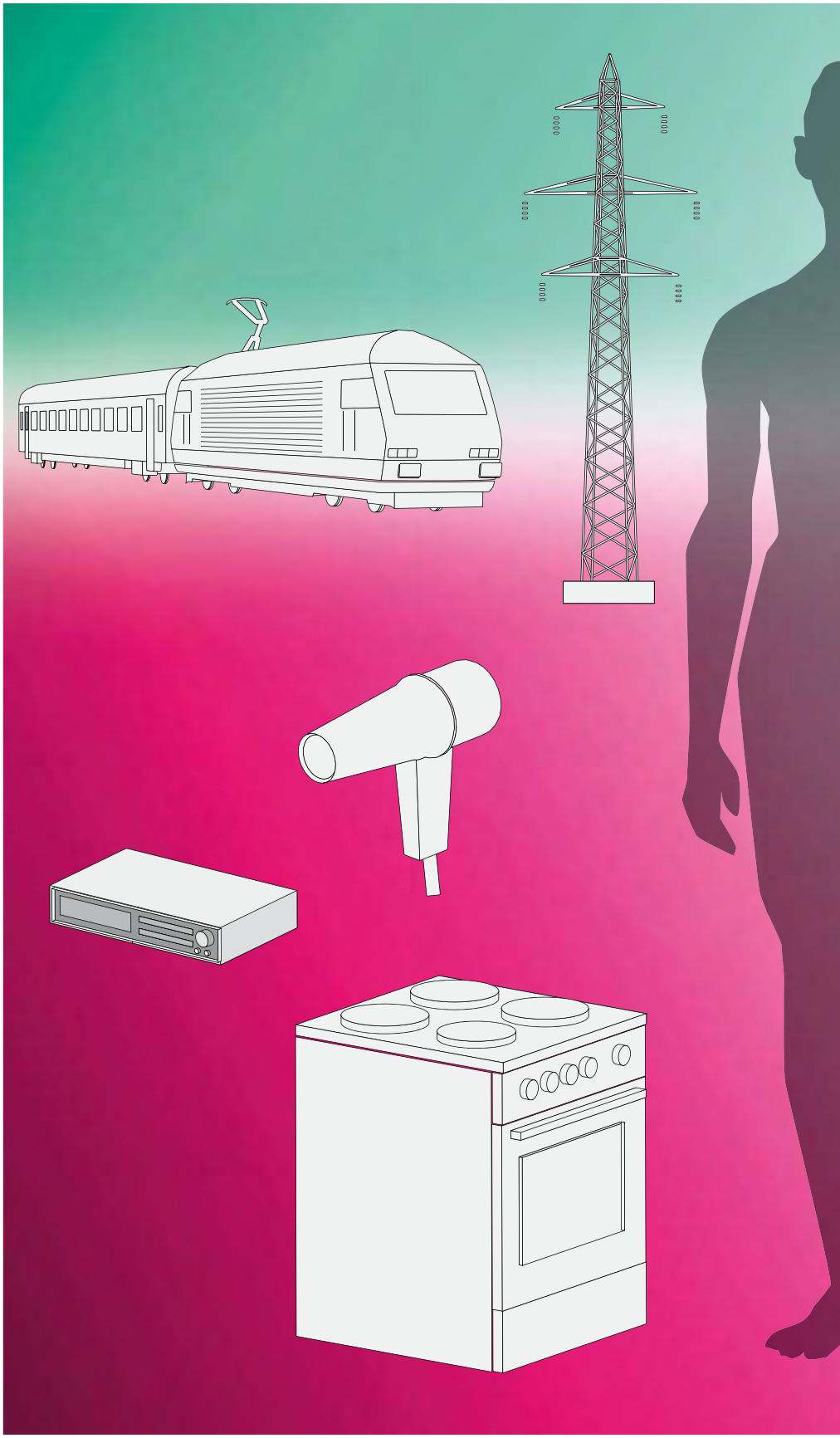
Various studies have revealed, however, that biological reactions may occur even if field strengths are well below the internationally defined thresholds. These reactions are referred to as subliminal effects.
Experiments conducted on both animals and human beings have identified changes in behaviour, interference with learning capacity and impacts on the hormone system. For example, it has been found that lower than usual levels of the hormone melatonin are produced. Melatonin controls the biological day/night cycle, has a stimulating effect on the immune system and inhibits the growth of tumours. Melatonin deficiencies are associated with sleep disorders, tiredness and depressive states. Research has also identified a variety of other impacts of low-frequency fields, including influences on growth and metabolism of cells and changes in genetic material.
The existence of subliminal effects is undisputed, but what we do not know is how they actually occur. Given the present-day status of knowledge, it is difficult to say whether these represent a health hazard, and if so under what circumstances.

Increased risk of leukaemia among children?

Epidemiological studies, which examine the frequency of occurrence of certain diseases among selected population groups, are a means of finding out more about any harmful effects that may be caused by non-ionising radiation. Studies of this sort have been carried out in a variety of countries since the early 1980s in order to determine whether low-frequency magnetic fields may cause or favour the development of cancer. For many years, the findings were varied and often contradictory, but as a result of more recent investigations and meta-analysis of earlier ones, researchers have meanwhile come to a uniform conclusion: the risk of contracting leukaemia is possibly twice as high among children who are exposed to magnetic fields over 0.4 μT for lengthy periods.
The International Agency for Research on Cancer (IARC) also came to the same conclusion, and in 2001 it classified low-frequency magnetic fields as potentially carcinogenic for human beings. It is of the opinion that weak magnetic fields represent a possible – though not probable or proven – leukaemia risk.
In Switzerland, around 60 children a year contract leukaemia. If long-term exposure to low-frequency magnetic fields of more than 0.4 μT really were to double the risk of children contracting leukaemia – which admittedly has not yet been definitively established – this means that about 1 new case a year would be attributable to magnetic fields, while the remaining 59 would be attributable to other causes.
The suspicion of a higher leukaemia risk is one reason to keep long-term exposure

Low-frequency fields

to low-frequency magnetic fields as low as possible as a precautionary measure. Insofar as electrical household appliances are the source, we ourselves are able to influence the level of exposure in our own homes. In contrast, electrical systems in our environment are subject to the provisions of the Ordinance relating to Protection from Non-Ionising Radiation, which entered into effect on 1 February 2000, and stipulates precautionary measures to reduce magnetic fields at locations occupied by people for lengthy periods of time, including residential dwellings, offices, schools, hospitals and playgrounds. At these locations, the installation limit value for all new high-voltage power lines and transformer stations at full load is 1 µT. However, long-term exposure is generally well below this level, since these systems seldom operate at full capacity.



In our daily life we are exposed to non-ionising radiation from a broad variety of sources. For example, railway catenaries, electricity supply systems and electrical household appliances all produce low-frequency electric and magnetic fields. If these are of high intensity, they can produce electric currents in the body that trigger undesirable nerve stimulations or muscle contractions.

High-frequency fields

TV and radio transmitters, mobile phone base stations, radar installations and microwave ovens all produce high-frequency radiation. This has different physical properties to low-frequency fields and its effects on human beings are also quite different. Intensive high-frequency radiation is converted in the body into heat, and this can harm sensitive organs. More research is required in order to clarify effects of low-level radiation.

Effects of high-frequency radiation

When we use a microwave oven, we are in fact utilising the heat produced by intensive high-frequency radiation. Here, biological tissue such as vegetables and meat absorbs the radiated energy and heats up. It is not only microwaves that heat up biological tissue, however: this process occurs as the result of high-frequency electromagnetic radiation from all sources – for example, radio and mobile phone transmitters – but it only occurs if the radiation is of sufficient intensity.

Many biochemical reactions in the human body only take place within a narrow temperature range. Diseases accompanied by high fever show us that these processes can already be severely disturbed if the body temperature rises by only a few degrees Celsius. For this reason, thermal impacts due to electromagnetic radiation have to be regarded as undesirable.

Hazardous thermal effects

In daily life we are normally not exposed to high-frequency radiation of such intensity that its thermal effects could harm our health.

A health risk arises if our body temperature increases by more than 1 to 2° C as a result of absorbed radiation. The resulting effects are similar to those experienced due to fever or overheating: memory disorders, interference with various bodily functions, including the reproductive organs. Organs that have poor blood flow and are therefore unable to cool quickly are especially at risk (e.g. the eyes, which can develop cataracts). If our body temperature increases even more, this can lead to internal burns or even death due to heat stroke.

Well-documented work accidents abroad, especially those involving radar equipment, demonstrate how dangerous high-frequency radiation can be. For example, a mechanic who inadvertently strayed very close to a radar transmitter suddenly felt very hot and suffered internal burns. He and two of his colleagues had to be taken to hospital with skin damage and severe coagulation problems. All three complained of tiredness, dizziness, headaches and pressure above the eyes. Scientists are well aware of these acute effects of intensive high-frequency radiation, which only occur above a certain level of radiation intensity. The corresponding threshold forms the basis for the definition of internationally recognised limits aimed at protecting the population against the harmful effects of short-term exposure.

Numerous non-thermal effects

Various studies have revealed, however, that biological effects may result even if radiation intensities are well below the internationally defined thresholds. Since they do not increase our body temperature, we refer to them as non-thermal effects.

Experiments on test subjects have demonstrated, for example, that radiation from mobile phones can influence brain waves and sleep patterns. In laboratory studies, behaviour changes among animals, and physiological changes in cell cultures, have been observed as the result of low-intensity, high-frequency radiation.

Epidemiological studies have also given rise to certain suspicions: studies carried out in the vicinity of TV and radio transmitters have yielded higher leukaemia and lymphoma rates than expected. However, findings are not uniform and some studies have methodological flaws.

To some extent, indicators of potential impacts on health come directly from the population. For example, an increasing number of people living in the vicinity of a now decommissioned short-wave radio transmitter in Schwarzenburg (canton of Bern) began to complain about nervousness, restlessness, insomnia, general weakness, tiredness and aching limbs, and a subsequent epidemiological study conducted on behalf of the federal government revealed a statistical correlation between sleep disorders and transmission patterns. However, the study was unable to definitively determine whether the various symptoms were in fact attributable to radiation from the transmitter, or whether confounding factors might have been involved.

Nonetheless, the fact that high-frequency radiation gives rise to non-thermal effects is undisputed. The problem is, we do not yet know how these effects come into being. Given the present-day status of knowledge, it is also difficult to say whether these effects represent a health hazard, and if so, under what circumstances. In view of the existence of contradictory findings and the fact that not all experiments can be successfully repeated, it is difficult to make a meaningful evaluation. This means that further research is essential if we are to gain an accurate picture of the impacts of low-intensity, high-frequency radiation on our health.

Intensive electromagnetic radiation can cause the body to heat up, and this results in symptoms similar to fevers. The limit values specified by the ONIR protect us against these undesirable thermal effects.

Phenomenon of electrosensitivity

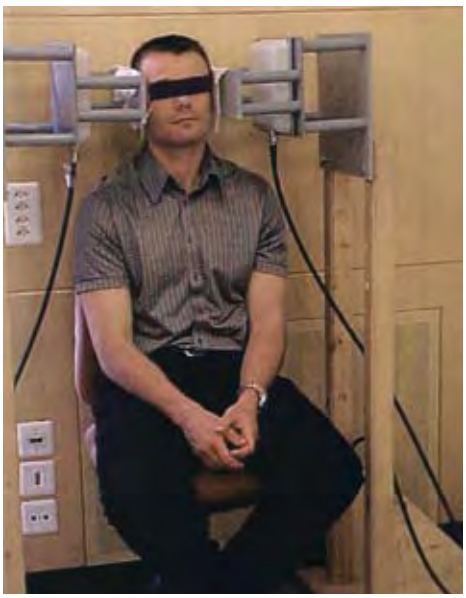
Human beings do not possess a sensory organ that enables them to directly perceive non-ionising radiation, but it appears that some especially sensitive people are able to perceive even very weak electromagnetic fields. Others feel certain that their health related symptoms are caused by electrosmog.

Perception of weak electromagnetic fields

Some people have the ability to consciously perceive weak electromagnetic radiation, which can be established in experimental arrangements and tests.Test subjects have to be able to tell the difference between a real and a sham exposure. Approximately 5 percent are able to accomplish this better than they could be expected to by chance. The ability to perceive weak electromagnetic fields does not mean, however, that the person concerned also suffers due to electrosmog.

Electrosensitivity

The term electrosensitivity (or electromagnetic hypersensitivity) is used when someone attributes his or her health problems to the effects of low-intensity non-ionising radiation. Here, people complain of frequent but non-specific symptoms such as sleep disturbances, headaches, nervousness, general tiredness, lapses of concentration, tinnitus (ringing in the ears), dizziness, aching limbs, heart pains.
As a rule, it is difficult to precisely determine the causes of these symptoms. In addition to electrosmog, a variety of other factors come into question, such as stress, noise, flickering light, chemicals, and physical or mental disorders. Furthermore, there are no generally acknowledged criteria for an objective diagnosis of electrosensitivity, and it also appears that ability to perceive weak fields and electrosensitivity exist independently of one another. This means that people with electrosensitivity do not necessarily have a higher perception of electromagnetic fields than average, and vice versa.
Many questions still need to be answered regarding these two phenomena, and therefore a great deal of research is still required.



In this scientific experiment, the subject's head is being exposed to electromagnetic fields similar to those produced by mobile phones. Exposure for only 30 minutes already alters our brain activity, but it is at present not possible to draw any clear conclusions from this with respect to potential harm to health.

People with electrosensitivity feel impaired by low intensity non-ionising radiation, even when the level is well below internationally recognised exposure limit values. The symptoms tend be non-specific, for example tinnitus (ringing in the ears).

Evaluation of effects of high-frequency radiation

Evidence	Effects		
	Serious	Reduced well-being	Relevance to health unknown
Established	Thermal effects (e.g. interference with memory and other functions, cataracts, internal burns)		
Probable		Non-specific symptoms (headaches, fatigue, problems of concentration, disquiet, burning skin, etc.)	
			Brain activity
			Sleep phases
Possible	Leukaemia/lymphomas		
	Brain tumours		
		Quality of sleep	
		Electromagnetic hypersensitivity	
			Cognitive functions, reaction times
Improbable	Mortality		
	Other types of tumour		
Not assessable	Stillbirth		
	Genotoxicity		
	Breast cancer		
	Eye tumours		
	Testicle tumours		
		Mental symptoms	
		Unspecific symptoms (insomnia, headaches, etc.)	
			Hormone system
			Immune system
			High blood pressure

Source of exposure
Various, above exposure limit values
Mobile phones
Mobile phones
Mobile phones
TV/radio transmitters
Mobile phones
Radio transmitters
Mobile phones
Mobile phones
Mobile phones
Various
Diathermy devices
Workplace exposure
Various
Mobile phones
Radar guns
Various
Mobile phone base stations
Various
Various
Radio transmitters

Explanations concerning the table on pages 12 and 13

The table on pages 12 and 13 is largely based on a study entitled "High frequency radiation and human health", published in 2003 and updated in 2004 (BUWAL UM-162-D), which was produced by the Institute for Social and Preventive Medicine, Basel, on behalf of the Swiss Agency for the Environment, Forests and Landscape. It presents a differentiated assessment of the findings from more than 200 studies.

The "evidence" column indicates the degree of certainty of each effect. For this purpose it has been divided into the following categories:

Established: The effect concerned is able to stand up to strict scientific examination.

Probable: The effect concerned has been established in a variety of studies, the quality of which is high enough to permit the exclusion of other influencing factors with a high degree of certainty, but a plausible causation mechanism is nonetheless lacking.

Possible: The effect concerned has been observed in various studies, but the findings are not consistent. Reports concerning individual cases support the scientific indicators.

Improbable: There are no indicators for the effect concerned, but multiple indicators of its absence.

Not assessable: The available data are insufficient for making a meaningful assessment.

Secondly, the relevance of the effects to human health was evaluated, regardless of their indicated degree of certainty:

Serious: The effect concerned represents a drastic restriction of quality of life. It is life threatening and will shorten life expectancy.

Reduced well-being: The effect significantly restricts quality of life and well-being, but the symptoms are not directly life threatening.

Relevance to health unknown: The effect is physiologically measurable, but the observed changes are within the normal variability range of healthy individuals. Since it is normally not perceived, it does not represent an acute health risk, nor does it have an impact on quality of life. However, it is not clear whether it could lead to a health risk in the longer term.