ANALYSIS OF EXPOSURE LEVELS NEXT TO GSM BASE STATIONS

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ABSTRACT

Measurement campaigns performed so far in the vicinity of GSM base stations clearly show that exposure levels are well below the limits recommended by the European Union for the general public. The results also demonstrate that the exposure levels vary by order of magnitudes depending on several physical and environmental factors. There is a clear need for harmonisation of measurement protocols.

INTRODUCTION

World wide, the use of mobile telephony has increased considerably with the introduction of the digital GSM 900 / DCS 1800 systems in the 1990s. Today 15 % of the population of the world are using mobile telephones, the penetration rate in Europe and the United States is being much higher, e.g. about 80 % of the population in Austria are using mobile phones. This increased use of mobile phones has led to an important deployment of base stations. The number of base stations in a country depends on several factors as the number of network providers, the number of users and the topography. In Austria more than 14,000 GSM base stations are operated by four network providers. Such base stations are often situated close to dwellings or houses and have become the reason for concerns of parts of the population in the recent years. Due to the public perception some questions became increasingly important. The concerned population often wants to know the level of exposure due to the base stations, if these levels of exposure might be health relevant and if the levels comply with national and international standards, guidelines, regulations or similar documents. To answer these questions local and national authorities, network providers and private persons often contract qualified institutions to evaluate the exposure level in restricted areas.

METHODS

Spot measurements

Several national and local measurement campaigns were performed in the last years, e.g. [1], [2] and [3]. In 1999 it was decided within the COST 244bis Action “Biomedical Effects of Electromagnetic Fields” that data from some European nations on the exposure levels of base stations should be compiled, to check the comparability of the data from different sources and countries and to identify gaps of knowledge concerning the data in the frame of a Short Term Mission [4]. The database collected within this Short Term Mission contains 346 frequency selective measurements on RF exposures from GSM base stations from Austria , France, Germany, Hungary and Sweden in places where the public has access. It is important to notice that these measurements do not give information on the maximum exposure levels in the vicinity of base stations. The purpose of these measurements was most time to give information on the exposure scenario in areas of interest for concerned people, and not to assess worst case exposure. Methods how to assess worst case exposure to base stations are described in the next section.

Evaluation of worst case exposure to single base stations

Within a measurement campaign performed in Salzburg in 2001, the highest exposure values in areas around base stations, where the population usually stays for a longer time, e.g. dwellings or offices, were determined using a special evaluation protocol [5]. Exposure levels from base stations were evaluated in the vicinity of 13 arbitrarily selected GSM base stations. 5 roof top mounted base stations, 4 micro cells and 4 mast mounted stations were examined. The first step to be done was to collect all necessary technical data of the respective base station like antenna diagrams and gains , input power, frequencies and number of carriers with BCCHs (Broadcast Channel) and carriers with TCHs (Traffic Channel) only. The base station needed had to be examined visually and the topography of the environment was

documented. The relevant information of all buildings in an area of about 200 m around the base station also needs to be known in order to perform a reliable simulation of the field distribution around the respective base station. In the frame of this project the software "Quick-Plan" developed by the Italian company Teleinformatica e Sistemi s.r.l. was used to perform the simulations. Based on the results of these simulations that give adequate information of the outdoor field distribution around a base station, the areas inside the buildings where the highest field levels are to be expected, can easily be identified. These areas usually consist of large parts of houses, therefore, in most cases it is not possible to identify exactly the rooms with the highest field levels. Therefore, it is imperative to perform some preliminary, evaluative measurements ("prescan") at the respective places inside the buildings using broadband field meters during the second step of the procedure. It has to be taken into account that immissions from other sources, e.g. broadcast station or radar installation may influence the results of the measurements.
Having identified the room with the highest field levels, the positions of the maximum level of the carriers with BCCHs of the considered base station are to be identified by a second "prescan". The second "prescan" is performed using a spectrum analyser and a log periodic directive antenna. Because the measuring engineer is forced to hold the antenna in his hands, the field distribution is influenced by this procedure. Consequently it is not possible to rely on the absolute field levels obtained during this second "prescan". Therefore the levels of the carriers with BCCHs are determined at the obtained positions by using the method Add3D to finally measure the exposure levels of the considered base station [6]. The contribution of the carriers with TCHs is also considered by calculation assuming that all slots of the respective carriers are emitting with the maximum possible power.

RESULTS

Spot measurements

52 % of these measurements were performed indoor. The highest power density measured among the 346 measurements at a single frequency was 13.4 mW/m², corresponding to 0.28 % of the ICNIRP exposure limit for the general public. The maximum power density at single frequencies varied between < 0.000001 and 13.4 mW/m². This corresponds to a variation of at least seven orders of magnitude. The median value was 0.01 mW/m² and eleven of the 346 measurements exceeded 1 mW/m². The sum of all levels in the GSM bands was available in 152 cases, the maximum sum was 47.6 mW/m² or about 1 % of the ICNIRP exposure limits of the general public. The exposure levels of the 152 measurements varied between < 0.000001 and 47.6 mW/m² corresponding to about eight orders of magnitude. The median level was 0.2 mW/m². It can be seen from the results that all measured exposure levels are at least two orders of magnitude below the limits recommended by the European Union and vary by about eight orders of magnitude in the different locations examined [7].

Evaluation of worst case exposure from single base stations

The highest power density found in the frame of this measurement campaign was 39.6 mW/m² and was found in the vicinity of a micro cell. In the environment of 8 out of 13 base stations the highest exposure level arising from the respective station exceeded 1mW/m². Next to the 13 stations 37 locations were examined in total. In 16 of these 37 locations a maximum exposure level of 1 mW/m² was exceeded. The maximum power densities found range between 0.0036 and 39.62 mW/m², exposure levels were higher in the vicinity of roof mounted antennas and micro cells compared to mast mounted installations.

DISCUSSION AND CONCLUSION

It is important to notice that the results of the two measurement campaigns presented within this report cannot be compared directly. The so called “spot measurements” give information on the exposure situation at a given moment in a certain position, exposure levels in the close vicinity of the selected positions might be higher. In contrast, the results obtained within the second measurement campaign represent worst case scenarios. The measurement protocols used within the measurement campaigns described differ significantly. This is a good example demonstrating the EU wide need for harmonisation of measurement protocols. There is an urgent need for more scientific rationale for new measurement methods to accelerate international standardisation processes, e.g. the work performed in the frame of CENELEC.

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