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THE RADIATION OF ELECTROMAGNETIC FIELDS OF VERY LOW FREQUENCY

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ABSTRACT

This paper analyzes the impact of very low frequency electromagnetic fields to human environment. Humans exposure to the electric and magnetic fields at very low frequency VLF (Very Low Frequency), primarily is related to the working environment, electrical grid as well us to various electrical energy application. Different sources of VLF fields are found in environment, houses and the workplace. These sources can be divided into two groups: DC (Direct Current) and AC (Alternating Current).

Key words: *Electromagnetic Radiation, Very low frequency, Biological effects.*

INTRODUCTION

The human environment comprises various sources of non-ionizing radiation. These consider: power lines, cable and satellite communications, power stations, electric transportation vehicles (electric trains, trams and trolleybuses), TV, radio repeaters, etc.. As a result there is an interaction between the electromagnetic fields and biological tissue. The effects of these fields can be harmful to humans if the field strength exceeds certain threshold values which are defined by the corresponding regulations and defined based on harmful effects. In order to analyze the biological effects of electromagnetic radiation and to make assess of the associated hazards in a particular situation, it is necessary to know strength of the field in frequency domain. The same has to be compared with the corresponding allowed value. The field strength values can be reached by applying analytical calculations, numerical methods, or by using the appropriate measurement equipment. Despite the fact that the non-ionizing electromagnetic phenomena have been well studied, interactions between electromagnetic fields and organic matter, and especially human body, are still not fully clarified.

SOURCES UNIDIRECTIONAL ELECTRIC AND MAGNETIC FIELDS

Electric fields caused by direct current (DC) are known as static fields, because they do not change over time. Their frequency is equal to zero and the wavelength of the atom. In this case, the circuit transmits all the energy and does not radiate at all. Therefore, we have only field. Since the field is static, there is no excitation of surrounding molecules and there is no heating. The electromagnetic field produced by direct current can cause a burning sensation when standing close to the source or high voltage source straightened hair. As an example we will present the natural and man-up one-way source of electromagnetic fields.

Magnetosphere

The Earth produces an electromagnetic field, which is almost static. This field makes the Earth with its magnetism, Solar activity and atmospheric discharges in the form of electrical and lightning storm. Earth's static electric field depends on the conditions in the atmosphere. During the calm and clear weather conditions, the field has a strength of about 150-300 V / m, but during an electrical storm may reach a value over 10.000V/m.

Intensity of the magnetic field ranges from 30μT to 70 μT depending on latitude and composition of the Earth's crust (magnetically conductive ore or local mountains). The volume density of the Earth's magnetic field at latitude of 50° is 58 μT, and on the equator (0 ° latitude) is 31 μT. The average volume density of Earth's magnetic field is 45 μT.

It is interesting to note that human movements within the Earth's magnetic field caused by induced electric field inside its body. For example, a quick run around 8 m / s creates an internal electric field of 400 μV / m. Such strength of the electric field can induce a low frequency magnetic field magnetic flux density of 20μT.

Magnetic field lines extending between the north and south poles as well as between the permanent magnet poles. At the north pole of the Earth, the lines of magnetic induction are directed toward Earth, the Earth's south pole directed away from Earth. Charged particles are trapped by this field, forming magnetosphere, which is part of the near-Earth space, just above the ionosphere. Earth's magnetosphere is a dynamic plasma floating belt-driven magnetic field, which sometimes comes into contact with the sun's magnetic field magnetosphere extends into space from the Earth approximately 80 to 60.000 km on the side toward the Sun to 300.000 km on the side facing away from the Sun.

The force pushes the magnetosphere solar wind, clutching the side toward the Sun and dragging on the night side of the long tail. This effect is called magnetic tail, which extends thousands of kilometres into space. Solar activity causing geomagnetic induced current that can flow in and out of the mains through various earthing points. The frequency of the current is very small (below 1 Hz) and can be placed in almost direct current. These currents measured in North America amounted to 184 A, while in Finland the measured value is 200 A.

Magnetic Resonance Imaging

Magnetic Resonance Imaging has become an important diagnostic tool for getting good insight into the human body. Stationary magnetic field creates a device called a MRS (Magnetic Resonance Scanner). Any system of magnetic resonance is composed of three main components that are necessary to obtain diagnostic images of soft parts of the human body. These three components been developed and perfected over the last 25 years that have passed since receipt of the first image, the soft parts of the human body magnetic resonance diagnostic method.

Three main components of the MRS system:

- Magnet that produces a homogeneous static magnetic field,
- Radio frequency transmitter and receiver and
- Gradient (magnetic) system in the X, Y and Z axes.

The physical principle of MRS consists of the following: the human body is exposed to a constant magnetic field of high-power (0.2 - 4 Tesla). On these circumstances, there is a reorientation of protons so that their magnetic axes placed parallel magnetic lines of outer magnetic field. Over gradient (additional powerful electromagnet) defines the cross-section image projection that is desired, whether it be coronary, sagittal or lateral. Certainly, the stronger gradients and higher scanning speed and resolution Get protected images. Intensity gradients are limited due to the negative impact on the patient's neural system stimulation. Gradient system for measuring 100 mT / m is set to 1 meter long tunnel and a field strength of 1.5 T in the center. the difference from the beginning to the end of the tunnel ranges from 1.45 T to 1.55 T. RF system for MRS, consisting of part of the emission and reception parts. Today the real RF transmitters are of the power of 35 KW with electronic tubes or less power - about 15KW with semiconductor devices. RF transmitter coil is fastened around the tunnel magnet and it can be linearly or circularly polarized. This coil is transmitting and receiving at the same time.

Outside broadcasting of radio frequency waves (frequency 21 MHz - 128 MHz) leads to disruption of basic positions and creation of magnetic lines of force lines of magnetic another direction. The frequency of this process depends on the strength of a homogeneous magnetic field, thus giving the larger magnetic field and frequency higher than frequency of the RF waves.

Cessation of broadcasting radio frequency waves at the outer side a gradual reduction of the magnetic lines of force that can be registered and the time to return to the ground level is measured. These signals are recorded, evaluated by different software and finally presented as figures. It is that MRS examinations devices have harmful effects on human health. However, it should be noted that due to the use of radio-frequency pulses very high power (12.000-15.000 W), each section of footage, human body temperature increases by 03 ° C.

A static magnetic field of the use does not cause any visible effects, especially the strength of the magnetic induction of 1.5 T. The magnetic field of 4 T may cause dizziness, light effects when moving the eyes and a metallic taste in the mouth. Magnetic resonance can be recognized only by patients who have a pacemaker installed it (on purpose) or acquired (incident) ferromagnetic foreign bodies in the body.

SOURCES TIME VARYING ELECTRIC AND MAGNETIC FIELDS

Time-varying electromagnetic fields generated by time varying AC (Alternating Current) electricity during transmission, distribution and use of electricity. The main sources of time varying electric fields in the work area are electric cables. The strength of these fields is in the range from 1 to 100 V/m. Flow of electrical current through a conductor produces a magnetic field. These fields always form a closed loop around the conductor which caused them. As the basic unit of magnetic flux density Tesla [T] is very large, it is the practice of using smaller units: microtesla [μT] and nanotesla [nT]. Under normal conditions in the workplace time-varying magnetic fields caused by electric grid ranging from 10 nT to 1 mT.

Frequency of a VLF field depends on the field sources. Although the dominant frequency of 50 Hz and 60, people are generally exposed to a mixture of frequencies, some of which may be much larger. For example, the frequency of certain parts of electronic equipment or TV monitor can go up to 120 kHz. In addition, during turning may occur sudden peak in the waveforms of current and voltage, leading to a high-frequency transient conditions that can cause the radiation frequency of a few MHz. Also, the non-linear characteristics of electrical devices can cause the creation of significant harmonics at frequencies of a few kHz. Electric and magnetic fields are components of the EM field. Electric fields are generated in apparatus involved in network installation, ah, these devices do not have to be in operation.

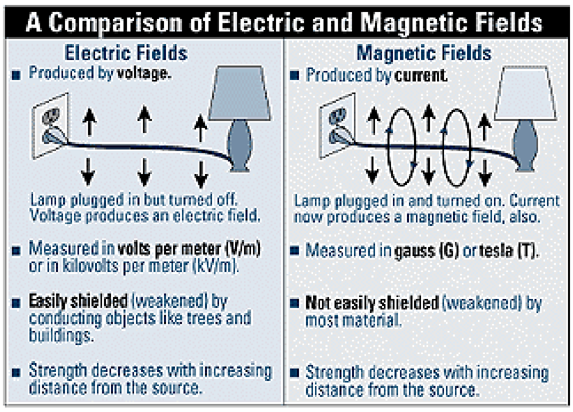

Figure 1. The characteristics of the electric and magnetic fields

The Figure 1 shows an example of a table lamp. Although table lamp is not in function i.e. switched off, the outlet along the power cable the electric field exists.

This example applies to all other electrical devices that are put into operation with a switch on the device. One can be protected against these electric fields by physical disconnection of the device from the network (removing the plug from the socket), installation of special switches on the enclosure to which certain power circuits may occasionally turn off (for example circuits bedrooms). For protection against electrical fields of this type there are various readily available and inexpensive materials.

Putting into operation the device (Fig. 1-b) the current will produces the magnetic field. The magnetic field passes through the Earth, people, and most of the material. They were severely restricted. VLF magnetic field strength decreases with distance from the source. For example, a conductor for the magnetic field strength is inversely proportional to the distance from the source code of the source. Which consists of multiple conductors strength of the magnetic field decreases with the square of the distance.

Magnetic field strength decreases with distance from the roots third source, which is in the form of coil windings. These relationships are important when it is necessary to reduce the strength of the magnetic field.

ELECTROMAGNETIC FIELDS AT VERY LOW FREQUENCIES IN OUR ENVIRONMENT

Given that the above sources of device components in our environment, we'll just consider these devices as sources of electromagnetic fields of very low frequency VLF. In this sense, we are exposed to VLF magnetic and electric fields originating from many sources: the transmission lines connecting power plants and households through distribution lines and cables that distribute energy into our homes, schools and workplaces, substations, transformers, installation of our homes and buildings, and various other electronic devices.

Electric power system

An electric power system is a network of electrical components used to supply, transmit and use electric power. An example of an electric power system is the network that supplies a region's homes and industry with power - for sizable regions, this power system is known as the grid and can be broadly divided into the generators that supply the power, the transmission system that carries the power from the generating centres to the load centres and the distribution system that feeds the power to nearby homes and industries. Smaller power systems are also found in industry, hospitals, commercial buildings and homes. The majority of these systems rely upon three-phase AC power - the standard for large-scale power transmission and distribution across the modern world. Specialised power systems that do not always rely upon three-phase AC power are found in aircraft, electric rail systems, ocean liners and automobiles.

Electric power is the mathematical product of two quantities: current and voltage. These two quantities can vary with respect to time (AC power) or can be kept at constant levels (DC power).

Most refrigerators, air conditioners, pumps and industrial machinery use AC power whereas most computers and digital equipment use DC power (the digital devices you plug into the mains typically have an internal or external power adapter to convert from AC to DC power). AC power has the advantage of being easy to transform between voltage levels and is able to be generated and utilised by brushless machinery. DC power remains the only practical choice in digital systems and can be more economical to transmit over long distances at very high voltages .

The ability to easily transform the voltage of AC power is important for two reasons: Firstly, power can be transmitted over long distances with less losses at higher voltages levels. So in power systems where power plant is distant from the consumer, it is desirable to step-up (increase) the voltage of power at the generation point and then step-down (decrease) the voltage near the load. Secondly, it is often more economical to install turbines that produce higher voltages than would be used by most appliances, so the ability to easily transform voltages means this mismatch between voltages can be easily managed.

Solid state devices, which are products of the semiconductor revolution, make it possible to transform DC power to different voltages, build brushless DC machines and convert between AC and DC power. Nevertheless devices utilising solid state technology are often more expensive than their traditional counterparts, so AC power remains in widespread use.

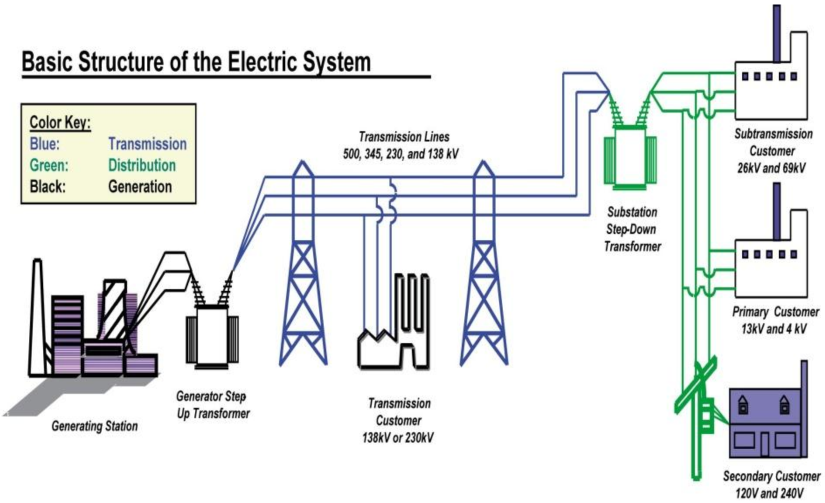

Figure 2. Basic structure of the electric system

If you look at the picture of a typical power system, (Figure 2) you will recognize come to the conclusion that the transmission system (transmission line) is the main source of the electric and magnetic fields, because of the great length of the conductor and the high voltage line. But other elements, such as electrical device in industry and households, electrical installations and distribution part of the system, are very important sources of electromagnetic fields in our environment.

Electrical energy produced in power plants is distributed to consumer areas via high voltage power lines from 35 kV to 400 kV. The voltage is reduced by transformers to 400/230 V for local distribution. The general population is exposed to magnetic fields at the network frequency, 50 Hz in as, via three individual sources: high voltage transmission power lines, the local system for the distribution and low voltage electricity at home and at work, and electrical household appliances. The first two sources create basic, so-called background magnetic radiation, known as the magnetic flux density of the environment.

Overhead power lines

Transmission and distribution lines can be called by one name - power lines. Overhead power lines are the less expensive way to transfer electricity. Usually consist of parallel conductors, which carry most of the energy with very few losses or small radiated energy. Field between the conductors is intense, but it is usually closed between them. The strength of the magnetic field line is determined by the rate of electricity, the proximity of the transmission line, the transmission line height above ground, distance between phases, column geometry and distance from other lines.

Highest levels of electric and magnetic field lines are located in the area where the conductors are closest to the earth, and it is midway between the two pillars. Because of the ambient temperature, the height of the lowest conductor (h2) was flying lower and higher in the winter, because the levels of the fields in the area flying higher and lower in winter (Figure 3).

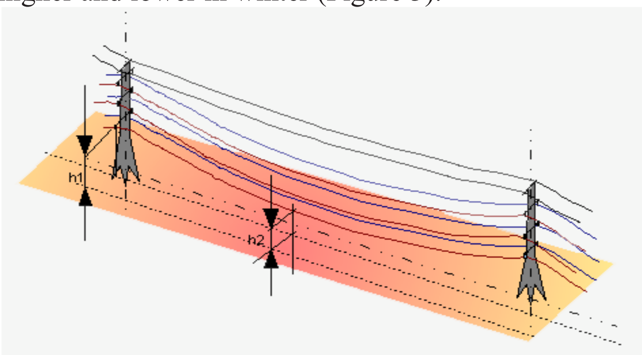

Figure 3. Distribution of the field lines between the columns. Darker red zone with a higher level in the field or in a brighter colour

Lately, most take account of the distribution and geometry of the column conductors to significantly reduced magnetic field.

At any point the field can be determined by superimposing fields of each wire. If, for example. the three-phase line, then the voltages and currents of each phase conductor to move in, and the resultant field vector calculated based on the sum of the fields of each of the conductors. The only point fields are added which produces a relatively high field strength, while the other points may cancel each other. Thus, the field wires can be very complex prostomu distribution. Addition to these normal variations in field strength electric field under the conductor is changing depending on their surroundings. In the picture shown is 4 phenomenon of concentration of the electric field above the person's head beneath the conductors.

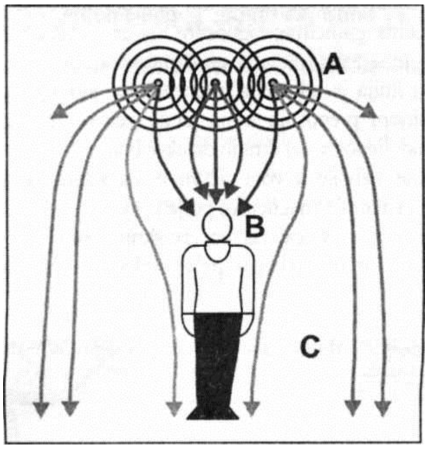

Figure 4. Concentration of the electric field above the person's head beneath the conductors

Because the electric field tends to end up in (or shift to) a grounded object, and because the human body is electrically conductive and near potential electrical field surrounding the Earth is directed toward human head (B). Urinary areas (C) with a weakened electric field strength. All over the world there are vast energy network. That means that almost complete human populations exposed to various fields of power system components. The only difference is in the degree of exposure that varies in the day, days in the week, the season, and depending on the ambient temperature. Most fields are usually located beneath high voltage transmission lines, however, the field strength depends on the strength of the current.

Transformer stations

Transformer stations (Fig.5) are one of the most important parts of the energy system, which is used to change the voltage level, and perform other functions in the transfer of control and flow of electrical energy. There are several ways to build substations in order to achieve a reliable electricity system. In essence, they are complex equipment such as circuit breakers, high voltage switches, grounding, transformers intended course with the changing voltage control. Since the substations are often located near schools and homes, must be considered as sources close to the electric and magnetic fields.

Figure 5. Transformer station

Transformers are sources of strong magnetic fields because their principle of operation is based on a time-varying magnetic fields. The problem of the magnetic field near cells is more complex, since the current entering or leaving the station, in the general case are not symmetric. Field produced by equipment weaks with distance and do not spread outside the physical boundaries stations. However, the magnetic field near the station is stronger than in other parts. Approximate values that can be found near the fence transformer cells depends on the level of voltage: 10 μT for 275-400 kV cells and 1.6 μT station for 11 kV.

Transformer as standalone devices found in rural areas (Column transformers), and in urban areas, mostly inside residential buildings. Transformers in buildings adversely affect the people in the apartments above them. These transformers, create an extremely strong electric and magnetic fields. Unfortunately, to enable lower expenses of their installation, they are frequently installed in the buildings. That is not in line with technical recommendation which allowed that kind of installation in exceptional cases, only. This radiation is stronger than transmission radiation.

Electromagnetic fields in the apartments directly above the transformers were even a hundred times stronger then allowed through regulations. This radiation, which half a meter from the floor becomes harmless, dangerous for pregnant women and children and is a common cause of "unexplained" leukaemia. Such transformers reduce the voltage to 380/220 V, that is used in home installations. VLF fields in the vicinity of the transformer can be strong, based on small dimensions off the coil through which the current passes. Values measured at the street, directly below the pole-mounted transformers are not much higher than those measured under overhead power lines.

Electrical installations

Average value of the magnetic fields in homes which are away from power lines and transformer stations is small. The mean value of the magnetic fields in the houses in major cities is around 0.1 μT. Values in the smaller towns and villages are of half of noted value. In cities, about 10% of homes have at least one room where a field value exceeds 0.2 μT. If a house is near power lines and substations strength magnetic fields are even greater. It was found that 0.5% of houses have values of magnetic fields in excess of 0.2 µT. For commercial buildings, transformers and distribution boxes are placed in separate rooms in the buildings. Field values in areas around such premises or buildings have a value from 1 µT to 10 mT.

Vehicles on electric power

Electric trams and trains (Figure 6) are also sources of static and VLF fields. For traction they somewhere use direct current somewhere alternating current. Near the coaches floor the static magnetic fields can reach 0.2 mT, and time-varying magnetic fields can reach several hundred µT. At the headquarters of passengers, electric fields can reach up to 300 V / m and magnetic field reaches values of a few tens µT.

Values are highly dependent on the level of design and location of electrical equipment and machinery within the train composition. Traction motors and equipment are often placed under the floors in the coach. They create a ver intense fields in the area of the floor below which they are located. Passengers were further exposed to magnetic fields from sources that are close to the tracks.

Figure 6. Radiation Sources in the traffic

Television screens and computer monitors

Monitors or video display terminal are output unit of the computer equipment which is used to display data from the computer. There are two basic types of monitors : monitors cathode CRT (Cathode Ray Tube) and TFT monitors (Thin Film Transistor).

CRT monitors work on the principle of TV technology. The main part of the monitor is cathode ray tube CRT (Cathode Ray Tube). On the back of the picture tube set, there are three electron guns, which emit beams of electrons through a metal mesh or a screen to be placed on the inside of the glass monitor. The screen surface is covered with phosphor strips, which counts them bright red, green, Combination of these colours enable any other colour. By the the coils (vertically and horizontally) the image on the screen is drawn point by point and the horizontal lines from left to right. The lines are drawn respectively from top to bottom, and when all the sails are delineated single image. In cathode ray tubes that are used in standard TV sets, the images are drawn 50 times per second (50 Hz), which is due to the inertia of the human eye is almost impossible to detect. In a monitor draws a picture every 50-85 seconds (50-85 Hz), and the quality as much as 120 times per second (120 Hz), and therefore are characterized by a still picture.

TFT monitors operate by LCD (Liquid Crystal Display) technology. These monitors have cathode ray tubes, liquid crystal, but between two glass plates, two polarizers, colour filters and two layers for alignment. Behind these layers of backlight which usually consists of more fluorescent lamps.

Bringing power to the alignment layer, it generates an electric field that smoothed liquid crystals, which prevents the light to pass through them, while eliminating voltage allows the passage of light. This technology uses an FET (Field Effect Transistor) transistors to control liquid crystal states of molecules. Since the monitor does not have this type of electron gun and bail coils, the radiation is much lower. Consequently, TFT get much more information about any of these harmful radiation monitors.

Classic CRT video display terminal that is still the most widely used, include the following categories: optical radiation (ultraviolet, visible, infrared), radio frequency electromagnetic fields, low-frequency time-varying magnetic fields, low frequency electric field time-variant and electrostatic field.

As a response to growing concern for the effects caused by radiation of very low frequency, the Swedish government has developed a set of standards that should minimize exposure to such radiation while working with video terminals. Norms are named after the initials of the Swedish Institute for measurement and testing (Swedish Boardfor Measurement and Testing), MPR II. Sometime later TCO 92 standards are set which initially reduce harmful radiation by 50 to 70%. These standards deal with frequency oscillator for horizontal and vertical removal of the monitor's cathode rays, as frequency power supply lines. In determining the standards certain measurements of electric and magnetic fields at different points around the monitor were performed.

TCO in 1995. expanded its regulations on environmental protection and became the first global environmental regulation also contains TCO 95 and a much larger set of regulations for the CRT and FPD (Fiat Panel Display) monitors.

The current and most stringent standard for monitors is TCO 99th.

CONCLUSION

The paper discusses the radiation of electromagnetic fields of very low frequency. All natural as well as “man created” sources were analyze. The electromagnetic fields of extremely low frequency in our environment are related to overhead power lines, electrical vehicles, TV and computers**.** Although the electrical and magnetic fields often occur together, the emphasis is on the negative impact of a magnetic field. This is because the magnetic field is difficult to avoid based that it propagates through the buildings and people while electric fields have little ability to penetrate through building them even human skin.

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