Original Research Papers

INVESTIGATION OF RADIO-FREQUENCYPOWER DENSITY DISTRIBUTION AROUND GSMMAST IN KEFFI TOWN, NIGERIA

ABSTRACT

In this study, an investigation of radiofrequency power density distribution around GSM mast in Keffi town, Nigeria was determined. Radiofrequency meter(Electrosmog ED- 155A) was used to measure the EM radiation at 50, 70, 90,110, 130, 150, 170, and 190m away from mobile base stations. A total of fifteen mobile base stations were randomly selected in Keffi town covering about four network providers (MTN, Globacom, Etisalat, and Airtel), according to their proximity to buildings, number of antennas mounted on their masts, how close they are to other base stations and the population density around them.The result reveal that MBS5 was found to have the highest value of average power density compared to that of the remainder, with a contribution of about 16% (2908.38 $\mu W/m^2$). The least contribution was recorded in MBS3 with only about 1% (173.71$\mu W/m^2$). The other MBS with significant contribution are MBS6 (15%), MBS11 (15%), MBS10 (13%), MBS8 (13%) and MBS13 (11%) with average power densities of 2878.72$\mu W/m^2$, 2767.28$\mu W/m^2$, 2385.43 $\mu W/m^2$, 2382.70 $\mu W/m^2$, and 1996.36 $\mu W/m^2$ respectively. The findings reveal that the measured values of power densities across all the sites are well below the RF radiation exposure safety limit set by International Commission on Non-ionizing Radiation Protection(ICNIRP) when compared with the findings in this study. Therefore, RF radiation exposure from mobile base stations in Keffi town may pose no health risk to the people living within the area.

Key words: Mobile base station, Radio-frequency radiation, Power density and RF meter.

INTRODUCTION

Mobile communications technology are now common in Nasarawa State particularly Keffi town. The introduction of communication systems in the year 2002 in Nigeria has increased radiofrequency radiation exposure of the general public to telecommunications and mobile base stations [1].

There is widespread public concern about the potential adverse health effects of mobile phones and especially their associated base stations alongside with hundreds of apparently conflicting reports in the media about the health effects of mobile phones and base stations as reported by

Zenon [2]. Studies have shown that exposure levels of about 3kHz-5MHz generates painful nerves impulses while 100kHz-3GHz leads to temperature rise of the body and frequencies of 300GHz can change the cellular DNA and initiate a carcinogenic transformation [3]. In medicine, it is used for the treatment of liver cancer, cosmetic surgery, sleep Apnea, Snoring, rapid heartbeat syndrome etc, [4].

The increased use of mobile phone has led to increased deployment of base stations. There are two sources of radiofrequency radiation exposure from the mobile telephone system: base station antenna and mobile phone.Exposure from base station antennas is continuous and it irradiates the whole body and expose an entire community in different ways according to position and separation distance. The mobile phone system works as a network containing base stations within each cell. These base stations can link with a number of handsets. The mobile phone and base stations communication with each other, sharing a number of operation frequencies [5, 6].

A cellular phone transmits 1 to 2 Watt of power inthe frequency range of 824-849 MHz (CDMA),890-915 MHz (GSM900), 1710-1780 MHz and1805-1880MHz (GSM 1800). In Nigeria, theSpecific Absorption Rate (SAR) limit for cellphones is 1.6W/kg, which is actually for 6minutes per day usage [7]. It has asafety margin of 3 to 4, so a person should notuse a cell phone for more than 18 to 24 minutesper day. This information is not commonly knownto most people in Nigeria, so people use cellphones for more than an hour per day withoutrealising the related health hazards [8, 9].

MATERIALS AND METHOD

Measurement of Electromagnetic radiationwas carried usingRF Meter (Electrosmog ED- 155A). The RF meter is a frequencyweightedbroadband device for monitoring highfrequencyradiation in the specific ranges of900MHz, 1800MHz, and 2.7GHz. Measurements of power density were made by simply pointing the RF meter to the source of the RF radiation. A maximum of 190m radial distance from the foot of the base station was considered and measurement were taken at 20 m interval from each base station starting with 50m. The proximity of residential buildings, office buildings and schools to base stations forms the bases for choosing this range of distance. A total of fifteen (15)mobile base stations were randomly selected in Keffi towncovering about four (4) network providers –MTN, Globacom, Etisalat, and Airtel,according to their proximity to buildings, number of antennas mounted on their masts, how close they are to other base stations and the population density around them.

The meter was set to the triaxial measurement mode and also to the maximum instantaneous measurement mode, to measure the maximum instantaneous power density at each point. Each measurement was made by holding the meter away from the body, at arm's length and at about 1.5m above the ground level pointing towards the mast as suggested by Victor et al [10]. The values of the measured Electric field taken after the meter is stable (about 2 min) were recorded. We ensured that the measured values were not influenced by unwanted sources and disturbances. Such precautions taken were to avoid the movement of the meter during measurements and excessive field strength values due to electrostatic charges. We also ensured (where possible) that phone calls and movement of cars were reduced before taking measurements. Global

positioning system (GPS) was used to take the geographical location of the MBS investigated as shown in Table 1.

Table 1. Geographical locations of the Mobile Base Stations investigated.

Base Stations	Geopoints	
	Latitude	Longitude
MBS1	N8^{0}51’10.5408’’	E7^{0}52’59.34’’
MBS2	N8^{0}49’40.662’’	E7^{0}52’35.262’’
MBS3	N8050’2.25’’	E7^{0}52’32.448’’
MBS4	N8^{0}50’47.766’’	E7^{0}51’55.416’’
MBS5	N8^{0}50’49.674’’	E7^{0}51’59.91’’
MBS6	N8^{0}50’41.274’’	E7^{0}52’30.744’’
MBS7	N8^{0}50’48.096’’	E7^{0}52’41.526’’
MBS8	N8^{0}50’52.866’’	E7^{0}52’44.298’’
MBS9	N8^{0}50’17.34’’	E7^{0}53’3.474’’
MBS10	N8^{0}51’25.788’’	E7^{0}52’1.83’’
MBS11	N8^{0}51’32.268’’	E7^{0}51’57.528’’
MBS12	N8^{0}51’20.592’’	E7^{0}52’55.644’’
MBS13	N8^{0}51’19.176’’	E7^{0}53’21.636’’
MBS14	N8^{0}51’34.002’’	E7^{0}53’48.042’’
MBS15	N8^{0}51’14.436’’	E7^{0}53’56.388’’

The meter measures the value the electric field Eand converts it into the magnetic field **H** and the power density **S** using equation (1) [ICNIRP, 1998]. The RF meter was set to display the value of power density S. The power density values were converted to μW/m^{2}from mW/m^2 taken from the RF meter display. The conversion formula is given as:

$$S = EH = \frac{E^2}{377} = 377\Omega H^2 \quad (1)$$

The meter can also measure electric field E along a differentaxis, but readings can also be taken in all Es atthe same time (Triaxial) using:

$$E^2 = E_x^2 + E_y^2 + E_z^2 \quad (2)$$

Where E_x, E_y and E_z are the electric field in x, y and $z$coordinate directions.

RESULTS AND DISCUSSION

The results of the measured power density S for all the mobile base station investigated is shown in Table 2.We observed that MBS5 was found to have the highest value of average power density compared to that of the remainder, with a contribution of about 16% (2908.38 μW/m^2) as shown inTable 3 and Figures 1. The least contribution was recorded in MBS3 with only about 1% (173.71μW/m^2). The other MBS with significant contribution are MBS6(15%), MBS11 (15%), MBS10 (13%), MBS8 (13%) and MBS13 (11%) with average power densities of 2878.72μW/m^2, 2767.28μW/m^2, 2385.43μW/m^2, 2382.70 μW/m^2, and 1996.36 μW/m^2 respectively.

Table 2: Measured Power Density of surveyed MBS at 20 m distance interval

Base station	Distance from the antenna (m)							
	50	**70**	**90**	**110**	**130**	**150**	**170**	**190**
MBS1	399.08	200.40	370.50	178.60	215.30	330.90	209.81	303.40
MBS2	663.70	694.23	937.12	303.30	491.99	619.51	390.79	205.00
MBS3	246.50	120.70	224.54	191.00	105.89	195.80	176.60	128.61
MBS4	1180.02	332.23	208.29	325.90	711.55	679.00	797.98	341.83
MBS5	4803.70	3294.41	3999.90	3564.43	1827.59	1592.72	2919.45	1264.87
MBS6	3403.11	3235.54	4540.18	3450.30	2835.54	1914.24	1294.43	2356.40
MBS7	510.12	304.32	448.68	178.61	163.71	235.32	304.00	299.13
MBS8	3524.43	3100.70	2324.21	2766.33	1827.23	1826.90	1294.65	2397.18
MBS9	247.31	102.70	125.80	192.45	132.71	294.44	277.21	178.60
MBS10	3400.10	2235.51	3600.72	3500.33	2935.62	1814.11	1340.65	256.40
MBS11	3490.70	3294.12	3990.12	3540.66	1923.81	1814.87	2809.11	1274.85
MBS12	399.23	210.40	180.31	180.57	117.12	250.56	309.43	358.40
MBS13	3440.44	1240.50	1550.24	2330.33	1826.32	1920.23	1300.71	2362.12
MBS14	236.65	130.23	234.13	320.32	200.43	110.39	196.12	180.09
MBS15	987.12	912.22	450.22	380.39	216.50	430.98	430.98	310.44
Mean	**1795.48**	**1293.88**	**1545.66**	**1426.90**	**1035.42**	**935.33**	**936.79**	**814.49**

Table 3: Mean power density of each Mobile Base Station and their percentage (%) contribution

Base station	**Average Power density ($\mu W/m^2$)**	**Percentage Contribution (%)**
MBS1	276.00	2.0
MBS2	538.21	3.0
MBS3	173.71	1.0
MBS4	572.10	3.0
MBS5	2908.38	16.0
MBS6	2878.72	15.0
MBS7	305.49	2.0
MBS8	2382.70	13.0
MBS9	193.90	1.0
MBS10	2385.43	13.0
MBS11	2767.28	15.0
MBS12	250.75	1.0
MBS13	1996.36	11.0
MBS14	201.05	1.0
MBS15	514.86	3.0

Significant fluctuation in datacollection during measurement was observed. It is expected that the variation of the power fluxdensity should obeys inverse–square-law ($P_t /4\pi R^2$) asyou move farther away from the reference mobile base station. The measured power fluxdensities however

deviated as shown in Figure 2. This deviation could result fromeither of the following: obstruction constituted by immobile structures placed or erected within the line of sight of measurement; wave interference from other sources of electromagnetic radiation around reference base station such as radio and TV antennas, receivers etc; interference from radiation and/or noise from moving objects such as vehicles, motorcycles etc; topography (or elevation) of the land area around reference base station with respect to radial distance away from base station; and wave interference from other mobile base stations clustered around a reference base station.

The graph in Figure 2 shows that power flux densitydecreases exponentially with distance. That is atdistance, d= 0, the power density S ismaximum and ford> 0, the power densitydecreases exponentially.

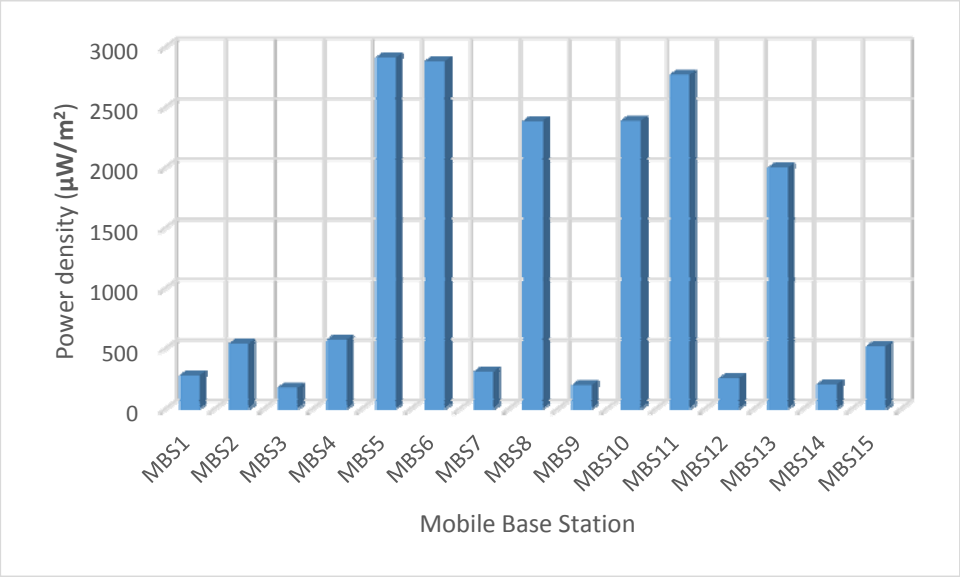

Figure 1: Mean power density of each MBS

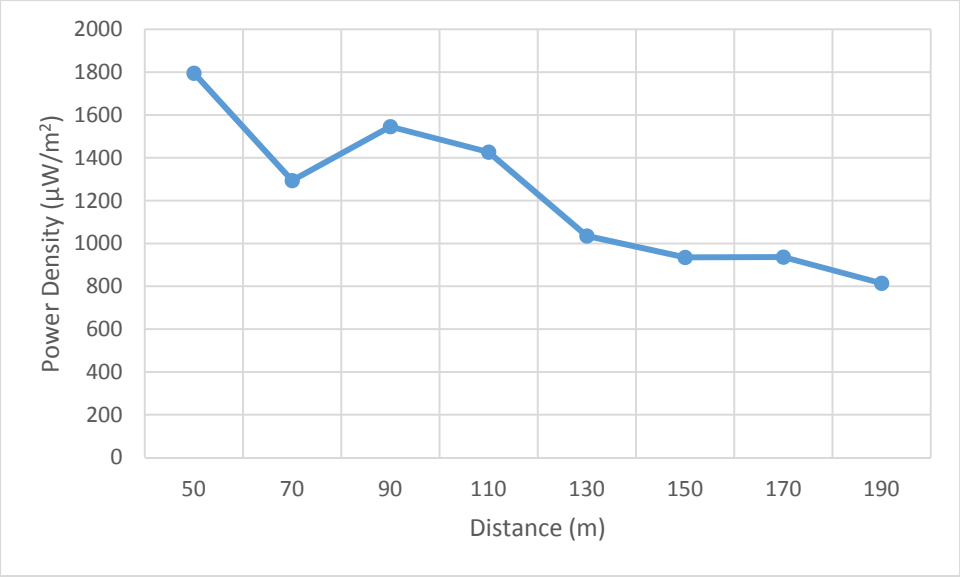

Figure 2: Mean power flux density vs distance plot for all Mobile Base Station

The effects from excessive power density can lead to headaches, concentration difficulties and behavioral problems in children and adolescents; and sleep disturbance headaches and concentration problems in adults. Other long term effect of Power density can cause loss of memory and cancer that will be experienced after severe years of exposure. 900 mHz emission has the effect of thermal heating of body tissue.

CONCLUSION

Over the years, a lot of work has been done to understand how radiofrequency (RF) radiation interacts with matter. Different instruments have been use to study the health impact of non-ionizing radiation which includes environmental health assessment and epidemiological surveys to assess the level of RF exposure in the environment.The present study was carried out to determine the RF radiation exposure from mobile base stations (MBS) in Keffi town, Nasarawa State, Nigeria. It has been observed from the findings that the measured values of power densities across all the sites are well below the RF radiation exposure safety limit set by ICNIRP for the general public and occupational exposure when compared with the findings in this study. Therefore, RF radiation exposure from mobile base stations in Keffi town may pose no health risk to the people living within the area. It is recommended that mobile network providers should site mobile base stations at least 50 m distance away from residential building areas, school buildings, office buildings and so on.

REFERENCE

1. Ibitoye ZA, AwedaAM..Assessment of radiofrequency power density distribution around GSM and broadcast antenna masts in Lagos City, Nigeria Nig," *QJ Hospital Med.*2011, vol. 21, pp. 35-40.
2. Zenon S.*Biological effects of electromagnetic fields and radiation*, The review of Radio science 1990-1992 ed. W.R Stone. New York: Oxford University1998 Press pp. 737-770,.

3. Cember H, Johnson T E. *Introduction to health physics*, 4th ed. New York: McGraw-Hill Company Inc, 2009.
4. JeffreyS B, Gary M M,.*Modern electronic communication,* 9th ed. pp. 4-5. ISBN 978-013 2251136, 2008.
5. Mohammed Idriss. Ahmed, Mohammed Osman Sid Ahmed, Hafiz F.AL Rahman, IsamSalihM .Mousa and HajoIdriss Investigation of electromagnetic radiation emitted from mobile base stations in Khartoum State*. International Journal of Scientific and Research Publications, Volume 6,* Issue 4, April 2016 98 ISSN 2250-3153
6. U. Bergqvist, G. Friedrich,Y.Hamnerius,L.MartensG.Neubauer,G.Thuroczy, E.Vogel and J.Wiart, "Mobile Telecommunication Base Stations Exposure of Electromagnetic Field", Report of a short Term Mission on Base Statation Exposure with COST244bits, 2001, pp. 1-77.
7. ICNIRP Publication: 1998, '*ICNIRP Guidelines for limiting exposure to time-varying electric, magnetic and Electromagnetic fields*'. Health Physics, 74(4), 494-522
8. Bashir M. A,OyedumO. D., Tyabo MA, and Muraina N. An Assessment of Human Exposure to RF Radiation from Mobile Transceiver Stations in Minna, Okene and BirninKebi, Nigeria. *Physical Science International Journal. 18(3): 1-5, 2018; Article no.PSIJ.38409 ISSN: 2348-0130*
9. Adekunle A, Ibe KE, Kpanaki ME, Umanah RI, Nwafor CO, Esseng NA. Evaluating the effects of radiation from cell towers and high tension power lines on inhabitant of Buildings in Ota, Ogun State. Journal of Communications in Applied Sciences. 2015;3(1):1-21.
10. Victor U. J. N., Nnamdi N. J., Silas S. D., Abraham A. O., and Patrick U. Assessment of Radio-Frequency Radiation Exposure Levels from Selected Mobile Base Stations (MBS) in Lokoja, Nigeria. *IOSR Journal of Applied Physics Volume 3, Issue 2 PP 48-55*