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A COMPARATIVE STUDY OF RADIATION LEVELS IN BRAŞOV

BY

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Abstract. A group of residents of a new apartment block have accused health problems with symptoms similar to those produced by strong electric fields. Such problems arose in an area in close proximity to a group of antennas. This paper presents the results of ionising and non-ionising radiation measurements in the most used frequency range. The results are compared with the limit values allowed by national and international legislation and with values measured in a different location. The chosen location is similar to an apartment in a crowded area. The results of measurements lead to the conclusion that non-ionising radiation level stays within acceptable limits but the Radon level is within the attention limit.

Key words: non-ionising radiation; Radon level; ionising radiation.

1. Introduction

People are worried about radiation health effects, some due to the increasing number of antennas and the media which won't tackle the issue consistently. A group of residents in the immediate vicinity of antennas, as seen in Fig. 1 *a*, accused possible symptoms due to a very strong electric field. The antennas are placed on the Pedriatic Hospital of Braşov, although some research (Kheifets *et al*., 2005) urges caution regarding children's exposure to electric

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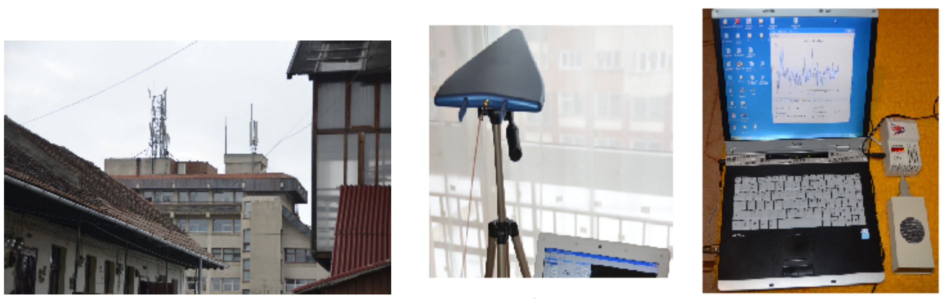
fields because of the developing nervous system. Radiation is classified into

1. Non-ionizing radiation (electro-magnetic) with health effects that are still under discussion, yet the carcinogenic effects could not be proved.
2. Ionizing radiation, which have shown carcinogenic effects.

Electromagnetic field measurements were made in two frequency ranges in which the field strength is greater, in the low frequency range around 50 Hz and in the high frequency range for mobile communications. Ionizing radiation measurements were made with a Geiger-Müller counter which determines the total amount of radiations and an electronic detector that measures the concentration of Radon in air. Images taken during measurements are given in Figs. 1 *b* and 1 *c*.



a *b* *c*

Fig. 1 – Location of measurements (*a*), spectral analyser mounted on a tripod and the laptop for computer data acquisition (*b*), Geiger-Müller counter, Safety Siren 3 device and data acquisition computer (*c*).

Various measurements were performed in different locations, usually following a single type of radiation. Therefore, Henderson & Bangay (2006) have presented the results of electromagnetic field measurements in the frequency ranges for mobile communications CDMA800, GSM900, GSM1800, and 3G, in five cities in Australia, at distances between 50 and 500 m for 60 stations (base station), where the measured levels were low, at around 2% from the limit allowed. Hutter *et al*., (2006), have used the same frequency range and the symptoms were analysed for a group of 365 people.

The difficulty to distinguish between the effect of the electromagnetic field and the psychological effect created by the proximity of antennas was mentioned. Mantiply *et al*., (1997), have given data regarding the average level of electric and magnetic fields in homes and offices in Sweden and Norway, the maximum values ranging from 54 V/m and 15 V/m. Mild *et al*., (2002), look at a wide range of frequencies between 10 kHz and 30 GHz, and a wide range of field sources, the highest value being 500 V/m recorded in the vicinity of an antenna. Some significant results related to the measurement of ionizing radiation are given by Brahmanandhan *et al*., (2007), in a city in India where house building materials have a Radon level of 89 Bq/m^3 and radiation dose of 0.8 mSv/year. Another study (Vaupotic *et al*., 2000) shows that in schools from

Slovenia, the average radioactivity of the Radon produced is of 168 Bq/m^3, yet there is a small percentage of schools from Slovenia in which the level reaches the attention value of 400 Bq/m^3.

2. Measurement of Electric Field Strength

Fig. 2 *a* shows the measurement results in the 400 MHz...2,100 MHz range covering mobile communications. The frequencies at which the maximum field values were obtained are given in Fig. 2 *b*. Most peaks are in the 900 MHz band, and then in the 2,100 MHz band.

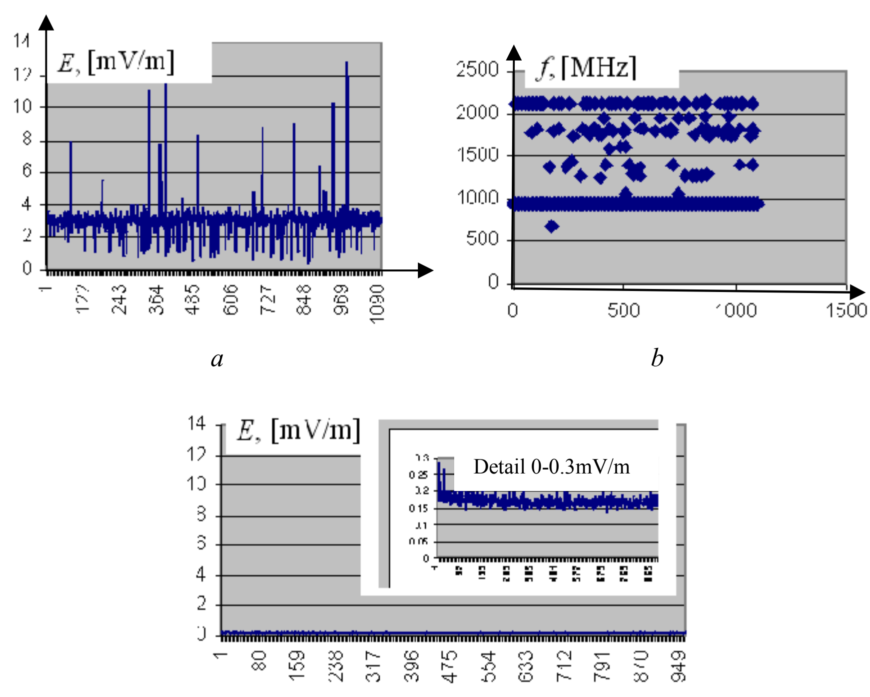
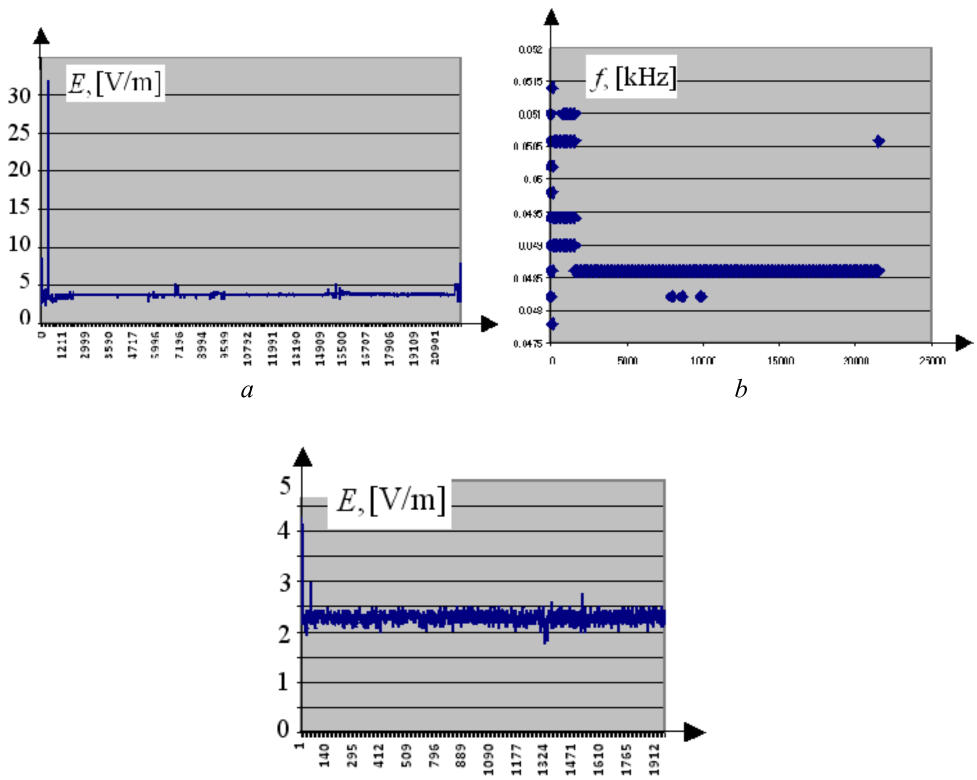


Fig. 2 – *a* – Electric field strength in the 400...2,100 MHz range; *b* – frequencies at which field peaks occurred; *c* – electric field strength in the witness location with detail.

Field measurement results in the witness location are given in Fig. 2 *c*. A lower field strength was observed, therefore a scaled graph was superimposed on the chart, the peak value being of 0.3 mV/m. The frequencies at which the field peaks occurred are mostly at 900 MHz and less at 1,800 MHz. In this location there are no peaks for 3G communications.

The electric field intensity of low frequency, around the 50 Hz value, is drawn in Fig. 3 *a*. The uniformity of the electric field can be observed in this figure, excepting the initial part where variations were caused by the presence of operators near the measuring samples. Most of the field peak values were recorded at a frequency of 48.5 Hz, as seen in Fig. 3 *b*. The field intensity graph in the witness location is represented in Fig. 3 *c* and presents the same characteristics as the location under test, the value of the field being smaller.



c

Fig. 3 – *a* – Electric field strength in the 47...52 Hz range; *b* – frequencies at which field peaks occurred; *c* – electric field strength in the witness location.

3. Measuring Radiation with Geiger-Müller Counter

The radiation dose measured with the Geiger-Müller counter was expressed in μSv/h and is represented in Fig. 4 *a* for the marked location and in Fig. 4 *b* for the witness location. In the witness location several measurements were made. As one of them shows, represented in Fig. 4 *c*, a significant increase in radiation dose was observed, as the average value has increased from 0.35 μSv/h to 0.632 μSv/h for a period of 24 h, due to the occurrence of maximum solar activity (January 2012). The mean values were close in the marked location and in the witness location.

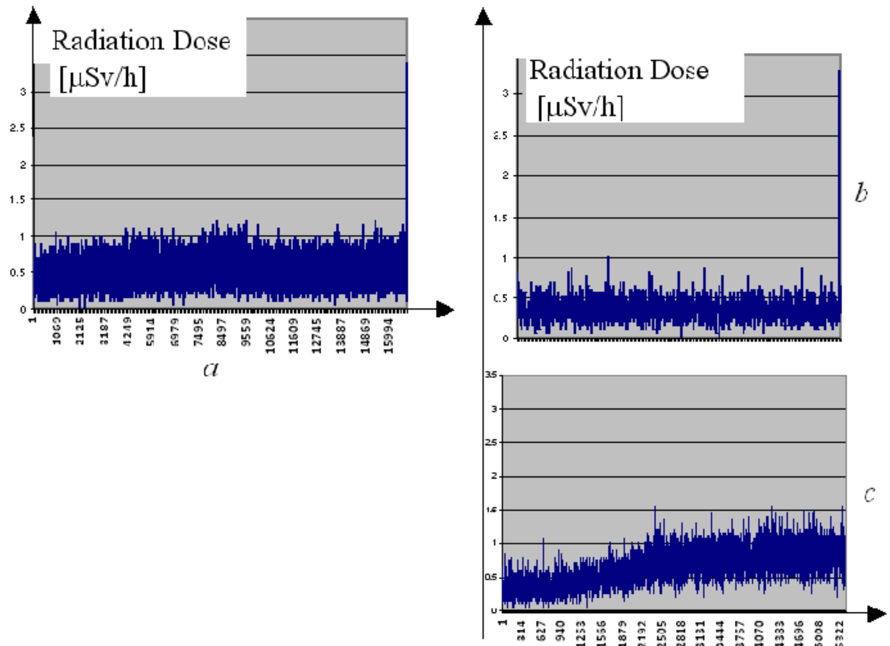


Fig. 4 – *a* – Radiation dose in the marked location; *b* and *c* – in the witness location.

4. Radon Concentration Measurements in Air

Radon develops as Radium is disintegrated, which occurs by decay of Uranium-238 contained by Earth's crust. In the outside air the concentration depends on the soil, air currents, etc. and ranges from 0.2 to 0.7 pCi/L. The risk of disease is very low. High concentration is found around uranium mines. In

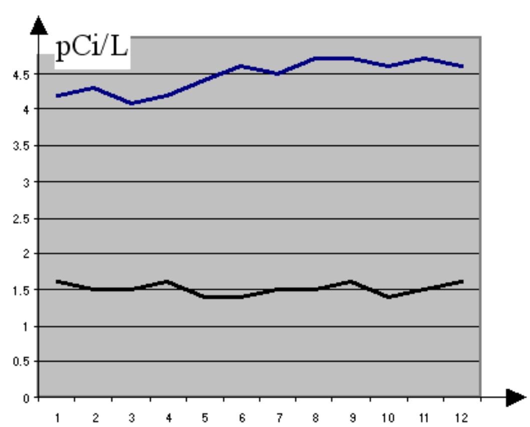


Fig. 5 – Radon concentration in air in the marked location (the graph above) and in the witness location (the graph below).

buildings concentration is higher at the ground floor and underground and depends mostly on the soil, the building materials and ground insulation. The building type and the used materials as well as the ventilation system affect the Radon concentration. Measurement results of Radon concentration in air are given in Fig. 5; the graph above is for the marked location and the graph below is for the witness location.

The SI unit of measure is Bq/m^3 but the Safety Siren 3 device displays the concentration in pCi/L. The conversion from pCi/L to Bq/m^3 is done using the relation 1 pCi/L = 37 Bq/m^3. Exposure to Radon on the inside creates a significant risk of disease, as 3,000 cases of cancer are reported each year. Radon is the second cause of developing lung cancer after smoking. The measured value in the marked location is much greater than the normal one.

5. Conclusions

The limits for electromagnetic fields have been established for Europe and for Romania. The limits for population from Order *1193*/2006 depend on the frequency, so in the 0.025 kHz...0.8 kHz range the limit is of $250/f$, and in the 400...2,000 MHz range the limit is of $1.375f^{1/2}$. The electric field intensity measurements at high (HF) and low frequency (LF) are summarized in Table 1, in mV/m.

Table 1

Frequency	Average value	Average value – witness location	Allowed value
HF	3.05	0.17	40,000
LF	3.63	2.28	5,000

The measurements were made on different days, the average value of the electric field varying according to the communication traffic. Thus, the following average values were recorded: 12.84, 5.38, 7.98, 24.97 and 24.29 mV/m.

The measurements for radiation dose are summarized in Table 2, in μSv/h. The maximum allowed value is in accordance with the USA NRC (Nuclear Regulatory Commission). Near the Fukushima reactor the radiation dose from the nuclear accident in 2011 was of 1,000,000 μSv/h.

Table 2

Average value	Average value – witness location	Allowed value
0.522	0.35	20

The measurements for Radon concentration in air are summarized in Table 3. The EPA (US Environmental Protection Agency) recommends that for values above 4 pCi/L corrective measures should be taken and WHO (World Health Organization) recommends a lower level of 2.7 pCi/L. The highest value measured in Braşov (Ogruțan *et al*., 2010) was of 6.7 pCi/L.

Table 3

Average value	Average value – witness location	Allowed value
4.46	1.50	4

A final analysis of the measurement data shows that the value of the high frequency electric field is below the permissible limits (0.007%) and the average value of the low frequency electric field is also below the permissible limits (0.072%). Compared to the witness location, the electric field values are higher due to a greater proximity towards the GSM communications antennas and a higher density of cables carrying electric power through the public supply network.

In the ionising radiation domain, the ionising radiation dose is below the permissible limit (2.61%) but the Radon concentration in air is above the attention limit (111.5%) established by EPA and above the attention limit established by WHO (165%). The measured Radon value is above the normal values (Cosma *et al*., 2009). Track detectors were placed in the marked location (alpha track Radon detector). If they will show Radon concentrations above the attention limit, then the cause of Radon occurrence should be found, such as, for example, one of the construction materials used. It is also possible that the results coming from the measuring device are erroneous, because of electromagnetic interference that can occur when measuring currents with very small values (Ogruțan *et al*., 2010).

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O ANALIZĂ COMPARATIVĂ A NIVELULUI RADIAȚIILOR DIN BRAȘOV

(Rezumat)

Rezidenții unui bloc de locuințe nou, aflat în vecinătatea unui grup de antene, au acuzat probleme de sănătate, cu simptome similare cu cele produse de câmpurile electrice puternice. Se prezintă rezultatele măsurătorilor de radiații ionizante şi neionizante, în gamele de frecvențe cele mai des utilizate. Rezultatele obținute conduc la concluzia că nivelul radiațiilor neionizante rămâne în limite acceptabile, dar nivelul de Radon se află în limita de atenție.