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Electric and magnetic fields caused by power transmission lines

Introduction

Electric and magnetic fields occur everywhere where electricity is produced, transmitted or used, including in all of our homes. Transmission lines are therefore only one of a number of sources of electric and magnetic fields that exist. This position paper examines electric and magnetic fields mainly from the point of view of the transmission lines of the main grid.

In Finland, high-voltage 110 kV transmission lines have been in use since the 1920s, and the first 400 kV transmission lines were constructed in the 1950s. Electric and magnetic fields generated by transmission lines occur only in the immediate vicinity of transmission lines. Even so, they attenuate very quickly when approaching distances where people are staying more permanently. Electric and magnetic fields are strongest in locations at which the power conductors are closest to the ground.

Electric fields caused by transmission lines

The strength of an electric field caused by a power line depends on the power line's voltage, which remains relatively constant. Beneath a 400 kV power line of the main grid, the strength of an electric field reaches a maximum of 10 kV/m and beneath a 110 kV power line 2 to 3 kV/m. When moving further away from the centre line of the power line, the electric field attenuates rapidly. The electric field is also effectively attenuated by vegetation and structures.

No threshold values have been defined in legislation with regard to public exposure to the electric fields of transmission lines, as provisions have been set out under the Electrical Safety Act on transmission lines which, when adhered to, guarantee that the strength of an electric field in the vicinity of a power line is always kept at a safe level.

However, electric fields may cause people to have sensations, as objects in the vicinity of an electric field that are isolated from the earth and conductive to electricity, such as metal shovels and tools, will become electrically charged. A human being will also become electrically charged while working below a power line. This is not something a person will generally notice. However, when wearing thick-soled footwear such as rubber boots, a person may feel a weak spark when touching an earthed object such as a metal fence post. This phenomenon is similar to and as harmless as a spark generated when removing a synthetic fibre pullover. A sparking umbrella below a power line, for example, is harmless and is caused by electrical charging. Interference with pacemakers and wearable defibrillators below transmission lines is unlikely, but not impossible. For this reason, people who have been fitted with pacemakers should avoid being under transmission lines and, when moving in terrain, should aim to walk below transmission lines at the point at which their height from the ground is the greatest, i.e. close to the pylons.

Magnetic fields caused by transmission lines

The magnetic field of a power line is proportional to the current in the power line. This varies constantly according to the grid load. The strongest magnetic fields measured

beneath a 400 kV power line have been in the range of 10 µT when the power line has contained a high current. When moving further away from the centre line of the power line, the magnetic field attenuates rapidly. As an example, the above-mentioned field attenuates to one tenth at a distance of around 50 metres from the centre line of the power line.

The Ministry of Social Affairs and Health (STM) has considered magnetic fields in its decree (1045/2018), which came into force on 15 December 2018. The exposure of the population to magnetic fields is restricted in the decree to 200 microtesla (µT) that is not exceeded even directly beneath 400 kV transmission lines.

The legislation is based on the restrictions that provide protection from all known potential adverse effects of exposure to electric and magnetic fields. The limitation of exposure and its grounds are reviewed periodically by the European Union and the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

Land use around transmission lines and the siting of new transmission lines

When current design practices are followed, the electrical and magnetic fields caused by transmission lines will remain well below STM threshold values.

The STM decree does not require leaving a safety zone outside the line corridor and there are no official guidelines or regulations in Finland concerning the siting of transmission lines based on electric and magnetic fields. However, there is no desire for activities to take place in the vicinity of transmission lines that could possibly increase the electrical safety risk or where the closeness of transmission lines would give people cause for concern. For this reason, power grid operators can provide guidance on land use planning and zoning. However, power grid operators have no legal rights to restrict construction outside the power line corridor.

The siting of new transmission lines complies with the Government Decision on national land use objectives in accordance with Section 22 of the Land Use and Construction Act (132/1999). For example, the act states that the siting of transmission lines must primarily take advantage of existing power line corridors. This means siting new transmission lines either in place of old ones or alongside them. This may lead to situations in which the power line is inevitably built closer to the activities and residential areas that were built around the old power line. Even so, the threshold values will not be exceeded.

The impact of electric and magnetic fields on health is constantly being studied

The health impact of electric and, in particular, magnetic fields has been studied from the 1970s. Also, the use of electricity and therefore also magnetic fields has continuously increased in our living environment.

The International Agency for Research on Cancer (IARC), which is part of the World Health Organisation (WHO), has classified low-frequency magnetic fields as Group 2B, that is, potentially carcinogenic. Even so, this classification does not mean that there would be a significant increase in incidences of cancer. In addition to low-frequency magnetic fields, Group 2B includes certain vegetable preservatives, Aloe vera and exhaust gases. However, an increase in risk or a causal relation has not been

scientifically proven for this group. For example, there is no known biological mechanism of action that could explain the potential ability of magnetic fields to cause cancer.

Some studies have also indicated that magnetic fields could have effects at significantly lower levels of exposure than the threshold values of the STM decree. The research findings that have engendered the most discussion are those that show a slight increase in the incidence of child leukaemia when the magnetic flux density in an apartment is more than 0.4 µT. There have been many additional international studies on the link between different types of cancer and 0.4 µT magnetic field exposure. However, no clear evidence of a link has been observed. Neither have animal experiments shown that exposure to a magnetic field causes cancer in the test animals.

It must also be taken into account that the magnetic flux density of 0.4 µT is already exceeded in the vicinity of a number of electrical household appliances and equipment. Thus, applying this value in our current electricity-based society is virtually impossible.

Research on electric and magnetic fields is continuously monitored by organisations and authorities. In all of its activities, Fingrid complies with the regulations imposed by the authorities and also monitors the research in the field on its own initiative.

Electric and magnetic fields form part of our daily lives

Over the last century, electricity has become an indispensable part of our daily lives. As a form of energy, electricity is easy to handle and can be transmitted cost-effectively and cleanly. Electricity is used in households, industry and the transport sector. A person living in a modern society will be surrounded by electromagnetic fields emitted by electrical equipment, especially in suburban and urban areas. Sources of background fields include electric lines (including non-visible underground cabling), transformers and switchboards located in buildings, electrical power networks in buildings, household electrical appliances, computers, the electric motors of trains, including their power supply systems, anti-theft gates at stores, radio stations, mobile phones and their base stations. Industry and medicine also use equipment that generates strong electromagnetic fields. Significant natural sources include the Earth's own magnetic field, lightning and the Sun, which emits powerful electromagnetic waves over a wide wavelength.

The background magnetic field in residential apartments resulting from alternating current is usually just under 0.1 µT. In most cases, the magnetic field originates from electrical devices connected to the household’s mains network and, in particular, from stray currents present in the mains and earthing. Electric underfloor heating can also increase an apartment’s background magnetic field to the level of 0.1 to 0.2 µT. It is typical that the magnetic field caused by household appliances and home electronics rapidly attenuates as the distance grows. Even if the magnetic field on the surface of the device is quite large (from 100 to up to 2,000 µT), the field attenuates to a level of 0 to 0.6 µT at a distance of less than one metre from the device.

Thus, electricity grids are only one source of electric and magnetic fields and do not provide a significant increase in the fields otherwise present in the normal living environment of people.

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