

EMF MEASUREMENTS IN THE BTS CELLULAR STATIONS OF VODAFONE ALBANIA

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Abstract: The paper focuses on the field measurement, procedures, narration, and the used equipment. The Vodafone Albania is one the two mobile operators offering GSM services to the Albanian market. The need of having an independent estimation of the EMF, in the nearby of the BTS Stations, drove the Vodafone to refer to the electronic department of the UPT. The presented paper refers to the measurements of only one of 150 measured sites. The methodology, and Equipments used are the same in every site survey. The final report is published in the official website of the UPT, and linked from the website of the Vodafone Albania.

Keywords: Electric field, magnetic field, Wandel-Goltermann, BTS (base transceivers station).

Polytechnic University of Tirana (UPT) has expertise in the field of human exposure assessment to radio-frequency fields. Work performed includes site surveys, numerical predictions (computer simulations) and the interpretation and establishment of guidelines for limiting exposure. For the past three years UPT has focused its efforts in this area on the assessment of human exposure to cell phone technologies. These include measurements and numerical predictions of exposure to cell phones and base station antennas. UPT publishes its research results in international peer reviewed literature and has written numerous technical reports on base station site surveys performed on request from Vodafone AL

Vodafone AL has asked UPT to assist in a countrywide base station school site survey. The aim of the survey is to measure the electromagnetic radiation on school grounds where Vodafone base stations have been installed and to compare the measured results to the ICNIRP guidelines for limiting exposure.

Table 1. Glossary of term and abbreviations

BCCH	Broadcast Channel.
dB	Decibel.
GPS	Global Positioning System.
ICNIRP	International Commission on Non-Ionizing Radiation Protection.
MHz	Megahertz.
RF	Radio-frequency.
W/m²	Watts per square meter.

The equipment used for the measurement in the survey is the Wandel&Goltermann EME-300 probe 8.3. Date of calibration is the 24.05.2005. Calibration was performed by Narda Germany. The calibrated field strength

measuring system Wandel & Goltermann type EMR-300 consists of the following three components:

- Field probe (type 8.3) to measure the electrical field strength
- Readout unit (EMR-300) in a separate case and connected through a fiber optical link with the
- Optical to serial interface

Technical data (according to manufacturer's specifications)

Frequency range 100 KHz...3GHz

Field strength display range 1...600V/m.

The instrument can record and store instantaneous, maximum and mean values of electric and magnetic field values. According to all European and International standards, the measured values in the frequency range 100 kHz – 10 GHz should be expressed in any 6 minute time period. In the measuring set up used, acquisition, storage and processing of the measurements data is controlled with a portable pc via a double optical interface and special software. The duration of measurements was six minutes for each quantity (electric and magnetic field strength and power density).



Fig.1 –Picture of the BTS and Equipment, during the measurement

The acquisition and the storage of all measured values is controlled with a portable powerful PC which controls the instrument via a special software (ETS-1 of Wandel – Goltermann), adjusting all functional and measurement parameters. This computer system is using a double optical fiber interface to an RS 232 input and the abovementioned software package for acquisition, storage and processing of the field values. The instrument is placed on a specially designed non-conductive wooden tripod and measurements are taken in a height of 2 m above ground. The measurement procedures followed were based on internationally established procedures for radio-frequency exposure assessment together with policies and procedures, developed by Vodafone Al.

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Measurements have been performed according to the following standards:

- “Measurement of exposure to radiofrequency electromagnetic fields – Field Strength in the frequency range 100 kHz to 3 GHz”, EN 61566:1997, IEC 61566: 1997.
- “Measurement and evaluation of high frequency (9 kHz to 300 GHz) electromagnetic fields with regard to human exposure”, IEC 61983, Draft, Ed.1.0, 02-04-2001.
- “Recommended practice for the measurement of potentially hazardous electromagnetic fields - RF and microwave”, IEEE Standard No.C95.3-1991.

Table 2. Reference Values for GSM 900MHz Band

Electric Field Strength	41.25V/m
Magnetic Field Strength A/m	0,111 A/m
Power Density	4,5W/m²

Table 3. Reference Values for GSM 1800MHz Band

Electric Field Strength	58.34V/m
Magnetic Field Strength A/m	0,157 A/m
Power Density	9 W/m²

Table 4. Site information

Site Name:	Vasil Shanto
Site Location:	Tirane

Table 5. Antenna and Transceiver Specifications

Parameter	Sector 1	Sector 2	Sectors3
Frequency Bands	GSM900	GSM900	GSM900
Antenna Make	Celwave	Cetwave	Celwave
Antenna Type	APXV90-1814B	APXV90-1814B	APXV90-1814B
Gain (dBi)	15.7	15.7	15.7
Number of Transceivers	2	3	3
Transmit Cower per Transceiver (W)	20	20	20
Losses (dB):Combiner / Duplexer/Cable	2.8	2.8	2.8
Elevation Beam Width [Deg]	9	9	9
Azimuth Beam Width (Deg)	72	72	72
Electrical Tilt Angle (vdown / -up)	8	8	8
Mechanical Tilt Angle (+down / -up)	5	0	3
Front to Back Ratio (dB)	26	26	26
Beam Direction from True North	50	170	280
Antenna Height above Ground	16	16	16
BCCH Channel Frequency (MHz)	941.6	945.6	944.2

Technical staff of UPT trained in base station site surveys performed the measurements. The auditing process undertaken by UPT involves the processing of measured results and ensuring that the measured data reported is consistent with the typical radio-frequency field values that could be expected from the type and number of transmitters and antennas installed at the site. The reported results provide information on the exposure at the specific location and the specific time of the survey. Nonetheless, it can be concluded with confidence that, unless the site hardware (transmitters and antennas) is changed, the results in this document represent the typical exposure conditions present at the school ground. Furthermore, it can be concluded with confidence that the exposure at any location on the school ground where children have free access is hundreds of times below the ICNIRP guidelines for limiting exposure.

Table 6. List of areas where measurements were performed

Location Identity	Description
P1	25m From tower, direction of sec A.
P2	40m From tower, direction of sec A.
P3	25 m From tower, direction of sec C.
P4	Corner of building 1, between sec C&B 5 m
P5	3 m , direction of sec A.
P6	2 m between sec B&C.
P7	2nd Floor building 4, direction of sec C.

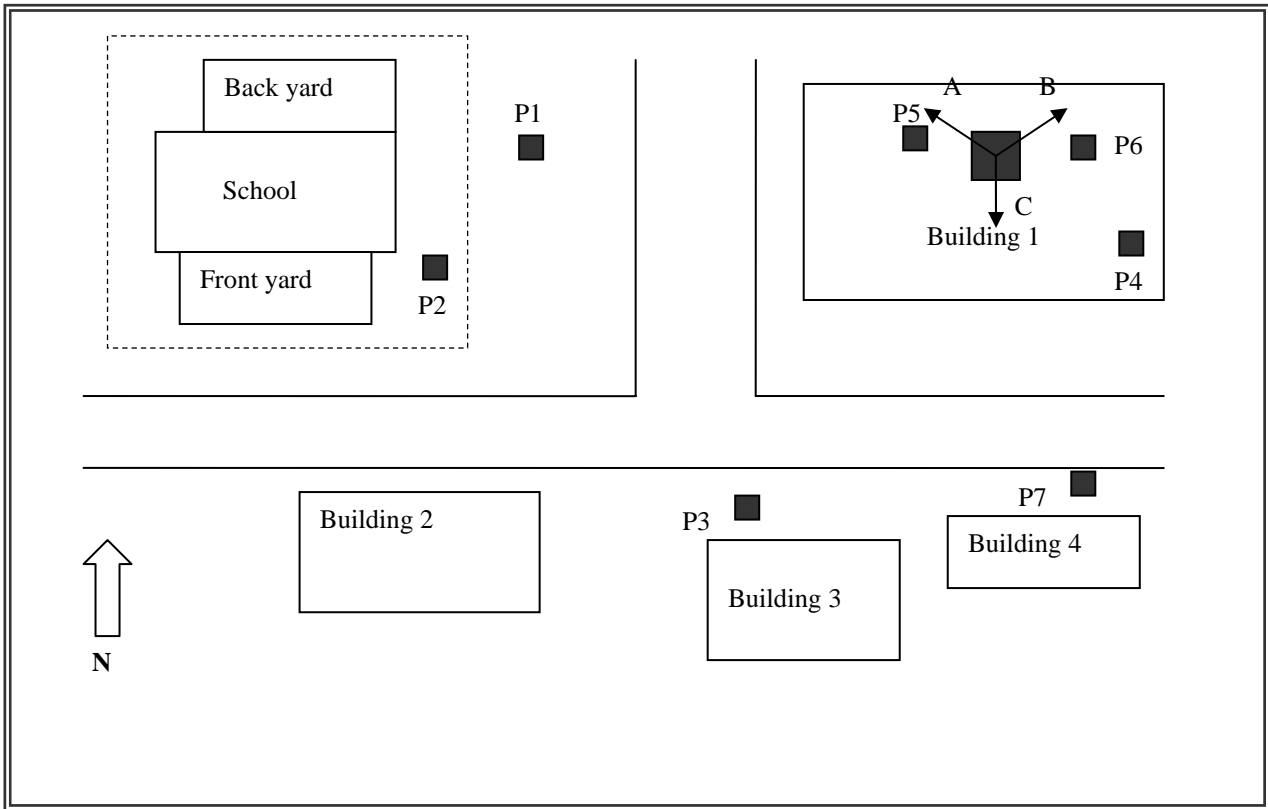


Fig.2 –Map of the BTS relative position to the School and living area

Magnetic field strength value versus time and the reference value $H = 0.111 \text{ A/m}$

Site Survey Results on different points

Table 7. Position of P1

Measurement number	1
Location description	25m From tower, direction of sec A.
Location on map	P1

Electrical field strength value versus time and the reference value $E = 41, 25 \text{ V/m}$

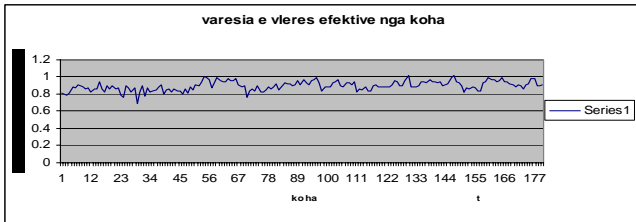


Fig.3 Graph from spectrum analyze data of Electrical field strength value versus time on the point P1



Fig.4 Graph from spectrum analyze data Magnetic field strength value versus time on the point P1

Table 8. Position of P2

Measurement number	2
Location description	40 m From tower, direction of sec A.
Location on map	P2

Electrical field strength value versus time and the reference value $E = 41, 25 \text{ V/m}$

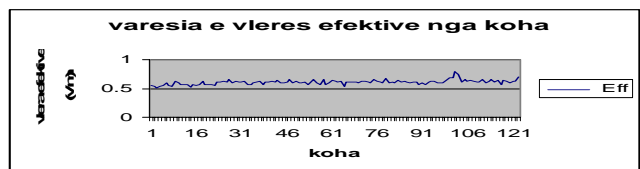


Fig.5 Graph from spectrum analyze data of Electrical field strength value versus time on the point P2

Magnetic field strength value versus time and the reference value $H = 0.111 \text{ A/m}$

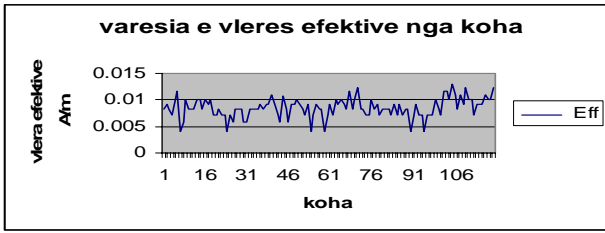


Fig.6 Graph from spectrum analyze data Magnetic field strength value versus time on the point P2

Table 9. Position of P3

Measurement number	3
Location description	25 m From tower, direction of sec C.
Location on map	P3

Electrical field strength value versus time and the reference value $E = 41, 25 \text{ V/m}$

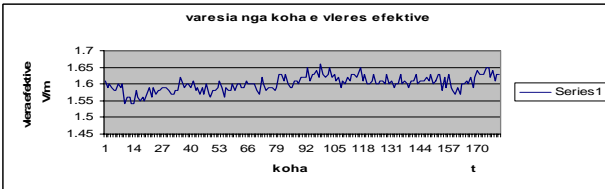


Fig.7 Graph from spectrum analyze data of Electrical field strength value versus time on the point P3

Magnetic field strength value versus time and the reference value $H = 0.111 \text{ A/m}$

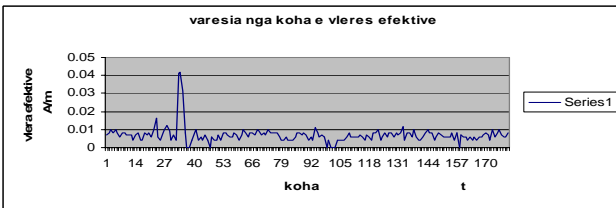


Fig.8 Graph from spectrum analyze data Magnetic field strength value versus time on the point P3

Table 10. Position of P4

Measurement number	4
Location description	Corner of building 1, 5 m
Location on map	P4

Electrical field strength value versus time and the reference value $E = 41, 25 \text{ V/m}$

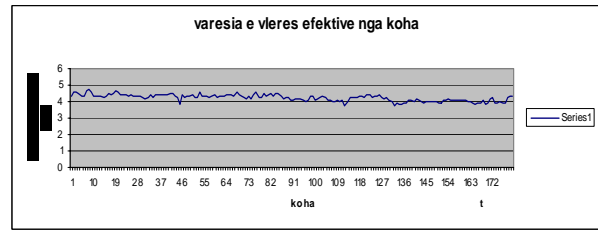


Fig.9 Graph from spectrum analyze data Magnetic field strength value versus time on the point P4

Magnetic field strength value versus time and the reference value $H = 0.111 \text{ A/m}$

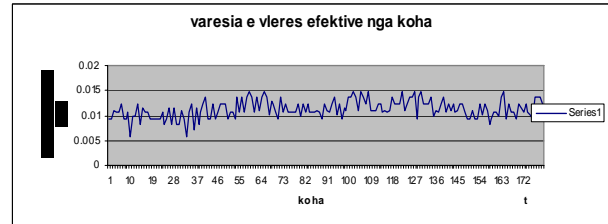


Fig.10 Graph from spectrum analyze data Magnetic field strength value versus time on the point P4

Table 10. Position of P5

Measurement number	5
Location description	3 m , direction of sec A.
Location on map	P5

Electrical field strength value versus time and the reference value $E = 41, 25 \text{ V/m}$

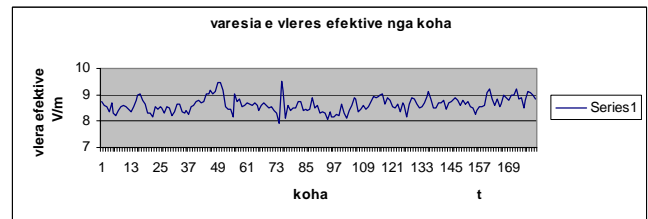


Fig.11 Graph from spectrum analyze data of Electrical field strength value versus time on the point P5

Magnetic field strength value versus time and the reference value $H = 0.111 \text{ A/m}$

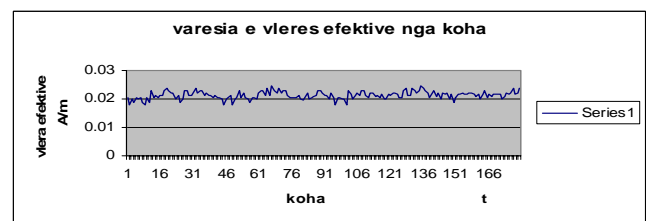


Fig.12 Graph from spectrum analyze data Magnetic field strength value versus time on the point P5

Table 11. Position of P6

Measurement number	6
Location description	2 m between sec B&C.
Location on map	P6

Electrical field strength value versus time and the reference value $E= 41, 25$ V/m.

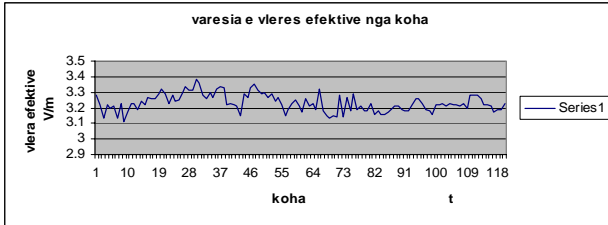


Fig.13 Graph from spectrum analyzes data of Electrical field strength value versus time on the point P6.

Magnetic field strength value versus time and the reference value $H= 0.111$ A/m.

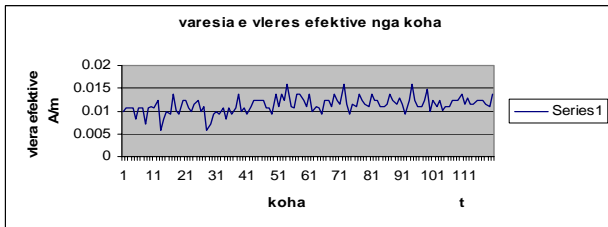


Fig.14 Graph from spectrum analyzes data Magnetic field strength value versus time on the point P6.

Table 12. Position of P7

Measurement number	7
Location description	2nd Floor building 4, direction C
Location on map	P7

Electrical field strength value versus time and the reference value $E= 41,25$ V/m.

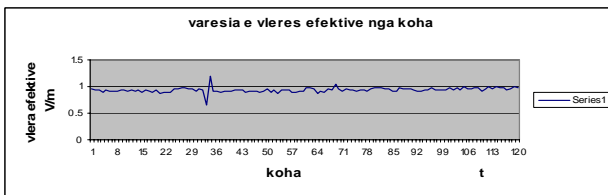


Fig.15 Graph from spectrum analyzes data of Electrical field strength value versus time on the point P7.

Magnetic field strength value versus time and the reference value $H= 0.111$ A/m.

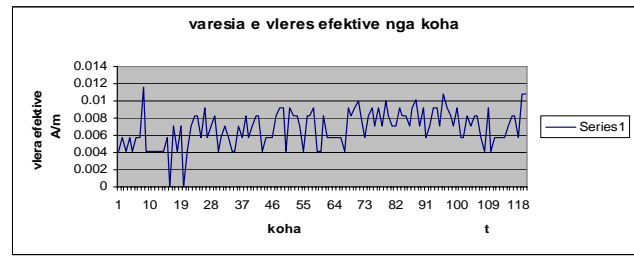


Fig.16 Graph from spectrum analyzes data Magnetic field strength value versus time on the point P7.

The Final conclusions for the School area

The table with average values of E, H, and P for any of 7 points were taken measures.

Table 13. Average of E, H, and P

Location Identity	Average of E (V/m)	Average of H (A/m)	Average of P (W/m ²)
P1	0.8825	0.006911	0.006098958
P2	0.67725	0.007642	0.005175545
P3	1.601278	0.007008	0.011221756
P4	4.229389	0.011267	0.047652526
P5	8.6355	0.021349	0.18435929
P6	3.2315	0.011338	0.036638747
P7	0.936167	0.006838	0.00640151

The table with average values of E, H, and P for any of seven points were taken measures gives these results for average of P

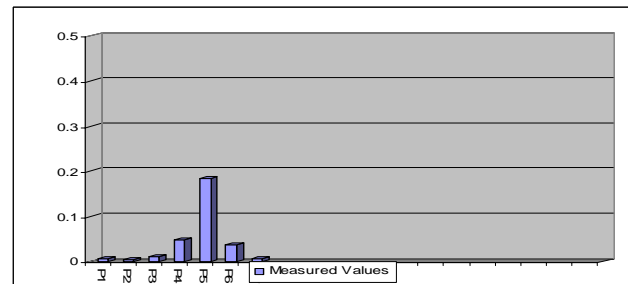


Fig.17 Graph from average of P

Diagram for Density of Radiated Power (W/m²) in all 7 Points.

The E.U Recommendations and ICNIRP Limit Value of Density of Radiated Power for 900 MHz is: 4.5 W/m².

Below is the graph which show average of Electrical field

Diagram for electrical field (V/m) in all 7 Points.

E.U Recommendations and ICNIRP Limit Value

for 900 MHz (41.25V/m)

E.U Recommendations and ICNIRP limit Value

for 10-400Mhz (28V/m)

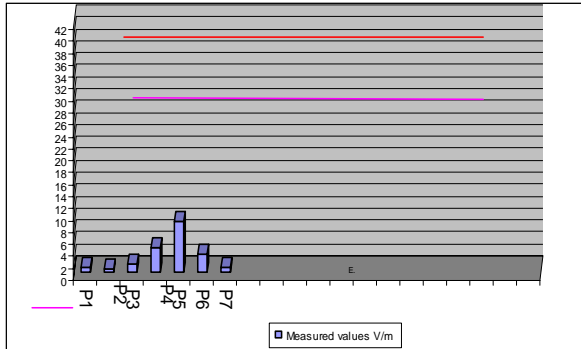


Fig.18 Graph from average of E.

Diagram for magnetic field (A/m) in all 7 Points.

E.U Recommendations and ICNIRP Limit Value

for 900 MHz (0.11nA/m)

E.U Recommendations and ICNIRP limit Value

for 10-400 MHz (0.073 A/m)

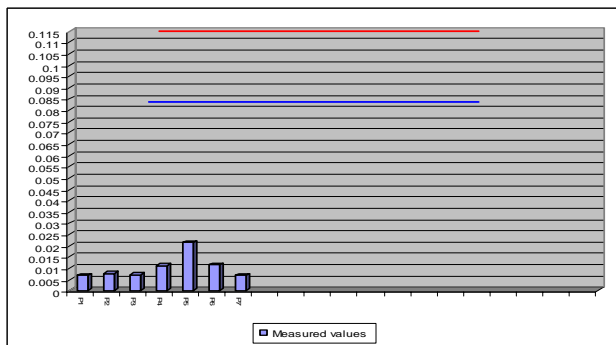


Fig.19 Graph from average of H.

The tables with the results of measurements, are checked against the reference values of the European Council's recommendation of 12 July 1999 (1999/519/EC) (recommendations which adopts the values of the ICNIRP's guidelines stated in "Guidelines for limiting exposure to time-varying electric, magnetic and electro-magnetic fields up to 300 GHz" – Health physics Vol. 74, April 1998). Our comments are as following:

Electric field strength. The results of the measurements for all the locations are found to be below the reference values from the above mentioned institutions. The reference values of the EF for the 900 and 1800 MHz band are respectively 41,25 V/m and 58,34 V/m, As you

can see from the tables the values we measured are everywhere less than 12V/m.

The magnetic field strength, measuring is below the reference value 0,111 A/m, defined in the European Council's recommendation. The maximum figure for the MF is 0,03 A/maths values are many times lower than even the strict limit set for the band 10 – 400 MHz, which is only 0,073 A/m,

Concerning power density, the results for all locations measured were below the reference values as defined in the European Council's recommendation. These values are many times lower than even the strict limit set for the band 10 – 400 MHz, which is only 2 W/m² while for the 900 and 1800 MHz band the limit values are respectively 4.5 W/m² and 9 W/m².

As conclusion, it must be stated that as shown from the above mentioned measurement results, for all the examined sites, no place in access to the general public, has excess of the reference values.

REFERENCES

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Mr. Argenti Lala studied at the Polytechnic University in Tirana, near the Faculty of the Electrical Engineering, the Electronics Department. He finished his studies in 1999, being qualified as

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