PRACTICAL ISSUES CONCERNING CELLULAR BASE STATION EMISSIONS AND POPULATION EXPOSURE IN ROMANIA

S. Miclaus*, P. Bechet**, C. Goiceanu***, O.V. Olariu*,**, S. Demeter*

* Land Forces Academy, Tech. Sci. Dept., Sibiu, Romania
** Information Systems and Communications Training Centre, Sibiu, Romania
***Public Health Institute, Non-ionising Radiation Dept., Iasi, Romania

s.miclaus@personal.ro

Abstract: More than half of Romania's population use mobile phone services, the need for cellular base station emission measurements becoming obvious. Following European standards and rules implemented in this country, present work focused on compliance testing of radiofrequency exposure of general public due to mobile communication in GSM standard. A number of seven sensitive urban locations in the area of one city were chosen for evaluation, and another extra-urban one, allowing also refinement of the methodology and expertise in the view of further measurement campaigns. The frequency selective method was used by means of software controlled R&S TS-EMF system. Peak and average E-field values were obtained with known uncertainty limits and especially the temporal variation of the exposure was followed. All the measured field values were far bellow the reference levels stated by ICNIRP. Present results cannot support a general conclusion regarding population exposure, due to restricted number of measured locations. Also to complete that total quotient of exposure due to whole radiofrequency spectrum was not evaluated.

Introduction

Rapid spreading of mobile technology led to increasing of public concern regarding the health and safety aspects of mobile telecommunications equipment. Safety guidelines for protecting humans from radio-frequency exposure are in use in Europe [1].

Romania has implemented a number of measures to protect the public against exposure to electromagnetic fields, but have no specific national standard. The Order of the Ministry of Health and Family no. 1957/1995 – "Standards on Occupational Medicine" regulates the occupational exposure to electromagnetic fields. The Regulation establishes maximum allowed values of intensity and power density for high frequency electromagnetic fields, ranging from 0.1 MHz to 300 GHz (radio and microwave radiation). The national authority dealing with energy, National Regulatory Authority for Energy - ANRE, has laid down a set of General Occupational Health and Safety Regulations (NGPM), which were enacted by the Ministry of Labour and Social Solidarity (MMSS) in 1996. These regulations set out the maximum authorised limit values for exposure to electromagnetic fields and a number of measures aimed at reducing them. The General Occupational Health and Safety Regulations are legally binding and were based on specific standards applying to various fields of activity. The Ministry of Health and Family (MSF) dealt with ICNIRP guidelines [2] and the Recommendation 99/ 519/ EC [3], which were implemented in December 2002 in the form of national reglementations. Moreover, the MSF is working towards obtaining the necessary authorisation to be able to monitor telecommunications (transmitters for radio, TV, mobile phone and radar, etc.) and the base stations. The present number of mobile telephone users in Romania is about 12 million, for a total population of 22 million people (approx. 55% of the population).

The following GSM networks operate in Romania: Cosmorom S.A. - GSM 1800, Mobifon SA (Connex GSM) – GSM 900 and Orange Romania SA - GSM 900/1800.

Some measurements of base station emissions in connection to exposure assessment were made in the last couple of years, but authorities claim that technical resources for such measurements and monitoring are insufficient. In the majority they were done by using broadband survey meters (EMR-300) by the Inspectorate General for Communications (IGCTI), on demand or to check that the field levels comply with the Occupational Health and Safety reference levels.

ICMET Craiova was involved in a joint venture with Germany, setting up a calibration laboratory for electromagnetic field measurement equipment up to 1 GHz, to be extended in the range of 0.9 – 1.8 GHz, with a view to covering the second band for mobile telephony. The field calibration laboratory of ICMET will assure traceability of the German standard and European standards respectively.

Romania has implemented a number of measures to raise public awareness on the health effects of electromagnetic fields and on the measures taken to prevent them. Relevant information is available to the public via the ACER Bulletin and ACER website (http://www.acero.ro), GSM Magazine, mobile telephony company websites and the press (which features related international press reports).

On this background, our group research efforts at this stage were focused on getting the standardized

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expertise in compliance verification and exposure assessment respectively. The measurements that were done at this time can not be considered a measurement campaign, but this will be the next step.

Our specific experimental task was to make in situ measurements for compliance verification in the area of eight GSM base stations, either in GTU or GHT propagation conditions [4]. Measurements were conducted by the frequency-selective method.

Materials and Methods

The only real-life quantities that can be measured for assessment of base station emissions are the free-field electric and magnetic field strengths (E and H). Standards, therefore, provide derived limits, given in terms of power flux density S (W/m^2) or in terms of E (V/m) and H (A/m).

At the operating frequencies of mobile communications base stations, the far-field region starts at quite short distance from antenna and, therefore, the measurement of the electric field strength is, generally, sufficient.

The measurement protocol took into account the objective of the research which was compliance verification [5],[6]. No a-priori knowledge was available regarding sources emissions or the environment. The general scheme for compliance verification was not completely followed, since no simulation was made prior to measurements and no measurement with broadband field probe was prior made. The measurements were executed by means of a frequency-selective device, in locations that theoretically, in ideal propagation conditions, should fit the maximum field-level prediction. The choice of measurement points (location and number of points) was in accordance with the general considerations in [3]. Processing of measured data and final report followed.

The portable measurement system TS-EMF by Rohde&Schwarz was used and it was composed by a spectrum analyser type FSH 3 with its isotropic sensor (figure 1). The system was operated and controlled by the R&S RFEX software.

The system is designed for measurements of the E-field strength. For the major services, measurement packets are defined. This ensures that optimum settings are used and allows evaluation according to single frequencies, complete services and total emission.

Due to configurability the system can be easily adopted to special measurement tasks. Since the tri-axis sensor has got an isotropic characteristic, the measurement is done independent from direction or polarization of the emitter. This makes measurements easier. In contrast to directional antennas it is no longer necessary to move the antenna for covering all directions and polarization.

Reproducible time averaging method with well known uncertainty estimation can be performed on one single point in the area of interest. The measurement instrument is used in the sweeping mode, so as to determine the measurement points.

Figure 1: The R&S TS-EMF system used for measurements

Different measurement modes were possible and applied: a) single measurement (e.g. for overview); b) average and peak (e.g. 6 minutes average); c) long term (e.g. determination of time variations in the signals). The most used was the average & peak measurements.

The measurement configuration was made by selection of the interest packet in the RFEX software, namely "GSM 900 packet" and "GSM 1800 packet". The calculation of the isotropic field strength value was made automatically out of the measurements of the three axis. The data reduction via measurement software was possible in order to reduce the amount of measurement data.

Data presentation of the measured emissions (field strength, power density and ‰ of ICNIRP limit) was possible as a sum value and could be split into frequency bands if necessary.

To achieve the best accuracy, the system TS-EMF was delivered with individual calibration. The calibration values were stored in the software RFEX and the calibration values were automatically calculated in the measurement result. The following components are covered during calibration: a) the antenna-factor, which is taken from the data sheet of the tri-axis probe; b) the cable loss from the tri-axis probe to the input of the spectrum analyzer is contained in the antenna factor since the cable is part of the probe. If an additional cable (extension cable) is used to connect the tri-axis probe, this cable has to be indicated in the parameters of the software RFEX.

To increase the sensitivity of the TS-EMF System, the function Threshold-Calibration can be introduced, and in all measurements this was applied.

In the case of GSM900 packet the resolution bandwidth chosen for the measurements was of 100kHz and the trace mode was max hold. The dwell time was of 5000 ms and in the case of average values the measurement period was of 6 minutes. Reference level

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was set to 91 dBµV and threshold calibration was set to 71 dBµV/m. For GSM1800 packet, the resolution bandwidth was of 200kHz and the dwell time was of 10000 ms. Reference level was set to 100 dBµV and threshold calibration was set to 96 dBµV/m.

All measurements were made fully-automatic using the R&S software RFEX and they were performed inside macrocells and mostly outdoor. The eight locations chosen for measurements were situated in intra-urban highly populated areas, and only in one case it was situated remote from the city. All were positioned in the vicinity of the transmitter sites, the distance between the measurement system and the base stations being from 40 to 300m.

Results

The measured values in the eight locations were mostly referred as the ‰ of the E-field ICNIRP limit [6]. In seven of the locations only the GSM900 signals were present, while in the eighth one the GSM1800 signals could also be detected. Table 1 shows peak and average values of ‰ RMS of the E-field in these locations for the GSM packets.

Table 1: Values of the measured field in different locations

Location no.	Peak ‰ RMS ICNIRP	Average ‰ RMS ICNIRP	Peak E-field, RMS (V/m)	Average E-field, RMS (V/m)
1	4.37	3.59		
1			0.1820	0.1392
2	1.46	1.20		
3	0.70	0.50		
3	0.30	0.27		
4	0.16	0.13		
5	14.53	10.87		
6	1.97	1.77		
6	2.87	2.10		
6	3.05	2.83		
6	0.11	0.09		
6	1.06	0.84		
6	0.09	0.07		
6	2.03	1.91		
6	1.17	0.94		
6	0.05	0.04		
6	2.74	1.93		
6	6.56	6.08		
6			0.2745	0.2584
7	2.50	5.66		
7	3.38	5.99		
8	1.81	1.52		
8	2.10	2.07		
8	1.05	0.97		

In locations 1-7 from Table 1 the GSM900 emissions were measured, while for location 7 the GSM1800 emission was measured. Temporal variation was also followed, and specific attention was given to location no. six, where measurements were repeated randomly, in the same position, for different moments of the day, and different days. All the measurements were made outdoor, with the exception of the third location which was an indoor one. Exception location 2, which was in a hilly extra-urban terrain, all the others was positioned in typically urban condition.

Figure 2 shows the spectrum of the peaks in the measured band for location no.5 – marked grey line in Table 1, which showed the highest values in our set of investigations. The location is situated at 50m from a macrocellular base station in urban area.

Figure 3 indicate the spectrum of the E-field average values in the GSM900 band in the case of location no.6 – grey line. This is positioned at 75m from a base station in the urban area.

Figure 4 shows the repartition of the E-field peak values in the GSM900 band in the case of location no.7 – grey line. This is positioned at 40m from a base station in the urban area.

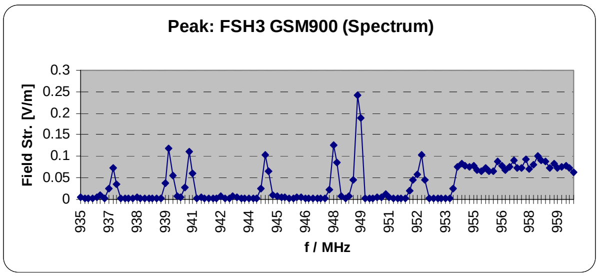

Figure 2: Spectrum of the peak E-field components of GSM900 measured signal in location no.5

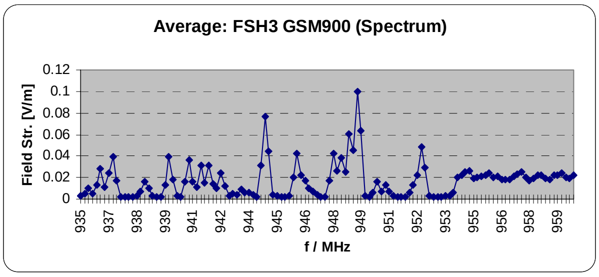

Figure 3: Spectrum of the average E-field components of the GSM900 measured signal in location no.6

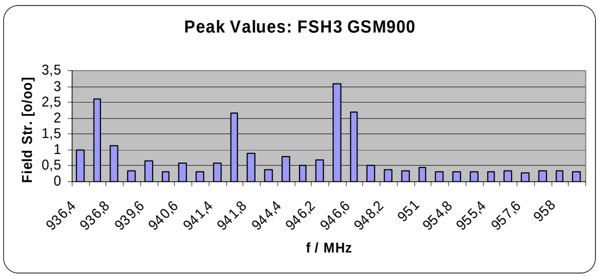

Figure 4: Repartition of the peak E-field values of the GSM900 signal measured in location no.7

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As seen from Table 1, the exposure quotients were much less than 1.

Discussion

The number of measurement positions around a single base station was limited due to objective reasons. Large variations of the field strength were still obvious in some locations. Theoretical predictions (ideal conditions, no simulation) of field maxima positions around a base station where measurements were made directly in the line of sight, did not fit to measured values map. Spatial variation of electromagnetic fields is due to directional behavior of emitting antennas, to the specificity of the electromagnetic environment (sub-urban, urban) and also to fast-fading.

Temporal variation of electromagnetic field was present, and well followed in case of one base station (location no.6). This feature was due to traffic variations but also to changing of the environment. However, either in the case of highest traffic, the field levels where far bellow reference.

Conclusions

A survey of radiofrequency electromagnetic fields emitted by some GSM900 and GSM1800 transmitters was undertaken at eight locations in an urban area (Sibiu city) in the centre of Romania. The chosen locations for measurements fitted position of some sensitive places. Compliance testing was followed in order to compare to the ICNIRP reference level for the general public exposure.

Measurement protocol took into account the recommendation [3]. Measurements were made by the frequency-selective method, software driven. The software also provided the programming of antenna factors and feeder cable insertion loss, given a well known uncertainty level.

Operators' technical information of the radiofrequency sources was not available. No simulations were made prior to measurements.

All the measured values were far bellow the reference level given by ICNIRP, exposures were small fractions of guidelines, the RF exposure complying with the legislation in force.

Acknowledgement

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