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ELECTROMAGNETIC RADIATION FROM 400 KV TRANSMISSION LINE BITOLA 2 – MELITI

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ABSTRACT

The main parts of the Macedonian transmission network are 400 kV transmission lines. They form the 400 kV ring consisting of three transmission lines that connect the largest energy consumption located in the northern part, with the largest production capacities located in the southwestern region. The electromagnetic field affects humans with a certain electromagnetic radiation, which we can freely say is a certain electro smog, i.e. electromagnetic pollution, with which we are constantly surrounded. What will be the biological response of the human organism exposed to electromagnetic waves, is conditioned by the energy that they carry with them and transfer to the cells, i.e. the human body. Field measurements were performed, using the 3D EMF TESTER instrument and results were obtained and analyzed.

Keywords: electromagnetic field, electromagnetic radiation, 400kV transmission lines, measuring instrument, impact on health

INTRODUCTION

In today's modern living and working, man has reached a high level of technological development with the invention of machines and devices that have made his life easier. Radiation exposure also comes from man-made sources, ranging from nuclear energy production to the medical use of radiation for diagnosis or treatment. Today, the most common sources of ionizing radiation are medical devices, including X-ray machines and computed tomography scanners. Great interest in radiation research has existed for a long time. At that time, the emphasis was placed only on the impact of natural radiation. Many countries and several international organizations have adopted guidelines or standards for exposure to electromagnetic fields (EMF) in professional environments and for exposure to the general (non-professional) population. Such guidelines and standards are based on an evaluation of the established scientific literature, including an evaluation of the consistency of the findings that have been reported. In order to preserve our health and protect the environment on which our survival directly depends, man should work on the development of technology by prioritizing the reduction of harmful impacts [1],[2].

1. Electromagnetic field

Electromagnetic fields are a combination of invisible electric and magnetic fields. These fields are generated by natural phenomena such as the Earth's magnetic field, but also by human activities, where the use of electricity is the most common. Most artificial electromagnetic fields change their direction at regular intervals, ranging from extremely low frequencies (power lines), through medium frequencies (computer screens) to high radio frequencies (mobile phones). The term static describes fields that do not change over time (i.e. with a frequency of 0 Hz). Static magnetic fields are generated by devices that use direct current and are used in medical imaging. In physics, electromagnetism is presented as the interaction that occurs between electrically charged particles through electromagnetic fields. The electromagnetic force is one of the four fundamental forces of nature and is the dominant force in the interactions of atoms and molecules. Electromagnetism can be considered a combination of electrostatics and magnetism, which are closely intertwined phenomena, but are distinct. Electromagnetic forces occur between any two charged particles. The electromagnetic force is responsible for many physical and chemical phenomena that can be encountered in everyday life [3].

2. Electromagnetic radiation

There has been a great interest in the study of radiation for a long time. At first time, the emphasis was placed only on the influence of natural radiation. Electromagnetic radiation is a change in the electromagnetic field as a function of time [4]. This radiation is a carrier of electromagnetic interaction (force) and can be interpreted as a wave or as a particle, depending on the case. The particles that quantize electromagnetic radiation are photons. Any charge generates an electromagnetic field by changing its speed of motion. This information spreads through space at the speed of light and the properties of the corresponding electromagnetic wave are directly related to the dynamics of the change in the motion of the charge. Alternatively, if we view electromagnetic radiation as the emission of particles (photons), the energy they carry is directly related to the wavelength, or frequency, of the wave. The higher the frequency, the higher the energy of the photon.

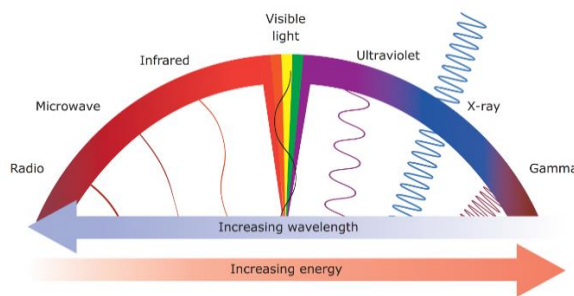


Figure 1: Types of radiation in the electromagnetic spectrum

The properties of electromagnetic radiation depend on its wavelength and as such are divided into electric, radio and microwave waves, then infrared, visible and ultraviolet light, X-rays and gamma rays. The entire range of wavelengths of electromagnetic radiation is called the electromagnetic spectrum.

The effect of these waves on people varies depending on the frequency and amplitude of the signal, as well as the distance from the transmitter (base station) and the duration of exposure to these waves.

3. 400 kV transmission lines

The main parts of the Macedonian transmission network are the 400 kV transmission lines. In addition, 400 kV transmission lines are used for interconnection between neighboring transmission systems. The 110 kV transmission network is the most widespread and developed. It connects large hydroelectric and thermal power plants, all major settlements, as well as industrial centers. The connection between the 400 kV and 110 kV transmission networks is realized through five substations: TS Skopje 4, TS Skopje 5, TS Bitola 2, TS Dubrovo and TS Shtip.

The Macedonian transmission system is best connected to Greece. The interconnection is established with two 400 kV interconnecting transmission lines: TS Bitola 2 - TS Lerin (Lerin) and TS Dubrovo - TS Thessaloniki (Thessaloniki).

The benefits of these interconnections are reflected in revenues such as reduced electricity losses, increased cross-border transmission capacity and increased transits between regional systems and equalization of the difference in electricity prices in the region. In addition to the above-mentioned general benefits, there are other positive impacts that contribute to social values, such as increased reliability of supply, reduced investments in electricity generation capacities for national system reserves, reduced production costs [3], [4].

4. Impact of electromagnetic radiation on human health

The biological response of the human organism exposed to electromagnetic waves is determined by the energy they carry with them and transfer to the cells, i.e. the human body. The authors who deal with this topic have identified three scientific models with which they explain this biological response, which are: direct energy transfer, increase in the half-life of free radicals and the force of the released/moved molecules or ions from the affected biological tissues. In direct transfer, the application, i.e. the transferred energy carried by the electromagnetic wave, depending on the strength of the energy, generates a cellular signal that causes the appearance of an unwanted (side) effect. If this side effect completely disappears, a reversible effect occurs. If the human organism happens to adapt to this stimulus, this condition is called adaptation. The appearance of negative health effects and disease will occur if the adaptation and compensatory capacities of the biological structures of the human organism are exceeded.

There are different types of effects caused by exposure to electromagnetic fields. They are conditioned by the time of exposure and their physical characteristics. For example, non-thermal effects are caused by stimulation of sensory organs, muscles and nerves. Others cause thermal effects due to heating of the body or certain parts of it. Both thermal and non-thermal effects are also called direct effects because their occurrence depends on the exposure threshold. If this limit value is not exceeded, then no harmful effects will occur, but indirect effects because exposure to electromagnetic waves does not show a cumulative effect. Indirect effects refer to:

- electric shock and burns when contacting conductive objects (live wires);
- interference with wearable medical devices such as insulin pumps;
- effects of foreign bodies present in the body, tattoos, piercings, etc.;
- interference with active and passive implanted medical devices in the human body (pacemakers, defibrillators, artificial joints, metal parts of the body);
- interference with medical electronic devices [5].

The biological response of the human body to exposure to a static and/or oscillating magnetic field depends on the ability of biological tissues to behave as conductors and on the potential of the gradient field to cause an electric current (current). The human body has several

conductors, namely blood and muscle and nerve fibers. Blood is a liquid and here the static magnetic field can cause a flow because it appears as a conductor moving in a static magnetic field. This phenomenon is especially pronounced when the blood passes through the heart muscle. The appearance of a current flow in this case can cause a change in the elevation of the S-T segment, which is accordingly registered in the electrocardiographic image. These changes are completely reversible and are not associated with serious and persistent biological effects. Particular caution should be exercised when it comes to exposure in people with impaired cardiac function because the elevation of the S-T segment can be an indicative sign of heart attack, ischemia or electrolyte imbalance [6], [7].

Numerous studies indicate three groups of possible adverse effects on the cardiovascular system based on modeling and calculations of possible exposure to static magnetic fields, which are the following:

- changes in heart rate;
- induction of ectopic heartbeats; and
- increased likelihood of arrhythmia occurrence or recurrence.

The magnetic fields that generate the extremely low frequency waves create an intracorporeal electric field. This field, compared to the laws of induction, itself increases with increasing frequency and cross-section. The strength of the induced electric field increases from zero value in the center of the body to a maximum value on its surface. Depending on whether the motor or sensory nerve fibers are stimulated, muscle contractions and a feeling of itching and tingling occur, which occur as a result of exposure to an oscillating magnetic field that manifests itself in peripheral nerve and muscle stimulation. In a situation where the stimulation of the heart muscle is disturbed, it is theoretically possible to cause a frequency disorder, arrhythmia and ventricular fibrillation, phenomena that pose a direct threat to human life [8].

5. Measurements of electromagnetic radiation performed near the 400 kV transmission line Bitola 2 – Meliti

For the purposes of my work, I performed measurements of electromagnetic radiation at steel lattice poles of a 400 kV transmission line near TPP Bitola. I performed the measurements using the measuring device 3D EMF TESTER, Model:EMF-828. The EMF tester is an economical, portable hand-held instrument designed and calibrated to measure electromagnetic field radiation over a wide range from 30 Hz to 300 Hz [13]. This measuring instrument is intended to check the value of the magnetic induction B and the value of the magnetic field strength H[8], [9],[10].

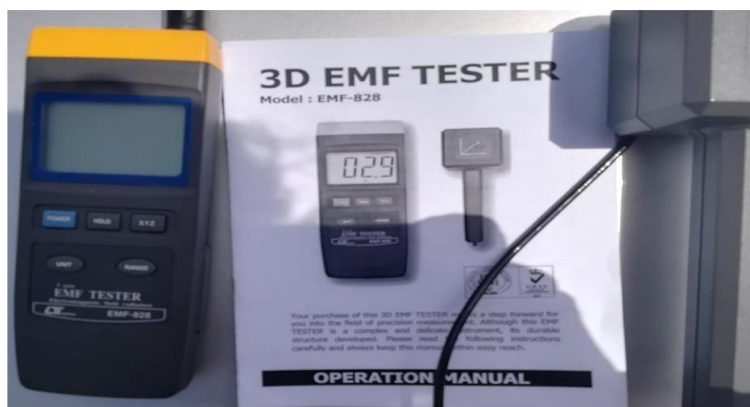


Figure2: 3D EMF TESTER, Model:EMF-828

I performed the measurements at 1 m, 5 m and 10 m horizontal distance from the pole, between the two steel lattice poles of the transmission line itself. The distances at which the

measurements were performed are at 0.6 m, 1.5 m and 2.3 m above the ground (the person) where the measurement was performed. I performed the measurements at 08:05 h. The value of the currents through the transmission line during the measurement at that moment by phases (obtained from the Bitola 2 substation at REK Bitola) are: $I_1=411A$, $I_2 = 440A$ and $I_3 = 424A$. The average value of the current was taken: $I_a = 426 A$

The following table presents the horizontal distance of 1 m from the steel grid pole of a 400kV transmission line:

Table 1: Horizontal distance 1 m from the pole

	0.6 m	1.5 m	2.3 m
$B_x (\mu T)$	0.30	0.53	0.46
$B_y (\mu T)$	1.65	1.71	1.94
$B_z (\mu T)$	0.33	0.68	0.13
$B (\mu T)$	1.71	1.92	1.99

The following table shows a horizontal distance of 5 m from the pole:

Table 2: Horizontal distance 5 m from the pole

	0.6 m	1.5 m	2.3 m
$B_x (\mu T)$	0.32	0.79	0.56
$B_y (\mu T)$	1.97	1.65	1.73
$B_z (\mu T)$	0.26	0.52	0.07
$B (\mu T)$	2.01	1.90	1.82

The following table shows a horizontal distance of 10 m from the pole:

Table 3: Horizontal distance 10 m from the pole

	0.6 m	1.5 m	2.3 m
$B_x (\mu T)$	0.45	0.74	0.69
$B_y (\mu T)$	1.65	1.64	1.66
$B_z (\mu T)$	0.03	0.72	0.17
$B (\mu T)$	1.71	1.94	1.81

The appearance of the 400 kV transmission line pole is shown in the following figure:

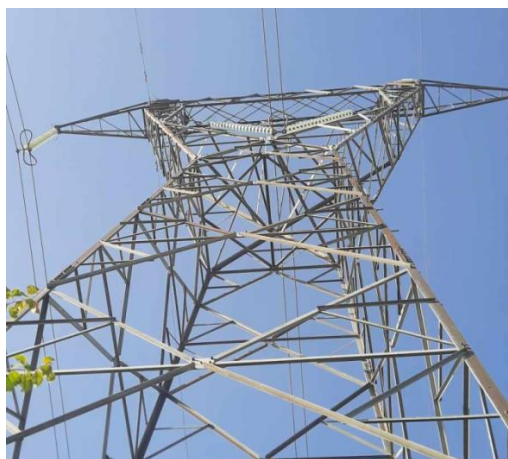


Figure 3: 400 kV transmission line pole where the measurement was performed

CONCLUSION

For the purposes of my work, a study of electromagnetic radiation from a 400 kV transmission line was conducted, in order to assess the risk to human health. The measurements were performed with a 3D EMF TESTER device in the field of electromagnetic radiation sources, near REK Bitola.

According to the measurement of the pole shown in the picture, at a horizontal distance of 1 m from the pole and a height of 0.6 m from the ground, along the coordinates X, Y and Z, the total measured value is 1.71 μT . At a height of 1.5 m from the ground, the total measured value is 1.92 μT . At a height of 2.3 m from the ground, the total measured value is 1.99 μT . At a horizontal distance of 5 m from the pole and a height of 0.6 m from the ground, the total measured value is 2.01 μT . At a height of 1.5 m from the ground, the total measured value is 1.90 μT . At a height of 2.3 m from the ground, the total measured value is 1.82 μT . At a horizontal distance of 10 m from the pole and at a height of 0.6 m from the ground, the total measured value is 1.71 μT . At a height of 1.5 m from the ground, the total measured value is 1.94 μT . At a height of 2.3 meters from the ground, the total measured value is 1.81 μT .

The life that we all live in this modern century, we could not imagine without the use of electricity. A reasonable attitude of each of us would be that when assessing the risk, there would be neither overestimation nor underestimation of the possible consequences of the impact of EM radiations. It ultimately comes down to assessing whether the harm is greater than the benefit. To solve the problem, we must not think of moving backwards and giving up on the progress we have made. Also, we must not "rush" forward and cause uncontrolled progress in technique and technology, to the detriment of human health. We should seek the solution in the controlled use of devices that generate these radiations. I would like to emphasize again that this problem has been considered by various national and international institutions, but to this day, none of them has concluded that adverse effects on the health of people who are normally exposed in everyday life have been established with certainty.

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