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"Non Ionising Radiation in Brazil: Recent Progress in Estimation, Measurements and Monitoring".

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Abstract - The recent developments on non ionising radiation safety and the use of the Precautionary Principle in Brazil are reviewed in this paper. The national legislation, based on the ICNIRP recommended limits, and some more restrictive local standards, considering in part the non thermal effects, are discussed.

"Exclusion Zones" are estimated for some typical transmission stations (e. g., radio base stations for cellular systems) considering different standards. Inside the Exclusion Zone the fields are above the limits of the standard into consideration. Some measured results are shown and compared with the theoretical estimations, and with the available standards.

The Specific Absorption Rate (SAR) in the heads of adults and of a ten years old children when using cell phones are calculated. This uses the Finite Difference Time Domain - FDTD method . Comparisons with the results simulated by other authors, as well as with some measured results are discussed and compared with the limits established in the available standards.

Recent monitoring systems installed in some regions in Brazil are also briefly described.

Perspectives for the near future.

INTRODUCTION

There has been a dramatic increase in the use of mobile phone technology in the last decades, with widespread benefits in many professional and private activities. In parallel with this, the concern regarding the possibility of adverse health effects due to the absorption of electromagnetic fields by humans also increased. For several years, many research groups in different countries were developing research projects on these subjects in the areas of medicine, biophysics, engineering, etc. Also, the World Health Organization (WHO) has coordinate efforts including many countries to access the existing

scientific evidence of harmful health effects of non ionizing radiation (NIR) emitted from different communication equipment, such as the mobile phones and their base stations, with special emphasis to the non-thermal effects.

In principle, the base stations radiate more energy. However, their antennas are usually located on the top of elevated towers (or masts) and the radiated energy is mainly concentrated in the horizontal direction. Therefore people are usually far from these antennas, and also in directions reasonably apart from those of maximum radiation.

Because the conventional monopole (or whip) antennas being used now in mobile phones typically show a circular radiation pattern in the horizontal plane, they may radiate substantial levels of energy in almost all directions, very close to the body and during considerable time. It is observed that when they are operated very close to the user's head (e.g., 2,5 cm or less) , most of energy is absorbed in the head tissues (such as the bone, the brain, eye, etc), and less energy is radiated to the nearest base station. This situation is undesirable since quality of communication is worse, and the Specific Absorption Rate (SAR) in the user's head and the battery drain are increased. In this work the thermal and the non-thermal effects of the non-ionising radiation (NIR) are briefly described. The brazilian legislation, based on the ICNIRP recommended limits, and some more restrictive local standards, considering in part the non thermal effects, are discussed. Then the typical base station radiated fields are estimated and compared to the available recommendations limiting human exposure to NIR. On the basis of these comparisons, exclusion zones are defined, in which the correspondent reference standard limit is not observed. Recent monitoring systems installed in some regions in Brazil are also briefly described. The specific absorption rate (SAR) in the head of mobile phone users (adults and children) is simulated using the Finite Difference Time Domain (FDTD) method in three dimensions (3 D) when conventional monopole and planar antennas are employed.

The performance simulation of microstrip rectangular patch antennas, as well as its predicted and measured results are presented. An algorithm based in 3D FDTD is developed to model the radiation pattern in the horizontal plane and the electric field in the Fresnel region. Measured horizontal radiation pattern is shown. It can be seen that there is a strong correlation between the measured and the FDTD simulated results when the ground plane is finite and when it is not effectively grounded. This type of antenna may be of great interest in new generation of mobile phones, improving its performance, reducing the battery drain and the SAR in the user's head.

The new generation (e.g. 2.5 G and 3 G) of cellular phones, including services of message, voice, data, video, etc., will transmit higher data rates and may require higher transmitted power. This would result in greater risk for the cellular phone user unless alternatives such as directive antennas were employed. Hence it is expected that these antennas, simple, compact and adequate for the integration with the cellular phone structure, with low cost and reasonable performance would perform an important function in the next generation of cellular phones.

It is important to remark that the usual guidelines used for the human exposition limitations (e.g., ICNIRP/CENELEC, IEEE/ANSI) only consider the thermal effects of the non ionizing radiation. If the non-thermal effects became definitely demonstrated, then the exposition limits will have to be substantially reduced. Therefore alternatives such as the planar antennas for mobile phones would become more relevant.

The results are discussed and compared to the Precautionary Principle. Among others, it is observed that in the case of typical base stations, the estimated and measured fields are usually below the limits, even when compared to the more restrictive recommendations, maintaining a good quality of communication. Also, the benefits of the directional antennas use in new generation of mobile phones are discussed.

The spread use of mobile phones by the children and the young people is considered. These, for different reasons, are more susceptible than the adults.

Finally, the perspectives for the near future are discussed.

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