MONITORING OF THE ELECTROMAGNETIC FIELD SOURCES IN DIAGNOSTICS OF THE ENVIRONMENT HAZARDS

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Unwanted exposure caused by antennas of the mobile telephony basic stations can be evaluated if the station parameters are known. However, theoretical estimations are not confirmed often by measurements due to their specific character and time-varying level of radiation that depends on the station loading, antennas and propagation geometry, season etc. Comparative measurements, performed by different meters, have confirmed applicability of the Narda SRM-3000 type meter for monitoring.

Introduction. It is difficult to forecast the results of influence of drastic changes of electromagnetic environment on human life development because Earth life has developed in conditions of natural electromagnetic fields (EMF). Very intensive development of movable radio communication, especially cellular telephony, has taken place during last years. Many base stations, used in mobile telephony, work in frequency range from a few hundreds to some thousands MHz.

Electromagnetic fields are considered as harmful biological effect and permissible exposure limits (PEL) are determined for professionals, which work is connected with EMF, and for other population. So necessity of the EMF levels control is obvious [1–7].

Metrology of EMF (including biologically active and dangerous for health) has 35 years tradition in Wroclaw University and Technology engineering college. During this period many modern measuring probes (selective, wideband and even superwideband ones) on the base of the universal MEH-1 EMF meter has been developed (Fig. 1) [7].

Situation of measuring crews is simple in the case, when it concerns with only one EMF source, as shown at Fig. 2 (the transmitter and feeder in Solec Kujawski) [5, 7].

Figure 1 – EMF measure MEH-1 for EMF components measurement in the 10 Hz–50 GHz band is widely applied in EMF metrology

Figure 2 – Measurement of the radio transmitter EMF components

But very often situation of our measuring crew was complicated because of presence of a few "dangerous" operators on one tower and impossibility of switching-off of some transmitters in view of character and kind of their work during measurements. So it is necessary to develop probes to solve the mentioned problems.

Different levels of PEL in different frequencies ranges, non-monochromatic character of the generated EMF, many sources of EMF give often different results in the same

point in dependence from kind or type of the applied measuring probe.

Protection regulations and methods of determining EMF in surrounding of different sources. Investigations of estimation of EMF harmfulness for living organisms as well as for different biological and technical objects are constantly continued [5].

The diagrams of PEL of E and H in dependence from the source working frequency are presented at Fig. 3.

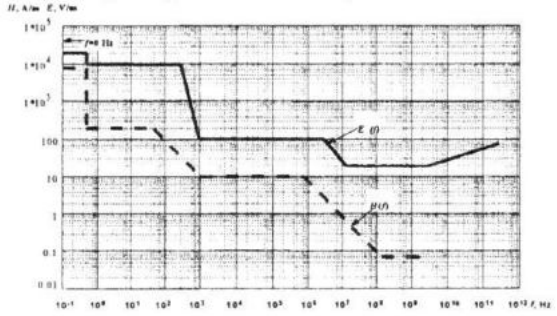

Figure 3 – PEL for the EMF electric and magnetic components

Determination of the EMF intensity levels in the points surrounded by the sources with the same working frequency does not cause difficulties in determination of the borders of protective zones in near zone. Some typical results of the measurements carried out near the transmitter in Solec Kujawski (Fig. 2) are shown graphically at Fig. 4.

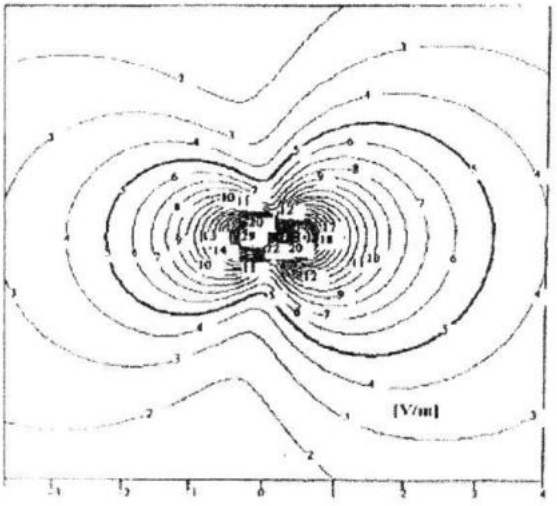

Figure 4 – Diagram of E of the antenna nearby the long-wave transmitter in Solec Kujawski (Poland)

The same concerns the antenna of a mobile telephony base station if it works with constant power. An example of the cellular telephony antenna characteristic from the catalogue 730370 is presented at Fig.5 [8].

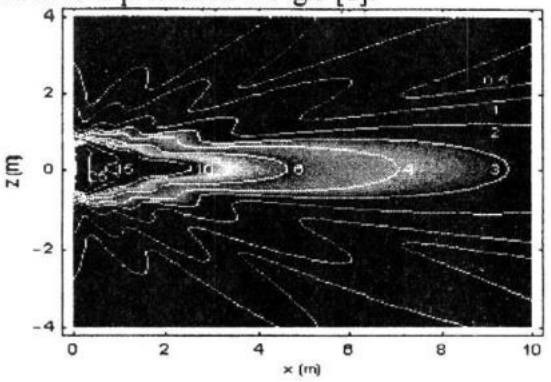

Figure 5 – Intensity of E [V/m] in main plane of E of the antenna 730370

It should be noticed that in metrology practice UKF and UHF transmitters, radio line systems, different systems of radiotelephone work simultaneously and the frequency spectrum is occupied very tightly. So, fields from different frequency ranges and with different protection can take place in measuring area, and a measurer should study all parameters of the used probes, especially their suppression out of the pass bands.

Decrease of amplitude-frequency of probes usually is equals to 6 dB per octave.

To solve that problem some manufacturers of measuring instruments propose probe frequency characteristics that are identical to the standards of PEL frequency dependency. It is illustrated by Fig. 6 [3, 5].

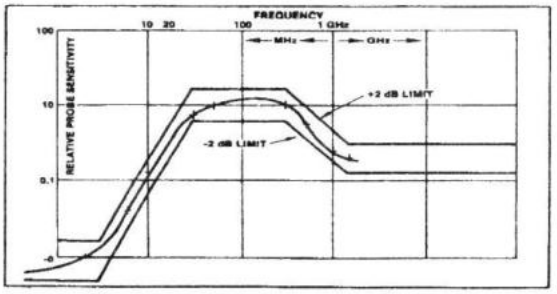

Figure 6 – The probe characteristic with special shape

Such method consists in increasing of suppression out of passband especially at high frequencies.

Problem of EMF radiation caused by cellular telephony base stations is actual because additional stations of third generation will be used in the nearest years.

Determination of hazards caused by both components E and H of near EMF field in surrounding of typical antennas of the cellular telephony base stations as well as elaboration of methods of estimating of the EMF intensity with the aim to prognosticate possible hazards are very essential for station operators themselves.

With every day we can observe more and more new antennas placed in cities, especially on roofs of inhabited buildings (Fig. 7), hospitals or schools that cause increasing worries of neighbouring dwellers.

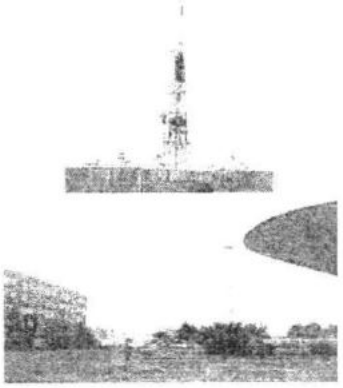

Figure 7 – Methods of installing of base station antennas on building roofs and on free standing towers

Antennas of various shapes and sizes are installed on high towers situated on open areas (Fig. 8). Wide spreading of such devices gives birth to the question: has EMF, emitted by that antennas or whole antenna systems, negative influence?

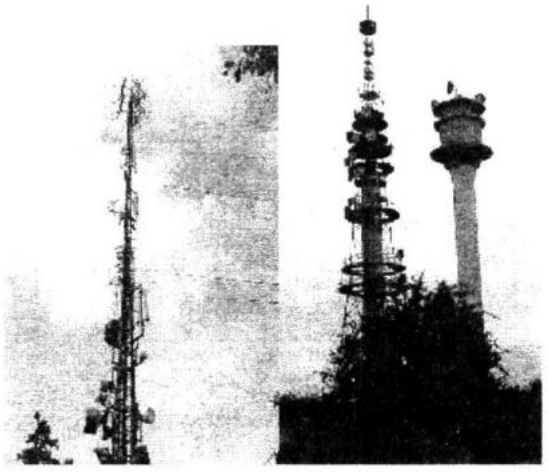

Figure 8 – Using of tower antennas outside built-up areas

Often such stations are installed on corners or inside buildings only for assurance of communication with workers or inhabitants (Fig. 9).

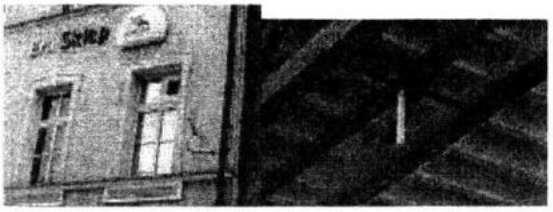

Figure 9 – Examples of places of antenna installing

The controversial problem of harmful influence of EMF created by devices of cellular systems on the human and environment has raised alongside with development of cellular telephony. Base station antennas that are visible (in connection of methods of their installation) on roofs or near inhabited buildings wake fear of invisible and unknown radiation among inhabitants (especially after results of radiation caused by the breakdown of power station in Chernobyl) [3–5]. Some "protest committees" are very angry with the situation, when on reaching prohibition of antenna installation on the building roof of defended housing estate they can see an antenna tower from windows of the house where its fanatic "enemies" live (Fig. 7).

Current knowledge about possible antenna EMF harmful influence is still very superficial. That gives birth to suspicion, that harmful results can appear even then, when level of risks is considerably smaller than considered as non-harmful at present. Continuous pressures from side of public opinion leads to r=the situation, when problem of protection in front of possible harmful influence of EMF, produced by devices of cellular telephony, cause great interest not only in Poland [1, 4, 9-11].

"Outside" persons are mainly influenced by EMF radiated by antennas of base station, which work through 24 hours. These persons are not connected professionally with devices of systems of cellular telephony and provided by them services. Additionally, anxiety is caused by fact, that ill or physically handicapped persons, small children, which organisms are less resistant or more sensitive to all kind of additional aggressive external factors, can live near stations. That is testified by formulated in some western countries recommendation for choice of base station

location near schools, hospitals, and even housing estates. Recently in Austria and Switzerland took place attempts to limit level of exposition in municipal environment to the level 100-times lower than recommend at present in Poland [5]. Such activities of "protest committees" lead to considerable resistance from the side of operators, because they have to search of new location, grow costs of getting permissions to locate a base station, building of additional station, change station location or decrease transmitter power of a station. Investigation of evaluation of EMF harmfulness field for living organisms as well as different biological and technical objects are constantly continued and even potential possibility of hazard leads to necessity of assumption the environment protection against EMF including inhabitants as well as persons connected professionally with PEM.

New elaboration of EMF selective measures for determination of hazards in real conditions. As it was noticed above, level of EMF hazards caused by base station antennas can be determined if distribution of that EMF is known. That distribution can be obtained in two ways: by measurements or by computer simulation. Especially difficult is to analyze, both by measuring and simulation methods, the near field of antennas. In the cases of measurements near EMF sources the applied instruments should fulfill some additional requirements such as small (in electrical meaning) dimensions of a sensor that measures specific EMF component for assurance of permissible errors of measurement, amplitude and phases characteristics, etc [3, 5].

Determination of near field of the antenna by simulation methods needs usually use of advanced full wave methods, such as method of moments or FDTD method (Finite-Difference Time-Domain).

But theoretical considerations do not find practical confirmation in the results of carried out measurements near real broadcasting object, in view of specific character of work of this type of station i.e. changing its radiated power in dependence from change of the station load in specific temporary period, season peculiarities of the object on the area, where the base station is situated, etc [12]. The Kyivstar operator station is an example of such base station (Fig. 10) established in 2005 on the 22-meter water-supply tower on the territory of Shatsk Experimental Base of the Physico-Mechanical Institute of the National Academy of Sciences of Ukraine situated in the forest above Lake Switiaz in Wolyn.

An apple-tree orchard is situated in the forest near the base station antenna (Fig. 10 –13).

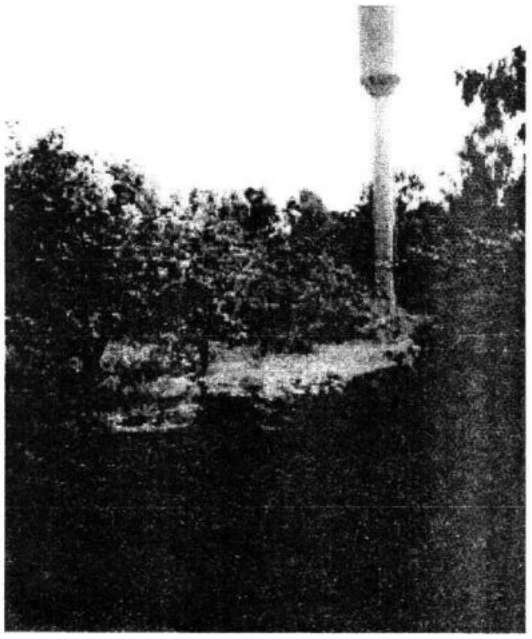

Figure 10 – A water-supply tower, cellular telephony base station installed on it and yellowed apple-tree

Figure 11 – View of base station antennas from the side of a road

In August of 2007 neighbouring inhabitants observed changes of leaves of part of apple-trees, which began to become yellow at the 35 meters distance from the antennas of the base station. At the same time decrease of fruit quantity on those trees were noticed. Additionally inhabitants observed also faster yellowing of leaves of birches and cracking as well as changes of colour of bark of trees (Fig. 12).

Figure 12 – View of apple-tree near the base station (16 September, 2008)

Taking into account above mentioned the authors organized and carried out in 2008 new complex measurements on the station area and compared received results. Measurements conducted in previous year with utilization accessible then measure of EMF intensity of the P3-41 type of Russian production which works in the band from 300 MHz to 40 GHz and has sensitivity 0.26 $\mu W/m^2$ did not give any results. Measurements were executed on height about 2 m above surface of the ground, what is presented at Fig. 13 and 15 [13, 14, 17]. Indications were equal to zero in view of insufficient sensitivity of the measure.

Figure 13 – The apple-tree orchard during measurements in the 2008 September

All measurements carried out in 2007 in different points on the territory of the whole station complex as well as on territory of the antenna field of the radio-telescope URAN-3 gave zero result because of too low sensitivity and too wide passband. It was affirmed also, that it is necessary to use a measure of EMF intensity or a spectrum analyzer with regulated widths of measuring ranges and minimum sensitivity 0,01 $\mu V/cm^2$ [14–16].

With that aim the LWiMP ITTA of Technical University of Wroclaw engineering college bought selective radiation measure of the SRM-3000 type and it was used in September of 2008 to carry out measurements alongside with observation of the orchard. That measure works in two modes of work "Safety Evaluation" (estimation of safety) and "Spectrum Analysis" (analysis of spectrum), which permit to use combination of frequency ranges, in which fields intensity has to be measured, or determination of all EMF components in chosen environment as well as getting of spectral characteristics or determining maximum values in the range from 75 MHz to 3 GHz.

That measure gives a possibility of fast defining EMF intensity in specific space as well as finding maximum value in some space (terrain, room, etc).

Figure 14 – Measurements on the territory terrain of antenna complex of radio-telescope URAN-3

Fragment of carried out measurements with using the selective measure of radiation of SRM-3000 type near one of the "III" trees is shown at Fig. 15.

Figure 15 – Measuring EMF by the SRM-3000 instrument near the apple-tree (which bark from the side of the antenna has brown or dark-yellow colour) that is situated about 25 m from the tower antenna of the base station

Some results of measurements carried out in characteristic points on the station territory and beyond it different time of day and night are presented graphically at Fig. 16–21.

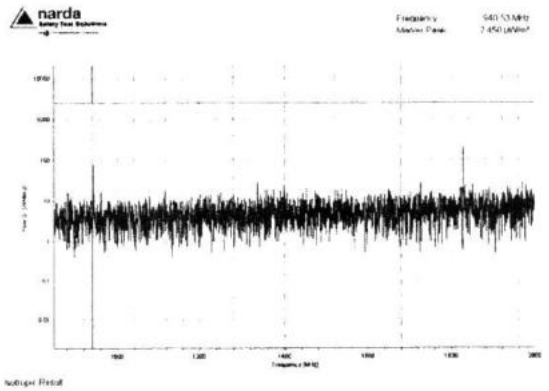

Figure 16 – Changes of power density indoor on the complex territory at 00.02.48 on 16.09.2008

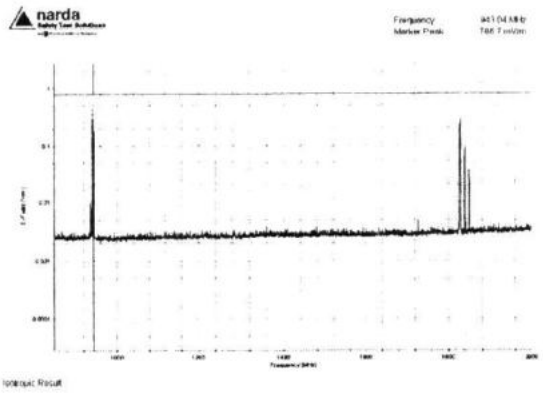

Figure 17 – Changes of electric field near the antenna at 8.10 on 16.09.2008

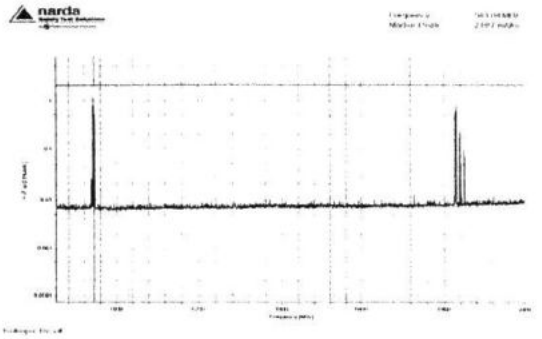

Figure 18 – Changes of magnetic field near the antenna at 8.10 on 16.09.2008

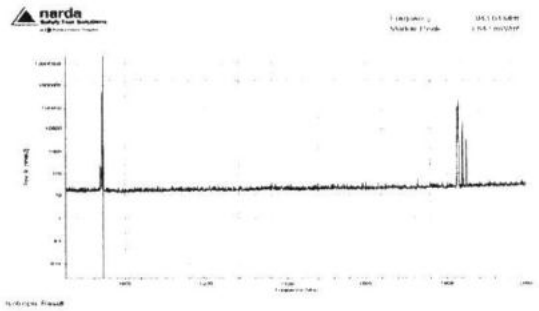

Figure 19 – Changes of power density near the antenna at 8.10 on 16.09.2008

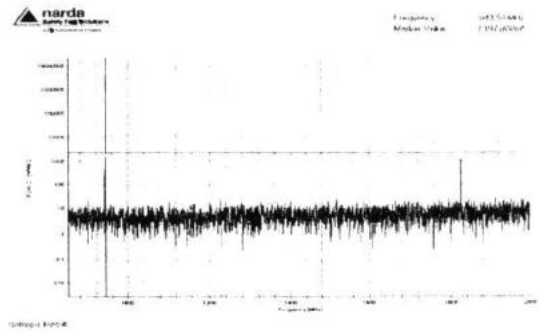

Figure 20 – Changes of power density near the antennas of radio-telescope URAN-3 at 10.20 on 16.09.2008

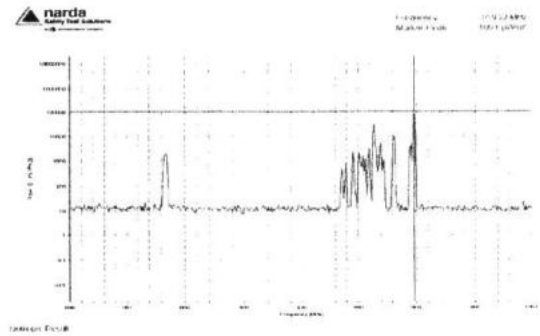

Figure 21 – Changes of power density near the antenna after changing of measuring passband

Conclusions

1. On the base of many facts of EMF influence on people and environment it is possible to affirm, that in last times its negative influence has been observed.

2. More and more people do not doubt that EMF influences on ecosystem as well as on the health of the people that are situated in the areas of EMF radiation.

3. Now more and more facts prove that EMF influences on environment and vegetable world, though that influence can not be explained directly by physical phenomena.

4. For solution problems of EMF influence on environment, which in this moment is investigated insufficiently, one should to begin systematic monitoring in some specific points, carrying out periodical measurements of EMF components and analyzing received results. From our point of view such monitoring should be realized on areas which are not radiated too much, for example, on areas of national parks etc. Measurements carried out on the territory of complex in Shatsk confirm full usefulness of the selective radiation measure of SRM-3000 type manufactured by Narda Safety Test Solutions for monitoring of such types of EMF sources.

References

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