CHAPTER – 3

LITERATURE REVIEW

3.1 Background

In recent years there has been a growing awareness of the dangers that Electromagnetic Radiation (EMR) poses. As a result researchers have looked at several areas of risk and therefore there is a mix of multiple studies in different research areas for the evaluation of its potential health effects. As per WHO[9], different types of studies investigate distinct aspects of the problem.

Laboratory studies on cells (in vitro), aim to elucidate the fundamental underlying mechanisms that link electromagnetic field exposure to biological effects. They try to identify mechanisms based on molecular or cellular changes that are brought about by the electromagnetic field - such a change would provide clues to how a physical force is converted into a biological action within the body. In these studies, single cells or tissues are removed from their normal living environment which may inactivate possible compensation mechanisms.

Another type of laboratory study, involving animals (in vivo), is more closely related to real life situations. These studies provide evidence that is more directly relevant to establishing safe exposure levels in humans and often employ several different field levels to investigate dose-response relationships. It's not always clear if the results from these types of studies will apply to humans.

Epidemiological studies or human health studies are another direct source of information on long-term effects of exposure. These studies investigate the cause

[9] http://www.who.int/peh-emf/about/WhatisEMF/en/index2.html (accessed 6 March 2016)

and distribution of diseases in real life situations, in communities and occupational groups. Researchers try to establish if there is a statistical association between exposure to electromagnetic fields and the incidence of a specific disease or adverse health effect.

Epidemiological studies alone typically cannot establish a clear cause and effect relationship, mainly because they detect only statistical associations between exposure and disease, which may or may not be caused by exposure. Moreover, an observed statistical association may be due only to statistical effects or the study itself may have suffered from some problem with its design.

Therefore, finding an association between some agent and a specific disease does not necessarily mean that the agent caused the disease. Establishing causality requires that an investigator considers many factors. The case for a cause-and-effect link is strengthened if there is a consistent and strong association between exposure and effect, a clear dose-response relationship, a credible biological explanation, support provided by relevant animal studies and above all consistency between studies.

Most of the reports/ papers reviewed as a part of this study, in general tried to draw conclusions based on all the above methods of researches. While searching for effects of EMRs from mobile towers, a lot of studies/ researches/ reports/ papers were found, but after giving a brief about history of growth of mobiles and discussing the theory of EMR, some of them talked a bit of EMR from mobile towers but mostly all of them moved on to EMR effects of mobile phones. So in this chapter, out of the reviewed literature, only that has been

discussed which had specific reference to 'Electromagnetic Radiations through Mobile Towers'. Secondly, within the limited timeframe, only a few literature could be covered, out of the innumerable available. It has tried to cover the oldest & the latest, international as well Indian, so as to cover the entire spectrum, arranged in chronological order.

3.2 Report by IEGMP, UK titled Mobile Phones and Health[10]

An independent expert group on mobile phones (IEGMP) was formed in UK in August 1999 by Sir Walter Bodmer, Chairman of the National Radiological Protection Board (with headquarters in Chilton near Oxford, now a part of Public Health England). The expert group was chaired by Professor William Stewart of Tayside University Hospitals NHS Trust, Dundee and consisted of members from the field of epidemiology, experimental biology related to exposure to Electromagnetic fields & radio frequencies, oncology (the study related to cancers and tumors), physics, radio engineering, statistics, neurophysiology, from the NRPB Advisory Group on Non-Ionising Radiation (AGNIR) and also one member from WHO. The terms of reference of the expert group were - to consider possible effects from the use of mobile phones, base stations and transmitters on health, to conduct rigorous assessment of existing research and to give advice & also to make recommendations on further work that should be carried out to improve the basis for sound advice. The group collected inputs from across the UK and abroad; from scientists, members of the public, various

[10] Independent Expert Group on Mobile Phones, UK (11 May 2000) *Mobile Phones and health*

group, mobile-phone-related companies, network operators, Federation of the Electronics Industry (FEI), media reports and regional public meetings.

Sir William Stewart, Chairman, IEGMP, in the foreword, has called it as a balanced report which adopted an evidence-based approach to health issues in particular, but the report also considered user choice and the importance of such new technologies to the economy.

The report starts with discussion about growth of mobile, its technology, public perception & concerns and then moves on to explain about RF fields from mobile technology including mobile phones and base stations. Here it states that for mobile phones, exposures will be principally to the side of the head for hand-held use or to the parts of the body closest to the phone during hands-free use and for base station emissions, exposures of the general population will be to the whole body but normally at levels of intensity many times less than those from handsets. In addition to mobile phone base stations, there are a large number of other RF emitting sources in the environment, including antennas for radio, television and paging. Exposures of individuals to RF radiation from these sources will depend upon their proximity and may be above those from mobile phone base stations, although still well below guidelines.

The group further discussed in detail about the scientific evidence related to interaction of radiofrequency fields with tissues, experimental studies, lab studies related to effects of RF radiation on people, mobile phones & driving and epidemiological studies. Under experimental studies the group analyzed in detail the earlier researches related to effect on nervous system, carcinogenic

processes & cell growth, immune system & longevity, reproduction & development, cardiovascular system, etc.

In relation to nervous system the report says that most consistent evidence indicates that changes in neuronal excitability, neurotransmitter function and behaviours will occur when exposure induces significant heating, such that core body or local tissue temperatures increase by about 1°C or more. The evidence for effects in the absence of heating is generally not consistent and convincing. However, some studies suggest that low level exposure at specific frequencies of amplitude modulation and energy levels may affect membrane proteins, the flux of calcium and other ions across the membranes of neurons. The relevance of these results to mobile phone technology and to human health is unclear. Despite much publicity, the evidence for an effect on spatial memory in rats in the absence of whole-body heating is weak. In addition, there are differences in the pattern of RF energy deposition between rodents and people. This makes direct extrapolation from these animal studies to changes in human cognitive performance, uncertain. The tissue penetration of RF fields means that, while the intensity of exposure is fairly uniform within the small brain of a rodent, only regions close to the ear will be effectively exposed in the much larger human brain. Primate brains, however, not only have greater anatomical similarity to those of people, but also have similar proportions, resulting in a better model of the distribution of absorbed energy.

Regarding cancer-related studies the report says that some individual experimental studies have suggested that RF radiation can initiate tumour

formation, enhance the effects of known carcinogens or promote the growth of transplanted tumours. However, in some of these the intensity was high enough to produce thermal effects. The balance of evidence, from both in vitro & in vivo experiments, indicates that neither acute nor chronic exposure to RF field increases mutation when temperatures are maintained within limits. This suggests that RF exposure is unlikely to act as a tumour initiator.

The report further says that no consistent effects of low level RF exposure have been reported on blood-forming and circulating blood cells. Most of the earlier studies used continuous-wave fields, but a well-conducted lifetime study in rats exposed to low level, pulsed RF fields also found no effect. Similarly regarding immune system the report says that the effects due to thermal levels of RF exposure were generally found to be transitory, returning to normal levels following termination of RF exposure.

Regarding longevity the report says that in general, studies conducted to determine if RF exposure affects longevity have revealed no influence on lifespan in experimental animals. Indeed, most convincing changes reported are very slight increases in lifespan. In relation to effects on reproduction and development, it says that there is no convincing evidence from studies of rodents that exposure to RF fields at levels associated with mobile pose any risk for fetus or for male fertility. Developmental effects, similar to those known to be induced by heat, have been reported in rodents following large (3–4°C) temperature increases in fetus during prenatal RF exposure, it is important to repeat this study under better controlled conditions. In relation to cardiovascular

system the report says that studies on animals do not justify any concern about influence of RF radiation at levels associated with mobile phones on heart or circulation. Effects at high intensities appear to be due to heating of the body.

Moving ahead the report discusses about laboratory studies of effects of EMR on People, wherein it says that there is, on the basis of published evidence, no basis for concern about effects of mobile phone use on heart and circulation. However, this subject merits more experimental work on human volunteers. Also based on epidemiological studies on general health effects it says that apart from risks associated with use of mobile phones while driving, there is no persuasive epidemiological evidence that exposure to RF radiation in general - or to limited extent investigated, mobile-phone-related exposures in particular – causes disease in people. Although epidemiological research do not give cause for concern, it has limitations to give reassurance that there is no hazard.

Sir William Stewart, Chairman, IEGMP, in the foreword, has summarized the conclusions as, "The report points out that the balance of evidence does not suggest mobile phone technologies put the health of the general population of the UK at risk. There is some preliminary evidence that outputs from mobile phone technologies may cause, in some cases, subtle biological effects, although, importantly, these do not necessarily mean that health is affected. There is also evidence that in some cases people's well-being may be adversely affected by the insensitive siting of base stations. New mechanisms need to be set in place to prevent that happening. Overall, the report proposes that a precautionary approach be adopted until more robust scientific information

becomes available." Accordingly the group has recommended precautionary approach based advice to Government, industry, research requirements, need for better public information & consumer choice and the role of NRPB.

While discussing about guidelines, the report in its summary states that in 1998 the International Commission on Non-Ionizing Radiation Protection (ICNIRP) had published its own guidelines covering exposure to RF radiation. These were based on essentially same evidence as that used by NRPB and for workers limits on exposure are similar. However, under ICNIRP guidelines, the maximum levels of exposure of public are five times less than those for workers. The reason for this approach was the possibility that some members of the general public might be particularly sensitive to RF radiation. However, no detailed scientific evidence to justify this additional safety factor was provided. The ICNIRP guidelines for the public have been incorporated in a European Council Recommendation (1999), which has been agreed in principle by all countries in the European Union (EU), including the UK. In Germany the ICNIRP guidelines had been incorporated into statute. Both the NRPB and ICNIRP guidelines were based on the need to avoid known adverse health effects.

Review of the report

The report by IEGMP of UK is a proactive report which came up with the forethoughtful concept of analyzing possible effect of mobile phone, base station and transmitters on health of human beings at that early stage. In the late 20th century, when this report was prepared, mobile technology in developed nations was in its adolescent stage where there was only 1 phone on every 2 men, while

in developing nations like India it was still in its infant stage. In addition, when human culture was stepping forward towards becoming more unified due to globalization, where mobile technology also played an important role, the need to address unrecognized effects from use of mobile phones, worked as a milestone.

The group analyzed many researches/ studies available at that time although still limited and put forward scientific evidence, which suggest that there may be biological effects occurring at exposure levels above specified guidelines and hence recommended precautionary approach. The main binding limitation of the report was that it lacked a long term base of earlier studies. Little research specifically relevant to these emissions had been published and yet there had been little opportunity for any health effect to become manifest. Secondly, assessment of any health risk resulting from exposure to RF fields depends on results of a well conducted and reproducible scientific study and need for these is all the more greater because any effect of the exposure to RF fields at the levels encountered from mobile telecommunications, if any, is likely to be subtle and long term. No study no matter how large and well-designed can prove as to what amount of electromagnetic exposure is always safe for everybody under any circumstances, as it involves innumerous variables and requires a well-defined statistical analysis of such data, taking into consideration all the scientific, emotional and physical aspects, which proves to be the biggest shortcoming.

Although most of the public concern has always been related to Electromagnetic Radiations from mobile towers but the report discusses about exposure from radio frequency (Electromagnetic Radiations) in general mostly

from mobile phones and very little from mobile towers. One reason for this as stated in the report at one place is that for base station emissions, exposures of the general population will although be continuous and to the whole body but normally at levels of intensity many times less than those from handsets.

3.3 Systematic review on the health effects of exposure to radiofrequency electromagnetic fields from mobile phone base stations[11] published in WHO

This paper written by Martin Röösli, Patrizia Frei, Evelyn Mohler and Kerstin Hug of Swiss Tropical and Public Health Institute and University of Basel, Socinstrasse, Switzerland was published online in the December 2010 volume of Bulletin of the WHO. The review was funded by the WHO. Out of the authors, Kerstin Hug is supported by Swiss Federal Office for Environment, Patrizia Frei & Evelyn Mohler by Swiss National Science Foundation and Martin Röösli is supported by Swiss School of Public Health+. Objective of paper was to evaluate the literature (available at that time), with an aim to present a systematic review of the scientific literature concerning all the health effects of exposure to mobile phone base station (MPBS) radiation that had been investigated till that date.

The paper starts with a brief about mobile technology and then talks about public concerns and controversy about the potential health effects related to it

[11] Martin Röösli, Patrizia Frei, Evelyn Mohler & Kerstin Hug (December 2010) 'Systematic review on the health effects of exposure to radiofrequency electromagnetic fields from mobile phone base stations', *Bulletin of the World Health Organization 2010*, 88(12): 877-953 (Online) http://www.who.int/bulletin/volumes/88/12/en/

like a small proportion of the population attributes non-specific symptoms of ill-health, such as sleep disturbances or headache, to exposure to electromagnetic fields. This phenomenon is described as electromagnetic hypersensitivity (EHS). Additionally, individuals who are hypersensitive to electromagnetic fields often claim to be able to perceive radiofrequency electromagnetic fields in their daily life. People are generally exposed to MPBS radiation under far-field conditions, i.e. radiation from a source located at a distance of more than one wavelength. This results in relatively homogenous whole-body exposure. MPBS exposure can occur continuously but the levels are considerably lower than the local maximum levels that occur when someone uses a mobile phone handset.

The group performed a systematic literature search of all papers published before March 2009. For this, group adopted inclusion & exclusion criteria so as to include human laboratory trials & epidemiological studies and considered all the health effects that had been addressed. These included self-reported non-specific symptoms (e.g. headache, sleep disturbances, concentration difficulties), physiological measures (e.g. hormone levels, brain activity), cognitive functions, genotoxicity, cancer and various chronic diseases. For a study to be eligible, far-field exposure from MPBSs had to be investigated, i.e. a relatively homogenous whole-body field in GSM900/ GSM1800/ UMTS frequency range and relationship between exposure and outcome had to be statistically quantified. In addition, basic quality criteria had to be fulfilled. Trials had to apply at least two different exposure conditions in a randomized and blinded manner. Epidemiological studies had to quantify exposure using objective measures (such as distance to

nearest MPBS, spot or personal exposure measurements, or modelling), possible confounders had to be considered and selection of study population had to be clearly free of bias in exposure and outcomes. Personal exposure measurements assess total radiation absorbed by the whole body, whereas spot measurements quantify short-term exposure in a single place, usually the bedroom.

In total, 134 potentially relevant publications were identified by the group; 117 articles were excluded as they did not meet their inclusion criteria. Of the 17 articles included in the analyses, 5 were randomized trials and 12 were epidemiological or field intervention studies. The majority of the studies examined non-specific symptoms. Of all non-specific symptoms, headache was most often evaluated. Other non-specific symptoms were, concentration difficulties or dizziness, fatigue or self-reported sleep disturbances, increased arousal score among individuals with EHS during UMTS exposure, increase in calmness but no effect on mood or alertness, cold hands and feet, etc.

As per the paper, "When data from all epidemiological studies & randomized trials were considered together, no single symptom or symptom pattern was found to be consistently related to exposure. The cross-sectional epidemiological studies, however, showed a noteworthy pattern: studies with crude exposure assessments based on distance showed health effects, whereas studies based on more sophisticated exposure measurements rarely indicated any association. Four randomized double-blind trials addressed the ability to perceive presence of RF electromagnetic field. None of these trials revealed a correct field detection rate better than expected by chance and there was no evidence that individuals

who were hypersensitive to electromagnetic fields were more likely to determine correctly the presence or absence of exposure than individuals who were not."

Regarding cognitive functions the paper says exposure effects on cognitive functions were investigated in three trials and two epidemiological studies. All three trials investigated effect of UMTS base station exposure but found no effect in a variety of cognitive tests. One epidemiological study produced inconsistent results, whereas the other showed no exposure effects in several cognitive tests.

Similarly for physiological measures paper says that three laboratory studies investigated different physiological responses. In one, no significant changes in blood volume pulse, skin conductance and heart rate were observed. Likewise, as measured, skin surface temperature, heart rate & local blood flow in fingertip were not altered by UMTS base station exposure in a Japanese study. In a third trial, recordings from 13 study participants exposed to a GSM1800 base station field for two nights did not differ from recordings for two nights of sham exposure.

Further the group identified no study that investigated an association between chronic diseases other than cancer and MPBS exposure. An ecological study compared cancer incidence among 177,428 persons living in 48 municipalities in Bavaria between 2002 and 2003 in relation to MPBS coverage. Municipalities were classified on a crude three-level exposure scale based on the transmission duration of each MPBS and proportion of population living within 400m of MPBS. No indication of overall increase in cancer incidence was found in municipalities belonging to highest exposure class. Number of cases was too small for analysis.

As per the paper, in response to public concerns, most studies dealing with exposure to EMFs from MPBSs have investigated non-specific symptoms of ill-health, including self-reported sleep disturbances. Majority of studies have not shown any occurrence of acute symptoms after exposure to GSM900, GSM1800 or UMTS fields from MPBSs. Sporadically observed associations in randomized laboratory trials did not show a consistent pattern in terms of symptoms or types of exposure. In their review of epidemiological studies the group found that the more sophisticated the exposure assessment, the less likely it was that an effect would be reported. They also found no evidence that individuals who claim EHS are more susceptible to MPBS radiation than the rest of the population.

The group concludes by saying that review does not indicate an association between any health outcome and radiofrequency electromagnetic field exposure from MPBSs at levels typically encountered in people's everyday environment. The evidence that no relationship exists between MPBS exposure and acute symptom development can be considered strong because it is based on randomized trials applying controlled exposure conditions in a laboratory. Regarding long-term effects, data are scarce and the evidence for the absence of long-term effects is limited. Moreover, very little information on effects in children and adolescents is available and the question of potential risk for these age groups remains unresolved. Further research should focus on long-term effects and should include children and adolescents. Additional cross-sectional studies would be of limited value, so future studies should apply a longitudinal design. Because there is no evidence that potential health effects would be restricted to

MPBS frequency bands, such studies should include an assessment of exposure to other sources of radiofrequency electromagnetic fields in daily life, such as mobile and cordless phones and wireless local area networks.

Analysis of the paper

In response to the rising grievances in public and to address the Dutch study describing decreased well-being associated with base station exposure, a very systematic and vivid review was done by a group of researchers under the aegis of WHO. The methodology adopted involved various statistical tools to have unbiased conclusion and to overcome the shortcomings which usually prove to be the drawbacks in other studies. It was made sure during the selection of studies that they were free of bias in terms of exposures and outcomes. Each data was extracted independently by two researchers on one of the two standardized forms. Differences in data extraction were resolved by consensus.

The review appears to have some limitations as well, for it had to base its review on cross-sectional studies due to limited availability of long term studies and if the data is scarce the evidence of harm should not necessarily be interpreted as evidence that no harm exists. Secondly, three epidemiological studies suggesting a link between cancer incidence and proximity to base station and another three studies indicating an association with non-specific symptoms were excluded as they did not meet their quality criteria, which can be arguable.

One important aspect towards which the review draws attention is the fact that a homogenous BTS field of 1 V/m is estimated to yield an average whole body SAR of 6 μW/Kg and a 1 gm peak SAR in brain of 73 μW/Kg. This is considerably

lower than peak SAR caused by mobile phones (about 1-2 W/kg). Thus a finding of acute brain related effects (e.g. Headaches or changes in brain physiology) would be expected from mobile phones rather than from base station exposures.

3.4 Report on Cell Tower Radiation[12] by Prof. Girish Kumar

Prof. Girish Kumar of Electrical Engineering Department at IIT Bombay, in December 2010, submitted this Report on Cell Tower Radiation to Secretary, DoT, Delhi. Initially the report says that non-thermal effects are not well defined but it has been reported that they are 3 to 4 times more harmful than thermal effects. Further regarding cell phones it states that in USA, SAR for cell phones is 1.6 W/Kg which is actually for 6 min. per day usage. It has a safety margin of 3 to 4, so a person should not use cell phone for more than 18-24 min. This information is not commonly known to people in India, so crores of people use it for more than an hour without realizing its associated health hazards.

The report then moves on to technical discussion related to process of mobile working and states that a base station and its transmitting power are designed in such a way that mobile phone should be able to transmit and receive enough signal for proper communication up to a few kilometers. Majority of these towers are mounted near the residential and office buildings to provide good mobile phone coverage to the users. These cell towers transmit radiation 24x7, so people living near tower will receive 10,000 to 10,000,000 times stronger signal than required. In India, crores of people reside within these high radiation zones.

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[12] Kumar, Prof. Girish (December 2010) *Report on Cell Tower Radiation submitted to Secretary, DOT, Delhi*

Further, the report explains about Radiation from the cell towers and states that effectively, several KW of power may be transmitted in the main beam direction. Next it discusses the formula for Radiated power density from the cell tower and based on it, gives the power density at various distances for a specific case of Transmitter power = 20W and Gain of transmitting antenna = 17 dB = 50 considering ideal condition where there is no absorption, reflection, diffusion, etc.

Table 3.1: Power density at various distances from the transmitting tower

Distance R (m)	Power density in W/m^2	Power density in $\mu W/m^2$
1	79.6	79,600,000
3	8.84	8,840,000
5	3.18	3,180,000
10	0.796	796,000
50	0.0318	31,800
100	0.008	7,960
500	0.000318	318

(Source: Report on Cell Tower Radiation by Prof. Girish Kumar)

The report also says that power density values given above are for a single carrier & a single operator. If multiple carriers are being used & multiple operators are present on same roof top or tower, then above values will increase manifold. However, radiation density will be much lower in direction away from main beam. Hence one should know actual radiation pattern of the antenna (which unfortunately is not made public) to calculate exact radiation density at a point.

Next the report analyzes the news reported in Mid-day, Mumbai dated Jan. 3, 2010, which stated – 'Mumbai's swanky Usha Kiran building says the four cancer cases there could be linked to mobile towers installed on the facing Vijay Apartments' and says, "people living in the 6th, 7th and 8th floor in Usha Kiran building will get maximum radiation as they are in main beam direction. People

living on the other floors will receive lesser radiation as beam maxima is reduced considerably. In horizontal direction again, people living in front side of antenna will receive much higher radiation compared to people living in back of antenna. From above table, it may be noted that for a single transmitter, power density at R = 50m is equal to 0.0318 W/m^2 = 31,800 $\mu W/m^2$. Even for 3 transmitters in the same direction, it comes out to be approximately 0.1 W/m^2 = 100,000 $\mu W/m^2$, which has caused cancer to several people in a duration of 2 to 3 years."

Moving ahead the report says, "India has adopted radiation norms given by ICNIRP guidelines of 1998 for safe power density of f/200, where frequency (f) is in MHz. Hence, for GSM900 transmitting band (935-960 MHz), power density is 4.7W/m^2 and for GSM1800 transmitting band (1810-1880 MHz), it is 9.2W/m^2. ICNIRP guidelines clearly state that for simultaneous multiple frequency fields, sum of all radiation must be taken into consideration. However, India has applied this limit to individual carrier, so radiation exceeds by several times than even prescribed by ICNIRP guidelines, depending upon total number of transmitters in area. Some people (especially older, housewives, children) living near towers are exposed to this radiation 24 hours a day. Unfortunately, ICNIRP has considered only the thermal effects of radiation, whereas scientists all over the world have found non-thermal effects of these radiations to have significant health effects and these non-thermal health effects occur at levels much below these norms."

The report further states that current USA standards for radiation exposure from cell phone towers are 580-1,000 microwatts per sq. cm. ($\mu W/cm^2$), but they are now considering revising the norms. Over 100 physicians and scientists at

Harvard and Boston University Schools of Public Health have called cellular towers a radiation hazard and 33 delegate physicians from 7 countries have declared cell phone towers a "public health emergency". Many countries in the world have adopted much stricter maximum permissible radiation density values of 0.001 to 0.24 W/m^2 (1/100th to 1/1000th of ICNIRP guidelines) as shown in Table 3.2 below. People in these countries have studied extensively the health hazards of cell tower radiation to adopt stricter radiation norms.

Table 3.2: International Radiation Density Limits for GSM1800

Power Density (W/m^2)	International Exposure limits adopted by various countries
10	FCC (USA) OET-65, Public Exposure Guidelines at 1800 MHz
9.2	**ICNIRP and EU recommandation 1998 – Adopted in India**
3	Canada (Safety Code 6, 1997)
2	Australia
1.2	Belgium (ex Wallonia)
0.5	New Zealand
0.24	Exposure limit in CSSR, Belgium, Luxembourg
0.1	Exposure limit in Poland, China, Italy , Paris
0.095	Exposure limit in Italy in areas with duration > 4hours
0.095	Exposure limit in Switzerland
0.09	ECOLOG 1998 (Germany) *Precaution recommendation only*
0.025	Exposure limit in Italy in sensitive areas
0.02	**Exposure limit in Russia (since 1970), Bulgaria, Hungary**
0.001	"Precautionary limit" in Austria, Salzburg City only
0.0009	*BUND 1997 (Germany) Precaution recommendation only*
0.00001	**New South Wales, Australia**

(Source: Report on Cell Tower Radiation by Prof. Girish Kumar)

Next the report says, "At many places, cell phone towers are mounted on roof top of residential/ commercial building. Even though antenna radiates less power vertically down but distance between antenna and top floor is usually few meters, so the radiation level in top two floors remain very high. A calculation of how much microwave power will be absorbed by human body if exposed to so called

safe radiation level adopted in India of 4.7 W/m^2 for GSM900 band - will be 583.2 KW-sec which implies that human body can be safely kept in microwave oven for 19 minutes per day. How many people in the world are willing to put themselves, their family members and their unborn children in an open microwave oven for 19 minutes/day? Telecom providers or policy makers can argue about body being adaptable to external threats and radiation is spread over whole day. However, question remains, would we like to put our citizens in an open microwave oven for 19 minutes/day over the years. Also, this is only for a single source. For multiple sources, it will increase correspondingly. Thus, the safe limit adopted by India is extremely high and millions of people are suffering because of this."

Further, while discussing the formula for received power it states that the purpose of a cell tower is to provide adequate signals to mobile phone for its proper operation. 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 R = 50m is at least 50 to 60 dB higher, which translates to 100,000 to 1,000,000 times stronger signal than a mobile phone requires. There are millions of people who live within 50m distance from cell towers and absorbing this radiation 24x7.

Next the report says, "Radiation measurements were carried out in a lady's apartment, who had developed cancer within a year of installation of cell tower. Radiation level between -4 to -10 dBm was very high. At 900 MHz, -10 dBm received power is equivalent to 7,068 μW/m^2, implying that safe radiation norms must be reduced considerably than adopted by India, which is 4,700,000 μW/m^2."

As per the report, radiation measurements were carried out at various places in Gurgaon, Delhi and Mumbai. Some of these readings are given in Table 3.3.

Table 3.3: Measured Radiated power and power density at various locations

Location	Measured power in dBm	Power Density in W/m2	Power Density in μW/m2
Delhi-Gurgaon Highway near Toll (3 towers)	0	0. 70686	70,686
Khar Bridge, Mumbai	0	0.70686	70,686
Bridge b/w Vashi and Sanpada, Navi Mumbai	-4	0.028274	28,274
Worli Naka	-4	0.028274	28,274
Tilak Bridge, Dadar	-4	0.028274	28,274
Resident1,4th Fl. Sergeant House Lady w/cancer	-6	0.017756	17,756
Bandra Bridge	-6	0.017756	17,756
Airport Bridge	-6	0.017756	17,756
Resident 2, Rane Society, Powai	-10	0.007069	7,069
Near Hub mall, Goregaon	-10	0.007069	7,069
Mahalaxmi Temple, Bhulabhai Desai Road	-10	0.007069	7,069
Haji Ali, Juice Centre	-10	0.007069	7,069
IIT Bombay, Main Building	-10	0.007069	7,069
Gandhi Nagar-over railway bridge-near building	-12	0.00446	4,460
JK Cement group, Worli	-12	0.00446	4,460
Ustav Chowk, Kharghar	-12	0.00446	4,460
Siddhivinayak Temple	-14	0.002814	2,814
Vikroli - before Godrej	-14	0.002814	2,814
Govandi- Residential towers - near Indian Oil	-14	0.002814	2,814
Kemp's Corner	-14	0.002814	2,814
Race Course- Haji Ali	-14	0.002814	2,814
Powai Plaza	-14	0.002814	2,814
Belapur Flyover, near RBI- CIDCO	-16	0.001776	1,776
Vile Parle	-16	0.001776	1,776
Peddar Road (Punjab National Bank)	-16	0.001776	1,776
Dadar Plaza	-16	0.001776	1,776
Poddar Medical College	-16	0.001776	1,776
Vashi Highway – near Turbhe	-18	0.00112	1,120

Andheri Bridge- continuous high till Jogeshwari	-18	0.00112	1,120
Nerul Bridge	-20	0.00707	707
Vivero pre School (opposite powai lake)	-22	0.000446	446
Powai police station	-22	0.000446	446
L&T Bridge	-24	0.000446	281.4
Rajeev Gandhi nagar	-26	0.000177	177
On road near Evita (Hiranandani Building)	-28	0.000112	112
D-Mart,Hiranandani, Powai	-34	0.000028	28
Poddar Road opp. Mukesh Ambani Residence	-36	0.000028	17.8
IIT Bombay School of Management – Entrance	-46	0.00000178	1.78
Resident at Central Area, IIT Bombay	-56	0.000000178	0.178

(Source: Report on Cell Tower Radiation by Prof. Girish Kumar)

After discussing above technical matters, report moves on to biological effects due to microwave radiation wherein it says that effect is much more significant in body parts which contain more fluid, like brain consisting of 90% water. Effect is more pronounced where the movement of fluid is less, e.g. eyes, brain, joints, heart, abdomen, etc. Human height also is much greater than wavelength of cell tower frequencies, so there will be multiple resonances in body, which creates localized heating inside body. This results in boils, drying up of fluid around eyes, brain, joints, heart, abdomen, etc. Out of the various health hazards discussed in report, those associated with cell towers only, are discussed here.

Regarding calcium ion release from cell membranes it says that studies have shown that weak EMF fields remove calcium ions bound to membranes of living cells, making them more likely to tear, develop temporary pores and leak. For DNA damage it says that cellular telephone frequencies can lead to damaged DNA. Studies show, microwave exposure at levels below current FCC exposure standard, produces single and double strand breaks in DNA. Microwave radiation

can also interfere with natural processes involved in DNA replication and repair. In reference to effects on Heat Shock Proteins it says that non-thermal effects of RF radiation accumulate over time and risks are more pronounced after several years of exposure. Effects are not observed in initial years of exposure as body has certain defense mechanisms and pressure is on the stress proteins of body.

Further the report says that radiation from cell towers and mobile phones affects human skin. EMFs degrade immune system & stimulate various allergic & inflammatory responses. High radiation from cell towers can result in an increase in mast cells, which explains the clinical symptoms of itch, pain, edema and erythema. Melatonin, a vital natural neuro-hormone is a powerful antioxidant, antidepressant and immune system enhancer. Every night on sleeping melatonin levels rise. It goes through blood & clears cells that is it, scavenges free radicals in cell to protect DNA & reduce possibility of cell becoming carcinogenic. Studies with animals and humans show a reduction in melatonin levels following radiofrequency radiation exposure from cell phones and cell sites. Turning off the transmitters resulted in a significant increased melatonin levels within few days.

For neurodegenerative diseases the report says that people living near base stations are also at risk for developing problems such as headache, memory loss, nausea, dizziness, tremors, muscle spasms, numbness, tingling, altered reflexes, muscle & joint paint, leg/ foot pain, depression and sleep disturbance. More severe reactions include seizures, paralysis, psychosis and stroke. It also says that there is an increased risk of several types of cancers following prolonged exposure to mobile phone/ tower radiation, such as, salivary gland

tumors, facial nerve tumors, skin, blood, testicular, breast cancer, etc. Next the report says that there have been several epidemiological studies of people living near cell phone antennas in Spain, the Netherlands, Israel, Germany, Egypt, Austria, etc. All these studies document adverse health effects at levels below FCC or ICNIRP guidelines. The report summarizes the studies as below:

France – A study by Santini in 2002, based on symptoms experienced by people living in vicinity of base stations recommended that cellular phone base stations should not be sited closer than 300m to populations. This is probably not possible in urban area, so the solution is to reduce the transmitted power level.

Germany – Researchers like Eger H in 2004 found that proportion of newly developing cancer cases was significantly higher among patients who had lived within 400m from cellular transmitter during past 10 years, compared to away.

Israel - This study by Wolf R and Wolf D in 2004, based on medical records of people living within 350m of a long established phone mast, showed a fourfold increased incidence of cancer compared with general population and tenfold increase among women, compared with surrounding locality farther from mast.

Spain – The study by Oberfeld in 2004 found significant ill-health effects among people living in vicinity of 2 base stations within 50-150m of antenna at average power density of 0.11 + 0.19 $\mu W/cm^2$, which is considerably lower than 1000 $\mu W/cm^2$ established by FCC. This demonstrates that FCC guideline does not protect.

Sweden was one of the first countries to claim 100% mobile connectivity. Survey studies show that somewhere between 230,000 - 290,000 Swedish men and

women out of a population of 9,000,000 are now EHS. Sweden is only country to recognize EHS as functional impairment/ physical degradation & not disease.

UK – In Berkeley House, Staple Hill, Bristol, UK, where Orange mobile mast was erected on roof of five story building; several people on top floor had cancer. In Warwickshire, 31 cancer patients were detected on a single street & quarter of 30 odd staff at special school, within sight of 90 ft. high mast, developed brain tumor. The masts are being pulled down under growing protests of thousands of people.

Australia – Due to billions of times more EMR emitted by billions of mobile phones and wireless communication data transmission, almost one-third of world population (about 2 billion) may suffer from Cell Phone Cancer beside other major body disorders like heart ailments, impotency, migraine, epilepsy by 2020.

India – Builder in Riddhi Park, Thakurlee (West) had installed mobile tower before residents occupied building. Within 4 months of occupying top floor flat, Mrs. Bhat was diagnosed brain tumor. Her neighbor delivered baby with cancer of spinal cord. Another neighbor gave birth to child having Birth Defects and child died immediately. All residents are now demanding demolition of tower. Mrs. Bhat left her flat now staying in Goregaon & spent Rs.10 lakhs for treatment on brain tumor. However her health is now improving. Mr. Bhagwant Deshpande of Solapur has reported 9 deaths due to cancer living within 91m from two towers.

Further the report says, "EMR from cell phone & tower affects birds, animals, plant & environment. The reason is that surface area of birds is relatively larger than their weight in comparison to human body, so they absorb more radiation (power = power density x area). Since fluid content is small due to less weight, it

gets heated up very fast and also magnetic field disturbs their navigational skills." Regarding effect on Honey Bees, the report says that several studies show that HF electromagnetic fields of mobile phones alter resonant stimulus of living organisms & can cause modifications in certain areas of their brain. Changes in brain structure of bees can be cause of alteration of their returning capabilities. Similarly, when birds are exposed to weak electromagnetic fields, they disorient and begin to fly in all directions, which explain migratory birds undermining navigational abilities. A large number of birds like pigeons, sparrows, swans are getting lost due to interference from new unseen enemy, mobile phone masts. Microwaves from phone masts also interfere with reproductive success of birds.

Next, while discussing effect on mammals & amphibians, the reports says, "study in Germany showed that cows grazing near cell towers are more likely to experience still births, spontaneous abortions, birth deformities, behavioral problems and general declines in overall health. Similarly, impaired immune system in sheep, reproductive & developmental problems in dogs & cats, anxiety & alarm in rabbits and frequent death of domestic animals such as, hamsters & guinea pigs living near base stations has been observed. EM pollution is a possible cause for deformations and decline of some amphibian populations too. Studies also show definitive clues that cell phone EMF can choke seeds, inhibit germination & root growth, thereby affecting overall growth of agricultural crops & plants. A reduction in wheat & corn yield in fields near high EMF lines has been reported. Progressive deterioration of trees near phone masts is also observed." The report also gives possible solutions to reduce ill effects of tower radiation

wherein it says that India has adopted very relaxed radiation norms of 4.7 W/m^2 for GSM900, whereas serious health effects have been noted at as low as 0.0001 W/m^2 = 100 $\mu W/m^2$. First step to be taken is to tighten radiation norms & yet it should be practical enough to be cost effective without causing too much inconvenience to users. All operators must be strictly asked that power density inside residential or office buildings, schools, hospitals and at common frequently visited places should be within norms. People must be informed about harmful radiation effects & corrective measures taken by Govt. People must be informed that for initially, they may have problem (especially people living far away from tower) due to reduction in transmitted power but it is for their health benefit.

As per the report, "solution is to have more numbers of cell towers with lesser transmitted power. In addition, repeaters or signal enhancers or boosters may be installed where signal is weak. Care to be taken that maximum power transmitted must not exceed 0.1 W because of their close proximity to users. Self-certification by operators must be immediately abolished; measurements must be done by third party, which is independent & trustworthy. Radiation measurements must be monitored continuously, so that operators do not increase the transmitted power during peak period. Very strict penalties must be imposed on those operators, who violate these norms as it causes serious health hazards to innocent people."

The report says that reduction in transmitted power for above solutions will definitely increase installation & maintenance cost, due to which operators all over are claiming that there are no radiation health hazards. Increase in cost of deployment of network can be met by increasing per minute charges by 30-35p.

Also, Govt. may consider reducing tax or license fee in overall interest of saving lives of people, birds, animals, plants, environment, thereby saving mother earth.

The report concludes by saying, "The seriousness of health hazards due to radiation from the cell phones & towers has not been realized among common man. Cell operators continue to claim no health issues. Even organizations like WHO, ICNIRP, FCC, etc. have not recommended strict safe radiation guidelines, whereas several countries have adopted radiation norms, which are 1/100th to 1/1000th of these values based on their studies. Cell phone industry is becoming another cigarette industry, which kept claiming that smoking is not harmful & now there are millions, who have suffered from smoking. In addition to the continuous radiation from cell towers, there is radiation from cell phones, wireless phones, computers, laptops, TV towers, FM towers, AM towers, microwave oven, etc. People are exposed to all these radiations which are additive in nature. Hence, it is imperative that stricter radiation norms must be enforced by the policy makers. This does not mean that living near these towers has to be stopped. It is known that automobiles create air pollution – has their usage stopped? Instead, solutions were found such as unleaded petrol, catalytic converters to reduce emission, CNG driven vehicles, hybrid vehicles, etc. If mobile companies accept that radiation causes serious health problems, will people stop using cell phones? Not really, because the cell technology has its several advantages. However, then researchers/ technocrats/ entrepreneurs will come out with possible solutions, which may be expensive but that cannot be greater than the health risk faced by humans, birds, animals and environment."

Review of the report

The report appears to be one of the most comprehensive and commonly referred out of all the reports/ papers seen in India. The methodology adopted by the Prof. explains and touches all living beings from human to birds, animals & honey bees & also plants. In report elaborate theoretical technical details related to radiation patterns of antennas & calculations related to power from them have been given along with sample measurements at some places to check status.

The point that power of Electromagnetic Radiations reduces at a very fast rate as one moves downward as compared to moving horizontally away from antenna is worth noting. According to it, people living around antenna in horizontal plane, will receive much higher radiations, that too specifically in front side as compared to back side but surely safe limits need to be maintained and people should be aware about it. But the cases of cancer pointed out by him need further detailed observation & analysis. A paper posted by Dr. Ben Kim, on 8 Sept '15 in National Health Care[13] gives a take home point, "a 1 millimeter cluster of cancerous cells typically contains somewhere in the ball park of million cells, and on an average, takes about six years to get to this size. Generally, a tumour can't be detected until it reaches the 1 millimeter mark. So to develop a mass that is likely to be problematic (say, about 5 centimeters to put a number to this example), make no mistake in understanding that this is a journey of many years."

In Biological effects on human beings, most diseases referred in report, work on theory that when a person makes a long call the heat passing through ears

[13] http://drbenkim.com/how-fast-does-cancer-grow-spread (accessed 6 March 2016)

hits the head. It suggests that it is critical that children under 16 use cell phones only for essential calls as they have much higher danger of getting a brain tumor. Adding to it the report mentions that excessive use of mobile phone can cause infertility, abortion, congenial malfunction, DNA damage, interference with pace makers, effects on stress proteins, Blood brain Barrier damage, risk to pregnant women, tinnitus & ear damage, effect on eye, weakening of bones, salivary gland tumour, sleep disorders, etc. But contrary to title of report 'Cell Tower Radiation', it points out adverse effects of usage of mostly mobile phones rather than towers.

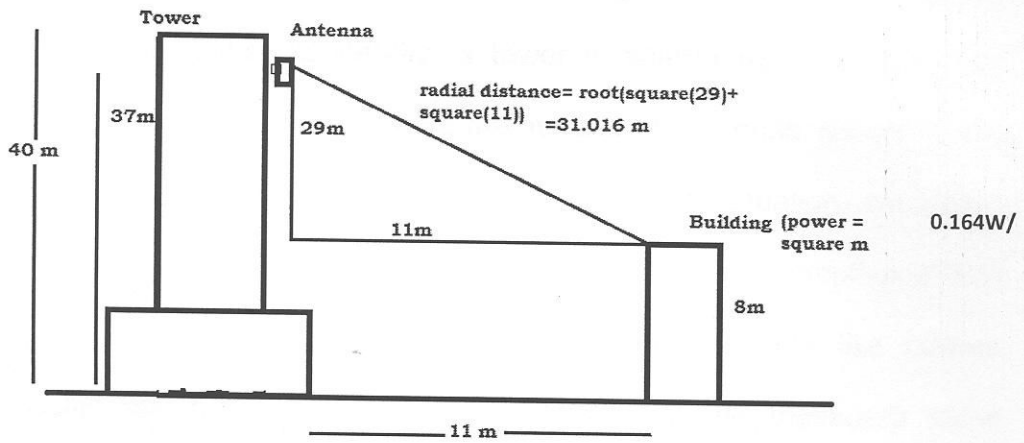
Further, report on adverse effect on birds, animals, honey bees and plants, seem to be insufficiently worked, as according to bird lovers, snatching away of habitat is prime cause of disappearance of sparrow. Also pigeons can be easily cited on mobile towers & their increasing population is a menace now. Rather, rise in population of pigeons and crows is attributed as a reason for decline in the number of smaller birds like sparrows, bulbuls, etc. Similarly, it is said, honey bees are losing their habitat due to thinning density of trees. As per an article originally published in March 2014 on website of global research[14] it was nowhere mentioned that EMR is sole cause of bee population decline. In fact they blame it on pesticides, fungicides climate change and changes in agriculture pattern by the farmers. Effect on plants again needs more research because the conclusion seems to be insufficient and growing pollution is said to be the cause of reduction in plant growth and also choking of seeds due to growing pollution is evident.

[14] http://www.globalresearch.ca/death-and-extinction-of-the-bees/5375684 (accessed 6 March 2016)

3.5 TRAI Information paper titled Effects of Electromagnetic Field Radiation from Mobile Towers and Handsets[15]

TRAI (Telecom Regulatory Authority of India) has issued an Information paper No. 01/2014-QoS titled "Effects of Electromagnetic Field Radiation from Mobile Towers and Handsets", on 30th July 2014. In the paper, after discussing about EMR & mobile BTS, it explains specifically about measurement of EMRs from mobile tower using figures. When a building of height 8m is located at 11m horizontal distance from 40m Ground based tower (with antenna at height of 37m), as shown in figure 3.1 below, then calculated EMF power density is 0.164 Watts/sq.m and the building is within limits of norms prescribed.

Figure 3.1: EMF power density levels from mobile BTS



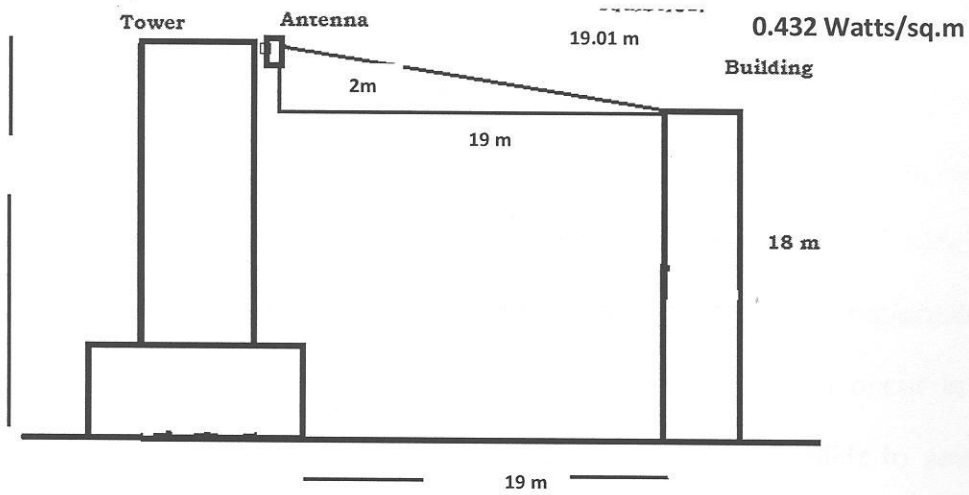
(Source: TRAI Information paper)

Similarly, as per paper, even for building of height 18m located at horizontal distance of 19m from 10m tower at roof of building 10m high, calculated EMF

[15] Telecom Regulatory Authority of India (30th July, 2014) *Information paper No. 01/2014-QoS on Effects of Electromagnetic Field Radiation from Mobile Towers and Handsets.*

power density is 0.432 W/sq.m and the building (assuming that effect of radiation is only from main lobes) is within limits of norms prescribed as shown in fig 3.2 below. (For 900MHz GSM, limit prescribed is 0.45 Watts/sq.m)

Figure 3.2: EMF power density levels from mobile BTS



(Source: TRAI Information paper)

Further the paper says, "Generally, a tower is shared by more than one operator to provide mobile services. More the number of antennas, greater is the power intensity in nearby area. In any particular exposure situation, calculated values are compared with reference value (ICNIRP levels). Compliance with reference level will ensure compliance with relevant quantities like current density, specific absorption rate and power density. If the measured value exceeds reference level it is necessary to test compliance with the relevant field quantity to determine whether additional protective measures are necessary."

The paper also gives additional factors on which EMF radiation depends,

- Frequency/ wavelength of RF signal being transmitted;
- Radio Frequency Power radiated from the antenna;

- Duration of Exposure of RF signal at a given distance from the antenna;
- Exposure from other antennas located in the area;
- Duration/ frequency of recurrent exposure;
- Temperature and humidity.

Next the paper says that exposure to low-frequency EMF normally results in negligible energy absorption and no measurable temperature rise in the body. However, exposure to EMF at frequency above 100 KHz can lead to absorption of energy & increase in body temperature. At frequencies between 100 KHz and 20 MHz, significant absorption may occur in the neck and legs; at frequencies in the range of 20 MHz to 300 MHz, relatively high absorption can occur in the whole body; when frequencies are in the range of around 300 MHz to several GHz, significant local, non-uniform absorption occurs; and in frequencies above 10 GHz, energy absorption occurs primarily at the body surface. In case of mobile, frequencies ranging from 800 MHz to 2100 MHz are normally used.

Further, the paper after giving details about EMRs from mobile phones and process of evolution of guidelines in India; gives details about relevant ICNIRP guidelines, latest EMF norms in India and those followed in some of the countries internationally, which are shown below in Tables 3.4 to 3.6.

Table 3.4: ICNIRP safety norms

Frequency Range	Power Density (Watt/Sq. Meter)
400MHz to 2000MHz (2GHz)	f/200
2GHz to 300GHz	10

(f: is the frequency of operation in MHz) (Source: TRAI Information paper)

Table 3.5: Revised EMF radiation norms for mobile towers (BTS) in India

Frequency	ICNIRP Radiation norms	Revised DoT Norms effective from 01.09.2012
900 MHz	4.5 Watt/ sq.m	0.45 Watt/sq.m
1800 MHz	9 Watt/ sq.m	0.9 Watt/sq.m
2100 MHz	10.5 Watt/ sq.m	1.05 Watt/sq.m

(Source: TRAI Information paper)

Table 3.6: International EMF radiation norms for mobile towers (BTS)

International Exposure limits for EMF (1800 MHz)	
12 W/m2	USA, Canada and Japan
9.2 W/m2	ICNIRP and EU recommendation 1998
9 W/m2	Exposure limit in Australia
2.4 W/m2	Exposure limit in Belgium
1.0 W/m2	Exposure limit in Italy, Israel
0.5 W/m2	Exposure limit in Auckland, New Zealand
0.45 W/m2	Exposure limit in Luxembourg
0.4 W/m2	Exposure limit in China
0.2 W/m2	Exposure limit in Russia, Bulgaria
0.1 W/m2	Exposure limit in Poland, Paris, Hungary
0.1 W/m2	Exposure limit in Italy in sensitive areas
0.095 W/m2	Exposure limit in Switzerland
0.09 W/m2	ECOLOG 1998 (Germany)
0.001 W/m2	Exposure limit in Austria

(Source: TRAI Information paper)

Next, the paper states that the biological effects of radio waves are being explored. Various studies have been conducted in different countries; however, there is no conclusive evidence of adverse effect of EMF radiation on human health. WHO released a fact sheet on "Electromagnetic fields radiation and public health: mobile phones" in June 2011, in which it said that

"..to date, no adverse health effects have been established as being caused by mobile phone use".

Some more statements as per the paper, from other international organizations related to mobile towers, are:

Health Protection Agency (HPA), UK (April 2012) – *"No convincing evidence that RF field exposures below guideline levels of ICNIRP cause health effects in adults or children."*

UK Independent Advisory Group on Non-Ionizing Radiation (AGNIR) (2012) – *"In summary, although a substantial amount of research has been conducted in this area, there is no convincing evidence that RF field exposure below guideline levels causes health effects in adults or children"*

Danish Cohort Study, 2011 – *"There is no evidence of any increased risk of brain or nervous system tumours or any cancer mobile phone subscribers"*

Norwegian Institute of Public Health (NIPH), 2012 – *"The large total number of studies provides no evidence that exposure to weak RF fields causes adverse health effects."*

Out of the studies supporting or discrediting the conjecture of effects of EMR on biological life form, given in paper, relevant part related to effects from EMRs in general and mobile towers in particular are discussed ahead. The paper states, "There have been arguments that EMR has potential to mutate DNA & cause cancer. However, to mutate DNA, a certain threshold energy is needed (energy per photon). It takes about 12 eV to ionize water (hydrogen-oxygen covalent bond). EM radiation with photonic energy of more than 10 eV is generally considered ionizing. Visible light photons have about 2 eV of energy while EM radiation photons at 300 GHz have only 1.24 meV (approx.) of energy.

Hence, clearly EM radiation originating from cellular operations does not have enough energy to break chemical bonds or cause ionization. Hence diseases like cancer cannot be attributed to EM radiation from communication infrastructure."

The paper further says that one potentially harmful effect of RF radiation is dielectric heating due to absorption of EMR. However, if temperature increase is small, brain blood circulation is capable of disposing excess heat by increasing local blood flow. This is normal cellular response to increase in temperature and does not have any adverse effect on body. Some also argue that there are other various symptoms like fatigue, sleep disturbance, loss of memory, disturbance indigestion etc. which have been attributed to exposure to low-level EMR from wireless devices. These symptoms are collectively known as Electromagnetic Hypersensitivity (EHS). Several surveys, as listed below, have found a variety of self-reported symptoms that include subjective symptoms, sleeping problems, and cognitive performance for people who live close to base stations.

1. *Santini, R; Santini, P; Danze, JM; LeRuz, P; Seigne, M (January 2003). "Survey Study of People Living in the Vicinity of Cellular Phone Base Stations". Electromagnetic Biology and Medicine (London: Informa Healthcare) 22 (1): 41–49.*
2. *Navarro, Enrique A; Segura, J; Portolés, M; Gómez-Perretta de Mateo, Claudio (December 2003). "The Microwave Syndrome: A Preliminary Study in Spain". Electromagnetic Biology and Medicine (London: Informa Healthcare) 22 (2): 161– 169.*

3. *Oberfeld, Gerd; Navarro, Enrique A; Portoles, Manuel; Maestu, Ceferino; Gomez- Perretta, Claudio (2004). "The Microwave Syndrome: Further Aspects of a Spanish Study". In Kostarakis, P. Biological effects of EMFs: Proceedings, Kos, Greece, 4–8 October 2004, 3rd International Workshop. Ioannina, Greece: Electronics, Telecom & Applications Laboratory, Physics Dept., University of Ioannina: Institute of Informatics & Telecommunications, N.C.S.R. "Demokritos".*
4. *Abdel-Rassoul, G; Abou El-Fateh, O; Abou Salem, M; Michael, A; Farahat, F; El- Batanouny, M; Salem, E (March 2007). "Neurobehavioral effects among inhabitants around mobile phone base stations" (PDF). NeuroToxicology (New York, NY: Elsevier Science) 28 (2)*
5. *Bortkiewicz, A; Zmyślony, M; Szyjkowska, A; Gadzicka, E (2004). "Subjective symptoms reported by people living in the vicinity of cellular phone base stations: review". Medycynapracy (in Polish) (Warsaw: PaństwowyZakładWydawnictw Lekarskich) 55 (4): 345–352.*
6. *Hutter, H-P; H Moshammer, P Wallner, M Kundi (May 1, 2006). "Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations". Occupational and Environmental Medicine (London, UK: the BMJ Publishing Group) 63 (5): 307–313.*

But it is to be noted that there are significant challenges in conducting studies on people near base stations, especially in assessment of individual exposure, as reported in similar studies. In end paper gives the summary as, "EMR is a fact of life. Most human beings are exposed to some form of EMR daily basis. In context

of the telecom industry, such radiation emanates from mobile towers & phones. Crux of matter is that whenever regulations & standards are set to limit any possible harm that such radiation could have on human beings, such regulations & standards must have a scientific basis. In the absence of being founded on science, regulation/ standard could be assailed as arbitrary. Moreover, it could end up limiting growth of industry merely based on a presumption. More studies have to be undertaken, especially India specific studies. And, until those studies are completed and results validated, we need to be careful on how we approach EMF radiation."

Review of the paper

TRAI, the Telecom Regulatory Authority of India is an independent regulator of the telecommunications business, established by an Act of Parliament to regulate telecom services and tariffs in India. Under its mission to create & nurture conditions for growth of telecom in India; it has published this information paper with an aim to answer ongoing confusion in Indian society. Its first attention is to technically explain calculation of EMRs in respect to mobile base stations & effects of radio waves from them. It has assimilated various studies/ researches from around the world to come to a conclusion that though the guidelines adopted by DOT are sufficient but has also advised a precautionary approach till sufficient researches specific to Indian scenario are conducted in this field and final conclusions regarding safest possible norms can be established.

3.6 Paper: RF radiation from mobile phone towers and their effects on human body[16]

A paper titled RF radiation from mobile phone towers and their effects on human body, written by Lalrinthara Pachuau, Lalrintluanga Sailo & Zaithanzauva Pachuau of Department of Physics, Mizoram University and P C Lalngneia of Department of Physics, Indian Institute of Technology, Guwahati, Assam was published in Indian Journal of Radio & Space Physics, Vol.43, April 2014, pp 186-189. This paper was based on survey conducted with an aim to study different symptoms of health effects of RF radiation faced by the inhabitants living in close proximity (less than 50m) to mobile base station of GSM900 at the selected locality in Aizwal, Mizoram, India. As per the paper, "The study was carried out for the first time ever in the state in the year 2012 after six years of exposure to RF radiation. Absolute power densities have been measured at some selected houses. Frequency spectrum was analyzed at different sites."

In this study, "A survey was conducted, similar to that for study on mobile phone users by Santini et al. Survey was conducted on 38 persons (21 female, 17 male) of 15 different houses on 12 different symptoms, which included: fatigue, nausea, sleep disruption, discomfort, headache, memory loss, skin problem, hearing problem, dizziness, muscular pain, visual disruption, difficulty in concentration, etc. Level/ degree of complaints for the studied symptoms was expressed by the participants using a scale: 0 = never, 1 = sometimes, 2 = often,

[16] Pachuau Lalrinthara, Sailo Lalrintluanga, Pachuau Zaithanzauva, Lalngneia P.C. (April 2014) 'RF radiation from mobile phone towers and their effects on human body', *Indian Journal of Radio & Space Physics*, 43: 186-189

3 = very often. Health hazards faced by inhabitants were analysed & compared based on sex." The paper concluded by saying, "It has been observed that measured value of power densities at all sites are higher than that of safety recommendation of Bioinitiative 2012, Salzburg resolution 2000 and EU (STOA) 2001, but well below safety limit recommended by ICNIRP and DoT. However, it has been observed that many inhabitants have health complaints on different symptoms although tower had been erected in 2006. It has been observed that females are having more health complaints than males. As a whole, residents living in 50m from tower are having more health complaints than those living outside. It is concluded and suggested that mobile phone towers should not be located within 50 metres distance from residential houses."

Review of the paper – Although through survey the study has tried to bring out some inferences related to health issues of the people living around a mobile tower, but it could not be established that the observed issues were due to Electromagnetic Radiations from mobile towers only, because these days, the symptoms like fatigue, nausea, sleep disruption, discomfort, headache, memory loss, skin problem, hearing problem, dizziness, muscular pain, visual disruption, difficulty in concentration, etc. are said to occur because of life style, environmental pollution, tensions, eating habits, food adulteration, etc. also.

3.7 Feature article: Effect of short-term mobile phone base station exposure on cognitive performance, body temperature, heart rate and blood pressure of Malaysians in ARPANSA website[17]

The Australian Radiation Protection And Nuclear Safety Agency (ARPANSA) of Australian Government, under the section EMR literature survey, provides monthly updates on published literature related to electromagnetic fields and health in the frequency range 0-300 GHz. Published literature includes articles in peer-reviewed journal, scientific-body report, conference proceeding, fact sheet, etc. The site was searched for latest material related to mobile towers/ base stations. Information related to this article by Malek F, Rani KA, Rahim HA, Omar MH, was found in the ARPANSA EMR Literature Survey of August 2015. This human provocation study examined if there is any association between radio frequency (RF) electromagnetic fields and electromagnetic hypersensitivity (EHS). Two hundred participants (half claiming to be EHS and half non-EHS) were divided into four groups, three being exposed to three different types of mobile phone base station RF fields: GSM900, GSM1800, or UMTS and one group sham-exposed. A series of tests to evaluate cognitive performance were conducted before, during & after exposure. Physiological parameters like body temperature, blood pressure & heart rate were monitored. Authors concluded that there is no difference in the cognitive performance and physiological parameters between group of people with EHS and without EHS, regardless of exposure type.

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[17] Malek F, Rani KA, Rahim HA, Omar MH (2015) 'Effect of short-term mobile phone base station exposure on cognitive performance, body temperature, heart rate and blood pressure of Malaysians', Sci Rep 2015; 5: 13206-1 - 13206-5 (Online)
http://www.arpansa.gov.au/radiationprotection/emr/literature/august15.cfm

Comments by ARPANSA – There have been many provocation studies investigating possibility of association between RF exposure in mobile telephony and cognitive function. A review by Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) mentioned that for symptoms triggered by short-term exposure to RF (measured in minutes to hours), consistent results from multiple experiments give a strong overall weight of evidence that such effects are not caused by exposure. A review published by Swedish Radiation Protection Authority has also conveyed the same message regarding EHS and RF exposure. Environmental exposure from RF sources is dominated by antennas used for broadcasting and telecommunication services like mobile base stations. Historical data from spot measurement campaigns and continuous radiation monitoring systems around the world indicate that the introduction of new mobile telecommunication technologies after deployment of GSM and UMTS systems did not substantially change average levels of EMF in environment. At the same time, other technologies, like digital broadcasting, have in some regions contributed to the reduction of EMF exposure from far field sources. This provocation study included participants who claimed to have EHS symptoms. It is important to note that authors reported no difference in cognitive function between sensitive & normal participants, regardless of whether exposure was present or not.

3.8 Perception in the Indian Society

To understand the perception in Indian society related to Electromagnetic Radiations from mobile towers, news items published in newspapers, magazines and social media sites were searched/ scanned. Some of them are as below,

3.8.1 Mobile tower risks: Rajasthan High Court issues notice to telecom operators[18]

This news item was published in DownToEarth, a fortnightly magazine by Centre for Science and Environment (CSE), on Tuesday 06 March 2012. An excerpt of news item is as follows, "Following a writ petition by two senior citizens citing increased incidence of cancer because of mobile towers, the Rajasthan High court, has issued notices to 13 mobile service providers, including Vodafone and Airtel, and seven government agencies. ….. The petitioners – retired Justice I S Israni and Nirmala Singh – have collected various news reports and studies to show the harmful effects of radiation. Through examples of illegally constructed towers in their own neighborhood they have attempted to question the larger issue of regulation and monitoring of these towers. In the plot next to Israni's and Singh's house in different localities of Jaipur mobile service providers have 'illegally erected a mobile tower' says the petition. The one next to Singh's house is owned by Bharti Infratel Ltd and she in November 2011 had requested the municipal authority and the urban development and housing department to take action against the company. But her notice was not even acknowledged by the government. The petition says the towers were installed without permission. Citing right to life as a fundamental right, the petition filed on February 24, 2012, requested the court to take action against the service providers and the authorities concerned. The petition says that harmful and hazardous radiation from these

[18] Moyna (Tuesday 6 March 2012) 'Mobile tower risks: Rajasthan High Court issues notice to telecom operators', *DownToEarth* (Online) http://www.downtoearth.org.in/news/mobile-tower-risks-rajasthan-high-court-issues-notice-to-telecom-operators--37196

towers have become a health and safety concern for all residents. They also cause noise pollution due to the power backup through generators. ....."

3.8.2 Campaign against Mobile Tower Radiation: Bhatti mein Shahar[19]

Relevant parts of this news published on 11 April 2013 are as follows, "The Rajasthan Patrika Group (Rajasthan, India) of newspapers launched a campaign, Bhatti mein Shahar, in 3 states against illegal installations, lack of licensing norms, and excessive levels of radiation of mobile cell towers. The newspaper found that, for this technology, no policy was in place to monitor possible health effects nor were conclusive studies ever brought to light. Patrika - Media Action Group (MAG - the social action wing of the newspaper group) engaged and educated concerned citizens, launched a helpline, and raised the issue, through concerned citizens, by filing 'Public Interest Litigation (PILs)'. ..... Following the campaign and PIL, the Rajasthan High court passed a verdict to remove towers from schools, playgrounds, hospitals, and heritage buildings - a decision challenged by the tower companies in Supreme Court of India. Meanwhile, Madhya Pradesh municipality has passed an act for licensing and installation norms of towers. ....."

3.8.3 Cell tower radiation increases risk of brain cancer[20]

This news item was published in dna Mumbai, daily newspaper on Saturday, 20 Sep 2014. An excerpt of news item is as follows, ".....There are 15 lakh mobile

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[19] Mathur Shipra (11 April 2013) 'Campaign against Mobile Tower Radiation: Bhatti mein Shahar-City in Furnace', *Rajasthan Patrika* (Online) http://www.comminit.com/global/content/campaign-against-mobile-tower-radiation-bhatti-mein-shahar-city-furnace

[20] Porecha Maitri (Saturday 20 September 2014) 'Cell tower radiation increases risk of brain cancer', *dna* (Onine) http://www.dnaindia.com/mumbai/report-cell-tower-radiation-increases-risk-of-brain-cancer-2020015

towers in India. Most of them are in dense clusters and in non-uniform distances. Experts have raised concerns over the upcoming 4G towers. 'Each tower has close to four or more antennae attached to it. Each antennae will transmit at least forty watts of power which is extremely high. At the moment, 2G towers emit close to 20 watts of power. More transmission in 4G towers may cause compliance issues,' said Professor Girish Kumar, department of electrical engineering, Indian Institute of Technology (IIT). 'Across Europe, power transmission of antennae is not more than 1-5 watts. Higher the power transmission, more amplified is the range of frequency of mobile tower.' Cellphone operators often increase power transmission in fewer towers to save costs of building more towers at uniform distances. 'India needs 15 lakh more towers, but that would lead to incurring of Rs.30,000 crore for cellphone companies. So, they are increasing power transmission which is harmful to human health,' added Kumar."

3.8.4 No space for more mobile towers – Public protest setting up cell towers, but demand better coverage[21]

This news item was published in Deccan Chronicle, daily newspaper, in Thiruvananthapuram on Sep 16, 2015. An excerpt of news item is as follows, "Even as public ire against mobile service providers for call drops keeps on escalating, hundreds of applications by various mobile service providers to install mobile phone towers are caught up in public protests. Pressure is also mounting on the government to relax procedures for allowing sanction of mobile phone towers. According to sources, the mobile service providers are in a difficult

[21] Raghunath Arjun (16 September 2015) 'No space for more mobile towers', *Deccan Chronicle* (Online) http://www.deccanchronicle.com/150916/nation-current-affairs/article/no-space-more-mobile-towers

situation as the centre had even threatened action against call drops. Insufficient number of towers in proportion to the increasing mobile call traffic is one major reason for the call drops. ..... Even as health hazards posed by mobile phones and cell towers are yet to be established, people still associate a fear factor with mobile phones. The Delhi High court recently rejected a petition filed by residents of a locality against installing a mobile tower in the locality. The court maintained that the petitioners should first stop using mobile phones if they felt that mobile phone towers were harmful, sources pointed out."

3.8.5 Call Drops, Tower Radiation Complaints Can't Go Together: Ravi Shankar Prasad[22]

This news was in NDTV, New Delhi on Sep 18, 2015. An excerpt of news item is as follows, "..... 'The complaint against call drops and that against tower radiation cannot go together,' Mr Prasad said answering questions at an event in New Delhi organised by the Ficci-supported International Chamber of Commerce. ..... The minister spoke of 'a sinister campaign' of the ill-effects of mobile tower radiation. 'There is an exhaustive World Health Organisation report on the matter that this radiation is not injurious to health. One should only think of the radiation that one is normally exposed in doing X-rays or MRIs,' he said. ....."

3.8.6 Twitter

To get a first-hand feel about the perception in society, related to Electromagnetic Radiations from mobile towers, the twitter site was searched with

[22] Indo Asian News Service (18 September 2015) 'Call Drops, Tower Radiation Complaints Can't Go Together: Ravi Shankar Prasad', *NDTV* (Online) http://www.ndtv.com/india-news/call-drops-tower-radiation-complaints-cant-go-together-ravi-shankar-prasad-1218892

keywords – tower radiations, on 18th February 2016. Around 50 tweets were found during last 1 year, out of which 9 were of the view that there is no harm, 22 were trying to say they are harmful and 19 appeared to be either neutral or confused regarding the effects of radiation and were inquisitive about it.

3.9 Analysis

After going through all the studies and views of different spectrums of the society, one can gather that researches on the subject are still indecisive and contradictory. Further researches are required to establish whether or not one is safe in the hands of the new technology. The public demands concrete answers to the ever more pressing questions but science cannot provide a guarantee of absolute safety yet the development of research appears to be reassuring overall.