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Electromagnetic (EM) radiation basics and standards

As we know this is the age of mobile evolution across the globe. To meet the demands of increasing number of mobile and wireless devices telecom operators are deploying large number of cellular towers. These cellular towers are referred as base stations or Node-Bs or ENodeBs depending upon the wireless standards. These cellular mobile phone towers employ multiple antennas and transmit electromagnetic waves

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to serve the subscribers. Mobile and wireless standards are evolving very fast and equipments based on emerging technologies are getting deployed across the world. The standards include WiMAX, EVDO, CDMA, WiBro, LTE, iBurst, LTE Advanced and more.

Due to existence of multiple technologies and simultaneous transmissions from various towers have become point of concern for the safety of the common public. This is due to electromagnetic radiations from these cellular towers are above the limit prescribed by government and health organizations. If the EM radiation is above the limit then it will cause various health related diseases such as brain tumour, eye cancer, damage to tissues etc. As per survey conducted people living near the cellular tower are the worst affected. Figure below depicts the zones surrounding the cellular tower i.e. base station. As mentioned there are three zones viz. exceedance zone, occupational zone and compliance zone. In the exceedance zone power density levels are higher compare to compliance zone. In the compliance zone , the power levels are within limit prescribed by various health agencies.

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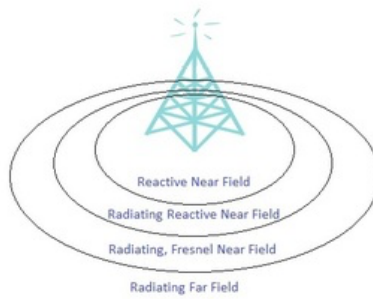
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Zones of Transmitting Base Station



Radiating Field Regions of Base Station

The figure also depicts EM radiation field regions around the antenna. As mentioned there are reactive near field, radiating reactive near field, radiating fresnel near field and radiating far field regions. For the RF exposure assessment it is required to measure E field, H field and SAR (Specific Absorption Rate). All these parameters depend upon observer location (i.e. field region) and field impedance.

RF level set by ICNIRP

As mentioned high level of RF exposure to humans will result into heating of the body parts (tissues) and will have adverse effects. This is due to the fact that humans do not have heat dissipating capabilities. Especially parts such as eyes and kneecaps will be affected more. There are two main types of radiations ionising and non ionising. We know that Human body will have large components as water. Ionising **EM radiation** breaks the chemical bonds of water while non-ionising EM radiation do not break the bonds.

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Hence non-ionising **electromagnetic radiation** is harmful for human beings.

International Commission on non-ionising radiation protection (ICNIRP) has developed international guidelines and limits for EM radiation. The same have been mentioned in the table-1 below.

Type of RF exposure	Frequency range (MHz)	E field strength (V/m)	H field strength (A/m)
General Public use	400 to 2000 2000 to 300000	$1.375*f^{1/2}$ 61	$0.0037*f^{1/2}$ 0.16
Occupational use	40 to 2000 2000 to 300000	$3*f^{1/2}$ 137	$0.008*f^{1/2}$ 0.36

Compliance distance from Base Station Antenna

As mentioned there are various zones around the base station antenna based on RF strength of the transmitter power. This depends on compliance distance which is calculated based on EIRP and

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operating frequency (or wavelength). The table-2 below mentioned the compliance distance from the base station antenna based on these parameters.

Type of RF Exposure	Frequency Range (MHz)	Compliance Distance(meter)
General Public	400 to 2000 2000 to 300000	About 6.38* $(\text{EIRP}/\text{Freq})^{1/2}$ to $8.16*(\text{EIRP}/\text{Freq})^{1/2}$ About 0.143* $(\text{EIRP})^{1/2}$ to 0.184* $(\text{EIRP})^{1/2}$
Occupational application	400 to 2000 2000 to 300000	About 2.92* $(\text{EIRP}/\text{Freq})^{1/2}$ to $3.74*(\text{EIRP}/\text{Freq})^{1/2}$ About 0.0638* $(\text{EIRP})^{1/2}$ to 0.0184* $(\text{EIRP})^{1/2}$

Electromagnetic radiation mitigation techniques

There are countries where in RF exposure limit or EM radiation is monitored by government and standard agencies. In the countries where in the same is not

closely monitored and government is generous about the radiations, will have environment adverse effects on the general public. In these countries, it is strongly desired to take action to reduce or mitigate the EM radiation. Following are the techniques used for Electromagnetic radiation mitigation.

- Transmit Power directly depends on power density and square of E/H . Hence reduction in transmit power will result into reduction in RF radiation level. But this leads to coverage area reduction.
- As power density at a point from antenna depends on antenna height. If antenna height is increased then RF field strength at the observer point will be reduced due to increase in distance.
- It is advised to decrease Vertical Radiation Pattern (VRP) downtilt to reduce the EM radiation.
- Higher antenna gain and lower transmit power can be used in near proximity to the antenna. This results into same EIRP. This help in limiting the RF radiation greatly.
- As VRP is the function of elevation angle. It is

basically distribution of RF energy in vertical plane. Optimization of VRP will result into reduction in Electromagnetic radiation.

- HRP (Horizontal Radiation Pattern) depends on azimuth angle. This represents distribution of energy across horizontal plane. A narrow horizontal beam along with low transmit power will reduce the EM radiation.

All these techniques can be applied either individually or combined for EM radiation mitigation. Other than the mitigation techniques mentioned above, following are the basic tips for health concern to be adopted by all the mobile phone or wireless device users. This helps avoid exposure to unnecessary RF radiation.

- Minimize the usage of mobile phones and/or wireless devices.
- Do not continuously wear wireless ear phone devices based on wireless technologies such as bluetooth, zigbee etc.
- Do not allow childrens to use them more.

- Try to use them in the safer zone areas far from the base station or cellular towers.

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