Mobile tower radiation– Affects, Assessments and Monitoring of IIT Roorkee Campus

Akanksha Jain, Kamal Jain, Ajay Gairola

Abstract— **India is one of the fastest growing mobile telecommunication industries in the world sustaining its growth by large number of subscribers, lower tariff rates and falling price of mobile phones. The demand from large population across the country puts pressure on service providers to strengthen the mobile communication infrastructure.The strengthening in terms of installation of more towers raises the public concern for health effects related to mobile towers. This brings forth the need to study and monitor the radiation level and to assess its impacts. The present study carried out in IIT Roorkee campus aims to examine and analyse the mobile tower radiation levels in the campus. Experiments have been performed and power levels were recorded at selected sites.The radiation level is under permissible limits as per the guidelines adopted in India.**

IndexTerms— **Mobile tower, Electromagnetic radiation, Radio frequency, Health effects.**

I. INTRODUCTION

Today use of mobile phone is not limited to voice communication only, it finds its application in every domain of life, be it voice communication, text messaging, internet or using mobile phone for navigational purpose with GPS installed in it. These advancements in mobile technology have made our lives easier and comfortable. In spite of all these advances, there are some downsides of the modern technology.This includes various health concerns related to the radiofrequency exposure during mobile phone use.Due to the demand of high signal strength especially in densely populated areas, towers are present in clusters. These clusters consist of antennae from multiple service providers which add to the radiation level in the vicinity of tower.This increase in radiation level also increases the vulnerability of neighbourhood.

In 2011, International Agency for Research on Cancer (IARC) has classified the radiation from mobile phone on the IARC scale into Group 2B i.e. possibly carcinogenic.

It is evident from the study carried out in north India that the issues of Non Ionizing Electromagnetic Radiation (NIEMR) are very critical in Indian context [27]. The vulnerability issues lies in the fact that there is no guideline or standard developed according to the Indian scenario. Currently India has adopted European standard ICNIRP with some modifications in it [2].

There are various approaches for calculations and measurement of cell tower radiation in near and far field zones. It is possible to mitigate the radiation level by changing various antenna parameters. Antenna parameters such as transmitting power, antenna height, down tilt in the VRP (Vertical Radiation Pattern) antenna gain, change in HRP (Horizontal Radiation Pattern) can alter the radiation exposure[23]. Cell phone use during pregnancy may induce behavioural problems that corresponds the effects of ADHD (Attention Deficit Hyperactivity Disorder) according to the study conducted on mice offspring [10]. Behavioural changes were also observed among birds close to the phone antennae [27]. Various neurobehavioral changes were observed in the inhabitants living near the mobile phone base stations. There are risks of neuropsychiatric problems. Complains of headache, dizziness, memory changes, sleep disorder had been reported among the individuals.

Mobile communicates in radio frequency range of electromagnetic spectrum, which is a non-ionizing radiation. Radiation in general means the process through which energy in the form of particles or waves is transmitted. Radio signals (3 KHz - 300 GHz (Radio frequency)) are part of our daily life, emitted by both natural and artificial sources like the sun, the earth and the ionosphere, and by artificial sources. Cell phone towers, AM, TV towers ,FM radio towers Wi-Fi, mobile phones, Wi-Max, cordless phones and other wireless devices are source of electromagnetic radiations continuously emitting radio frequency and microwave radiation. Exponential rise in the EMF level due to wireless technologies such as Wi-Fi, WI-Max has been reported.

Though all radiations have some health issues, the question arises that what is the need of a dedicated study for radiation emitted from the mobile towers? The answer lies in the fact that demand due to increasing population gives rise to an increased number of mobile users and subsequently more numbers of mobile tower stations. Due to the requirement of high signal strength especially in densely populated areas, they are becoming more vulnerable and exposed to radio frequency radiation emitted from cell tower.

This calls for the need for separate study pertaining to effects of radiation on human health specifically in Indian context.

Radio frequencies are allocated to forty different types of radio communication services as defined in the ITU's Radio Regulations. Telecommunication technology uses separate

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channels for mobile to base station and vice versa. In India, frequency of 935-960 MHz (GSM 900), 1810-1880 (GSM 1800) and 2110-2170 (3G) is very common. In India, mobile phones operate in the frequency range of 824 - 849 MHz (CDMA), 890 - 915 MHz (GSM 900) and 1710 – 1780 MHz (GSM 1800) and transmit 1 to 2 Watt of power (Kumar, 2010).

Exposure to radiation also depends upon the type of mobile phone CDMA, GSM or smart phone and also on the manufacturer. The study is limited to only radiation from mobile tower base station and does not consider the effects due to mobile phone use[5] [17]**.** Since the use of mobile is inevitable in the society, there is a need to study the vulnerability issues and to devise proper mitigation measures.In Indian context, it is even more important to study the cell tower radiation exposure level and its effect on public because of the population growth and high demand for the mobile phone. The scenario is even worse as there is lack of awareness among individuals. Also the average per day use of mobile phone in India is far more than what was considered in various studies [11] [29].

II. RADIATION FROM THE CELL TOWER AND RADIATED POWER DENSITY

A GSM900 antenna (with directional antenna gain of 17dB), is able to transmit several KW of power. The GSM band of 25 MHz is divided into twenty sub-bands allocated to various operators.[11]

Power density $P_d$at a distance R is given by

$$Pd = \frac{Pt \times Gt}{4\pi R^2}$$

where, Pt = Transmitter power in Watts
Gt = Gain of transmitting antenna
R = Distance from the antenna in meters

The power density from above formula is only for one carrier form single operator. If multiple carriers are involved the power density will increase manifold. Also, it depends upon the radiation pattern.

Prof Kumar compared heating effects of cell tower radiation with that of microwave and concluded that heating effects similar to put our citizens in an open microwave oven safely for 19 minutes considering previous norms for GSM 900 with power density of 4.7 W/m^2.

Safe radiation level adopted in India of power density is 0.47 W/m2 for GSM900 band according to new norms. As per our interpretation of the calculations performed by Prof Kumar, if we model human body as a cylinder, then its area will be 1.436 square meter (average height 5'6" = 1.67 m and waist 34" = 86 cm). So, power received by human body will be power density x area = 0.675 Watts. In one hour, microwave energy absorbed will be 0.675 x 3600 = 2.43 KW-sec. In one day, microwave energy absorbed will be 2.43 x 24 = 58.32 KW-sec. A typical microwave oven has a rating of 700 to 1000 W, and with say 60% efficiency, microwave power output is approximately 500 W. This implies that human body can be safely kept in a microwave oven for 58.32 KW-sec / 500 W = 116.6 seconds = 1.9 minutes per day.

If even decreasing the power density, exposure duration is not increasing the then does it make sense to lower the power density? Yes, this means the comparison is not valid, also, it has been proved that lowering the power density and increasing the gain will decrease the exposure level.

III. STANDARDS AND MONITORING METHODS

India has adopted $1/10^{th}$ of the radiation norms given by ICNIRP guidelines, 1998 for safe power density [2] [9]. According to ICNIRP guidelines, simultaneous exposure from all the sources should be taken into account. According to Indian norms this limit is applied to individual carrier which makes radiation level higher than prescribed by ICNIRP guidelines, depending upon the total number of transmitting antennas. In urban areas, towers are found in groups or nearby areas which add up to the level of radiation and affect the inhabitants.

The value of distance are based on empirical estimation considering that all the antennae emitting at their maximum RF power of 20 Watts and exactly in the same direction with same height (a worst case scenario). In practical condition, value of the safe distance from buildings will depends on actual scenario and may be less than the given in table

Table III.1 : Safe distance from antenna depending upon the number of antenna [4]

Number of antenna(e) pointed in the same direction	Building/Structure safe distance from the antenna(e) at the same height (in meters)
1	20
2	35
4	45
6	55

IV. GROUND SURVEY ASSESSMENT

The study was carried out in three phases of field surveys performed from February 2014 to April 2014 in the IIT Roorkee campus.A total of thirteen site locations were identified on the basis of exposure duration (residential or office), usability and accessibility to general public and distance from tower located in the campus. Sites have been selected on the basis of general public exposure and duration, sensitive areas such as schools, hospitals etc. scattered in whole campus.

Providing adequate signal to mobile phone is the main purpose of cell towers. At -69 dBm input power, a mobile phone shows full strength and require a received power range of -80 to -100 dBm for satisfactory working (Cell Tower Radiation Report, 2010).Day one and day three survey was on working day and second & fourth day was holiday. It is observed that 38% to 46% times the radiation level exceeded the required power level for full signal strength during the whole survey. The maximum radiation level was recorded at Century Gate which is -56.23113 dBm, for GSM 1800 frequency band in evening on non-working day; higher than the power required for full strength of mobile signal.The site is directly facing base station antenna installed over the roof of a building opposite to the site under observation. It is one of the most densely populated areas which further add to the exposure and increase the vulnerability.

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Figure IV.1Century gate: observation site location

Obtained measurement is grabbed in the form of bar graph for GSM 900, GSM1800 and 3G is shown in the following Figures 6.2- 6.4. It is observed that there are only two locations among all the sites where GSM 900 signals are present at different time during the survey week.

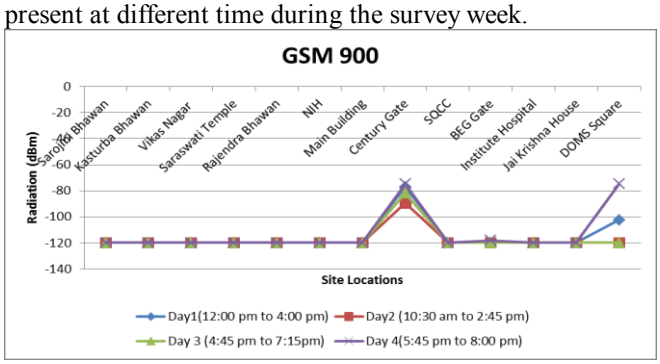

Figure IV.2 :Radiation Variation in GSM 900

From the graphs it is clear that the GSM 1800 network is dominating in the campus. 3G signals are also present in the study area but poor network of GSM 900 is observed showing more variation in the network strength compared to other two networks. Maximum strength of the signal is recorded at Century Gate, IIT Roorkee, where readings were taken in the direction of tower installed opposite to the site location. Though this is the maximum value found in this survey still it is far below the ICNIRPguidelines adopted in India. [2] [9]

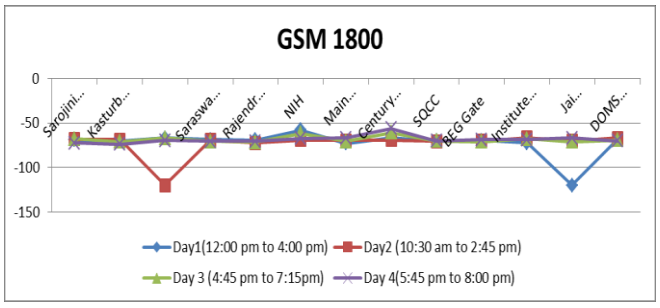

Figure IV.3 : Radiation variation in GSM 1800

On comparing the data of working day and non-working day, no significant variations were obtained. There is sudden shift in radiation level at Vikas Nagar from -66.7701 dBm on day one to -120 dBm on day two, which is attributed to direction of the instrument or sudden drop in the signal values. Remaining all the data does not shows any such variations.

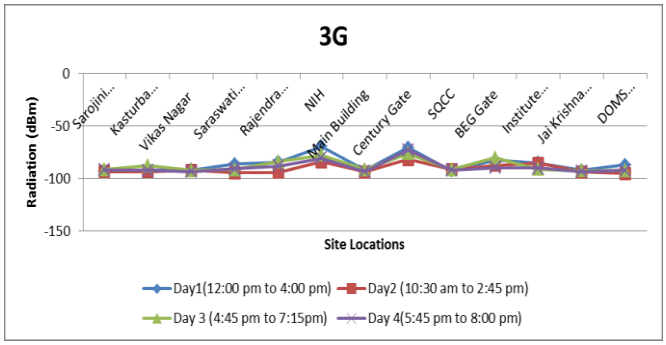

Figure IV.4 :Radiation Variation in 3G

V. CONCLUSION

The study area is safe as per the guidelines adopted in India. However health impact of the radiations needs further medical studies specific to the Indian trend. Field survey results have shown that the power of GSM 1800 is predominant in the campus among the other system of communications, whereas strength of GSM 900 is poor. GSM 900 signals are present only at century gate and department of management studies square. The radiation level for 3G band lies in between the two above stated frequency bands.It may be noted that, reduction in power density will reduce the radiation effect. So more stringent guidelines should not decrease the duration rather health impacts should be minimised by regulating the radiation level. There is need for long term studies, considering antenna characteristics (such as radiation pattern in vertical and horizontal direction and other technical specification), exposure level, and duration of use, intensity variation with distance. One cannot avoid using cell phone, the only thing can be done is to reduce and regulate the radiation exposure up to safe limit so that radiation hazard related to RFR can be minimised. There is a need for more detailed guidelines specific to the parameters which can alter the radiation exposure.

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