POSSIBLE EFFECTS OF ELECTROMAGNETIC FIELDS ON PEOPLE

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Abstract: In daily life everybody is, to a greater or lesser degree, exposed to electromagnetic fields. Examples are the fields produced by kitchen appliances, radio transmitters and mobile phones. Exposure to electromagnetic fields (EMF), if they are strong enough, can lead to short term health effects.
But a distinction must be made: exposure to low frequency fields that are strong enough can lead to dizziness, seeing light flashes and feeling tingling or pain through stimulation of nerves, but exposure to radiofrequency fields that are strong enough can lead to heating of body tissue, and result in damage to tissues and organs. For both low frequency and radiofrequency fields exposure limits have been set below which these acute effects do not occur.
Long-term health effects are not well understood. Research into possible long-term health effects of long-lasting exposure to EMF below the exposure limits is still ongoing. Scientific studies that compare groups of children who live near and far away from an overhead power line have indicated that the children exposed to magnetic fields above 0.3 to 0.4 microtesla may have a greater chance of getting leukaemia. The magnetic field due to the power line possibly plays a role in this greater chance, but there is no proof for a causal relationship.
There is also no proof for a causal relationship between exposure to radiofrequency electromagnetic field from cell phones and occurrence of cancer in the head such as glioma. There is ongoing research on possible non-specific health effects such as fatigue, loss of concentration, sleep disturbance, headache and 'electrohypersensitivity'. However, a causal relationship with EMF exposure has not been established.
Several studies with appropriate methodologies reflect the capacity of electromagnetic radiations to cause adverse health effects and there are several credible mechanisms that can account for the observed effects.
Hence, appropriate exposure assessment is crucial for identification of dose-response relation if any, and the elucidation of biological interaction mechanism. For the time being, the public should follow the precautionary principle and limit their exposure as much as possible.
In the next period, there will be a research, which with the help of the management team of the Hospital „Plodnost“ in Bitola, will be done with the consent of the patients. The research will aim to examine the link between electromagnetic waves and infertility.
Keywords: Electromagnetic fields, research, exposure, effects

1. INTRODUCTION

The electromagnetic field affects a person with a certain electromagnetic radiation, which can be freely said to be a certain electro smog, or electromagnetic pollution, with which we are constantly surrounded. Electromagnetic pollution is actually any amount of radiation that is larger than natural and is almost everywhere around us. Part of it is due to radiation from the Sun and the Earth, yet most of it comes from man-made sources.
Hence, the question arises for continuous analysis and research of electromagnetic effects on humans, and through this paper will be given another scientific component in how to deal with the consequences on human health from this phenomenon. Appropriate knowledge from analyzes already performed in several countries and possible given parameters will be used.
One of the most important elements that should give a realistic picture of the impact of electromagnetic fields on people, is the correct assessment of their exposure, which is actually a big problem, because during a day, the exposure is individual for each person, depending on the environment in which he lives and works. Therefore, certain knowledge about the biological effects of non-ionizing radiation from different sources will be presented, and appropriate knowledge from analyzes already performed in several countries and possible given parameters will be used.
In the practical part of this paper, the determination of magnetic fields in the vicinity of the distribution transformer ETN630 kVA by the finite element method FEM 4.2 is shown. at nominal load, and then field measurement was performed.
In the next period, there will be a research, which with the help of the management team of the "Plodnost" Hospital, will be done with the consent of the patients. The research will aim to examine the link between electromagnetic waves and infertility.

2. MUTUAL CONNECTION OF ELECTROMAGNETIC FIELDS AND PEOPLE

Man in everyday life is exposed to different types of electromagnetic fields. So far, scientists do not have a single opinion on how much a person's daily exposure to the use of electronic devices, mobile phones, computers, the external influence of power lines, transformers, etc., affect human health. However, their conclusion is that the influences must not be ignored.

For frequencies below the 300Hz band, low-frequency (LF) electromagnetic fields are generated. In living beings, including humans, tissues have electrical properties, so that LF fields have a long wavelength and a small depth of penetration into them. Thus, at low frequencies, the electric and magnetic fields can be viewed separately, while at high frequencies the electromagnetic field is unique.

The difference between electrical and magnetic components in a low-frequency electromagnetic field is that the magnetic components do not induce a surface charge. They pass through the body and hardly weaken at all, because the magnetic permeability of the body and the air are almost identical. The difference between the actions of the electric and magnetic field at low frequencies in the human body is shown in Figures 1 and 2. From this we can conclude that the measurement of the magnetic field in living organisms is relatively simple, as to the measurement of the electric field.

Figure 1. Electric field lines in humans

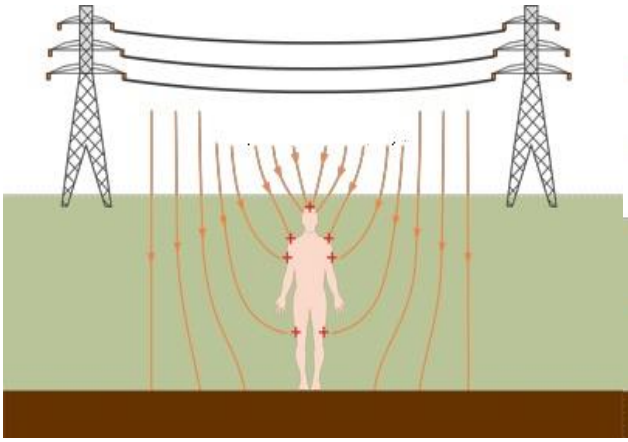
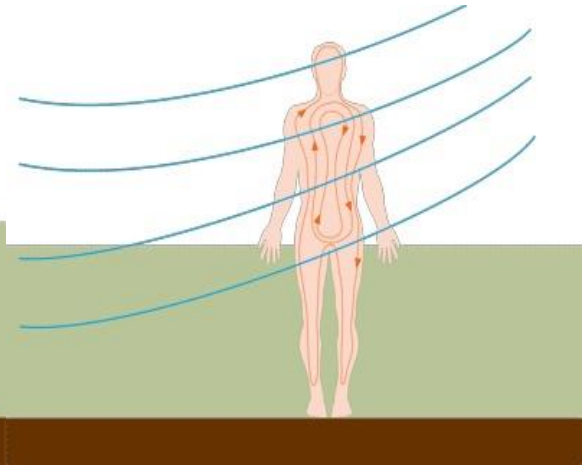


Figure 2. Lines of a magnetic field in humans



3. EXPOSURE ASSESSMENT

Exposure to electromagnetic waves greatly depends on where people move, where they live and what they do. It is therefore not easy to determine the strength of the fields to which a person is exposed. However, according to certain indicators during which people spend in an activity or a certain micro-environment, it can be concluded that the greatest exposure to magnetic fields at low frequency (at a frequency of 50 Hz) occurs near overhead power lines and in close to equipment that has its own motor, such as razors and chargers for laptops or mobile phones. The National Institute of Public Health and the Environment of the Netherlands announced that after the tests performed on 96 volunteers, daily activities with the highest exposure to sources of low-frequency magnetic fields are sleeping, ironing clothes and cooking with electrical appliances. Electric alarm clocks and chargers for mobile phones have the greatest contribution during sleep. The individual average daily dose of exposure ranged from 0.013 μT to 2.03 □□, and according to this, the arithmetic mean exposure of the volunteers was 0.132 □□. These measures can be significantly used in order to ensure the lowest possible exposure, within the production of a single device.

In some studies, children living near power lines are thought to be more likely to develop leukemia. People living or working near transformers are also thought to be exposed to greater magnetic influences.

The exposure, due to the density of the magnetic flux, depends on the instantaneous current, so it is possible for magnetic fields up to 40 μT to occur incidentally, under the transmission line or near a transformer, but usually the value is lower. It is important to note that such exposure levels occur directly below the power lines, or in the immediate vicinity of a transformer, and the exposure decreases with distance from them.

Issues involving the long-term effects of electromagnetic fields on human organisms are most commonly associated with cancerous diseases. The International Agency for Research on Cancer (IARC), which is part of the World Health Organization (WHO), has classified low-frequency magnetic fields (IARC 2002) and RF radiation (IARC 2011, 2013) in the so-called "Group 2B", or possible carcinogens for humans. This classification means that the number of tests to date on human health impacts are still small to reach reliable conclusions, which means that further research is needed. Table 3 lists the most important biological effects of non-ionizing radiation from various sources.

Table 3 Biological effects of non-ionizing radiation from various sources

	Source	Wavelength	Frequency	Biological effects
UVA	Solar radiation	318 nm - 400 nm	750 THz - 950 THz	Eye-photochemical cataract Skin-erythema, pigmentation
Visible light	Lasers, Sunlight, Fire, LED bulbs	400 nm - 780 nm	385 THz - 750 THz	Skin-aging Eco-photochemical and thermal injuries to the retina
IR-A	Lasers, remote controls	780 nm - 1.4 μm	215 THz - 385 THz	Eye - thermal injury to the retina, thermal cataract Skin burns
IR-B	Lasers, telecommunications	1.4 μm - 3 μm	100 THz - 215 THz	Eye - corneal burns, cataract, Skin burns
IR-C	Lasers, far infrared	3 μm - 1 mm	300 GHz - 100 THz	Eye - corneal burns, cataract, Heating the surface of the body
Microwave	PCS Phones, Cell Phones, Microwave Oven, Cordless Phones, Motion Detectors, Radar, Wi-Fi	1 mm - 33 cm	1 GHz - 300 GHz	Warming up of tissue
Radiofrequency radiation	Cell Phones, TV, FM, AM, Short Waves, Cordless Phones	33 cm - 3 km	100 kHz - 1 GHz	Warming up of tissue, increased body temperature
Low frequency RF	Transmission lines	> 3 km	< 100 kHz	Collecting a charge on the surface of the skin, Disorders in the nervous and muscular systems
Static fields	Strong magnets	infinite	0 Hz	Magnetic - dizzy vomiting Electric charge on the surface of the body

4. PRACTICAL MEASUREMENT OF MAGNETIC FIELDS NEAR THE TRANSFORMER

Power distribution transformers are the most widely used in the distribution network of power systems. Therefore, it is especially important to make different types of analyzes that would improve the basic characteristics, and thus reduce their harmful impact on the immediate environment and people.

To check the value of the magnetic induction B and the value of the magnetic field strength H in the vicinity of the distribution transformer ETN630 kVA, the measuring device 3D EMF TESTER was used. The measurement was performed at several measuring points on two sides of the transformer, one of which is high voltage, and the measurement results are shown in Table 4. We should have in mind that the field measurements were performed without knowing exactly the sheet metal thickness and internal parameters of the transformer.

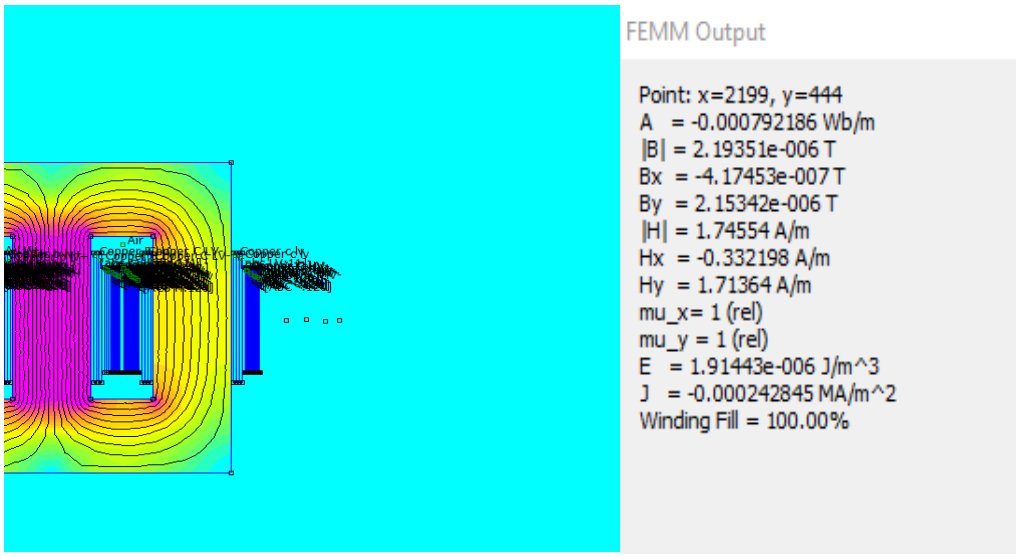
Table 4. Results from external measurements

Measure points	Bx (μT)	By (μT)	Bz (μT)	|B| (μT)
Side 1 (highvoltage) On the door	0,75	0.12	0,28	0,799
20 cm from the door	0,31	0,05	0,24	0,395
40 cm from the door	0,80	0,08	0,10	0.810
Side 2	0.95	2,8	0,65	3,023
10 cm from the door	0,66	1,70	0,62	1,926
20 cm from the door	0,54	1,23	0,4	1,402
30 cm from the door	0,31	1,01	0,27	1,09

Previously, with the software package FEM 4.2, an analysis was made with the given characteristics of this transformer, in order to determine whether the values of magnetic induction obtained by analysis with this tool, match the field measurements.

Comparing the values obtained through the analysis made with the software package FEM 4.2 and the results of the measurements, it can be concluded that they do not deviate greatly. Due to the volume of the analysis, which is in my master thesis "Mutual impact of electromagnetic fields and people, simulation of electromagnetic fields and practical measurements", the condition of about 10 cm from the transformer door, or the distance required to is analyzed, in the case of an approach by a human or other living being, and thus the impact on it, is shown.

Figure 5. Values obtained by analysis with the software package FEM 4.2



5. CONCLUSION

Practical transformer analysis with FEM 4.2. offers the possibility of testing the magnetic impact and radiation near a particular transformer. Future measurements can help improve the characteristics of power transformers in order to reduce radiation near the transformer. This is especially important because transformers are located near many residential buildings and kindergartens, although the current performance of their construction is significantly better. The analyzes given by relevant world institutions in this paper should provide additional stimulation for greater scientific research in this area and in our country. It should be kept in mind that according to EU recommendations, a person should not be exposed to magnetic induction greater than 100 μT. But on the other hand, this figure does not take into account long-term exposure, so in Sweden, after many years of research, the maximum limit is 0.2 μT. Such recommendations and measurements should provide insight into further possible changes in the legislation in the Republic of Northern Macedonia, so that instead of recommendations intended only for employees exposed to this type of fields, they would contain an appropriate legal form for all citizens.

In this regard, in the next period, there will be research, which with the help of the management team of the Hospital "Plodnost", will be done with the consent of patients. The research will aim to examine the conection between the impact of electromagnetic fields and infertility.

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