

EMF risk for operators mounting, adjusting and maintaining base stations

T. Shalamanova · I. Iliev · M. Ivanova ·
M. Israel

Published online: 24 July 2007
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Abstract In the recent years concerns whether exposure to electromagnetic fields (EMF) from base station antennae can cause adverse health effects are grown. Great attention is paid on risk of EMF exposure to people living in a close proximity of base stations. In this issue, a point of interest is the personnel mounting, adjusting and maintaining base stations. Their working tasks require stay in high EMF levels' conditions. There are only few studies concerning this specific occupational group. The results from our previous investigation (COST 281—Graz, 2006) show that in many cases on performing some specific tasks operators are overexposed according to our national legislation, and IC-NIRP guidelines. Here, we present an extended study covering more base stations and more precise scenario for performed tasks and working positions. Results of exposure assessment are presented. They include energetic load calculations on the basis of Bulgarian national legislation, and the corresponding SAR values. Data are used to determine permissible time duration for each particular work operation and served as a base for limiting the exposure and proposal for protective measures for the personnel.

Keywords Base stations · Energetic load · SAR · EMF risk

1 Introduction

There are a lot of recent publications dealing with the emission of mobile communication antennae in settlements affecting the population health. Unfortunately, the results

are contradictory and more evidences are needed for the possible effect of electromagnetic fields (EMF) at frequency 900 MHz and 1,800 MHz which provokes diseases like cancer, cardiovascular disorders and other health consequences among the population.

Furthermore, little attention was paid to the risk of RF exposure on service staff of base stations and mobile communication antennae up to now. There is evidence that despite the special requirement of the manufacturers that service operations should be performed when antennae are switched off, the personnel frequently works when the antennae emit, i.e. without interrupting the emission, and very close to them. Mild et al. (2005) reports similar practice among the service staff of base stations and antennae in Sweden.

2 Aim and scope

This study is aimed at assessing the risk of the microwave EMF radiation for the service staff of base stations and mobile communication antennae.

For this purpose typical antennae systems were investigated on routine operations of the personnel which they perform in close proximity and around antennae. EMF values were measured and exposure assessment is made for each particular operation. Energetic loading of the organism and whole body SAR were calculated as well. The scenario, technological operations and their average duration were presented by the mobile operators.

The object of investigation is personnel working on base stations antennae emitting EMF with frequencies about 900 MHz, and UMTS systems with 2,100 MHz.

On pictures No. 1, 2 and 3 are presented various technological operations in the close proximity of single

T. Shalamanova · I. Iliev · M. Ivanova · M. Israel (✉)
National Center of Public Health Protection, Sofia, Bulgaria
e-mail: m.israel@ncphp.government.bg



Pic. 1 Operation aside and in front of emitting antenna



Pic. 3 Operation close to the connectors (lower edge)



Pic. 2 Operation behind the antenna



Pic. 4 Operation between antennae

antennae for which were made corresponding measurements and evaluations.

On pictures No. 4 and 5 are presented various technological operations in the close proximity of more than one antennae (mounted a pole) for which were made corresponding measurements and evaluations.

This study does not deal with the exposure close to antennae, mounted on telecommunication masts.

The study covers temporary workplaces for adjustment, maintenance and repair of antennae, mounted on base

stations. The selected sites cover all possible working conditions, under which the respective service tasks are performed by the staff.

3 Exposure assessment

The evaluation of electromagnetic effects was performed as follows:



Pic. 5 Operation close to lower edges of antennae

1. Measurement of EMF for various procedures performed by the personnel and evaluation of the compliance with the respective exposure limits
2. Evaluation of the energetic loading (exposure assessment) for various processes, activities and shifts and its compliance with the respective limit values of Bulgarian and European standards.
3. Calculation of Specific Absorption Rate, SAR W/kg.

4 Materials and methods

4.1 Measurement equipment

Power—meter ‘NARDA’, model EMR-21C of “NARDA Safety Test Solutions”

The evaluation was performed on the basis of different national and international standards. (Ordinance 1999; Bulgarian State Standard BSS; ICNIRP (1998); Directive

(2004) Exposure evaluation was made on the basis of the following standards:

Bulgarian State Standard (BSS) 17137–90. Occupational hygiene. Microwaves. Permissible values and requirements for control (Bulgarian State Standard BSS).

Guidelines for limiting exposure to time varying electric, magnetic, and electromagnetic fields (up to 300 GHz), ICNIRP (ICNIRP 1998) Table 1.

5 Measurement method

Measurements were made in wide frequency range by nonselective method.

All measurements were made in few selected typical sites. Measuring device was chosen with probe sensitive to electrical component of EMF.

To avoid human influence on the measurement process handle and optical cable were connected to the device. Data were collected using Narda EMR-21C software, installed on laptop. In cases when the height of antenna mounting allows performing measurements from the rooftop level the equipment was mounted on tripod.

Data were collected considering the typical work positions of base station service workers. The average (averaged over 6 min) and maximum power densities were measured. Energetic loading was calculated with respect to the mean time for performing the above-mentioned work tasks.

Energetic loading of the organism was calculated considering the duration of performed operations.

6 Results of measurements and calculations

The results of measurements are shown according to the tasks performed by the service staff of mobile communication antennae and base stations. The measurement points correspond to the location of the subjects at work with respect to the antennae.

In Table 2 are shown operation types, operating duration time, permissible time duration and calculated values of energetic loading of the organism, and whole body SAR values as well (Fig. 1).

Table 1 Value limits in accordance to ICNIRP and BSS 17137–90

Standard (MHz)	Power density S, $\mu\text{W}/\text{cm}^2$	Average time t , h	SAR W/kg	Energetic loading W, $\mu\text{W h}/\text{cm}^2$
<i>ICNIRP</i>				
900	2250	0.1	0.4	–
2100	5000	0.1	0.4	–
<i>BSS 17137–90</i>				
900	1000	1	–	200
2100	1000	1	–	200

Table 2 Data of exposure assessment according to the typical operation positions. Calculated values of exposure are in accordance to the cited standards above

No	Operation position	Operation duration (data from the operator)	Calculated Permissible time duration, according to BSS 17137–90	Energetic loading of the organism W_{\max} , $\mu\text{W}\cdot\text{h}/\text{cm}^2$	SAR, W/kg
CDMA antennae					
1	Changing the position of the antenna <i>Single Antennae</i> <i>Operation in a close proximity of antennae</i>	30 min	1 h 7 min	90.00	0.012
2	Behind antennae	2 h	4 h 15 min	94.00	0.002
3	In front of antennae	2 h	Not permissible	5000.00	0.242
4	Close to the lower edge of a single antennae	2 h	30 min	806.00	0.244
5	Near emitting antennae (distance up to 2 m)	2 h	15 min	1640.00	0.076
6	Along the feeder line <i>Antennae mounted on a pole (wrist type)</i> <i>Operation in a close proximity of more than one antenna</i>	4 h	> 8 h	25.60	0.001
7	In the area among antennae, on a pole	6 h	7 h 15 min	165.60	0.004
8	Between side edges of antennae	6 h	2 h 44 min	438.60	0.007
9	Operation close to the lower edge of antennae	6 h	19 min	3725.40	0.046
10	Operation on new antennae	6 h	Not permissible	7338.00	0.064
UMTS antennae					
<i>Single Antennae</i> <i>Operation in a close proximity of antennae</i>					
11	Operation behind antennae	2 h	2 h 19 min	173.00	0.006
12	Operation in front of antennae	2 h	Not permissible	2694.00	0.062
13	Operation close to the lower edge of antennae	2 h	3 h 20 min	120.00	0.004
14	Operation on new antennae	2 h	1 h 42 min	234.60	0.010
15	Operation along the feeder line	4 h	> 8 h	17.20	0.001

Calculated energetic loadings, which are bold in the Table 2 are above than the exposure limits according to the Bulgarian National Standards

7 Analysis of results and conclusions

The average and maximum power density, measured at the temporary workplaces for adjustment, maintenance and repair operations, exceed the limit values of Bulgarian standards in most cases, namely for works performed close to antennae. Even when EMF values don't exceed the limits calculated energetic loading is above the limit though for short-duration tasks.

The energetic loading is within the permissible limits only during works done behind the antennae or along the antenna-feeder lines.

Measured values, compared to ICNIRP guidelines and EU Directive 2004/40/EC are not in compliance for operations performed in front the antennae.

Nevertheless high measured EMF values and calculated energetic loading of the organism, the whole body SAR values correspond to the ICNIRP guidelines basic restriction for occupational exposure. Our legislation is stringent and

it allows limitation of the time duration of exposure based on the energetic loading of the organism. In some of the assessed operations the stay in such conditions is forbidden. Although compliance of SAR values to the guidelines, we consider that the personnel exposure especially on particular operations is significant. Therefore employers should take the following measures in order to protect the workers' health:

- technological operations in the close proximity of antennae should be performed after switching off emitters;
- use of personal protective equipment (clothes, glasses, etc.) when it is not possible to switch antennae off,
- when protective equipment is not used, combinations of technological operations should be made respecting the following limitation of the exposure:

$$\frac{\sum W_i}{W_{\text{lim}}} \leq 1$$

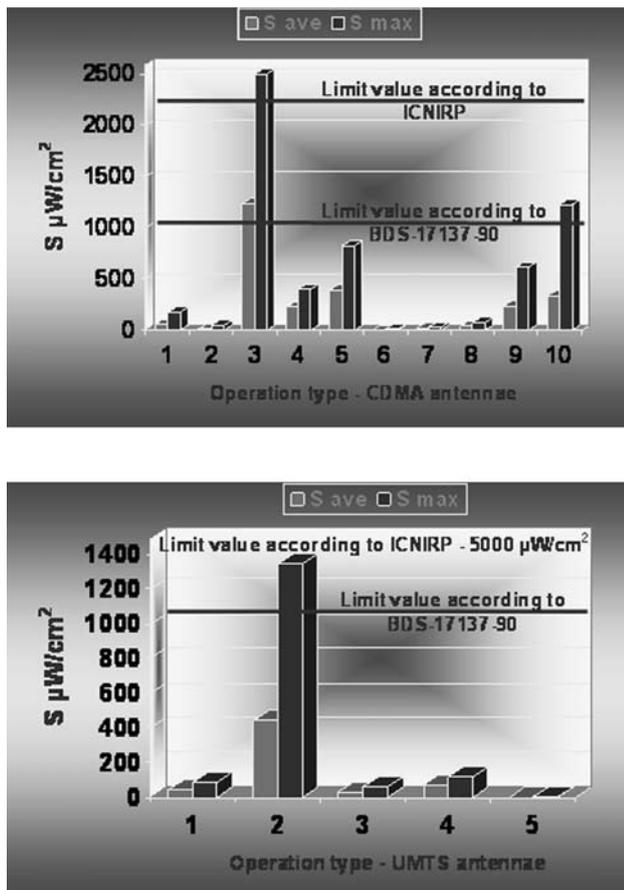


Fig. 1 Presents mean and max measured values of power densities on each operation position, for CDMA and UMTS antennae. * Numbers from 1 to 15 correspond to the operation positions shown in Table 2

where W_i is the total energetic loading of the organism resulting from the “i”—technological operation; W_{lim} is the maximum permissible energetic loading of the body according to the national standards.

Others not less important recommendations for the operators’ safety work are the followings:

- permissible time duration specified in Bulgarian regulations should be kept;

- workers should use personal dosimeters, which provide data about the cumulated dose;
- periodical training of the staff about the risks of EMF and protection.

In conclusion, a high risk for EMF exposure is found for workers mounting and maintaining base stations for mobile communication. Measures should be taken to improve the working conditions with respect to EMF by decreasing exposure, carrying administrative and organizational actions, ensuring continuous monitoring and personal protection. The energetic loading should be regularly assessed, while the field should be currently monitored by personal dosimeters. Periodical medical check-ups done by neurologist, cardiologist, therapist and ophthalmologist should be included into the prophylaxis program. Last but not least, the qualification of the staff in standards, biological effect, methods of measurement and protection against microwave fields should be currently maintained. Special attention should be paid to workers with active implants.

Acknowledgement We would like to thank P. Tchobanoff, a physicist working at the Military Medical Academy, Sofia for calculations of SAR.

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