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Analysis of Electromagnetic Radiation from Base Station Antennas to Prevent Health Hazards

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Abstract: This paper presents the Practical Analysis of Base Transceiver Station (BTS) Effects on the Human Body in Lagos Environs. In This paper electromagnetic radiation from base station antennas installed for various wireless communication purposes has been investigated based on effective isotropic radiated power calculation. This was achieved using the measured and calculated values of some electromagnetic parameters such as power density, and electric field intensity on different frequency value. For this purpose, selected sites where GSM, CDMA, 3G/UMTS, and WiMax Antenna installed. On the basis of calculation it has been found that equivalent (EIRP), Threshold EIRP and its ratio is not greater than unity. This particular site said to be compliant and does not impose any health effect. For public, the Exclusion zone (Compliance distance) from GSM, CDMA, 3G/UMTS, WIMAX antenna at a distance of 8.00,7.03,8.434 and 6.868 m respectively.

Keywords— Mobile Tower Radiations, Electromagnetic Radiations, Signal Strength, Mobile Phone

I. INTRODUCTION

People use mobile phones for the purpose of communication at home, work or anywhere they are but only few are concerned about the their health implications and possible safety measures. Most of the People are not aware of Mobile Phone and Cell Tower Radiations which are very harmful due to electromagnetic radiation (EMR) exposure. This paper is divided in to two sections. In first section, effects of mobile towers radiations have been discussed while in second section, we have reviewed case studies of different countries. directional antennas are used, which typically may have a gain of around 17 dB (numeric value is 50).

II. RADIATION FROM THE CELL TOWER

GSM900 base station antenna transmits in the frequency range of 935 - 960 MHz This frequency band of 25 MHz is divided into twenty 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 20W of power. So, one operator may transmit 50 to 100W of power and there may be 3-4 operators on the same roof top or tower, thereby total transmitted power may be 200 to 400W. 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]. The density of cell towers is directly connected to the density of population.

III. EM RADIATION AND STANDARDS

Electromagnetic (EM) radiation is a form of energy exhibiting wave-like behavior as it travels through space. It has both electric and magnetic field components, which oscillate in phase perpendicular to each other and perpendicular to the direction of energy propagation.

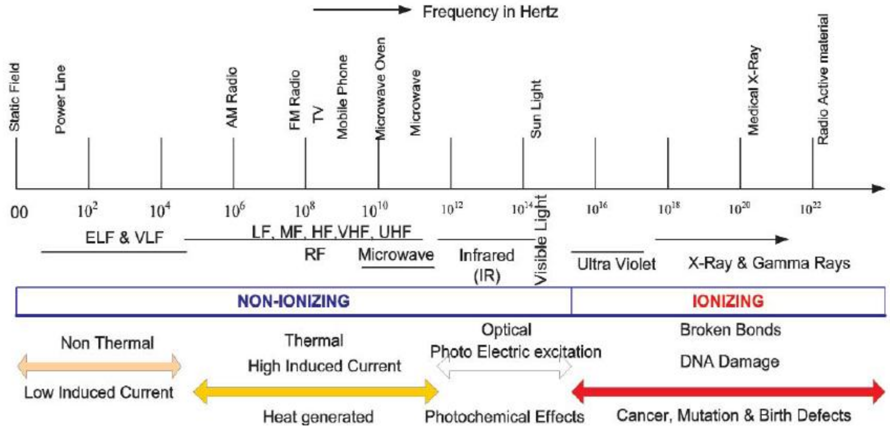


Fig.1: EM spectrum indicating radiation zones

When referring to biological radiation exposures, EM radiation is divided into two types: ionising and non-ionising. Because the human body is composed of about 60 percent water, ionising and non-ionising radiations refer to whether the RF energy is high enough to break chemical bonds of water (ionising) or not (non-ionising). Technically, all radiation and fields of the electromagnetic spectrum that do not normally have sufficient energy to produce ionization in matter; characterized by energy per photon less than about 12 electron volts (eV).

In any particular exposure situation, measured or calculated values of any of these quantities can be compared with the appropriate reference level. Compliance with the reference level will ensure compliance with the relevant quantities like current density (electric/magnetic field intensity), specific absorption rate (SAR), and power density. If the measured or calculated value exceeds the reference level, it is necessary to test compliance with the

relevant field quantity and to determine whether additional protective measures are necessary.

Fig.2: Marking of different zones around a base station antenna

VI. PROCEDURE FOR DETERMINING INSTALLATION CLASS

It is expected that operators providing a particular telecommunication service use a limited set of antennas and associated equipment with well-defined characteristics. Furthermore, installation and exposure conditions for many emitter sites are likely to be similar. Therefore, it is possible to define a set of reference configurations, reference exposure conditions and corresponding critical parameters that will enable convenient classification of sites. For each combination of reference antenna parameters and accessibility condition, determine the threshold EIRP. This threshold EIRP, which will be denoted as EIRPth, is the value that corresponds to the exposure limit for the power density or field from the reference antenna for the accessibility condition. The determination may be performed by calculation or measurements. An installation source belongs to the inherently compliant class if the emitter is inherently compliant (as defined above). There is no need to consider other installation aspects. For each site, an installation belongs to the normally compliant class, if the following criterion is fulfilled:

$$\sum_i \frac{EIRP_i}{EIRP_{th,i}} \leq 1$$

where EIRPi is the temporal averaged radiated power of the antenna at a particular frequency i, and EIRPth,i is the EIRP threshold relevant to the particular antenna parameters and accessibility conditions. For a multiple-antenna installation, the following two conditions need to be distinguished:

• If the sources have overlapping radiation patterns as determined by considering the half-power beam width, the respective maximum timeaveraged EIRP should satisfy the criterion.

• If there is no overlap of the multiple sources, they shall be considered independently.

In the case of EMF exposure assessment, however, a large phase difference and thus a shorter distance marking the beginning of the far-field zone is acceptable. A realistic

Practical distance from a large antenna, where the far-field begins is:

Rf= 0.5D^2/ƛ

Where Rf = distance which marks the beginning of the far-field region

D = the maximum dimension of the antenna

ƛ = wavelength, in metres (m)

(a) Determination of EIRPth

The procedure is the following:

1) Determine the field or the power density for each point O, where exposure can occur, for the particular antenna.

2) Find the maximum power density Smax within the exposure area from this set.

3) The condition Smax = Slim gives the EIRPth where Slim is the relevant limit given by the EMF exposure standard at the relevant frequency.

This procedure may be performed by calculations methods or by measurements. If measurements are used, it is necessary to perform them at a number of representative locations for each accessibility configuration and antenna type.

1. In 1st case Antenna is installed on an inaccessible tower – the centre of radiation is at a height h above ground level. There is a constraint h > 3 m.

2. In 2nd case Antenna is installed at ground level – the centre of radiation is at a height h above ground level. There is an adjacent building or structure accessible to the general public and of approximately height h located a distance d from the antenna along the direction of propagation. There is a constraint h > 3 m.
3. In 3rd case Antenna is installed at ground level – the centre of radiation is at a height h (h > 3 m) above ground level. There is an adjacent building or structure accessible to the general public and of approximately height h' located at a distance d from the antenna along the direction of propagation.

The EIRPth would be calculated:-

$$\text{Lesser of:} \quad \frac{f\pi}{2000A_{sl}}(h-2)^2 \quad \text{or} \quad \frac{f\pi}{2000}\left[\frac{h-2}{\sin(\alpha+1.129\theta_{bw})}\right]^2$$

$EIRP_{th}$ For Operator 1 works out = 34718.18 W

The EIRP [T] / $EIRP_{th}$ therefore works out to 827.9/34718.18W = 0.0238

If it is a shared site, similar calculation are made for the other operators and total ratio calculated as under:

$$\Sigma\,(EIRP/EIRP_{th}) = (EIRP\,[T]/EIRP_{th})_{Op1} + (EIRP\,[T]/EIRP_{th})_{Op2} + (EIRP\,[T]/EIRP_{th})_{Op3}$$

The EIRPth would be (On Adjacent Building Roof Top)

$$\text{Lesser of:} \quad \frac{f\pi}{2000A_{sl}}(h-2)^2 \quad \text{or} \quad \frac{f\pi}{2000A_{sl}}\left[\frac{d^2+(h-h')^2}{d}\right]^2$$

Thus the $EIRP_{th\ for}$ the Operator 2 works out to be 1304.62 W

EIRP (Pilot) = 43 – 3 – (45x3.69) + 15.8 = 54.13 dBm = 258W

EIRP [T] = 258 + 258 x 3 = 1032W

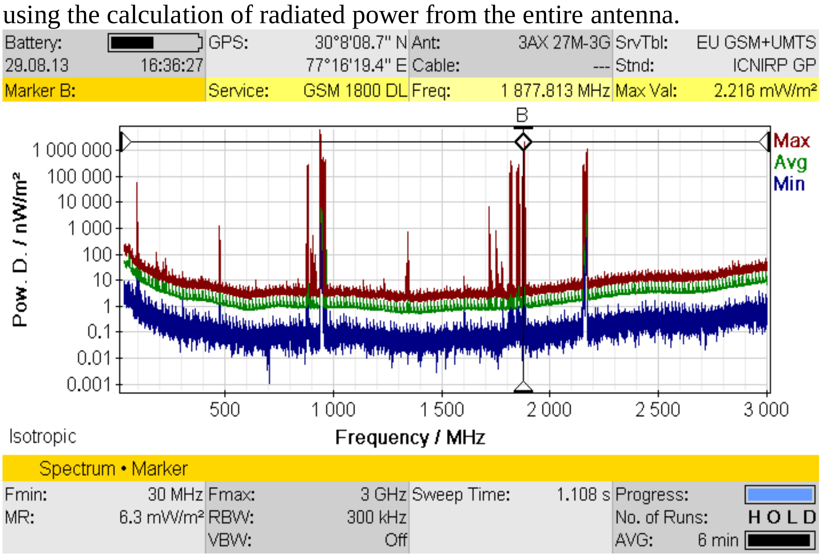
The Ratio EIRP [T] / $EIRP_{th}$ = 1032 / 1304.62 = 0.79

Similar calculations are made for the other operators and total ratio calculated as under:

$$\mathbf{\Sigma\,(EIRP/EIRP_{th}) = (EIRP\,[T]/EIRP_{th})_{Op1} + (EIRP\,[T]/EIRP_{th})_{Op2} + (EIRP\,[T]/EIRP_{th})_{Op3}}$$

V. RESULT AND DISCUSSION

Consider a site provide 4 different services (GSM, CDMA, 3G/UMTS, WIMAX). The assessment of exposure level has been done for this site using the calculation of radiated power from the entire antenna.



From this figure the EIRP 2.216mW/m^2 at 400 to 3000 MHz.

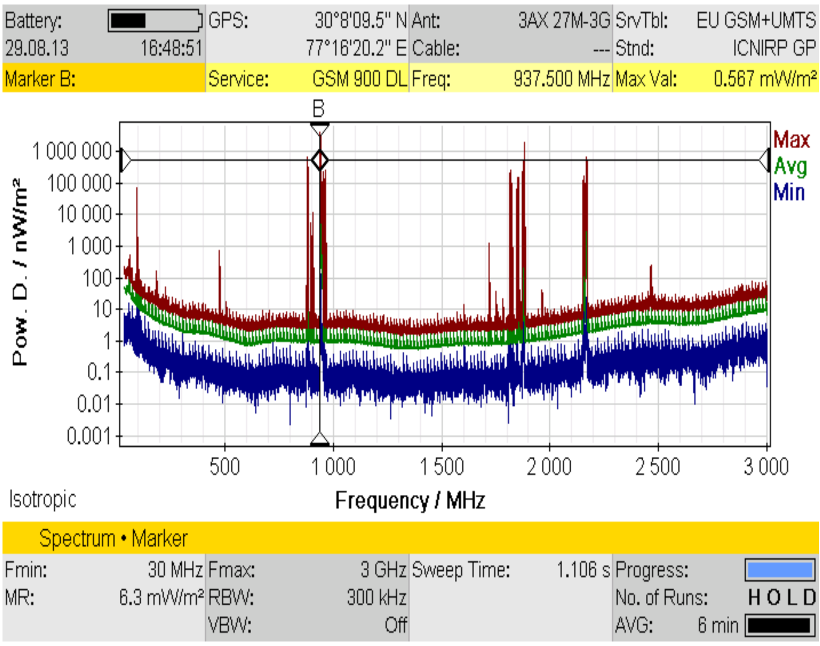


Figure show the EIRP 0.567mW/m^2 at 400 to 3000 MHz.

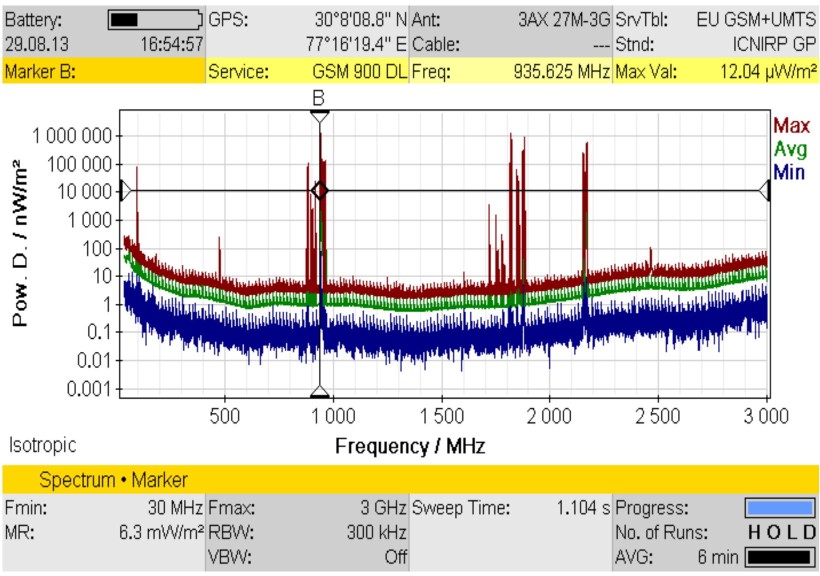


Figure show the EIRP 12.04mW/m^2 at 400 to 3000 MHz

VI. CONCLUSION

Most of the People are not aware of Cell Tower Radiations which are very harmful due to electromagnetic radiation (EMR) exposure. People living near cell tower receive strong signal strength but at the expense of health. So, little bit poor connectivity is better to have better health. From the experiment we found that the effective isotropic radiated power from base station antenna is not exceed unity. Further, it is important to note that the present threshold limits prescribed by the ICNIRP are considered to be rather too generous and hence, there is a need to review and remedy the situation and not wait until it becomes the subject matter of a public-interest petition in the light of possible environmental adverse effects.

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