Socialstyrelsen
THE NATIONAL BOARD OF HEALTH AND WELFARE

Information Sheet

June 2005

To:
Municipal environment and health protection committees
County council boards
Other relevant authorities

Electromagnetic fields from power lines

This information sheet has been produced in consultation with the National Board of Housing, Building and Planning, the National Electrical Safety Board and the Swedish Radiation Protection Authority. It aims to furnish decision makers with updated data for assessment purposes.

Summary
The connection between exposure to electromagnetic fields from power lines and certain other electrical installations and the increased risk of leukaemia in children has been discussed for many years. During 2001[1] a comprehensive review was carried out of the epidemiological[2] research reports that existed at the time. The results from the review indicate that there is a certain increase in the risk of leukaemia among population groups exposed to magnetic fields of 0.4 μT or more (equivalent to long-term exposure to 50 Hz magnetic field in housing). However, no risk increase is seen below 0.4 μT. There is no known mechanism that could explain how exposure to such a weak, low-frequency field might affect the risk of illness.

The scientific basis of data is still considered insufficiently sound to establish a limit value. One of the reasons for this is that there is no biological explanatory model for the effect on the cancer risk.

Power legislation and the rules of the Environmental Code on caution are applicable with this kind of exposure. They mean that risks to people's health should be avoided as far as it may be considered economically reasonable.

Background
At the beginning of the 1990s a Swedish study of magnetic fields from power lines[3] showed that there was a discernable increase in the risk of child leukaemia with exposure to 0.2 μT. Results from other studies indicated an increased risk of brain tumours and leukaemia in adults who had experienced such exposure in their professional environment.

The overall judgement was that the studies did not provide sufficient grounds for setting limit or target values. One of the reasons for this uncertainty was that it was not thought possible to discount the existence of other factors in the proximity of the power lines that might have contributed to the risk increase. There was also no biological explanatory model.

The relevant authorities jointly wrote guidelines for decision makers entitled "Myndigheternas försiktighetsprincip om lågfrekventa elektriska och magnetiska fält" ["The authorities' principle of caution with regard to low-frequency electrical and magnetic fields", in Swedish], which was published in 1996. It shows how an attitude of caution could be used in decisions affecting "fields that deviate strongly from what might be considered normal in the present environment", even though no limit values have been set.

Current research in this area shows a somewhat different picture compared with the past. There have also been changes in the legislation. The Environmental Code, which came into force on 1 January 1999, stipulates (among other things) the exercise of caution when there are grounds for concern that an operation might be hazardous, for example, to human health. The National Board of Health and Welfare has therefore decided, in consultation with the National Board of Housing, Building and Planning, the National Electrical Safety Board and the Swedish Radiation Protection Authority to update the information on the risks involved with electromagnetic fields from power lines.

Long-term effects of low-frequency electromagnetic fields

About 25 years ago the first epidemiological study[4] was published, the results of which shows that long-term exposure to weak, low-frequency electromagnetic fields (of the type to which people can be exposed in their everyday environment, e.g. close to power lines) could increase the risk of cancer in children. This led to a suspicion that there might be some unknown mechanism for interaction between low-frequency fields and human beings.

An in-depth research project was set up. The epidemiological research followed up previous studies of child cancer and also looked at other cancer-related illnesses and disorders other than cancer. Studies have shown covariance between living by power lines and various illnesses such as heart and vascular disorders, neuro-degenerative illnesses and reproduction effects.

With regard to cancer in children, the research has confirmed that there is a connection between exposure to low-frequency electromagnetic fields and a provable increase in the risk of leukaemia. For other illnesses it has been much harder to repeat the results. Based primarily on the child leukaemia results, the IARC has classified low-frequency electromagnetic fields as *possibly carcinogenic* (Classification 2B). In the IARC's view, there is limited evidence to suggest that the fields might be carcinogenic[5].

For some of the other illnesses suspicions still remain that exposure to low-frequency fields might be a contributory factor in causing them but for most of the illnesses the

suspicions have gradually waned. Animal studies have shown no increased risk of cancer.

Together with the epidemiological research an extensive experimental research project has also been undertaken. Its main purpose is to try to find a mechanism that could explain the epidemiological results. The only interaction between low-frequency electromagnetic fields and human beings known today is the induction of current in the body. This, however, cannot constitute an explanation since the fields with proven effects within the epidemiological research are considered too weak to influence the human organism. A number of other hypotheses have been advanced and tested to explain the observed risk increase. These have gradually been rejected or in each case left unproven. No new, previously unknown mechanism has been identified, nor is there any strong candidate for such a mechanism.

The main reason why, in spite of the results from the epidemiological research, no stronger conclusions have been reached as regards the risks with low-frequency electromagnetic fields is that there is no biological explanatory model for the correlations found. Some researchers reject on theoretical/physical grounds the conclusion of the IARC and other analysts that low-frequency electromagnetic fields with the exposure levels that exist in the public environment might cause ill-health. Their justification is that the energy transfer from the fields is so small that health effects etc in the form of cancer are not possible.

Risk assessment
Later research, especially a new analysis (reference 1), does not indicate any connection between exposure to magnetic fields under 0.4 μT and leukaemia in children. For exposures higher than 0.4 μT a connection can still be seen with leukaemia in children. The research is based on long-term exposure to 50 Hz magnetic field in homes. There is, however, no known mechanism that can explain how exposure to such weak, low-frequency fields could affect the risk of illness.

As regards long-term health effects, ICNIRP[6] believes that the available epidemiological data on cancer risks is insufficient to establish limit values.

According to the epidemiological data, fewer than one case of child leukaemia per year could be caused by magnetic fields in Swedish homes. This therefore means that fewer than 1 percent of all children are exposed to 0.4 μT or more in their homes. In total around 80 children a year are affected by leukaemia in Sweden.

Risk handling
The need for caution is defined in Chapter Two of the Environmental Code[7]:

Section 3 “all who run or intend to run an operation or implement a measure shall carry out the protective measures, observe the restrictions and take the cautionary measures needed to prevent, inhibit or counteract any possibility that the operation or measure might cause damage or inconvenience to human health or the environment. To the same end, any professional activity must use the best possible technology. These cautionary measures shall be implemented as soon as there are grounds to assume that an operation or measure might cause damage or inconvenience to human health or the environment”.

Section 7 “the requirements relating to sections 2-6 shall apply to the extent that it cannot be considered unreasonable to fulfil them. When making this judgement special attention shall be given to the use of protective measures and other cautionary measures compared with the costs of such measures…”

These words make clear that risks to human health should be avoided as far as is economically possible. They also tally with the sentiments expressed in “Myndigheternas försiktighetsprincip om lågfrekventa elektriska och magnetiska fält”. The principles for risk handling are therefore the same today as they were in the past.

Acute effects of low-frequency electromagnetic fields
Strong currents through the body can cause acute biological effects and health risks. The reference values that exist for low-frequency electromagnetic fields are based on such effects, and their purpose is to prevent effects on the central nervous system. The reference values are set with safety margins. The values that apply to the general population are 50 times lower than the levels at which one sees biological consequences in the form of an effect on the nervous system. The fields that occur in the general environment are considerably lower than the reference values.

Target values
As regards acute effects of electromagnetic fields, the Swedish Radiation Protection Authority has published general guidelines on the subject of the general public’s exposure[8]. This guidance specifies levels for such things as magnetic fields. For low-frequency magnetic fields, i.e. fields with a frequency level of 50 Hz, a target value of 100 μT is given[9]. This value may be compared, for example, with the magnetic field to be found under a 400 kV power line, which is around 20-30 μT.

Sensitivity to electricity
Sensitivity to electricity may be defined as the symptoms experienced by an individual when close to or when using electrical equipment and which that individual attributes to the aforementioned equipment. Different individuals experience different degrees of discomfort or ill-health.

The studies that exist indicate that electromagnetic fields are not a sufficient factor to trigger the problems connected with sensitivity to electricity. Nor has it been possible to demonstrate effects when exposing individuals to fields from electrical appliances which they themselves claim are causing them discomfort. The studies also show that electrical or magnetic fields are not a necessary factor in triggering the problems connected with sensitivity to electricity.

Facts concerning electromagnetic fields
Electromagnetic fields have existed since the birth of the universe. Light, heat and ultraviolet radiation are examples of such fields. The electromagnetic spectrum can be divided into an ionising segment and a non-ionising segment. *Ionising radiation* is the term used for radiation where the wavelengths are shorter than 0.1 μm (wavelengths shorter than ultraviolet light). The radiation has sufficient energy to break up chemical compounds. *Non-ionising radiation* has long wavelengths and is too weak to break up chemical compounds.

Electromagnetic fields are generated wherever there is electrical current. Unlike electrical fields, magnetic fields are not screened by insulation material or buildings. For this reason, among others, the discussion of possible health risks in connection with power-frequency fields has focused on the magnetic component.

The most noticeable source of magnetic fields in the public environment is power lines and transformer stations, but fields also occur as a result of unbalanced currents in electrical cables under the ground, or around transformers or other installations in buildings. Fields can also be greater close to electrical motors, e.g. when operating electric trains. A large number of sources of exposure are not visible and the only way to identify magnetic fields is through measurements.

Low-frequency fields have long wavelengths. The frequency of 50 Hz is equivalent to a wavelength comparable to the radius of the earth (6,400 km). The fields pass through the human body but the only known interaction is that an electrical current is induced. The current density is a function of the magnetic flow density (measured in the unit Tesla, T), which is normally used to describe magnetic fields.

Supervision of electromagnetic fields from power lines
In addition to the Environmental Code, electromagnetic fields are taken up in the Electricity Act and the Radiation Protection Act.

The National Electricity Safety Board has a specific supervisory responsibility as set out in the Electricity Act for electrical safety with installations and electrical products, and this includes electromagnetic fields from power lines. The legislation on electrical safety is applied from the network licence phase and continues for as long as the power line is in operation. The board exercises its supervisory duty by checking that the owner of the power line has met the requirements of the act in terms of adequate safety with respect to personal injury in connection with the concession. The board also deals with reports from individuals that electromagnetic fields from, for example, power lines do not meet the safety requirements. The inspection follows the general guidance drawn up by the Swedish Radiation Protection Authority on limiting the public's exposure to electromagnetic fields (reference 8). In addition to these recommendations, the board also complies with “Myndigheternas försiktighetsprincip om lågfrekventa elektriska och magnetiska fält”.

The Swedish Radiation Protection Authority (SSI) is the central administrative authority that deals with issues relating to the protection of human beings, animals and the environment against the harmful effects of ionising and non-ionising radiation. According to Radiation Protection Act, the Swedish Radiation Protection Authority has been given the task of developing radiation protection in Sweden. In this capacity SSI has published general guidance on restricting the public’s exposure to electromagnetic fields (reference 8) and also carries out measurements to check that the values set out in the general guidelines are maintained.

The municipal environmental committees have an operative supervisory responsibility for issues affecting the environment and health under the Environmental Code. This includes the public’s exposure to chemical and physical risk factors, and electromagnetic fields from power lines are one of many such examples. *The National*

Board of Health and Welfare is the central supervisory authority for issues relating to health protection in the Environmental Code. The county council boards also have a supervisory and advisory role under the Environmental Code for issues of this kind.

The National Board of Housing, Building and Planning is the central authority for issues relating to built-up areas and households with land and water, physical planning, construction and administration of buildings, and also housing issues. The National Board of Housing, Building and Planning manages and supervises the way in which (among other things) the health and safety issues are observed in the building permits and in physical planning.

[Footnotes follow]

[1] Ahlbom et al: Review of the Epidemiologic Literature on EMF and Health, Environmental Health Perspectives, Volume 109, Supplement 6, December 2001.

[2] Epidemiological research investigates the occurrence of different illnesses in a population, or studies whether there is a connection between a particular exposure and an illness or condition. A common feature of epidemiology's different areas of application is a theoretical and methodological basis. This involves tools for defining issues, designing studies and interpreting results from studies. A prerequisite for high-qualitative epidemiological research is that it must be based on statistical methods of analysis adapted to epidemiological data. There must also be knowledge specially geared towards the current area of research.

[3] Feychting et al: Magnetic fields and cancer in children residing near Swedish high-voltage power lines. American Journal of Epidemiology 138:467-481, 1993.

[4] Wertheimer et al: Electrical wiring configurations and childhood cancer. American Journal of Epidemiology 109:273-284, 1979.

[5] IARC (*International Agency for Cancer Research*, which is the World Health Organisation's cancer research institute) has devised groupings to classify the degree of proven carcinogenic effect on humans. Group 1 – carcinogenic effect on humans; Group 2A – probable carcinogenic effect on humans; Group 2B – possible carcinogenic effect on humans; Group 3 – not classifiable in terms of cancer risk in humans; and Group 4 – no carcinogenic effect on humans.

[6] ICNIRP is an international commission involved with protection against non-ionising radiation.

[7] According to the Electricity Act (1997:857) the Environmental Code should be applied within the framework of the electricity legislation when handling concessions.

[8] The Swedish Radiation Protection Authority's general guidance on limiting the exposure of the public to electromagnetic fields (SSI FS 2002:3).

[9] The corresponding value for electromagnetic fields generated by railway power lines is 300 μT.

Artikelnummer: 2006-1-19