

Analytical Assessment of Non Ionized Electromagnetic Radiation from the Communication Towers/Cell Phone

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Abstract—Since World War II, the background level of EMF from electrical sources has risen exponentially, most recently by the soaring popularity of wireless technologies such as cell phones. Mobile communication technology using RF and microwaves spectrum has induced public fear about possible adverse effects on human physiology. Several decades of international scientific research confirm that EMFs are biologically active in animals and in humans. Though a lot of studies and research are going on in many of the countries and very few conclusive results are available. An attempt has been made to collect the data in the very busy and densely area and in the Amity University Campus. Aim is to check the level of radiation from the communication tower. And then analyze the data to check weather this level is affecting the students or not. By taking this data as the reference we are also comparing the other situations of the other communication towers and their base transceiver stations.

Keywords—*Electromagnetic Radiations, EMI, EMC, Communication tower effects, radiation, cell phone hazards*

I. INTRODUCTION

After the 90th decay mobile and cell phone has become the life line of all the people. People are using cell phone day and night and every where some times in the bathroom also. Mobile phones communication employs microwave frequencies of electromagnetic spectrum.

All electromagnetic waves including RF wave is also termed as radiation. Probably because the term is very near to 'radioactive', many people have mistakenly thought that all radiations are radioactive. Actually, radioactive is an adjective used to describe materials that are energetically unstable at the atomic level and they loss energy by emitting ionizing radiation.

On a contrary, **RF wave is non-ionizing.**

There is a huge difference between ionizing radiation and non-ionizing-radiation. onizing radiation has energy high enough to change the chemical characteristics of an atom and therefore alter biological cells in human being, causing cell mutation and eventually cancer in human body. On the other hand, non-ionizing radiation do not have the energy to cause cell mutation.

Since last 2-3 years, a systematic campaign has been launched in media about the dangerous "radiation" from cell phone towers. It was called 'radiation' intentionally to scare

the public, as a common man links the word with dangerous products of nuclear accidents. The radiations, which are nothing but electromagnetic waves, are identified by their frequency bands.^[1]

Visible light and frequencies lower than it, on the other hand, are regarded completely harmless. The cell phone towers emit waves in the UHF range which is much below the heat and visible light frequencies.

Coming to the power of these radiations, never will these evangelists report the fact that for a two way communication, the minimum power received by the mobile hand set from the tower and, received by the tower from the hand set has to be the same. So, a mobile tower and a mobile phone actually radiate more or less the same amount of power. Comparing tentative level of emitted powers from some of the most commonly identifiable devices:

Micro wave oven: 1 Kilo watts

Police wireless: 20-50 watts (VHF)

First Generation Mobile system (in 90s) in New York: 250-500 Watts (UHF)

Door Darshan: 10-20 Kilo Watts (UHF)

Cell tower antennas transmit in the frequency range of 869 to 890 MHz (CDMA), 935 to 960MHz (GSM900), 1810 to 1880 MHz (GSM1800) and 2110 to 2170 MHz (3G). Mobile phone operators divide a region in large number of cells, and each cell is divided into number of sectors. Generally, there are three sectors with equal angular coverage of 120 degrees in the horizontal direction. The base stations are connected to directional antennas that are mounted on the roofs of buildings (RTT – Roof Top Tower or RTP - Roof Top Pole) or on Ground Based Towers (GBT). The antennas may have electrical or mechanical down-tilt, so that the signals are directed towards ground level. Large numbers of these towers are mounted near the schools, hospitals, residential and office buildings to provide good mobile phone coverage to the users. These cell towers transmit radiation 24x7, so people living within 100's of meters from the tower will receive 10,000 to 10,000,000 times stronger signal than required for mobile communication. In India, crores of people reside within these high radiation zones.^[3, 10]

Measurements Procedure:

Microwave Radiation level measurement from cellular base station used a Log periodic antenna and a spectrum analyzer. These measurements are carried out in the frequency span of 0.15 MHz to 1050 MHz. The antenna was placed at an approximate height of the human physiology i.e. level of head and chest at sitting and standing position respectively from the floor to capture the radiations in the desired range of frequency.

The received power was measured using spectrum analyzer connected to antenna using calibrated RF cable. All the measurements are focused on the mobile cellular frequencies. The records were also taken to find out the maximum radiation level in frequency band at few locations in line of the sight of transmitting antennas of the base stations.

Radiated power density from the cell tower

The radiated levels were recorded in dbm using spectrum analyzer.

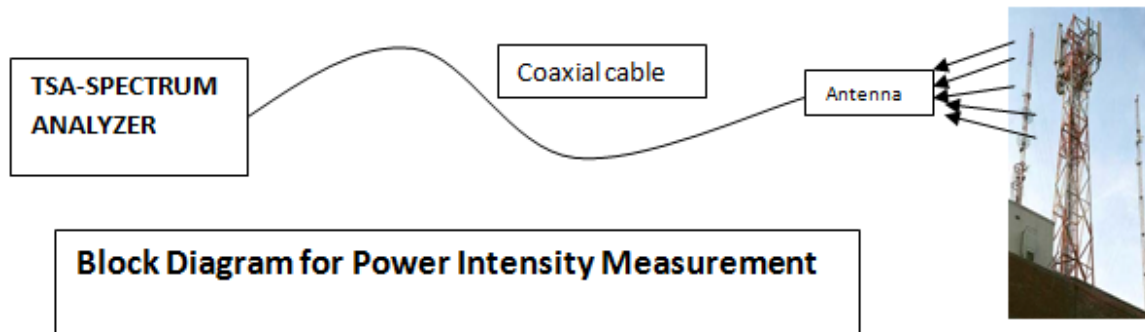


Fig 1: Block Diagram for Power Intensity Measurement

Firstly the readings were taken at the lab of the AISST Dept. round about 400m. Far away from the tower and then the other observations were taken place at the different distances. We have first converted these readings to Electric field strength and then by the use of the following equations we have changed them into Power density ($\mu\text{W}/\text{cm}^2$). Considering that the cellular base stations radiation is received at the mobile handset, which can be consider as far field case.

Electric Field Strength and power Density is computed by the following equations.

Measured Power at the spectrum Analyzer = P dbm

dbm to db μ V conversion Factor = 107

Measured Power in db μ V = 107 + P

Cable Loss = CL db

Field Intensity (E) = (107 + P + CL) db μ V/m

Electric Field Strength (FS) = $10^{(E/20) \cdot (10^{-6})}$ V/m

Power Density = $\text{FS}^2/3770$ mW/cm²

The location and calculated data is shown in the following table:

Firstly the observations were taken at the lab which was round about 400 m. (by air) far from the towers where final readings were taken.

Observation Table

Frequency (MHz)	Location	Field Strength (V/m)	Power Density ($\mu\text{W}/\text{cm}^2$)
935	At lab	1.0957	0.3184
958	At lab	1.0753	0.3067
945	At lab	1.1559	0.354
886	At lab	1.0009149	0.265737
841	At lab	1.00578	0.26833
780	At lab	1.002299	0.267
586	At lab	1.0001449	0.265328
159	At lab	1.000003641	0.265253
120	At lab	1.0000022	0.2967
104.7	At lab	1.000914922	0.265737
98.3	At lab	1.00009145	0.2653
80	At lab	1.000577	0.2652
18	At lab	1.0000364	0.265271

Table 1: Measurements and observations were taken at closed room of the lab

Cellular base station set up on the terrace of different buildings at different heights and the distances. Measurements were carried out various sides of the laboratory and then on the top of the building also.

Frequency (MHz)	Location	Field Strength (V/m)	Power Density ($\mu\text{W}/\text{cm}^2$)
935	At tower base	1.7807117	0.84109
958	At tower base	1.43917	0.5493
945	At tower base	1.581443	0.6633
886	At tower base	1.0957	0.3184
841	At tower base	1.03707	0.2852
780	At tower base	1.01459	0.27305
586	At tower base	1.000364	0.265445
159	At tower base	1.0000577	0.2652
120	At tower base	1.00009145	0.2653
104.7	At tower base	1.0002299	0.267
98.3	At tower base	1.000364	0.265445
80	At tower base	1.0009149	0.265737
18	At tower base	1.00057	0.2655

Table 2: Measurements and observations were taken at the terrace at the distance of 25m.

Till now we have taken all the readings and now we are comparing both the observed values of the power density. That will conclude many things as there is a huge difference in the readings of the nearby tower and far away from the tower. But this is obvious thing and we all know it. Second thing we observed that the exposed level of this frequency is occurring many health problems to the students who are

reading under the building. A survey has been done to conclude that various health problem are coming into picture.

A chart has been produced which is concluding the difference between the frequencies of the observation values at the terrace and the lab of the 2nd floor of the Amity.

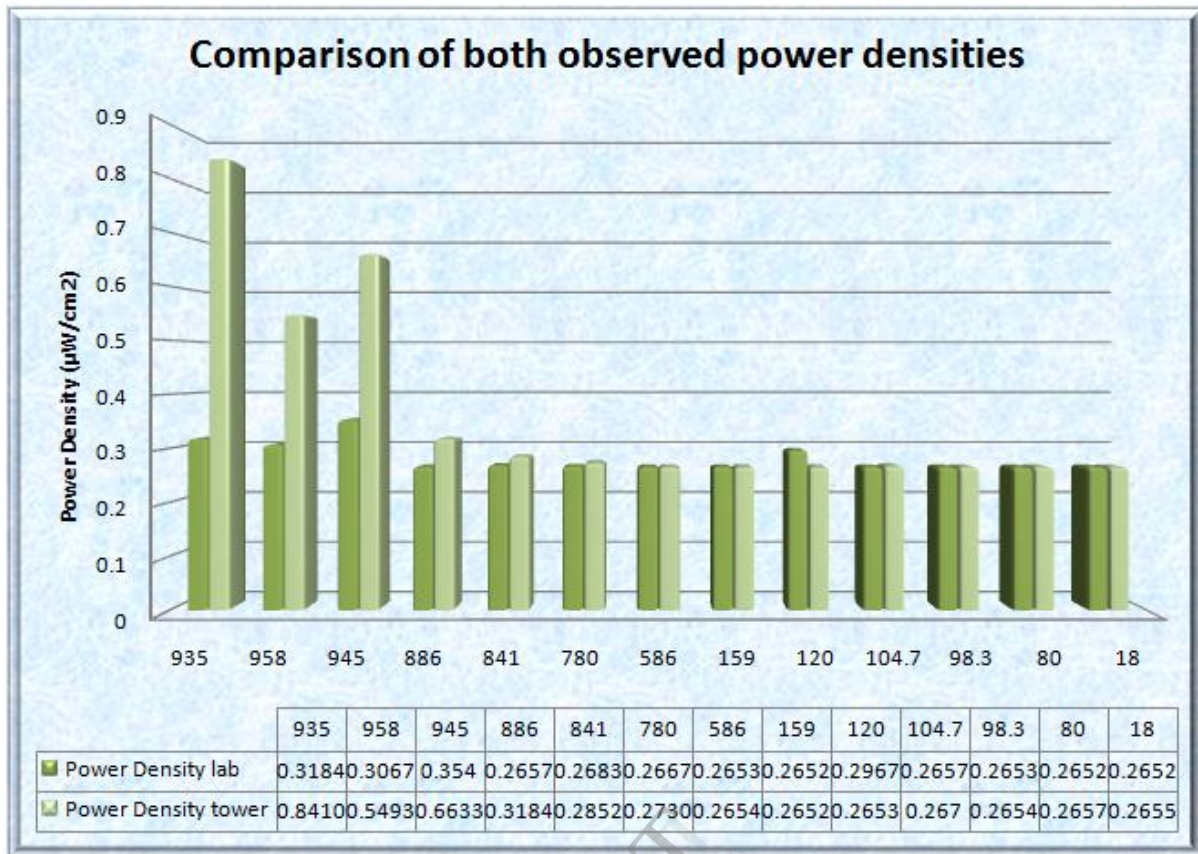


Fig.2: This chart is showing the power density at various frequencies.

Just by giving a simple look at the chart the exposure level and power density can be compared.

The measured received power values are comparable to the theoretical values in the direction of main beam. Hence, it is important to know the radiation pattern of the antenna to know the exact radiation density at a given location. The purpose of a cell tower is to enable cell phone to receive adequate signal for its proper operation. However, all the above readings of radiation density are within the ICNIRP guidelines of safe radiation, which are adopted in India. Yet, many people living closer to these towers have several health problems.

There are the some credible articles which are saying that cell tower level RF exposures (estimated to be 0.01 to 0.5 $\mu\text{W}/\text{cm}^2$).

As we talk to the students of Amity University we noted down all the problems they are facing and compare with the students of other departments. We analyzed that closest to the cellular antennas had the highest incidences of the following disorders:

- fatigue
- Sleep disturbances
- Headaches
- Feeling of discomfort
- Difficulty in concentrating
- Depression
- Memory loss

- Visual disruptions
- Irritability
- Hearing disruptions
- Skin problems
- Cardiovascular disorders
- Dizziness

Even then same thing was also noticed that those classes which are taking place near the Wi-Fi terminals are also affected little bit.

We collected all the information just as a survey with the students and compare the problem with the records available on internet and match them all. By the observation and matching data we reached on the conclusion that towers are not safe for the students

Possible solutions to reduce the ill effects of cell tower radiation

It is recommended that maximum cumulative power density allowed should be reduced with immediate effect to 0.01 W/m^2 , which should then be subsequently reduced to 0.001 W/m^2 within 1 to 2 years, so that network planning can be carried out in a phased manner. There are several health hazards due to radiation from the cell towers to the human, birds, animals and environment. ^[1, 5, 6]

- The power density inside residential or office buildings, schools, hospitals, and at common

- frequently visited places should be within the guidelines.
- People must be informed about the harmful radiation effects and for some time, they may have network problem (especially people living far away from the cell tower) due to reduction in the transmitted power, but it is for their overall health benefit.

Measured values are much lesser than the theoretical values in the directions other than main beam of radiation because of reduction in the gain in that direction. Measured power levels after accounting for cable losses at several places varies between 0 to -10 dbm, which is extremely high. A mobile phone shows full strength at -69 dbm input power and works satisfactorily in the received power range of -80 to -100 dbm. In comparison with -80 dbm level, the measured power level

at several places is at least 50 to 80 dB higher, which translates to 100,000 to 100,000,000 times stronger signal than a mobile phone requires. There are millions of people who live near these cell towers and absorbing this radiation 24×7 .^[12, 13]

Solution is to have more numbers of cell towers with lesser transmitted power. When power transmitted is reduced, it will not require power hungry power amplifiers having lower efficiency. Heating effect will also be reduced, so lesser cooling or no cooling will be required; all of these will reduce the power requirement, which can also be met by solar panel. Thus, high power diesel generators will also be not required; which will reduce the noise and air pollution. Reduction in carbon emission will earn carbon credits.

Here is the list of some serious problems which are discussed in such a manner that at what level of exposure the EM Radiations are hazardous to the health

Risk factor of	Power Density (Microwatts/centimeter ² - uW/cm ²), SAR (Watts/Kilogram)	Reference
Human semen degraded by exposure to cell phone frequency RF increased free-radical damage.	1.0 W/Kg	De Iuliiis, 2009
Changes in cell cycle; cell proliferation (960 MHz GSM mobile phone)	0.000021 - 0.0021 W/Kg	Kwee, 1997
Adults exposed to short-term cell phone radiation reported headaches, concentration difficulties.	0.005 - 0.04 uW/cm ²	Thomas, 2008
RFR related to headache, concentration and sleeping problems, fatigue	0.05 - 0.1 uW/cm ²	Kundi, 2009
Wi-Fi level laptop exposure for 4-hr resulted in decrease in sperm viability.	0.5 - 1.0 uW/cm ²	Avendano, 2012
Well-being and cognitive function affected in humans exposed to GSM-UMTS cell phone frequencies; RF levels similar near cell sites	0.000064 - 0.000078 W/Kg	TNO Physics
Changes in brain glial cells with TDMA 836.55 MHz frequency	0.0009 W/Kg	Stagg, 1997
Heat shock protein HSP 70 is activated by very low intensity microwave exposure in human epithelial amnion cells	0.0021 W/Kg	Kwee, 2001
Digital cell phone RFR at very low intensities causes DNA damage in human cells; both DNA damage and impairment of DNA is reported	0.0024 - 0.024 W/Kg	Phillips, 1998
750 MHz continuous wave (CW) RFR exposure caused increase in heat shock protein (stress proteins). Equivalent to what would be induced by 3 degree C. heating of tissue (but no heating occurred)	0.001 W/Kg	De Pomerai, 2000
Changes in active avoidance conditioned behavioural effect is seen after one-half hour of pulsed radiofrequency radiation	0.0027 W/Kg	Navakatikian, 1994
MW modulated at 7 Hz produces more errors in short-term memory functioning on complex tasks (can affect cognitive processes such as attention and memory)	0.0095 W/Kg	Lass
Whole-body exposure to RF cell phone radiation of 900-1800 MHz 1 cm from head of rats caused high incidence of sperm cell death; deformation of sperm cells; prominent	1.8 W/Kg	Yan, 2007

clumping together of sperm cells into "grass bundle shapes" that are unable to separate/swim. Sperm cells unable to swim and fertilize in normal manner.		
GSM cell phone exposure affected gene expression levels in tumour suppressor p53-deficient embryonic stem cells; and significantly increased HSP 70 heat shock protein production	1.5 W/Kg	Czyz, 2004
850 MHz cell phone radiation decreases sperm motility, viability is significantly decreased; increased oxidative damage (free-radicals) significantly decreased; increased oxidative damage (free-radicals)	1.46 W/Kg	Agarwal, 2009
Significant elevation in micronuclei in peripheral blood cells at 2450 MHz (8 treatments of 2-hr each)	1.0 - 2.0 W/Kg	Trosic, 2002
Sleep patterns and brain wave activity are changed with 900 MHz cell phone radiation exposure during sleep	1.0 W/Kg	Borbely, 1999
Significant increase in concentration difficulties using 1800 MHz cell phone compared to 900 MHz cell phone	1.0 W/Kg	Santini, 2001
Four-fold increase in eye cancer (uveal melanoma) in cell phone users	1.0 W/Kg	Stang, 2001
Increase in headache, fatigue and heating behind ear in cell phone users	1.0 W/Kg	Sandstrom, 2001
GSM cell phone use modulates brain wave oscillations and sleep	1.0 W/Kg	EEG Huber, 2002

This data is taken from the Internet sources and incemic-conference-proceedings-2012 and 2010. [1, 2, 14, 15, 16, 17, 8, 7]

Measurements of radiations must be done by third party, which is independent and trustworthy. Also, radiation measurements must be monitored 24x7, so that operators should not increase the transmitted power during the peak period. In overall saying Self certification by the operators must be immediately abolished.

There should be Very strict penalties imposed on those operators, who violate norms as it causes serious health hazards to innocent people. [9]

Conclusion

The seriousness of the health hazards due to radiation from the cell phones and cell towers has not been realized among the common man. Cell operators continue to claim that there are no health issues. Cell phone industry is becoming another cigarette industry, which kept claiming that smoking is not harmful and now there are millions of people around the world who have suffered from smoking. In fact, cell phone/tower radiation is worse than smoking; as one cannot see it or smell it, and its effect on health is noted after a long period of exposure. Therefore, majority of people tend to have casualness towards personal protection.

From the above data of exposure level we can see all the side effects of the radiation coming from the communication towers and the cell phones. Even then the Base transceiver station of any communication tower is also emitting the radiation. Yet it can't be declared dangerous because human being is exposing to it only for a short period of time which is negligible as compare to others.

Thus the conclusion is clear that the radiation coming out from the communication tower is affecting the health of the students depending on the distance from the tower. Same effects are observed on the other nearby locations of the towers.

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