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Analysis of Electric Field Strength and Magnetic Field Strength in the Vicinity of Cellular Base Trans-receive Station

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Abstract— ***Today, for the present world generation cell phone is the essential and necessary handheld device. Within few years, the number of mobile users increases drastically. Due to the increase of the number of mobile users, the number of BTS towers also increases. These towers emit electromagnetic radiation which is highly dependable upon their radiated power. This paper investigates about the amount of electromagnetic field emits by the tower and compare that values with the guidelines and limits that are to be set by International Commission on Non Ionized Radiation Protection (ICNIRP).***

Keywords— ***Specific Absorption Rate (SAR), Dosimety, Maximum Permissible Exposure (MPE), Radio Frequency (RF) wave, ICNIRP, Electromagnetic Field (EMF).***

I. INTRODUCTION

The numbers of sources that emit electromagnetic radiations like mobile base stations, radio broadcasting transmitter, television transmitter etc. increases drastically according to the number of users to provide better and cheaper services. Out of these sources the growth of number of mobile phones are unbelievable.

This rapid growing sector has now 45.2% (in 2012) mobile users throughout the world are present and this number is still increases with a very high rate. Due to there is a need to install large amount of mobile towers for better connectivity and service. These towers produces high amount of electromagnetic field.

From the above statistics it is clear that because of the nearly half of the amount of world's population there is a large amount of exposure of electromagnetic field which affects everyone in this world. So ICNIRP sets a guideline for these towers to radiate minimum EM wave's s that it affects less to the human's body. These base station towers are basically radio transmitter having antenna which is mounted on the roof top tower or on the ground base.

The numbers of antenna in cities are much higher than the rural area because of the number of users. Due to the shortage of proper location, companies are helpless to install their towers on the roof of the buildings. Due to which it affects the large number of people's health. But the power density of electromagnetic field weakens very quickly as the distance from antenna increases. When the distance from antenna is double the power density reduces by 0.25 and when the distance is triple it becomes 0.11. The effects of this exposure may be thermal or non- thermal by nature.

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II ICNIRP/IEEE SAFETY STANDARDS

ICNIRP/IEEE sets various guidelines for the exposure of electric field strength and magnetic field strength exposure for humans at different frequencies which are as follows:

Table-1 Reference levels for public exposure

Frequencies	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
1 MHz-10MHz	$87/f^{1/2}$	0.73/f
10MHz-400MHz	28	0.73
400MHz-2GHz	$1.37f^{1/2}$	$0.0037f^{1/2}$
2GHz-300GHZ	61	0.16

Some parameters are also set for human tissues which absorbs these radiations. These parameters are as follows:

Table-2 Human tissues parameters

Frequencies	ε_r	σ (S/m)	ρ (kg/m^3)
900MHz	42.5	0.86	1040
1800MHz	41	1.69	

Parameters for current densities absorbed by different part of bodies are also set by ICNIRP. Each and every part of human body can tolerate electric and magnetic field strength differently. Here the values are shown for KHz frequencies. As the frequency increases the value of current densities are also increases. The readings which are coming from BTS tower are taken in MHz so the value of current density which is also related with electric and magnetic field strength are much high. The limit of values of current density for human body parts are as follows:

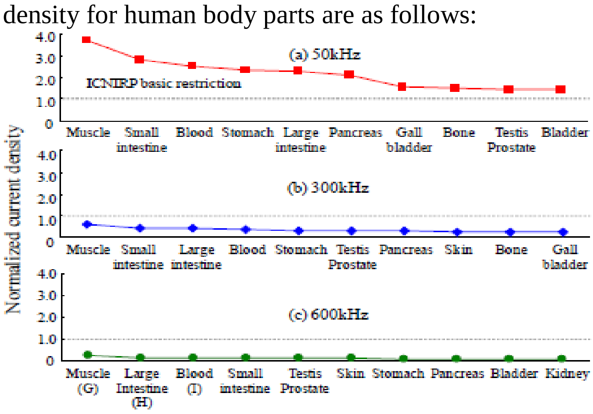

Fig.1 The analysis results of normalized current density(maximum current density) ICNIRP basic restriction

III. SPECIFICATIONS OF TOWER

Base Trans-receive Station (BTS), is very important part of GSM or CDMA architecture. It is used for transmitting as well as receiving purposes. It contains three sectors in it having 120^{o} coverage angle each. Handover and handoff process is also occurred at this terminal due to which there is the transmitting and breakdown of calls occurred. It emits the electromagnetic radiations. All the traffic measurement are measured from this site. It needs a unique local authentication password to access all its data. The specification of BTS which is used here are as follows:

Fig.2 Base Trans-receive Station (BTS) which is used

Table-3 General Specifications of the used tower

Lat/Long	26˚51' 17.0"/75˚47' 43.3"			
Type	Roof Top Tower(RTT)			
Building Height AGL	18 m			
Antenna Height AGL	(m)	25	25	33
System type		GSM	GSM	CDMA
Base Channel Frequencies	MHz	1800	1800	872.315
Carriers / Sector		4	4	3
Tx Power	(dBm)	43	43	43

Layout plan of the building including all its corners and having 13 m radius on which tower is situated is as follows:

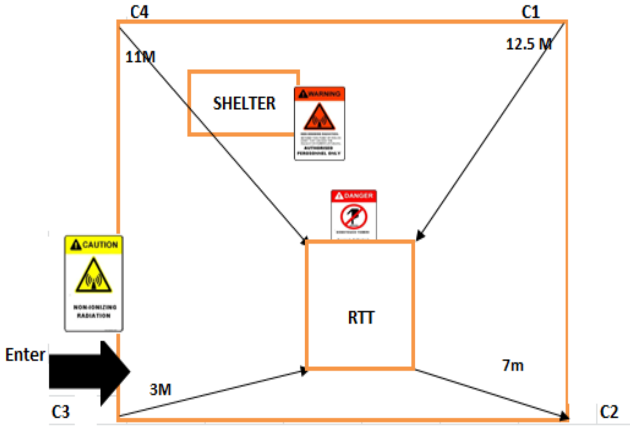

Fig.3 Layout plan of building showing all its dimensions

IV ABOUT THE MEASURING DEVICE

These readings are taken by SRM-3306 that is a *selective radiation meter* which is working in the frequency range from 9 kHz to 6 GHz. It provides easy to use test system, consisting of a base unit and antennas. It is used for non-directional detection of fields and their sources. All functions and parameters can be set directly on the SRM basic unit via menus and the numerical keypad, soft keys, or the rotary control. As well as this, the SRM also provides facilities for saving and recalling measurement settings (setups) and entire measurement sequences (routines). The PC software included with the device, “SRM-3006 Tools”, includes editable tables for antennas and cables from other manufacturers, user-defined evaluation curves, and lists of services and operators.

Fig.-4 SRM-3006 Shows the readings in form of bar

V. ELECTRIC FIELD STRENGTH AND MAGNETIC FIELD STRENGTH

Magnetic fields are the results of the physical movement of electric charge (electric current) whereas electric field produces due to presence of electric charges.

$$B = \mu H$$

Where, B is magnetic flux and is expressed as Tesla (T), H is Magnetic field strength and is expressed in A/m and µ is constant of proportionality which is equals to 4π X 10^{-7}.

If we consider a far field region then the main characteristics of plane wave are as follows:

- The geometry of wave front must be planer.
- It must follow the law of proportionality that means, E and H are perpendicular to each other.
- The phase of E and H are same and their amplitude are must be constant. The ratio of their amplitudes must be 377 ohms which is equal to the characteristic impedance of the free space.
- The power per unit area is known as power density and it is related with the both factors as follows:

$$S = EH = E^2/377 = 377H^2$$

Here the formulae are taken can be conveniently employed for the estimation of these strengths with respect to RF safety guidelines issued by the International Committee on Non-Ionizing Radiation Protection (ICNIRP).

VI. RESULTS

Readings that are to be set by ICNIRP and IEEE for the public exposure are as follows:

Table-4 Limits of public exposure according to ICNIRP and IEEE

Type	Frequency MHz	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
GSM	1800	58.124	0.1569
CDMA	872.315	40.462	0.1092

Note: Above readings are calculated by the set formulae given by ICNIRP and IEEE.

Calculated readings which are only for GSM that are taken from the BTS tower at the different corners are as follows:

Table-5 Readings that are to be taken from BTS tower

Type	Corners	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
GSM	C1	0.2631	0.0005462
	C2	0.26041	0.0005406
	C3	0.2666	0.0005535
	C4	0.1464	0.0005887

Graphical representation of above readings is as follows:

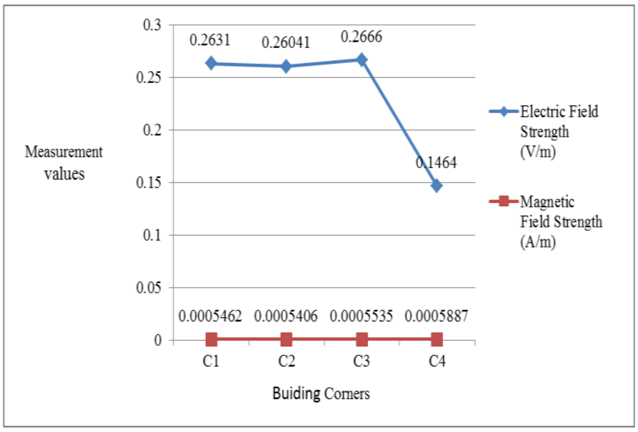

Fig.-5 Graphical analysis of electric field and magnetic field strengths respectively

VII. CONCLUSION

According to telecom regularities and other committees which are working on non- ionized radiation, the value of Specific Absorption rate is less than 2 W/m^2. Now, we have to check time to time weather companies follow these rules or design their equipment as per policy. From the above readings it is shown that the outcomes are in the limit of public exposure but it is still necessary that these towers located somewhere so that it can affect minimum to the human health. Each and every part of human's body has a specific limit of this exposure as it is shown already. The much affected areas are stomach, pancreases, Bladder and Kidney. So, may be the readings are very low but the safety precautions are needed.

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