

ALRAMING TREND OF RADIATIONS DUE TO CELL PHONE AND PROJECTIONS FOR 2050

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ABSTRACT

Research, development and usage of wireless technology products have altered the landscape of modern human beings in countless ways, in office, at home and on mobility. However, they have created and added a new pollution in the environment i.e. electronic pollution due to EMF radiation. In spite of recent studies indicating possible harmful effects of EMF radiation on environment, there is no long term data available on the amount of power density radiation by cell phones. The aim of this research work is to experimentally measure the EMF radiation by cell phones during on / Idle mode, Rx and Tx modes. The experiments were conducted using Nardas 8718B radiation survey meter at the centre frequencies of 800 MHz and 1800 MHz. Population and cell phones projections for India, China, USA and the whole world are also included in this research work. An attempt is made to indicate EMF levels radiated into environment from 2020 to 2050.

Keywords : Electromagnetic Field (EMF) Radiation; Radiation Survey meter ; probe ; Mobile Telephony ; Environmental EMF exposures; Wireless Technology

I. INTRODUCTION

Environment represents the totality of physical, chemical, biological, behavioural and socio-economic factors. The galloping developments in the field of wireless technology products in the last two decades have increased the modern human involvement, its related ecological, biological and physical systems resulting in various undesirable and unintentional negative impacts on environment and human health. The most pervasive environmental exposure in industrialized as well as developing countries to day is the Electro Magnetic Fields (EMF) exposures created by the vast array of wireless technologies. The EMF radiation pervading

the environment is now increasingly realised and this has added to a new pollutant to the list of pollutants into the environment.

Rapid development and usage of electronic products in all walks of life, electronic pollution has become a great concern to entire world community. In this electro-magnetic pollution has assumed prominent importance which is in limelight in recent times for all negative reasons. The intensity of manmade electromagnetic radiation has become so ubiquitous and it is now increasingly recognised as a form of invisible and insidious pollution which

is affecting human health and environment alike in different ways [1].

Recent studies have indicated that mortality at communication towers over 200ft, may be a threat to the healthy population of birds and the EMF radiation from cell phone towers may probably be the reasons for the vanishing butterflies, bees, insects and sparrows. Studies have also shown that there seems to be effects on birds exposed to the EMF radiation and losing navigational ability. They get disoriented and fly in different direction [2]-[3].

Electromagnetic radiations are not easily recognised and detectable,. However their impacts are being felt on human health hazards such as blood barrier resulting in neuronal damage, risk to children/pregnant women, DNA damage, skin problems, ringxiety including ear damage, cause for tumour in the eye, sleep disorders, headaches, increase in cancer causes which have been attributed by World health Organization(WHO) and other researchers. WHO has conducted study in 13 countries has reported 5117 brain tumour cases[4]-[6]. Professor Girish Kumar of IIT, Bombay has in his research quoted saying there are 200 research papers contributing to effects of EMF radiation to human health problems [7] &[8]. The impact of EMF radiation on environment further escalates on forests, birds, bees and wildlife [7] & [9]. The cello phone operators association and government of India reject these allegations due to lack of evidence. Thus the conflict among designers,

manufacturers, corporate, distributors, government and consumers need to be controlled and resolved. In such a situation there is a great demand for determination of quantum of EMF radiation into environment and society.

Every year, hundreds of thousands of new cell phones are introduced into market. Mobile telecom revolution in the modern world has triggered not only the growth of world economy but has changed the life style of millions of people. Mobile telephony is growing exponentially in India and across the world. At present there are about 800 million mobile subscribers in India and over 4.03 billion in the world.

The population projections for India[10], China[11], USA[12] and the entire world[13]-[16] are as shown in the table.1 below till 2050.

Country	2020 Popln (Billions)	2030 Popln (Billions)	2040 Popln (Billions)	2050 Popln (Billions)
India	1.326	1.460	1.571	1.657
China	1.423	1.454	1.376	1.320
USA	0.325	0.351	0.392	0.438
World	7.900	8.800	9.800	10.60

Table 1. population projections for 2050

The growth of cell phone numbers and their estimated projections for India, China, USA and the entire world [17] for 2050 are as shown in the table below.

Country	2020 Cell Phones (Millions)	2030 Cell Phones (Millions)	2040 Cell Phones (Millions)	2050 Cell Phones (Millions)
India	994.5	1460	1178	1242
China	1071.8	1454	1045	1003

USA	338	365	408	456
World	6873	7656	8526	9222

Table 2. Cell phones projections for 2050.

Due this exponential growth of population, urbanization, consumer electronics products concern for environment and human health hazards is growing throughout the world. There is a great need to know what are the EMF emissions into environment by cell phones for 2050. Hence, measurement and estimation of EMF emissions into environment and society are required to be determined through experiments. II Experimental Methodology

In spite of the recent studies indicating possible harmful impact of EMF on several species, there are no long-term data available on the environmental impacts of EMF radiations as of now. Studies on impact of cell phones and cell phone towers and EMF radiations on birds and other wildlife are almost non-existent in India. Moreover pollution from EMF radiations being a relatively new environmental issue. In this research work EMF radiations of 30 randomly selected cell phones and their EMF emissions were measured on, receiving and transmitting modes.

For this research work Narda 8718 B Radiation Survey Meter was used. These 8700 series EMF measurement system offers a very broad selection of probes. 8700D series probe has a quick release, eight pin connector that allows the probe to attach directly to 8718B Radiation Survey meter and hence it was used. The 8718 B Radiation Survey

meter can store up to 6 probes. The procedure illustrated in Narda EM Radiation Survey Meter 8718B [18] & [19] was followed in measuring the direct digital readings for selected six mobiles in three conditions, i.e.; ON, Receiving and Transmitting conditions. The auto-zeroing with international calibration and spatial averaging facility of this radiation Survey meter were utilized for this research work. The Narda 8718 B radiation Survey meter and 8700 D antenna probe are as shown in figure 1. Below.



Figure 1: Radiation Survey Meter 8718B with 8710 Probe

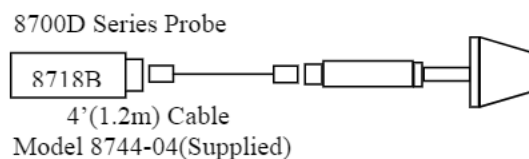


Figure 2: Radiation Survey Meter 8718B Connectivity with 8710 Probe

The following salient features and steps were followed in the research work for EMF emissions measurement.

- (a) Connecting the antenna probe 8710 D with the Radiation Survey Meter.
- (b) Placing the probe inside the radiation free storage case.
- (c) Switching on the meter.

- (d) Selecting the exact probe model from the list of probes.
- (e) Selecting the test frequency.
- (f) Auto zeroing with inbuilt features of the meter.
- (g) Reading the back ground EMF level.
- (h) Measure the EMF levels in different modes (on/Tx/Rx) placing different models of mobiles at the same distance from the probe.
- (i) Subtracting the back ground levels from the respective readings.
- (j) Tabulating the EMF data according to the modes and the models.

III Results , Analysis and Discussion

The EMF radiation levels of 6 randomly selected cell phones were experimentally measured using Narda Radiation Survey meter 8718 B along with probe 8700D. The EMF levels were determined under three specific conditions on cell phones, namely ON, Receiving and Transmitting conditions. These measurements were carried out at centre frequencies of 800 MHz and 1800 MHz.

The table 1 shows the population projections for 2050 and table 2 indicates the cell phones projections for 2050 for India, China, USA and the entire world. In this research work for calculating cell phones projections for India, China, USA and the world for 2050, it is assumed that 74.71%, 75.32, 103.9% and 87% of respective countries population will be owning the cell phone connectivity. It is seen that 154% of Russian

population will be having cell phone connectivity, though not included in this research work. Table 3 indicates the experimentally measured and averaged EMF radiation levels at 800 and at 1800 MHz centre frequencies. These measurements are for 30 selected cell phones during On, receiving and Transmitting conditions at centre frequencies of 800 MHz and at 1800 MHz.

The table 4 and 5 illustrate the EMF radiated power densities of India, China, USA and the entire world due to different statuses of cell phones alone such as on, receive and transmit conditions at 800 MHz and 1800 MHz centre frequencies for 2020 to 2050.

(a) EMF Radiation projections for India

In 2020 when India is asleep and all cell phones are in on(sleep) mode, India emits EMF power density of 27.14 and 79.56 million watts per square meter at 800 MHz, 1800 MHz into environment respectively. By 2050 these figures would increase to 33.91 & 99.36 million watts per square. These figures for 2030 and 2040 are as shown in tables 4 and 5 respectively. The radiated power densities when all cell phones of India are in receiving and transmitting modes are also shown in tables 4 & 5 at stated frequencies for 2020,2030,2040 and for 2050. The cell phones radiated power densities in on, receive and transmit modes by India at 800 MHz, 1800 MHz shown in bar charts in figures 3 and 4 for 2020, 2030, 2040 and 2050 respectively.

Assuming that 50% of cell phones of India are transmitting and 50% are receiving which is most realistic, in 2020 India will contribute 2517 and 3257.5 million watts per square meter into environment at 800 MHz and at 1800 MHz respectively at any given time. These quantities will increase to 3140 and 4068 million watts per square meter by 2050 respectively at 800 and 1800 MHz at any given time by India.

(a) EMF Radiation projections for China

In 2020 when China is asleep and all cell phones are in on(sleep) mode, China emits EMF power density of 29.26 and 84.74 million watts per square meter into environment at 800 MHz and at 1800 MHz respectively. By 2050 these figures would reduce to 27.38 & 80.24 million watts per square at the above stated frequencies. The radiated power densities when all cell phones of China are in receiving and transmitting modes are shown in tables 4 &5 at stated frequencies for 2020, 2030,2040 and for2050. The cell phones radiated power densities in on, receive and transmit modes by China at 800 MHz, 1800 MHz are shown in bar charts in figures 5 & 6 for 2020, 2030, 2040 and for 2050 respectively. Assuming that 50% of cell phones of China are transmitting and 50% are receiving which is most realistic, at any given time by 2020 China will radiate 2709 and 4633 million watts per square meter into environment at 800 MHz and at 1800 MHz respectively. These quantities will reduce to 2535 and 3285 million

watts per square meter by 2050 at 800 MHz and at 1800 MHz respectively.

(c) EMF Radiation projections for USA

by 2020 when USA is asleep and all cell phones are in on(sleep) mode, USA emits EMF power density of 9.227 and 27.04 million watts per square meter at 800 MHz, 1800 MHz into environment respectively. By 2050 these figures would be at 12.45 & 36.48 million watts per square meter at the above stated frequencies. The radiated power densities when all cell phones of USA are in receiving and transmitting modes are shown in tables 4 & 5 at stated frequencies for 2020, 2030, 2040 and for 2050. The cell phones radiated power densities in on, receive and transmit modes by USA at 800 MHz, 1800 MHz are shown in bar charts in figures 7 and 8 800 MHz

Frequency	Average Rad Power Density- On mode (w/m ²)	Average Rad Power Density- Rx mode (w/m ²)	Average Rad Power Density- Tx mode (w/m ²)
800 MHz	0.0273	2.319	2.738
1800 MHz	0.08	3.198	3.354

Table 3. Average EMF radiation of a cell phone

Country	2020 Rad Power Density			2030 Rad Power Density		
	ON	Rx	Tx	ON	Rx	Tx
India	27.14	2306	2723	39.86	3385	3997
China	29.26	2485	2934	39.69	3371	3981
USA	9.227	783.8	925.4	9.964	846.4	999.3
World	187.6	15938	18819	209.8	17754	20962

Table 4(a) Cell phone EMF Radiation projections for 2030 at 800 MHz

Country	2040 Rad Power Density			2050 Rad Power Density		
	ON	Rx	Tx	ON	Rx	Tx
India	32.15	2731	3225	33.91	2880	3401
China	28.53	2423	2861	27.38	2423	2861
USA	11.13	946.2	1117	12.45	1057	1248
World	232.8	19771	23344	251.8	21385	25249

Table 4(b) Cell phone EMF Radiation projections for 2050 at 800 MHz

Country	2020 Rad Power Density			2030 Rad Power Density		
	ON	Rx	Tx	ON	Rx	Tx
India	79.56	3180	3335	116.8	4669	4896
China	84.74	3427	3594	116.3	4649	4876
USA	27.04	1080	1133	29.20	1167	1224
World	549.8	21979	23052	612.5	24484	25678

Table 5(a) Cell phone EMF Radiation projections for 2030 at 1800 MHz

Country	2040 Rad Power Density			2050 Rad Power Density		
	ON	Rx	Tx	ON	Rx	Tx
India	94.24	3767	3951	99.36	3971	4165
China	83.60	3341	3504	80.24	3207	3364
USA	32.64	1304	1525	36.48	1458	1704
World	682.1	27266	31870	737.8	29491	30930

Table 5(b) Cell phone EMF Radiation projections for 2050 at 1800 MHz for 2020, 2030, 2040 and for 2050 respectively.

Assuming that 50% of cell phones of USA are transmitting and 50% are receiving which is most realistic at any given time by 2020 USA will contribute 854.6 and 1106.5 million watts per square meter into environment at 800 MHz and at 1800 MHz respectively. These quantities will increase to 1152 and 1494 by 2050 at 800MHz and at 1800 MHz respectively

EMF Radiation projections for Entire WorldBy 2020 when entire world is asleep and all cell phones are in on(sleep) mode, entire world emits EMF power density of 187.6 and 549.8 million watts per square meter at 800 MHz and at 1800 MHz into environment respectively. By 2050 these figures would increase to 251.8 & 737.8 million watts per square meter respectively at the above stated frequencies. The radiated power densities when all cell phones of USA are in receiving and transmitting modes are shown in tables 4 and 5 at stated frequencies for 2020, 2030, 2040 and for 2050. The cell phones radiated power densities in on, receive and transmit modes by entire world at 800 MHz and at 1800 MHz are shown in bar charts in figures 9 and 10 for 2020, 2030, 2040 and for 2050 respectively.

Assuming that 50% of cell phones of entire world are transmitting and 50% are receiving which is most realistic at any given time, by 2020 entire

world will be radiating EMF power density of 17379 and 22516 million watts per square meter at 800 MHz and at 1800 MHz into environment respectively. These quantities will increase to 23317 and 30211 million watts per square meter by 2050 at the stated frequencies respectively.

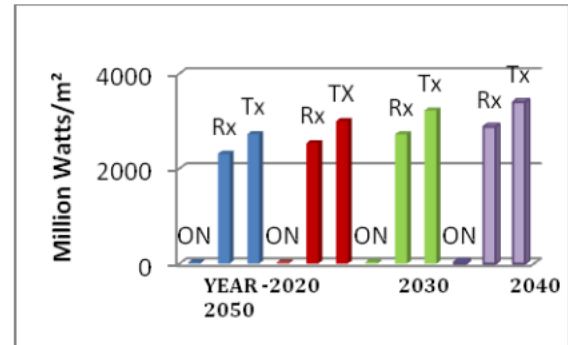


Fig3:Cell Phone EMF Radiation pollution projection for INDIA at 800MHZ

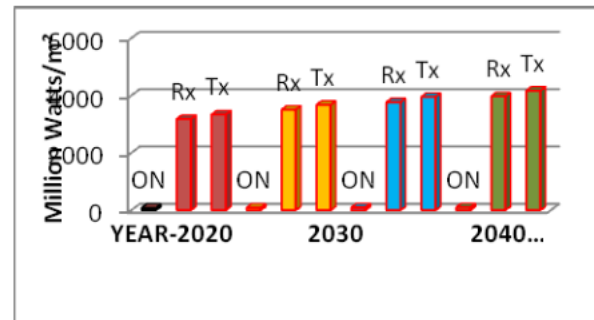


Fig4:Cell Phone EMF Radiation pollution projection for INDIA at 1800MHZ

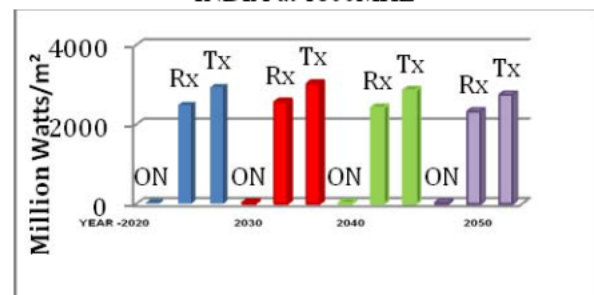


Fig5:Cell Phone EMF Radiation pollution projection for CHINA at 800MHZ

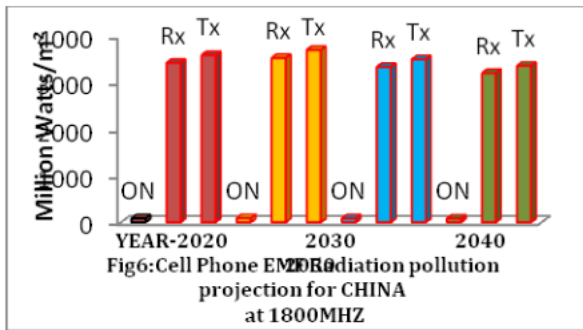


Fig6:Cell Phone EMF Radiation pollution projection for CHINA at 1800MHZ

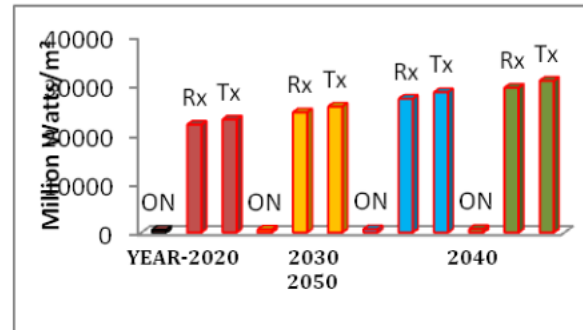


Fig10:Cell Phone EMF Radiation pollution projection for World at 1800MHZ

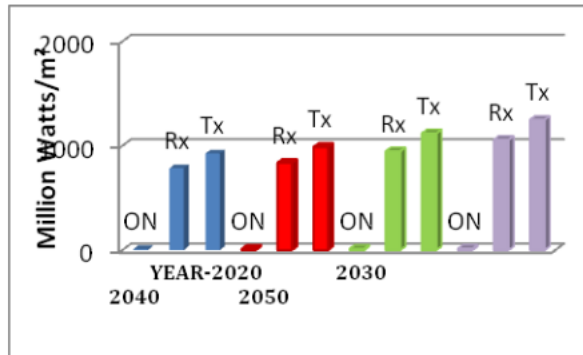


Fig7:Cell Phone EMF Radiation pollution projection for USA at 800MHZ

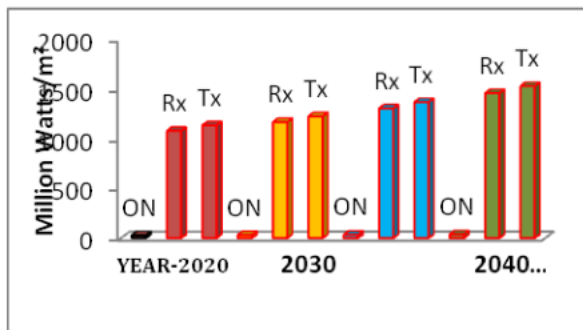


Fig8:Cell Phone EMF Radiation pollution projection for USA at 1800MHZ

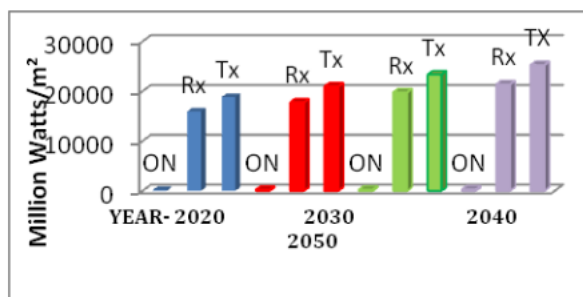


Fig9:Cell Phone EMF Radiation pollution projection for World at 800MHZ

IV. CONCLUSION

The cell phones connectivity in modern society have altered the land scape of human beings in countless beneficial ways, however created the environmental exposures to Electromagnetic fields. As technology progresses and data demands have increased on mobile network, towns, cities and even rural villages have seen sharp increase in the cell phone numbers as projected in table 2 for India, China, USA and the entire world. Further as the costs of mobile technology and the cell phones have fallen, their uses have multiplied dramatically and the overall levels of exposure of the population and environment as a whole have increased drastically. The RF sources emit EMF radiation continuously. The level of EMF from sources has risen exponentially, by soaring popularity of wireless technology. As of now there are no long term data available on environmental impacts of EMF radiation, in spite of the recent studies indicating possible harmful effects on several species. Moreover, electronic pollution from EMF radiation being a relatively new environmental issue. There is a lack of established standard procedures and protocols to

study and monitor the EMF effects especially among wildlife/ environment, which often make the comparative evaluation between studies difficult. In addition the uncoordinated research in this field, the necessary regulatory policies and their poor implementation mechanism also have not kept pace with growth of wireless technology.

There had already been some warning bells sounded in the case of bees and birds, which probably heralds the seriousness of this issue and indicates the vulnerability of other species as well. The EMF radiations are being associated with the observed decline in the population of sparrow in London and several other European cities[20]. In this research work Population and cell phones projections have been stated for India, China, USA and the world for 2020 to 2050.

A cell phone that is 'ON', but not in use also radiates EMF energy. The EMF radiations from 30 randomly selected cell phones were measured using 8718B radiation survey meter with antenna probe 8710D. This meter has auto zeroing and spatial averaging facility to determine radiated power density. Based on this measurements and determination the projection of EMF radiated quantities in to environment for India, China, USA the whole world have been successfully projected with bar charts at three different status of cell phones such as on, receive and transmit modes. These projections are included for two different frequencies for 2020, 2030,2040 and for 2050.

These measurements were carried out at 800 MHz and at 1800MHz respectively.

It is seen that when the entire world sleeps and cell phones are in on(sleep) mode it radiates power densities of 549.8, 612.5, 682.1 and 737.8 millions of watts per square meter 2020,2030,2040 and 2050 at 1800 MHz respectively. Realistically assuming 50% of world is asleep at any given time the world radiates EMF power densities of 274.9, 306.25, 341 and 361 millions of watts per square meter into environment by 2020, 2030, 2040 and 2050 respectively. Similarly, assuming that 50% of the world is awake and is transacting routine business, the world will radiate power densities of 22575.5, 25081, 27931 and 30211 millions of watts into environment at any given time by 2020, 2030,2040 and 2050 at 1800 MHz respectively. This assumption of 50% of the world transacting business means 50% of cell phones are in transmitting mode and rest 50% are in receiving mode.

The power density quantities measured for 2013 and projected for 2050 call for immediate uniform EMF radiation policies. This is more so when referred to International Exposure Standards, in this it is seen that USA, Canada and Japan have $12\text{W}/\text{m}^2$, ICNIRP [21] and European recommendation 1998-adopted in India has $9.2\text{w}/\text{m}^2$ (Reduced by 10 times in 2012 by India), exposure limit in Austria is $0.001\text{w}/\text{m}^2$. The EMF radiation projected in this research paper expected to be approximately correct and will be same into the environment across the world. It cannot recognize the Geography of any

country. There is a strong case in point to have a uniform EMF radiation policy across the world. This is more so because of the reason that cell phones can work in Austria with exposure limit of 0.001w/m^2 and in USA, Canada and Japan with the exposure limit of 12W/m^2 , there is a strong message from this research paper to advocate that entire world needs a single exposure policy. The EMF projections due to cell phones alone along with other EMF sources must be used as the precautionary principle and should prevail to better the standards of EMF radiation limits to match the best in the world to sustain the environmental safety.

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