MOBILE COMMUNICATIONS: RADIO FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE AND PUBLIC SAFETY

A Dissertation submitted to Punjab University, Chandigarh for award of the degree of Master of Philosophy in Social Sciences, in partial fulfilment of the requirement of Advanced Professional Programme in Public Administration (APPPA)

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CERTIFICATE

I have the pleasure to certify that **Shri Piyush Chand Gupta** has pursued his research work and prepared the dissertation entitled **"Mobile Communications: Radio Frequency Electromagnetic Field Exposure and Public Safety"** under my guidance and supervision. This dissertation is result of his own research and to the best of my knowledge, no part of it has earlier comprised any other monograph, dissertation or book. This dissertation is being submitted to the Punjab University, Chandigarh for award of the degree of Master of Philosophy in Social Sciences, in partial fulfilment of the requirement of Advanced Professional Programme in Public Administration (APPPA) of the Indian Institute of Public Administration (IIPA), New Delhi.

I recommend that the dissertation of **Shri Piyush Chand Gupta** is worthy of consideration for the award of degree of Master of Philosophy in Social Sciences from Punjab University, Chandigarh.

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DECLARATION

I, the undersigned, hereby declare that this dissertation titled **"Mobile Communications: Radio Frequency Electromagnetic Field Exposure and Public Safety"** for the award of the degree of Master of Philosophy in Social Sciences by Punjab University, Chandigarh is my own work and that all the sources, I have accessed or quoted, have been indicated or acknowledged by means of complete references. The dissertation has not been submitted for any other degree /diploma or elsewhere.

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ABSTRACT

Introduction:

Mobile communication technology has become indispensable and ubiquitous part of the modern society. Mobile phones have radically altered the way that people work, socialize, organize, and entertain themselves. Personal productivity, Knowledge Enhancement, Public services, Health care services, Entertainment, Lifestyle and Social Connectivity are the major fields which are largely benefitted by the mobile communications worldwide. Mobile communications also contribute for the increase in GDP and employment. There are about 9.42 Billion mobile subscribers worldwide, more than the population and 5.21 Billion unique mobile users. India's telecommunication network is second largest in the world having 1.172 billion subscribers as on 31st December 2019, primarily contributed by 1151.44 Million wireless subscribers (> 98%). As per Telecom Regulatory Authority of India (TRAI), out of tele-density of 88.56% in December 2019, wireless contributes for 86.98 % and wire line contributes for 1.59 % only.

Statement of Problem:

A robust and scalable mobile infrastructure including towers is a pre-requisite and mandatory for seamless and good quality mobile services. With the increasing number of mobile towers, there has been a public concern for exposure from Mobile Communication Technology. Sometimes, Public becomes reluctant and expresses reservations when a new Mobile Tower is being installed in the near vicinity. Even in few cases, working mobile towers had to be shifted due to public arrogance.

There is, therefore, a need to study the possible effects of Radio Frequency Electromagnetic Field (RF EMF) Waves emitted by Mobile Towers and Mobile Phones, and the guidelines issued, and standards set by the Government for limiting the exposure of RF EMF Waves.

Research Objectives:

1. To study the guidelines and standards set by the Government related to Radio Frequency Electromagnetic Field ((RF EMF) Waves exposure by Mobile Communication Technology for Public Safety and their validity in today's scenario.
2. To understand the possible effects of RF EMF Waves from Mobile Communication Technology.
3. To analyze the measures being taken by Government of India to deal with inconvenience and possible adverse effect from exposure of RF EMF Waves by Mobile Communication Technology and their impact.
4. To suggest Policy Interventions through which the possible adverse effects from the exposure of RF EMF Waves by Mobile Communication Technology can be minimized.

Methodology:

The present study uses the mix of Descriptive, Exploratory and Analytical Research. Both, primary and secondary data sources are used for this study. The secondary data has been collected from Books, articles and journals available on the subject including online

information available on Internet. The various reports published by eminent International and national agencies and guidelines and regulations on the issue have been studied. The Primary data was collected through structured questionnaire, interview/discussions with senior officers of Department of Telecom (DOT) and other personalities to have their opinion on the subject. Besides this, Emission level of RF EMF waves of some Mobile Towers were collected. The data so collected was analysed and further interpreted to yield useful information and findings.

Findings:

The major findings are as below:

- The analysis of responses of structured questionnaire, inter alia, revealed that although respondents were of the opinion that a strong mobile infrastructure including towers is mandatory for good mobile services, yet there was difference of opinion regarding whether EMF emissions from Mobile Communications pose serious health hazards to the public or not. There seems the further need of making more efforts to change the public perception, utilizing all available Mass Communication means and Media Campaigns, on the issue.
- The RF EMF Exposure level of one hundred mobile towers in Delhi Licensed Service Area (LSA) comprising Delhi state and NCR Area of Gurugram, Faridabad, Noida, Greater Noida, Ghaziabad was collected and the analysis showed that all Mobile towers were emitting well within the safe limits set by Government of India and further, very much below the ICNIRP safe limits.
- Discussions held with various experts revealed that since the country has adopted one

of the most stringent EMF exposure limits for Mobile Towers which are ten times more stringent than the limits prescribed by ICNIRP and recommended by WHO and Also, norms set with regard to mobile handsets are also stricter than ICNIRP limits, the present exposure limits should continue unless some contradictory evidences emerge, to fill the knowledge gap, as the result of researches already going on.

- Analysis of data collected from LSA Field Units of DOT and from other sources, revealed that Government is taking adequate measures to change the perception of public on the issue. Like in all other ongoing processes, there is further scope of making these efforts more efficient as emanated from the field survey.

Conclusions:

Following conclusions may be drawn, primarily:

- As per WHO, EMF exposures below the limits recommended in ICNIRP international guidelines do not appear to have any known consequence on health. However, there are gaps in knowledge still needing to be filled before better health risk assessments can be made.
- The norms set by Government of India on EMF Exposure are quite strict vis-à-vis ICNIRP guidelines. These norms are adequate and should continue in today's scenario.
- In order to ensure compliance to prescribed safety norms of EMF radiation from mobile towers and further for spreading the awareness among the public, adequate steps are being taken by the government. There is further scope of making these efforts more efficient.
- Many researches have revealed that risk from mobile phones is much more than mobile towers.

Recommendations:

Following are the major recommendations emerging from the study:

- **Need for further Research:** At present there are gaps in knowledge which need to be filled before better health risk assessments can be made. There is need for more India specific studies and government should undertake adequate revision in safety standards and norms, if so necessitated by the results so obtained.

- **Need to study Impact of New Technologies:** Advance technologies are being deployed in the area of Mobile Communications very frequently. Since long term health impacts, to be observed of these technologies, takes significant time, the agencies responsible for it, including, government should monitor these impacts very strictly, regularly and closely.

- **Monitoring and Compliance:** Government should undertake regular monitoring to ensure compliance to the prescribed stricter precautionary norms of EMF radiation from mobile towers. It has to be ensured that **the prescribed norms be followed scrupulously and in case of violation of norms, strict punishment should be imposed.**
- **Capacity building of Officials:** The government should conduct short term capacity building / skill up gradation programmes for field officers/officials involved in testing and monitoring processes. Field units must be strengthened with required infrastructure and logistics like tools, testers, staff and vehicle.
- **Public Awareness and Education:** For changing the perception of masses and boosting the confidence towards the issue, public awareness and education is the

key. Government is taking adequate measures however, there is a need to take all such measures on a broad platform covering all aspects with the help of all available mass communication media. Kerala LSA has adopted best practices for changing the perception of public, which other LSAs should follow.

- **Mechanism to resolve Public Grievances related to Mobile Towers:** State Level Telecom Committees (STC), District Level Telecom Committees (DTC) and also Local Level Telecom Committees may be constituted in order to effectively address Public Grievances relating to installation of towers and issues related to telecom infrastructure. These committees may also work to fill credibility gap on the issue.
- **Need to involve Local Bodies:** While setting up new mobile towers, there should be requirement of consultation by Infrastructure Provider/Telecom Service Provider, with local authorities and the public taking into account aesthetics and public sensitivities. Open communication during the planning stages can help to create public understanding and better acceptance of the facility.
- **Building Public Confidence:** Adequate measures like involving local representative of public while checking radiation level etc. may be undertaken for building public confidence.

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LIST OF ABBREVIATIONS

5 G	Fifth Generation (of Wireless Communications Technologies)
AI	Artificial Intelligence
AM	Amplitude Modulation
ARPANSA	Australian Radiation Protection And Nuclear Safety Agency
AUSPI	Association of United Service Providers in India
BMI	Body Mass Index
BR	Basic Restrictions
BTS	Base Transceiver Station
CDMA	Code Division Multiple Access
CMTS	Cellular Mobile Telecom Services
COAI	Cellular Operators Association of India
DNA	Deoxyribonucleic Acid
DoT	Department of Telecommunications
DST	Department of Science and Technology
DTC	District Telecom Committee
EHC	Environmental Health Criteria
EHS	Electromagnetic Hypersensitivity
ELF	Extremely Low Frequency
EM	Electro-Magnetic
EMF	Electromagnetic Fields
EMR	Electromagnetic radiation

FCC	Federal Communications Commission
FDA	Food and Drug Administration
FM	Frequency Modulation
GHz	Giga Hertz
GPS	Global Positioning System
GSM	Global System for Mobile
HF	High Frequency
IARC	International Agency for Research on Cancer
ICMR	Indian Council of Medical Research
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEEE	Institute of Electrical and Electronics Engineers
IEGMP	Independent Expert Group on Mobile Phones
IMC	Inter-Ministerial Committee
IOT	Internet of Things
ITU	International Telecommunications Union
LSA	Licensed Service Area
MHz	Mega Hertz
MPBS	Mobile Phone Base Station
MPE	Maximum Permissible Exposure
NIR	Non-Ionizing Radiations
NOC	No Objection Certificate
NRPB	National Radiological Protection Board
QOS	Quality of Service

RF	Radio Frequency
RFR	Radio Frequency Radiation
ROW	Right of Way
RTP	Roof Top Pole
RTT	Roof Top Tower
SACFA	Standing Committee on Radio Frequency Allocation
SAR	Specific Absorption Rate
SERB	Science and Engineering Research Board
SMS	Short Messaging Service
STC	State Telecom Committee
TEC	Telecommunication Engineering Center
TEMA	Telecom Equipment Manufacturers Association
TERM	Telecom Enforcement Resource and Monitoring
TRAI	Telecom Regulatory Authority of India
TSP	Telecom Service Provider
UAS	Unified Access Services
UHF	Ultra High Frequency
UMTS	Universal Mobile Telecommunications System
VHF	Very High Frequency
WHO	World Health Organization
WLAN	Wireless Local Area Network
WPC	Wireless Planning and Coordination

CHAPTER 1

INTRODUCTION

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INTRODUCTION

1.1 Background:

Telecommunications and particularly, Mobile Communication has become an integral part of our lives. Mobile phones have radically altered the way that people work, socialize, organize, and entertain themselves. Personal productivity, Knowledge Enhancement, Public services, Health care services, Entertainment, Lifestyle and Social Connectivity are the major fields which are largely benefitted by the mobile communications worldwide. There are about 9.42 Billion mobile subscribers worldwide[1], which is more than the population and is continuously growing at a faster pace. Out of these subscribers, 5.21 Billion are the unique mobile users as some people have more than one mobile connections.

India has been the front runner in this growth of mobile communication and its telecommunication network is the second largest in the world by number of telephone connections (both fixed and mobile phone) with 1.172 billion subscribers as on 31st December 2019[2]. Tele-density in India has grown from 3.58% in March 2001[3] to 88.56 % in December 2019. The main contributor to this exponential growth has been the rise in number of wireless subscribers, which have grown from 3.58 Million in March 2001 to 1151.44 Million in December 2019. As per the Telecom Regulatory Authority of India

1 https://gsmaintelligence.com/data accessed 15 March 2020

2 Telecom Regulatory Authority of India. (2020). *Press Release No. 17/2020 Dated 25 Feb. 2020*

3 Department of Telecommunications. (27 December 2019). *Telecom Statistics India-2019.* https://dot.gov.in/sites/default/files/Telecom%20Statistics%20India-2019.pdf?download=1 accessed 15 January 2020

(TRAI), out of the tele-density of 88.56 % in December 2019, wireless contributes for 86.98 % and wire line contributes for 1.59 %.

Mobile communications also contribute for the increase in GDP and employment. In 2018, mobile technologies and services generated 4.6%[4] of GDP globally, a contribution that amounted to $3.9 trillion of economic value added. It is considered that 10% increase in Mobile broadband leads to more than 1 % increase in GDP. The mobile ecosystem also supported almost 32 million jobs (14 million directly and 18 million indirectly) and made a substantial contribution to the funding of the public sector, with more than $500 billion raised through general taxation. By 2023, mobile's contribution will reach $4.8 trillion (4.8% of GDP) as countries around the globe increasingly benefit from the improvements in productivity and efficiency brought about by increased take-up of mobile services. Further ahead, 5G technologies are expected to contribute $2.2 trillion to the global economy over the next 15 years, with key sectors such as manufacturing, utilities and professional/financial services benefiting the most from the new technology. There have been continuous innovations in the field of mobile communications at technological level and provisioning of new services as well. There are more than 60 % smartphones out of total mobile phones in the world. 4 G Technology has already overtaken other technologies viz. 2G and 3G in 2019 and introduction of 5G Technology is about to revolutionize the overall impact of mobile communication on its users very soon particularly in the field of Internet of Things(IOT), Content Provision, Artificial Intelligence(AI), Devices, Bigdata, Cloud Computing, Blockchain etc.

[4] https://gsmaintelligence.com/research/ accessed 29 February 2020

A Mobile Tower is a structure, which houses the electronic communications equipment along with an antenna to support mobile communication in a network. In other words, mobile phones work by communicating through the mobile towers, using Radio Frequency Electromagnetic Field (RF EMF) Waves and so these Mobile Towers serve as the essential backbone for Mobile Communication. These are essential for realizing the vision of inclusive growth. The success of initiatives like Digital India, Smart Cities and right to Broadband, which the Government intends to implement in mission mode, depends on this critical and essential infrastructure.

1.2 Statement of the Problem:

Mobile communications play an important role in social and economic growth and disaster management for which mobile towers are a pre-requisite. A robust and scalable mobile infrastructure including towers is must for universal access to communication, effective delivery of services to citizens and financial inclusion. As the mobile connections are increasing in the country at a rapid pace, the mobile towers should also increase proportionately, in order to avoid Network Congestion, Call Drops, Slow Internet Speed and other similar issues. This has led to installation of large number of mobile towers, especially in the dense urban areas. To provide seamless Mobile services in the country, there is a vast base of mobile networks encompassing all available set of technologies which includes 2G, 3G & 4G. There are 21,87,504 Base Transceiver Stations (BTS)[5] and 5,92,870 mobile towers installed in the country catering to a vast base of 1.151 Billion mobile connections. There is a public concern about the possible effects on human health

[5] https://tarangsanchar.gov.in/emfportal accessed 02 March 2020

due to this vast base of mobile connections and the network of mobile towers. The present dissertation attempts to study and analyze these concerns in the context of guidelines issued and standards set by the Government for limiting the exposure of Radio Frequency Electromagnetic Field Waves, being used for Mobile Communication Technology, validity of the same in today's scenario and further impact of the efforts made by the Government for changing the perception of General Public towards issue of EMF Exposure from Mobile Communication Technology.

1.3 Research Objectives:

Research Objectives include:

1. To study the guidelines and standards set by the Government related to Radio Frequency Electromagnetic Field (RF EMF) Waves exposure by Mobile Communication Technology for Public Safety and their validity in today's scenario.
2. To understand the possible effects of RF EMF Waves from Mobile Communication Technology.
3. To analyze the measures being taken by the Government of India to deal with inconvenience and possible adverse effect from the exposure of RF EMF Waves by Mobile Communication Technology and their impact.
4. To suggest Policy Interventions through which the possible adverse effects from the exposure of RF EMF Waves by Mobile Communication Technology can be minimized.

1.4 Rationale:

Radio signals are part of everyday life, being emitted both by natural sources like the sun, the Earth and the ionosphere, and by artificial sources such as: 4G LTE cell tower base stations, broadcast towers, radar facilities, remote controls, medical, electrical and electronic equipment. The radio frequency sources including transmitting towers such as AM, FM radio towers, TV towers, Cell phone towers, etc. emit radio frequency/ microwave radiation continuously. The level of EMF from sources has risen exponentially, by soaring popularity of wireless technology such as smartphones, cordless phones, Wireless Internet (Wi-Fi) Wi-max and other wireless devices. The Smartphone and its base station communicate using a two-way radio communication. This radio communication produces Electro-magnetic fields. The increased use of smartphones has raised public interest in possible health issues associated with exposure to electromagnetic energy. People are concerned about exposure from Smartphone handsets & cell tower base stations.

As per the Department of Telecommunications, Government of India[6] "There is a public concern over possible health effects from Electromagnetic Field Radiation (EMR) exposure from diverse EMR sources especially Mobile Base Transmitter Station (BTS) antennae and mobile. In this regard, several studies have been conducted in different countries, under the aegis of World Health Organization (WHO). WHO has referred to approximately 25,000 articles published around the world over past 30 years and based on an in-depth review of scientific literature, has concluded: 'current evidence does not conform the existence of any health consequences from exposure to EMF radiation' Since

[6]Department of Telecommunications, Government of India. *A journey for EMF*. https://dot.gov.in/journey-emf accessed 29 February 2020

the effects on human beings are to be studied over a long period of time, further studies are going on around the world. Additionally, WHO has recommended that the National authorities should adopt international standards, namely International Commission for Non-Ionizing Radiation Protection (ICNIRP)/ Institute of Electrical and Electronics Engineers (IEEE). Department of Telecommunications (DoT), Government of India has taken necessary steps and adopted stricter norms for safety from EMF radiations from mobile towers and mobile handsets".

There are instances where the general public has expressed its concern for exposure from Radio Frequency Electromagnetic Waves of Mobile Communication Towers and sometimes become reluctant and express reservations when a new Mobile Communication Tower is being installed in the near vicinity. Even in few cases, the working mobile towers had to be shifted due to the public arrogance. The concern of Public may sometimes be right, but it has also to be understood that this concern in the society has also created a non-enabling environment for continuing with the high pace mobile growth as witnessed till now. Operational issues like Network Congestion, Call Drops, Slow Internet Speed and other similar issues have been observed in those areas where there are inadequate Mobile Towers. It may further hamper growth which may in turn have its effect on the economic progress of the country.

There is, therefore, a need to study the possible effects of Radio Frequency Electromagnetic Field (RF EMF) Waves emitted by Mobile Communication Towers and Mobile Phones as well. It becomes more important in Today's scenario when New Technologies like 5G are emerging day by day and are about to impact, in a big way, the fields of Internet of Things (IOT), Content Provision, Artificial Intelligence (AI), Devices,

Bigdata, Cloud Computing, Blockchain etc. There is a further need to study the guidelines issued and standards set by the Government for limiting the exposure of RF EMF Waves, being used for Mobile Communication Technology including the study of validity of these guidelines and standards in today's scenario and furthermore, the study of the efforts made by the Government for changing the perception of General Public towards issue of EMF Emission from Mobile Communication Technology including their impact.

1.5 Research Questions:

Research Questions clearly define a significant area of interest which requires investigation or study. It is always kept in mind by the researcher while collecting the data so as to meet the defined objective(s) of the investigation or study.

The following are the Research Questions for the study:

1. What are the guidelines and standards set by the Government related to RF EMF Waves exposure by Mobile Communication Technology for Public Safety and their validity in today's scenario?
2. What are the possible effects of RF EMF Waves from Mobile Communication Technology?
3. What measures are being taken by the Government of India to deal with inconvenience and possible adverse effect from the exposure of RF EMF Waves by Mobile Communication Technology and their impact?
4. What Policy Interventions can be suggested to the Government through which the adverse effects from the exposure of RF EMF Waves by Mobile Communication Technology can be minimized?

1.6 Research Design:

Research design facilitates the smooth sailing of the various research operations, making research as efficient as possible, yielding maximal information with minimal expenditure of effort, time and money. Basically, it is the strategy to gather the Data. The prime purpose of the Research Design is to answer Research Questions. Research design has a significant impact on the reliability of the results obtained.

The Research Design used in the present study is the mix of Descriptive, Exploratory and Analytical in nature. Descriptive research has been used to obtain information concerning the Concept, Source and possible effects of Electromagnetic Field (EMF) Waves. Information regarding actions taken by International agencies like WHO, ICNIRP, International Telecommunications Union- Telecommunication Standardization (ITU-T), International Agency for Research on Cancer (IARC), IEEE and other international agencies to address the issue of RF EMF Wave Exposure from Mobile Communication Technology and Public Safety in terms of guidelines and recommendations published for International Safety standards have also been obtained by Descriptive Research. Further, guidelines and standards set by the Government of India on this issue have been gathered by Descriptive Research. Validity of these Guidelines, standards set and recommendations in today's scenario has been explored using exploratory research. Further the measures being taken by the Government of India to deal with inconvenience and possible adverse effect from the exposure of RF EMF Waves by Mobile Communication Technology have been explored using exploratory research. Analysis of the data gathered from Primary and Secondary Sources related to the study has been done using Analytical Research.

1.7 Limitations:

Due to the peculiar nature of the research topic, studies for a sufficiently long period of time are warranted to observe the health effects of RF EMF Waves emitting from Mobile Communication Technology which is not possible presently due to the constraints of limited time frame, logistics and resources.

Practically, it is not possible to monitor the prolonged effects of RF EMF Waves from a single source on one particular living being hence primary research in this particular manner has not been carried out.

As the issue is not very old, hence some of the researches may still be ongoing and may not be concluded as yet, so getting their final results may not be possible.

1.8 Scope of Further Study:

The present study has been carried out in a limited time frame and constrained logistics and resources. A research can be carried out on a long term basis to study the prolonged effects of RF EMF Waves exposure from Mobile Communication Technology on public health and on environment & ecosystem also. Further, the present study is focused only on exposure from RF EMF Waves of Mobile Communication Technology and Public Safety. Studies to know the impact of ultraviolet and higher frequencies (i.e. X-rays and gamma rays) on human health can also be carried out.

The present study has been carried out based on the present recommendations, guidelines and standards set on the matter. There may be the requirement of further studies, once these recommendations, guidelines and standards are changed, when results of ongoing researches necessitate so.

There may be requirement of studies if technological advancement takes place in such a manner that the recommendations, guidelines and standards have to be changed.

1.9 Methods to Be Applied and Data Sources:

Both primary and secondary data sources are used for this study, which include, primarily-

i. Books, articles and journals available on the subject.

ii. Reports published by eminent International agencies like WHO, ICNIRP, ITU-T, IARC, IEEE and other international and national agencies on the subject including guidelines and regulations on the issue.

iii. Data available with concerned Government departments including Department of Telecom and its Field Units, Telecom Regulatory Authority of India, Telecom Engineering Center related to policies, schemes and evaluation reports on the subject.

iv. Primary data obtained through field survey (using structured questionnaire).

v. Primary data obtained through holding interview/discussions with senior officers of DOT and other experts to have their opinion on the subject.

vi. Collection of Emission level of RF EMF waves of some Mobile Towers for checking whether the emission level is within the limits as prescribed by Government of India or not.

vii. Data available about some prominent court judgments in respect of EMF Exposure.

viii. Data available on Government website tarangsanchar.gov.in.

1.10 Chapterisation Scheme:

The research study has been discussed according to the following chapterisation scheme:

Chapter 1: Introduction (Including Background, Statement of the Problem, Research Objectives, Rationale of the study, Research Questions, Research Design, Limitations, Scope of Further Study, Research Methodology and Data Sources etc.).

Chapter 2: Electromagnetic Field Waves: Concept, Source and Effects.

Chapter 3: Literature Review.

Chapter 4: Radio Frequency Electromagnetic Field Waves & Public Safety: Government Initiatives and Policy Measures in Mobile Communications to address the issue **(**including actions taken by various agencies).

Chapter 5: Review of Government Initiatives and Policy Measures: **Data Analysis and Interpretation:**

(a) Analysis of Primary Data Collected.

(b)Analysis of Secondary Data available in the form of some Reports/Recommendations/Articles/ Papers etc.

Chapter 6: Conclusion and Recommendations.

CHAPTER 2

ELECTROMAGNETIC FIELD WAVES: CONCEPT, SOURCE AND EFFECTS

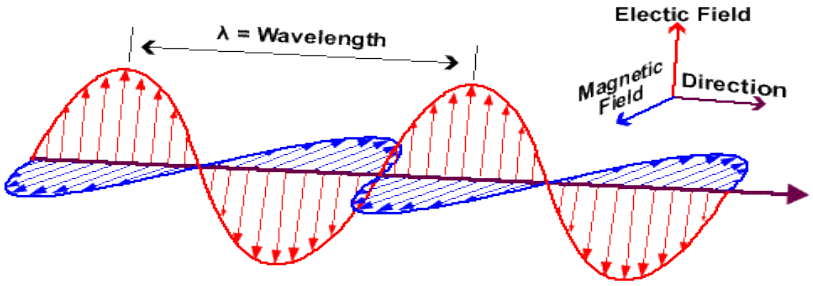
CHAPTER 2
ELECTROMAGNETIC FIELD WAVES: CONCEPT, SOURCE AND EFFECTS

2.1 Introduction:

Electromagnetic Field (EMF) Waves have been around in different forms since the birth of the universe. They differ from each other by frequency and visible light is its most familiar form. There are electro-magnetic fields of various other frequencies from outer space reaching earth in addition to ultraviolet rays or visible light.

Electromagnetic waves or EM waves are waves that are created as a result of vibrations between an electric field and a magnetic field. Electromagnetic waves are formed when an electric field comes in contact with a magnetic field. They are hence known as ‘electromagnetic’ waves. They are deflected neither by the electric field, nor by the magnetic field. However, they are capable of showing interference or diffraction. An electromagnetic wave can travel through anything - be it air, a solid material or vacuum. It does not need a medium to propagate or travel from one place to another. Mechanical waves (like sound waves or water waves), on the other hand, need a medium to travel. EM waves are 'transverse' waves. This means that they are measured by their amplitude (height) and wavelength (distance between the highest/lowest points of two consecutive waves). In other words, Electromagnetic waves are synchronized self-propagating oscillations of electric and magnetic fields, which propagate at the speed of light. The oscillations of the two fields are perpendicular to each other and perpendicular to the direction of wave propagation and energy, forming a transverse wave as shown in Figure 2.1.

Figure 2.1: Electromagnetic Waves



(Source : https://socratic.org/questions/what-is-the-source-of-electromagnetic-waves)

Electric fields are created by differences in voltage: the higher the voltage, the stronger will be the resultant field. Magnetic fields are created when electric current flows: the greater the current, the stronger the magnetic field. An electric field will exist even when there is no current flowing. If current does flow, the strength of the magnetic field will vary with power consumption, but the electric field strength will be constant.

Electric and magnetic fields are fundamental forces in nature. Together they create invisible electromagnetic waves which pass through the environment - like waves or ripples on the surface of water. Electromagnetic waves have different properties and uses, depending on their wavelength. Radio waves occur within a specific range of wavelengths and are useful for transmitting sound and digital signals.

Electromagnetic radiation is a form of energy emitted by all matters/objects, natural (including sun, earth, human beings etc.) as well as manmade above absolute zero temperature (0 °K or -273.15 °C).[7] X-rays, ultraviolet rays, visible light, infrared light, heat, microwaves, and radio and television waves are all examples of electromagnetic

[7] https://www.e-education.psu.edu/natureofgeoinfo/node/1883 accessed 01 February 2020

energy. Hotter objects radiate more electromagnetic energy than cooler objects. Hotter objects also radiate energy at shorter wavelengths than cooler objects. The Sun emits (average temperature ≈ 5800 °K) more energy than the Earth (average temperature ≈ 288 °K), and the Sun's radiation peaks at shorter wavelengths (in the visible portion of the Electromagnetic spectrum at 0.5 micrometers, wavelength of green light). Manmade objects emitting Electromagnetic Radiation include electrical as well as electronic devices. An electric wire carrying current through it also emits Electromagnetic Radiation. Most of the Electrical and Electronic home appliances emit Electromagnetic Radiations in the range of Low Frequencies (LF) to Extremely Low Frequencies (ELF) including electric heaters, voltage transformers, TVs, laptops, tablets, electric motors in various appliances viz. washing machines, fridge, air-conditioning systems, fans, sewing machines, analog clocks, electric shavers, showpieces using electric motors, hair dryers etc. Devices including Electronic Products, like medical and non-medical equipments, X-ray systems, ultrasound equipments, lasers, microwave ovens, mobiles, IOT enabled devices, cordless phones, remotes of TV, AC and other devices, wireless door bells, wireless routers/ modems, wireless gaming equipments, Wi-Fi enabled equipments, blue tooth enabled equipments, etc all emit Electromagnetic Radiation. However, the wavelengths at which all these devices radiate Electromagnetic Waves are different, depending upon their operating frequencies.

2.2 Natural sources of electromagnetic fields

Electromagnetic fields are present everywhere in our environment but are invisible to the human eye. Electric fields are produced by the local build-up of electric charges in the

atmosphere associated with thunderstorms. The earth's magnetic field causes a compass needle to orient in a North-South direction and is used by birds and fish for navigation.

2.3 Human-made sources of electromagnetic fields

Besides natural sources the electromagnetic spectrum also includes fields generated by human-made sources: X-rays are employed to diagnose a broken limb after a sport accident. The electricity that comes out of every power socket has associated low frequency electromagnetic fields. And various kinds of higher frequency radio waves are used to transmit information – whether via TV antennas, radio stations or mobile phone base stations.

2.4 Radio Frequency (RF) Electromagnetic Field Waves

Part of the electromagnetic spectrum extending from 3 kHz frequency to 300 GHz is referred as radio frequency (RF). Television and radio transmitters (including base stations) and microwaves, mobile telephones, and radars produce radio frequency fields. These fields are used to transmit information and form the basis of telecommunications as well as radio and television broadcasting all over the world. Many home devices also transmit EMF at radio frequencies such as cordless phones, baby monitors and radio-controlled toys.

2.5 Electro Magnetic Field Radiation

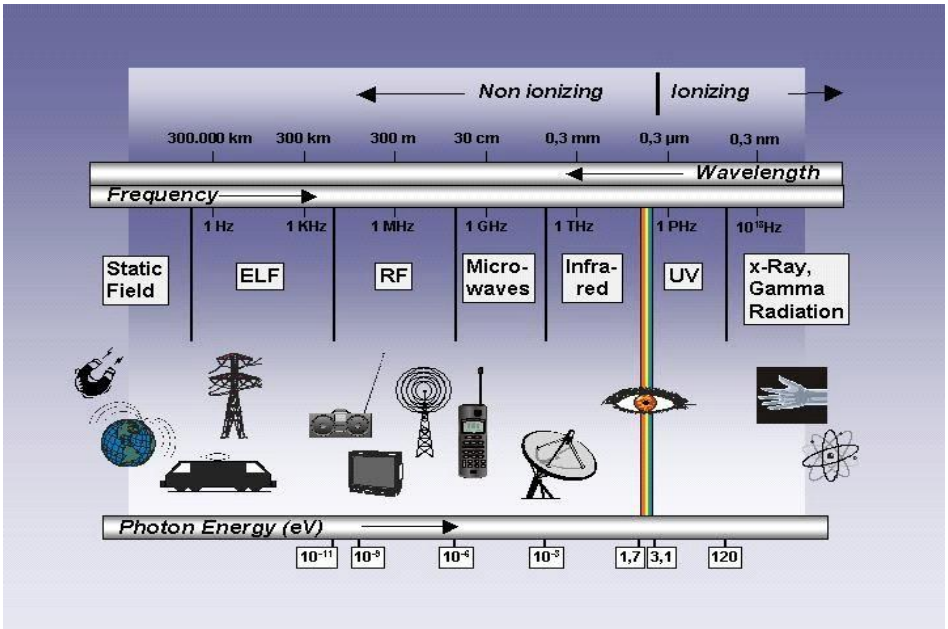
Electromagnetic field (EMF) radiation is the flow of photons through space. Each photon contains a certain amount of energy, and the different types of radiations are defined by the amount of energy found in the photons. The electromagnetic spectrum is the range of all types of EM radiation. X-rays used in hospitals or the radio waves from a radio station are all part of this spectrum.

2.6 Uses of Electromagnetic Radiation

Apart from the use in telephony, some other important uses of electromagnetic radiation[8] as shown in Figure 2.2 as below, in our day to day life are as follows:

- Conversion of electromagnetic radiation from Sun (solar energy) to chemical energy (food) by plants through the process of photosynthesis.
- X-ray used for bone structure imaging at hospitals.
- X-ray used in Security Scanner at Airports and shopping malls.
- Microwave used in microwave ovens and radars.
- Radio waves used in radio and television broadcasts.
- Visible light used for normal vision.
- Infra-red waves used in night vision goggles and in TV remote controls.

Figure 2.2: Uses of Electromagnetic Radiation



(Source: TRAI, Information paper No. 01/2014-QoS published 30th July, 2014)

[8] 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.*

2.7 Electromagnetic Spectrum

Electromagnetic waves travel with the speed of light. They can be characterized by either the frequency or wavelength of their oscillations. The range of all possible frequencies of Electromagnetic Radiations is called as the electromagnetic spectrum. The Electromagnetic spectrum includes: gamma rays, X-rays, ultraviolet radiation, visible light, infrared radiation, microwaves and radio waves, in order of decreasing frequency and increasing wavelength. Thus, the electromagnetic spectrum extends from below low frequencies used for communication to gamma radiations at the short wavelength (high frequency) end, thereby covering wavelengths from thousands of kilometers down to the size of an atom. Table 2.1 below, depicts the electromagnetic spectrum.

Table 2.1: Electromagnetic Spectrum

<table>
<tr><th colspan="3">Class</th><th>Frequency</th><th>Wavelength</th></tr>
<tr><td rowspan="6">Ionizing radiation</td><td rowspan="2">Γ</td><td rowspan="2">Gamma rays</td><td>300 EHz</td><td>1 pm</td></tr>
<tr><td rowspan="2">30 EHz</td><td rowspan="2">10 pm</td></tr>
<tr><td>HX</td><td>Hard X-rays</td></tr>
<tr><td rowspan="2">SX</td><td rowspan="2">Soft X-rays</td><td>3 EHz</td><td>100 pm</td></tr>
<tr><td>300 PHz</td><td>1 nm</td></tr>
<tr><td>EUV</td><td>Extreme ultraviolet</td><td>30 PHz</td><td>10 nm</td></tr>
</table>

			3 PHz	100 nm
	NUV	Near ultraviolet		
Visible			300 THz	1 μm
	NIR	Near infrared		
			30 THz	10 μm
	MIR	Mid infrared		
			3 THz	100 μm
	FIR	Far infrared		
			300 GHz	1 mm
Micro-waves and radio waves	EHF	Extremely high frequency		
			30 GHz	1 cm
	SHF	Super high frequency		
			3 GHz	1 dm
	UHF	Ultra high frequency		
			300 MHz	1 m
	VHF	Very high frequency		
			30 MHz	10 m
	HF	High frequency		
			3 MHz	100 m
	MF	Medium frequency		

			300 kHz	1 km
	LF	Low frequency		
			30 kHz	10 km
	VLF	Very low frequency		
			3 kHz	100 km
	ULF	Ultra low frequency		
			300 Hz	1 Mm
	SLF	Super low frequency		
			30 Hz	10 Mm
	ELF	Extremely low frequency		
			3 Hz	100 Mm

(Source : https://en.wikipedia.org/wiki/Electromagnetic_spectrum)

The most common sources of exposure as shown in table 2.2 below, include the FM/AM radio, TV transmission, Cellular networks using GSM, CDMA, WLAN, Bluetooth, Zigbee, Wi-Fi and Wi-Max technologies, which occupy the VHF, UHF, L, and S band of frequencies. The effects due to FM, AM and TV transmissions are localized to the areas around the location of towers and the Bluetooth, Zigbee applications operate at low power levels.

Table 2.2: EMF Sources

Sl. No.	EMF Source	Operating Frequency	Transmission Power	Number
1.	AM/FM Tower	540 KHz-108 MHz	1 KW – 30 KW	380
2.	TV Tower	48 MHz – 814 MHz	10 – 500 Watt	1201
3.	Wi-Fi	2.4 – 2.5 GHz	10 – 100 mW	
4.	Cell Towers	800, 900, 1800, 2100, 2300 MHz	20 W	~ 5 lakh
5.	Mobile Phones	GSM-1800/CDMA GSM-900	1 W 2 W	900+ Million

(Source: TRAI, Information paper No. 01/2014-QoS published 30th July, 2014)

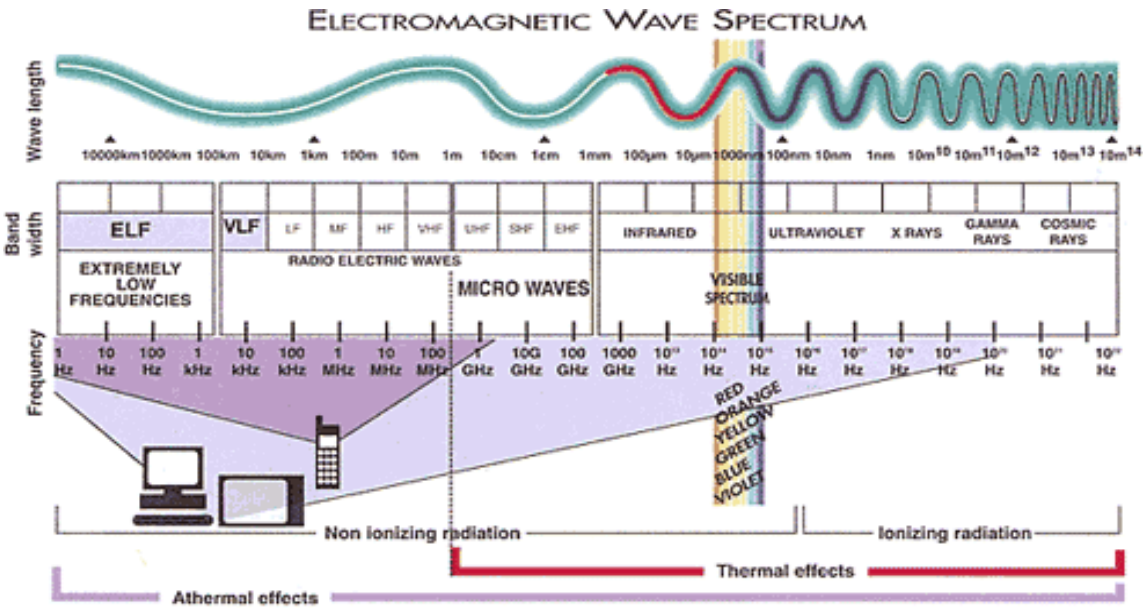
2.8 Types of EMF radiation

EMF radiations are divided into two categories, ionizing and non-ionizing, depending on frequency and the power level.

2.8.1 Ionizing radiation is electromagnetic radiation whose waves contain energy sufficient to overcome the binding energy of electrons in atoms or molecules, thus creating ions. e.g. Ultraviolet rays, X-rays, gamma rays and cosmic rays as shown in the figure 2.3 below.

2.8.2 Non-ionizing radiation refers to any type of electromagnetic radiation that does not carry enough energy per quantum to ionize atoms or molecules. e.g. low frequency radiations like radio waves, microwaves, and infrared radiations as shown in figure 2.3.

Figure 2.3: Types of EMF Radiations



(Source: TRAI, Information paper No. 01/2014-QoS published 30th July, 2014)

EM emissions in the frequency range of 1 Hz to 1THz (1000 GHz) are termed as non-ionizing and do not have enough energy to alter the chemical bonds of the human body. EMF health effects related to the non-ionizing radiation include tissue heating at levels above limits. EM emissions at frequencies above 1 THz are termed as ionizing and have enough potential to alter the chemical bonds of human tissue and resulting in serious genetic damage on prolonged exposure. Radio devices emit non-ionising radiation.

2.9 Effect of Ionization

As some of the radiations can ionize atoms/molecules, they do have an adverse effect on the living organisms. They can break chemical bonds and damage vital molecules. If such damage is minor, cells may be able to repair themselves, otherwise cell death may occur. If the damage is at a higher rate, dead cells cannot be replaced quickly enough.

2.10 Effects of EMF exposure on human health[9]

Effects of EMF radiation can be studied in two ways i.e. bio-effects and health effects: -

2.10.1 Bio-effects are measurable responses to a stimulus or to a change in the atmosphere and are not necessarily harmful to our health. Biological effects can be two types i.e. Thermal and Non-Thermal effects.

2.10.1.1 Thermal Effects: -

- Refers to the heat generated due to absorption of EMF radiation.
- While using a cell phone, most of the heating effect occurs at the surface of the head, causing its temperature to increase by a fraction of a degree.
- Prolonged thermal effect may lead to increase in body temperature.

2.10.1.2 Non-Thermal Effects: -

- Non-thermal effects are attributed to the induced electromagnetic effects inside the biological cells of the body which is possibly more harmful.

2.10.2 Health effects are the changes which may be short term or long term. These effects stress the system and may be harmful to human health.

2.11 Mobile Communications and EMF Radiation

Let us first understand, in simple terms, how mobiles and wireless devices work[10].

[9] 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*.Pg.9. https://main.trai.gov.in/sites/default/files/EMF_Information_Paper_30.07.2014.pdf accessed 01 February 2020

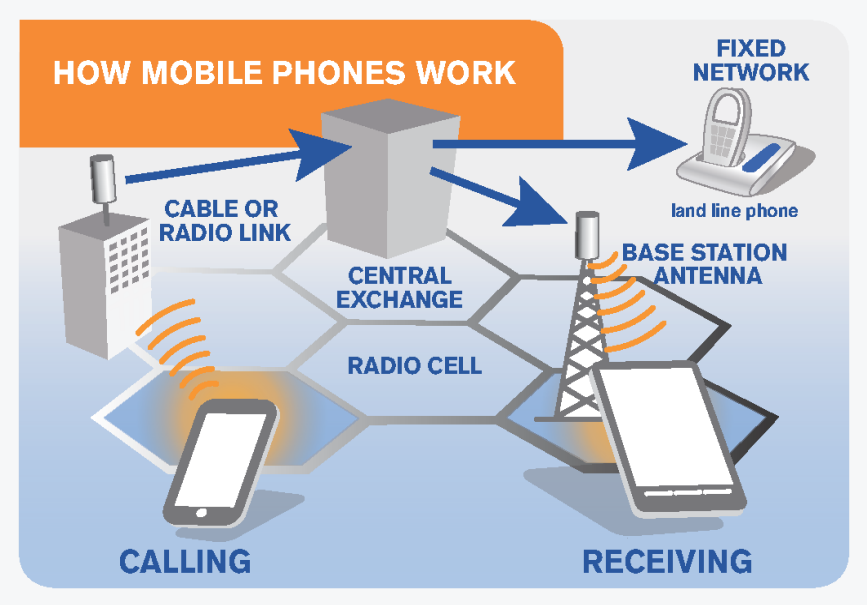
[10] http://emfguide.itu.int/en/emfguide_m.html#page3_1 accessed 31 December 2019

A mobile phone or wireless device is a low-power two-way radio operating at a maximum of 2 Watts (peak). It contains both a transmitter and a receiver and uses radio frequency fields to send and receive calls, text messages, emails, pictures and data.

When we make a call on a mobile phone, send or receive text messages or data, we are connected to a nearby base station through a radio frequency signal. The base station then communicates with the core of the network to a central exchange to determine where the call is to be forwarded to, then either our call is forwarded to the fixed line network and to an individual fixed land line phone, or if we are calling another mobile phone, our call will be forwarded to another base station and on to the mobile phone we are calling.

When we access data via our mobile device, the central exchange connects us to the internet.

Figure 2.4: How Mobile Phones Work



(Source: http://emfguide.itu.int/en/emfguide_m.html#page3_1)

The EMF radiation in mobile services is primarily from two sources: - **radiations from BTS and radiation from mobile handsets** – both of which are at the relatively low end of electromagnetic spectrum. The energy carried by them is unable to break chemical bonds in molecules. Thus, they fall under the non-ionizing radiation category.

2.11.1 Radiations from mobile phones

A mobile handset or a cellular phone is a low-power, two way radio. It contains a transmitter and a receiver. It emits EMR to transmit information to the base station and it also acts like a receiver of information. Radio signals in a mobile phone are generated in the transmitter and emitted through its antenna. Presently, Mobile phones operate at frequencies between 450 and 2700 MHz with peak powers in the range of 0.1 to 2 watts. Analog mobile phones which are being phased out, use up to 2 Watts, while a digital mobile phone has an average power level of 0.25 watt. Phones typically operate at much lower levels during normal use as the phone power is automatically adjusted to the minimum radio signal level needed for call quality. This extends battery life. The handset only transmits power when it is turned on.

Different mobile handsets create varying electromagnetic fields owing to differences in their design and construction, as well as their electronics and antenna. It is indicated by the SAR (Specific Absorption Rate) value or limit. SAR is the rate at which Radio Frequency (RF) energy is absorbed in the human body over a given time when exposed to EMF and expressed as the power absorbed per unit mass. SAR values are usually expressed in the units of Watts per kilo gram (W/kg) of tissue. This measurement is used to determine whether a mobile phone complies with safety norms/ guidelines. EMF radiation levels are

within limits because the power radiated from the headset is low around 1 W. Between 100 kHz and 10 GHz, these basic restrictions are provided on SAR to prevent whole body heat stress and excessive localized tissue heating. The limits for SAR, as determined by the strength of the electromagnetic field necessary to reach the body are accordingly set and they are an indicator for ensuring that equipment like mobile phones are operating within the prescribed parameters. SAR is usually averaged either over the whole body, or over a small sample volume (typically 1 g or 10 g of tissue). The value cited is then the maximum level measured in the body part studied over the stated volume or mass.

Every model of mobile handset has specific SAR value. The SAR rating of mobile handset is a specified value which indicates that the device will never exceed the maximum level of consumer RF exposure as indicated in the rating. It does not indicate the amount of RF exposure the consumers experiences during the normal use of the device. The actual SAR level of an operating device can be below the maximum value and variable, depending on a number of factors. A mobile phone which operates at lower power is considered more efficient. In India, the SAR limit for cell phones prescribed is 1.6 W/Kg averaged over one gram of human tissue.

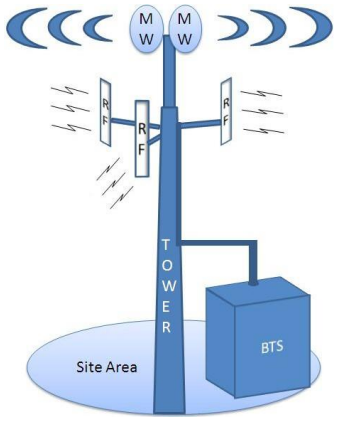
2.11.2 Electromagnetic Radiation from mobile towers

For providing mobile services, telecom service providers establish base transceiver stations (BTSs), at suitable locations, as per their Radio Frequency (RF) Network Planning for proper coverage of the area and for meeting capacity requirements. A typical BTS is an equipment that facilitates wireless communication between user equipment e.g. a mobile phone and a network of the telecom service provider. Every antenna on a cell phone tower radiates electro-magnetic power. Mobile phone base stations are radio transmitter with

antennas mounted on either free standing masts or on the buildings. Radio signals are fed through cables to the antennas and then launched as radio waves into the area or cell around the base station. Several types of antennas are used for the transmission; panel-shaped sector antennas or pole shaped Omni- antennas are used to communicate with mobile phones. Disk antennas form terminals for point to point microwave links that communicate with other base stations and link the network together. Sometimes the base stations are connected together with Optical Fiber cables (OFC) instead of microwave links. Depending on the location of the base station and the level of mobile phone uses to be handled, base station may be anything from only a few hundred meters apart in major cities to several kms apart in the rural areas.

A typical BTS site diagram is shown below in figure 2.5.

Figure 2.5: A Typical BTS site



(Source: TRAI, Information paper No. 01/2014-QoS published 30th July, 2014)

An actual BTS Site (Roof Top Pole) diagram is shown in **Figure 2.6**.

Figure 2.6: An Actual Roof Top Pole Site

(Source: Field Survey)

2.11.2.1 BTS contains a number of radio transmitters and each of these has the same maximum output power. The outputs from the individual transmitters are then combined and fed via cables to the base station antenna, which is mounted at the top of a tower/ mast (or other suitable structure). Thus, the radiated power would ideally be equal to the sum of the output power from the transmitters except for a small loss that occurs in the combiner and connecting cables. It should be noted that all the transmitters are not operational continuously; this depends on the call traffic in each of the sectors. However, the level of exposure is maximum at the time of peak traffic when all the channels are utilized and hence sectors with higher call traffic carry the risk of having maximum EM exposure.

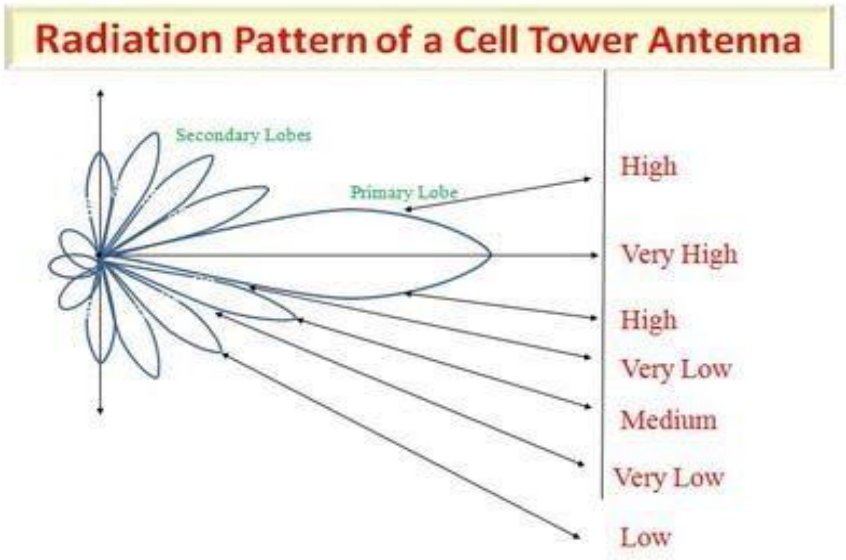
2.11.2.2 Types of Base Stations[11]:-

There are many different types of base stations used by operators i.e Macro cell, Micro cell or Pico cell. Categorization is based on the purpose of the site rather than in terms of technical constraints such as radiated power or antenna height. In India macro cellular base station provide the main infrastructure for a mobile phone network and their antennas are mounted at sufficient height to give them a clear view over the surrounding geographical area.

Micro cell base stations provide additional radio capacity where there are a high number of users such as in cities and towns. Micro antennas tend to be mounted on street level poles or external walls of existing buildings. Micro antennas are similar to macro cell antennas technically of smaller capacities. The power of each base station transmitter is set to a level that allows a mobile phone to be used within an area for which the base station is designed to provide coverage. Higher powers are needed to cover larger cells. The maximum power for individual macro cellular base station transmitter is 20 Watts. For a low capacity base station with only one transmitter, the radiated power does not vary over time. With larger capacity base stations having multiple transmitters the output power can vary over time and with the numbers of calls being handled. One of the transmitters will transmit continuously at full power, whereas other transmitter will operate intermittently and with varying power levels up to the maximum. Micro cellular base stations tend to operate at lower power level around 2-3 Watts and have fewer transmitters because of their smaller coverage area.

[11] Department of Telecommunications Inter-Ministerial Committee. (2010). *Report of Inter-Ministerial Committee on Electromagnetic Fields Radiation.* Pg.8-9

Figure 2.7: Radiation from mobile BTS



(Source: TRAI, Information paper No. 01/2014-QoS published 30th July 2014)

2.11.3 The real source of EM radiation is the transmitting antenna – not the transmitter itself, because the transmitting antenna is the main source that determines electromagnetic field distribution in the vicinity of a transmitting station. Rectangular shaped "Panel" antennas are the most commonly used, which direct the radio signal power outward, in a beam that is typically very narrow in the vertical direction but quite broad in the horizontal direction. Radiation will be highest from the primary lobe in the horizontal direction. There is also radiation from secondary lobes which ranges from medium to very low when transmitting horizontally as seen in the figure 2.7 above. Hence, the direct exposure to the primary lobes along the line of antenna is the most severe of the exposed radiation. The radiation levels relatively taper as one moves away from the line of the antenna to its side lobes. The transmission power levels, and the gain of the antennas used for transmission are the major factors to be considered when dealing with exposure levels.

The distance from the source of radiation is another critical factor. The radiation level received from an antenna, usually measured as power density is the power passing through 1 m^2. The power is usually measured in watts (W), mill watts (mW) or microwatts (μW), where 1W = 1,000mW = 1,000,000μW, and the intensity is measured in watts per square meter or W/m^2 (or in mW/m^2 or $\mu W/ m^2$). Since the area of a sphere surrounding a source increases as the square of its radius, then in an ideal case (in the absence of any nearby objects including the ground) the power falls off by $1/R^2$, where R is the distance.

The Power Density (P_d) of radiated EMF power at a distance R is given by,

$$P_d = \left(\frac{P_t \times G_t}{4\pi R^2}\right)$$

Where, P_t = power transmitted, W.

G_t = gain of the transmitting antenna, V/V.

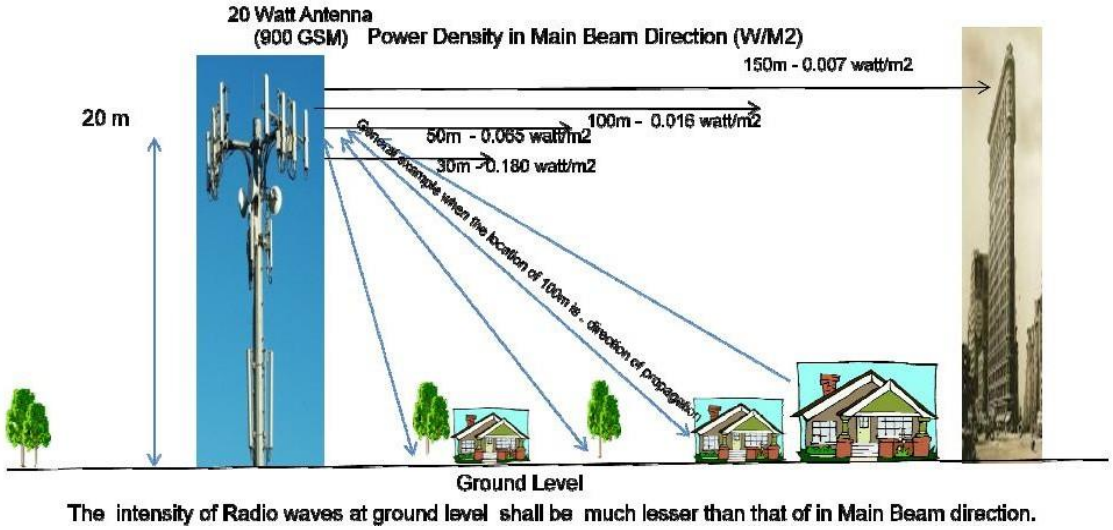
R= distance from antenna, m.

Hence, $P_d \propto \left(\frac{1}{R^2}\right)$

As one moves away from antenna, the power received weakens very quickly and is reduced to $1/4^{th}$ when distance from source doubles and $1/9^{th}$ when distance is tripled and so on.

The EMF power density varies with distance as shown in **Figure 2.8**.

Figure 2.8: Power levels from the antenna



(Source: Government of India, Ministry of Communications & IT, Department of Telecommunications Handbook on *Mobile Communication – Radio Waves & Safety*)

EMF radiation from Mobile Towers, further, depends on the following[12]: -

- 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.

The power of a base station varies depending on the area that needs to be covered and the number of calls processed. This is low compared to other transmitters such as radio and television, which usually work at power levels ranging from several kilowatts to several

[12] 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*. https://main.trai.gov.in/sites/default/files/EMF_Information_Paper_30.07.2014.pdf. Pg. 16

megawatts. Assessments of personal exposure levels are most accurately achieved through onsite field measurements. Theoretical calculations are also common but are complicated by the many factors that influence the actual exposure such as the height, tilt and direction of antenna, absorption from trees and plants or reflections from buildings, as well as distance.

CHAPTER 3

LITERATURE REVIEW

CHAPTER 3

LITERATURE REVIEW

Review of literature is a vital part of any study or research. It helps to know the research areas covered by earlier studies and aspects untouched by researchers. Since the issue of exposure by Radio Frequency Electromagnetic Fields pertains to public largely, a lot of literature has been published in the form of research papers, information papers, reports, guidelines, recommendations including by international agencies like WHO, ICNIRP, IEEE, ITU-T etc. Some of research papers including international as well as Indian, oldest as well as latest were studied in the available limited time frame and review of some of relevant literature is given as below: (Reports,, recommendations and guidelines of some international agencies like WHO, ICNIRP,IEEE,ITU-T,IARC etc. and of Government of India on the subject will be discussed in next chapter)

- In the paper by Bortkiewicz. A.[13]**(**2019)**,** it was found that Evaluation of the long-term relationship of exposure to EMF emitted by base stations with subjective symptoms require better methodological observational studies than the majority of publications published so far. It was concluded that the problem of health effects of RF EMF has not been definitively resolved, but due to the results of previous research on possible health effect of RF EMF, it seems necessary to use precautionary principles and As Low as Reasonably Achievable(ALARA) principles, when the new sources of electromagnetic emissions will be planned and installed.

[13] Bortkiewicz A. (2019). Health effects of Radiofrequency Electromagnetic Fields (RF EMF). *Industrial health, 57*(4), 403–405. https://doi.org/10.2486/indhealth.57_400

- In the Research Paper by Timo Kumlin et al[14](2007), the increasing use of mobile phones by children and teen- agers was addressed by conducting the research on juvenile rats. Possible morphological and functional changes were evaluated in the central nervous system of young male Wistar rats exposed to 900 MHz mobile phone signal for 2 h/day on 5 days/week. After 5 weeks of exposure at whole-body average specific energy absorption rates of 0.3 or 3.0 W/kg or sham exposure, six rats per group were examined histologically, and the remaining 18 rats per group were subjected to behavioral tests. No degenerative changes, dying neurons, or effects on the leakage of the blood-brain barrier were detected. No group differences were observed in the open-field test, plus maze test or acoustic startle response tests. In the water maze test, however, significantly improved learning and memory were detected in rats exposed to RF fields It was concluded that the results do not indicate a serious threat to the developing brain from mobile phone radiation at intensities relevant to human exposure. However, the interesting finding of improved learning and memory warrants further studies.

- In the paper by Singh et al[15] (2016), a pilot study was done on the General health and salivary function due the effect of Electromagnetic radiations from mobile phone base stations and it was unveiled that people living in the vicinity of mobile phone base

[14] Kumlin, T., livonen, H., Miettinen, P., Juvonen, A., van Groen, T., Puranen, L., Pitkaiaho, R., Juutilainen, J. and Tanila, H. (2007) Mobile Phone Radiation and the Developing Brain: Behavioral and Morphological Effects in Juvenile Rats. *Radiation Research, 168,* 471-479. https://doi.org/10.1667/RR1002.1

[15] Singh, K., Nagaraj, A., Yousuf, A., Ganta, S., Pareek, S., & Vishnani, P. (2016). Effect of electromagnetic radiations from mobile phone base stations on general health and salivary function. *Journal of International Society of Preventive & Community Dentistry*, *6*(1), 54–59. https://doi.org/ 10.4103/2231-0762.175413.

stations had various health complaints but the association with base transmitter stations (BTS) could not be established. The potential health effects cannot be restricted to mobile phone base station frequency bands alone. It can also be attributed to exposure due to other sources of radiofrequency Electromagnetic radiations in daily life such as mobile phones, cordless phones, and wireless local area networks. Additional studies applying a longitudinal design and involving more subjects were warranted to evaluate the effect of EMRs on general health and more specifically to oral health.

- In the report by an independent expert group on mobile phones (IEGMP) UK[16], chaired by Professor William Stewart of Tayside University Hospitals NHS Trust, Dundee(2000), possible effects from the use of mobile phones, base stations and transmitters on health were studied and it was concluded that there was no conclusive evidence to establish the adverse effect of Mobile Technologies on human health. The report further suggests 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 (National Radiological Protection Board) UK.

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

- In the paper by Kaur et al [17](2016), a study of different research papers on effects of Electromagnetic Radiation on health has been done and it has been opined that those research papers suggest the increased risk of many diseases like Alzheimer, heart diseases, miscarriage, brain tumors, leukemia, stress, fatigue, depression, memory loss, sleep disorders, DNA damage, hormonal imbalance, etc. due to the RF EMF Exposure. The paper, however, does not produce any scientific evidence in support of the opinion expressed. The paper recommended that the safety guidelines provided by various organizations such as ICNIRP should be followed to minimize the health issues related to the exposure of radiations. It further recommended that following some simple mobile phone usage habits such as the time, distance between the mobile and body, etc. can prevent the various health hazards from the radiations of the mobile phones

- In the Bulletin of the World Health Organization (December 2010), a paper was published by Röösli et al[18]. The researchers aimed 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. It was concluded that review does not indicate an association between any health outcome and radiofrequency electromagnetic field exposure from MPBSs at levels typically

[17] Kaur, S., Kaur, J., & Sandhu, S. (2016). Effects of Mobile Radiations and its Prevention. *International Journal of Computer Science and Mobile Computing*, *5*(2), 298-304

[18] Röösli,M., Frei,P., Mohler, E.,& Hug, K. (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. https://doi.org/10.2471/BLT.09.071852. (Online) http://www.who.int/bulletin/volumes/88/12/en/ accessed 21 January 2020

encountered in people's everyday environment. The paper concluded that 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. The paper recommended that 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.

- Prof. Girish Kumar of Electrical Engineering Department at IIT Bombay, in December 2010, submitted one Report on Cell Tower Radiation to Secretary, DoT, Delhi[19]. 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 the report, elaborate theoretical and technical details related to radiation patterns of

[19] Kumar, Prof. Girish. (December 2010). *Report on Cell Tower Radiation submitted to Secretary, DOT, Delhi.* https://www.ee.iitb.ac.in/~mwave/GK-cell-tower-rad-report-DOT-Dec2010.pdf accessed 22 January 2020

antennas & calculations related to power from them have been given along with sample measurements at some places to check status. It was concluded that to safeguard the humans from continuous radiation by various sources including cell towers, cell phones, wireless phones, computers, laptops, TV towers, FM towers, AM towers, microwave oven etc. stricter radiation norms must be enforced by the policy makers.

- 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[20]. 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*". Paper states that the guidelines for EMF radiations from BTS and mobile handsets in India are very stringent when compared to developed countries. In case of EMF radiation from BTSs, the prescribed values are 1/10th the ICNIRP guidelines and they are better than the standards adopted by some developed countries like USA, Canada, Japan and Australia. Also, for EMF radiation from handsets, the SAR values prescribed

[20] 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*. https://main.trai.gov.in/sites/default/files/EMF_Information_Paper_30.07.2014.pdf accessed 31 December 2019

are no more or the same as that in developed countries like USA, Canada, Japan and Australia.

Paper concludes that "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.

- In the Dissertation submitted, by Agrawal S.[21] (2016) the effects of Electromagnetic Radiations from various sources have been studied and the existing research-based evidences related to mobile towers and their impact on society was analyzed, purely with the aid of the selected secondary sources. Also, there have been significant technological changes since 2016.
- American Cancer Society has opined on the issue[22] that "The amount of exposure from living near a cell phone tower is typically many times lower than the exposure from using a cell phone. About 30 studies have looked at possible links between cell phone use and tumors in people. Most studies to date have not found a link between cell phone use and the development of tumors, although these studies have had some important limitations. This is an area of active research." It further states that "Laboratory studies have looked at whether the types of RF waves used in cell phone communication can

[21] Agrawal S. (2016). *Electromagnetic Radiations through Mobile Towers- Understanding The Debate And Policy*. [Master's Dissertation, Indian Institute of Public Administration]. Indian Institute of Public Administration Repository.

[22] American Cancer Society. *Do cellular phone towers cause cancer?* https://www.cancer.org/cancer/cancer-causes/radiation-exposure/cellular-phones.html accessed 31 January 2020.

cause DNA damage. Most of these studies have supported the idea that the RF waves given off by cell phones and towers don't have enough energy to damage DNA directly. Because of this, it's not clear how cell phones and towers might be able to cause cancer, but research in this area continues." The society referred many studies and found that there were mixed results, but no study gave any conclusive scientific evidence. Society hopes that studies now being done should give a clearer picture of the possible health effects in the future. Until then, people should take precautions to limit their exposure.

- Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) published its opinion[23] on 27.01.2015 on Potential health effects of exposure to electromagnetic fields (EMF). The purpose of this Opinion was to update the SCENIHR Opinions of 19 January 2009 'Health effects of exposure to EMF' and 6 July 2009 'Research needs and methodology to address the remaining knowledge gaps on the potential health effects of EMF' in the light of newly available information since then, and to give special consideration to areas where important knowledge gaps were identified in the previous Opinion. In addition, biophysical interaction mechanisms and the potential role of co-exposures to environmental stressors have been discussed. The opinion as given by SCENIHR is important in Indian context as the same has been referred by number of Indian courts while pronouncing the judgements in related court cases.

[23] Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). (January 27,2015). *Potential health effects of exposure to electromagnetic fields (EMF)*. https://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_041.pdf accessed 30 November 2019

The committee expressed its opinion to exposures from all types of sources and to all the frequency ranges from ELF to THz. However, in the context of this dissertation, i.e. for RF frequency range, the committee expressed the opinion that overall the epidemiological studies on mobile phone RF EMF exposure did not show an increased risk of brain tumours. These studies did not indicate an increased risk for other cancers of the head and neck region. Committee further opined that the results of cohort and incidence time trend studies did not support an increased risk for glioma while the possibility of an association with acoustic neuroma remains open. Epidemiological studies do not indicate increased risk for other malignant diseases including childhood cancer.

In view of the committee, Overall, there was a lack of evidence that RF EMF affects cognitive functions in humans.

For symptoms triggered by short-term exposure to RF fields (measured in minutes to hours), committee was of the opinion that the consistent results from multiple double-blind experiments gave a strong overall weight of evidence that such effects are not caused by RF exposure. For symptoms associated with longer-term exposures (measured in days to months), the evidence from observational studies was broadly consistent and weighs against a causal effect. However, it has gaps, most notably in terms of the objective monitoring of exposure.

As per SCENIHR opinion, human studies on neurological diseases and symptoms showed no clear effect, but the evidence was limited.

The previous SCENIHR Opinion concluded that there were no adverse effects on reproduction and development from RF fields at non-thermal exposure levels. The

inclusion of more recent human and animal data did not change this assessment. Human studies on child development and behavioural problems had conflicting results and methodological limitations. Therefore, the evidence of an effect is weak. Effects of exposure on foetuses from mother's mobile phone use during pregnancy were not plausible owing to extremely low foetal exposure. The committee further opined that studies on male fertility are of poor quality and provide little evidence.

Committee, however, recommended a prospective cohort study in adults investigating long-term effects of RF fields associated with use of mobile phones, with a high priority. The study should be of sufficient size and duration to allow the evaluation of realistic effect sizes. The study should reflect the latest developments in exposure assessment, and additional outcomes could include cerebrovascular and neurodegenerative disease.

- In the Research Paper by Miller et al[24] (2019,), the International Agency for Research on Cancer (IARC) categorization of RFR(Radio Frequency Radiation) as a "possible" (Group 2B) human carcinogen has been referred and it was noted that a broad range of adverse human health effects associated with RFR had been reported since the IARC review. The paper recommended that IARC should re-evaluate its 2011 classification of the human carcinogenicity of RFR, and that WHO should complete a systematic

[24] Miller A. B., Sears M. E., Morgan L. L.,Davis D. L., Hardell L., Oremus M. & Soskolne C. L. (2019). Risks to Health and Well-Being From Radio-Frequency Radiation Emitted by Cell Phones and Other Wireless Devices. *Frontiers in Public Health*,*8*(7):223,1-10, https://doi.org/10.3389/fpubh.2019.00223
(Online) https://www.frontiersin.org/articles/10.3389/fpubh.2019.00223/full accessed 30 November 2019

review of multiple other health effects such as sperm damage. In the interim, governments, public health authorities, and physicians/allied health professionals should warn the population that having a cell phone next to the body is harmful, and to support measures to reduce all exposures to RFR.

- In the research paper by Pachuau et al[25] (2016), the results of one 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 have been published. The paper says that 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 had been measured at some selected houses. Frequency spectrum was analyzed at different sites.

  As per the paper, measured value of power densities at all sites were 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. Although the measured power densities were very low compared to the recommendations of ICNIRP and the current Indian standard, it was observed that many inhabitants were still having complaints on the non specific health symptoms since the erection of the tower. From the comparisons of health complaints of male and female from each locality, it was observed that females were having more complaints than male. The most common complaint was muscle pain. It was the view that there

[25] Pachuau, L., & Pachuau, Z. (2016). Health Effects of Mobile Tower Radiation on Human — Case Study. *International Journal of Applied Physics and Mathematics,6*(2),72-79. https://doi.org/10.17706/ijapm.2016.6.2. 72-79

were many other factors which could contribute to the health complaints other than RF/MW radiation. As per the paper, it was not wise to conclude that all the observed health complaints were due to the radiation alone. However, it had been observed that more was power density, more was the health complaints.

- In the paper by Simko et al (September 2019)[26], the health impact of Higher Frequencies (6-100 Ghz, Millimeter Waves) proposed to be used by Fifth Generation (5 G) Technology of wireless communication has been discussed. The paper analyzed 94 relevant publications performing in vivo or in vitro investigations. There were no epidemiological studies dealing with wireless communication for this frequency range, thus, the review covered studies performed in vivo and in vitro. Each study was characterized for: study type (in vivo, in vitro), biological material (species, cell type, etc.), biological endpoint, exposure (frequency, exposure duration, power density), results, and certain quality criteria. Eighty percent of the in vivo studies showed responses to exposure, while 58% of the in vitro studies demonstrated effects. The responses affected all biological endpoints studied. It was found that there was no consistent relationship between power density, exposure duration, or frequency, and exposure effects. It was concluded that the available studies did not provide adequate and sufficient information for a meaningful safety assessment, or for the question about

[26] Simkó, M., & Mattsson, M.-O. (2019).5G Wireless Communication and Health Effects—A Pragmatic Review Based on Available Studies Regarding 6 to 100 GHz. *International Journal of Environmental Research and Public Health*,*16*(18),1-23. https:// doi.org/10.3390/ijerph16183406

non-thermal effects and there is a need for research regarding local heat developments on small surfaces, e.g., skin or the eye, and on any environmental impact. The following conclusions were drawn:

i. Regarding the health effects of Millimeter Waves (MMW) in the 6–100 GHz frequency range at power densities not exceeding the exposure guidelines, the studies provide no clear evidence, due to contradictory information from the in vivo and in vitro investigations.

ii. Regarding the possibility of "non-thermal" effects, the available studies provide no clear explanation of any mode of action of observed effects.

iii. Regarding the quality of the presented studies, too few studies fulfill the minimal quality criteria to allow any further conclusions.

- Department of Telecom, Ministry of Communications, Government of India, on its web site www.dot.gov.in, has given detailed information on the issue and the action taken in this matter, under the title **" A journey for EMF"[27].** It states that with reference to Electromagnetic Radiation emanating from cellular mobile towers, World Health Organization (WHO) in its Fact Sheet No. 304, May 2006 on Electromagnetic Fields and Public Health (Base Stations and Wireless Technologies) has concluded that **to date, no adverse health effects have been established as being caused by mobile phone use**.

  As per the website, Department of Telecommunication (DoT), since 2008, has been monitoring global developments and has already taken necessary steps and adopted

[27] Department of Telecom, Government of India. *A journey for EMF*. https://dot.gov.in/journey-emf accessed 29 February 2020

stricter norms for safety from EMF radiation that are emitted from mobile towers and mobile handsets. Government of India has been taking due precautions and necessary actions in respect of EMF radiation emitted from mobile towers and mobile handsets by issuing various guidelines and norms taking into account the international standards/norms prescribed by International Commission on Non Ionizing Radiation Protection (ICNIRP) as recommended by World Health Organisation. DoT has launched Tarangsanchar, a web portal for Information sharing on Mobile Towers and EMF Emission Compliances, with a view to generate confidence and conviction with regard to safety and harmlessness from mobile towers, clearing any myths and misconceptions. The portal can be accessed at www.tarangsanchar.gov.in. The EMF Portal provides a public interface where an easy map-based search feature has been provided for viewing the mobile towers in vicinity of any locality. By click of a button, information on EMF compliance status of mobile towers can be accessed."

The above Literature Reviews evidently show that there are divergent and conflicting views of the researchers/authors on the topic. Some of them report the absence of any risk to human beings from EMF radiations, whereas others report the presence of a risk; however, most of them are away from any conclusive remarks and come with the usual academic caveat about further studies. Further, no study could be found on the impact of the measures being taken by the Government of India to deal with the issue of the exposure of Radio Frequency Electromagnetic Field Waves by Mobile Communication Technology and Public Safety.

CHAPTER 4

RADIO FREQUENCY ELECTROMAGNETIC FIELD WAVES & PUBLIC SAFETY: GOVERNMENT INITIATIVES AND POLICY MEASURES

CHAPTER 4

RADIO FREQUENCY ELECTROMAGNETIC FIELD WAVES & PUBLIC SAFETY: GOVERNMENT INITIATIVES AND POLICY MEASURES

There has been world-wide growing public concern on possible adverse health effects due to Electro-magnetic field (EMF) Radiation from mobile towers and mobile handsets. Over the past few years, a number of health activists and resident organisations have started opposing the erection of telecom towers on rooftops of houses and in densely populated areas, claiming that radiation from such installations causes serious health risks.

There have been several studies suggesting either the presence or absence of risk to human beings from EMF radiation. The main areas of concern are the radiation emitted by the base transceiver stations (BTS) and mobile handsets. Concerns have also been raised that continuous exposure to EMF radiation emanating from telecom towers causes harmful thermal and non-thermal health effects. The effects of exposure to EMF have created an active scientific debate among the research agencies across the globe.

The present chapter has been divided into three broad sections. First section deals the action taken by International agencies like WHO, ICNIRP, ITU-T, IARC, IEEE and other international agencies to address the issue in terms of guidelines and recommendations published for International Safety standards. Second section studies the guidelines and standards set by the Government of India related to Radio Frequency Electromagnetic Field Waves exposure by Mobile Communication Technology for Public Safety. Third section reviews the measures being taken by the Government of India to deal with inconvenience

and possible adverse effect from the exposure of Radio Frequency Electromagnetic Field Waves by Mobile Communication Technology. It includes actions taken to ensure compliance to various safe limits and standards as set by the Government and further, steps taken for handling the issue like awareness of public, publishing the advisory to state governments and other steps.

4.1 Actions taken by International Agencies

Since the subject matter relates to the public health, it has been considered seriously and many international agencies including World Health Organization (WHO) are pro-actively working for the safeguard of the public. As part of its charter to protect public health and in response to public concern over health effects of EMF exposure, the World Health Organization (WHO) established the International EMF Project[28] in 1996 to assess the scientific evidence of possible health effects of EMF in the frequency range from 0 to 300 GHz. The International EMF Project, one out of around 200 programmes/ projects being run by WHO, encourages focused research to fill important gaps in knowledge and to facilitate the development of internationally acceptable standards limiting EMF exposure.

As per the International EMF project progress report, June 2013-2014[29], oversight of the Project is provided by the International Advisory Committee (IAC), composed of members of international organizations, WHO collaborating centres, and national

[28]World Health Organization. *What is International EMF Project?* https://www.who.int/peh-emf/project/EMF_Project/en/ accessed 15 December 2019

[29]World Health Organization. *International EMF Project Progress Report June 2013-14*. https://www.who.int/peh-emf/project/IAC_2014_Progress_Report.pdf?ua=1 accessed 17 December 2019

authorities from all regions of the world. The Project has formal collaboration with different entities, i.e. non-governmental organizations (NGOs), international organizations and WHO collaborating centres. It also cooperates in an ad-hoc manner with other institutions (e.g. co-sponsoring of meetings) and with individual experts.

The International Agency for Research on Cancer (IARC), a specialized agency of WHO, based in Lyon, France, has strong links with the International EMF Project. Its mission is to coordinate and conduct research on causes of human cancer, mechanism of carcinogenesis and to develop scientific strategies for cancer control. It is involved in both epidemiological and laboratory research.

The International Telecommunications Union (ITU) is the leading United Nations agency for information & communication technology issues and global focal point for governments & private sector in developing networks & services. All three of its sectors – the Telecommunication Standardization Sector (ITU-T), the Radio communication sector (ITU-R) and the Telecommunication Development Sector (ITU-D) have been involved with the WHO EMF Project through Study Group 5 - Protection from Electromagnetic Environment Effects.

EMF Project is also having active collaboration with the International Commission on Non-Ionizing Radiation Protection (ICNIRP) - an NGO in official relations with WHO. ICNIRP and WHO have been in discussions regarding aligning timelines on the development of the Environmental Health Criteria (EHC) RF monograph and the ICNIRP RF guidelines.

Further as per the report referred above, WHO receives its funding principally through assessed contributions from Member States and voluntary contributions but with the

economic crisis over the past few years, assessed contributions have become a smaller proportion of the total resources received, and reliance is increasing significantly on specified voluntary contributions provided by partners and donors. Over the years, several governments have given direct contributions to the WHO EMF Project, either on a periodic or ad-hoc basis.

4.1.1 Electromagnetic fields and public health – Base stations and wireless technologies[30] (Backgrounder, May 2006)

WHO (International EMF project) has been issuing various fact sheets and over the past year, several fact sheets have been renamed as backgrounders. This fact sheet no. 304 of May 2006, although has become a backgrounder now, but is very much relevant to be discussed here because it reviews the scientific evidence on the health effects from continuous low-level human exposure to base stations and other local wireless networks.

Regarding the health concerns, it says, "A common concern about base station and local wireless network antennas relates to the possible long-term health effects that whole-body exposure to the RF signals may have. To date, the only health effect from RF fields identified in scientific reviews has been related to an increase in body temperature (> 1 °C) from exposure at very high field intensity found only in certain industrial facilities, such as RF heaters. The levels of RF exposure from base stations and wireless networks are so low that the temperature increases are insignificant and do not affect human health. Recent surveys have indicated that RF exposures from base stations and wireless technologies in

[30] World Health Organization, The International EMF Project (May,2006) *Backgrounder: Electromagnetic fields and public health – Base stations and wireless technologies*. (Online) http://www.who.int/peh-emf/publications/facts/fs304/en/ accessed 18 December 2019

publicly accessible areas (including schools and hospitals) are normally thousands of times below international standards."

It also says that in fact, due to their lower frequency, at similar RF exposure levels, body absorbs up to five times more signal from FM radio and TV than from mobile base stations. This is because the frequencies used in FM radio (around 100 MHz) and in TV broadcasting (around 300 to 400 MHz) are lower than those employed in mobile telephony (900 MHz and 1800 MHz) and because a person's height makes the body an efficient receiving antenna. Further, radio and television broadcast stations have been in operation for the past 50 or more years without any adverse health consequence being established. While most radio technologies have used analog signals, modern wireless telecommunications are using digital transmissions. Detailed reviews conducted so far have not revealed any hazard specific to different RF modulations.

While discussing specifically about Cancer, it says, "Media reports of cancer clusters around mobile phone base stations have heightened public concern. It should be noted that geographically, cancers are unevenly distributed among any population. Given the widespread presence of base stations in the environment, it is expected that possible cancer clusters will occur near base stations merely by chance. Moreover, the reported cancers in these clusters are often a collection of different types of cancer with no common characteristics and hence unlikely to have a common cause. Scientific evidence on the distribution of cancer in the population can be obtained through carefully planned and executed epidemiological studies. Over the past 15 years, studies examining a potential relationship between RF transmitters and cancer have been published. These studies have not provided evidence that RF exposure from the transmitters increases the risk of cancer.

Likewise, long-term animal studies have not established an increased risk of cancer from exposure to RF fields, even at levels that are much higher than produced by base stations and wireless networks."

Similarly, regarding other effects, it says that there have been few studies which have investigated general health effects in individuals exposed to RF fields from base stations. This is because of difficulty in distinguishing possible health effects from very low signals emitted by base stations from other higher strength RF signals in environment. Thus, most studies have focused on RF exposures of mobile phone users. Human and animal studies examining brain wave patterns, cognition and behaviour after exposure to RF fields, such as those generated by mobile phones, have not identified adverse effects. RF exposures used in these studies were about 1000 times higher than those associated with public exposure from base stations. No consistent evidence of altered sleep or cardiovascular function has been reported. Some individuals have reported experiencing non-specific symptoms upon exposure to RF fields emitted from base stations and other EMF devices. As recognized in other WHO fact sheet 'Electromagnetic Hypersensitivity', EMF has not been shown to cause such symptoms.

Regarding protection standards, it says that international exposure guidelines have been developed to provide protection against established effects from RF fields by the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998) and the Institute of Electrical and Electronic Engineers (IEEE, 2005). National authorities should adopt international standards to protect their citizens against adverse levels of RF fields. They should restrict access to areas where exposure limits may be exceeded.

Regarding public perception of risk, it says, "Some people perceive risks from RF exposure as likely and even possibly severe. Several reasons for public fear include media announcements of new and unconfirmed scientific studies, leading to a feeling of uncertainty and a perception that there may be unknown or undiscovered hazards. Other factors are aesthetic concerns and a feeling of a lack of control or input to the process of determining the location of new base stations. Experience shows that education programmes as well as effective communications and involvement of the public and other stakeholders at appropriate stages of the decision process before installing RF sources can enhance public confidence and acceptability."

The fact sheet, now a backgrounder, concludes by saying, "Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects". Regarding the WHO Initiatives, it intimates that while no health effects are expected from exposure to RF fields from base stations and wireless networks, research is still being promoted by WHO to determine whether there are any health consequences from the higher RF exposures from mobile phones.

4.1.2 ICNIRP Guidelines for EMF Radiation[31] (published in: Health Physics 74 (4):494-522; 1998)

A number of national and international organizations have formulated guidelines establishing limits for occupational and residential EMF exposure. The exposure limits for EMF fields developed by the International Commission on Non-Ionizing Radiation

[31] International Commission on Non-Ionizing Radiation Protection (ICNIRP). (1998). *ICNIRP Guidelines For Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (Up to 300 GHz).* https://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf accessed 15 January 2020

Protection (ICNIRP) - a non-governmental organization formally recognised by WHO, were developed following reviews of all the peer-reviewed scientific literature, including thermal and non-thermal effects. The standards are based on evaluations of biological effects that have been established to have health consequences. The main conclusion from the WHO reviews is that EMF exposures below the limits recommended in the ICNIRP international guidelines do not appear to have any known consequence on health.

In 1974, the International Radiation Protection Association (IRPA) formed a working group on non-ionizing radiation (NIR), which examined the problems arising in the field of protection against the various types of NIR. At the IRPA Congress in Paris in 1977, this working group became the International Non-Ionizing Radiation Committee (INIRC). In cooperation with the Environmental Health Division of the World Health Organization (WHO), the IRPA/INIRC developed a number of health criteria documents on NIR as part of WHO's Environmental Health Criteria Programme, sponsored by the United Nations Environment Programme (UNEP). Each document includes an overview of the physical characteristics, measurement and instrumentation, sources, and applications of NIR, a thorough review of the literature on biological effects, and an evaluation of the health risks of exposure to NIR. These health criteria have provided the scientific database for the subsequent development of exposure limits and codes of practice relating to NIR.

At the Eighth International Congress of the IRPA (Montreal, 18–22 May 1992), a new, independent scientific organization—the International Commission on Non-Ionizing Radiation Protection (ICNIRP)—was established as a successor to the IRPA/INIRC. International Commission on Non-Ionizing Radiation Protection (ICNIRP) is a body of independent scientific experts covering areas of Epidemiology, Biology, Dosimetry and

Optical Radiation and a number of consulting experts. This body studies possible adverse effects on human health from exposure to non-ionizing radiation. ICNIRP's principal aim is to disseminate information and advice on the potential health hazards of exposure to non-ionizing radiation.

The functions of the Commission are to investigate the hazards that may be associated with the different forms of NIR, develop international guidelines on NIR exposure limits, and deal with all aspects of NIR protection. Biological effects reported as resulting from exposure to static and extremely-low-frequency (ELF) electric and magnetic fields have been reviewed by UNEP/ WHO/IRPA (1984, 1987). Those publications and a number of others, including UNEP/WHO/IRPA (1993) and Allen et al. (1991), provided the scientific rationale for these guidelines.

ICNIRP published guidelines in 1998 for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). The main objective of this publication was to establish guidelines for limiting EMF exposure that will provide protection against known adverse health effects. An adverse health effect causes detectable impairment of the health of the exposed individual or of his or her offspring; a biological effect, on the other hand, may or may not result in an adverse health effect.

In the most simplistic manner, as per the ICNIRP Guidelines, the levels of safety for EMF Exposure are:

TABLE 4.1:

ICNIRP Safety Limits for EMF Exposure

Frequency Range	E-Field Strength (Volt/Meter (V/m))	H-Field Strength (Amp/Meter (A/m))	Power Density (Watt/Sq. Meter (W/Sq. m))
400 MHz to 2000MHz	$1.375\ f^{1/2}$	$0.0037f^{1/2}$	f/200
2GHz to 300GHz	61	0.15	10

(Source: ICNIRP 1998 Guidelines)

These are the safe limits for EMF Exposures below which they do not appear to have any known consequence on health. The same have been reviewed and validated by WHO while publishing the framework for developing the health-based EMF Standards (2006).

ICNIRP further published the guidelines for safety limits of exposure to radiofrequency energy produced by mobile handsets as below:

TABLE 4.2:

ICNIRP Safety Limits for EMF Exposure Produced by Mobile Handsets

	Whole-body average SAR (W/kg)	Localized SAR head and trunk (W/kg)	Localized SAR limbs (W/kg)
General Public Exposure	0.08	2	4

(Source: ICNIRP Guidelines)

Note: - SAR values are averaged over a 6 minutes period using 10 gram average mass.

Specific Absorption Rate (SAR) is a measure of the rate at which energy is absorbed by the human body when exposed to a radio frequency electromagnetic field.

4.1.3 ICNIRP statement[32] on the "Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (Up To 300 GHz)" Published In: Health Physics 97(3):257-258; 2009

Since the publication of the ICNIRP "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)" (ICNIRP 1998), many scientific studies of the effects of such fields had been published. Hence, ICNIRP in 2009 reviewed its guidelines published in 1998 and in the opinion of ICNIRP, the scientific literature published since the 1998 guidelines had provided no evidence of any adverse effects below the basic restrictions and did not necessitate an immediate revision of its guidance on limiting exposure to high frequency electromagnetic fields.

4.1.4 International Joint Workshop held on 2nd Dec.2016 in Tokyo, Japan[33]

An International Workshop on Non-Ionizing Radiation Protection took place on 2nd December 2016 in Tokyo, Japan. ICNIRP technically co-sponsored the workshop, which was organized and financially supported by the Japanese National Institute of Information and Communications Technology (NICT). The main topics of the workshop were the revision of the ICNIRP HF guidelines and NIR protection related to 5G system.

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[32]International Commission on Non-Ionizing Radiation Protection (ICNIRP). (2009). *ICNIRP Statement On The Guidelines For Limiting Exposure To Time-Varying Electric, Magnetic, And Electromagnetic Fields (Up To 300 GHz)*. https://www.icnirp.org/cms/upload/publications/ICNIRPStatementEMF.pdf accessed 18 January 2020

[33]https://www.icnirp.org/en/workshops/article/nict-icnirp-workshop-2016.html accessed 01 February 2020

Future Workshop: Ninth International NIR Workshop on 7-8 May 2020 in Seoul, Korea

The Ninth International NIR Workshop is scheduled on 7-8 May 2020 in Seoul, Korea. However, as per information made available by ICNIRP secretariat on website(icnirp.org), with the Sars-CoV-2 virus (COVID-19) spreading more intensively now in parts of Korea and worldwide, they have put on hold the registration process until further notice. Together with the Korean Local Organizing Committee, ICNIRP is following up the situation closely and considering all alternatives including maintaining, postponing or cancelling the NIR workshop. The situation is very uncertain. As per the message, ICNIRP will keep informed via the website as the situation evolves and ultimately about the decision taken.

4.1.5 ICNIRP RF EMF Guidelines 2020:

ICNIRP has published the latest guidelines on March11, 2020[34] on limiting exposure to Radio Frequency Electromagnetic Fields for the protection of humans exposed in the frequency range 100 kHz to 300 GHz. The guidelines cover many applications such as 5G technologies, Wi-Fi, Bluetooth, mobile phones, and base stations. This publication replaces and supersedes the 100 kHz to 300 GHz part of the ICNIRP (1998) radiofrequency guidelines, as well as the 100 kHz to 10 MHz part of the ICNIRP (2010) low-frequency guidelines. As compared to guidelines published in 1998, there are some of the changes in the 2020 guidelines that are relevant to 5G exposures are for frequencies above 6 GHz. These include[35]:

[34] ICNIRP. (March 11,2020). Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). *Health Physics 118(00):000–000; 2020*. *Pre-print*. DOI: 10.1097/HP.0000000000001210. accessed 12 March 2020

[35] https://www.icnirp.org/cms/upload/presentations/ICNIRP_Media_Release_110320.pdf accessed 12 March 2020

- The addition of a restriction for exposure to the whole body;
- The addition of a restriction for brief (less than 6 minute) exposures to small regions of the body; and
- The reduction of the maximum exposure permitted over a small region of the body.

4.1.6 Classification of Radio Frequency Electromagnetic Fields by IARC as possibly carcinogenic to humans[36]:

The International Agency for Research on Cancer (IARC) is part of the World Health Organization. Its mission is to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control. The Agency is involved in both epidemiological and laboratory research and disseminates scientific information through publications, meetings, courses, and fellowships. On 31st May 2011, the WHO/ International Agency for Research on Cancer (IARC) issued a press release. Its opening line says, "IARC has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer, associated with wireless phone use." The main point worth mentioning here is that it mostly discusses about the increased risk of cancer due to phone use and not towers.

As per the press release, "From May 24–31 2011, a Working Group of 31 scientists from 14 countries met at IARC in Lyon, France, to assess the potential carcinogenic hazards from exposure to radiofrequency electromagnetic fields. These assessments have

[36] International Agency for Research on Cancer (31 May 2011) .*Press Release No. 208: IARC classifies radiofrequency electromagnetic fields as possibly carcinogenic to humans*.(online) https://www.iarc.fr/wp-content/uploads/2018/07/pr208_E.pdf accessed 01 February 2020

been published as Volume 102 of the IARC Monographs, which is the fifth volume in this series to focus on physical agents, after Volume 55 (Solar Radiation), Volume 75 and Volume 78 on ionizing radiation (X-rays, gamma-rays, neutrons, radio-nuclides), and Volume 80 on non-ionizing radiation (extremely low-frequency electromagnetic fields). The IARC Monograph Working Group discussed the possibility that these exposures might induce long-term health effects, in particular an increased risk for cancer and evaluated the literature available at that time on the following exposure categories involving radiofrequency electromagnetic fields:

- occupational exposures to radar and to microwaves;
- environmental exposures associated with transmission of signals for radio, television and wireless telecommunication; and
- personal exposures associated with the use of wireless telephones."

The Working Group reviewed the evidence critically and overall evaluated as being limited among users of wireless telephones for glioma and acoustic neuroma, and inadequate to draw conclusions for other types of cancers. The evidence from the occupational and environmental exposures mentioned above was similarly judged inadequate. The Working Group did not quantitate the risk; however, as per the press release, "one study of past cell phone use (up to the year 2004), showed a 40% increased risk for gliomas in the highest category of heavy users (reported average: 30 minutes per day over a 10-year period)."

As a result, Dr Jonathan Samet (University of Southern California, USA), overall Chairman of the Working Group, indicated, "the evidence, while still accumulating, is strong enough to support a conclusion and the 2B classification. The conclusion means that

there could be some risk, and therefore we need to keep a close watch for a link between cell phones and cancer risk."

IARC Director, Christopher Wild said, "Given the potential consequences for public health of this classification and findings, it is important that additional research be conducted into the long- term, heavy use of mobile phones. Pending the availability of such information, it is important to take pragmatic measures to reduce exposure such as hands-free devices or texting."

4.1.7 IARC Monographs[37]

IARC Monographs identify environmental factors that can increase the risk of human cancer. These include chemicals, complex mixtures, occupational exposures, physical and biological agents and lifestyle factors. Since 1971, more than 900 agents have been evaluated by IARC, of which approximately 400 have been identified as carcinogenic or potentially carcinogenic to humans and grouped as,

Group 1: The agent is carcinogenic to humans. This category is used when there is sufficient evidence of carcinogenicity in humans. E.g. Ultraviolet Radiation, X & gamma radiation, solar radiation, tobacco, etc.

Group 2: This category includes agents for which, at one extreme, the degree of evidence of carcinogenicity in humans is almost sufficient, as well as those for which, at the other extreme, there are no human data but for which there is evidence of carcinogenicity in experimental animals. They are further grouped as,

[37] International Agency for Research on Cancer. *Agents Classified by the IARC Monographs, Volumes 1–112*. (Online) https://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf accessed 02 February 2020

Group 2A: The agent is probably carcinogenic to humans. This category is used when there is limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals. E.g. DDT, benzene, red meat (consumption), petroleum refining (occupational exposure), etc.

Group 2B: The agent is possibly carcinogenic to humans. This category is used for agents for which there is limited evidence of carcinogenicity in humans and less than sufficient evidence of carcinogenicity in experimental animals. E.g. chloroform, surgical implants – polymeric prepared as thin smooth film, pickled vegetables (traditional Asian), magnetic fields, etc.

Group 3: The agent is not classifiable as to its carcinogenicity to humans. This category is used most commonly for agents for which the evidence of carcinogenicity is inadequate in humans and inadequate or limited in experimental animals. E.g. cholesterol, caffeine, ampicillin, tea, etc.

Group 4: The agent is probably not carcinogenic to humans. This category is used for agents for which there is evidence suggesting lack of carcinogenicity in humans and in experimental animals.

The definition of evidence relevant to carcinogenicity is as follows:

Sufficient evidence of carcinogenicity: Working Group considers that a causal relationship has been established between exposure to agent & human cancer.

Limited evidence of carcinogenicity: A positive association has been observed between exposure to the agent and cancer for which a causal interpretation is considered by the

Working Group to be credible, but chance, bias or confounding could not be ruled out with reasonable confidence.

Inadequate evidence of carcinogenicity: The available studies are of insufficient quality, consistency or statistical power to permit a conclusion regarding the presence or absence of a causal association between exposure and cancer, or no data on cancer in humans are available.

Evidence suggesting lack of carcinogenicity: There are several adequate studies covering full range of levels of exposure that humans are known to encounter, which are mutually consistent in not showing a positive association between exposure to the agent and any studied cancer at any observed level of exposure.

In terms of what the IARC 2B classification means, the WHO has summarized - "Possibly carcinogenic to humans is a classification used to denote an agent for which there is limited evidence of carcinogenicity in humans and less than sufficient evidence for carcinogenicity in experimental animals." It would be pertinent to mention that IARC has classified 285 agents in Group 2B carcinogenic category which, inter alia, includes some commonly used items like Coffee, Pickled vegetables (traditional in Asia), Aloe Vera (whole leaf extract), Talc-based body powder (perineal use of) etc. However, IARC in its World Cancer Report 2014[38] on mobile phones and cancer, and environmental exposures from transmitters have mentioned -

"*No consistent association has been found between use of mobile (cell) phones and brain tumours"*

[38] International Agency for Research on Cancer. (2014). *World Cancer Report 2014* (online) https://publications.iarc.fr/Non-Series-Publications/World-Cancer-Reports/World-Cancer-Report-2014 accessed 05 February 2020

"With regard to environmental exposures from transmitters, including television, radio, and military transmissions as well as mobile phone networks, the evidence is inadequate due to lack of high-quality studies with accurate individual exposure assessment,"

World Health Organization (WHO) is yet to take a conclusive view on classification of radiofrequency electromagnetic fields as possibly carcinogenic to humans by International Agency for Research on Cancer (IARC). WHO in its response to this classification has stated in its recent Fact sheet No 193 on Electromagnetic fields and public health[39], which was reviewed in October 2014 – "*In response to public and governmental concern, WHO established the International Electromagnetic Fields (EMF) Project in 1996 to assess the scientific evidence of possible adverse health effects from electromagnetic fields. WHO will conduct a formal risk assessment of all studied health outcomes from radiofrequency fields exposure by 2016*." The report is yet to be finalized / published.

4.1.8 Framework for developing health-based EMF Standards by WHO (2006)[40]

Understanding the health impact of electromagnetic fields (EMF) falls within the mandate of the World Health Organization (WHO) in the area of environmental health, WHO aims to help Member States achieve safe, sustainable and health-enhancing human environments, protected from biological, chemical and physical hazards. In this context,

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[39] World Health Organization. *Clarification of mooted relationship between mobile telephone base stations and cancer*. https://www.who.int/mediacentre/news/statements/statementemf/en/ accessed 10 February 2020

[40]World Health Organization. *Framework for developing health-based EMF Standards.* https://www.who.int/peh-emf/standards/EMF_standards_framework%5B1%5D.pdf accessed 10 February 2020

the International EMF Project was established at WHO in 1996 in response to general concern over health effects of EMF exposure. WHO's International EMF Project has provided a unique opportunity to bring together over sixty countries to identify criteria for EMF standards setting and to develop the Framework for Developing Health-based EMF Standards. The aim of the EMF Project is to encourage the establishment of exposure limits and other control measures that provide the same or similar level of health protection for all people. Meetings on standards development were held in all six WHO regions to obtain input from scientists and government officials around the globe for inclusion into this Framework. While WHO strongly promotes the use of international standards, some countries feel the need to develop or refine their own standards. Hence, a framework has been suggested by WHO in 2006 to develop or review the EMF Standards. This Framework is intended for national advisory and/or regulatory bodies that are developing new standards for EMF, reviewing the basis of their standards, or reconsidering specific quantitative values such as reference levels and safety factors. The overall purpose of this Framework is to provide advice on how to develop science-based exposure limits that will protect the health of the public and workers from EMF exposure. This Framework addresses how quantitative exposure standards can be developed. The general steps in this process include an evaluation of the scientific literature, determination of threshold levels, choice of safety factors for different populations at risk, and derivation of exposure limits. Other considerations regarding the overall practicability of the standard, compliance procedures and the use of precautionary measures are also addressed.

4.1.9 Environmental Health Criteria monograph on Radiofrequency fields[41]

WHO has addressed possible health effects from exposure to EMF through 3 Environmental Health Criteria (EHC) monographs on extremely low frequency (ELF - up to 100 kHz) fields (1984), static (0Hz) and ELF magnetic fields (1987) and radiofrequency (RF - 100 kHz to 300 GHz) fields (1993). WHO revises them if new data are available that would substantially change the evaluation, if there is public concern for health or environmental effects of the agent because of greater exposure or if appreciable time period has elapsed since last evaluation. So, 3 monographs spanning 0- 300 GHz EMF frequency range had been planned by WHO: static fields (0Hz), ELF fields (up to 100 kHz) and RF fields (100 kHz – 300 GHz). So far, they have developed first two volumes on Static Fields (2006) and ELF fields (2007). WHO is undertaking a health risk assessment of RF fields, to be published as a monograph in the EHC Series, which will complement other two monographs and will update the monograph on radiofrequency fields (1993).

4.1.10 International survey on rating potential adverse health outcomes from exposure to radiofrequency fields (June 2018)[42]

WHO will commission a number of systematic reviews that will analyze and synthesize the available evidence on the most important potential adverse health outcomes.

[41]World Health Organization. *An Environmental Health Criteria Monograph*. https://www.who.int/peh-emf/research/rf_ehc_page/en/

[42] World Health Organization. (2018)**.** *International survey on rating potential adverse health outcomes from exposure to radiofrequency fields (June 2018).* https://www.who.int/peh-emf/research/rf_ehc_page/en/index2.html accessed 01 March, 2020

Appropriate selection of these health outcomes is therefore key to producing a useful monograph, considering available resources and timeline of the project.

To prioritize health outcomes, WHO sought the opinion of experts on the topic of radiofrequency electromagnetic field exposures and health to complete an online survey titled "Rating Potential Adverse Health Outcomes of Exposure to Radiofrequency Fields" to help prioritize the health outcomes to be addressed systematically. Over 300 RF experts were invited, and 167 responses received. A paper is currently being finalized for submission in a peer-reviewed publication.

4.1.11 RELAUNCH Call for Expressions of Interest for systematic reviews (2020)[43]

The World Health Organization's (WHO) Radiation Programme has an ongoing project to assess potential health effects of exposure to radiofrequency electromagnetic fields in the general and working population. To prioritize potential adverse health outcomes, WHO conducted a broad international survey in 2018. Ten major topics were identified for which WHO will now commission systematic reviews to analyze and synthesize the available evidence.

WHO has invited eligible teams to indicate their interest in undertaking a systematic review on one (or more) of the following topics:

- SR2 – Cancer (animal studies)
- SR4 – Adverse reproductive outcomes (animal and in vitro studies)

[43]World Health Organization. (2020). *RELAUNCH Call for Expressions of Interest for systematic reviews.* https://www.who.int/peh-emf/research/rf_ehc_page/en/index1.html accessed 02 March 2020

- SR10 – Effect of exposure to heat from any source on pain, burns, cataract and heat-related illnesses.

4.1.12 Institute of Electrical and Electronics Engineers (IEEE) Standards C 95.1-2005[44]

The Institute of Electrical and Electronics Engineers (IEEE) published the standards for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields in the frequency range from 3 kHz to 300 GHz in 2006 as IEEE Std C 95.1-2005. Recommendations were made to protect against established adverse health effects in human beings associated with exposure to electric, magnetic and electromagnetic fields in the frequency range of 3 kHz to 300 GHz. The recommendations were expressed in terms of basic restrictions (BRs) and maximum permissible exposure (MPE) values. The BRs are limits on internal fields, specific absorption rate (SAR), and current density; the MPEs, which are derived from the BRs, are limits on external fields and induced and contact current. The recommendations, which protect against effects associated with electrostimulation and tissue and whole- body heating, were intended to apply to all human exposures except for exposure of patients by, or under the direction of, physicians and medical professionals.

As per the recommendations, BRs and MPEs for the frequency range 100kHz to 3 GHz are as below:

[44] IEEE International Committee on Electromagnetic Safety (Standards Coordinating Committee 39). (2006). *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.* http://emfguide.itu.int/pdfs/C95.1-2005.pdf

Table 4.3: Basic Restrictions (BRs) for frequencies between 100 kHz and 3 GHz

		Action level[a] SAR[b] (W/kg)	Persons in controlled environments SAR[c] (W/kg)
Whole-body exposure	Whole-Body Average (WBA)	0.08	0.4
Localized exposure	Localized (peak spatial-average)	2[c]	10[c]
Localized exposure	Extremities[d] and pinnae	4[c]	20[c]
[a]BR for the general public when an RF safety program is unavailable.			
[b]SAR is averaged over the appropriate averaging times as per Table of MPE.			
[c]Averaged over any 10 g of tissue (defined as a tissue volume in the shape of a cube).*			
[d]The extremities are the arms and legs distal from the elbows and knees, respectively.			

*The volume of the cube is approximately 10 cm^3.

(Source: IEEE Standards C 95.1-2005)

Table 4.4: Action level Maximum Permissible Exposure (MPE) for the General Public (when an RF safety program is unavailable)

Frequency Range (MHz)	RMS Electric Field Strength (E)[a] (V/m)	RMS Magnetic Field Strength (H)[a] (A/m)	RMS power density (S) E-field, H-field (W/m^2)
0.1–1.34	614	$16.3/F_m$	$(1000, 100\,000/f_M^2)^b$
1.34–3	$823.8/f_M$	$16.3/F_m$	$(1800/f_M^2, 100\,000/f_M^2)$
3–30	$823.8/f_M$	$16.3/f_M$	$(1800/f_M^2, 100\,000/f_M^2)$
30–100	27.5	$158.3/f_M^{1.668}$	$(2{,}9400000/f_M^{3.336})$
100–400	27.5	0.0729	2
400–2000	–	–	$f_M/200$
2000–5000	–	–	10
5000–30 000	–	–	10
30 000–100 000	–	–	10
100 000–300 000	–	–	$(90f_G-7000)/200$

(Source: IEEE Standards C 95.1-2005)

Note —f_M is the frequency in MHz, f_G is the frequency in GHz.
[a]For exposures that are uniform over the dimensions of the body, such as certain far-field plane-wave exposures, the exposure field strengths and power densities are compared with the MPEs in the Table. For non-uniform exposures, the mean values of the expo- sure fields, as obtained by spatially averaging the squares of the field strengths or averaging the power densities over an area equivalent to the vertical cross section of the human body (projected area) or a smaller area depending on the frequency are compared with the MPEs in the Table.
[b]These plane-wave equivalent power density values are commonly used as a convenient comparison with MPEs at higher frequencies and are displayed on some instruments in use.

(Source: IEEE Standards C 95.1-2005)

Frequencies between 100 kHz and 3 GHz:

The MPE for fields between 100 kHz and 3 GHz are derived on the basis of limiting the whole body averaged (WBA) SAR, which is proportional to the spatial average of the incident plane wave equivalent power density (or squares of electric and magnetic field strengths), averaged over the projected area of the body. Therefore, the MPE corresponds to the spatially averaged plane wave equivalent power density or the spatially averaged values of the squares of electric and magnetic field strengths. In practice, a measurement over the length of the body is sufficient for assessing exposures for comparison with the MPE.

Frequencies greater than 3 GHz:

For frequencies greater than 3 GHz, the MPE is expressed in terms of the incident power density. To provide a transition in the frequency range 3 GHz to 6 GHz, compliance with this standard may be demonstrated by evaluation of either incident power density or local SAR. From 3 GHz to 30 GHz, the power density is spatially averaged over any contiguous area corresponding to 100 λ^2, where λ is the free space wavelength of the RF field in centimeters. For frequencies exceeding 30 GHz, the power density is spatially averaged

over any contiguous area of 0.01 m^2 (100 cm^2), not to exceed a maximum power density of 1000 W/m^2 in any one square centimeter as determined by a calculation or a conventional field measurement.

If these standards are closely studied, then it is found that the Basic Restrictions (BRs) and Maximum Permissible Exposure (MPE) values as per IEEE standards are similar to those of ICNIRP recommendations, in case of Frequency range of our interest, for safe emission limits for SAR in case of mobile handsets and for safe RF EMF Exposure limits in case of Mobile Towers, respectively.

4.1.13 IEEE Std C95.1-2019[45]

IEEE revised its standards published earlier as IEEE Std C 95.1-2005 and published in 2019, new Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields in the frequency range, 0 Hz to 300 GHz. This standard specifies exposure criteria and limits to protect against established adverse health effects in humans associated with exposure to electric, magnetic, and electromagnetic fields in the frequency range of 0 Hz to 300 GHz. These limits, incorporating safety margins, are expressed in terms of Dosimetric Reference Limits (DRL) and Exposure Reference Levels (ERL). DRLs are expressed in terms of *in situ* electric field strength, specific absorption rate (SAR), and epithelial power density. ERLs, which are more easily

[45] IEEE International Committee on Electromagnetic Safety (Standards Coordinating Committee 39). (2019). *IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz.* https://ieeexplore.ieee.org/document/8859679 accessed 15 February 2020. doi 10.1109/IEEE STD.2019.8859679

determined, are limits on external electric and magnetic fields, incident power density, induced and contact currents, and contact voltages intended to ensure that the DRLs are not exceeded. The limits, which protect against adverse health effects associated with electrostimulation of tissue and local and whole-body heating, are intended to apply to the described human exposure conditions. However, these levels are not intended to address exposures of patients or human research subjects under the care of medical professionals for which other risks and benefits might apply. These exposure limits might not prevent interference with medical and other devices that might exhibit susceptibility to electromagnetic interference (EMI).

As per the standards, DRL upto 300 GHz frequency is restricted as given below in Table 4.5 and Table 4.6 below:

Table 4.5 : Dosimetric Reference Limits (100 kHz to 6 GHz)

Conditions	Persons in unrestricted environments SAR (W/kg)[a]	Persons permitted in restricted environments SAR (W/kg)[a]
Whole-body exposure	0.08	0.4
Local exposure[b] (head and torso)	2	10
Local exposure[b] (limbs and pinnae)	4	20

(Source: IEEE Std C95.1-2019)

[a] SAR is averaged over 30 min for whole-body exposure and 6 min for local exposure.

[b] Averaged over any 10 g of tissue (defined as a tissue volume in the shape of a cube).

Table 4.6 : Local exposure DRLs (6 GHz to 300 GHz)

Conditions	Epithelial power density (W/m^2)[a,b,c]	
	Persons in unrestricted environments	Persons permitted in restricted environments
Body surface	20	100

(Source: IEEE Std C95.1-2019)

[a] Epithelial power density through body surface is averaged over 6 min.

[b] Averaged over any 4 cm^2 of body surface at frequencies between 6 GHz and 300 GHz (defined as area in the shape of a square at surface of the body).

[c] Small exposed areas above 30 GHz: If the exposed area on the body surface is small (< 1 cm^2 as defined by−3 dB contours relative to the peak exposure), the epithelial power density is allowed to exceed the DRL values of Table 6 by a factor of 2, with an averaging area of 1 cm^2 (defined as area in the shape of a square at the body surface).

Similarly, ERLs for whole-body exposure of persons in unrestricted environments (100 kHz to 300 GHz) are given as per standard as in Table 4.7 below:

Table 4.7: ERLs for Whole-body Exposure of Persons in Unrestricted Environments (100 kHz to 300 GHz)

Frequency range (MHz)	Electric field strength (E)[a,b,c] (V/m)	Magnetic field strength (H)[a,b,c] (A/m)	Power density (S)[a,b,c] (W/m^2)		Averaging time (min)
			SE	*SH*	
0.1 to 1.34	614	16.3 / *F*m	1000	100 000 / fM^2	30
1.34 to 30	823.8 / *f*M	16.3 / *f*M	1800 / fM^2	100 000 / fM^2	30
30 to 100	27.5	158.3 / $fM^{1.668}$	2	9 400 000 / $fM^{3.336}$	30
100 to 400	27.5	0.0729	2		30
400 to 2000	—	—	*f* M / 200		30
2000 to 300 000	—	—	10		30

NOTE—*SE* and *SH* are plane-wave-equivalent power density values, based on electric or magnetic field strength respectively, and are commonly used as a convenient comparison with ERLs at higher frequencies and are sometimes displayed on commonly used instruments.

(Source: IEEE Std C95.1-2019)

[a] For exposures that are uniform over the dimensions of the body, such as certain far-field plane-wave exposures, the exposure field strengths and power densities are compared with

the ERLs in Table 4.7 . For more typical nonuniform exposures, the mean values of the exposure fields, as obtained by spatially averaging the plane-wave-equivalent power densities or the squares of the field strengths, are compared with the ERLs in Table 4.7 .

b f_M is the frequency in MHz.

c The *E, H,* and *S* values are those rms values unperturbed by the presence of the body.

Again, if these standards are closely studied, then it is found that the dosimetric reference limits (DRL) and exposure reference levels (ERL) as per IEEE standards C95.1-2019 are similar to those of ICNIRP recommendations, in case of Frequency range of our interest, for safe emission limits for SAR in case of mobile handsets and for safe RF EMF Exposure limits in case of Mobile Towers, respectively.

4.1.14 Recommendation ITU-T K.52 (Series K: Protection Against Interference): Guidance on complying with limits for human exposure to electromagnetic fields[46]

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis. It has published recommendations namely ITU-T K.52 for the Guidance on complying with limits for human exposure to electromagnetic fields. Recommendation

[46] International Telecommunication Union Telecommunication Standardization Sector (ITU-T). (2018). *Recommendation ITU-T K.52: Guidance on complying with limits for human exposure to electromagnetic fields.* https://www.itu.int/rec/T-REC-K.52-201801-I/en accessed 05 March 2020

ITU-T K.52 aims to help with compliance of telecommunication installations and mobile handsets or other radiating devices used against the head with safety limits for human exposure to electromagnetic fields (EMFs). Starting from year 2000, a total of seven editions of K.52 Recommendations have been published. The last recommendation has been approved on 21.09.2018. It presents general guidance, a calculation method and an installation assessment procedure. The assessment procedure for telecommunication installations, based on safety limits provided by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), helps users to determine the likelihood of installation compliance based on accessibility criteria, antenna properties and emitter power. The IEC Standard for the compliance measurement of mobile handsets is recommended.

As per Para 6 of the Recommendation K.52 (EMF safety limits), in many cases, local or national regulatory agencies or standards bodies promulgate the EMF safety limits. If such limits do not exist, or if they do not cover the frequencies of interest, then ICNIRP limits should be used.

As per Para 7 of the Recommendation(Compliance of wireless communication devices),or wireless communication devices operating in the frequency range of 300 MHz to 6 GHz, compliance with the ICNIRP safety limits can be achieved by applying the measurement procedures for SAR in [IEC 62209-1] and [IEC 62209-2]. Also, in certain cases, local or national regulatory agencies or standards bodies may recommend national or regional measurement practices in the spirit of [IEC 62209-1] in order to get a SAR value for wireless communication devices used next to the ear.

Standard IEC 62209-1:2016[47] is the measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices. (Part 1: Devices used next to the ear (Frequency range of 300 MHz to 6 GHz))

Standard IEC 62209-2:2010/AMD1:2019 Amendment 1[48] is regarding the Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures . Its Part 2 is Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz).

4.1.15 Recommendation ITU-T K.61[49] (Series K: Protection Against Interference): Guidance on measurement and numerical prediction of electromagnetic fields for compliance with human exposure limits for telecommunication installations

Recommendation ITU-T K.61 helps telecommunication operators to verify compliance with exposure standards promulgated by local or national authorities. This Recommendation gives guidance on measurement methods that can be used to achieve a compliance assessment. It also provides guidance on the selection of numerical methods

[47] *Standard IEC 62209-1:2016*. https://webstore.iec.ch/publication/25336 accessed 22 February 2020

[48] *Standard IEC 62209-2:2010/AMD1:2019*. https://webstore.iec.ch/publication/61098 accessed 22 February 2020

[49] International Telecommunication Union Telecommunication Standardization Sector (ITU-T). (2018). *Recommendation ITU-T K.61: Guidance on measurement and numerical prediction of electromagnetic fields for compliance with human exposure limits for telecommunication installations.* https://www.itu.int/rec/T-REC-K.61-201801-I/en accessed 22 February 2020

suitable for exposure prediction in various situations. Starting from year 2003, a total of three editions of Recommendation K.61 have been published (latest on 13.01.2018).

As indicated earlier, this Recommendation helps telecommunication operators to verify compliance with exposure standards promulgated by local or national authorities. Indications on the need to perform an exposure assessment for a telecommunication installation such as a base station are provided in [ITU-T K.52]. Indications on the process for putting a telecommunication installation such as a base station into service are provided in [ITU-T K.100]. The assessment is based on the evaluation of the electromagnetic field and on accessibility considerations. The electromagnetic evaluation can be carried out by measurement or numerical prediction. This Recommendation defines tools, methods and procedures that can be used to achieve a compliance assessment. The compliance with radio-frequency exposure standards can be achieved by measurement of electromagnetic field strength, provided that calibrated instruments are used, and measurement uncertainty is correctly expressed.

Supplement 9 to ITU-T K-series Recommendations[50]

As mentioned earlier, ITU-T publishes K-Series recommendations for the Protection Against Interference. Supplement 9 to ITU-T K-Series Recommendations contains an analysis of the impact of the implementation of 5G mobile systems with respect to the

[50] International Telecommunication Union Telecommunication Standardization Sector (ITU-T). (2019). *ITU-T K.Suppl.9(05/2019):5G Technology and Human Exposure to Radiofrequency Electromagnetic Fields.* https://www.itu.int/itu-t/recommendations/rec.aspx?rec=13939 accessed 22 February 2020

exposure level of electromagnetic fields (EMFs) around radiocommunication infrastructure. Its second edition has been published on 22.05.2019.

5G is the fifth generation of mobile networks, a significant evolution of the fourth generation (4G) long-term evolution (LTE) networks. 5G has been designed to meet the extensive growth in data and connectivity of today's modern society, the Internet of things (IoT) with billions of connected devices, and tomorrow's innovations. 5G will initially operate in conjunction with existing 4G networks before evolving to fully standalone networks in subsequent releases and coverage expansions.

5G will predominately use additional spectrum in the 3-100 GHz range to add significantly more capacity compared to current mobile technologies. The additional spectrum and greater capacity will enable more users, more data and faster connections. It is also expected that there will be future reuse of the existing low-band spectrum for 5G as legacy networks decline in usage and to support future use cases.

The increased spectrum also includes the millimetre waveband (mmWave) above 30 GHz. The mmWave frequencies provide localized coverage as they mainly operate over short line of sight distances.

As per para 8 of the recommendations,

5G systems will use frequencies that are already addressed by international radio-protection standards. Two international bodies: the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and Institute of Electrical and Electronics Engineers (IEEE) have developed exposure guidelines and defined exposure limits in terms of specific absorption rate (SAR) and electric and magnetic field strength and power density in the 5G frequency band. These exposure guidelines form the basis of policy and

regulation in many countries. However, exposure limits differ in some countries and in some cases are more restrictive. ITU recommends that if radio frequency (RF) EMF limits do not exist, or if they do not cover the frequencies of interest, then ICNIRP limits should be used.

Restrictions are based directly on established health effects. Reference levels for human exposure to electric, magnetic and electromagnetic fields are derived from the basic restrictions using the worst- case assumption about exposure. In many cases, it is difficult to assess basic restriction levels in real situations. If the reference limits are met, then the basic restrictions will also be met; however, if the reference levels are exceeded, it does not necessarily mean that basic restrictions are exceeded. Reference levels are used, as it is comparatively easy to measure them; basic restrictions are used mainly for mobile handsets and in cases where exposure exceeds reference levels.

In Table as below, basic restrictions and reference levels from [b-ICNIRP Guidelines] and [b-IEEE Std C.95.1] are presented. Average limits values shall be measured over 6 min.

Table 4.8 : Electromagnetic Field International Whole Body Exposure Limits

Frequency band	[b-ICNIRP Guidelines] limit	[b-IEEE StdC.95.1] limit
10 MHz < $f \leq$ 3 GHz	0.08 W/kg	0.08 W/kg
3 GHz < $f \leq$ 10 GHz	0.08 W/kg	10 W/m^2
10 GHz < $f \leq$ 300 GHz	10 W/m^2	10 W/m^2
400 MHz < $f \leq$ 2 GHz	2 W/m^2-10 W/m^2 (28 V/m-61 V/m)	2 W/m^2-10 W/m^2 (27.5 V/m-61V/m)
f > 2 GHz	10 W/m^2 (61 V/m)	10 W/m^2 (61 V/m)

(Source: ITU-T K.Suppl.9(05/2019))

Regarding Radio frequency electromagnetic field exposure due to future 5G deployment, para 9 of recommendations mentions that:

To date, the World Health Organization (WHO), the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) of the European Union and ICNIRP have concluded that exposure related to wireless networks and their use does not lead to adverse effects for public health if it is below the limits recommended by the ICNIRP. Research on possible human health effects of RF EMF exposure to mmWave frequencies goes back many decades and is continuing. These opinions are based on considerable scientific research that has been conducted on mobile phone frequencies. There are fewer biological studies on frequencies above 24 GHz. Some countries plan to support research on biology, epidemiology and dosimetry in this area. In terms of research specifically on the 5G frequency range, [b-EMF portal] (endorsed by [b-WHO]) lists approximately 350 studies on mmWave EMF health-related research. Further research may still be required on some specific implementations of 5G technologies.

Hence, according to the recommendations, since the 5G Technology shall be deployed in the frequency bands for which the safe limits have already be recommended by ICNIRP and IEEE, hence already existing guidelines shall be valid for 5G Technology also, broadly.

Para 10 recommends that

…..

some communication materials be written in order to educate and inform about the new 5G technology and human exposure to RF EMFs.

Key messages about 5G RF EMF exposure are:

– *existing international exposure guidelines are not technology specific and apply to all new applications;*

– *visual impact: 5G will use similar physical antennas, and power as 4G, but with a new technology that allows very high data rates;*

– *exposure levels: home transmitters and their characteristics are not expected to differ significantly from that of existing Wi-Fi;*

– *in the short-term, the 5G network is not intended to replace existing networks, but will operate in conjunction with existing 4G networks.*

The recommendations hence advice for the proper communication and information to the public regarding the 5G Deployment and human exposure to RF RMF.

4.2 Guidelines and Standards set by the Government of India for EMF safe exposure Limits

In the year 2008 when mobile connections in India had crossed the mark of 300 Million, mobile tele-density was reaching 30% mark and annual mobile growth rate had stabilized to around 150%,Government of India, based on global developments and growing public concerns in India, started to focus its attention towards EMF Emission from mobile towers and mobile phones. In India, this monitoring work is done by Department of Telecommunications (DoT), who issues instructions regarding setting up of acceptable EMF emission limits and the testing procedure to be followed.

Since the mobile services in India are operated by various Telecom Service Providers (TSPs) based on the licences issued to them, as a first step, DOT issued orders to amend

the conditions of Licence agreement of various Cellular Mobile Telecom Services (CMTS) and Unified Access Service (UAS) providers on 4th November 2008[51]. As recommended by WHO, DoT adopted the ICNIRP (1998) Guidelines and prescribed limits/ levels for antennas (Base Station Emissions) for general public exposure, as an immediate measure. In the licence agreement, a clause 46.5A was inserted after clause 46.5, which reads as under,

"46.5 A. Licensee shall conduct audit and provide self-certificates annually as per procedure prescribed by Telecommunication Engineering Centre (TEC)/ or any other agency authorized by licensor from time to time conforming to limits/ levels for antennae (Base station Emissions) for general public exposure as prescribed by International Commission on Non-Ionizing Radiation Protection (ICNIRP) from time to time. The present limits/levels are reproduced as detailed below:

TABLE 4.9: Safety Limits of Electromagnetic Radiations from Mobile Towers (BTS) Adopted by Government of India in the Year 2008

Frequency Range	**E-Field Strength (Volt/Meter (V/m))**	**H-Field Strength (Amp/Meter (A/m))**	**Power Density (Watt/Sq. Meter (W/Sq. m))**
400 MHz to 2000MHz	$1.375\ f^{1/2}$	$0.0037f^{1/2}$	f/200
2GHz to 300GHz	61	0.15	10

(f=frequency in MHz)

(Source: DOT Website)

[51] https://dot.gov.in/sites/default/files/15.Amendements%20dated%2004.11.2008.pdf?download=1 accessed 29 February 2020

Note: The compliance in the form of Self Certificate shall commence six months after the date of issue of prescribed test procedure by TEC or any other agency authorized by licensor."

As per above letter, operators are required to conduct audit and submit self-certificates on annual basis. For this, based on, ITU-T Recommendation K.52 (2004) (Guidance on complying with limits for human exposure to EMF) & ITU-T Recommendation K.61 (2003) (Guidance to measurement & numerical prediction of EMFs for compliance with human exposure limits for telecom installations), TEC, the technical wing under DoT, issued an elaborate test procedure for measurement of EMFs from base station antenna for telecommunication sector during the last quarter of 2009, which was then circulated to all operators.

Based on the above test procedures, DoT asked all the operators to submit self-certificates of all their sites by 15.05.2010 (date later extended to 15.11.2010 and then to 31.03.2011) to DoT's field unit in each state i.e. the Telecom Enforcement Resource & Monitoring (TERM) cell. Additionally, it was ordered that

- Any new BTS site will start radiating only after self-certification,
- TERM cell was also entrusted with the job of 10% random sample check and to test the sites against which there are public complaints,
- The cost of this testing, @ Rs.10,000 per site and the testing tools & equipments are to be provided by the concerned operator,
- In case of any site failing in tests, penalty of Rs.5 lakh was imposed per BTS per operator, with a time limit of 1 month to comply else site to be shut down.

4.2.1 Revision of norms:

On 24.08.2010, due to continuing public concern about adverse effect of EMF radiation on health, DoT set up an Inter-ministerial Committee consisting of officers from DoT, Indian Council of Medical Research (Ministry of Health), Department of Biotechnology and Ministry of Environment and Forest to examine the effects of Electromagnetic Field radiation from base stations and mobile phones on human health at levels below the existing standards. The committee took into consideration the presentations/ viewpoints of Prof. J. Behari from JNU, Telecom Equipment Manufacturers Association (TEMA), Cellular Operators Association of India (COAI)/ Association of Unified Service Providers in India (AUSPI), Telecom Users Group of India (TUGI), Consumer Care Society (CCS), Bangalore and Prof. Girish Kumar, IIT, Bombay. Inter-Ministerial Committee (IMC) in its report examined the environmental and health related concerns and indicated that most of the laboratory studies were unable to find a direct link between exposure to radio frequency radiation and health; and the scientific studies as yet have not been able to confirm a cause and effect relationship between radio frequency radiation and health. The effect of emission from cell phone towers is not known yet with certainty. The inter-ministerial committee (IMC) examined 90 international and national studies/reference papers, related with the EMF radiation, before finalizing its recommendations.As per the report[52] *"The hot tropical climate of the country, low body mass index (BMI), low fat content of an average Indian as compared to European countries and high environmental concentration of radio frequency radiation may place Indians under high risk of radio frequency radiation*

[52] Department of Telecommunications Inter-Ministerial Committee. (2010). *Report of the Inter-Ministerial Committee on Electromagnetic Radiation,* pg.33

adverse effect and the level of susceptibility of an average Indian may be different. Hence revision of radiation norms may be considered for adoption in India keeping in view the possible health concern."

Recommendation of committee, related to mobile base stations stated, "*The RF exposure limits in India may be lowered to 1/10th of the existing level keeping in view the data submitted by COAI/ AUSPI during presentation made to the committee and trend adopted by other developed countries."* Similarly, that related to handsets the committee stated, "*Adoption of SAR level for mobile handsets limited to 1.6 Watt/Kg, averaged over a 6 minutes period and taken over a volume containing a mass of 1 gram of human tissue as per the FCC norms of U.S."*

4.2.2 Based on above recommendations, DoT issued orders to all the operators asking for the self-certificates for all BTSs, as per the lowered norms, with effect from 01.04.2012 (later shifted to 01.09.2012).

Table 4.10: Revised Safety limits for Electromagnetic Radiations from Mobile Towers (BTS) in India

Frequency Range	E-Field Strength (Volt/Meter (V/m))	H-Field Strength (Amp/Meter (A/m))	Power Density (W/Sq. m)
400MHz to 2000MHz	$0.434f^{1/2}$	$0.0011f^{1/2}$	f/2000
2GHz to 300GHz	19.29	0.05	1

(f=frequency in MHz) (Source: DoT website)

Accordingly the revised test procedure as per the new norms was issued by TEC in Oct.2012[53] and the revised norms were incorporated by DoT in the Licence agreements on

[53] Telecom Engineering Center Department of Telecom. (2012). *Test Procedure for Measurement of Electromagnetic Fields from Base Station Antenna.* http://www.tec.gov.in/pdf/Radio/Test%20Procedure%20EM%20Fields%20From%20BTS%20Antennae%20OCT%202012.pdf accessed 01 March 2020

10.01.2013[54] wherein the period of self-certification was also changed from 1 year to 2 years with the running cycle ending on 31.03.2013. As per the TRAI information paper[55], consequent to this revision by DoT, Indian standards are now 10 times more stringent than many countries (like USA, Canada, Japan and Australia) in the world which follow ICNIRP guidelines.

Table 4.11: Revised EMF Radiation Safety Limits (in Power Density) for Mobile Towers (BTS) in India

Frequency	ICNIRP Radiation Norms (Power Density)	Revised DoT Norms effective from 01.09.2012 (Power Density)
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 and above	10.0 Watt/ sq.m	1.0 Watt/sq.m

(Source: TRAI, Information paper No. 01/2014-QoS published 30th July 2014)

4.2.3 EMF Radiation limit from Mobile Handsets:

With effect from 1st Sept. 2012, the SAR values for mobile phones have been revised to 1.6 W/kg averaged over 1 gram of human tissue.

Table 4.12: Revised EMF Radiation Safety Limits for Mobile Handset in India

Frequency (10 MHz to 10 GHz)	ICNIRP SAR Limit	Revised SAR Limit effective from 01.09.2012
General Public Exposure	2 Watt/Kg (averaged over 10gm tissue)	1.6 watt/Kg (averaged over 1 gm tissue)

(Source: TRAI, Information paper No. 01/2014-QoS published 30th July 2014)

[54] https://dot.gov.in/sites/default/files/146.pdf?download=1 accessed 01 March 2020

[55] 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*

The International EMF Exposure Limits for Mobile Towers (BTS) at 1800 MHz is given in Table 4.13.

Table 4.13: International EMF Exposure Limits 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) Precaution recommendation only
0.001 W/m2	Exposure limit in Austria

(Source: TRAI, Information paper No. 01/2014-QoS published 30th July 2014)

4.2.4 Following are the reference levels of EMF Exposure based on international and national guidelines:

Table 4.14: Reference levels for the General Public at 900 & 1800 MHz at International Level

Country or Organization	Document	900 MHz		1800 MHz	
		Electric field (V/m)	Power density W/m^2	Electric field (V/m)	Power density W/m^2
International health based guidelines					
ICNRP	ICNIRP 1998	41.25	4.5	58.3	9.0
International/ IEEE	IEEE,1999 USA	47.6	6.0	67.3	12
European/ European Committee for Electro technical Standardization (Technical committee)	CENELEC,1995	41.1	4.5	58.1	9.0
National health based guidelines					
Australia/ Standard Association of Australia	AS/NSZ, 1998	27.5	2.0	27.5	2.0
East European health based guidelines					
Hungary/ Hungarian Standard Institution	Hungary, 1986	6.1	0.1	6.1	0.1
National guidelines based on precautionary approaches					
--	Belgium	20.6	1.1	30	2.4
Italy/ Ministry of Environment	Italy 1, 1998	20	1.0	20	1.0
Italy/ Ministry of Environment	Italy 2, 1998	6	0.1	6	0.1
Switzerland/Schweizer Bunndesrat	NISV, 1999	4	0.04	6	0.1
Local recommendations, based on precautionary approaches					
Austria Local	S vorGW 1998	0.6	0.001	0.6	0.001

(Source: DOT IMC Report, 2010)

SAR values for mobile handsets in some countries have been restricted as follow:

Table 4.15: Restricted SAR Values for Mobile Handsets at International Level

Countries	SAR value limits
China	2W/kg averaged over 10g of tissue
Singapore	2W/kg averaged over 10g of tissue
Ghana	2W/kg averaged over 10g of tissue
Brazil	2W/kg averaged over 10g of tissue
Nigeria	2W/kg averaged over 10g of tissue
Japan	2W/kg averaged over 10g of tissue
Republic of Korea	2W/kg averaged over 10g of tissue
Europe	2W/kg averaged over 10g of tissue
Australia	1.6 W/kg averaged over 1 g of tissue
USA	1.6 W/kg averaged over 1 g of tissue
Canada	1.6 W/kg averaged over 1 g of tissue

(Source: TRAI, Information paper No. 01/2014-QoS published 30th July 2014)

India has adopted the most stringent SAR values for mobile handsets when compared to other countries (at par with USA, Canada & Australia).

From 01 September 2013, only mobile handsets with the revised SAR value of 1.6 W/kg are permitted to be manufactured or imported into India. It is mandatory for manufacturers to display the SAR level on each mobile handset.

4.2.5 On 20.11.2013, DoT revised the penalties in case of violation on the matter of Electromagnetic Radiations as penalty for delay/ non-submission of self-certificate for new/ up-gradation of BTS as

Table 4.16: Revised penalties for new/ upgraded BTS

Delay from due date	Total penalty per BTS per incidence
Up to 15 days	Rs.5,000/-
Beyond 15 days to 30 days	Rs.20,000/-
Beyond 30 days to 60 days	Rs.50,000/-
Beyond 60 days	BTS to be shut down

(Source: DoT website)

- Penalty for delay/ non-submission of biennial self-certificate for existing BTSs

Table 4.17: Revised penalties for delay/ non-submission of self-certificate

Delay from due date	Total penalty per BTS per incidence
Up to 30 days	Rs.5,000/-
Beyond 30 days to 60 days	Rs.20,000/-
Beyond 60 days to 90 days	Rs.50,000/-
Beyond 90 days	BTS to be shut down

(Source: DoT website)

- In case of non-compliance of norms being found by TERM cell, the penalty was increased to Rs.10 lakh per BTS.
- As per the latest guidelines issued by Department of Telecommunications vide Letter No. **800-36/2014-AS.II Dated 29.03.2019,** If a site fails to meet the EMR criterion, in case of a shared site, now a penalty of Rs 20 lakh per BTS per incidence has been prescribed to be imposed on rogue BTS(s) (BTS whose exposure ratio/index is more than '1') if the site becomes compliant after removing contribution of that rogue BTS(s).

4.2.6 Review of exposure limits in 2014 by Committee constituted in compliance of direction by Hon'ble High Court Allahabad:

In a Writ Petition filed in Hon'ble High Court Allahabad, Lucknow bench, the Hon'ble Court vide its order dated 10.01.2012 constituted a committee including Members from IITs Kharagpur, Kanpur, Delhi, Roorkee, Bombay and from other scientific institutions of the country including Indian Council of Medical Research (ICMR) and All India Institute of Medical Science (AIIMS) Delhi who submitted its Report on 17-01-2014. The Committee observed[56] that the Department of Telecom has taken adequate steps to impose stricter precautionary limits for EMF radiation from mobile towers as well as from mobile handset/phones. After due consideration of the human health concerns on account of EMF radiation being raised in public and the Report of the Committee, the Government has decided in February 2014 that the present prescribed precautionary EMF safe exposure limits are adequate and need no further change at this stage.

4.3 Measures being taken by the Government of India to deal with inconvenience and possible adverse effect from the exposure of RF EMF by Mobile Communication Technology.

4.3.1 Ensuring compliance to various safe limits standards:

4.3.1.1 Safe limits for emission from Base Transmitting Stations (mobile towers) - DoT on 08.04.2010 directed all CMTS/UAS licensees for compliance of the reference limits/ levels prescribed, by way of self-certification of their Base Transmitting Stations (BTS)

[56] https://dot.gov.in/sites/default/files/DOC120314-002.pdf accessed 29 February2020

for meeting the EMF radiations norms. As per these directions, all BTSs should be safe limit compliant and all BTSs should be self-certified as meeting the radiation norm. Self-certification is submitted to respective License Service Area (LSA) field units of DoT (earlier called TERM Cells) All new BTS sites start radiating commercially only after self-certificate has been submitted to relevant LSA field units of DoT. In order to ensure compliance to the prescribed stricter precautionary norms of EMF radiation from mobile tower, the extensive audit of compliance of self-certificates being submitted by telecom service providers and base transceiver station (BTS) sites is carried out by LSA field units of DoT. This is regularly done by LSA field units of DoT for the purpose of limiting the EMF radiation exposure and keeping general public areas in the vicinity of towers safe. The testing is done as per procedures prescribed by Telecom Engineering Centre (TEC) from time to time. TEC has published the Test Procedure for measurement of EMF from BTSs vide document no. TEC/TP/EMF/001/04.JUNE.2018.[57]

4.3.1.2 If a site fails to meet the EMR criterion, in case of a shared site, a penalty of Rs 20 lakh per BTS per incidence has been prescribed to be imposed on rogue BTS(s) (BTS whose exposure ratio/index is more than '1') if the site becomes compliant after removing contribution of that rogue BTS(s). However, if the site is not compliant even after removing the contribution of that rogue BTS (s), then a penalty in proportion to the exposure ratio (Rs. 20 lakh x Exposure Ratio) is prescribed to be imposed on all the remaining participating BTSs. In addition to levy of financial penalty as mentioned above, if the BTS

[57] Telecom Engineering Center Department of Telecom. (2018). *Test Procedure for measurement of Electromagnetic Fields from Base Station Antenna.* http://www.tec.gov.in/pdf/Radio/TSTP%20EMF%20Measurement.pdf accessed 15 January 2020

is not made compliant to the EMF radiation norms within 30 days by the erring TSP, the same is required to be shut down as per prescribed procedure in accordance with Letter No. **800-36/2014-AS.II Dated 29.03.2019**

4.3.1.3 As of 31.12.2019, a total of 8,51,195 number of BTSs have been tested by various LSA field units of DoT, out of which a total of 359 BTSs have been found non-compliant to EMF radiation norms (exceeding the prescribed radiation limits) since the inception of BTS testing by LSA field units of DoT from 16.11.2010. Further, a penalty of more than 20 Crores has been levied for such BTSs.

4.3.1.4 In addition to imposition of penalty on account of violation of EMF radiation norms (exceeding the prescribed radiation limits), penalty is also being levied for violation of EMF self-certification norms and violation of EMF signage norms. For non-submission/ delayed submission of self-certificates in case of biennial cycle or new BTS installation or BTS upgradations, a graded financial penalty ranging from Rs 5,000/- to Rs 50,000/- is imposed on defaulting TSPs depending upon the delay w.e.f. 20.11.2013. Before 20.11.2013, a penalty of Rs. 5,00,000/- per self-certificate was prescribed on account of any of the above violations.

4.3.2 Spreading the awareness in public on EMF issue:

4.3.2.1 Steps Taken by DoT:

i. Department of Telecommunications (DoT) has initiated a nation-wide Awareness Programme on EMF Emissions & Telecom Towers to build a direct bridge of engagement between different stakeholders and to fill the information gap with

scientific evidence. These Programmes have further been followed up at sub-state level by the LSA field units of DoT so that more and more people are made aware about the scientific facts on health effects of EMF emissions from mobile towers.

ii. Pamphlets/ Information Brochures on various topics related to EMF have also been published and distributed in various regional languages.

iii. Detailed information on EMF related issues and steps taken by Government of India in this regard have been made available on DoT website www.dot.gov.in in the section "A Journey for EMF" (http://www.dot.gov.in/journey-emf).[58]

iv. DoT has issued Broad guidelines for issue of clearances for installation of Mobile Towers that were revised with effect from 01.08.2013 and forwarded to Chief Secretaries of all the State Governments. These guidelines require State Governments along with DoT to organize public awareness programmes involving civil society members.

v. Government has issued advertisement for ensuring safety from radiations of mobile towers & handsets which has been published in National & Regional Newspapers.

vi. During EMF testing to check the compliance of EMF radiation norms, officers of LSA field units of DoT have been interacting with local resident of societies/localities and

[58] Department of Telecom. *A Journey for EMF*. http://www.dot.gov.in/journey-emf accessed 01 March 2020

educating them about Mobile phone/Tower radiation and make aware about misconception of EMF radiation related health consequences.

vii. DoT has issued an informative guide[59] on 'Mobile Communications – Radio Waves and Safety' which covers a basic introduction to radio waves, various terminologies, Do's & Don'ts related to mobile phone usage, clarification of various myths regarding deployment, use of Radio waves/ Safety Standards and frequently asked questions relating to Mobile phones & Human health, in common language.

In the FAQ in last question related to difference between EMF Radiation from mobile phone towers and mobile phones, it says, "Radiation emitted from cell phone is of a short-term, repeated nature (coherent) at a relatively high intensity, whereas Radiation emitted from BTS (mobile towers) is of long duration but is of a very low intensity. Also, in the starting section of Radio Waves and Human Body, it says, "A strong EMF may be due to a weak radiation source nearby or a powerful source far away. A human body is exposed to more EMF radiation in case of a call from mobile phone in comparison to the one from a mobile tower. The mobile phone is a weak source of RF signal, but it is very close to human body, whereas the more powerful mobile tower is at far end."

[59] Department of Telecommunications. *Handbook on Mobile Communication – Radio Waves & Safety*

4.3.3 EMF Web portal

4.3.3.1 Department of Telecom (DoT), Ministry of Communications has launched Tarang Sanchar[60], a web portal for Information sharing on Mobile Towers and EMF Emission Compliances, with a view to generate confidence and conviction with regard to safety and harmlessness from mobile towers, clearing any myths and misconceptions. The portal can be accessed at www.tarangsanchar.gov.in. The EMF Portal provides a public interface where an easy map-based search feature has been provided for viewing the mobile towers in vicinity of any locality. By click of a button, information on EMF compliance status of mobile towers can be accessed. Detailed information about any tower site, if requested, will be sent on email to the users.

4.3.3.2 Additionally, any person can request for EMF emission measurement at a location by paying a nominal fee of Rs 4000/- online. Local License Service Area (LSA) field unit of DoT will conduct the test (the requestor can be present, if he so desires) and the test reports will be provided.

4.3.3.3 The portal also has 'EMF Overview' and 'Learn' Sections, which provide numerous articles, booklets and videos, to further educate the citizens about EMF and coverage of telecom services. Public can also access the 'DoT Initiatives' section which has information on various leaflets, articles and Frequently Asked Questions. The portal has the complete collated technical details of about 22 lakh

[60] https://tarangsanchar.gov.in/emfportal accessed 02 March 2020

base stations (BTSs) spread across the country of all technologies (2G, 3G, 4G etc.) and of all Telecom Service Providers (TSPs).

4.3.4 Advisory for local governments

4.3.4.1 Although fixation of standards for exposure limits of radio frequency field emissions from mobile base stations, monitoring their compliance, all radiation related technical issues, issues related to Access Service Licence/ Infrastructure Provider registration and SACFA clearance for frequency allocation at any place are dealt with by DoT but the NOC/ approval for installation of mobile towers is given by local bodies which come under state governments. Accordingly, DoT has given advisory in the form of broad guidelines related to clearances for installation of Mobile Towers, to all the State Governments on 23.08.2012 which were later revised from 01.08.2013[61].These guidelines were finalized after careful consideration of views of all stakeholders including State Government and Civil society, keeping in view the need to maintain the present momentum of telecom growth while addressing the public concerns about safety and human health.

As per the advisory guidelines for State Government issued by DoT, no restriction has been imposed on installation of tower on specific buildings such as schools/hospitals/playgrounds etc. These guidelines were re-iterated to State Governments through DoT's letter dated 28.10.2014. and some of its salient points are as follows:

[61] https://dot.gov.in/sites/default/files/Advisor%20STC%20DTC.pdf accessed 01 March 2020

4.3.4.2 Documents to be submitted by Telecom Service Providers/ Infrastructure Providers for obtaining clearance from local bodies/ state governments for installation of mobile towers:

- Copy of relevant license/ Infrastructure Provider Registration Certificate from Department of Telecommunications.
- Data Sheet
    - Name of Service/Infrastructure Provider
    - Location
    - Tower Reference: i) Height, ii) Weight, iii) Ground/Roof Top, iv) Pole/wall mounted, v) Number of antennae
- Copy of SACFA clearance/ copy of SACFA application for the said location submitted to WPC wing of DoT with registration number as WPC acknowledgement along with undertaking that in case of any objection/ rejection, TSPs/ Infra Providers will take corrective actions/ remove the tower.
- Copy of structural stability certificate for ground based tower. In case of roof top BTS towers, structural stability certificate for the building and tower based on written approvals of any authorized Structural Engineer of state/ local bodies/ Central Building Research Institute (CBRI), Roorkee/ IIT/ NIT or any other agency authorized by local body.
- Copy of type test certificate issued by Automotive Research Association of India (ARAI) to the manufacturers of the Diesel Generator (DG) Sets.
- Copy of clearance from Fire Safety Department only in case for high rise buildings where Fire Clearance is mandatory.

- For forest protected areas, the copy of clearance from State Environment & Forest Department, if applicable.
- Local bodies may also seek submission of copy of No Objection Certificate (NOC) from Building Owner/ entities having roof top rights or roof top tenants in case of roof-based tower/ land-owner in case of ground based tower, as the case may be. As per their rules in force, State Governments, may seek fresh NOC at the time of renewal of site (tenancy) contract for mobile tower.
- Acknowledgement receipt issued by TERM Cells (DoT)(Now LSA Units) of the self-certificate submitted by Telecom Service Provider/ Infrastructure Provider in respect of BTS/ mobile tower (ground based/ roof top/ Pole/ wall mounted) in the format as prescribed by TEC, DoT, establishing/ certifying that all General Public areas around the tower will be within safe EMR exposure limit as per peak traffic measurement after the antennae starts radiating.

4.3.4.3 Action by State government/ Local body

- Nominal one time Administrative Fee as decided by the State Government to recover its costs on issue of permission for installation of tower.
- Single Window Clearance may be provided in a time bound manner to telecom service provider/ infrastructure provider by the local body/ State Government. This will ensure issuance of faster clearances.
- Telecom towers have been given infrastructure status by Government of India vide gazette notification no 81 dated 28.03.2012. All benefits, as applicable to infrastructure industry, should be extended. Electricity connection may be provided to BTS site on priority.

- Telecom installations are lifeline installations and a critical infrastructure in mobile communication. In order to avoid disruption in mobile communication, an essential service, sealing of BTS towers/ disconnection of electricity may not be resorted to without the consent of the respective TERM Cell of DoT in respect of the EMF related issues.
- State Governments along with DoT may organise public awareness programmes involving civil society members.
- In order to effectively address Public Grievances relating to installation of towers & issues related to telecom infrastructure, State Govts. may setup:
    - State Level Telecom Committee (STC) consisting of officers from TERM Cells, State Administration, representative(s) of concerned Telecom Service Provider(s) and eminent public persons etc.
    - District Level Telecom Committee (DTC) consisting of officers from District Administration, representative(s) of concerned Telecom Service Provider(s) and eminent public persons etc.

4.3.5 On the directive of Prime Minister's Office (PMO), Department of Science & Technology (DST) has constituted a Committee on 01.10.2012, under the Chairmanship of former Director General (ICMR), having representative from IIT Chennai, Indian Institute of Toxicology Research, Lucknow, Department of Telecom, Ministry of Environment & Forest, ICMR and DST to examine the harmful effects from Cell towers on the population living in the vicinity and for developing the frame of reference for calling out Request For Proposals (RFPs) for scientific assessment of health hazards and adverse impact on ecology.

4.3.5.1 Based on the recommendation of this Committee, Science and Engineering Research Board (SERB)[62] has invited R&D proposals in June, 2013 for scientific investigations on radiation hazards and risk potentials from Mobile Towers and Handsets on Life (humans, living organisms, flora & fauna and environment) and related Research & Development (R&D) initiatives. The SERB had constituted an Expert Committee/Task Force comprising of various experts from Medical & Engineering Institutes which had short listed 19 research studies as below. These studies have been initiated and are being supported for funding at the total cost of Rs. 9.9 crore.

Table 4.18: List of Projects Approved under Cell Tower Radiation Programme

Sr. No.	Project Title	Address of Institute
1.	Cell tower radiation: Psychosocial implications.	National Institute of Mental Health Neurosciences, Hosur Road, Bangalore, Karnataka.
2.	Molecular genetic correlates of DNA damage and repair and of circadian rhythm dysfunction in humans from non- ionizing radiation exposure.	Guru Nanak Dev University Amritsar, Punjab.
3.	Morphological, functional, biochemical and behavioural evaluation post - emf radiation.	All India Institute of Medical Sciences, New Delhi, Delhi.
4.	Effects of EMF exposure on the blood and semen parameters including sperm morphological changes by scanning and transmission electron microscopy in rabbits.	
5.	To study the effect of mobile phones on well-being, sleep and cognitive function.	
6.	Effect of EMF radiation due to mobile phone use on sleep and neurocognitive functions: A molecular approach.	
7.	Effect of microwave radiation (Mobile Telephony) on the reproductive system of the human male and modulation of the effect by environmental variables.	Indian Institute of Technology Kharagpur, West Bengal.

[62] http://www.serb.gov.in/pdfs/linkages/Cell%20Tower%20Radiation.pdf accessed 01 March 2020

8.	Development of nano composite absorbers for suppression of excess EMF radiation.	Thiagarajar College of Engineering, Madurai, Tamil Nadu
9.	Impact of EMF radiation on animal development at cellular and molecular levels.	Agharkar Research Institute, Pune, Maharashtra.
10.	Effect of electromagnetic frequency radiation (EMF) on auditory system of mobile users.	All India Institute of Medical Science, Rishikesh, Uttarakhand.
11.	Investigations on the prenatal and postnatal EMF radiation exposure in a mouse model.	Manipal University, Manipal, Karnataka.
12.	Mobile phone and tower exposure measurements and biological correlations.	Amity University, Noida, Uttar Pradesh.
13.	To study the effect of electromagnetic radiations on biological cell/ tissues/ blood cell using non-invasive imaging techniques.	Indian Institute of Information Technology and Management Gwalior, Madhya Pradesh
14.	Exploration of biological impacts of electromagnetic frequency radiation of cell-phone range and understanding mechanism of its action in plant system.	Punjab University Chandigarh, Chandigarh.
15.	To study the effect of mobile phones on well-being, sleep and cognitive function.	Sri Venkateswara Institute of Medical Sciences, Tirupathi, Andhra Pradesh.
16.	To study the effect of mobile phones on well-being, sleep and cognitive function.	Post Graduate Institute of Medical Education and Research Chandigarh, Chandigarh.
17.	Mobile-based diagnosis of sleep apnea.	Indraprastha Institute of Information Technology New Delhi, Delhi.
18.	Brain hemodynamics, cognition and subtle energy levels in teenagers: Investigation of potential acute effects of mobile phone induced EMF and the protective value of yoga intervention.	Swami Vivekananda Yoga Anusandhana Samsthana University, Bangalore, Karnataka.
19.	Statistical estimation of electromagnetic radiation using large data analysis of cell phone signal levels.	Indian Institute of Technology Madras, Chennai, Tamil Nadu

(Source: SERB website)

Recapitulating the actions taken by International Agencies and Government of India, it may be said that a lot of work has been done by the International agencies like WHO, ITU, ICNIRP, IARC, IEEE etc. to address the public concern of health issues by RF Electromagnetic Field Exposure. However, to find some conclusive evidence of health effects, some more quality researches are still required including India specific research. Government of India has adopted even ten times more stricter norms than recommended by ICNIRP, for EMF emissions from mobile towers. LSA Field units of DOT have been entrusted the responsibility to monitor the adherence of norms by the Telecom Service

Providers (TSP). All concerned have to ensure the proper implementation of the safety norms, as prescribed, in the larger interest of the general public. All needful actions must be taken to change the perception of the general public towards EMF Exposure from Mobile Communication Technology.

CHAPTER 5

GOVERNMENT INITIATIVES AND POLICY MEASURES:

DATA ANALYSIS AND INTERPRETATION

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GOVERNMENT INITIATIVES AND POLICY MEASURES:

DATA ANALYSIS AND INTERPRETATION

Data analysis and interpretation is the process of assigning meaning to the collected information and determining the conclusions, significance and implications of the findings. It is done with the goal of discovering useful information, informing conclusion and supporting decision-making.

In the present chapter, analysis of data, collected from different sources, primary as well as secondary, has been made and diagrammatic representation for data like bar graphs, line charts, pie charts etc. has been used for better visualization.

The following Data analyses and Interpretations have been done in subsequent sections, primarily:

a. Analysis of the data collected through the field survey using structured questionnaire.

b. Analysis of RF EMF Emission Level of Mobile Towers of Delhi LSA.

c. Analysis of efforts made by the Government for Ensuring compliance to various safe limits of RF EMF Emission.

d. Analysis of EMF Emission measurements as requested by the public on payment basis.

e. Analysis of Status of RTI Applications and Public Grievance Cases in relation to Mobile Tower Radiation.

f. Analysis of the actions being taken by Government for changing the perception of Public towards issue of Mobile Communication Technology.

g. Analysis of discussion with Senior officers and experts on RF EMF Emission issue.

h. Analysis of Recommendations of Inter- Ministerial Committee and action taken by Government of India on those recommendations.

i. Analysis of some prominent court judgments in respect of EMF Radiations.

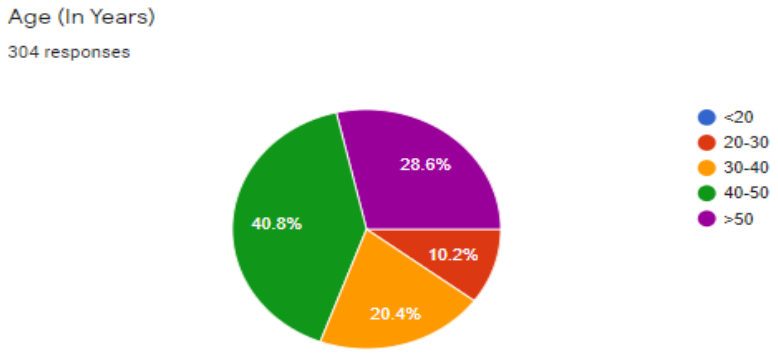
5.1 Analysis of the data collected through the structured questionnaire

With the purpose of having an insight of the impact of actions and measures being taken by Government of India to address the issue of EMF Waves Exposure from Mobile Communication Technology and Public Safety, a structured questionnaire was designed and sent to the target population. Copy of the questionnaire is attached at Appendix -1.

Basic Data about Respondents

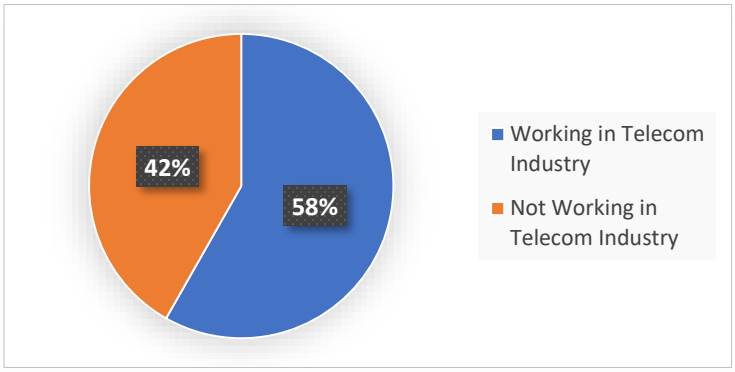
The target population included persons of different occupations like officers of various Government services as well as Defense Services, Telecom Officers, Research Academia, Teachers, Professors of Engineering Colleges, Service Providers, Medical Professionals, Private Service employees, Self -employed persons etc and of different age groups. A total of 304 responses were received. Around 41 percent of the respondents were in the age group of 40-50 years, 28.6 percent were more than 50 years, 20.4 percent were in the age bracket of 30-40 years and 10.2 percent were between 20-30 years. Figure 5.1(a)

Figure 5.1(a): Age Profile of Respondents



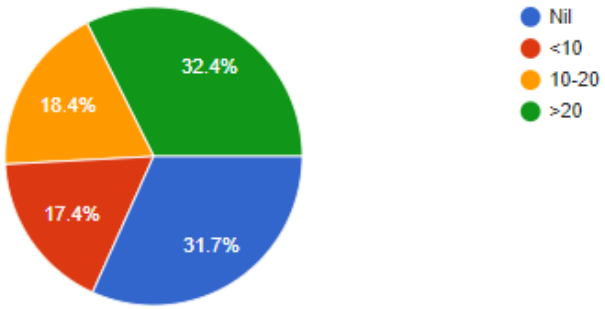
58 percent of the respondents were working in telecom industry. Figure 5.1(b)

Figure 5.1(b): Occupation of Respondents



The respondents working in Telecom Sector were having varied experience, as shown in Figure 5.1(c) (in Years)

Figure 5.1(c): Experience of Respondents in Telecom Industry



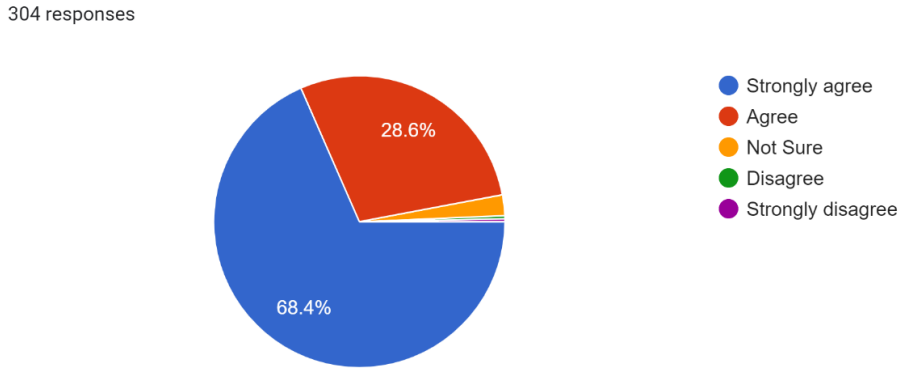
The analysis of the responses received of the questionnaire and the inferences drawn thereof are as below:

Mobile Infrastructure:

A robust and scalable mobile infrastructure including towers is a pre-requisite and must for universal access to communication, effective delivery of services to citizens and financial inclusion as per the opinion of majority of the respondents. Almost 70 percent of the

respondents strongly agreed that suitable and proper infrastructure is must to deliver proper services. Figure 5.1(d)

Figure 5.1(d): Analysis of Responses about Mobile Infrastructure



Issue of Call Drop/Slow Mobile Internet Speed

Call Drop/ Slow Mobile Internet Speed are the problems which have ever been experienced by almost all the respondents (99%) while using mobile phone. As per the opinion of majority of respondents, insufficient number of mobile towers leading to improper network coverage is one of the reasons for this issue of Call Drop/Slow Mobile Internet Speed. Figure 5.1 (e) & (f)

Figure 5.1(e): Analysis of Responses about Call Drop/Slow Mobile Internet Speed issue

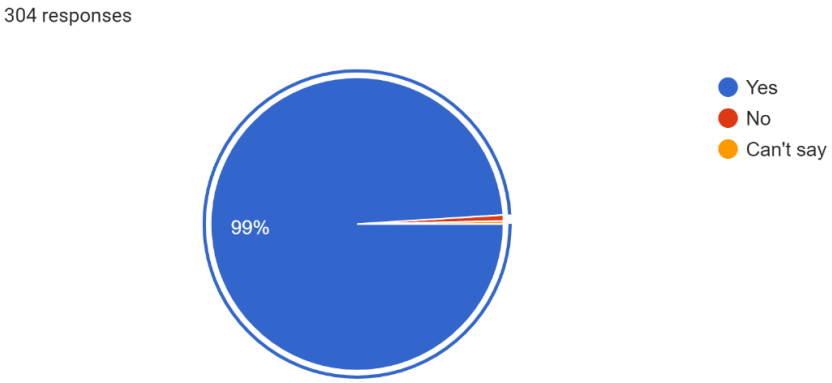
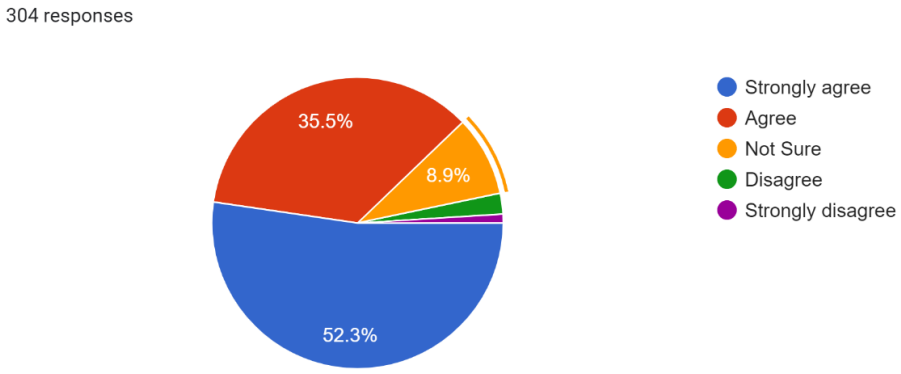


Figure 5.1(f): Reasons for the Call Drop

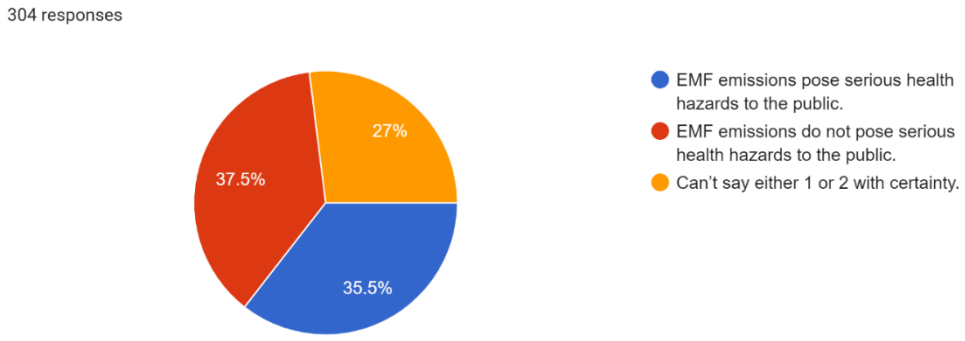


Perception about health hazards from Electro Magnetic Field (EMF) Emission of Mobile Communications:

The respondents were asked question whether EMF emissions from Mobile Communications pose serious health hazards to the public or not. Almost equal number of Respondents were having the contradictory opinion, while 27% of the respondents were not sure whether there is any such health hazard or not(Figure 5.1 (g)) .The respondents, who were of the opinion that EMF emission from Mobile Communications pose serious health hazards to the public, when further probed regarding any data, document, scientific or other evidence or any particular instance, which could substantiate their opinion, but they could not enumerate the same. Their opinion might be based on the hearsay from friends, media or some other source of information. Further analysis of individual responses revealed that even some of the Professors of Engineering Colleges, Teachers and Research Academia were also of the view that these Emissions pose serious health hazards to the public. It emanates the need to run Awareness Programmes in Schools, Colleges and

Universities. There seems the need of making more efforts for public awareness and education utilizing Mass Communication means and Media Campaigns on the issue of EMF Exposure and Public Safety.

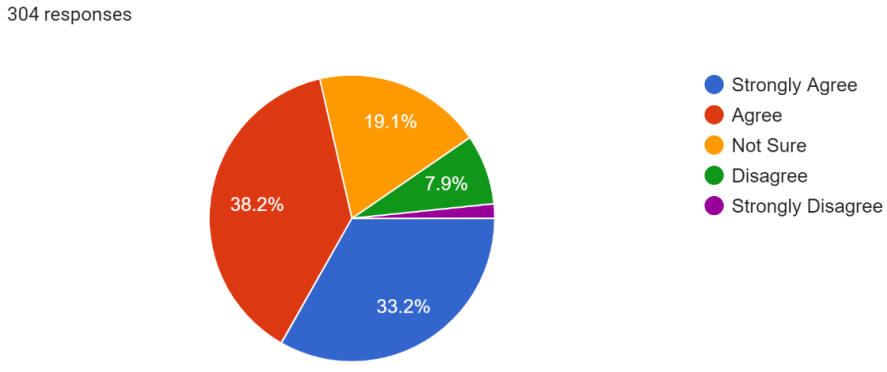
Figure 5.1(g): Analysis of Responses about Health Hazards Perception



Effect of EMF Emission from Mobile Phones:

Majority of the Respondents were in the agreement that the effects of EMF Exposure from mobile towers are debatable, but surely, whatever slight effects, if any, appear to be miniscule as compared to that of mobile phone itself. Figure 5.1(h)

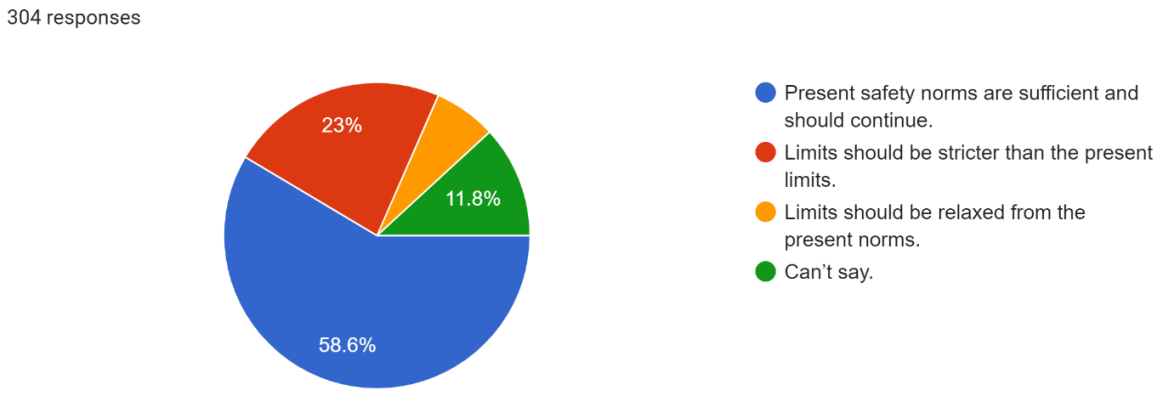
Figure 5.1(h): Analysis of Responses about Mobile Phone EMF Emission Effect



Adequacy of Present norms for safety limits set by the Government:

When asked about the adequacy of the governmental norm for safety, almost 60 percent of respondents said that the present norms set by Government of India for the maximum permissible limits of EMF Emission from Mobile Towers and Mobile Handsets are sufficient and should continue. Figure 5.1(i)

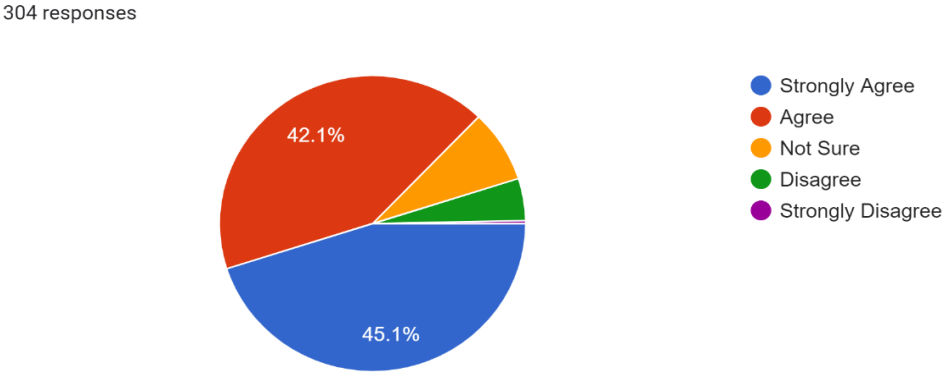
Figure 5.1(i): Analysis of Responses about Adequacy of Present norms safety limits



Opinion about the steps taken by the Government:

Steps taken by the Government for addressing the issue of EMF Waves emission and Public Safety are in the right direction in the opinion of majority of the respondents. Figure 5.1(j).

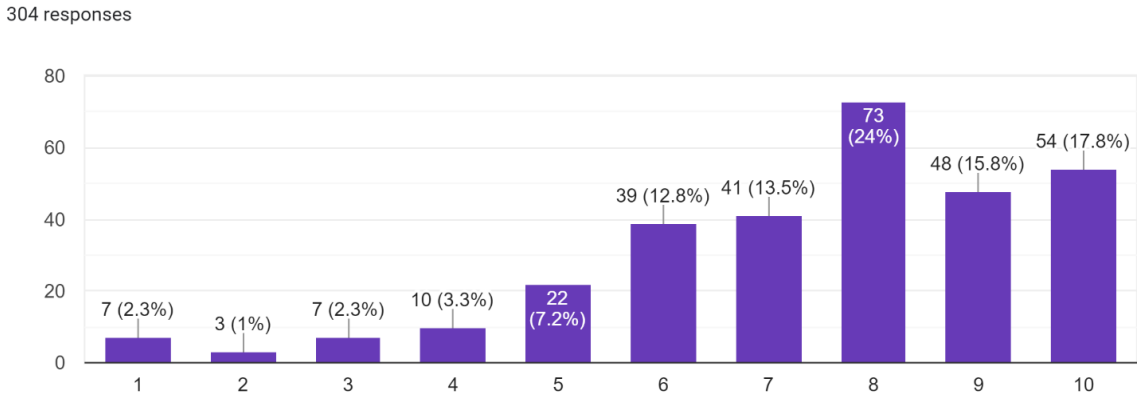
Figure 5.1(j): Analysis of Responses about Steps taken by the Government



Rating of the efforts made by the Government:

It was requested to rate the efforts made by the Government on the issue of EMF Waves emission and Public Safety, on a scale from 1 to 10. The maximum respondents (73 in No.) have rated these efforts as 8. Figure 5.1(k).

Figure 5.1(k): Analysis of Responses about Rating of the efforts made by the Government



Suggestions for Changing the Perception of General Public:

Respondents have also furnished certain suggestions regarding actions which Government should further take to change the perception and boost the confidence of General Public towards issue of EMF Emission from Mobile Communications. The main suggestions as received are as below:

- **Need for awareness and education**: Though the government efforts appear to be commensurate with the challenges, the public concerns remain unaddressed due to trust deficit on what the government says on this issue. Effective media campaign to create awareness is also equally important. The data indicates that there is mere apprehension

among the respondents regarding health hazards from the emissions. The main reason for it is lack of knowledge among the public. Therefore, there is need for government to ensure more engagement of common public and more mass communication through various medium. For that the government must conduct programs for public awareness. More public touch points need to be created on continuous basis for their awareness. More interaction with public through mass media and awareness campaigns. Assistance may be taken by forming independently empaneled bodies involving academicians, doctors and public authorities.

Following measures have been suggested by the respondents:

- **Awareness among young**: The youth are more connected with the technology and use it more often. Therefore, facts about emission levels, its effect on health and precautionary measures in use of mobiles should be shared with them at school and college level.
- Public awareness on social media, FM channel, cable TV in local language is required.
- **Participation of Civil Society Organizations**: NGOs and civil society organizations should be involved in generating awareness on mobile technology among masses. The government can also organize awareness program in educational institutions and rural areas with the help of NGOs; this will help to mitigate public fear.
- Prime Minister's MAN KI BAAT platform could be used to give citizens trust. Programme like DECATHELON are also effective.
- More aggressive publicity through all means is required especially in rural

sector and lower section of society.

- Confidence building exercise be done, involving some public representatives in the form of committee etc., to increase and convey the awareness.
- Spread more awareness by printing on handphone boxes/brochures, SIM-card application forms etc. Audio/video ads via radio/TV media, corporate counselling programs etc.
- Proper communication of information to public and strict guidelines implementation by Infra providers/TSPs is must for change in perception of public.
- Information should be printed mandatorily on mobile phone package just like the warning on cigarette packet.
- A leaflet of Do's and Don'ts while using mobile handset should be made mandatory with every new mobile handset package.

- **Participation of Citizens in Audit:** Compulsory periodic audit is a good medium for ensuring compliance to stipulated norms. Government should allow citizens to participate in all audits. Citizens should also be facilitated to do random checks. Something similar to quantity of fuel checking at petrol pumps. This will help build confidence among public.
- **Mobile Infrastructure:**
  - Telecom sector should be treated as infrastructure. All towers should display emission levels measured on at least quarterly basis. The height of

towers should be raised. Right of Way (ROW) should be given to roll out maximum tower for smooth network as poor QOS affects many parameters.

- In general, the public is not so averse to radiation effects of towers as compared to installation of tower structure nearby their homes fearing structural safety etc. Therefore, Central and State Governments should come out with a clear policy to provide space for towers in all Governments owned premises (like for example Central Delhi). Similarly, the approval procedure for new towers, including structural approval should be enforced and streamlined.
- Upcoming technologies like 5G etc. may require even much more densification. End effect will be socio economic inclusion through digital inclusion. Ultimately these towers will contribute in building Shrestha Bharat. So, all citizens to strongly cooperate the government guidelines in putting adequate no of towers while checking health hazards of citizens by the way of implementing radiation guidelines.
- All telecom operators should be asked to deploy technologies like Self Optimizing Network (SON) to better utilize RAN Infrastructure. Adoption of hot spots in gray areas/ blind spots to provide better coverage. Sharing of RAN resources.
- The VoLTE facility available in mobile for calling through Wi-Fi is better solution to adding tower or increasing the radiation of towers. As customers complain about weak signals and call drop Wi-Fi is best solution with

comparatively low radiation.

- Promote cabled data transfer rather than open air.
- Some Digital devices should be installed at various places or towers to show the level of radiations with details of safe limits.

- **Business Self-regulation:** General perception is that involved companies should self-regulate and honestly find out long term solution for eradication of EMF waves effect on health and adopt precautionary measures to reduce the effect. And, if they fail to do so on their own, government should direct them to adopt these measures forcibly.
- **Better Monitoring and Supervision by Government:** The government should strengthen the implementation of current regulations. Periodic checks to be made and reports should be published for public and punitive actions should be taken against defaulters.
- **Stricter Punishment for violation of Norms:** The respondents were of the opinion that the Penalty may be enhanced. Some opined that the same should be made 10 times of the present and there should be stricter enforcement. This will encourage better compliance. Strict action be taken if any breach of radiation found by any of the service providers.
- **Need for Research**: More research must be carried out with regard to the effects of EMF on human body.

5.2 Analysis of RF EMF Emission Level of Mobile Towers of Delhi LSA

Government of India adopted the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines in the year 2008 for basic restriction levels of Electromagnetic radiation from Mobile towers and Mobile phones. These norms for

exposure limit for the Radio Frequency Field (Base Station Emissions) have been made 10 times more stringent to the existing limits prescribed by ICNIRP. Directions in this regard have been issued to the Mobile Operators on 30.12.2011. License Amendment in this regard has been issued on 10.01.2013 and 26.06.2013.

The present limits/level are reproduced as detail below –

Table 5.1: Present Safety Limits of EMF Emissions for Mobile Towers (BTS) in India

Frequency Range	E-Field Strength (Volt/Meter)	H-Field Strength (Amp/Meter)	Power Density (Watt/Sq.Meter)
400 MHz to 2000MHz	$0.434f^{½}$	$0.0011f^{½}$	f/2000
2GHz to 300GHz	19.29	0.05	1

(Source: DOT Website)

In order to ensure compliance to the prescribed stricter precautionary norms of EMF radiation from mobile tower, the extensive audit of Electromagnetic Emission by base transceiver station (BTS) sites is carried out by LSA field units of DoT. As per the norms, upto Ten Percent of the Total BTS operating in the LSA to be Audited by the field units on annual basis. This is being done by LSA field units of DoT for the purpose of limiting the EMF radiation exposure and keeping general public areas in the vicinity of towers safe. The testing is done as per procedures prescribed by Telecom Engineering Centre (TEC) from time to time. TEC has published the Test Procedure for measurement of EMF from BTSs vide document no. TEC/TP/EMF/001/04.JUNE.2018.

In order to ascertain whether the Electromagnetic Field Emission by the Mobile Towers is within the prescribed safety norms of Government of India or not, the RF EMF Emission level of one hundred mobile towers in Delhi LSA (i.e. Delhi state and NCR Area including

Gurugram, Faridabad, Noida, Greater Noida and Ghaziabad) was collected. Test procedure has been prescribed by TEC in its document Dated 04.06.2018[63]

Following is the testing procedure broadly:

1. Test Instruments Required

All instruments used for measuring RF fields have the following basic components covering the frequency range of interest:

i) Field Strength Meter or Spectrum Analyzer.

ii) An isotropic antenna or probe to sample the field.

iii) Embedded software or Laptop to process the measured results.

iv) For Frequency Selective measurements in UMTS/LTE, dedicated decoder is required.

It is important that EMF Measuring Instruments should have valid calibration certificate.

Example of Spectrum Analyser for measuring RF fields is shown in **Figure 5.2.**

For EMF Compliance check of a site, following devices or device(s) supporting the following features may also be required:

(a) Built in or plug in GPS Receiver for Longitude-Latitude logging.

(b) Laser Distance Meter.

(c) Digital Camera.

(d) Magnetic Compass for azimuth measurement.

(e) Measuring Tape.

[63] Telecom Engineering Center Department of Telecom. (2018). *Test Procedure for measurement of Electromagnetic Fields from Base Station Antenna*. http://www.tec.gov.in/pdf/Radio/TSTP%20EMF%20Measurement.pdf accessed 30 November 2019

Figure 5.2 : Spectrum Analyser Model SRM 3006 (Narda)

(With Tripod) **(Without Tripod)**

(Source: Field Survey) (Source: Field Survey)

For checking Longitude-Latitude of the Mobile Tower Site, example of the GPS Device is as below (Figure 5.3)

Figure 5.3 : GPS Device Model GPS 72 H (GARMIN)

(Source: Field Survey)

2. If the tenancy ratio of any mobile tower is more than one (i.e. more than one BTS operating on the tower, then the lowest operating frequency had to be taken for determining the maximum allowed limit of EM Radiation. For example, if the lowest operating frequency on a tower is 900 MHz, then maximum permissible EMR power density limit shall be f/2000=900/2000=0.45 W/m^2.
3. Broadband measurements are done for first stage subject to the condition that measured values do not exceed 50% of DoT prescribed limits in terms of power density value corresponding to the lowest frequency radiated at that site. Broadband measurement to be conducted for the frequency range from 700 MHz to 3 GHz. Broadband measurement of power density (watt /sq. m) may be done with an isotropic field probe.
4. Frequency Selective measurements with extrapolation for maximum traffic have to be performed if the broadband measurement exceeds 50 % of limits prescribed by DoT.
5. Measurement Spots and Time at any given base station location under test, the E Field Strength / Power Density measurements may be undertaken at: (i) Various points & Corners on the roof top (which are publicly accessible) in case of RTT / RTP sites. (ii) On roof top of adjacent buildings, and at various heights if required. (iii) Representative Locations on Ground Level surrounding the site, if required. At each location, the measurement has to be done for a period not less than 6 minutes, and RMS value of Electric Field/ Power density is measured during the above period of 6 minutes. When using Broadband Instruments, the RMS value of power density as measured above is compared with the DoT Limit of the lowest Frequency being used at the base station site.

Figure 5.4: Roof Top Tower (RTT) Site

(Source: Field Survey)

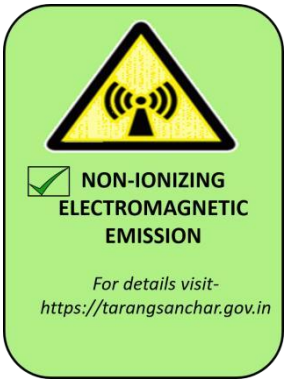
6. At the start of the test, firstly the North direction is checked using the instrument and first reading is taken at that corner for a period of minimum six minutes. Subsequently, other readings are taken in other corners each for a minimum of six minutes.

Figure 5.5 : Roof Top Pole (RTP) Site

(Source: Field Survey)

7. **Safety Signage** The proper safety signage has also to be checked. The mobile service operator has to ensure provision of proper signage warning for general public. The sign board should be clearly visible and identifiable. The sample of signboard is given below for reference:

Figure 5.6: Sample of Safety Signboard



(Source Test Procedure Document No. TEC/TP/EMF/001/04.JUNE.2018).

Figure 5.7: Safety Signboard at the site

(Source: Field Survey)

The rules for placement of signage are as follows: (1) The signage is to be fixed at an appropriate point on the roof of the building of base station in case of RTT/RTP or on the tower structure in case of GBT. (2) For base station installed on self supporting towers/GBM, the safety signage may be pasted around / install on the tower structure at 2 to 4 meters above the ground level.

Size of Signage: Signage shall be of 200mmX150mm.

The RF EMF Emission Levels of the Mobile Towers were compiled and compared to the ICNIRP Limits and also to the safe limit standards as finalized by Government of India (which are ten times stricter than those of the ICNIRP Limits) and are presented as Table 5.2.

Table 5.2:

Comparison of RF EMF Emission Levels of Mobile Towers with ICNIRP Safe Limits and with Government of India Safe Limits

Sr. No.	Address of the Tower Site	Tenancy Ratio	Lowest Operating Frequency at the tower(f)	Maximum Permissible RF Power Density safe emission limit as per ICNIRP Standards (f/200) in W/m2	Maximum Permissible RF Power Density safe emission limit as per Indian Standards (f/2000) in W/m2	Actual Measured RF Power Density Emission Level (W/m2)	% Emission level as compared to ICNIRP Standards	% Emission level as compared to Indian Standards
1	Lajpat Nagar Part -I, New Delhi-110024	4	877.5	4.3875	0.43875	0.03789	0.86	8.64
2	Central Market, Lajpat Nagar-II New Delhi 110024	6	877.5	4.3875	0.43875	0.01209	0.28	2.76
3	Nehru Nagar, Ring Road, New Delhi 110065	4	877.5	4.3875	0.43875	0.03121	0.71	7.11
4	Village- Tuglakabad, Sangam Vihar, H-Block, New Delhi-110062	3	877.5	4.3875	0.43875	0.03315	0.76	7.56
5	Power House Colony Near Hanuma, Faridabad	3	877.5	4.3875	0.43875	0.02892	0.66	6.59
6	Sector 32, Faridabad	3	877.5	4.3875	0.43875	0.007022	0.16	1.60
7	DLF Industrial Area, Part- 1, Faridabad	6	877.5	4.3875	0.43875	0.007481	0.17	1.71
8	Sector 35, Noida, U.P Pin Code-201307	8	877.5	4.3875	0.43875	0.02566	0.58	5.85
9	Sector-34 NOIDA PIN 201307	3	877.5	4.3875	0.43875	0.001658	0.04	0.38

Sr. No.	Address of the Tower Site	Tenancy Ratio	Lowest Operating Frequency at the tower(f)	Maximum Permissible RF Power Density safe emission limit as per ICNIRP Standards (f/200) in W/m2	Maximum Permissible RF Power Density safe emission limit as per Indian Standards (f/2000) in W/m2	Actual Measured RF Power Density Emission Level (W/m2)	% Emission level as compared to ICNIRP Standards	% Emission level as compared to Indian Standards
10	Sector-33 NOIDA PIN 201307	3	877.5	4.3875	0.43875	0.001318	0.03	0.30
11	Village Harsaon, Ghaziabad	11	877.5	4.3875	0.43875	0.01534	0.35	3.50
12	Sarai Khwaja, Sector- 41, District: Faridabad,	10	940.2	4.701	0.4701	0.07127	1.52	15.16
13	Shiv Colony, Link Road, Sector-19, Old Faridabad, Haryana	13	940.2	4.701	0.4701	0.08174	1.74	17.39
14	Ashoka Enclave, old Sher Shah Suri Road, Near Shri Radhika Mall, Faridabad	10	940.2	4.701	0.4701	0.04164	0.89	8.86
15	Shivaji Nagar, Gurgaon, Haryana	12	877.5	4.3875	0.43875	0.03263	0.74	7.44
16	Hari Nagar, Ashram, New Delhi	10	940.2	4.701	0.4701	0.08883	1.89	18.90
17	Block-G, Back Alley Park, Jungpura Extention, Delhi	5	940.2	4.701	0.4701	0.01547	0.33	3.29
18	Temple Road, Bhogal, New Delhi	10	940.2	4.701	0.4701	0.0577	1.23	12.27
19	Kilokari , Opp. Maharani Bagh , Delhi	9	940.2	4.701	0.4701	0.02237	0.48	4.76
20	Okhla Industrial Area, Phase - II, New Delhi	12	940.2	4.701	0.4701	0.03328	0.71	7.08
21	Okhla Industrial area, Phase-1, New Delhi	15	940.2	4.701	0.4701	0.0798	1.70	16.98

Sr.No.	Address of the Tower Site	Tenancy Ratio	Lowest Operating Frequency at the tower(f)	Maximum Permissible RF Power Density safe emission limit as per ICNIRP Standards (f/200) in W/m2	Maximum Permissible RF Power Density safe emission limit as per Indian Standards (f/2000) in W/m2	Actual Measured RF Power Density Emission Level (W/m2)	% Emission level as compared to ICNIRP Standards	% Emission level as compared to Indian Standards
22	DTC Tehkhand Depot, Tuglakabad, New Delhi	12	940.2	4.701	0.4701	0.002583	0.05	0.55
23	C R Park, Chittaranjan, New Delhi	6	940.2	4.701	0.4701	0.01583	0.34	3.37
24	Rampuri, Kalkaji, New Delhi	5	940.2	4.701	0.4701	0.06112	1.30	13.00
25	NRI Complex, Greater Kailash-IV, New Delhi	2	956.2	4.781	0.4781	0.05103	1.07	10.67
26	DJB BPS, Alaknanda main, New Delhi	10	940.2	4.701	0.4701	0.003624	0.08	0.77
27	LSC, DDA Flats, Kalkaji, Delhi	9	940.2	4.701	0.4701	0.02093	0.45	4.45
28	Greater Kailash, Part II, New Delhi	7	940.2	4.701	0.4701	0.01554	0.33	3.31
29	Shaheed Suryasen Marg Road, Kalkaji, New DelhiI	14	940.2	4.701	0.4701	0.004377	0.09	0.93
30	Main road, Kalkaji Extension, New Delhi	6	940.2	4.701	0.4701	0.03108	0.66	6.61
31	Sector-12, Noida-U.P,201301	11	940.2	4.701	0.4701	0.0636	1.35	13.53
32	D Block, Sector 11, Noida, Uttar Pradesh	8	940.2	4.701	0.4701	0.02969	0.63	6.32
33	Sector 10 Noida -U.P.	9	940.2	4.701	0.4701	0.03745	0.80	7.97
34	Sector-55,Noida-U.P.	8	940.2	4.701	0.4701	0.01921	0.41	4.09

Sr.No.	Address of the Tower Site	Tenancy Ratio	Lowest Operating Frequency at the tower(f)	Maximum Permissible RF Power Density safe emission limit as per ICNIRP Standards (f/200) in W/m2	Maximum Permissible RF Power Density safe emission limit as per Indian Standards (f/2000) in W/m2	Actual Measured RF Power Density Emission Level (W/m2)	% Emission level as compared to ICNIRP Standards	% Emission level as compared to Indian Standards
35	Sector-56, Noida, U.P.	8	940.2	4.701	0.4701	0.03261	0.69	6.94
36	Sec- 58 , Noida,UP-201301	8	940.2	4.701	0.4701	0.09914	2.11	21.09
37	Sec-9, Noida,UP	9	945.2	4.726	0.4726	0.05514	1.17	11.67
38	Dhakka Jor, Bhai Parmamand Colony, Delhi	10	940.2	4.701	0.4701	0.104	2.21	22.12
39	Dr. Mukherjee Nagar,Delhi	10	940.2	4.701	0.4701	0.0507	1.08	10.78
40	Nehru Vihar, New Delhi	6	940.2	4.701	0.4701	0.0416	0.88	8.85
41	Outram Lines, Kingsway Camp, Delhi	10	940.2	4.701	0.4701	0.02612	0.56	5.56
42	DDA Park, Majnu Ka Tila, Delhi	12	940.2	4.701	0.4701	0.006604	0.14	1.40
43	Gandhi Colony, NIT, Faridabad, Haryana	11	940.2	4.701	0.4701	0.01795	0.38	3.82
44	Sector 16A, Part I, Faridabad, Haryana	16	937.6	4.688	0.4688	0.0875	1.87	18.66
45	Udyog Vihar VI, Sector 37, Gurgaon, Haryana	7	948.2	4.741	0.4741	0.03843	0.81	8.11
46	Village Khandsa Gurgaon Haryana	4	948.2	4.741	0.4741	0.02047	0.43	4.32
47	Udyog Vihar Industrial Area Phase VI, Sector 37, Gurgaon, Haryana	11	877.5	4.3875	0.43875	0.05589	1.27	12.74
48	Pace City-II, Gurugram, Haryana	7	877.5	4.3875	0.43875	0.06544	1.49	14.92

Sr.No.	Address of the Tower Site	Tenancy Ratio	Lowest Operating Frequency at the tower(f)	Maximum Permissible RF Power Density safe emission limit as per ICNIRP Standards (f/200) in W/m2	Maximum Permissible RF Power Density safe emission limit as per Indian Standards (f/2000) in W/m2	Actual Measured RF Power Density Emission Level (W/m2)	% Emission level as compared to ICNIRP Standards	% Emission level as compared to Indian Standards
49	Village- Deri Machha, Dhoom Manikpur, Gr. Noida. U.P.	10	877.5	4.3875	0.43875	0.001834	0.04	0.42
50	Loha Mandi, GZB, Uttar Pradesh	8	948.2	4.741	0.4741	0.002143	0.05	0.45
51	Vivekanand Nagar, GZB, UP	6	877.5	4.3875	0.43875	0.008804	0.20	2.01
52	Chaukhandi Chowk, Near Tilak Nagar Thana, New Delhi	8	948.2	4.741	0.4741	0.0108	0.23	2.28
53	Tilak Nagar, New Delhi	8	948.2	4.741	0.4741	0.06416	1.35	13.53
54	New Mahavir Nagar, Tilak Nagar, New Delhi	9	877.5	4.3875	0.43875	0.0255	0.58	5.81
55	Block-C, Sector-17, Pocket-8, Dwarka, Delhi	9	948.2	4.741	0.4741	0.005219	0.11	1.10
56	Sec-3, Dwarka, Delhi		948.2	4.741	0.4741	0.02048	0.43	4.32
57	Tagore Park, Model Town, Dhaka Colony, Delhi	10	948.2	4.741	0.4741	0.09165	1.93	19.33
58	Sector-10A, Gurgaon, Haryana	7	948.2	4.741	0.4741	0.02449	0.52	5.17
59	Wazir Nagar, Kotla, New Delhi	9	948.2	4.741	0.4741	0.06001	1.27	12.66
60	Otla Mubarakpur New Delhi	7	948.2	4.741	0.4741	0.05151	1.09	10.86
61	Defence Colony, Ring Road, Delhi	10	948.2	4.741	0.4741	0.01468	0.31	3.10

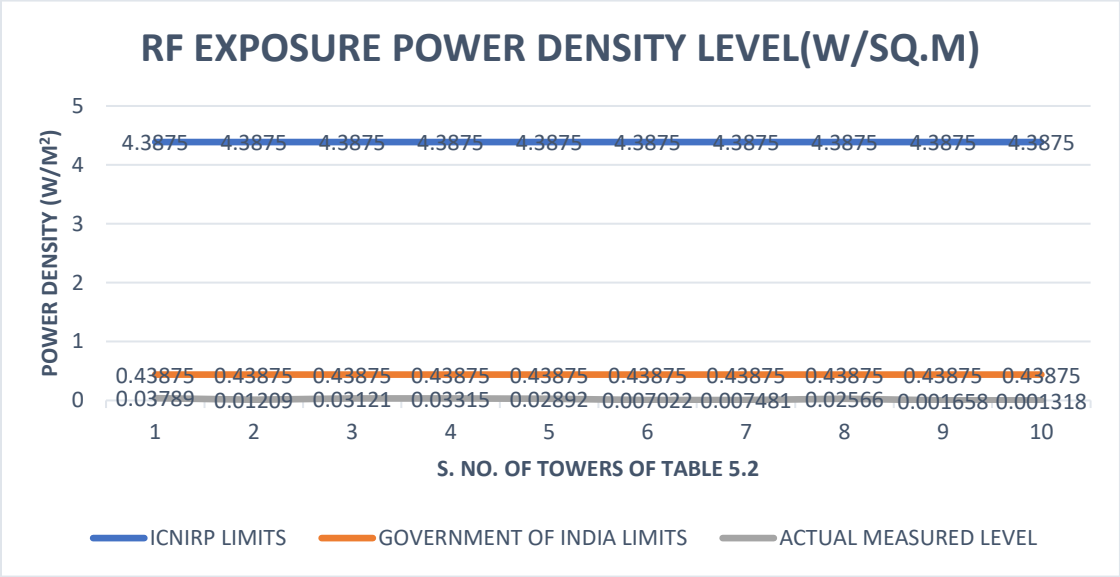
Sr.No.	Address of the Tower Site	Tenancy Ratio	Lowest Operating Frequency at the tower(f)	Maximum Permissible RF Power Density safe emission limit as per ICNIRP Standards (f/200) in W/m2	Maximum Permissible RF Power Density safe emission limit as per Indian Standards (f/2000) in W/m2	Actual Measured RF Power Density Emission Level (W/m2)	% Emission level as compared to ICNIRP Standards	% Emission level as compared to Indian Standards
62	Vill. Baraula Sec 49, Noida ,UP	8	948.2	4.741	0.4741	0.05883	1.24	12.41
63	Arya Pura, Subji Mandi, Delhi	6	948.2	4.741	0.4741	0.02635	0.56	5.56
64	Durgapuri, Vijay Enclave, New Delhi	10	940.2	4.701	0.4701	0.07369	1.57	15.68
65	Dabri Village, Delhi	8	940.2	4.701	0.4701	0.0268	0.57	5.70
66	DLF Industrial Estate, Phase-I, Faridabad	7	940.2	4.701	0.4701	0.06947	1.48	14.78
67	Sanjay Colony, Arthala, Mohan Nagar, Ghaziabad	11	940.2	4.701	0.4701	0.06074	1.29	12.92
68	Anand Industrial Estate Mohannagar, Ghaziabad, UP	11	940.2	4.701	0.4701	0.03988	0.85	8.48
69	UPSIDC, Industrial Area, Loni Road, Ghaziabad	4	948.2	4.741	0.4741	0.104	2.19	21.94
70	Sangam Vihar,Delhi	8	940.2	4.701	0.4701	0.06079	1.29	12.93
71	Qutab Institutional Area, Ber Sarai, Delhi	10	940.2	4.701	0.4701	0.05847	1.24	12.44
72	Katvariya Sarai, New Delhi	12	940.2	4.701	0.4701	0.0374	0.80	7.96
73	Safdarjung Enclave, New Delhi	14	937.6	4.688	0.4688	0.08969	1.91	19.13
74	Green Park Ext. New Delhi	4	948.2	4.741	0.4741	0.0457	0.96	9.64
75	DLF Industrial Area, Moti Nagar, New Delhi	7	877.5	4.3875	0.43875	0.03788	0.86	8.63
76	Sudershan Park,New Delhi	8	940.2	4.701	0.4701	0.05301	1.13	11.28
77	Rajouri Garden, New Delhi	6	937.6	4.688	0.4688	0.06188	1.32	13.20

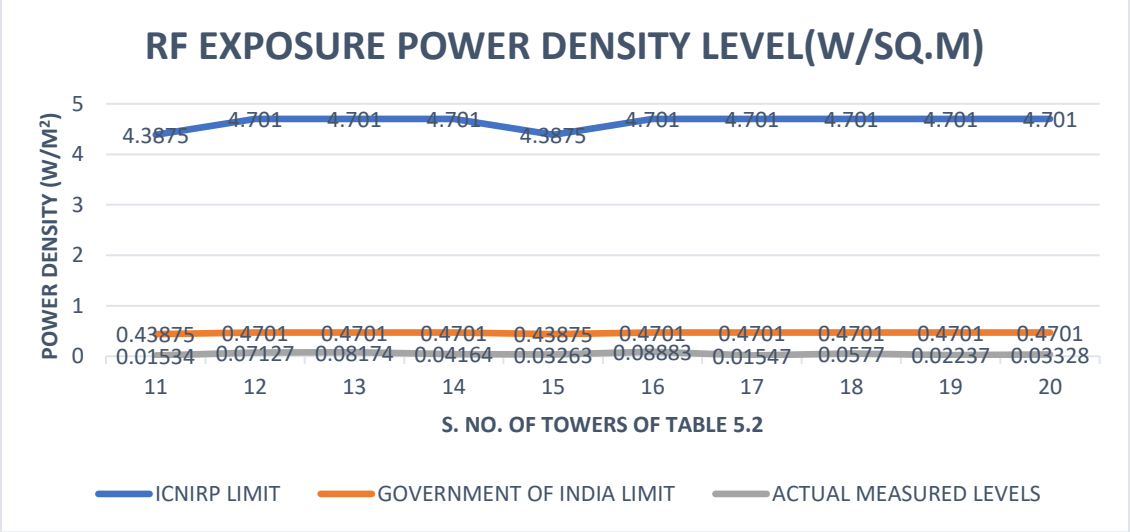
Sr.No.	Address of the Tower Site	Tenancy Ratio	Lowest Operating Frequency at the tower(f)	Maximum Permissible RF Power Density safe emission limit as per ICNIRP Standards (f/200) in W/m2	Maximum Permissible RF Power Density safe emission limit as per Indian Standards (f/2000) in W/m2	Actual Measured RF Power Density Emission Level (W/m2)	% Emission level as compared to ICNIRP Standards	% Emission level as compared to Indian Standards
78	Major Rajeev Bhasin Marg, Ramesh Nagar, New Delhi	12	937.6	4.688	0.4688	0.1036	2.21	22.10
79	Basai Darapur, Bali Nagar, New Delhi	7	937.6	4.688	0.4688	0.04708	1.00	10.04
80	Chanakya Place,Part I, New Delhi	9	937.6	4.688	0.4688	0.04367	0.93	9.32
81	Palam Village, New Delhi	13	937.6	4.688	0.4688	0.07412	1.58	15.81
82	Gopal Nagar Najafgarh, New Delhi	10	937.6	4.688	0.4688	0.02929	0.62	6.25
83	Old Roshanpura, Najafgarh, Delhi	9	937.6	4.688	0.4688	0.03365	0.72	7.18
84	Shiv Colony,Faridabad.	4	948.2	4.741	0.4741	0.01504	0.32	3.17
85	Sec-28, Faridabad, Haryana	6	948.2	4.741	0.4741	0.02744	0.58	5.79
86	Mahavir Enclave, New Delhi-110045	9	877.5	4.3875	0.43875	0.0619	1.41	14.11
87	Village Sihi, Sec-08, Faridabad, Haryana	11	877.5	4.3875	0.43875	0.04992	1.14	11.38
88	Sector-9, Faridabad, Haryana	11	877.5	4.3875	0.43875	0.05087	1.16	11.59
89	Sec-92,Noida,U.P.	7	940.2	4.701	0.4701	0.01895	0.40	4.03
90	C block, Susant lok, Gurgaon, Haryana	7	940.2	4.701	0.4701	0.03068	0.65	6.53
91	Chittranjan Park, New Delhi	13	937.6	4.688	0.4688	0.03652	0.78	7.79

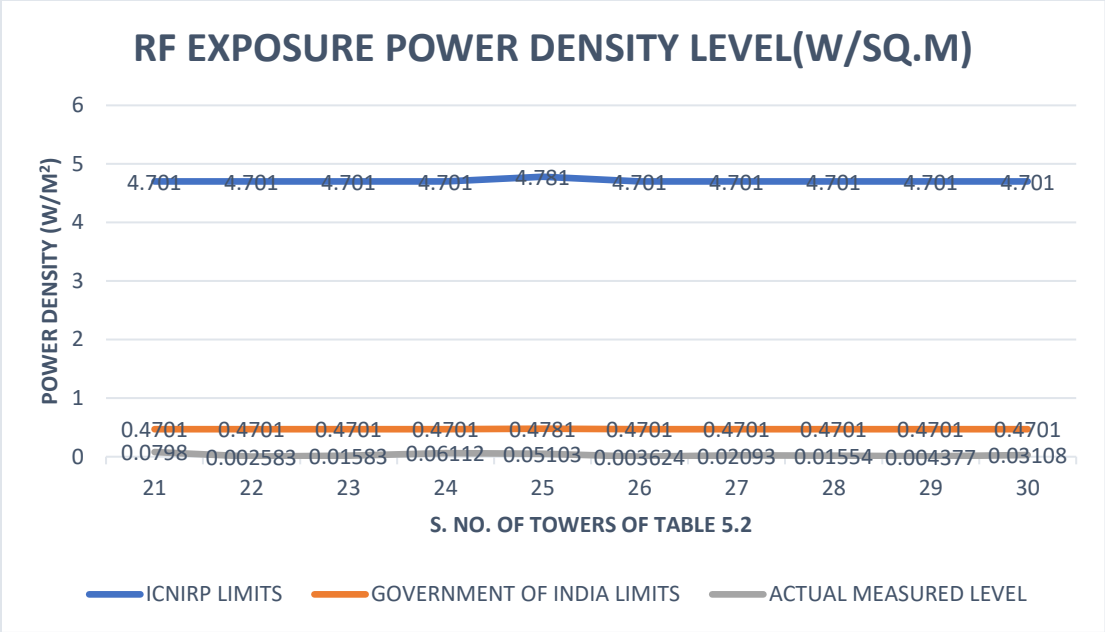
Sr.No.	Address of the Tower Site	Tenancy Ratio	Lowest Operating Frequency at the tower(f)	Maximum Permissible RF Power Density safe emission limit as per ICNIRP Standards (f/200) in W/m2	Maximum Permissible RF Power Density safe emission limit as per Indian Standards (f/2000) in W/m2	Actual Measured RF Power Density Emission Level (W/m2)	% Emission level as compared to ICNIRP Standards	% Emission level as compared to Indian Standards
89	Sec-92,Noida,U.P.	7	940.2	4.701	0.4701	0.01895	0.40	4.03
90	C block, Susant lok, Gurgaon, Haryana	7	940.2	4.701	0.4701	0.03068	0.65	6.53
91	Chittranjan Park, New Delhi	13	937.6	4.688	0.4688	0.03652	0.78	7.79
92	Pushp Vihar, Delhi	12	877.5	4.3875	0.43875	0.04487	1.02	10.23
93	Saraswati Vihar, Pitampura,Delhi	11	877.5	4.3875	0.43875	0.009117	0.21	2.08
94	Sector 12,Pocket 2,Dwarka,Delhi	7	877.5	4.3875	0.43875	0.01302	0.30	2.97
95	Vill.- Khera Dabar, New Delhi	9	935.2	4.676	0.4676	0.002569	0.05	0.55
96	Mahaveer Enclave, New Delhi	9	877.5	4.3875	0.43875	0.04427	1.01	10.09
97	Village Shahbad Mohammadpur Delhi-110061	5	877.5	4.3875	0.43875	0.003564	0.08	0.81
98	VPO Bijwasan, New Delhi110061	8	877.5	4.3875	0.43875	0.005233	0.12	1.19
99	MCF, Sector-8, Faridabad, Haryana	11	877.5	4.3875	0.43875	0.02195	0.50	5.00
100	Sector-2 Noida Uttar Pradesh	7	877.5	4.3875	0.43875	0.07483	1.71	17.06

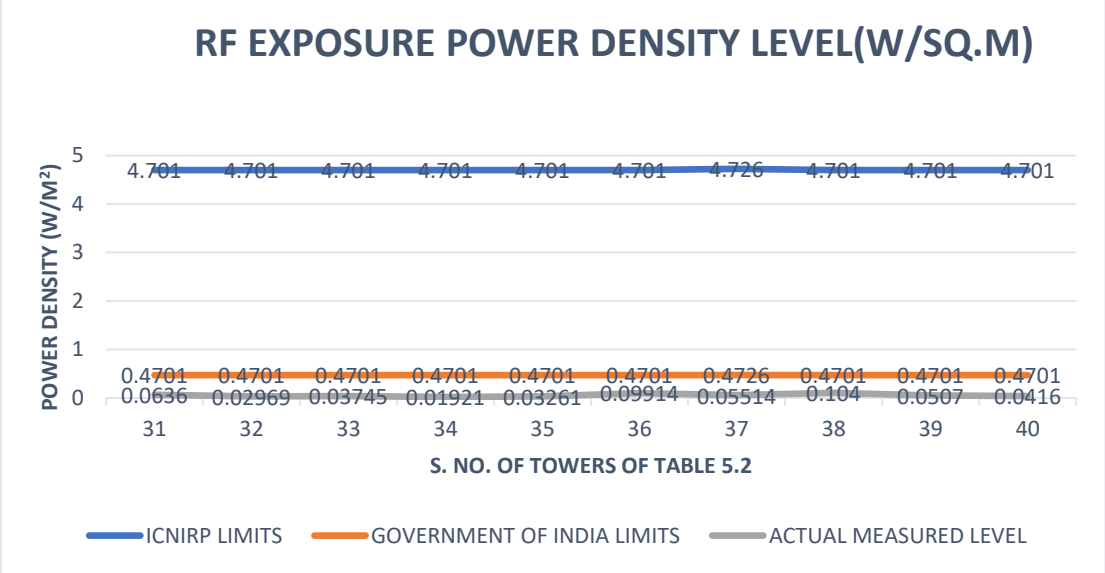
The information as compiled may be represented graphically as in Figure 5.8 below for better visualization. (As indicated at horizontal axis, first Graph shows RF Exposure level of First ten mobile towers of Table 5.2 i.e from serial number 1 to 10, second graph shows from serial number 11 to 20 of Table 5.2 and so on)

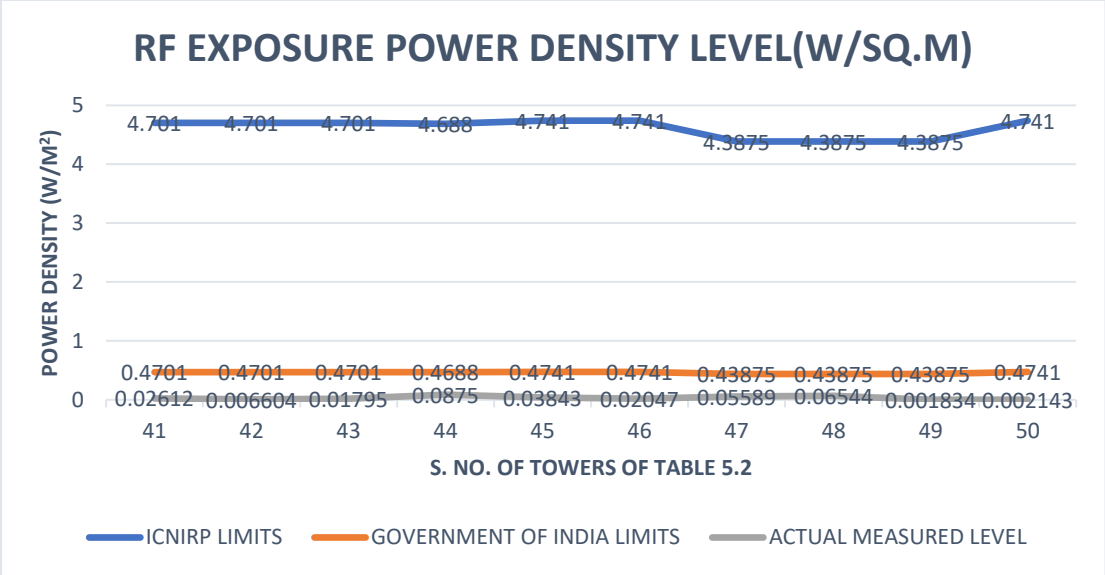
Figure 5.8: RF Exposure Power Density Level of One Hundred Mobile Towers

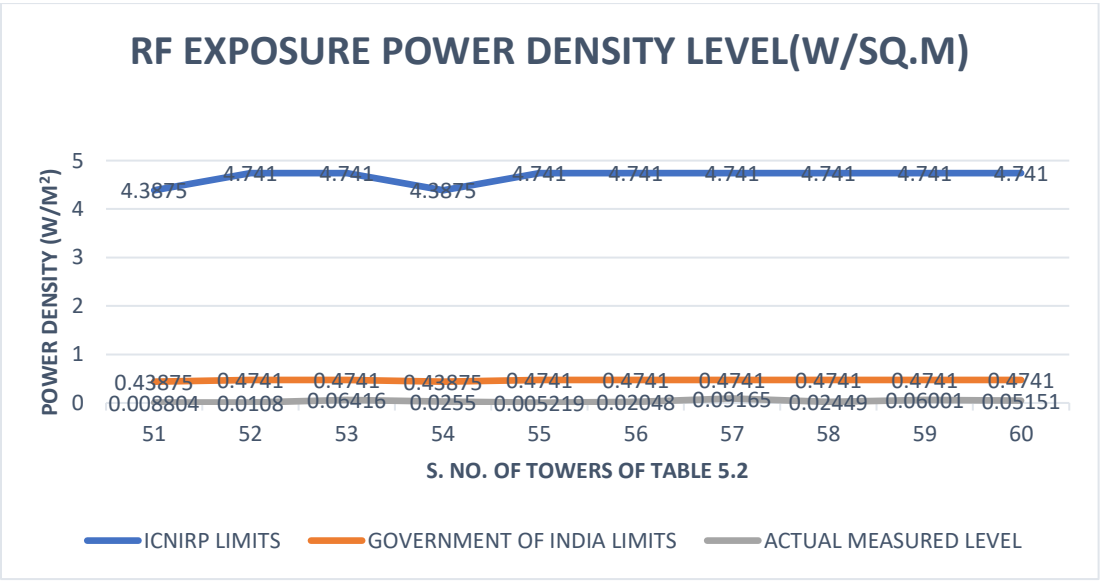


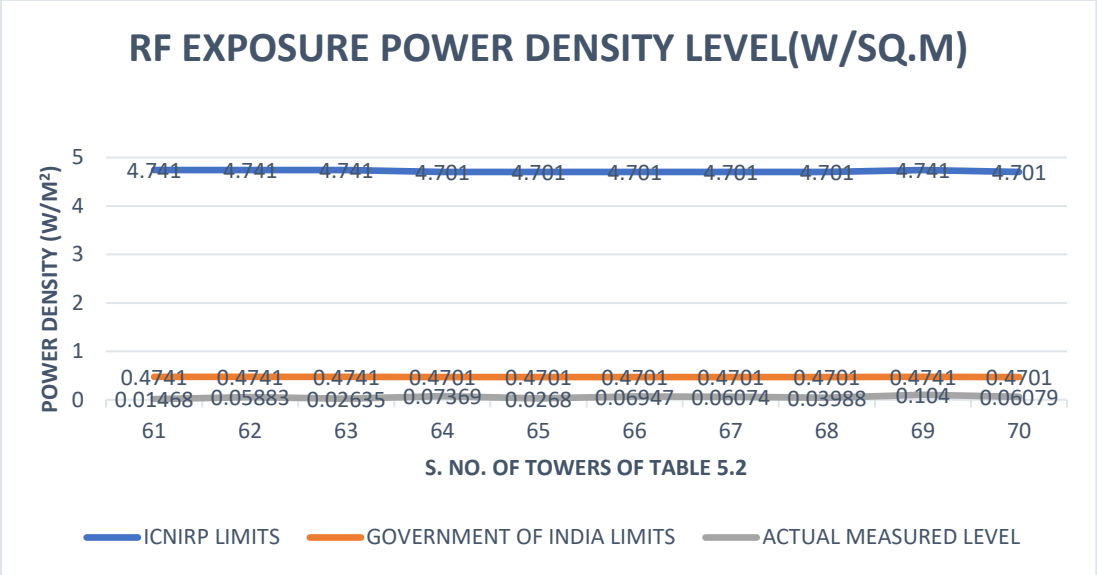


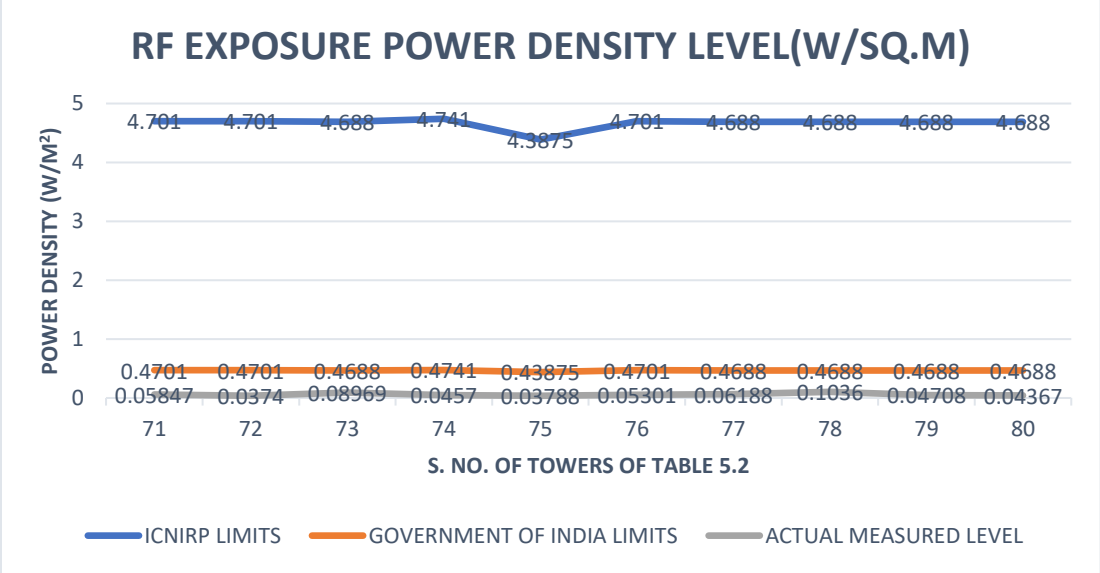

RF EXPOSURE POWER DENSITY LEVEL(W/SQ.M)
POWER DENSITY (W/M²)
6
5
4
3
2
1
0
4.701 4.701 4.701 4.701 4.781 4.701 4.701 4.701 4.701 4.701
0.4701 0.4701 0.4701 0.4701 0.4781 0.4701 0.4701 0.4701 0.4701 0.4701
0.0798 0.002583 0.01583 0.06112 0.05103 0.003624 0.02093 0.01554 0.004377 0.03108
21 22 23 24 25 26 27 28 29 30
S. NO. OF TOWERS OF TABLE 5.2
ICNIRP LIMITS
GOVERNMENT OF INDIA LIMITS
ACTUAL MEASURED LEVEL

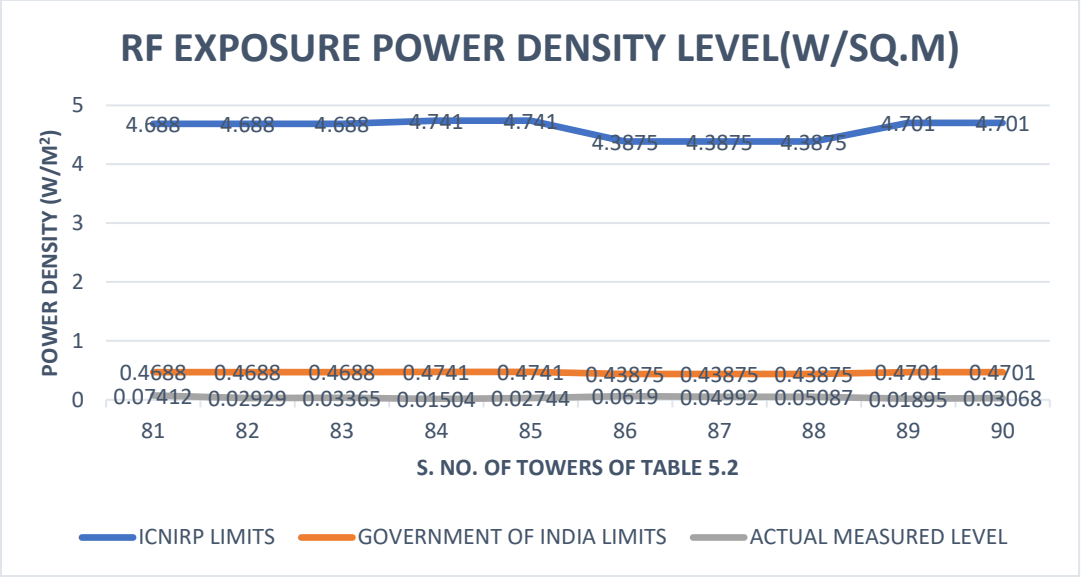

RF EXPOSURE POWER DENSITY LEVEL(W/SQ.M)
POWER DENSITY (W/M²)
5
4
3
2
1
0
4.701 4.701 4.701 4.701 4.701 4.701 4.726 4.701 4.701 4.701
0.4701 0.4701 0.4701 0.4701 0.4701 0.4701 0.4726 0.4701 0.4701 0.4701
0.0636 0.02969 0.03745 0.01921 0.03261 0.09914 0.05514 0.104 0.0507 0.0416
31 32 33 34 35 36 37 38 39 40
S. NO. OF TOWERS OF TABLE 5.2
ICNIRP LIMITS
GOVERNMENT OF INDIA LIMITS
ACTUAL MEASURED LEVEL

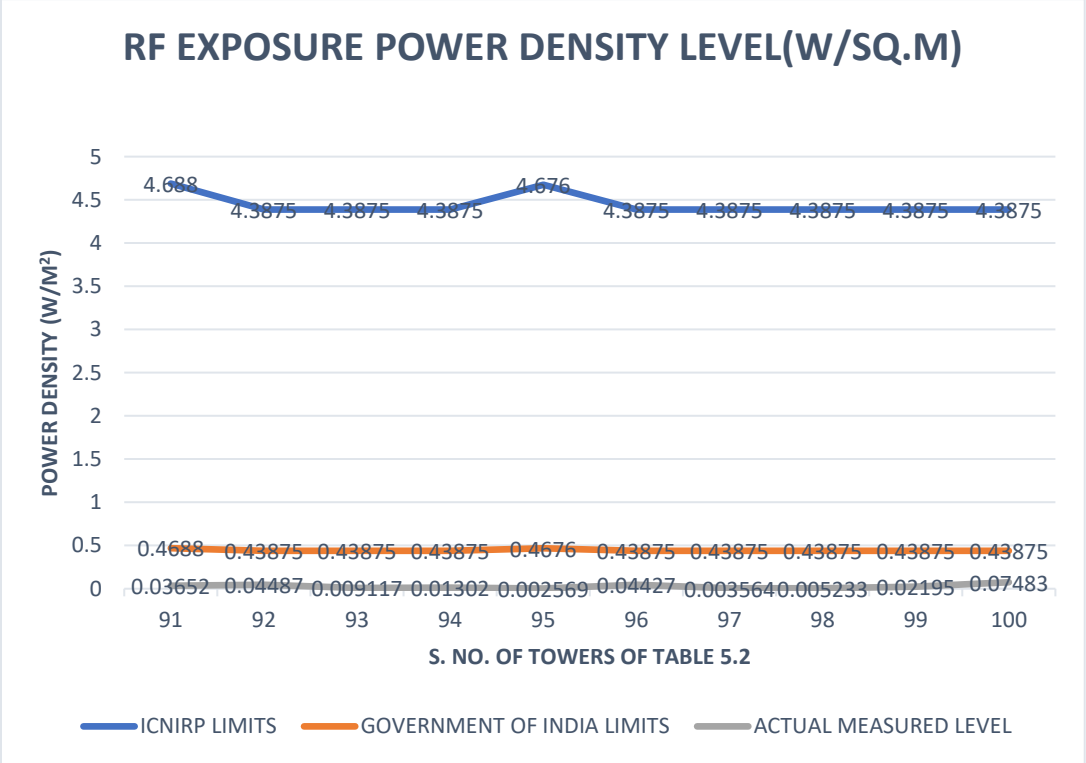

RF EXPOSURE POWER DENSITY LEVEL(W/SQ.M)
POWER DENSITY (W/M²)
5
4
3
2
1
0
4.701 4.701 4.701 4.688 4.741 4.741 4.3875 4.3875 4.3875 4.741
0.4701 0.4701 0.4701 0.4688 0.4741 0.4741 0.43875 0.43875 0.43875 0.4741
0.02612 0.006604 0.01795 0.0875 0.03843 0.02047 0.05589 0.06544 0.001834 0.002143
41 42 43 44 45 46 47 48 49 50
S. NO. OF TOWERS OF TABLE 5.2
ICNIRP LIMITS
GOVERNMENT OF INDIA LIMITS
ACTUAL MEASURED LEVEL


RF EXPOSURE POWER DENSITY LEVEL(W/SQ.M)
POWER DENSITY (W/M²)
5
4
3
2
1
0
4.3875 4.741 4.741 4.3875 4.741 4.741 4.741 4.741 4.741 4.741
0.43875 0.4741 0.4741 0.43875 0.4741 0.4741 0.4741 0.4741 0.4741 0.4741
0.008804 0.0108 0.06416 0.0255 0.005219 0.02048 0.09165 0.02449 0.06001 0.05151
51 52 53 54 55 56 57 58 59 60
S. NO. OF TOWERS OF TABLE 5.2
ICNIRP LIMITS
GOVERNMENT OF INDIA LIMITS
ACTUAL MEASURED LEVEL


RF EXPOSURE POWER DENSITY LEVEL(W/SQ.M)
POWER DENSITY (W/M²)
5
4
3
2
1
0
4.741 4.741 4.741 4.701 4.701 4.701 4.701 4.701 4.741 4.701
0.4741 0.4741 0.4741 0.4701 0.4701 0.4701 0.4701 0.4701 0.4741 0.4701
0.01468 0.05883 0.02635 0.07369 0.0268 0.06947 0.06074 0.03988 0.104 0.06079
61 62 63 64 65 66 67 68 69 70
S. NO. OF TOWERS OF TABLE 5.2
ICNIRP LIMITS
GOVERNMENT OF INDIA LIMITS
ACTUAL MEASURED LEVEL


RF EXPOSURE POWER DENSITY LEVEL(W/SQ.M)
POWER DENSITY (W/M²)
5
4
3
2
1
0
4.701 4.701 4.688 4.741 4.3875 4.701 4.688 4.688 4.688 4.688
0.4701 0.4701 0.4688 0.4741 0.43875 0.4701 0.4688 0.4688 0.4688 0.4688
0.05847 0.0374 0.08969 0.0457 0.03788 0.05301 0.06188 0.1036 0.04708 0.04367
71 72 73 74 75 76 77 78 79 80
S. NO. OF TOWERS OF TABLE 5.2
ICNIRP LIMITS
GOVERNMENT OF INDIA LIMITS
ACTUAL MEASURED LEVEL


RF EXPOSURE POWER DENSITY LEVEL(W/SQ.M)
POWER DENSITY (W/M²)
5
4
3
2
1
0
4.688 4.688 4.688 4.741 4.741 4.3875 4.3875 4.3875 4.701 4.701
0.4688 0.4688 0.4688 0.4741 0.4741 0.43875 0.43875 0.43875 0.4701 0.4701
0.07412 0.02929 0.03365 0.01504 0.02744 0.0619 0.04992 0.05087 0.01895 0.03068
81 82 83 84 85 86 87 88 89 90
S. NO. OF TOWERS OF TABLE 5.2
ICNIRP LIMITS
GOVERNMENT OF INDIA LIMITS
ACTUAL MEASURED LEVEL


RF EXPOSURE POWER DENSITY LEVEL(W/SQ.M)
POWER DENSITY (W/M²)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
4.688 4.3875 4.3875 4.3875 4.676 4.3875 4.3875 4.3875 4.3875 4.3875
0.4688 0.43875 0.43875 0.43875 0.4676 0.43875 0.43875 0.43875 0.43875 0.43875
0.03652 0.04487 0.009117 0.01302 0.002569 0.04427 0.003564 0.005233 0.02195 0.07483
91 92 93 94 95 96 97 98 99 100
S. NO. OF TOWERS OF TABLE 5.2
ICNIRP LIMITS
GOVERNMENT OF INDIA LIMITS
ACTUAL MEASURED LEVEL

Further, the analysis of the compiled information was done and following observations are made:

1. All the Mobile towers are radiating Electromagnetic emission well within the safe limit standards as set by Government of India.
2. As compared to ICNIRP safe Limits, the radiation level is very very low. In some cases, it is even less than one percent of ICNIRP safe Limits.
3. An Inter-Ministerial Committee (IMC) consisting of officers from DoT, Indian Council of Medical Research (Ministry of Health), Department of Biotechnology and Ministry of Environment and Forest was constituted on 24.08.2010 to examine the effect of EMF Radiation from mobile base stations and mobile phones. Inter-Ministerial Committee (IMC) in its report observed that:

…..

3.2 The field measurement under taken by the Cellular Operator Association of India in Metro cities like Delhi, Chennai and Mumbai have shown that the measured values are hundreds of time lower than that of the prescribed reference level (as prescribed by ICNIRP). *It is important that safety standards be rational and avoid excessive safety margins. To establish rational standards that will make future safer, the RF exposure limits in India may be lowered to 1/10th of the existing reference level.*

The above analysis of the RF EMF Exposure levels of Mobile Towers in Delhi, validates the observations made by IMC as the measured values are hundreds of time lower than that of the reference level as prescribed by ICNIRP, in most of the cases. It is pertinent to mention here that based on the recommendation of the IMC; Government of India had

lowered the RF Exposure limits to 1/10th of the reference level existing at that time.

4. In a Writ Petition filed in Hon'ble High Court Allahabad, Lucknow bench, the Hon'ble Court vide its order dated 10.01.2012 constituted a committee including Members from IITs Kharagpur, Kanpur, Delhi, Roorkee, Bombay and from other scientific institutions of the country including Indian Council of Medical Research (ICMR) and All India Institute of Medical Science (AIIMS) Delhi who submitted its Report on 17-01-2014. The Committee observed that the Department of Telecom has taken adequate steps to impose stricter precautionary limits for EMF radiation from mobile towers as well as from mobile handset/phones. After due consideration of the human health concerns on account of EMF radiation being raised in public and the Report of the Committee, the Government has decided in February 2014[64] that the present prescribed precautionary EMF safe exposure limits are adequate and need no further change at this stage.

   The RF Electromagnetic emission levels of mobile towers collected as above, clearly validate the decision taken by Indian Government for safe limit standards in February 2014.

5. As per information made available by Department of Telecom(DOT), as of 31.12.2019, a total of 8,51,195 number of BTSs have been tested by various LSA field units of DoT, out of which a total of 359 BTSs have been found non-compliant to EMF radiation norms (exceeding the prescribed radiation limits) since the inception of BTS testing by LSA (then TERM Cells) field units of DoT from 16.11.2010. In Delhi LSA, no mobile tower/BTS has been found non-compliant to EMF Radiation safety norms in EMF Audit. The above analysis also validates the information made available by DOT with

[64] https://dot.gov.in/sites/default/files/DOC120314-002.pdf accessed 01 March 2020

regard to Delhi LSA.

6. In case of RTT (Roof Top Towers), tenancy ratio is very high. As can be seen from the table 5.2, in some cases, it is more than even 15-16. It may be due to need of catering the high population density of Delhi LSA.

Review of efforts made by the Government to ensure compliance to various safe limits standards of RF EMF Emission and Spreading the awareness in public on EMF emission issue:

In Chapter 4, the efforts made by Government of India to ensure compliance of safe limits of RF EMF Emission (Section 4.2) and efforts made to spread the awareness in Public on EMF Exposure issue (Section 4.3) were deliberated. In the present section, it has been attempted to review those efforts.

5.3 Analysis of efforts made by the Government for ensuring compliance to various safe limits of RF EMF Emission

In order to ensure compliance to the prescribed stricter precautionary norms of EMF radiation from mobile tower, the EMF audit of upto Ten percent of Mobile base transceiver station (BTS) is carried out by LSA field units of DoT. This is regularly done by LSA units of DoT for the purpose of limiting the EMF radiation exposure and keeping general public areas in the vicinity of towers safe. The testing is done as per procedures prescribed by Telecom Engineering Centre (TEC) from time to time. TEC has published the Test Procedure for measurement of EMF from BTSs vide document no. TEC/TP/EMF/001/04.JUNE.2018. The same has been detailed in Section 5.1, as above.

LSA field units of DoT have their own EMF strength measuring instruments and they do not depend on TSPs for carrying out the testing related to measurement of EMF radiation, whenever required. Further, the following safeguards are provided to ensure independent and fair testing: -

i. All the testing related to measurement of EMF radiation to cross check the compliance of EMF radiation norms is being carried out by the officers of LSA field units of DoT itself as per TEC test procedure and are not dependent on TSPs for providing the measurement data.

ii. The EMR strength measuring instrument have valid calibration certificates and are calibrated and certified by independent national /international accredited labs.

iii. In addition, the BTS transmitted power snapshots before and after carrying out the testing may be taken by LSAs to rule out the possibility of manipulation.

iv. Moreover, the BTS which is to be tested is selected on random basis independently by LSA field units of DoT. Also, TSP representatives are required to sign on the results of the EMR measurement to ensure unbiased audit.

As of 31.12.2019, a total of 8,51,195 number of BTSs have been tested by DOT out of which a total of 359 BTSs have been found non-compliant to EMF radiation norms since the inception of BTS testing by LSAs from 16.11.2010. Hence, only 0.042 percent BTS have been found non-compliant out of the total BTS audited. Further, a penalty of more than Rs 20 Crores has been levied for such BTSs. As per Data analysis in section 5.2, EMF Exposure level, as collected, was significantly lower than the allowed safe limits in most of the cases. It was further, much lower than that of the ICNIRP Limits. The details of BTS tested and found non-compliant in last three years are as per Table 5.3 below:

Table 5.3: BTS tested and found non-compliant in last three years

Sr. No.	TERM Cell/LSA Unit	BTS Tested Since 16.11.2010 to 31.12.2019	BTS found Non-compliant Since 16.11.2010 to 31.12.2019	BTS Tested in the Year 2019	BTS Tested in the Year 2018	BTS Tested in the Year 2017	BTS found Non-compliant in the Year 2019	BTS found Non-compliant in the Year 2018	BTS found Non-compliant in the Year 2017
1	**Ahmedabad**					1555			0
2	**Andaman & Nicobar**	297	0	37	47	58	0	0	0
3	**Andhra Pradesh**	69345	3	10999	11429	4699	3	0	0
4	**Assam**	18607	2	4521	2719	3595	0	0	0
5	**Bangalore**				4003	5854		20	42
6	**Bihar**	29507	0	5035	6839	3713	0	0	0
7	**Chennai**	28666	30	5342	3738	4977	21	9	0
8	**Chhattisgarh**	13665	0	3500	2677	2102	0	0	0
9	**DELHI**	41264	0	11188	8428	6699	0	0	0
10	**GUJARAT**	51532	0	11077	10227	6665	0	0	0
11	**Haryana**	22918	1	4757	4233	3181	0	0	0
12	**Himachal Pradesh**	9888	6	2231	1235	1355	0	0	0
13	**Hyderabad**					5363			0
14	**JAIPUR**								
15	**Jammu and Kashmir**	9997	9	2184	2828	2453	0	9	0
16	**Jharkhand**	14716	0	3274	2481	2529	0	0	0
17	**Karnataka**	71594	121	13103	6122	5552	9	0	0
18	**KERALA**	44001	0	9737	8741	7002	0	0	0
19	**Kolkata**	20527	0	3742	3567	3597	0	0	0
20	**Lucknow**								
21	**Madhya Pradesh**	39894	14	9104	6665	7065	0	0	0
22	**Maharashtra**	39098	0	4901	4921	6446	0	0	0
23	**Mumbai**	21009	127	2631	3559	4708	0	0	0
24	**North East -1**	6176	8	1191	1691	1106	0	0	8
25	**North East-2**	4967	0	714	646	604	0	0	0
26	**ODISHA**	22751	0	5143	3559	2337	0	0	0
27	**Pune**	16696	14	3633	2496	3549	0	0	10
28	**Punjab**	35953	0	7971	7647	7026	0	0	0
29	**Rajasthan**	42689	1	8692	8287	8322	0	0	0
30	**TAMILNADU**	51311	0	12130	9285	6963	0	0	0

Sr. No.	TERM Cell/LSA Unit	BTS Tested Since 16.11.2010 to 31.12.2019	BTS found Non-compliant Since 16.11.2010 to 31.12.2019	BTS Tested in the Year 2019	BTS Tested in the Year 2018	BTS Tested in the Year 2017	BTS found Non-compliant in the Year 2019	BTS found Non-compliant in the Year 2018	BTS found Non-compliant in the Year 2017
31	**Uttar Pradesh (East)**	54231	10	12928	11434	10674	0	0	0
32	**Uttar Pradesh (West)**	33035	0	8335	6539	5537	0	0	0
33	**Uttarakhand**	10648	0	2582	2003	1457	0	0	0
34	**West Bengal**	26213	13	6474	5364	3935	0	0	7
	Grand Total	**851195**	**359**	**177156**	**153410**	**140678**	**33**	**38**	**67**

(Source: Department of Telecom)

Note: A. Ahmadabad Unit has been merged with Gujarat LSA.

B. Bangalore Unit has been merged with Karnataka LSA

C. Hyderabad Unit been merged with Andhra Pradesh LSA.

D. Jaipur Unit has been merged with Rajasthan LSA

E. Lucknow Unit has been merged with Uttar Pradesh (E) LSA.

5.4 Analysis of EMF Emission measurements as requested by the public on payment basis

Department of Telecom (DoT), Ministry of Communications has launched Tarang Sanchar, a web portal for Information sharing on Mobile Towers and EMF Emission Compliances, with a view to generate confidence and conviction with regard to safety and harmlessness from mobile towers, clearing any myths and misconceptions. The portal can be accessed at www.tarangsanchar.gov.in. The portal has many features and facilities as detailed in **Section 4.3.5.2**. One very interactive feature of the portal is that any person can request for EMF emission measurement at a location by paying a nominal fee of Rs 4000/- online. Local License Service Area (LSA) field unit of DoT conducts the test (the requestor

can be present, if he so desires) and the test reports are provided to the requestor. Additionally, the EMF Emission measurements are also uploaded on the portal.

The EMF Emission measurements as requested by the public on payment basis for the last four years were accessed from the portal and compiled state/UT-wise. The same is presented in Table 5.4 below:

Table 5.4: EMF Audits on Public Request

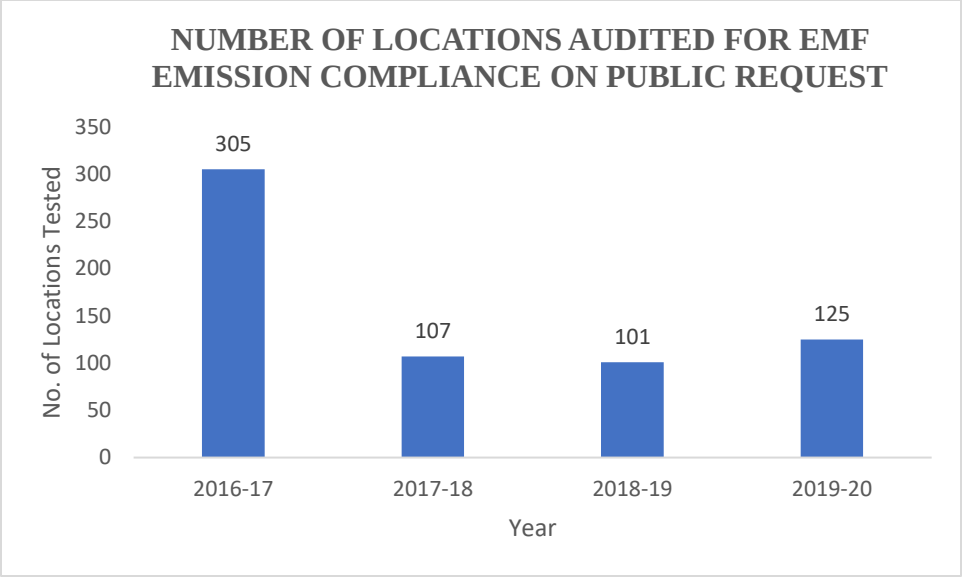
Sr. No.		Year	Year	Year	Year	Remarks
	State/UT	2016-17	2017-18	2018-19	2019-20	
1	Andaman & Nicobar (UT)	1	0	0	0	Site found compliant
2	Andhra Pradesh	3	1	3	3	All sites found compliant
3	Arunachal Pradesh	1	0	0	0	Site found compliant
4	Assam	20	3	2	1	All sites found compliant
5	Bihar	8	0	1	0	All sites found compliant
6	Chandigarh(UT)	0	1	0	0	All sites found compliant
7	Chattisgarh	0	0	0	1	Site found compliant
8	Dadra & Nagar Haveli (UT)	0	0	0	0	
9	Daman & Diu(UT)	0	0	0	1	Site found compliant
10	Delhi	40	11	19	11	All sites found compliant
11	Goa	0	1	0	0	Site found compliant
12	Gujarat	7	4	0	7	All sites found compliant
13	Haryana	7	3	3	6	All sites found compliant
14	Himachal Pradesh	1	1	1	0	All sites found compliant
15	Jammu & Kashmir	3	1	1	0	All sites found compliant
16	Jharkhand	0	1	0	0	Site found compliant
17	Karnataka	22	12	14	22	One site found Non-compliant. Show Cause notice issued to TSPs by concerned TERM Cell. Site was made compliant by TSPs

Sr. No.	State/UT	Year 2016-17	Year 2017-18	Year 2018-19	Year 2019-20	Remarks
18	Kerala	11	6	2	0	All sites found compliant
19	Lakshadweep (UT)	0	0	0	0	
20	Madhya Pradesh	4	1	1	4	All sites found compliant
21	Maharashtra	56	40	22	42	One site found Non-compliant. Show Cause notice issued to TSPs by concerned TERM Cell. Site was made compliant by TSPs. Retesting by TERM Cell was done on 09.03.2017 and the values found were 0.087 Watts per meter square
22	Manipur	0	0	0	0	
23	Meghalaya	0	0	0	0	
24	Mizoram	0	0	0	0	
25	Nagaland	0	0	0	0	
26	Odisha	9	0	0	1	All sites found compliant
27	Puducherry (UT)	0	0	0	0	
28	Punjab	4	1	0	2	All sites found compliant
29	Rajasthan	43	3	5	2	All sites found compliant
30	Sikkim	0	0	0	0	
31	Tamilnadu	13	5	8	3	All sites found compliant
32	Telangana	39	4	10	7	All sites found compliant
33	Tripura	0	0	0	0	
34	Uttar Pradesh	7	0	5	3	All sites found compliant
35	Uttarakhand	1	3	0	5	All sites found compliant
36	West Bengal	5	5	4	4	All sites found compliant
	Total	**305**	**107**	**101**	**125**	
	Grand Total	**638**				

(Source: www.tarangsanchar.gov.in)

The Compiled Data can be presented graphically as below for better visualization:

Figure 5.9: EMF Audits on Public Request



(Source: www.tarangsanchar.gov.in)

Following observations are made on the status of public requests for EMF Emission measurements as per compiled data above:

- Out of the total 638 locations, only 2 locations (One in Karnataka and another in Maharashtra) were found non-compliant i.e about 0.31 percent. These two sites were also made compliant afterwards and retested by the field units and found compliant.
- To generate the confidence in public that Mobile Towers are EMF Emission compliant, the measurements of the EMF Emission levels of requested locations are also uploaded on the portal transparently. Anyone can view these values and check the EMF Emission

level at that location. It gives the confidence in public that Mobile Towers are EMF Emission compliant.

- If we compare the requests as received in year 2016-17 vis-à-vis subsequent years, there is a significant fall. As compared to 2016-17 when 305 requests were received, there were only 107 requests (i.e. just 35%) in the year 2017-18, 101 requests (i.e. just 33%) in the year 2018-19 and 125 requests (i.e. just 41%) were received in the year 2019-20. It is in spite of the fact that the number of mobile towers has increased in these years progressively and significantly. It indicates that the confidence of the public and conviction with regard to safety and harmlessness from mobile towers has increased and their myths and misconceptions towards EMF Emission from mobile towers have cleared to some extent.

5.5 Analysis of Status of RTI Applications and Public Grievance Cases in relation to Tower Radiation

Information was collected from DOT HQ, New Delhi regarding the RTI applications and Public Grievance Cases received in last three years to analyse the effectiveness of efforts made to spread the awareness in Public on EMF Emission issue. The information as received from CS-III Cell, DOTHQ was appended to the BTS and mobile tower base in the same period alongwith the number of Public Awareness Programs conducted. Appended table is as below: (Table 5.5)

Table 5.5:
Number of RTI Applications and PG Cases in relation to Mobile Tower Radiation

Sl. No.		2017	2018	2019
1	**Number of Mobile BTS**	1710411	2041070	2202106
2	**Number of Mobile Towers**	461111	516201	586369
3	**Number of RTI Application received**	116	182	225
4	**RTI Appeals**	7	17	8
5	**Public Grievances**	42	77	51
6	**Grievance through PG Portal**	7	15	17
7	**Total PG Complaints**	49	92	68
8	**Number of Public Awareness Programs conducted in the country**	55	61	82

(Source: DOT)

Further, following information was sought from the LSA Field units of DOT for the last three years:

1. No. of PG Cases related to Tower Radiation during these periods, LSA wise
2. No of RTI cases for the same issue in the same period, LSA Wise
3. Details of awareness programmes conducted by LSAs in the same period, LSA Wise
4. Details of other actions being taken by Government for changing the perception of Public towards issue of Tower Radiation.

The information as received from the LSA Field units of DOT regarding point no. 1,2, and 3 was compiled and is presented in Table as below:

Table 5.6 A: Online PG Cases, RTI Applications and Awareness Programmes conducted in the year 2017.

Sr. No.	LSA	BTS as on 1.1.2018	PG Cases (in 2017)	RTI Applications (in 2017)	Awareness Programmes (in 2017)
1	**Andhra Pradesh**	128812	10	0	2
2	**Assam**	34667	8	1	3
3	**Bihar**	88070	15	0	0
4	**Chennai**	44532	Information clubbed with Tamil Nadu LSA		
5	**Delhi**	86667	124	4	2
6	**Gujarat**	103568	12	0	0
7	**Himachal Pradesh**	16745	22	0	0
8	**Haryana**	41836	5	0	8
9	**Jammu & Kashmir**	27226	2	0	0
10	**Karnataka**	120685	74	0	4
11	**Kolkata**	43048	Information clubbed with West Bengal LSA		
12	**Kerala**	84611	1	13	21
13	**Mumbai**	55859	11	4	2
14	**Maharashtra**	145278	19	0	0
15	**Madhya Pradesh**	98693	31	0	0
16	**North East**	21905	0	0	2
17	**Odisha**	44165	9	0	
18	**Punjab**	75580	1	0	9
19	**Rajasthan**	87621	42	2	2
20	**Tamil Nadu**	95165	35	72	0
21	**UP East**	111723	4	2	0
22	**UP West**	88604	22	0	0
23	**West Bengal**	65351	1	0	0
Grand Total		**1710411**	**448**	**98**	**55**

(Source: DOT)

Table 5.6 B: Online PG Cases, RTI Applications and Awareness Programmes conducted in the year 2018.

Sr. No.	LSA	BTS as on 1.1.2019	PG Cases (in 2018)	RTI Applications (in 2018)	Awareness Programmes (in 2018)
1	**Andhra Pradesh**	148255	12	0	
2	**Assam**	42446	3	0	
3	**Bihar**	108636	10	0	
4	**Channai**	49117	Information clubbed with Tamil Nadu LSA		
5	**Delhi**	98499	107	2	6
6	**Gujarat**	127806	23	1	1
7	**Himachal Pradesh**	20515	12	2	2
8	**Haryana**	51166	2	0	8
9	**Jammu & Kashmir**	35392	0	0	0
10	**Karnataka**	139596	83	0	5
11	**Kolkata**	46975	Information clubbed with West Bengal LSA		
12	**Kerala**	95777	4	3	34
13	**Mumbai**	59017	13	3	1
14	**Maharashtra**	164530	31	0	0
15	**Madhya Pradesh**	125418	6	0	0
16	**North East**	27238	0	0	0
17	**Odisha**	55234	1	4	0
18	**Punjab**	85483	2	0	3
19	**Rajasthan**	115537	24	4	1
20	**Tamil Nadu**	118176	95	80	0
21	**UP East**	133593	18	1	0
22	**UP West**	107481	23	3	0
23	**West Bengal**	85183	10	0	0
Grand Total		**2041070**	**479**	**103**	**61**

(Source: DOT)

Table 5.6 C: Online PG Cases, RTI Applications and Awareness Programmes conducted in the year 2019.

Sr. No.	LSA	BTS as on 1.1.2020	PG Cases (in 2019)	RTI Applications (in 2019)	Awareness Programmes (in 2019)
1	**Andhra Pradesh**	161759	21	0	2
2	**Assam**	48719	7	1	2
3	**Bihar**	126731	10	0	0
4	**Channai**	52895	Information clubbed with Tamil Nadu LSA		
5	**Delhi**	107702	231	4	1
6	**Gujarat**	132701	24	3	0
7	**Himachal Pradesh**	23257	12	2	1
8	**Haryana**	49060	10	0	6
9	**Jammu & Kashmir**	37315	3	0	0
10	**Karnataka**	141035	102	0	8
11	**Kolkata**	49133	Information clubbed with West Bengal LSA		
12	**Kerala**	90121	15	2	49
13	**Mumbai**	59864	7	2	0
14	**Maharashtra**	180368	38	0	2
15	**Madhya Pradesh**	142743	21	0	1
16	**North East**	31614	0	0	0
17	**Odisha**	61581	11	0	
18	**Punjab**	78408	5	23	8
19	**Rajasthan**	122306	25	1	1
20	**Tamil Nadu**	130757	221	87	0
21	**UP East**	154806	14	2	1
22	**UP West**	120271	39	8	0
23	**West Bengal**	98960	11	0	0
Grand Total		**2202106**	**827**	**135**	**82**

(Source: DOT)

Regarding the other actions being taken by LSAs for changing the perception of Public towards issue of Mobile Tower Radiation, the responses as received from field units are compiled as below:

a. Many LSA have carried out Public notices and newspaper advertisements in the leading English, Hindi and Regional Newspapers of the region.
b. Annually upto 10% BTS sites have been tested for EMF radiation and at the time of testing, complainant as well as general public residing in that locality have been made aware about misperception of EMF radiation related health hazard and also their undue apprehensions are cleared. General public also made aware on EMF and precautions regarding mobile handsets to allay undue apprehensions during regular EMF testing conducted by LSA Units.
c. Regular meetings are being held with Telecom Service Providers (TSPs) to sensitize them on the issue in some LSAs. They are being educated for spreading the awareness in the public about misperception of EMF radiation related health hazard.
d. Pamphlets/Leaflets are being distributed on regular basis to clear the apprehension of the public towards EMF Radiation from Mobile Towers.
e. SMS are being sent through Telecom Service Providers (TSPs) on regular intervals to aware the public and to boost their confidence on the issue of EMF Exposure from Mobile towers and mobile handsets.
f. EMF Awareness sessions on regular internal are held with local authorities, telecom industries and eminent doctors to bust the myth of EMF radiation from mobile towers. Wide coverage of the event by the media and large participation of the public is ensured in these sessions.

g. In many LSAs, State Telecom Committees (STCs) and District Telecom Committees (DTCs) have been constituted to effectively address Public Grievances relating to installation of towers & issues related to telecom infrastructure resolve Tower related complaints of the public. State Level Telecom Committee (STC) consists of officers from LSA field unit, State Administration, representative(s) of concerned Telecom Service Provider(s) and eminent public persons etc. Similarly, District Level Telecom Committee (DTC) consists of officers from District Administration, representative(s) of concerned Telecom Service Provider(s) and eminent public persons etc.

h. Resident Welfare Societies (RWAs) are also being contacted on regular basis to make aware them regarding the misconception of EMF Radiation from Mobile Towers and to clear their apprehensions.

i. In Karnataka LSA, during Bharatnet inspection in Gram Panchayats(GPs), Pamphlets published by DoT, Government of India in respect of Mobile Tower radiation, are being distributed to Panchayath Development Officer/ GP Staff for bringing awareness to change the perception of public in the villages towards the issue of radiation and to display in the Notice Board of GPs.

j. Actions taken by Kerala LSA unit are commendable. Following actions taken by Kerala LSA Unit:

- News Paper Advertisements Given as part of awareness of EMF Norms.
- As part of District Telecom Committee meetings, a Press note is being released making General Public aware of the EMF Norms and the sites Audited by DOT during a month.

- COAI organised a seminar on Mobile Towers with participation by Medical Experts and Media at Trivandrum, Ernakulam, Kozhikode and Thrissur.
- As part of ITU 5G meeting at Cochin a Public discussion on Mobile Towers held for which wide publicity was given.
- Indian Medical Association (IMA) Organised Workshops with Residents Association, Doctors, Media etc at Trivandrum and Kollam.
- DOT conducted Mobile Tower Awareness workshops at all Districts many times.
- Arranged a Training Program for Officials of Corporations, Panchayats etc at KILA (Kerala Institute of Local Administration) in Thrissur.
- EMF Awareness program were conducted through AIR and popular Local FM (Club FM) channels and also through Popular Local TV channels Like Amrita TV, Asianet TV etc .
- Awareness talks given at several Educational Institutions and IETE/IEEE sponsored programs at Ernakulam, Palakkad & Trivandrum Districts.
- Residential associations meetings were also held at Ernakulam, Kozhikode, Kannur, Trivandrum, Thrissur Districts by DOT.
- DDG and Director Participated in a chat show in a popular TV on "Mobile Towers Facts and Myths ".
- A Booklet in English and Malayalam (Local Language) on FAQs on Mobile Towers and Mobile Phones printed and circulated among General Public.
- A Video in Malayalam on EMR Awareness was made by DOT Kerala LSA and circulated through Social Media like Whatsapp, FaceBook.

- EMR Awareness Programs Conducted for the Mayor and Councilors of Various Municipal Corporations and Other Local Bodies.
- In the TAC (Telecom Advisory Committee) Meetings arranged by BSNL, the Chairman of TAC Honb'le MP and other Members of TAC were briefed about DOT Guidelines on EMR, Role of DOT at various SSAs.

Kerala LSA has further intimated the number of grievances resolved during DTC Meeting which were 641,1083 and 1746 for the years 2017,2018 and 2019 respectively.

5.6 Analysis of the actions being taken by Government for changing the perception of Public towards issue of Mobile Tower Radiation:

An analysis of the above government actions may be presented as below:

- As per information provided by Field LSAs of DOT, the EMF Audit of Mobile BTSs is being conducted upto ten percent of Total BTS base on annual basis in accordance to the Government norms. This is a positive action by Government to make the public confident that the Mobile Tower in their locality is not hazardous as its Emission is below the standards set by the Government. Further, such Audits deter the Telecom Service Providers (TSPs) to make Mobile Towers EMF Emission more than standards, as there is a heavy penalty for violation of norms. During the EMF Audit, general public residing in that locality is being made aware about misperception of EMF radiation related health hazard and also their undue apprehensions are cleared.
- There is an increase in consolidated number of public awareness programmes being conducted on year to year basis. However, the conduction of these programmes is not

uniform across LSAs. Some LSAs like Kerala, Karnataka, Punjab, Haryana, Delhi, Andhra Pradesh, are conducting these programmes on regular basis while some LSAs have not conducted even a single such programme.

- Due to the impact of positive actions of the Government, the Public Grievance (PG) Cases and RTI Applications on Mobile Tower Radiation in last three years have been limited in numbers. In some areas, the numbers have increased but it may be due to the increased sensitization and public awareness on the issue.
- As per interaction with officers of DOT, these PG Cases are being resolved promptly and to the satisfaction of the public. Being booked online, it can be viewed for how long period, any particular PG Case is pending and who is the defaulting officer/official.
- Similarly, RTI Applications are being disposed off within the stipulated time frame to the satisfaction of the applicant. As can be seen from Table 5.5, the percentage of RTI Appeals to the RTI Applications is less than ten percent.
- For spreading the awareness among the public regarding issue of EMF Emission from mobile towers and to bust the myths and misconception of the public, Kerala LSA is doing a commendable job. In Kerala, meetings of District Telecom Committees and State Telecom Committees are being conducted on regular basis and the complaints of public are being resolved through these committees. Regular press notes of these meetings are released and there is wide media coverage of the meetings. Kerala LSA is utilizing each and every opportunity and medium for spreading the awareness on the issue. The use of Radio FM and TV Channels, publication of the booklet in English and Malayalam on FAQs on Mobile Towers and Mobile Phones and circulation of the

same among general public, making and circulation of videos on Social media apps like Whatsapp and Facebook on EMR Awareness, conducting training sessions for local authorities on EMR Awareness, conducting regular meetings with Residential Welfare Associations, educating TAC Members, involving COAI and IMA in public awareness workshops are some of the initiatives which other LSAs should also follow to increase public awareness on EMF Radiation issue and to bust the myths and misconceptions as public carries, related to the issue.

5.7 Analysis of discussion with Senior officers and experts on RF EMF Emission issue

It was attempted to have discussions with officers in Department of Telecommunications, Telecom Engineering Center, License Service Area (LSA) Field Units of DOT, Private Telecom Infrastructure Providers, Professors of engineering colleges, Medical Professionals and other experts on the issue of EMF Radiation from Mobile Towers and Mobile Phones. The discussion was based on the following questions, primarily:

1. What is your view on the impact of EMF Exposure from Mobile Communication Technology?
2. Do you consider the standards set by Government of India for EMF safe emission Limits as adequate or they should be further revised?
3. What is your view on Measures being taken by the Government of India to deal with inconvenience and possible adverse effect from the exposure of Radio Frequency Electromagnetic Field Waves by Mobile Communication Technology?
4. What further steps may be taken by the Government on the issue?
5. Any other suggestion or opinion on the issue.

The analysis of the discussions held may be presented as below:

(i) With regard to health hazard from the EM Radiations of Mobile Communication Technology, majority of the experts were of the view that there is no conclusive scientific evidence of adverse health effects due to low level RF emission from mobile phone towers. They referred several studies which had been conducted in different countries, under the aegis of World Health Organization (WHO). WHO has referred to approximately 25,000 studies, published around the world over past 30 years, and based on an in-depth review of scientific literature, has concluded: "current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields". Since the effects on human beings are to be studied over a long period of time, further studies are going on around the world.

(ii) Some of the experts commented that as the long term researches are still continuing, the outcome of these researches should be awaited before taking any final view.

(iii) However, almost all the experts were having the view that although it is not clear that the EMRs from mobile towers cause any harm or not, but surely, mobile phone handsets pose more risk, if not used as per advisory issued by the Government. It is, therefore, important to step back & analyse the implications of mobile phones and strictly follow the guidelines of its usage.

(iv) With regard to the standards set by Government of India for RF EMF Safe exposure limits, majority opinion was that since Government has adopted the limits for basic restriction levels of Electromagnetic radiation from Mobile towers which are ten times more stringent than the limits prescribed by ICNIRP guidelines as recommended by

WHO and the norms set with regard to mobile handsets are also stricter than the ICNIRP limits, the Present safety norms in the country are sufficient and should continue. Some of the experts further added that these norms should be followed scrupulously.

(v) Measures being taken by the Government to deal with inconvenience and possible adverse effect from the exposure of Radio Frequency Electromagnetic Field Waves by Mobile Communication Technology were discussed in length. The Government of India, through Department of Telecom (DOT), has taken many steps for effectively addressing the issue of EMF Waves emission and Public Safety, including

(a) The EMF Audit of upto Ten Percent of the Mobile Towers on annual basis by LSA Field Units of DOT,

(b) Taking strict punitive actions in case of non-compliance of limits as set by Government,

(c) Publishing information on compliance status of mobile towers on web portal www.tarangsanchar.gov.in,

(d) Conducting public awareness workshops and programmes on the issue,

(e) Disseminating the Information through website dot.gov.in,

(f) Public Advertisements utilizing different medium like Newspaper, TV Channels, Radio, Leaflets/pamphlets etc.

(vi) DoT is organizing frequent workshops for field officers to ensure observance of the latest guidelines issued by DoT on the subject of EMF radiation and public safety so that these officers, at the time of EMF testing of mobile towers, can make aware the general public residing in that locality ,about the misperception of EMF radiation related health hazard and also their undue apprehensions are cleared.

(vii) RTI and PG Cases related to Mobile Tower Radiation are being resolved promptly and to the satisfaction of applicant/complainant.

(viii) One issue highlighted by senior officers was that Telecom towers are critical installations on which the backbone of mobile communication rests. In an area, if there is insufficient network coverage due to inadequate mobile towers, then there are chances of call drop during voice call and slow data speed when mobile internet is being used. People have to understand that more towers are prerequisite of higher speed and proper connectivity.

(ix) It was also discussed that the country has adopted one of the most stringent EMF exposure limits which are ten times more stringent than the limits prescribed by ICNIRP and recommended by WHO. Keeping the precautionary EMF safe exposure limits for the Radio Frequency Field (Base Station Emissions) as 10 times more stringent than the safe limits prescribed by ICNIRP for all areas in India, eliminates the need for fixing lower limits for specific areas like schools, hospitals, residential premises, children playgrounds. Some experts were also of the view that for such specific areas, limits may be reviewed.

(x) Public awareness and education is the key to handle the issue and boost the public confidence. Each and every available platform has to be utilized effectively. More and

more public awareness programmes utilizing social media, FM channel, cable TV in local language is required. Awareness programmmes in schools, with the help of NGOs, will help to mitigate public fear.

5.8 Analysis of Recommendations of Inter- Ministerial Committee and action taken by Government of India on those recommendations

On 24.08.2010, DoT set up an Inter-ministerial Committee consisting of officers from DoT, Indian Council of Medical Research (Ministry of Health), Department of Biotechnology and Ministry of Environment and Forest to examine the effects of Electromagnetic Field radiation from base stations and mobile phones on human health at levels below the existing standards. The committee took into consideration the presentations/ viewpoints of Prof. J. Behari from JNU, Telecom Equipment Manufacturers Association (TEMA), Cellular Operators Association of India (COAI)/ Association of Unified Service Providers in India (AUSPI), Telecom Users Group of India (TUGI), Consumer Care Society (CCS), Bangalore and Prof. Girish Kumar, IIT, Bombay. Inter-Ministerial Committee (IMC) in its report examined the environmental and health related concerns and indicated that most of the laboratory studies were unable to find a direct link between exposure to radio frequency radiation and health; and the scientific studies as yet have not been able to confirm a cause and effect relationship between radio frequency radiation and health. The effect of emission from cell phone towers is not known yet with certainty. The inter-ministerial committee (IMC) examined 90 international and national studies/reference papers, related with the EMF radiation, before finalizing its

recommendations.As per the report[65] *"The hot tropical climate of the country, low body mass index (BMI), low fat content of an average Indian as compared to European countries and high environmental concentration of radio frequency radiation may place Indians under high risk of radio frequency radiation adverse effect and the level of susceptibility of an average Indian may be different. Hence revision of radiation norms may be considered for adoption in India keeping in view the possible health concern."*

Recommendation of committee, related to mobile base stations stated, "*The RF exposure limits in India may be lowered to 1/10th of the existing level keeping in view the data submitted by COAI/ AUSPI during presentation made to the committee and trend adopted by other developed countries."* Similarly, that related to handsets the committee stated, "*Adoption of SAR level for mobile handsets limited to 1.6 Watt/Kg, averaged over a 6 minutes period and taken over a volume containing a mass of 1 gram of human tissue as per the FCC norms of U.S."*

Based on the recommendations by Inter-Ministerial Committee (IMC), these norms for exposure limit for the Radio Frequency Field (Base Station Emissions) have been made 10 times more stringent to the existing limits prescribed by International Commission on Non Ionizing Radiation Protection (ICNIRP). Directions in this regard have been issued to the Mobile Operators on 30.12.2011. License Amendment in this regard has been issued on 10.01.2013 and 26.06.2013. Regarding limits of SAR Values of mobile handset also, recommendations have been accepted and implemented. W.e.f. 01.09.2012 the maximum

[65] Department of Telecommunications Inter-Ministerial Committee. (2010). *Report of Inter-Ministerial Committee on Electromagnetic Fields Radiation*

SAR level has been revised to 1.6 watt/Kg, averaged over a 6 minutes period and taken over a volume containing a mass of 1 gram of human tissue.

The report of IMC has been proved very path breaking in the Journey of EMF Norms and Regulations in India. Before the recommendations of the committee, Government of India was just following ICNIRP Norms. It was the recommendations of committee, following which the norms of RF EMF Emission from Mobile Towers were made ten times more stringent than those of ICNIRP Norms. Recommendations regarding SAR Norms for mobile handsets were also accepted. The major recommendations of Inter-Ministerial Committee and the action taken by Government of India on those recommendations have been analysed and presented in the table 5.7 below.

Table 5.7: Recommendations of Department of Telecommunications Inter-Ministerial Committee and Action taken by Government of India

Recommendations **Mobile Handsets**	**Action Taken by Government of India**
Adoption of SAR level for mobile handsets limited to 1.6 Watt/Kg, averaged over a 6 minutes period and taken over a volume containing a mass of 1 gram of human tissue as per the FCC norms of United States.	Government of India has accepted and implemented the recommendation. W.e.f. 01.09.2012 the maximum SAR level has been revised to 1.6 watt/Kg, averaged over a 6 minutes period and taken over a volume containing a mass of 1 gram of human tissue
SAR value information is to be embossed and displayed in the handset. Information on SAR values for mobile handsets should be readily available to the consumer at the point of sale so that one can	Accepted and Implemented. It is mandatory for manufacturers to display the SAR level on each mobile handset.

make sure of the SAR value of the handset while buying a cell phone.	
Government may consider amendments in the **Indian Telegraph Act 1885 & rules notified there under** and necessary legislations if any so that only mobile handset satisfying radiation standards should be permitted for import / manufacture or sold in the country. Mobile handset manufactured and sold in India or Imported from other countries should be checked for compliance of SAR limit and no handsets of SAR value above the prescribed standard adopted in India should be manufactured or sold in the country.	Accepted and Implemented.
Mobile Base Stations The RF exposure limits in India may be lowered to $1/10^{th}$ of the existing level keeping in view the data submitted by COAI/ AUSPI during presentation made to the committee and trend adopted by other developed countries.	Accepted and implemented. Based on the recommendations by Inter-Ministerial Committee (IMC), these norms for exposure limit for the Radio Frequency Field (Base Station Emissions) have been made 10 times more stringent to the existing limits prescribed by ICNIRP. Directions in this regard have been issued to the Mobile Operators on 30.12.2011.
DOT should create a national data base with the information of all the base station, their emission levels and display on public domain for public information.	Accepted and Implemented. Department of Telecommunications (DoT), Ministry of Communications has launched Tarang Sanchar, a web portal for Information sharing on Mobile Towers and EMF Emission Compliances, with a view to generate confidence and conviction with regard to safety and harmlessness from mobile towers, clearing any myths and misconceptions. The portal can be accessed at www.tarangsanchar.gov.in. The EMF Portal provides a public interface where an easy map-based

	search feature has been provided for viewing the mobile towers in vicinity of any locality. By click of a button, information on EMF compliance status of mobile towers can be accessed. Detailed information about any tower site, if requested, will be sent on email to the users.
Impose restrictions on installation of mobile towers near high density residential areas, schools, playgrounds and hospitals.	Keeping the precautionary EMF safe exposure limits for the Radio Frequency Field (Base Station Emissions) as 10 times more stringent than the safe limits prescribed by ICNIRP for all areas in India, eliminates the need for fixing lower limits for specific areas like schools, hospitals, residential premises, children playgrounds. Recommendation not accepted.
To conduct the long term scientific research related to health aspect of EMF radiation exposure and associated technologies in India in the following areas: o Health effect of RF exposure in children. o Health effect of RF exposure in Foetus, mothers and elderly persons. o Combined electromagnetic field radiation effect exposure from multiple antennas of a shared infrastructure sites	Science and Engineering Research Board (SERB) has invited R&D proposals in June 2013 for scientific investigations on radiation hazards and risk potentials from Mobile Towers and Handsets on Life (humans, living organisms, flora & fauna and environment) and related Research & Development (R&D) initiatives. The SERB had constituted an Expert Committee/Task Force comprising of various experts from Medical & Engineering Institutes which had short listed 19 research studies, including those from Indian Institute of Technology (IIT) Madras, IIT Kharagpur, All India Institute of Medical Science (AIIMS) New Delhi, AIIMS Rishikesh, Thiagarajar College of Engineering Madurai, Postgraduate Institute of Medical Education and Research (PGIMER) Chandigarh,

	National Institute of Mental Health and Neurosciences (NIMHANS) Bangalore, Amity University Noida, Swami Vivekananda Yoga Anusandhana Samsthana University Bangalore, Guru Nanak Dev University Amritsar. These studies have been initiated and are being supported for funding at the total cost of Rs. 9.9 crore.
Department of Telecom may create a document "Radio waves and safety in our daily life" indicating various Dos and Don'ts related to mobile users clarifying various myths regarding deployment and use of radio waves and mandate each operator to print and issue the same to their customer at the point of sale for enhanced customer awareness. This will help in facilitating the right inputs and creating an environment where everyone can use the radio waves safely.	DoT has issued an informative guide[66] on 'Mobile Communications – Radio Waves and Safety' which covers a basic introduction to radio waves, various terminologies, Do's & Don'ts related to mobile phone usage, clarification of various myths regarding deployment, use of Radio waves/ Safety Standards and frequently asked questions relating to Mobile phones & Human health, in common language.

Review of revised exposure limits in 2014 by Committee constituted in compliance of direction by Hon'ble High Court Allahabad:

In a Writ Petition filed in Hon'ble High Court Allahabad, Lucknow bench, the Hon'ble Court vide its order dated 10.01.2012 constituted a committee including Members from IITs Kharagpur, Kanpur, Delhi, Roorkee, Bombay and from other scientific institutions of the country including Indian Council of Medical Research (ICMR) and All India Institute

Department of Telecommunications (2012) *A handbook on 'Mobile Communications – Radio Waves and Safety'*

of Medical Science (AIIMS) Delhi who submitted its Report on 17-01-2014. The Committee observed that the Department of Telecom has taken adequate steps to impose stricter precautionary limits for EMF radiation from mobile towers as well as from mobile handset/phones. After due consideration of the human health concerns on account of EMF radiation being raised in public and the Report of the Committee, the Government has decided in February 2014[67] that the present prescribed precautionary EMF safe exposure limits are adequate and need no further change at this stage and hence, the revised EMF safe exposure limits and SAR limits of mobile handsets as recommended by IMC are being followed till date in the country.

5.9 Analysis of some prominent Court Judgments in respect of EMF Radiations:

The matter of health effects of EMF Radiations from Mobile Towers has also been agitated in different High Courts from time to time. Several High Courts viz Hon'ble High Courts of Punjab & Haryana, Madras, Kerala, Gujarat, Delhi, Himachal Pradesh, Allahabad in the court cases related to issue of effects of the radiation from cell phone towers have given judgments whereby they have dismissed petitions, where the mobile tower installations at various locations, including residential, were challenged on grounds of health effects of EMF radiations. An analysis of some of the prominent judgments in respect of EMF Radiations is done as below:

[67] https://dot.gov.in/sites/default/files/DOC120314-002.pdf accessed 02 March 2020

1. Hon'ble Kerala High Court in the case of **Reliance Infocom Ltd. Vs. Chemanchery Grama Panchayat**[68], reported in **AIR 2007 Kerala 33** has observed on **12-10-2006** that the surveys conducted in proximity to the base stations indicated that the public was exposed to extremely low intensity RF fields in the environment and all the evidences indicated that they were unlikely to pose the risk to health. Observations of Division bench of the Kerala High Court, as contained in para 5 of the judgment are as follows:

"5. We have already found that RF exposures from Mobile Base Stations are much less than from radio, FM radio and television transmissions and that the consensus of scientific community is that the radiation from Mobile Phone Base Stations is far too low to produce health hazards if people are kept away from direct access to the antenna and the overall evidence indicates that they are unlikely to pose a risk to health. The strength of radio frequency fields in front of the antennae varies with the distance. Persons standing directly in front of the antennae in these high density zones will get higher exposures. We have also found that the height of Mobile Base Station antennae is normally 36 metres and the effect of radio waves depends on the distance from the base stations since the antennae are directed horizontally with a 5 degree downwards tilt. Human studies pertaining to base stations conducted by Santini R et al (2002), Bortkiewicz et al (2004) & Hutter & Kundi et al (2006) do not report any quantitative parameters related to health hazards. Therefore, it can safely be concluded that the

[68] WP(C). Nos.18242 of 2006 (V) & 16724 of 2006 (N) filed in Hon'ble Kerala High Court.

permission granted for installation of Mobile Base Station by the Panchayat would not cause as such any health hazards nor will it affect the fundamental rights guaranteed to citizens under Article 21 of the Constitution. Right to life enshrined under Art.21 includes all those aspects of life which make life meaningful, complex and worth living. Development of technology has its own ill-effects on human beings, but, at times people will have to put up with that at the cost of their advantages. Petitioner and others for installing towers will have necessarily to comply with the statutory provisions contained in Chapter XIX of the Kerala Municipal Building Rules, 1999 which permits construction of telecommunication towers over buildings. Petitioner has submitted that it has already satisfied all those conditions and in such circumstance, Panchayat has granted the Licence."

2. The case **K.P.Antony vs Chellanam Grama Panchayath** has been dismissed by **Hon'ble Kerala High Court**[69] vide Judgement dated **09-07-2009.** The relevant excerpts of the Judgement is as follows:

"In their counter affidavit, the 4th respondent would also take the contention that the reason for cancellation of the permit that the tower is a health hazard to the public has already been found unsustainable by this Court in Reliance Infocom Ltd., v. Chemanchery Grama Panchayat, 2006(4) KLT 695."

[69] WP(C) No. 4282 & 7127 of 2009 filed in Hon'ble Kerala High Court.

3. In the case **Reliance Telecommunications Ltd. V. S.I. of Police[70], Hon'ble Kerala High Court** has decided the case in favor of Telecom Service Provider on Dated 08-04-2010.

The relevant excerpts of the Judgement are as follows:

"In the instant cases, there is absolutely no question of any pollution and there is no pleading or proof as to any such instance and the only apprehension is with regard to the 'health hazards' likely to be created by the 'EMR'. As mentioned already, the Radio frequency waves are non-ionizing radiation, which cannot emit any electrons, unlike 'X-rays' and that apart, no Scientific Committee Report has been procured or produced to controvert the findings rendered by the Division Bench in Reliance's case 2006 (4) K.L.T. 695.

4. In the Writ petition filed by Indus Towers Limited[71], seeking police protection for erecting towers at Peringmala in Nedumangad, **Hon'ble Kerala High Court** has decided the case in favor of Infrastructure Provider on Dated 09-07-2013.The relevant excerpts of the Judgement is as follows:

"The writ petition was filed as early as on 16.10.2012. None of the respondents have filed any counter affidavit in this writ petition. The matter was heard. Whether the commissioning of a telecommunication tower would affect the health of the people of the area is an issue which is still being debated among the scientist communities all

[70] W.P. (C) No. 6433 of 2010 filed in Hon'ble Kerala High Court.

[71] WP(C) No. 24569 of 2012 filed in Hon'ble Kerala High Court.

over the world. This Court has, in two decisions, held that there is no evidence that the same will affect the health of the people. Whether it will affect the health of the people or not, it is an undisputed fact that we are bound to live for the rest of our lives with mobile phones in our pockets. The statute prescribes certain licenses and permits for erecting telecommunication towers. All what we can ensure is that such requirements are complied with in the erection and operation of the tower.

In the above circumstances, if the petitioner has obtained necessary permits and licenses, nobody can prevent them from erecting and commissioning telecommunication towers. Therefore, we dispose of the writ petition with a direction to respondents 1 and 2 to see that the petitioner is not prevented from commissioning the telecommunication tower already erected, if they have all W.P. the permits and licences to operate the telecommunication tower."

5. The Public Interest Litigation (PIL) **Sh. Ashwani Vs. State of U.P.**[72] has been dismissed by Hon'ble **Allahabad High Court** on **26-07-2013** stating:

"Till a proper research is made and conclusively it is shown that Mobile Towers in residential areas are a definite health hazard, it will not be proper to ask for removal of such towers from the residential areas, which is not prohibited under any law or executive decisions of the State. Petitioner has failed to properly research and has not stated that this issue has not been determined authentically."

[72] PIL No.-40535 of 2013 filed in Hon'ble High Court of Allahabad.

6. The PIL Smt. Asha Mishra Vs. State of U.P.[73] & 7 others along with 15 other petitions filed in **High Court of Allahabad** have been disposed of vide Judgement dated **12-04-2016.** The relevant excerpts of the Judgement is as follows:

"We felt constrained to burden this judgment with various extracts of the findings and recommendations of DOT, the Parliamentary Standing Committee as well as the WHO in order to establish that a plethora of material gathered by experts clearly negatives the perceived and alleged imminent threat and danger to health as was sought to be canvassed before us. ***All the experts have unanimously voiced their opinion that the present body of scientific research does not justify the threat to health and life as is sought to be portrayed by some quarters including the petitioners before us.***

On the above state of the record we find no merit in the challenge raised by the petitioners on this score. Bearing in mind the present conclusions and findings on the subject as expressed by experts across the board we find that there exists no justification for the submission of a present and imminent danger or threat to human health from the radiation emitted by mobile towers and BTS's. We further note that the studies undertaken both in India as well as by other international organizations have unanimously opined that the emissions from these equipments are minuscule and do not warrant the anxiety or fear which is sought to be generated in this batch of petitions. Our conclusion so recorded is of course not intended to relieve DOT or the Union Government from its obligation of continuing a scientific review of the subject." (Pg. 42-43).

[73] PIL No. 48084 of 2015 filed in Hon'ble High Court of Allahabad.

7. In the case **Sh. Dhup Singh Vs. Union of India[74]**, Hon'ble **High Court of Punjab & Haryana** dismissed the petition on **09-07-2014** stating:

"In view of the fact that Union of India had taken steps as mentioned in their detailed reply, no ground is made out for restraining the official respondent from installing mobile tower in residential area."

8. The Petition filed by **Indus Towers Limited vs Kanakpur Kansad Nagarpalika & other[75]** in **Hon'ble High Court of Gujarat** have been allowed vide Judgement dated **15-07-2014** stating that asking the petitioner to produce NOC from the residents of the society is beyond authority and power of respondent Nagarpalika. The relevant excerpt of the Judgement is as follows:

"7. In the circumstances, the present petition stands allowed in terms of Para Nos.19(A) and 19(B) quashing and setting aside the notice dated 30.08.2013 asking the petitioner to produce 'No Objection Certificate' from the residents of the society as beyond authority and power of the respondent Nagarpalika. The petitioner is permitted installation of the subject mobile tower and the respondent Nagarpalika shall not hamper or object the installation, functioning and operation of mobile tower in any manner. However, it goes without saying that the petitioner shall take note of the precautionary measures as laid down by the guidelines issued by the Department of Telecommunications, Ministry of Communications and IT, Government of India. Rule is made absolute."

[74] CWP No. 12047 of 2013 filed in Hon'ble High Court of Punjab & Haryana.

[75] No. C/SCA/16307/2013 in the Hon'ble High Court of Gujarat.

9.Based the judgment of Division bench of the Hon'ble Kerala High Court, mentioned above, the Hon'ble **High Court of Gujarat at Ahmadabad** has rejected the case **Muktipark Co Operative Society vs Ahmedabad Municipal Corporation & anr.**[76]alongwith two other cases. Hon'ble High Court has also mentioned:

"27. .....the radio frequency waves used for mobile phones are not covered under the definition of "radiation" as given in the Atomic Energy Act, 1962 and the non-ionizing radiations do not have the capability to ionize the matter with which they interact. The Radiation Protection Division (NRPB) of the U.K. Health Protection Agency in the year 2000 has reported that the balance of evidence indicates that there is no general risk to the health of the people living near the base stations on the basis that the exposures are expected to be small fractions of guidelines."

10. Hon'ble Madras High Court dismissed the petition **W.P. no. 27956/2014** on **27-10-2014** stating:

"2. If we have to accept the aforesaid plea of the petitioner, then we would have to shut down mobile services practically throughout Tamil Nadu. In Chennai, most areas would be thickly populated and if this test is applied, then there would be no mobile services available in Chennai.

3. Whether the society should live with or without mobile services or with other subject matters of perceived development, are matters relating to the policy decision of the

[76] C/SCA/5548/2014, CA no. 5597 of 2014 and CA No. 5159 of 2014 in the Hon'ble High Court of Gujarat.

Governments, which are elected by the people. It is not permissible for each individual to canvass his thinking on such issues and seek judicial restraint orders."

11. Hon'ble Madras High Court disposed of about 50 petitions along with the petition **K.R.Ramaswamy vs Secretary, DOT, UOI & ors.**[77] on **05-03-2015** stating:

"10. We are, thus, of the view that in a judicial proceeding these aspects cannot be analysed. There being no materials at least as on date, which can finally suggest any health hazards from these towers and the solution thereof, the Court would not venture into unchartered territory of technical expertise to determine the area where it should be installed. The Court, at best can place this matter before the appropriate Committee to look into this matter which the Kerala High Court already did and we have the benefit of the conclusion arrived at in those proceedings, as noticed above.

11. We are of the view that no further directions are required in these matters, other than to say that the concerned authorities would continue to analyse the materials as and when it emerges to look into the concern raised by the petitioners, especially, in view of the fact that there is no final view as yet on these aspects. Science grows and evolves and one does not know what may happen tomorrow. It is, in this context, we have made these observations"

12. CRL.O.P.(MD) Nos. 6885 and 6895 of 2015 and **WP.(MD) Nos. 5249 of 2010 along with 11 other petitions** filed in **Madurai Bench of Madras High Court** have also been

[77] W.P. No. 24976 of 2008 filed in Hon'ble Madras High Court

dismissed vide Judgement dated **15-04-2015** and **22-04-2015** respectively on the basis of the Judgement of Madras High Court in W.P.Nos.24976 of 2008 on 05-03-2015.

13. The Writ Petition **Resident Welfare Association vs Union of India & ors.**[78] filed in Hon'ble **High Court of Delhi** seeking a mandamus to the Union of India (UOI) to make proper amendments and issue new advisory guidelines incorporating the Recommendation No.13 of the Inter-Ministerial Committee (IMC) report of the year 2010-2011, of imposing restrictions on installation of mobile phone towers near high density residential areas, schools, playgrounds and hospitals has been dismissed by the Hon'ble court on **09-09-2015** stating:

"…

This Court cannot, upon being approached by residents or by association of residents, interfere with the works undertaken in accordance with the prevalent policy.

……

I am of the opinion that the said matters fall in the domain of policy making and the Courts, neither have the jurisdiction to nor where-with-all to take a call thereon. The appropriate authority has made the policy and while framing such policy, the report of the IMC has been duly considered. It is not for the Court to enter into the arena of finding out, whether the policy made by the expert body constituted, for going into the said question, is correct or not and that too on the basis of an opinion of some persons in the process of such decision making. It is the settled position in law (see Surgical Electronics Vs. Union

[78] WP (C) No. 8661 of 2015 filed in Hon'ble High Court of Delhi

of India 60 (1995) DLT 359 (DB) and Rajinder Kumar Khatri Vs. Delhi Development Authority MANU/DE/4005/2011) that such comments / opinions during the decision making process cannot form the basis of the challenge to the ultimate decision, even if contrary to the opinion at one level in the decision making process…..The Inter-ministerial Committee and its recommendations are but a stage in the making of the policy aforesaid."

The Hon'ble court also took notice of several judgments of the Kerala High Court vis. *M/s. Essar Telecom Infrastructure (P) Ltd. Vs. C.I. of Police, Angamali Police Station* MANU/KE/2780/2010 (FB), *Indus Towers Ltd. Vs. The Sub Inspector of Police* MANU/KE/1308/2014 (DB) and *Sudevan Vs. Mundur Grama Panchayat* MANU/KE/0839/2013, holding that **mobile phone towers do not pose any health hazard and stated:**

"*Citizens not wanting to give up use of cell phones cannot approach the Court to push the towers and antennas essential for use thereof, from their own door steps to another person's door step; if at all they feel that the technology is harmful for them, all they have to do to give up the use of the same and in which case there would also be no need for towers and antennas required to be installed for enabling use thereof."*

14. The Writ Petition **Kapil Chaudhary& anr vs Union of India &ors.** [79]filed in **High Court of Delhi** has been dismissed vide Judgement dated **26-04-2016.** The relevant excerpt of the Judgement is as follows:

"12. In view of the above, it is clear that there is no scientific data available to show that installation of mobile phone towers and the emission of the waves by the said towers

[79] WP(C) 5550 of 2015 filed in Hon'ble High Court of Delhi

is in any way harmful for the health or hazardous to the health of citizens. There is no conclusive data to the said effect. The petitioner has not been able to produce any data whatsoever showing any such harmful effects on the health of human beings. The petitioner has also not been able to show violation of any norms by the respondent."

15. The Writ Petition **Vikas Luthra vs Union of India & ors.** [80] filed in **High Court of Delhi** has also been dismissed vide Judgement dated **05-05-2016** on the basis of the above mentioned Judgement of Delhi High Court dated 26-04-2016. The relevant excerpt of the Judgement is as follows:

……..

"*In view of the above, it is clear that there is no scientific data available to show that installation of mobile phone towers and the emission of the waves by the said towers is in any way harmful for the health or hazardous to the health of citizens. There is no conclusive data to the said effect. The petitioner has not been able to produce any data whatsoever showing any such harmful effects on the health of human beings. The petitioner has also not been able to show violation of any norms by the respondent."*

Hon'ble court also mentioned that:

"Before parting with this matter, we deem it necessary to mention that the concerned authorities should, by way of communication through T.V., Radio etc. bring it to the notice of the people at large that there is no reason for them to fear the erection of the Base Transceiver Station, known as the Wi-Fi Mobile Tower. The reason why we are saying so

[80] WP(c) 6525 of 2012 filed in Hon'ble High Court of Delhi

is that the impression in the mind of a common man is that the Wi-Fi Mobile Towers erected all over the State has the potential to cause health hazard due to the emission of radio active waves from the said tower."

"For the foregoing reasons, writ petition is dismissed being devoid of merits".

16. The Writ Petition **Vijay Verma vs State of H P & ors[81].** alongwith three other cases filed in Hon'ble **High Court of Himachal Pradesh, Shimla** has been dismissed vide Judgement dated **30-11-2015** stating that they find no merit in these petitions. In its Judgement, Hon'ble Court has discussed judgements of various High Courts on the similar matter in detail and stated:

"It is evident from the aforesaid precedents that there appears to be broad consensus amongst all the High Courts save and except Rajasthan High Court, suggesting that radiation being emitted from the Mobile Base Stations do not cause serious risk on the health of the people living near these base stations."

…….

"At this stage, it would be pertinent to note here that the aforesaid judgment of Rajasthan High Court is not only subjudice, but even the substantive direction ordering removal of towers have been stayed by the Hon'ble Supreme Court.

[81] CWP 8283 of 2012 along with CWP No. 5282, 9747 of 2014 and 3287 of 2015 filed in Hon'ble High Court of Himachal Pradesh, Shimla

In so far as the recommendations of the Inter Ministerial Committee are concerned, which in fact formed the basis of the judgment of the Rajasthan High Court, the same have now been adopted as stricter norms for emission from the base stations being 1/10th of the limit prescribed by the ICNIRP…"

Hon'ble High Court has also quoted and discussed the entire write-up provided on the website of DoT under the section "A Journey for EMF" and stated that:

"The Department of Telecommunication (Ministry of Communication and Information Technology) has published on its website very instructive information regarding the health effect due to EMF"

After detailed discussion of the available materials, the Hon'ble Court has concluded that:

"17. It is evident from the perusal of the aforesaid reports that the exposures to electromagnetic fields (EMF) do not have any notable effect on the health of human beings. Evidently, the studies conducted till date by the two premier organizations i.e. WHO and SCENIHR go to indicate that despite a large number of studies having been carried out for the last two decades to assess the potential health risk on account of emission of EMF, no major adverse health effect has been noticed.

18. What in fact emerges is that radio frequency radiation from the mobile towers and phones are in minuscule range and is lakhs of time weaker than X-rays or UV rays or even normal visible light. In fact, so low that they simply cannot cause any disturbance of electrons in the basic atoms of matter or living tissue and hence classified as "non-ionising radiation".

19. Radiation in itself is nothing new and has been there since life began on earth three and a half billion years ago. Radiation is all around us and we are all actually submerged in naturally occurring ionizing radiation reaching us from the outer space, even from the radioactive elements and materials around us. Sunshine in itself is a familiar form of radiation.

20. We in view of the overwhelming material are of the considered view that as of now there is no cause of alarm with regard to the possible ill-effect on human health by electromagnetic Field (EMF radiation) from mobile phone towers and mobile phones because the limits adopted in India cannot have any biological effect on human. In fact, the limits set by India are much lower than the internationally adopted recommendations of the International Commission of Non-Ionizing Radiation Protection (ICNIRP) which account for thermal and non-thermal effect.

21. There is no conclusive evidence as on date which may have found any adverse health effect by EMF radiation from the mobile tower or mobile hand set by the WHO or SCENIHR and so long as EMF radiation power level in vicinity of Mobile Base Stations is below the prescribed limits, there should not be any cause or concern for adverse thermal effect on human beings living close to Mobile Base Station or in the nearby vicinity.

22. Now in teeth of the report submitted by the WHO and another report submitted by the SCENIHR, the individual opinions relied upon by the petitioners to claim that the EMF radiations from the Mobile Base Stations are source of health hazard, for the time being, can conveniently be brushed aside as having no scientific backing whatsoever and therefore, any such reports relied upon by the petitioners shall have to give way to the opinion rendered by the WHO and SCENIHR.

There have been many other similar cases filed in the High Courts of Punjab and Haryana, Chhattisgarh, Madras and other High Courts and almost in all the cases, the Hon'ble courts have decided the cases in favor of installation of towers for the good of general public in the light of absence of any conclusive scientific evidences for health hazard from EMF Emissions of Mobile Communication Technology.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

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CONCLUSIONS AND RECOMMENDATIONS

Introduction:

Mobile communication technology has become indispensable and ubiquitous part of the modern society. Mobile phone has become basic communication tool of everyday life for billions of people around the world. Major fields which are largely benefitted by the mobile communication technology worldwide are Public Services, Health Care Services, Social Connectivity, Entertainment, Knowledge Enhancement, Personal productivity etc. Mobile communications also contribute for the increase in GDP and employment. A robust and scalable mobile infrastructure including towers is a pre-requisite and mandatory for seamless mobile services with the ultimate goal of universal access to communication, effective delivery of services to citizens and financial inclusion. Base stations and telecommunications towers are continuously being erected to provide good quality Mobile Communications.

Together with the introduction of Mobile communication technology, there has been some public concern about the possible effects of this technology on human health. There is a public concern about the possible effects on human health due to this vast base of mobile connections and the network of mobile towers. Therefore, a need was felt to study the possible effects of RF EMF Waves emitted by Mobile Communication Towers and Mobile Phones as well. Also need was felt to examine the guidelines issued and standards set by the Government for limiting the exposure of RF EMF Waves, being used for Mobile

Communication Technology and validity of these guidelines and standards in today's scenario.

The present research has studied and analysed these concerns in the context of guidelines issued and standards set by the Government for limiting the exposure of RF EMF Waves, being used for Mobile Communication Technology and further the impact of the efforts made and measures taken by the Government for addressing the issue of these emissions on Public Safety, with the help of primary and secondary data. Possible effects of RF EMF Waves being emitted by Mobile Communication Technology were also understood with the study of available major researches, and Reports, and further, Guidelines and Recommendations published by International agencies like WHO, ICNIRP, ITU-T, IARC, IEEE and others to address the issue for International Safety standards obtained from various sources. Validity of the Guidelines and standards set on the issue by Government of India in today's scenario has been explored using exploratory research. Further the measures being taken by the Government of India to deal with inconvenience and possible adverse effect from the exposure of RF EMF Waves by Mobile Communication Technology have been explored using exploratory research. Analysis of the data gathered from Primary and Secondary Sources related to the study has been done. The major findings and conclusions emerging from the study are presented in the chapter.

6.1 Major Findings of the Study:

Following are the major findings of the study:

6.1.1 Findings from Secondary Data:

- A number of scientific researches to find out health risk from Mobile Communication Technology have been carried out with three major approaches, which are as below:
  (i) In vitro i.e. laboratory studies on cells,
  (ii) In vivo i.e. laboratory study involving animals, and
  (iii)Human health studies or Epidemiological studies.

- Major Reports/Reviews[82] conducted so far have indicated that emissions below the limits recommended in the ICNIRP (1998) EMF guidelines[83], do not produce any known adverse health effect. Epidemiological studies have indicated weak positive results, but they were inconsistent with each other. In this situation, scientists themselves are divided about significance of the data. On basis of the above, most scientists and clinicians agree that any health effects of low level electromagnetic fields, if they exist at all, are likely to be very small compared to other health risks that people face in everyday life. However, there are gaps in knowledge which still need further research before better health risk assessments can be made.

- WHO[84] on the basis of approximately 25,000 studies, published around the world over past 30 years, and based on an in-depth review of scientific literature, has concluded: "current evidence does not confirm the existence of any health consequences from

[82] https://www.who.int/peh-emf/research/en/ accessed 01 March 2020

[83] International Commission on Non-Ionizing Radiation Protection (ICNIRP). (1998). *ICNIRP Guidelines For Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (Up to 300 GHz).* https://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf

[84] Department of Telecom, Government of India. *A journey for EMF*. https://dot.gov.in/journey-emf accessed 02 March 2020

exposure to low level electromagnetic fields." WHO further states "considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF Signals from base stations and wireless networks caused adverse health effects." Since the effects on human beings are to be studied over a long period of time, further studies are being undertaken around the world.

6.1.2 Findings from Primary Data:

To gather the knowledge and opinion with regard to the impact of the efforts made and measures taken by the Government of India for addressing the issue of RF EMF Waves Emission by Mobile Communication Technology and Public Safety, a structured questionnaire was designed and sent to the target population, who included persons of different occupations like officers of various Government services as well as Defence Services, Telecom Officers, Research Academia, Teachers, Professors of Engineering Colleges, Telecom Service Providers, Medical Professionals, Private Service employees, Self -employed persons etc and of different age groups. The responses received were analysed and it was found that:

- Majority of the respondents were of the opinion that a strong mobile infrastructure including towers is mandatory for good mobile services. Insufficient number of mobile towers leading to improper network coverage is one of the reasons for Call Drop/Slow Mobile Internet Speed, an issue which has ever been experienced by almost all the respondents (99%).
- Almost equal number of Respondents were having the contradictory opinion regarding whether Electro Magnetic Field (EMF) emission from Mobile Communications pose serious health hazards to the public or not. 27% of the respondents were not sure

whether there is any such health hazard or not. The respondents, who were of the opinion that EMF emission from Mobile Communications pose serious health hazards to the public, could not substantiate their opinion by any supportive data, document, scientific or other evidence or any particular instance. Their opinion might be based on the hearsay from friends, media or some other source of information. Further analysis of individual responses revealed that even some of the Professors of Engineering Colleges, Teachers and Research Academia were also of the view that these Emissions pose serious health hazards to the public. It emanates the need to run Awareness Programmes in Schools, Colleges and Universities. There seems the further need of making more efforts utilizing Mass Communication means and Media Campaigns on the issue of EMF Emissions and Public Safety.

- Majority of the Respondents were in the agreement that the effects of EMF Exposure from mobile towers are debatable, but surely, whatever slight effects, if any, appear to be miniscule as compared to that of mobile phone itself.
- The majority of the respondents were of the view that the present norms set by Government of India for the maximum permissible limits of EMF Emission from Mobile Towers and Mobile Handsets are sufficient and should continue. The maximum respondents have rated the efforts of Government on the issue as 8, on a scale from 1 to 10.The steps taken by the Government for addressing the issue of EMF Waves emission and Public Safety are in the right direction, in the opinion of majority of the respondents.

6.1.3 Findings from the Analysis of EMF Emission Levels of Mobile Towers:

In order to ascertain whether the Electromagnetic Field Emission by the Mobile Towers is within the prescribed safety norms of Government of India or not, the RF EMF Emission level of one hundred mobile towers in Delhi LSA (i.e. Delhi state and NCR Area including Gurugram, Faridabad, Noida, Greater Noida, and Ghaziabad) was collected and it was found that:

1. All the Mobile towers were radiating Electromagnetic emission well within the safe limit standards as set by Government of India.
2. As compared to ICNIRP safe Limits, the radiation level was very low. In some cases, it was even less than one percent of ICNIRP safe Limits.

6.1.4 Analysis of EMF audit/ RTI Applications and Public Grievance Cases:

A study was done to review efforts made by the Government to ensure compliance to various safe limits standards of RF EMF Emission and measures taken to spread the awareness in public on EMF emission issue through the analysis of EMF audit of Mobile Base Transceiver Station (BTS), RTI Applications and Public Grievance Cases. Following were the major findings:

a) In order to ensure compliance to the prescribed stricter precautionary norms of EMF radiation from mobile tower, the extensive EMF audit of base transceiver station (BTS) sites is carried out by LSA field units of DoT upto ten percent annually as per norms. This is regularly done for the purpose of limiting the EMF radiation exposure and keeping general public areas in the vicinity of towers safe. Strict punitive action is being

taken against erring Telecom Service Providers in case a site is found non-compliant.

b) As of 31.12.2019, a total of 8,51,195 number of BTSs have been tested by various LSA field units of DoT, out of which only 359 BTSs have been found non-compliant to EMF radiation norms (exceeding the prescribed radiation limits) since the inception of BTS testing by LSA field units of DoT from 16.11.2010.

c) For EMF Emission measurements of the locations, there were 638 requests by the public on payment basis in last four years on the portal tarangsanchar.gov.in. Out of these 638 requests, only two locations were found non-compliant. To generate the confidence in public that Mobile Towers are, in general, EMF Emission compliant, the measurements of the EMF Emission levels of requested locations are also uploaded on the portal transparently. If we compare the requests as received in year 2016-17 vis-à-vis subsequent years, there is a significant fall.

d) For changing the perception of Public towards issue of Mobile Tower Radiation, many actions being taken by LSA field units of DoT including conduction of public awareness programmes, educating the public taking the help of mass communication means and media campaigns. There is an increase in consolidated number of public awareness programmes being conducted on year to year basis. However, organization of these programmes is not uniform across LSAs. Some LSAs like Kerala, Karnataka, Punjab, Haryana, Delhi, Andhra Pradesh, are conducting these programmes on regular basis while some LSAs have not conducted even a single such programme.

e) As per analysis made, Kerala LSA has adopted the best practices for changing the perception of public towards EMF Emissions of mobile communication technology. Other LSAs should also follow Kerala to increase public awareness on EMF Radiation

issue and to bust the myths and misconceptions as public carries, related to the issue.

f) Due to the impact of positive actions of the Government, the Public Grievance (PG) Cases and RTI Applications on Mobile Tower Radiation in last three years have been limited in numbers. In some areas, the numbers have increased but it may be due to the increased sensitization and public awareness on the issue.

6.1.5 Discussions with Experts:

- Discussions with officers in Department of Telecommunications, Telecom Engineering Center, License Service Area (LSA) Field Units of DOT, Private Telecom Infrastructure Providers, Professors of engineering colleges and other experts were also held on the issue of EMF Radiation from Mobile Communication Technology. Majority were of the view that since there is no conclusive scientific evidence of adverse health effects due to low level RF emission from mobile communication technology and the country has adopted one of the most stringent EMF exposure limits for Mobile Base Towers which are ten times more stringent than the limits prescribed by ICNIRP and recommended by WHO, the present exposure limits should continue unless some contradictory evidences emerge, to fill the knowledge gap, as the result of researches already going on.
- One issue highlighted by senior officers was that Telecom towers are critical installations on which the backbone of mobile communication rests. In an area, if there is insufficient network coverage due to inadequate mobile towers, then there are chances of call drop during voice call and slow data speed when mobile internet is being used. People have to understand that more towers are pre-requisite of higher mobile internet speed and proper connectivity.

6.2 Conclusions:

Following conclusions may be drawn from the above findings and study of available major researches, and Reports, Guidelines and Recommendations published by International agencies like WHO, ICNIRP, ITU-T, IARC, IEEE and others to address the issue:

- As per WHO, there is no convincing scientific evidence that the weak Radio Frequency (RF) Signals from base stations caused adverse health effects, considering the very low exposure levels and research results collected to date. From all evidence accumulated so far, no adverse short- or long-term health effects have been shown to occur from the RF Signals produced by base stations, as per WHO. The main conclusion from the WHO reviews is that EMF exposures below the limits recommended in the ICNIRP international guidelines do not appear to have any known consequence on health. However, there are gaps in knowledge still needing to be filled before better health risk assessments can be made.

- The norms set by Government of India for the maximum permissible limits of EMF Emission from Mobile Towers are Ten times stricter than the limits prescribed by ICNIRP as recommended by WHO. These are more stringent than many countries (like USA, Canada, Japan and Australia) in the world which follow ICNIRP guidelines. Also, the norms set with regard to mobile handsets are also stricter than the ICNIRP limits. India has adopted the most stringent SAR values for mobile handsets when compared to other countries (at par with USA, Canada & Australia). These norms have been evaluated and it may be concluded that the norms are adequate and should

continue in today's scenario.

- In order to ensure compliance to the prescribed stricter precautionary norms of EMF radiation from mobile towers, adequate steps are being taken by the government. They include extensive EMF audit of base transceiver station (BTS) sites carried out by LSA field units of DoT upto ten percent annually as per norms, strict punitive action being taken against erring Telecom Service Providers in case a site is found non-compliant, measurements of the EMF Emission as requested by the public on payment basis, prompt action on public complaints, etc.
- For spreading the awareness among the public regarding issue of EMF Exposure from mobile communication technology and to bust the myths and misconception of the public on the issue, Government is making all possible efforts, which include Conducting public awareness workshops on the issue, Educating the public taking the help of mass communication means and media campaigns, Publishing information on compliance status of mobile towers on web portal www.tarangsanchar.gov.in, disseminating the information through the web site dot.gov.in etc. Like in all other ongoing processes, there is further scope of making these efforts more efficient as emanated from the field survey.
- Many researches have revealed that risk from mobile phone is much more than mobile towers. It is so because, EMF emission reduces multifold with increase in distance. As mentioned earlier, it is reduced to $1/4^{th}$ if the distance from the antenna is doubled and to $1/9^{th}$ if it is tripled and so on ($P_d \propto (\frac{1}{R^2})$). Further, no matter how near the mobile tower be, it will always be farther from our personal mobile phones which are always emitting EMF Waves to connect to their base towers for signals. A strong EMF may

be due to a weak radiation source nearby like Mobile Phone or a powerful source far away like Mobile Tower. A human body is exposed to more EMF radiation in case of a call from mobile phone in comparison to the one from a mobile tower. The mobile phone is a weak source of RF signal, but it is very close to human body, whereas the more powerful mobile tower is at far end. Radiation emitted from cell phone is of a short-term, repeated nature (coherent) at a relatively high intensity, whereas Radiation emitted from BTS (mobile towers) is of long duration but is of a very low intensity. As per the researches till now, it is not clear that the EMF Waves from mobile towers cause any harm or not, but surely, whatever slight effects, if any, appear to be miniscule as compared to the mobile phone itself. It is important to step back & analyse the implications of mobile phones and strictly follow the guidelines of its usage.

6.3 Recommendations:

Following are the major recommendations emerging from the study:

- **Need for Research:** At present there are gaps in knowledge which need to be filled before better health risk assessments can be made. A number of researches at international level are underway. However, there is need for more India specific studies which may be completed in a minimum possible time and results should be made available to all. There should be adequate revision in safety standards and norms by the government, if so necessitated by the results so obtained.

- **Need to study Impact of New Technologies:** With the aim of improving Quality of Service (QoS), efficiency and performance, provision of new features, functionalities and services, Advance technologies are being deployed in the area of Mobile

Communications very frequently. Since the long term health impact to be observed of these technologies takes significant time, the agencies responsible for it including the government should monitor these impacts very strictly, regularly and closely. There should be impact analysis of all technologies for sufficient time period and on the basis of the same, revision in safety standards and norms may be undertaken by the government.

- **Monitoring and Compliance:** The Government should undertake regular monitoring to ensure compliance to the prescribed stricter precautionary norms of EMF radiation from mobile towers. It has to be ensured that **the prescribed norms be followed scrupulously and in case of violation of norms, strict punishment should be imposed.**
- **Capacity building of Officials:** The government should conduct short term capacity building / skill up gradation programmes for field officers/officials involved in testing and monitoring processes. Field units entrusted the work of checking the EMF emission level of Mobile towers, must be strengthened with required infrastructure and logistics like tools, testers, staff and vehicle.
- **Dissemination of Information:** The Government should also conduct regular meetings, conferences and seminars with the various stakeholders including Service Providers, State and Local Authorities, Civil Societies etc. to seek their feedback and suggestions on the issue of EMF Exposure and Public safety and update them on rules, regulations, policies and programmes on the issue.
- **Public Awareness and Education:** For changing the perception of masses and boosting the confidence towards the issue of EMF Exposure from mobile

communication technology, public awareness and education is the key. Government is taking many steps which include Conducting public awareness programmes and workshops on the issue, Educating the public taking the help of mass communication means and media campaigns and other measures. However, there is a need to take all such measures on a broad platform covering all aspects with the help of all available mass communication media. Following steps may be taken to bust the myths and misconceptions of the public on the issue of EMF exposure and public safety:

- The topic of EMF Waves Emission and Public Safety should be included in the academic curriculum of schools since class Ninth onwards and of colleges to spread awareness, proper education and remove the misconception about the issue. Also, there should be special awareness programmes and workshops in schools, colleges and universities to mitigate the fear and bust the myths related to the issue.
- There should be more number of public awareness programmes and maximum participation of the public should be ensured by wide publicity about these programmes well in advance. In some states, no awareness programmes have been conducted so far. These states should now start to conduct these programmes and workshops.
- More Awareness in rural villages can be through Government officers / other senior officers visiting panchayat at least once a year and educating people. In Urban areas such workshops in societies and colonies through RWAs will spread awareness.

- For spreading the awareness among the public regarding issue of EMF Emission from mobile communication technology and to bust the myths and misconception of the public, Kerala LSA is doing a commendable job. The best practice followed in Kerala can be replicated in other states with suitable modifications. In Kerala, meetings of District Telecom Committees and State Telecom Committees are being conducted on regular basis and the complaints of public are being resolved through these committees. Regular press notes of these meetings are released and there is wide media coverage of the meetings. Kerala LSA is utilizing each and every opportunity and medium for spreading the awareness on the issue. The use of Radio FM and TV Channels, publication of the booklet in English and Malayalam on FAQs on Mobile Towers and Mobile Phones and circulation of the same among general public, making and circulation of videos on Social media apps like Whatsapp and Facebook on EMR Awareness, conducting training sessions for local authorities on EMR Awareness, conducting regular meetings with Residential Welfare Associations, educating TAC Members, involving COAI and IMA in public awareness workshops are some of the initiatives which other LSAs should also follow to increase public awareness on EMF Radiation issue and to bust the myths and misconceptions as public carries, related to the issue.
- Separate funds should be allocated for all such measures which are being taken to spread the awareness and education among the public.
- Government may take the services of some role model like some famous celebrity for spreading the awareness in public in its mass communication

advertisements and media campaigns on the issue.

- There should be some Policy to nominate people from Civil Societies/RWA/Advocacy Groups/Influential Groups for Free training and interactive Information sessions about EMF Emission so that they can further educate their friends, family and many more people in their circle.
- There is a need to establish an effective system of health information and communication among scientists, governments, local authorities, telecom industry and the public. It can help to raise general awareness of programmes dealing with exposure to electromagnetic fields and mitigate the mistrust and fears.
- Many researches have revealed that risk from mobile phone is much more than mobile towers. Government should take more steps to make aware this fact to the public and also issue guidelines.
- In public awareness programmes, mass communications and media campaigns, the education about the proper use of mobile phone and guidelines issued by the government should also be given, besides the information on EMF Waves emission from mobile communication technology.
- A leaflet of Do's and Don'ts while using mobile handset should be made mandatory with every new mobile handset package. It must be made mandatory alongwith every SIM Card application also.
- There should be developed Mobile App-based service in line with Tarang Sanchar, a web portal for Information sharing on Mobile Towers and EMF

Emission Compliances, providing the same features and services to boost the public confidence further.

- Hands free gadgets should be sold mandatorily with the mobile phones.
- It should be made mandatory for each mobile phone retail centre to generate public awareness to the individual customer at the grass root level. A record is to be maintained at each retail outlet.

- **Mechanism to resolve Public Grievances related to Mobile Towers:** State Level Telecom Committee (STC)/ District Level Telecom Committee (DTC) may be constituted in order to effectively address Public Grievances relating to installation of towers and issues related to telecom infrastructure. These committees may also be effectively utilized as the platform for the public awareness and education programmes.
- **Building public confidence:** For building public confidence following measures may be taken:
  - Whenever radiation level check is carried out by DOT teams, local representative of public can be informed so that he or any other person who is interested to see level of radiation can be present at time of checking. A small awareness camp can also be organized there.
  - Some Digital devices/display board should be installed at mobile towers to show the level of radiations with details of safe exposure limits.
- **Need to involve Local Bodies:** Government should involve the local bodies and realize their roles in approval of new towers. While setting up new mobile towers, there should be requirement of consultation by Infrastructure Provider/Telecom Service Provider, with local authorities and the public taking into account aesthetics and public

sensitivities. Open communication during the planning stages can help to create public understanding and better acceptance of the facility.

- There may be committees at local level also consisting of Government officers (DOT), local authorities and renowned public figures on the tune of STC/DTC, which can resolve the Public Grievances at local level itself. These committees may work to fill the credibility gap on the issue.

Concluding Remarks:

Whether the mobile communications would affect the health of the people is an issue which is still being debated among the scientist communities all over the world. But it is an undisputed fact that we are bound to live for the rest of our lives with mobile phones in our pockets. In India, strict precautionary norms have been prescribed by the Government on this sensitive issue of Public Safety. These prescribed norms be followed scrupulously.

The fact remains that Public is concerned about the potential health risks associated with mobile communication technology, but it has also to be understood that this concern in the society has also created a non-enabling environment for continuing with the high pace mobile growth as witnessed till now .Operational issues like Network Congestion, Call Drops, Slow Internet Speed and other similar issues have been observed in those areas where there are inadequate Mobile Towers. It may further hamper growth which may in turn have its effect on the economic progress of the country. People have to understand that more towers are prerequisite of higher speed and proper connectivity. Society has to become aware of the ills of mobile and restrain itself. The potential detriments of Mobile Communication Technology are debatable, but their benefits outweigh these ill effects, if

any. The results of long term researches to understand these health effects are awaited and only these results will be able to eliminate the fear of people.

Nobel laureate Marie Curie has aptly said:

"Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less."

APPENDIX-1

SURVEY QUESTIONNAIRE

Background: Mobile communications play an important role in social and economic growth and disaster management for which mobile towers are a pre-requisite. As the mobile connections are increasing in the country at a rapid pace, the mobile towers should also increase proportionately, in order to avoid Network Congestion, Call Drops, Slow Internet Speed and other similar issues. This has led to installation of large number of mobile towers, especially in the dense urban areas. To provide seamless Mobile services in the country, there is a vast base of mobile networks. There is a public concern about the possible effects on human health due to this vast base of mobile connections and the network of mobile towers. The present dissertation attempts to study and analyze these concerns in the context of guidelines issued and standards set by the Government of India for limiting the exposure of Radio Frequency Electromagnetic Field Waves, being used for Mobile Communication and further the efforts made by the Government for changing the perception of General Public towards issue of EMF Emission from Mobile Communications.

It is requested to answer the following questions in relation to Electro Magnetic Field (EMF) waves emission and Public Safety:

Age (In Years)

Occupation

Experience in the Telecom Industry: (In Years)

Q.1 A robust and scalable mobile infrastructure including towers is a pre-requisite and must for universal access to communication, effective delivery of services to citizens and financial inclusion.

Do you agree?

1. Strongly Agree 2. Agree 3. Not sure 4. Disagree 5. Strongly Disagree

Q. 2 While using Mobile Phone, have you ever experienced the issue of Call Drop/ Slow Mobile Internet Speed

1. Yes 2. No 3. Can't say

Q.3 Do you agree that Insufficient number of mobile towers leading to improper network coverage is one of the reasons of this issue of Call Drop/Slow Mobile Internet Speed:

1. Yes 2. No 3. Can't say

Q.4 What is your view regarding Electro Magnetic Field (EMF) emission from Mobile Communications:

1. EMF emissions pose serious health hazards to the public.

2. EMF emissions do not pose serious health hazards to the public

3. Can't say either 1 or 2 with certainty.

If the response is '1' i.e. in your opinion, EMF emissions pose serious health hazards to the public, you are requested to quote any document, data, scientific or other evidence or any particular instance in support of your opinion.

Q.5. The effects of EMF Exposure from mobile towers are debatable, but surely, whatever slight effects, if any, appear to be miniscule as compared to that of mobile phone itself.

Do you agree?

1. Strongly Agree 2. Agree 3. Not sure 4. Disagree 5. Strongly Disagree

Q.6 The norms set by Government of India for the maximum permissible limits of EMF Emission from Mobile Towers are Ten times stricter than the limits prescribed by International Commission on Non Ionizing Radiation Protection (ICNIRP) as recommended by World Health Organisation (WHO). Also, the norms set with regard to mobile handsets are also stricter than the ICNIRP limits. In your opinion, are these limits set by the Government sufficient?

1. Present safety norms are sufficient and should continue.

2. Limits should be stricter than the present limits.

3. Limits should be relaxed from the present norms.

4. Can't say.

Q.7 The Government of India, through Department of Telecom (DOT), has taken many steps for effectively addressing the issue of EMF Waves emission and Public Safety, including (i)The EMF Audit of upto Ten Percent of the Mobile Towers, (ii)Taking strict punitive actions in case of non-compliance of limits as set by Government, (iii)Publishing information on compliance status of mobile towers on web portal www.tarangsanchar.gov.in, (iv)Conducting public awareness workshops on the issue(v) Public Advertisements (vi) Through the web site dot.gov.in etc.

Do you agree that the steps taken by the Government are in the right direction?

1. Strongly Agree 2. Agree 3. Not sure 4. Disagree 5. Strongly Disagree

Q.8. Please rate the efforts made by Government on the issue of EMF Waves emission and Public Safety, on a scale from 1 to 10.

Q.9. Please suggest some ideas/actions which Government should further take to change the perception and boost the confidence of General Public towards issue of EMF Emission from Mobile Communications.

Q 10. Any other suggestion/comment/opinion on the issue of EMF Waves emission and Public Safety, please:

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