International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-9 Issue-1, October, 2019

Variation in Radio Frequency Power and Field Intensity Value on Fixed Distance from Different Mobile Base Stations in and Around Symbiosis International (Deemed University), Lavale, Pune

Priyanka Tupe-Waghmare, Sushma Parihar, Aditya Jain

Abstract: ***The variations of radio frequency power on fixed distance from different mobile base stations on five selected locations in Pune, India have been studied and presented in this article. In this study the field locations with various exposure rates are selected according to the number of antennas installed on a mobile base station, height and operating frequency of the antenna respectively. All the measurements have been carried out with the help of R&S FSH4 with R&S®TS-EMF hand held spectrum analyzer. The experimental results demonstrated that the radio frequency radiation (RFR) emission of all frequency bands (GSM 900/1800, CDMA 1800) is far less than the recommended guidelines of ICNIRP.***

Keywords: ***International Commission on Non-Ionizing Radiation Protection (ICNIRP), Radiation Exposure Software (RFEX), Root Mean Square (RMS), Base Transceiver Station (BTS).***

I. INTRODUCTION

In recent years, number of mobile subscribers has been increased immensely due to the advancement in the telecommunication market (like 2G, 3G, LTE, WLAN etc). This leads to need for installation of several wireless networks and mobile base stations at various locations near commercial and residential areas. Also several operators are increasing RF power of the cell towers to meet the high demand from the customers in selected regions. The proximity of schools, colleges and hospitals with mobile base stations creates an anxiety to know about the exposure ratio around it.

Revised Manuscript Received on October 30, 2019.
* Correspondence Author
Priyanka Tupe-Waghmare*, Department of E&TC Engineering, Symbiosis Institute of Technology, Symbiosis International University, Pune, Maharashtra-India priyanka.tupe@sitpune.edu.in
Sushma Parihar, Department of E&TC Engineering, Symbiosis Institute of Technology, Symbiosis International University, Pune, Maharashtra-India sushmap@sitpune.edu.in
Aditya Jain, Department of E&TC Engineering, Symbiosis Institute of Technology, Symbiosis International University, Pune, Maharashtra-India aditya.jain@sitpune.edu.in

RF radiation levels vary from location to location, point to point due to the local amplification, absorption and reflection caused by the surrounding buildings [1]. Theoretically, RF power density is inversely proportional to square of distance [2]. This theoretical relationship explains as the distance from the antenna increases, intensity of emitted radiation decreases with the square of distance from antenna.

$$\text{Power Density} \propto 1/\text{distance}^2 \quad \ldots\ldots\ldots (1)[2]$$

The relation shown in equation 1 is ideal for power density calculation if there is no obstruction between point of measurement of antenna [2]. Considering a realistic free space RF propagation model for the calculation of power density at a distance r (meters) from far field of a transmitting antenna with G as gain, transmitted power Pt and received power Pr in Watt, it is given as

$$\text{Power Density (PD)} = Pt*G/4\pi r^2 \quad \ldots\ldots\ldots (2)[2]$$

The factors that attribute to EMF radiation are operating power of the antennas, radio frequency radiated from several packets (eg. GSM, CDMA band), frequency/wavelength of radio frequency signal being transmitted, height of the installation of antennas, exposure from other antenna's located in that area [1],[3].

International bodies like World Health Organization (WHO) and International commission on Non-ionizing radiation protection (ICNIRP) have taken a several measures to prevent health effect from RF radiation exposure. For installation or setup of any new mobile base station, service providers should follow certain rules and regulations of safety guidelines (ICNIRP) followed by India [1],[3].

In order to study the variation of radio frequency power variation and field intensity value at various locations in and around Symbiosis International University Lavale, Pune are - Location-1-Sus-gaon -latitude (18º, 33'12.257") and longitude (73º, 45', 14.928"), Location-2-Sai-chowk -latitude (18º, 32'36.822") and longitude (73º, 47', 6.228"), Location-3-Lupin Pharmaceuticals ,Inc. campus-latitude(18º,32',24.843") and longitude(73º,43',48.534"), Location-4 Symbiosis International University hilltop -latitude(18º,32',24.843") and longitude(73º,43',48.534"), Location-5 Symbiosis International University hill top -latitude(18º,32',24.6843") and longitude(73º,43',47.534"). The locations are selected according to operating frequency, height of installation of antennas [4].

II. EXPERIMENT SETUP

All the base stations transmitters are located in the area with medium population density

and situated on the rooftops. Five different locations are selected for measurement of power density and electric field value. The average height at which the antenna installed at a rooftop is 40-50 meters, 80-100 meters, 30-40 meters for the first three locations. There are three antennas installed at the mobile base station at location 1 and more than three for the other locations. At location number 4 and 5, the base stations are installed on the ground and the average height of antennas installed on mobile base station is around 12 meters. At the fourth location, multiple base stations are installed. All the above are shown in figure no.1

For measurement of field intensity, the portable hand held spectrum analyzer by Rohde and Schwarz company is used. The Isotropic antenna, the spectrum analyzer FSH4 and radio frequency exposure software are used for the measurement. The equipment has wide range of frequency from 9 KHz to 3.6 GHz covering all the cellular bands [5]. In isotropic antenna, the measurement is done independent of any polarization or direction. The software analyzes the input signal for an average of 6 minutes.

Table- I : Values currently followed in India (as per ICNIRP guidelines) [1],[3],[6],[7]

Frequency Range	E-field strength (V/m)	H-field strength (A/m)	Power Density (Watt/meter^2)
400 to 2000 MHz	$0.434f^{1/2}$	$0.011f^{1/2}$	f/2000
2 to 300 GHz	19.29	0.05	1

The above table represents the prescribed guidelines recommended by ICNIRP, which is to be followed by every mobile base station tower in India. The readings taken in the paper are for the fixed distance of 15 meters from the base stations as the field behaves like a plain wave after a distance of tens of wavelength from antennas [8]. The distance is chosen so as to know radio frequency radiation in the compliant zone which is the safest zone [1], [9].

The figure 1 shows the various antennas installed on a mobile base station and height of installed mobile base stations. The readings are taken at different locations with the help of hand held spectrum analyzer and RFEX software.

III.ANALYSIS & RESULTS

After measuring the field intensity values at different locations several results were observed. The first concluding result that was observed from the set of readings is at a fixed distance from base station which is found to be under the recommended ICNIRP safety guidelines followed in India.

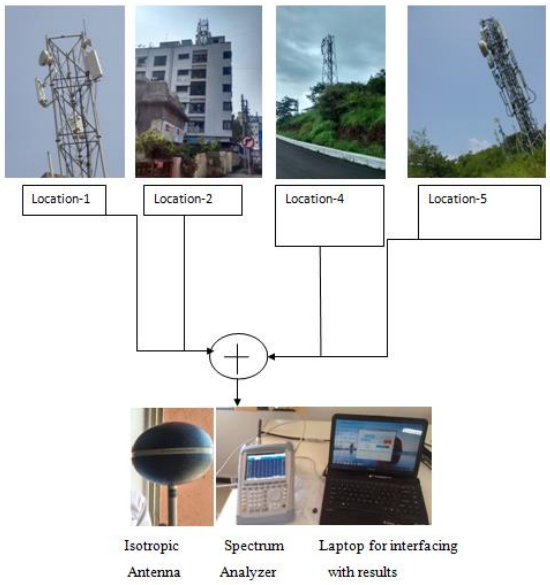

Figure1: Illustrates various locations where readings were taken and showing various mobile base stations

recommended ICNIRP safety guidelines followed in India.

Since the mobile base stations are installed at different heights, the peak field intensity value varies accordingly observed as shown in table 2

Table-II: Illustration of total field intensity value for all packets in V/m at various locations

Total field (RMS) in V/m for all packets					
Loca-tion	GSM 1800	GSM 900	CDMA 800	WLAN	Total
.	1.2278	0.1773	0.041	0.0931	1.5392
.	0.2209	0.278	0.0459	0.0779	0.6227
.	0.3471	0.5704	0.0072	0.0079	0.9326
.	3.2517	0.9141	0.4014	0.1794	4.7466
.	0.5983	0.1305	0.0222	0.1644	0.9154

The above table 2 represents maximum field intensity value of various cellular bands and corresponding maximum peak field intensity values at multiple locations. The maximum field intensity of 3.2517 V/m and the total field intensity of

4.7466 V/m were observed for GSM 1800 band at location 4 due to multiple cell towers at same location. The lowest field intensity value of 0.6227 V/m was observed for location 2 because the difference between height of the installed antennas. From the above table, the fluctuating field intensity value is observed for different packets as the effective height varies.

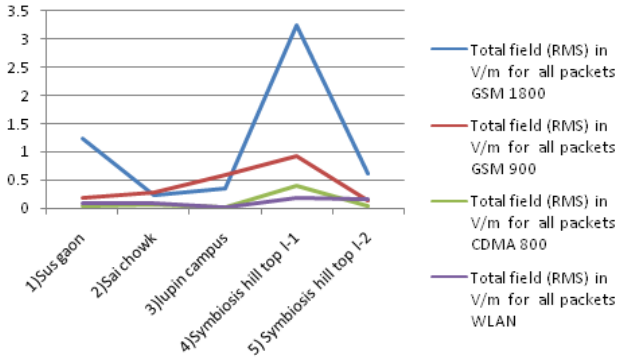

Figure 2: Illustration of variation of total field in V/m for several packets for different locations

The figure 2 illustrates the total field (RMS) compared to several locations .Here the blue line indicates the maximum peak which occurs at symbiosis hill top .From the above figure it can be clearly seen that GSM 1800 band is dominating in all the locations followed by GSM 900 band.

Table-III: Illustration of carrier frequency showing maximum field intensity value and power density value

Loca -tion	Maximum peak packet at carrier frequency MHz	Field intensity V/m	Power Density $\mu W/cm^2$
1.	GSM-1800(1826.2)	0.5601	0.0832
2.	GSM-1800(1826.2)	0.0976	0.0025
3.	GSM-900(936.8)	0.2682	0.0191
4.	GSM-1800(1832)	3.1077	2.5617
5.	GSM-1800(1832)	0.5123	0.0696

From table 3 is observed that the maximum exposure ratio is found for GSM-1800 band for the carrier frequency of 1826-1832 MHz.

The figure 3 and 4 show the maximum peak field intensity value and power density value for different carrier frequencies in different bands.

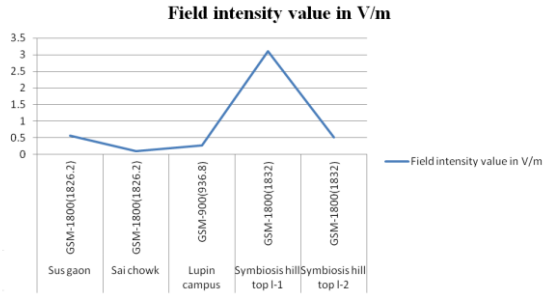

Figure 3: Illustration of peak field intensity value at particular carrier frequency for various locations with maximum exposure for different packets.

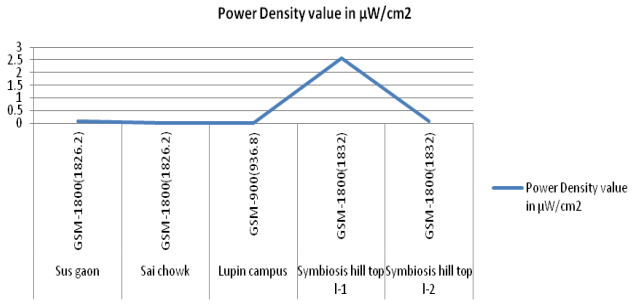

Figure 4: Illustration of power density value at particular carrier frequency for various locations with maximum exposure for different packets.

IV. CONCLUSION

All the mobile base stations are under the ICNIRP limit. The maximum exposure rate from several base stations varies according to the distance, height of installation, and the operating frequency used. There is similarity found that maximum packet field intensity and power density values is of GSM 1800 band which is around 1826-1832 MHz carrier frequency. The maximum peak intensity and power density value is found near Symbiosis International (Deemed University),Pune Lavale hill top as there are multiple towers near that location which causes maximum exposure. It is highly recommended to carefully scrutinize the variation of radiation from other sources at Symbiosis International (Deemed University), Lavale campus.

REFERENCES

1. Test Procedure for Measurement of Electromagnetic Fields from Base Station Antenna (For Telecommunication Sector) No: TEC/TP/EMF/001/02.SEP. 2012 http://www.dot.gov.in/sites/default/files/Annexures/TEC%20Test%20Procedure%20EMFields%20From%20BTS%20Antennae.pdf.
2. Ayinmode, B. O., and I. P. Farai. "Study of variations of radiofrequency power density from mobile phone base stations with distance." *Radiation protection dosimetry* 156.4 (2013): 424-428.
3. Government of India, report of the inter-ministerial committee in EMF radiation http://www.dot.gov.in/sites/default/files/1.IMC%20Report_0.pdf
4. Singh, R. "Assessment of electromagnetic radiation from base station antennas." *Indian Journal of Radio & Space Physics* 41 (2012): 557-565.
5. Portable EMF Measurement System TS-EMF and portable spectrum analyzer FSH3 and the RFEX software - Rohde and Schwarz user manual 2003.
6. Islam, Md, et al. "Radiation measurement from mobile base stations at a university campus in Malaysia." *American Journal of Applied Sciences* 3.4 (2006): 1781-1784.
7. International Commission on Non-Ionizing Radiation Protection. "ICNIRP statement on the "guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 ghz)"." *Health Physics* 97.3 (2009): 257-258.
8. Miclaus, S., and P. Bechet. "Estimated and measured values of the radiofrequency radiation power density around cellular base stations."*Romanian Journal of Physics* 52.3/4 (2007): 429.
9. Thors, Björn, et al. "On the estimation of SAR and compliance distance related to RF exposure from mobile communication base station antennas."*Electromagnetic Compatibility, IEEE Transactions on* 50.4 (2008): 837-848.

AUTHORS PROFILE

First Author Priyanka Tupe-Waghmare, Working as Assistant Professor in Electronics and Telecommunication Branch of Symbiosis Institute of Technology which comes under Symbiosis International (Deemed University).Author has completed Master in E&TC Engineering and teaching subjects related to communication engineering to the third and final year students.

Second Author Sushma Parihar, MTech Electrical Power Systems, Symbiosis Institute of Technology, Symbiosis International (Deemed University)

Third Author Aditya Jain, MTech E&TC, Symbiosis Institute of Technology, Symbiosis International (Deemed University)