ASSESSMENT OF GENERAL ELECTROMAGNETIC FIELD EXPOSURE FROM SELECTED CELLULAR MOBILE BASE STATIONS IN KOLHAPUR, INDIA

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ABSTRACT

In today's day to day life, the mobile phone is essential to every person that's why the use of mobile phone is increased tremendously in daily life; as, base stations are controlling the mobile phones activity and as they are situated in dense population areas in the city. There are great worries about the electromagnetic field exposure (EMF) from cellular base stations as they are situated in residential areas. The paper presents the assessment of general EMF exposure from cellular base stations and its analysis in terms of power density and electric field. As and when this information is published on the website the society and people will come to know the intensity of EMF exposure in surrounding areas of base stations. The average power density and electric field from base stations were recorded as 2412.16 microwatt/m^2 and 1634.07 mv/m. Results shows that the power density decreases as distance increases.. Cellular Mobile Base Stations (CMBS) 4, 10, 11, 12 are having highest contribution to electromagnetic field exposure. The average height of the mobile tower base station is found to be 125 feet. And average antennas mounted on the mobile tower were around 16. All measured EMF exposure levels were well below the reference level set by (Department of Telecom) DoT and (International Commission for Non-Ionizing Radiation Protection) ICNIRP. The goal of the paper is to measure the EMF exposure from base stations and publish the information on website for common people.

KEYWORDS: *Power Density, Cellular Mobile Base Station, Electromagnetic Field Exposure, Cellular Mobile Communication, and Handoff*

INTRODUCTION

During last one decade, there is an impressive development in cellular mobile communication. Different technologies were entered into cellular mobile communication such as GSM, CDMA, and UMTS and different versions as 2G, 3G, and 4G etc. in India.

This technological development has many advantages such as an increase in capacity, increase in coverage area, less number of handoffs etc., but at the same time there were some drawbacks, also because these technologies came with the source of electromagnetic radiation which consists of many small directional antennas on a base station tower. These antennas mounted on a cellular mobile tower radiate electromagnetic field around the surrounding area. If the cellular mobile tower is in a residential area, then surrounding people get exposed to electromagnetic field (EMF) radiated from antennas mounted on cellular mobile towers. Each antenna radiates EMF with transmitting power 2W to 10W. On an average, there are 20 antennas mounted on a cellular mobile tower [18].

In India, most of the cellular mobile base station towers were located in residential areas where population is dense then all resident people will get exposed to EMF radiation from base stations. And this is dangerous to the human health. Therefore the purpose of writing this paper is to measure and analysis the EMF exposure from cellular base stations was necessary and hence the study of EMF exposure from cellular base stations is carried out.

Till date the awareness regarding EMF exposure is less in India but more in developed countries, people from developed countries can ask about exposure levels from cellular base stations and will check whether it is below or above the reference level. This type of awareness was not seen in India. So to create the awareness among the people regarding EMF exposure, bringing the information in front of the common people is very essential.

Recent studies and surveys shows that there are certain health effects of electromagnetic radiation from cellular antennas on human being which is leaving in close proximity of the cellular base stations [5][6]. The radiation from cellular base station antennas is of Non-Ionizing radiation. It does not make any reaction with our body molecules, but still there are some adverse health effects due to this radiation, which are unknown to us and scientifically not proved. The recent studies showed different adverse health effects due to EM radiation from cellular base station antennas such as headache, thermal heating, and increase in body temperature by 1 ^{o}C, cancer, sleep disorders, dizziness, nervousness, fatigue and concentration problems, etc. The next section explains the actual measurement of EMF exposure from cellular base stations which are located in densely populated areas.

MATERIALS AND METHODS

In India, today there are number of cellular mobile phone systems such as GSM, CDMA and UMTS with various generations as 2G, 3G, and 4G. Also, different data and service providers were available as BSNL, Airtel, Reliance, Idea, Telenor and Vodafone.

Due to increase in cellular mobile subscribers, large numbers of cellular mobile base stations (CMBS) were installed to cover those subscribers in residential densely populated areas. In the recent years, the cellular mobile towers were installed in residential areas, but according to the norms, it should be 300 meters away from residential areas. Also one more issue is that the actual location of the mobile antenna tower is different and it is installed at different locations. On antenna towers the average numbers of directional antennas were around 20 and more. Each radiating in different direction to cover foot print of the surrounding area. According to DoT norms one can attach 4 to 6 antennas on a base station tower, but the actually number of antennas were installed. Therefore, this increases the EMF exposure in surrounding residential areas. Thus, measurement and analysis of EMF exposure from CMBS is essential [1] [2]. Directions regarding electromagnetic field exposure were given by world health organization (WHO) and International Commission for Non-Ionizing Radiation Protection (ICNIRP) time to time [3] [4].

For measurement of EMF exposure from CMBS, first base station sites were selected according to densely populated areas. Different selected base stations sites are Tarabai Park, kasba bawada post, Jarag nagar, R K nagar, Mahalaxmi Nagar, Subhash nagar and Kandal gaon etc. at these locations population found were dense. Here general EMF exposure was measured at a height of 1.5 meters. Reason for selecting 1.5 meter height is that the average height of Indian people is around 5 feet which approximately 1.5 meters. EMF exposure was measured in terms of power density and electric field. Power density was measured in microwatt/m2 and electric field in mv/m [7].

Both quantities were measured with the help of EMF exposure meter KM 195. It has an in build isotropic antenna which measures field in three directions that is x, y and z and gives resultant power density or electric field. The frequency range is from 500 MHz to 2.5 GHz which covers cellular mobile range. After selecting base station sites actual measurement of EMF exposure were started. Measurements were taken at a distance ranging from 10 meter to 100 meter or in some cases it is 120 meters in the steps of 10 meters. Readings were repeated at each position to avoid error in the measurement. Table 1 shows the selected base stations, their height and number of antennas on each cellular mobile tower. At last the average height and average number of antennas were calculated.

FIGURES AND TABLES

Table 1: Selected Base Stations

Sr. No	Cellular Mobile Base Station	Place of Base Station	Height of Base Station Tower (Feet)	Number of Antennas
1	CMBS 1	Kandal Gaon	60	16
2	CMBS 2	Rajendra Nagar	70	20
3	CMBS 3	R K Nagar	80	16
4	CMBS 4	Datt colony	60	16
5	CMBS 5	Shanta Durga Colony	150	16
6	CMBS 6	Jarag Nagar	120	16
7	CMBS 7	Pachgaon	150	16
8	CMBS 8	Jaiprabha Studio	160	16
9	CMBS 9	Mahalaxmi Nagar	150	16
10	CMBS 10	Opposite Dharya - prasad Hall	150	16
11	CMBS 11	Tarabai park	160	16
12	CMBS 12	Kasba bawada post office	200	16
Average height and number of antennas			125	16

From table 1 shows that the average height of the antennas in Kolhapur city is around 125 feet and average number of antennas is 16 on each mobile tower.

Here in this paper, we present the measurement results of selected mobile tower base stations. The mobile towers were selected from the densely populated areas. The measurements were taken by the electromagnetic field exposure meter KM195. Its frequency range is up to 3.5 GHz. Power density is measured from base stations from 10m to 150m. Total 12 base stations were selected for investigation of electromagnetic field exposure. Measurement height is approximately 1.5m and it is outdoor measurement. Measurement shows that electromagnetic field exposure increases from 10m to 100 or 120m and then it is decreases. Same is the case for electric field, it also increases from 10m to approximately 120m and then decreases. In case of Non line of sight sites we observe up and down in the electromagnetic field (EMF) exposure.

Table 2: Measured Power Density

Cellular mobile Base stations	Power density in microwatt/m2														
	10m	20m	30m	40m	50m	60m	70m	80m	90m	100m	110m	120m	130m	140m	150m
CMBS 1	19.963	11.94	60.020	8.591	5.868	3.733	3.151	5.878	2.747	2.885	2.734	51.36	10.924	1878.4	2.622
CMBS 2	1680.5	376.5	1280.1	1833.7	2.874	2.079	1189.5	0.199	0.51	1348.1	1.159	1.405	2.331	1466.9	1644.6
CMBS 3	1061.9	2.587	1130.2	581.1	387.9	1021	2.156	1653.8	960.8	296.2	849.9	214.4	1072.7	468.6	728.1
CMBS 4	1.644	7.515	5.99	1.258	1.92	7.177	36.31	9.481	5.367	3.409	1.675	11.878	25.6	2.805	2.604
CMBS 5	431.7	820.1	382	484.8	535	433.2	1167.8	1938	2.466	2.49	3.673	3.129	1034.2	643.6	369
CMBS 6	1452.9	3.02	3103.4	2.28	2.803	4.853	1697.3	2.605	2.665	2.551	2.027	1762	1437.5	1309.3	1574.2
CMBS 7	1828.6	1640.8	2.269	2.601	0.091	796.9	1079	1788.3	1141.4	180.21	1162.5	564.1	1732.3	1823.3	1821.3
CMBS 8	1062.1	400.2	1100.3	1.301	4.868	1022	2.226	1550.6	1061.2	3.412	921.2	1812	2.315	1455.2	1902.1
CMBS 9	3.021	14.146	2.534	1350	1037.4	1672.4	2.042	1485	1602.5	2.047	1104.5	2.22	2.508	1631.5	2.006
CMBS 10	2.162	862	1329.9	995.1	2.702	1143.1	1539.9	1291.5	103.13	12.96	2.21	1465	1854.2	712.3	1625.2
CMBS 11	2.77	2.905	2.11	2.485	1785.8	3.168	2.305	2.346	3.038	6.026	12.47	10.018	4.175	18.43	20.17
CMBS 12	2.509	2.509	2.509	2.509	2.509	2.509	2.509	2.509	2.509	2.509	2.509	2.509	2.509	2.509	2.509

Table 3: Measured Electric Field in mv/m

| Cellular mobile Base stations	Measured Electric field in mv/m														
	10m	20m	30m	40m	50m	60m	70m	80m	90m	100m	110m	120m	130m	140m	150m
CMBS 1	1507.2	1916.1	1923.6	3.026	2.668	1680	1370	2.108	1346	1475.3	1396.9	4.35	2.676	1194.7	18.905
CMBS 2	1182	341.8	852.3	1031.6	1442.7	999.3	825.1	1218.1	1302.5	1104.3	1614	1711.2	1250.6	897.7	915.2
CMBS 3	2.054	1330.6	681.8	770	404.7	706.2	1015	1074.8	635.9	370.6	725.4	319.9	559.9	498	727.7
CMBS 4	1267.2	3.448	2.405	3.535	3.025	1466.1	4.641	6.739	4.864	5.02	2.792	1380.8	3.604	3.824	1233.5
CMBS 5	638.7	293.9	1303.9	694.6	646.5	462	293	819.3	736.8	399	428.9	227.6	481.3	443.5	404.1
CMBS 6	1088.2	3.919	4.105	11.798	2.421	2.691	1217.3	1102.3	1546.4	1164.3	1162.8	1010.8	920.3	1049.4	924.6
CMBS 7	1020.9	1142.6	1112	1312.9	1834.5	647.8	808.5	1140.3	1077.7	387.9	447.2	712.3	855.4	1132.7	715.2
CMBS 8	1298.7	902.6	1281.2	845.3	1037.7	1094.6	917.4	629.5	624.9	606.8	862.2	811.1	1151.6	1259.7	1274.5
CMBS 9	14.146	729.8	1129.5	883	962.8	1481.4	1258.4	1090.4	891	997.4	1153.4	1101	1379.4	9.341	13.09
CMBS 10	1173.4	728.2	779.6	711.2	1092.6	1023.4	898.3	697.7	282.1	128.6	125.3	126.1	122.5	120.3	122.6
CMBS 11	1470.4	1245.4	1401	1185.1	1167	1306	1226.6	1300.4	1384.9	2.194	2.267	2.428	2.465	3.878	3.166
CMBS 12	1193.4	1306.9	1407	1260.2	1320.7	1254.1	1386.5	2.077	1726.5	1440.3	1352.7	1424	991.1	745.5	720.5
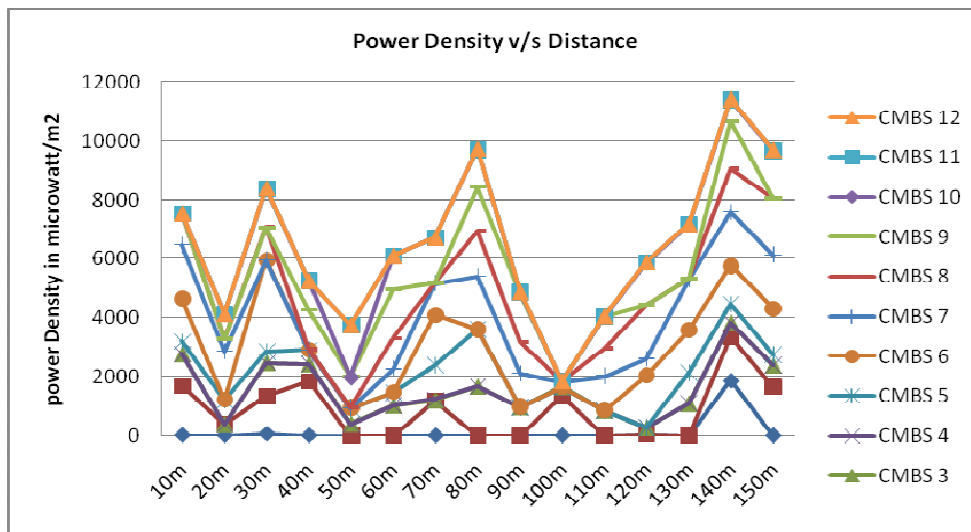
Figure 1: Power Density Variation According to Distance

Figure 1.0 shows power density variation, power density is measured in the intervals 10 meters to 150 meters. It shows up and downs in the power density as distance changes. Power density is measured by the RF power meter model KM 195. It has various modes of measurements such as average, average max and max. Along with this it also measures electric field in v/m, mv/m etc,

Table 4: Average Electric Field intensity and Power Density of each CMBS and Percentage Contribution

Base Stations	Place of Base Station	Average Power Density Microwatt/m2	Average Electric Field mv/m	% Contribution
CMBS 1	Kandalgaon	2682.77	1910.44	10
CMBS 2	Rajendra Nagar	1377.90	1112.56	5
CMBS 3	RK Nagar1	1011.30	791.63	4
CMBS 4	RK Nagar2	3394.98	3282.97	13
CMBS 5	Shantadurga Colony	1333.16	1822.58	5
CMBS 6	Jarag Nagar	2342.70	1622.27	9
CMBS 7	Pachgaon School	1361.92	975.84	5
CMBS 8	Mahalaxmi Nagar	2557.49	2523.56	10
CMBS 9	Opposite Dharya Prasad	1214.15	751.51	4
CMBS 10	Tarabai Park	6280.12	1872.32	24
CMBS 11	Kasba Bawada Post Office	3024.09	1309.06	11

Total twelve sites are selected ie CMBS 1 to CMBS 12. CMBS 5,6,10, 11 were located in densely populated area as compare to others. CMBS 5, 10, 11 having highest height some where around 200 to 300 feets.
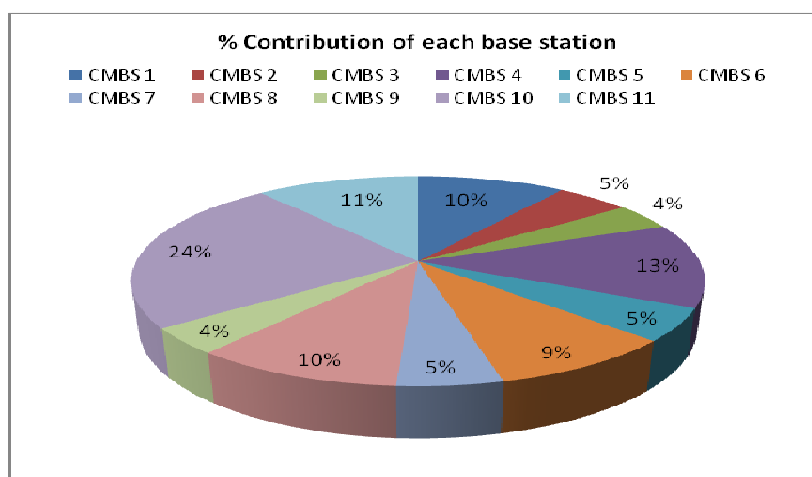

Figure 2: Percentage Contribution of Each Base Station

CONCLUSIONS

The average power density and electric field from each CMBS were going on decreasing as distance increases. Also, there are day time and night time variations in general EMF exposure. It is observed that the number of antennas on each base station tower was varied and average number of antennas on the tower were found to be somewhat around 20. In our study total 20 CMBS were studied and analyzed, the average power densities measured was 2416.41μw/m^2 and electric field was 1615.21mv/m. For CMBS3 power density was minimum and it was 1011.30 μw/m^2 and in case of CMBS10 it was maximum 6280.12 μw/m^2. CMBS 4, 10, 11, 12 are having highest contribution for electromagnetic field exposure. All values of average power density, electric field, maximum and minimum values were well below the norms set by DoT (Department of Telecom) and ICNIRP.

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