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EXAMINATION OF THE METAL PLATE EFFECT AS A COVER FOR ELECTROMAGNETIC FIELD OF MOBILE PHONE

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ABSTRACT
This paper presents the examination of the metal plate effects, as a protection against electromagnetic fields of mobile phones. A mobile phone and metal plate (dimension of 20x20 cm) are modeled in the software tool WIPL-D Pro. The intensity of the electric field in the near field is estimated. The simulation results are obtained for different characteristic positions of mobile phone in various kinds of distances from the metal plate. The analysis is performed at two characteristic frequencies, 900 MHz and 1800 MHz. It is precisely defined how many times, respectively, how many decibels it is necessary to increase the force with which mobile phone radiates, in case when cover in the form of a metal plate exists, so that the field level at the same point is the same where there is no metal plate.
Keywords: radiation, mobile phone, protection

1. INTRODUCTION
Mobile telephony is one of the most popular forms of communication in the modern world. Wireless communication systems operate at several frequencies of the electromagnetic spectrum. In the USA mobile phones work at two main frequencies 850 MHz and 1900 MHz. European mobile phones use GSM frequencies around 900 MHz and 1800 MHz [1].
Mobile phones operate at low amounts of energy; antenna radiates 600 mW for analog mobile phone and about 125mW for digital [2]. The most important recommendations that limit the exposure to electromagnetic fields are ICNIRP recommendations called "Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)", which is accepted all over Europe and CENELEC recommendations called "Human exposure to electromagnetic fields – High frequency".
In addition to the international recommendations made by certain organizations at the international level, there are the appropriate recommendations at the national level brought forth by the state institutions. The upper limit for permissible exposure to the field in Serbia is 28 V / m for frequency 50/60 Hz, while the intensity of the field for all other frequencies is 27.5 V / m [3].
Depending on the radiation energy, radiations are divided into two great classes, ionizing and non-ionizing radiation [4]. Non-ionizing radiation, which also includes the radiation from cell phones and base stations are the electromagnetic radiation of photon energy less than 12.4 eV. These radiations have a lower frequency and a lower amount of energy from ionizing radiation. Non-ionizing radiation is electromagnetic radiation that does not have sufficient energy to cause ionization in living organisms. Source of non-ionizing radiation is a device, installation or facility that emits or may emit non-ionizing radiation. Area of non-ionizing radiation also includes radio frequency spectrum.

2. ELECTROMAGNETIC FIELD FROM A MOBILE PHONE
Mobile phones communicate with a base station during a call. Base stations are mutually spaced in such a way that each base station covers a part of the territory.
The position of the mobile phone is in most cases directly to the head during the conversation. The farther the user is from the base station, the less exposed to electromagnetic radiation he is. However,

during the communication between a mobile phone and a base station the mobile phone uses a lot more power so that its signal can be registered from the base station [5]. It can be concluded that despite the fact that the base stations are densely installed and that there is a large number of base stations, they will mainly radiate less power because they have to cover a smaller area. Consequently, the lower power output is needed to establish communication, and the user is exposed to a small amount of radiation.

Mobile phone transmitter emits power (depending on the distance of the first base station) in the range of 0.1 to 2.0 W, and the base station up to about 25 W per channel, in GSM technology there is the possibility of dynamic power customizations (decrease radiated power).

3. EFFICIENCY OF THE METAL PLATE EFFECT AS A COVER FOR ELECTROMAGNETIC FIELD OF MOBILE PHONE

Electromagnetic propagation can be affected by the materials with different electrical properties. The depth of penetration of electromagnetic waves depends on the specific conductivity of the material and the operating frequency.

In this paper, examination of the metal plate effects, as protection against electromagnetic fields of mobile phones was examined. Mobile phone and a metal plate 20x20 cm are modeled in WIPL-D [6], as shown in Fig. 1.

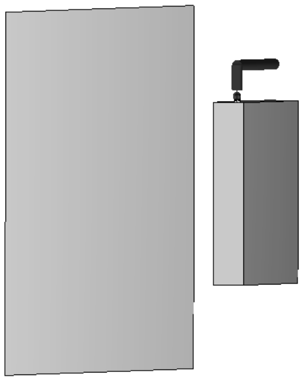

Figure 1. Mobile phone and a metal plate modelled in WIPL-D.

Simulations were performed and the results for several typical positions were obtained. The intensity of the electric field in the near field was observed, which is parallelepiped shape that leans on plate.

As a measure of the mean value of intensity of the electromagnetic field in a specific part of the space is used root mean square (RMS) value of the field for a network of points in a given space. It is calculated as the square root of the sum of the effective value of the electric field at each point defined near field. Based on the values for x, y and z components of the electric field, RMS (E) value of the electric field vector, which is a convenient parameter that shows the mean intensity of the field in this area, as shown in the equation (1), is calculated.

$$RMS(E) = \sqrt{\sum(E_{xj}^2 + E_{yj}^2 + E_{zj}^2)} \tag{1}$$

As a measure of the effectiveness of the protection we used S. E. value calculated for a certain part of space. It represents distinction the mean square value electric field intensity when there is and when there is no protection in the form of plate, it is a measure of the effectiveness of the protection of the metal plate, and is expressed in a positive dB.

$$S.E. = RMS(E0)\ [dB] - RMS(E)\ [dB] \tag{2}$$

Two dimensions imaginary parallelepiped, in which the intensity of the electric field is observed, correspond to the dimensions of the metal plate, while the third dimension is determined experimentally, after the simulation, as the limit at which the significant reduction in the field is observed and it has a value of 10 cm. Simulations were repeated for different positions of the mobile phone and the mobile phone different distances from the metal plate. Calculations were performed for two characteristic frequencies, 900 MHz and 1800 MHz.

4. RESULTS OF THE DATA PROCESSING

After these simulations, RMS (E) value of the electric field is calculated from the obtained numerical values of the electric field based on the formula (1). The values are then graphically represented, Fig. 2. Simulations were performed for seven typical position of the mobile phone.

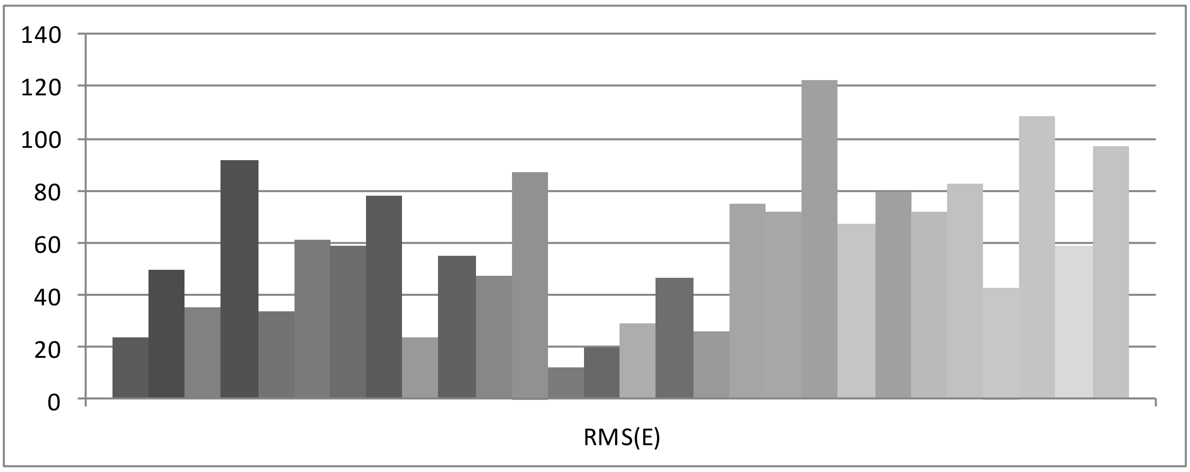

Figure 2. RMS values (E) corresponding to different positions of mobile phones, with and without cover plates at the frequencies of 900 MHz and 1800 MHz.

Using the formula (2), the values for the S.E. are obtained, and they are graphically shown in Fig. 3.

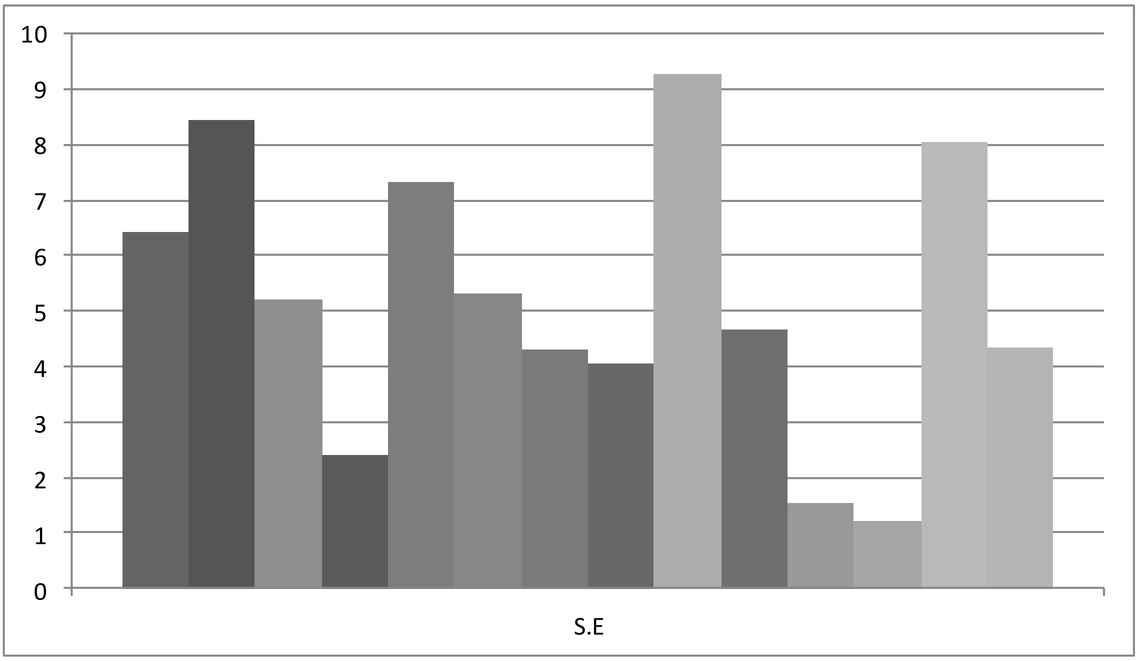

Figure 3. S.E. [dB] for seven different positions of the mobile phone, at the frequencies of 900 MHz and 1800 MHz.

The first pole of the Fig. 3 represents the case when the mobile phone is placed parallel to the metal plate at a distance of 10 cm at a frequency of 1800 MHz. The second pole presents the case when the mobile phone is placed parallel to the metal plate at a distance of 10 cm at a frequency of 900 MHz. The third pole occurs when the mobile phone is turned away from the plate at a distance of 10 cm at a frequency of 1800 MHz. The fourth pole is the case when the mobile phone is turned away from the plate at a distance of 10 cm at a frequency of 900 MHz. Fifth pole presents the case when the mobile phone is placed parallel to the metal plate, raised into a corner, at a distance of 10 cm at a frequency of 1800 MHz. The sixth pole occurs when the mobile phone is placed parallel to the metal plate, raised into a corner, at a distance of 10 cm at a frequency of 900 MHz. The seventh pole is the case when the mobile phone is placed parallel to the metal plate at a distance of 30 cm at a frequency of 1800 MHz. The eighth pole represents the case when the mobile phone is placed parallel to the metal plate at a distance of 5 cm at a frequency of 1800 MHz. The ninth pole is the case when the mobile phone is placed parallel to the metal plate at a distance of 30 cm at a frequency of 900 MHz. The tenth pole is the case when the mobile phone is placed parallel to the metal plate at a distance of 5 cm at a frequency of 900 MHz. The eleventh pole presents the case when the mobile phone is placed to the metal plate, raised into a corner, at a distance of 10 cm at a frequency of 1800 MHz. The twelfth pole is the case when the mobile phone is placed to the metal plate, raised into a corner, at a distance of 10 cm at a frequency of 900 MHz. The thirteenth pole occurs when the mobile phone is placed to the metal plate at a distance of 10 cm at a frequency of 1800 MHz. Fourteenth pole is the case when the mobile phone is placed to the metal plate at a distance of 10 cm at a frequency of 900 MHz.
Based on the obtained results can more accurately determine how many times (linear scale), or how many dB (for decibel scale), should increase the power of mobile phone radiation for the case where there is cover in the form of a metal plate, so that the level of the field at some point be the same as for the case where there is no cover.

5. CONCLUSION

As can be seen from the results obtained after the modeling of the mobile phone and the metal plate in WIPL-D, the effect of the metal plate as protection of mobile phone the radiation is not satisfactory. The specific graphs accurately show that the level of the field when there is a metal plate decreases in the range from 1.208 – 9.258 dB as compared to the case where the metal plate does not exist. From the obtained results it can be concluded that the metal plate is not an effective cover against mobile phone radiation. Analyzing the position of the mobile phone of interest, it is concluded that the plate did not provide adequate protection from electromagnetic field of mobile phone and it can be concluded that it is not an effective cover against the radiation. Better protection of the mobile phone radiation perhaps could provide plate considerably larger in size, order of several meters due to the frequency respectively the wavelength at which mobile telephones operate, it would, however, be very impracticable.

6. REFERENCES

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