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Review of Mobile tower radiation effects on Human and Mitigation techniques

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***Abstract*—**All over the world there has been rapid increase in the mobile phone users . mobile phones are popular as they permit people to make and maintain constant and continuous communication without affecting their liberty of lifestyle . As usage of mobile phone is increasing, demand for seamless service is also gets increase and it puts pressure on the service provider . for fulfilling this demand supporting infrastructure is required .To strengthen infrastructure , service provider requires to install more mobile phone tower . Enormous installation of the mobile phone tower throughout the world raised the health concern of high electromagnetic radiation in the area near to these towers. This brings forward the need to revise the radiation level, their impact on the public health and mitigation techniques for radiations .

Keywords- *Electromagnetic Field (EMF), Ionizing radiation, Non Ionizing radiation, Radiation mitigation techniques, exceedance zone, occupational zone, compliance zone*

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I. INTRODUCTION

In Last few years there has been a tremendous growth in the wireless communication industry. In 2013 approximately 97% people all over the world uses mobile phone , out of this 97% people, 57% people uses smart phone and rest of the people uses normal cell phones . In November 2013, a well known and widely followed analyst Benedict Evans states that, "Mobile is eating the World" [5]. Cellular wireless technology becomes ubiquitous and therefore it results into dramatic increase in the usage of wireless devices. In India mobile services were launched in 1995 [1] and after that India is consider as one of the fast emerging telephone industry in the world [2]

People use mobile phone not only for communication but also being used for making video, recording information, chatting, sending text, etc. It is a device which functions more than the communication device. This results into the rapid increase in the supporting infrastructure. The supporting infrastructure includes cell towers for providing communication link to and from the mobile phones. In order to provide the telecommunication facility to the subscriber wireless telecommunication system uses large number of mobile phone tower. This tower uses number of antenna which radiates electromagnetic waves. These mobile phone towers are positioned randomly near to schools, public playground, on commercial buildings and on the terraces of the urban residential areas without any regulations. Because of this population in that area get continuously affected by the low intensity radiations from the mobile tower.

II. HOW MOBILE PHONE TOWER WORKS

The main function of the mobile tower is to raise antenna which transmit as well as receive the radio frequency (RF) signal from or to mobile phones and other devices. Height of the cell tower must be 50-200feet so that it can cover the targeted area. Mobile phone towers are usually mounted on trees, water tank , tall buildings etc. mobile antennas and base station are connected to each other by using wires at ground level . Base station consist of transceivers, signal amplifier, combine and system controllers. Mobile phones make a communication with the nearby base station by using the RF waves. At very high level RF wave can cause heating of body tissue.

When a person makes a call signal is get transmitted from mobile phone's antenna to the nearby base station. In response to that base station allocate the available radio frequency channel. This allocated RF channel transmits the voice information to the base station. This voice signal gets also transmitted to the switching center. Switching center then transmits the call to its destination. This voice call then relayed back and forth during the call.

III. HOW MOBILE PHONE TOWER RADIATION AFFECTS HUMAN HEALTH

Due to increase in the mobile phone users, implementations of the mobile towers are growing rapidly. From the study of World Health Organization (WHO), INTERPHONE, IEGMP and SCENIHR it has been found that the electromagnetic radiation from mobile phone and mobile tower can cause the health issues which include the possibility of brain tumors, eye cancer, leukemia, salivary gland tumors. According to the International Agency for Research on Cancer (IARC) mobile phone radiation can be classified into Group 2B which can consider as the possible cause for carcinogenic to humans[6][7].Therefore to keep limitations on mushrooming of the mobile tower a systematic study is required for measurement of the radiation levels in some selected areas which having high population density .This will ensure that the power density levels should not increase beyond the prescribed threshold limit .

In India the present threshold limit decided by the government is one of the highest limits in the world, therefore preventive measures are required to be taken as it deals with public health issues.

IV. ELECTROMAGNETIC RADIATION AND STANDARDS

Electromagnetic radiation has been around since the birth of the universe; light can be consider as the most well known form of electromagnetic radiation. It is the propagated in the form of wave as it travels through the free space or material medium. It has electric as well as magnetic field components. These components propagate in phase and perpendicular to each other as well as perpendicular to the direction of propagation. Electromagnetic wave is transverse in nature and propagated with the speed of light [3].

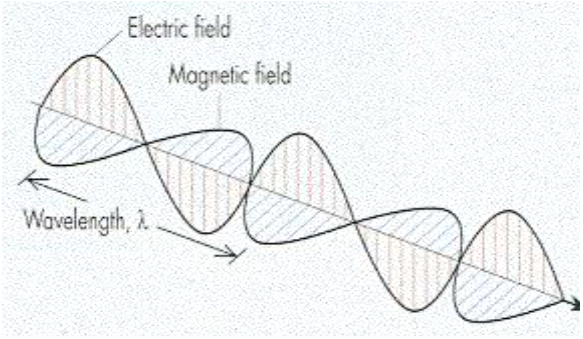

Figure 1. Electromagnetic Radiation Wave

Figure 1 shows diagrammatic representation of the electromagnetic wave and Figure 2 shows that Electromagnetic spectrum covers wide range of frequency or wavelength

V. TYPES OF ELECTROMAGNETIC RADIATIONS AND THEIR STANDARDS

With reference to the biological radiation exposures the electromagnetic radiation is divided into two types: Ionizing and Non Ionizing

A. *Ionization*

It is a process which has enough energy to remove tightly-bounded electrons from atoms and molecules, thus creating ions. High-frequency ultraviolet rays, X-rays, gamma rays and cosmic ray are the examples of ionization radiation.

B. *Non- Ionization*

This type of radiation does not carry adequate energy per quantum to ionize atoms or molecules for removing electrons from atom and molecules .It causes movement of atoms in molecules and causes vibration of them. It also forces electrons to move to higher energy state [4]. Extremely Low Frequency Radio Waves, Microwaves, Infrared, Visible Light and sunlight are considering as the examples of the Non – ionizing radiations.

ICNIRP has developed an international guidelines on exposure limits after examine the problems arises due to the non ionizing radiations. These reference limits are given in TABLE I [8] [9].

Very high levels of the RF radiations becomes harmful because RF signal energy causes rapid heating of the biological tissues which may results in to the tissue damage in the Humans.

TABLE I. REFERENCE LEVELS SET BY ICNIRP

Exposure category	Frequency range	E-Field Strength (V/m rms)	H-Field Strength (A/m rms)	Equivalent plane wave power flux density S_{eq} (W/m^2)
Occupational	100 kHz - 1MHz	614	1.63 / f	-
	1 MHz – 10 MHz	614 / f	1.63 / f	1000 / f^2
	10 MHz – 400 MHz	61.4	0.163	10
	400 MHz – 2 GHz	3.07 * $f^{0.5}$	0.00814 * $f^{0.5}$	f / 40
	2 GHz – 300 GHz	137	0.364	50
General Public	100 kHz – 150 kHz	86.8	4.86	-
	150 kHz – 1 MHz	86.8	0.729 / f	-
	1 MHz – 10 MHz	86.8 / $f^{0.5}$	0.729 / f	-
	10 MHz – 400 MHz	27.4	0.0729	2
	400 MHz – 2 GHz	1.37 * $f^{0.5}$	0.00364 * $f^{0.5}$	f / 200
	2 GHz – 300 GHz	61.4	0.163	10

Figure 3. Different zones around the Base Transreceiver antenna

On the basis of RF signal strength of the transmitter power, area around the base station can be divided in to three different zones namely exceedance zone, occupational zone and compliance zone as shown in figure. 3[11].

- compliance zone: In this zone potential exposure levels are below the limit
- Occupational zone: potential exposure to EMF is below the limit for occupational exposure, but beyond the limits for general public exposure.
- Exceedance zone: In this zone potential exposure to EMF exceeds the limit for both, occupational and general public exposure.

VI. EXPOSURE LEVEL ASSESSMENT

An Antenna is considered as the main source of the electromagnetic radiations. Antenna determines the distribution of electromagnetic field in the surrounding area of the transmitting station. The vicinity of an antenna is subdivided in to four regions as shown in figure. 4 [11].

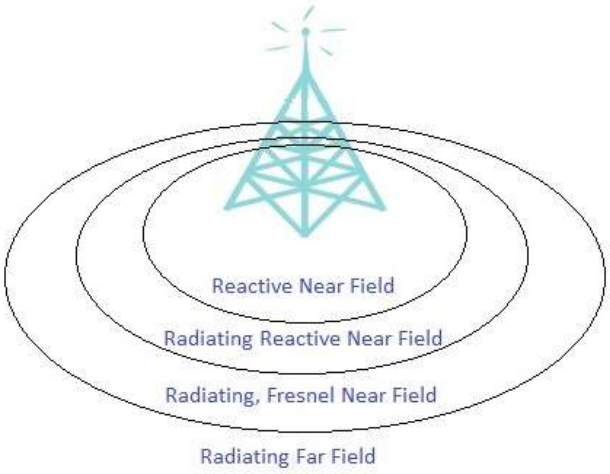

Figure 4. Radiation field regions of an antenna

The four regions around the antenna are: Reactive near field, reactive-radiating near field, radiating (Fresnel) near fields and radiating far field

Reactive near field region having radial distance of 0.62(D2/ λ) 1/2, where D is largest dimension of the antenna and λ is wavelength

Radial distance of the radiating near field is 2D2/ λ, if he field region is beyond the radiating near field region then it is consider as a radiating far field region.

For exposure level assessment measurement of field quantities is necessary. This field quantity includes electric (E) field intensity, magnetic (H) field intensity and Specific Absorption Rate (SAR). Location of the observer (near or far field region) and field impedance selects the field quantity.

In case of the reactive near field, both E and H components are measured and SAR is calculated. If observer is located very close to the antenna then SAR calculation is preferred rather than measuring E and H component.

In reactive radiating near field, if field impedance is not available then it is necessary to measure both E as well as H field component and if field impedance is available then it is possible to measure any of the one field component. In case of high electromagnetic impedance ($E/H>120\pi$) measurement of E component is required and if impedance of electromagnetic field is low ($E/H<120\pi$) then measurement of H component is sufficient.

In radiating near field region measurement of only E component is sufficient .In radiating far field region it is needed to measure either E or H field component for determining the equivalent power density.

VII. RADIATION MITIGATION TECHNIQUES

It is necessary to take certain and strong action if radiation level in any area which is nearby to public is higher than specified limits .For achieving this several mitigation techniques are as follows which can be used independently or in combination with each other if required.

A. Reduction in transmitter power

Power of transmitter is directly proportional to the power density and square of the electric field strength / magnetic field strength. Therefore decrement in the transmitter power results into the reduction in the radiation level but may also results in reduction of coverage area. The TABLE II provides an idea about the compliance distance.

TABLE II. SIMPLIFIED METHODS TO CALCULATE COMPLIANCE DISTANCES

Range of Radio Frequency	General Public Exposure	Occupational Exposure
1 - 10 MHz	$r = 0.10*\sqrt{\mathbf{eirp}} * \mathbf{f}$	$r = 0.0144*f*\sqrt{\mathbf{eirp}}$
10-400 MHz	$r = 0.319 *\sqrt{\mathbf{eirp}}$	$r = 0.143*\sqrt{\mathbf{eirp}}$
400-2000MHz	$r = 6.38*\sqrt{\mathbf{eirp}}/\mathbf{f}$	$r = 2.92*\sqrt{\boldsymbol{eirp}}/\boldsymbol{f}$
2000-300000MHz	$r = 0.143*\sqrt{\mathbf{eirp}}$	$r = 0.0638*\sqrt{\mathbf{eirp}}$

Where
r: minimum antenna distance in meter
f: frequency in MHz
eirp: Product of power supplied to the antenna and maximum antenna gain in watts .

B. Increase antenna height

Power density at any observation point is depends on the antenna height. If there is increase in the antenna height then due to increase in the distance, power density at the observation point gets reduced.

C. Reduction in down tilt of Vertical Radiation Pattern (VRP)

Vertical radiation pattern is one of the most important parameter in performance measurement of an antenna. This is because in line of sight mode all the energy radiated above the horizontal plane gets loss. To los can be overcome by tapering the vertical radiation pattern of the antenna system and by tilting the beam in downward direction [12].This down tilting of beam limits the coverage area but increases the frequency reuse possibility .Further , radiation level nearer to the antenna also gets increases.

D. Increasing Antenna Gain

Antenna gain is one of the important parameter as it combines directivity of an antenna as well as the electrical efficiency. Antenna gain determines how well the input power of the antenna gets converted into the electromagnetic radiations. It also determines how these radiations get directed in specified direction and prevents the radiations in other direction. Therefore by limiting the directivity of the antenna it is possible to control radiation level in such areas which are accessible to the people. Directivity of the antenna is related to the horizontal radiation pattern (HRP) and vertical radiation pattern (VRP). Change in HRP can reduce the radiation levels but affects the coverage area. Whereas VRP decides radiation as a function of distance to the antenna. Therefore for reducing the radiation levels in the nearby area of an antenna, gain can be used as it not affects the coverage area. So to achieve this high gain low power antenna can be used.

E. Using Multiple techniques simultaneously

In some cases it is required to use different methods in combination with each other for reducing the radiation levels. All the methods mention above are independent and in many cases can be used in combination with each other.

In addition to the above methods it is also the responsibility of wireless service provider to make sure the provision of proper signage, warning entry of general public in to the exclusion zone, etc. Also the cell phone users must adopt some habits such as avoid unnecessary use of mobile phones and other wireless devices, avoid continuously wearing of Bluetooth and other type of ear phones which works on wireless technologies and so forth.

CONCLUSION

There is robust development in the telecommunication industry. Mobile phones plays vital role in the telecommunication and becomes integral part of the modern lifestyle . Increase in the usage of mobile phone can cause the health hazards. Therefore the wireless service provider should consider and follow the recommendation given by ITU-T. Long term studies and research should be carried out on the antenna characteristics, exposure levels. One cannot avoid the use of mobile phone but limited use of mobile phone can limit the health risk .Also there is need to revise the guidelines and threshold limits specified by the ICNIRP.

REFERENCES

[1] http://dxm.org/techonomist/news/cellcal.html
[2] S Sivani, D Sudarsanam, "Impacts of radio-frequency electromagnetic field (RF-EMF) from cell phone towers and wireless devices on bio system and ecosystem – a review," Biology and Medicine, 4 (4): 202–216, 2012.
[3] http://abyss.uoregon.edu/~js/glossary/electromagnetic_radiation.html
[4] http://en.wikipedia.org/wiki/Non-ionizing_radiation
[5] http://ben-evans.com/benedictevans/2013/11/5/mobile-is-eating-the-world-autumn-2013-edition.
[6] http://en.wikipedia.org/wiki/List_of_IARC_Group_2B_carcinogens
[7] http://www.icnirp.org/en/applications/mobile-phones/index.html
[8] http://www.rfsafetysolutions.com/RF%20Radiation%20Pages/ICNIRP_Guidelines.html
[9] http://www.feko.info/support/lua-scripts/radiation-hazard-iso-surfaces-wizard/radiation-hazard-iso-surfaces-wizard
[10] http://www.antenna-theory.com/definitions/eirp.php
[11] http://www.rfwireless-world.com/Articles/Electromagnetic-radiation-basics-and-EM-mitigation-techniques.html
[12] Reyes C., and Ramos B, "Mitigation of Radiation Levels for Base Transceiver Stations based on ITU-T Recommendation K.70", World Academy of Science, Engineering and Technology Vol:4 2010-09-20.

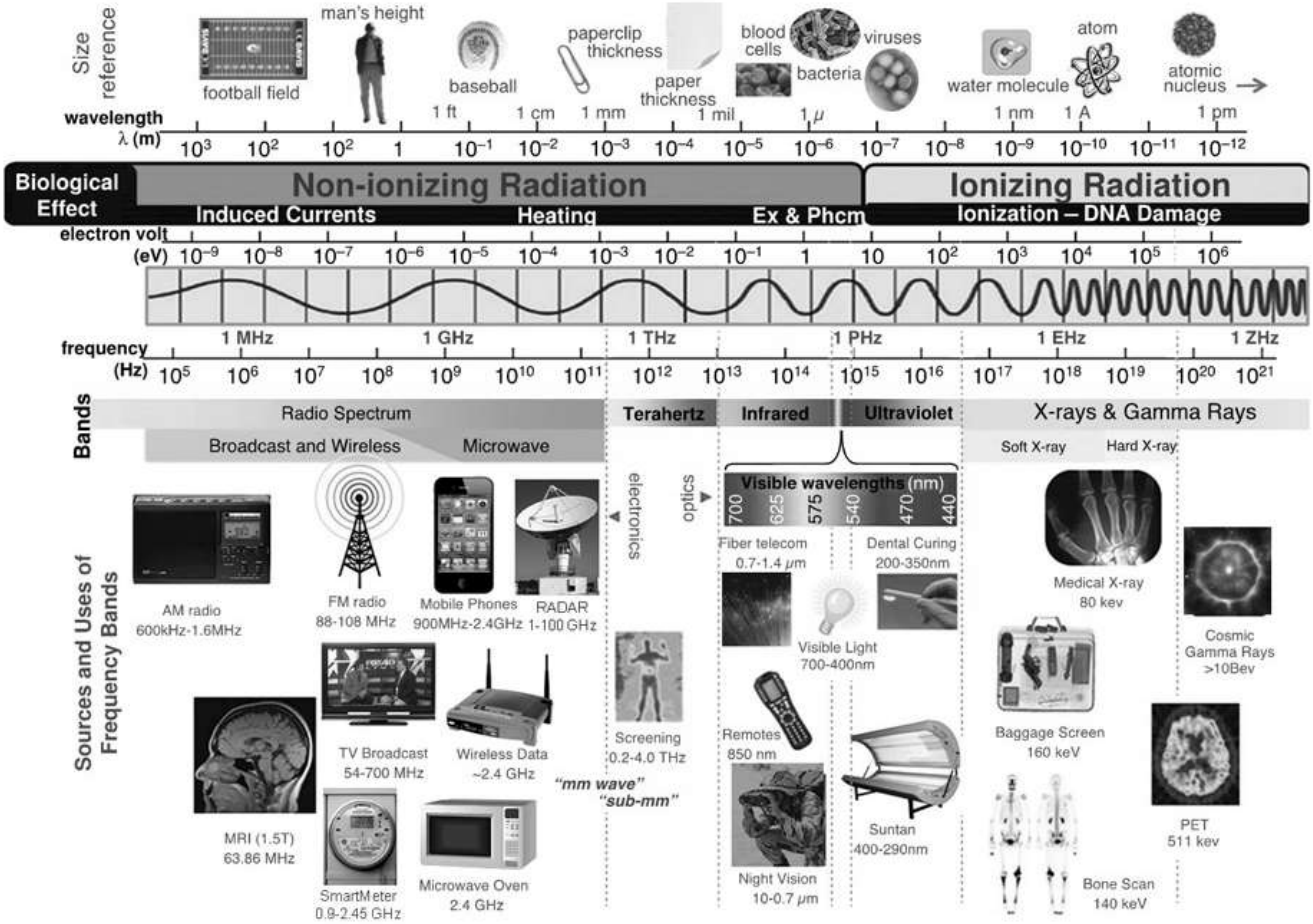

Figure 2: Electromagnetic spectrum