A Novel Study On Cell Tower Radiation In India

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Abstract

As the cell phone technology developing tremendously, we forget to account its negative effect which is caused due to the radiation transmitted by the cell phone tower. In this paper, we present study related to the GSM (global system for mobile communication) Cellular phone radiation which is transmitted from antenna site and tower inside the cell. Also, we present radiation pattern of the antenna from the cell tower, radiation norms adopted in different countries.

Key-words: GSM-900, GSM-1800, GSM-2100, radiated power density, radiated power.

1. Introduction

Cell phone technology has revolutionized the telecommunication scenario in India. Due to its several advantages, cell phone technology has grown exponentially in last decade. Currently 86 crore cell phone users and nearly 7.4 lakh cell towers in India to meet the communication demand. As the cell phones and cell towers are increasing without giving due respect to its disadvantage i.e. its radiation. The cellular base stations are transmitting continuously even when nobody is using the phone. This radiation effects are divided into thermal and non thermal effects. Thermal effects are similar to that of cooking in the microwave oven. Non thermal effects are not well defined but it is reported that non thermal effects are 3-4 times more harmful then thermal.

A cell phone transmits 1 to 2 Watt of power in the frequency range of 824-849 MHz (CDMA), 890-915 MHz (GSM900) and 1810-1880 MHz (GSM1800). A cell phone has a SAR (Specific Absorption Rate) rating. In USA, SAR limit for cell phone is 1.6 W/Kg which is actually for 6 minutes per day usage. It has a safety margin of 3 to 4. So a person should not use cell phone for more than 18 to 24 minutes per day. This information is not commonly known to people in India. So, crores of people use cell phone for more than an hour per day without realizing its associated health hazards.

Cell tower antennas transmit in the frequency range of 869-894 MHz (CDMA), 935-960 MHz (GSM900) and 1810-1880 MHz (GSM1800). Also, 3G is deployed in most of the cities, in which base station antenna transmits in the frequency range of 2110-2170 MHz Mobile phone operators divide a region in large no of cells, and each cell is divided into number of sectors. The base stations are normally configured to transmit different signals into each of these sectors. In general, there may be three sectors with equal angular coverage of 120 degrees in the horizontal direction as this is a convenient way to divide a hexagonal cell. If numbers of users is distributed unevenly in the surrounding area, then the sectors may be uneven. These base stations are normally connected to directional antennas that are mounted on the roofs of buildings or on free standing masts. The antennas may have electrical or mechanical down tilt, so that the signals are directed towards ground level.

A base station and its transmitting power are designed in such a way that mobile phone should be able to transmit and receive enough signal for proper communication up to a few kilometres. Majority of these towers are mounted near the residential and office buildings to provide good mobile phone **coverage to the users. These cell towers transmit radiation 24×7, so people living within 10'sof** meters from the tower will receive 10,000 to 10,000,000 times stronger signal then required for mobile communication. In India, crores of people exist in within these high radiation zones.

2. Radiation from the Cell Tower

A GSM900 base station antenna transmits in the frequency range of 935-960 MHz. This frequency band of 25 MHz is divided into 20 sub-bands of 1.2 MHz, which are allocated to various operators. There may be several carrier frequencies (1 to 5) allotted to one operator with upper limit of 6.2 MHz bandwidth. Each carrier frequency may transmit 10 to 20 W of power. So, one operator may transmit 50 to 100 W of power and there may be 3-4 operators on the same roof top or tower, thereby total transmitted power may be 200 to 400 W. In addition, directional antennas are used, which typically may have a gain of around 17 dB (numeric value is 50), so effectively, several KW of power may be transmitted in the main beam direction.

3. Radiated power density from the cell tower

Power density P_d at a distance R is given by:-

$$P_d = \left(\frac{Pt \times Gt}{4\pi R^2}\right)$$

Where, P_t = Transmitter power in Watts
G_t = Gain of transmitting antenna
R = Distance from the antenna in meters

For P_t = 20 W, G_t = 17 dB = 50, P_d for various values of R is given in Table 1.

Distance R (m)	Power density P_d in W/m^2	Power density P_d in μW/m^2
1	79.6	79,600,000
3	8.84	8,840,000
5	3.18	3,180,000
10	0.796	796,000
50	0.0318	31,800
100	0.008	7,960
500	0.000318	318

Table 1 – Power density at various distances from the transmitting tower

The power density values given in Table 1 are for a single carrier and a single operator. If multiple carriers are being used and multiple operators are present on the same roof or tower, then the above values will increase manifold. However, radiation density will be much lower in the direction away from the main beam.

Radiation pattern of the antenna

The simulated radiation pattern of GSM 900 antenna of approximately 17dB gain at 950 MHz of size 2400 mm × 30 mm is shown in fig 1. Radiation pattern of the antenna is shown in two planes – horizontal and vertical. There is one main lobe and several side lobes. For the main lobe, half- power beam-width

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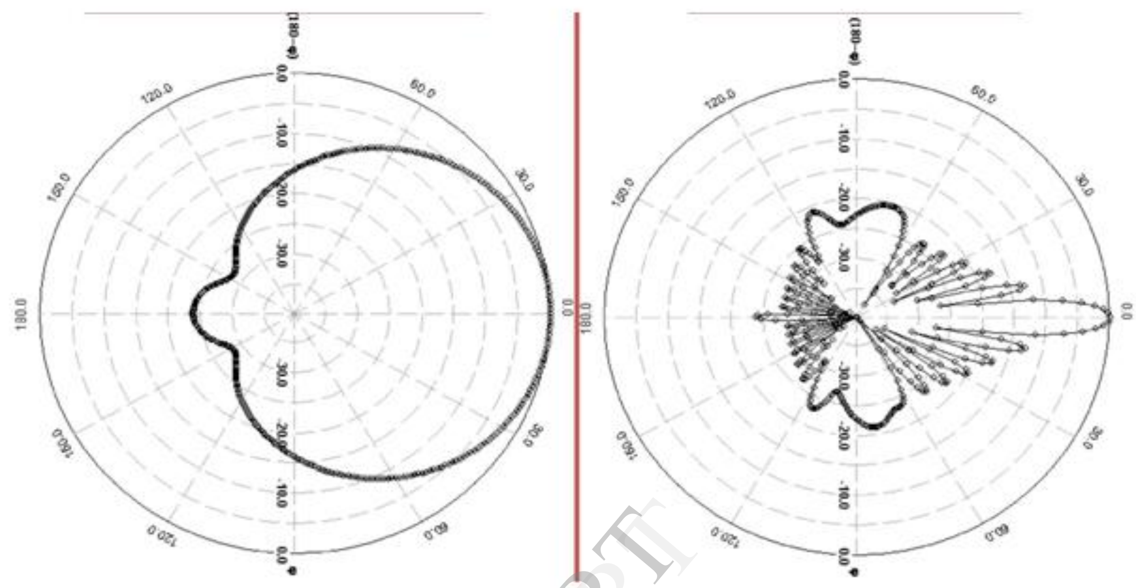
(HPBW- defined as angular range over which maximum power decreases to half of its value) in the horizontal direction is 65 degrees and HPBW in the vertical direction is 6 degrees. There are several side lobes, whose maximum levels are about -13 to -20 dB below the main level.



(a) **Horizontal plane**

(b) Vertical plane

Fig, 1- (a) Horizontal and (b) Vertical radiation pattern of a 17dB gain antenna.

4.

ADIATION NORMS ADOPTED IN DIFFERENT COUNTRIES

R

In India, we have adopted radiation norms given by International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines of 1998 for safe power density of f/200, where frequency (f) is in MHz. Hence, for GSM1800 transmitting band (935-960 MHz). Power density is 4.7 W/m^2 and for GSM 1800 transmitting band (1810-1880 MHz), it is 9.2 W/m^2. The ICNIRP guidelines clearly states that for simultaneous exposure to multiple frequency fields, the sum of all the radiation must be taken into consideration. However, in India, we have applied this limit to individual carrier, so the radiation level exceeds by several times than even prescribed by ICNIRP guidelines, depending upon the total number of transmitters in that area. Some of the people living near the towers are exposed to this radiation 24 hours a day. Unfortunately, ICNIRP has considered only the thermal effects of the radiation, where as scientist all over the world have non-thermal effects of these radiations to have significant health effects and these non-thermal health effects occurs at levels much below these norms.

The current USA standard for radiation exposure from cell phone towers is 580-1,000 microwatts per sq. Cm ($\mu W/cm^2$), but they are revising the norms. Many scientist and physicians of different countries have declared cell phone towers a "public health emergency". Many countries in the world have adopted much stricter maximum radiation density values of .001 to .24 W/m^2 (1/100th to

1/1000th of ICNIRP guidelines). As shown in Table 2. The people in these countries have studied extensively the health hazards of cell tower radiation to adopt stricter radiation norms. Even .1 W/m^2 = 100,000 $\mu W/m^2$ has caused cancer in a duration of 2-3 years.

Table 2 – International Radiation Density Limits for GSM1800

Power Density (W/m^2)	International Exposure limits adopted by various countries
10	FCC (USA) OET- 65 Public Exposure Guidelines at 1800 Mhz
9.2	ICNIRP and EU recommendation 1998 – Adopted in India
3	Canada (safety code 6, 1997)
2	Australia
1.2	Belgium (ex Wallonia)
0.5	New Zealand
0.24	Exposure limit in CSSR, Belgium, Luxembourg
0.1	Exposure limit in Poland, China, Italy , Paris
0.095	Exposure limit in Italy in areas with duration > 4 hours
0.095	Exposure limit in Switzerland
0.09	ECOLOG 1998 (Germany) Precaution recommendation only
0.025	Exposure limit in Italy in sensitive areas
0.02	Exposure limit in Russia (since 1970), Bulgaria, Hungary
0.001	"Precaution limit" in Austria, Salzburg city only
0.0009	BUND 1997 (Germany) Precaution recommendation only
0.00001	New South Wales, Australia

At many places, cell phone towers are mounted on the roof top of residential / commercial buildings. Even though antenna radiates less power vertically down but the distance between the antenna and top floor is usually a few meters, so the radiation level in the top two floors remain very high. From Table 1, power density at R = 3m is equal to 8,840,000 $\mu W/m^2$ in the main beam. In the vertically down direction, radiation is approximately 20-22 dB less and the roof may provide attenuation of 6 to 10 dB depending on the construction implying radiation density of 8,840 $\mu W/m^2$, which is still very high.

METHODS FOR RADIATION MEASUREMENTS

Power density measurement can be performed with an Advantest R3131 spectrum analyser (Rohde & Schwarz) and a calibrated periodic logarithmic log. per. antenna USLP 9143 (Schwarz beck). The power density measurements were conducted under real-life conditions and only downlink frequencies of the GSM cellular base stations are measured. The antenna is directed in various orientations in order to receive local maximum power densities by peak hold measurements in respect to orientation, polarization, reflection, and interference. For each narrow band region of interest i.e GSM900 or GSM1800.

THEORETICAL AND MEASURED RADIATED POWER

To measure the power at a distance R, an antenna is used to receive the power and a spectrum analyser or power meter is used to measure received power.

Power Received P_r by an antenna at a distance R is given by

$$P_r = P_t \times G_t \times G_r \times \left(\frac{\lambda}{4\pi R}\right)^2$$

Received power is directly proportional to the transmitted power, gain of transmitting and receiving antennas, and square of wavelength of the signal and it is inversely Proportional Square of distance. For transmitter power P_t = 20 W, transmitting antenna gain G_t = 17 dB, receiving monopole antenna gain G_t = 2dB, the received power at R = 50 m is:

At 887 MHz (tower transmitting frequency in CDMA), P_r = -3.2 dBm.
At 945 MHz (tower transmitting frequency in GSM900), P_t = -3.8 dBm.
At 1872 MHz (tower transmitting frequency in GSM1800), P_r = -9.7 dBm

5. CONCLUSION

In this paper, we take the first step in understanding cell tower radiation, the purpose of cell tower is that mobile phone should receive adequate signal for its proper operation. A mobile phone shows full strength at -69dBm input power and works satisfactorily in the received power range of -80 to -100dBm. In comparison with -80 dBm level, the measured power level at R = 50m is at least 50 to 60 dB higher, which translates to 100,000 to 1,000,000 times stronger signal than a mobile phone requires. There are millions of people who live within 50m distance from cell towers and absorbing this radiation 24 $\times$ 7.

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