Non-Ionizing Electromagnetic Radiation Effects on Biological Systems and Protection Methods

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Indian National Academy of Engineering

CONTENTS

FOREWORD

It is indeed my pleasure and privilege to write Foreword to the study report on 'Non-Ionizing Electromagnetic Radiation Effects on Biological Systems and Protection Methods'. The Indian National Academy of Engineering (INAE) commissioned this research study in February, 2014 with Ved Prakash Sandlas, as the Principal Engineering Investigator (PEI), to comprehensively review and define current status, internationally accepted guidelines on generation and control of electromagnetic radiations, position of related regulations in India and recommend safety levels.

This is the first research study being conducted with the revised guidelines formulated by INAE in December, 2013 to encourage the fellowship to pursue basic and applied research to validate and/or investigate novel engineering concepts relating to Products, Processes, with focus and thrust.

Realizing the importance of the subject of this study, INAE had earlier organized a Workshop cum Symposium on 'Electromagnetic Fields Bio-Interactions, Applications and Pollution', along with the Microwave Applications Society of India (MASI), on March 14-15, 2008 at the School of Environmental Sciences, Jawaharlal Nehru University (JNU). Electromagnetic Radiation emissions, related environmental pollutions and harmful effects on biological systems, particularly on human beings, have started engaging significant attention of the World Health Organization (WHO), medical professionals and general public during the last several years, particularly because of wide spread usage of mobile phones and related radio frequency radiation effects. This study report is quite timely and shall serve a comprehensive reference document, particularly for non-ionizing radiation exposure standards and guidelines for limiting and controlling related harmful effects.

I have been intimately engaged with the study and control of the effects of Ionizing and non-ionizing radiations and particles as part of my research and responsibilities in Department of Atomic Energy.

Thus I do understand importance and impact of the study by Ved Prakash Sandlas. He is known for rigour, commitment and passion in his pursuits. I am confident that this study report shall contribute significantly to enhance overall knowledge base about radiation effects of electromagnetic fields and provide a way forward for using the vital technologies based on electromagnetic fields for better quality of life on this beautiful earth planet.

Baldev Raj
President
Indian National Academy of Engineering
November 6, 2014

PREFACE

My experience of dealings with Electromagnetic Radiations (EMR) dates back to 1967, when i was working on the Radio Frequency (RF) subsystems of Sounding Rocket Payloads at the Thumba Equatorial Rocket Launching Station (TERLS), located at about 15 km north of Thiruvanathapuram. In those days, the subject of EMR was a small subset of the general area of Electromagnetic Interference and Electromagnetic Compatibility (EMI EMC). In those days, the RF subsystem at Thumba mainly consisted of VHF Telemetry Transmitter with related Antenna working at 240 MHz, UHF Telecommand Receiver working at 434 MHz and S-Band Radar Transponder with related Antenna working at 2.5 GHz.

Most of the EMI problems related to reflections of RF radiations from metallic Rocket Launcher and near-field couplings with receivers of Telecommand and Transponder systems, which used to generally get resolved after take-off. There is an interesting case of Rocket taking-off when the siren was sounded at T-5 minutes (signal to clear the launch pad) – which was diagnosed to the ground-loop current creating ELF (Extremely Low Frequency at 50 HZ power supply) field, and coupling with ignition circuit of the first stage motor. There is another case of Rocket Nosecone ejecting at the launch pad itself when the Radar Transponder was switched ON – because of the interference from 400 Watt S-band Transmitter to the electro-explosive squibs of the ejection mechanism. However, such problems were not suspected to be causing any biological or health effects.

During 1967-1980, there was an interesting speculative statistics floating within Thumba complex: those working in RF or Microwave area were likely to get only female children; during 1969-1972, as many as 1000 Scientists/Engineers joined every year at, the then, Space Science & Technology Centre, Trivandrum – many of them worked with Microwaves and got married during 1970-1975 – and had, on the average, two daughters. Of course, many Scientists considered this as a coincidence – not at all related to RF radiation effects – since, otherwise itself Kerala had higher percentage of females; some thought it may relate to the matriarchal system, general respect for females, higher literacy, tropical climate, etc. But some others thought it to be a fundamental EMF problem since the magnetic equator passed through Quilon – just 50 km north of Thumba – producing higher level of DC Magnetic field, further getting accentuated by RF and Microwave fields. In fact, the selection of Thumba as the first Sounding Rocket Station of India was guided by the nearness to the magnetic equator, considered important for study of atmosphere, climate, monsoon, etc. Of course, some of those having at least two daughters, considered them to be lucky, particularly because of the general feeling that the daughters would look after parents, better than sons.

Subsequently, i went on to organize nation-wide campaign for EMI EMC studies and facilities, and was instrumental in establishing SEMCEI, the Society of EMC Engineers (India) in 1987, as a Patron, and also the Indian Chapter of dB Society of USA. Since then, the subject of EMR Hazards had been included in every INCEMIC (International Conference on Electromagnetic Interference and Compatibility), as a special technical session, conducted bi-annually by SEMCEI. Another significant event was the International Conference on Millimeter Waves and Microwaves (ICOMM-90) held at DEAL (Defence Electronics Applications Laboratory), Dehradun, during Dec 19-21, 1990, as part of its Silver Jubilee

celebrations. In order to give higher level of thrust to the study of EMR effects on biological systems and related subjects, Microwave Applications Society of India (MASI) was established on Feb 27, 2001 with Prof Jitendra Behari as the Secretary, and me as the President. Since then, MASI had been holding annual national conferences to sensitize the subject of EMR Hazards; in fact, INAE and MASI organized a Workshop cum Symposium on 'Electromagnetic Fields Bio-Interactions, Applications and Pollution' on Mar 14-15, 2008 at the School of Environmental Sciences, Jawaharlal Nehru University (JNU).

After my retirement from regular Government service in 2005, i took up EMR effects as my primary area of engagement, as the Principal Advisor, Cogent EMR Solutions Ltd, New Delhi. In addition to working on Radiation Protection Solutions and Products, special efforts were made to initiate aggressive campaigns to sensitize the general public and Governmental agencies; and to file a PIL in the Supreme Court of India, leading to the adoption, in 2008, of the International Commission for Non Ionizing Radiation Protection (ICNIRP) guidelines for limiting EMF exposure for protection against known adverse health effects; which were further tightened to 1/10th of the prescribed limit with effect from Sep 1, 2012.

I am grateful to the Indian National Academy of Engineering for sponsoring the study of 'Non-Ionizing Electromagnetic Radiation Effects on Biological Systems and Protection Methods'. This study has given me the opportunity to consolidate related efforts made by national and international agencies and researchers, to learn and update myself on the present position on the subject, and to prepare this report as an up-to-date reference document, particularly for EMF exposure standards, guidelines for limiting and controlling harmful effects, etc. Most of the referenced information is available in the public domain, in printed publications or in the related websites; where ever difficulties are expected to access the original documents, relevant excerpts have been extracted and included as Appendixes for ready reference, so as to make the report self sufficient and complete in itself.

I would like to express my deep sense of gratitude to the members of the Project Monitoring Committee (PMC): Dr BN Suresh (Chairman), Dr Surendra Pal and Prof Ranjan K Mallik – for guidance and for finding time to review the study report; and also Brig Rajan Minocha for the help in the formulation of the study proposal, it being the first case after finalization of the new formats and procedures for managing research projects. A large number of researchers and experts have been contributing to the subject of this study – i have liberally drawn from their publications in the public domain – i wish to acknowledge with thanks their inputs, contributions and debates on the subject of EMR, EMF and related biological effects, particularly Prof Jitendra Behari, Dr DC Pande, Shri Rahul Kakapuri.

Ved Prakash Sandlas

New Delhi
September 30, 2014

CHAPTER 1
INTRODUCTION

Hazards of Electromagnetic Radiation (EMR) emissions and related harmful effects on biological systems, particularly on human beings, have started engaging significant attention of general public during the last few years. These emissions are synonymous with Electromagnetic Pollution, a kind of Environmental Pollution, polluting the very limited natural resource: Radio Spectrum. Till recently, continuous exposure to Electromagnetic waves (or radio waves) was localized to areas near broadcasting stations, radars, radio communication terminals, etc. – the related radiations were not adversely affecting inhabited areas and general public in residential areas, hospitals, schools, etc. The situation has changed significantly during the last few years with the proliferation of cell phones, related base station towers and other EMR sources. It is very easy to understand water, air or noise pollution or contamination. However, Electromagnetic Pollution is very much esoteric; it is not easily seen, tasted, smelled or felt; but it can be more damaging, something like a 'silent killer'.

Radio is just about 120 years old; impact of related radiations on the environment, particularly biological systems, is now only visible. In May 1895, Sir J C Bose reported his legendary work at 50 GHz to the Asiatic Society of Bengal at Calcutta and demonstrated that 'electric (radio) waves possessed all the characteristic optical properties of light waves'. Subsequently, Marconi commercially exploited radio waves for long distance communications, and opened up the world of wireless applications. In addition to cell phones, several house-hold devices such as microwave ovens, mixers, vacuum cleaners, hair dryers, cordless phones, WIL, WiFi, WiMAX, Bluetooth, etc. can be significant sources of EMR. Other EMR sources are Diesel Generators, Inverters, Electrical Sub-Stations, Power Transmission Lines, Electric Traction, house-hold electrical wiring, etc.

Common biological effects of EMR are headache and Migraines; eye irritations and Cataracts; loss of appetite; fatigue and exhaustion; giddiness or dizziness; vomiting sensation; loss of temper and fluctuation in BP; altered concentration and memory loss; anxiety and depression; sleep disruption or Insomnia; reduced REM sleep, altered EEG (brain wave), etc. Serious biological effects are brain tumors, Alzheimer's disease, Parkinson's disease, eye cancer, Epilepsy, Leukemia, stomach pain and digestive disorders; destabilization of the Lymphatic system, disturbances in the nervous system, interruption in the maintenance of hormones; brainwave disturbances in alpha, theta and delta wave signals, etc.

Scientific studies have demonstrated short term and medium term effects of EMR on animals and human beings; children, weak or sick persons, pregnant women and small animals are particularly vulnerable. Of course, debates are going on as to whether these effects are temporary or permanent. It is suspected that disappearance of butterflies and sparrows may also be related to the high level of electromagnetic pollution. There is a strong feeling that even 'global warming' may also be affected by excessive radiation levels. The Indian Council of Medical Research (ICMR) and the World Health Organization (WHO) have recommended precautionary approach in relation to the use and control of radiations and have also suggested adoption of internationally recommended acceptance standards and rules and regulations for reducing and limiting EM Radiation levels to ensure safety of general public.

During Feb 2008, Govt. of India, Ministry of Communications and Information Technology, Department of Telecommunications (DoT), Telecommunication Engineering Centre (TEC) approved the adoption of ICNIRP (International Commission on Non-Ionizing Radiation Protection) guidelines regarding basic

restrictions and reference levels for limiting EMF (Electromagnetic Field) exposures. ICNIRP reference level for exposure of general public is power density of 0.2-1.0 mW/cm^2 (2-10 W/m^2) in primary frequencies of interest (10-2000 MHz). The corresponding basic limit for SAR (Specific Absorption Rate – a measure of the rate of energy absorbed by an incremental mass contained in a volume element of dielectric material such as biological tissues) is 2 W/kg. Along with the adoption of ICNIRP guidelines in Feb 2008, it was also decided to carry out mandatory testing and certification by designated Conformity Assessment Bodies (CABs) to ensure compliance of related limits. Recently, Inter Ministerial Committee (IMC) of DoT, ICMR, DoB (Department of Biotechnology) and MoEF (Ministry of Environment and Forests), constituted on Aug 24, 2010, has examined 90 international and national studies/reference papers and recommended lowering mobile towers' EMF exposure limits to $1/10^{th}$ of the existing prescribed limits as a matter of abundance precaution. These recommendations have been accepted by the Govt. and directions issued vide DoT letter no. 800-15/2010-VAS (pt.) dated Apr 10, 2012 making the new norms applicable from Sep 1, 2012; SAR limit has also been reduced to 1.6 W/kg (from 2.0 W/kg) averaged over 1 gram of human tissue.

Harmful effects of low frequency Electromagnetic radiations from power transmission lines on human beings had also been of concern for quite some time. Using underground electrical power distribution cables in the cities, or the use of metal conduits for electrical wiring in the buildings, are not just architectural niceties or ethics; these are some of the standard engineering methods to reduce unwanted radiations from power lines. Overhead power distribution lines, particularly high voltage transmission lines near sub stations, are notorious for creating high radio noise, electrical noise and Electromagnetic interference. Electric Traction and related power transmission system also creates high level of low frequency EMR. While underground metro systems have an inbuilt protection against EMR, overhead metro lines through highly populated areas are of concern; they may have to consider 3rd rail for power transmission for reducing related Electromagnetic pollution. Experts recommend that future developments should adopt ELF safety limit of 2 mG (0.2 μT).

Some recent studies and arguments emphasize that there no such thing as safe electromagnetic radiation level. Generally accepted 'safe levels' vary from 1 $\mu W/m^2$ for sleeping areas and 10 $\mu W/m^2$ for other living and working areas, to as much as 1000 $\mu W/m^2$ (as against ICNIRP reference level of $2W/m^2$ – which is the upper limit for operations of normal wireless devices), recommending that significantly less – minimum possible – levels should be used for practical applications.

There is a strong need to initiate public awareness campaign to educate and guide unsuspecting members of our society, so that they can save themselves and their children from the harmful effects of electromagnetic pollution. There is an urgent need to incorporate appropriate amendments to the Indian Telegraph Act and other related laws so as to give enforcement powers to DoT to test and control radiations emanating from wireless systems. It is also essential that Govt. of India tightens control on unlawful radiations emanating from all other electrical and electronics devices and instruments, including electrical power generation and transmission systems so as to save the environment and make it suitable for healthy living.

Electromagnetic waves are nature's gift to mankind. It is essential that appropriate steps are taken to protect this natural resource; its equitable, cost-effective and safe utilization is very important for the efficient sharing of the spectrum and for ensuring health of all living things by using minimum possible radiations and controlling resultant pollution levels.

CHAPTER 2
BACKGROUND

About 150 years ago, Maxwell enunciated the Theory of the Electromagnetic Fields and laid the mathematical foundation of radio wave propagation by demonstrating that electric and magnetic fields travel through space as waves moving at the speed of light. However, the credit for the generation and demonstration of radio waves was shared by Hertz, Lodge, Bose and Marconi through simple laboratory experiments conducted about 120 years ago. The legendry work of Sir JC Bose at 50 GHz, reported in May 1895 at the Asiatic Society of Bengal at Calcutta and read before the British Association on Sep 21, 1896, is a milestone in itself. Bose generated, the then, unimaginably high frequency, to obtain a narrow pencil beam of electromagnetic waves which could be focused in to converging, diverging or parallel beam to demonstrate that that 'electric waves possessed all the characteristic optical properties of light waves'. In fact, at that time, Bose (and hence India) was in the fore-front, along with Hertz, Lodge and Marconi, and second to none, in the experimental generation of radio waves and practical utilization of Maxwell's mathematical theory of electromagnetic waves. Subsequently, Marconi commercially exploited radio waves for long distance communications, and opened up the world of wireless applications at the turn of the last century.

Electromagnetic radiations can be classified into ionizing radiations and non-ionizing radiations. Ionizing radiations carry sufficiently high energy to liberate electrons from atoms or molecules to ionize them. Ionizing radiations comprise electromagnetic waves of relatively short wavelengths of less than 120 nm (or frequencies higher than 2500 THz): upper ultraviolet, X-rays, Gamma-rays and cosmic rays. Non-ionizing radiations cover the entire electromagnetic spectrum (Appendix I) up to lower ultraviolet, including conventional radio waves, microwaves, millimeter waves and infrared rays.

Harmful effects of ultraviolet radiation (generally invisible to the human eye) were known for long time as sunburn and suntan, particularly to light-complexioned skin persons. Human skin normally reacts to mild doses of UV radiation by increasing the amount of protective melanin in the skin's outer layers. Too much of this radiation (even for short period of time), however, results in cellular damage from radiation burn. Luckily, the damaging effect of UV reduces considerably because the ozone layer of the atmosphere filters out the majority of this radiation.

Till recently, continuous exposure to other non-ionizing electromagnetic radiations or waves was localized to areas near broadcasting stations, radars, radio communication terminals, etc. – the related radiations were not adversely affecting inhabited areas and general public in residential areas, hospitals, schools, etc. The situation has changed significantly during the last few years with the proliferation of cell phones, related base station towers and other EMR sources.

The National Radiological Protection Board (NRPB), the public authority in UK created by the Radiological Protection Act 1970, originally for ionizing radiation, also covering non-ionizing radiation since 1974, published a comprehensive review report of epidemiological and experimental data relevant to the assessment of health effects from exposure to EMFs and provided advice on limiting exposures. NRPB subsequently reviewed its advice in 1999 following publication of exposure guidelines by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). During 1993-1999, many other similar studies have also been published by other agencies: Advisory Group on Non-Ionizing Radiation (AGNIR), World Health Organization (WHO), Independent Expert Group on Mobile Phones (IEGMP), International Agency for Research on Cancer (IARC), etc.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) was established at the Eighth International Congress (Montreal, 18–22 May 1992) of the IRPA (International Radiation Protection Association), as an independent scientific organization to investigate the hazards that may be associated with the different forms of Non-Ionizing Radiation (NIR), develop international guidelines on NIR exposure limits, and deal with all aspects of NIR protection. It is a publicly funded body consisting of the main Commission of 14 members, its Scientific Expert Group and its Project Groups. ICNIRP Commission members do not represent either their countries of origin or their institutes nor can they be employed by industry. ICNIRP's principal aim is to disseminate information and advice on the potential health hazards of exposure to non-ionizing radiation and covers all non-ionizing radiations including, the optical radiations (ultraviolet, visible and infrared - and lasers), static and time-varying electric and magnetic fields and radiofrequency (including microwave) radiation, and ultrasound. The reviews and risk assessments are carried out in collaboration with the World Health Organization (WHO).

In April 1998, ICNIRP published guidelines, replacing earlier advice, for limiting exposure to time-varying electric, magnetic and electromagnetic fields in the frequency range up to 300 GHz. The main objective was to establish guidelines for limiting EMF exposure that will provide protection against known adverse health effects. An adverse health effect is defined by ICNIRP as one which 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. ICNIRP guidelines are gaining acceptance in most European countries and many other countries of the world outside of North America. The limits for the electric and magnetic fields are very similar to the limits in the 1997 FCC Regulations of US.

In the United States, the Federal Communication Commission (FCC) is required by the National Environmental Policy Act of 1969, among other things, to evaluate the effect of emissions from FCC-regulated transmitters on the quality of the human environment. Several organizations in the US, such as the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), and the National Council on Radiation Protection and Measurements (NCRP) have issued recommendations for human exposure to RF electromagnetic fields. On August 1, 1996, the Commission adopted the NCRP's recommended Maximum Permissible Exposure limits for field strength and power density for the transmitters operating at frequencies of 300 kHz to 100 GHz. In addition, the Commission adopted the specific absorption rate (SAR) limits for devices operating within close proximity to the body. The Commission's limits for field strength and power density became effective on Oct 15, 1997 for all services except the Amateur Radio Service, for which it became effective on Jan 1, 1998. FCC had been updating and revising the emission standards; the last revision done in 2003 is now under review since 2013.

The European Commission urged and recommended EU Member States for harmonization of standards for protection from electromagnetic radiations and to impose limitations for exposure of the general public to EMFs in the frequency range up to 300 GHz, on Jul 12, 1999.

Australian Communications Authority (ACA) has progressively introduced regulations setting limits for human exposure to Electromagnetic Radiation (EMR) from Radio Frequency (RF) transmitters. The related standards were published by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and made applicable for suppliers of mobile and portable transmitting equipment with effect from Mar 1, 2003. The ACA license holders were mandated to comply with the EMR health exposure conditions with effect from Jul 1, 2004.

In India, the study of Electromagnetic Radiations emanating from cellular towers is being undertaken jointly by the Department of Telecommunications (DoT) and the Department of Science & Technology (DST) in collaboration with Indian Council of Medical Research (ICMR) and Ministry of Environment and Forests (MoEF) to drive norms based on credible scientific evidence taking into account the diversity of Indian social context. Telecommunication Engineering Centre (TEC) of DoT, and Wireless Planning and Coordination (WPC) Wing of the Ministry of Communications and Information Technology provide the technical advice on related matters.

Govt. of India, in the year 2008, adopted the International Commission for Non Ionizing Radiation Protection (ICNIRP) guidelines; which were further tightened to 1/10th of the prescribed limit with effect from Sep 1, 2012. The service providers are required to report compliance of radiation limits and radiation levels through self certification of their BTS (Base Transceiver Station) to Telecom Enforcement Resource & Monitoring (TERM) of DoT. TERM Cells are required to carry out the compliance monitoring of radiation levels on random basis for 10% of BTS towers.

While the studies of effects of relatively low power radiations such as from cell phones and related BTS towers, particularly continuous 24x7 exposures of general public, become serious during the last 20 years or so, the effects of higher power sources such as microwave radars on occupational personal were being studied since early 1950s all over the world; including in India since late 1980s. High power sources such as radars, radio broadcasting stations, TV transmitters and radio communication terminals are generally away from inhabited areas and hence may not be affecting general public in a routine way, but they are also required to satisfy radiation levels and field strength restrictions. The related issues were also being addressed by the EMI/EMC (Electromagnetic Interference/Electromagnetic Compatibility) community of the world, including by the Society of EMC Engineers (India) (SEMCEI) since its inception in 1987. Realizing the importance and urgency, the subject was also discussed in the Panel Discussion on “EMI/EMC and EM Radiation Hazards – Specifications, Standards and Measurement Methods – in Indian Context” held on Feb 24, 2006 at the International Conference on Electromagnetic Interference and Compatibility (INCEMIC-2006) held at Bangalore, and very comprehensive recommendations were made to manage the situation (Appendix II).

The Bio-Initiative Report 2012 (update of earlier report of 2007) has been prepared by a Working Group of 29 independent scientists and health experts from around the world (USA-10, Sweden-6, Austria-2, Canada-2, India-2, Italy-2, Greece-2, Denmark-1, Russia-1 and Slovak Republic-1) about possible risks from wireless technologies and electromagnetic fields. It covers about 1800 new studies reporting bio-effects and adverse health effects of electromagnetic fields (power-lines, electrical wiring, appliances and hand-held devices) – and wireless technologies (cell and cordless phones, cell towers, WiFi, wireless laptops, wireless routers, baby monitors, surveillance systems, wireless utility meters), etc. The Working Group recommends biologically based limits far more stringent than those now set by the Federal Communications Commission (FCC), Institution of Electronics and Electrical Engineers (IEEE), or the International Commission for Non-Ionizing Radiation Protection (ICNIRP) on the ground that existing standards are based on thermal (heating) limits, and do not address non-thermal (or low-intensity) exposures which are widely reported to cause bio-effects, and that there is no protection against cumulative effects stimulated by different parts of the EM spectrum.

Manmade generation and use of radio and electromagnetic waves is just over a century old; continuous exposure to electromagnetic radiations has not been sustained even by one generation of human beings or biological systems. Existence of natural background electromagnetic field has also been the subject of scientific investigations. Cosmic Microwave Background Radiation (CMBR) is the electromagnetic

radiation assumed to be left over from the 'Big Bang' – a kind of glow dating back to the epoch of recombination; it is strongest in the microwave region of the radio spectrum. CMBR was discovered in 1964 and earned 1978 Nobel Prize for American radio astronomers Arno Penzias and Robert Wilson. It is not associated with any star or galaxy. The CMBR has a thermal black body spectrum at a temperature of 2.72548±0.00057 K; the spectral radiance $dE_v/d\nu$ peaks at 160.2 GHz (wavelength of 1.9 mm), or at wavelength of 1.063 mm (frequency 283 GHz) if spectral radiance is defined as $dE_\lambda/d\lambda$ (spectral radiance is a measure of the quantity of radiation that passes through or is emitted from a surface and falls within a given solid angle in a specified direction – watts per steradian per square meter per Hz, $W \cdot sr^{-1} \cdot m^{-2} \cdot Hz^{-1}$ or $W \cdot sr^{-1} \cdot m^{-3}$ depending on whether the spectrum is a function of frequency or of wavelength). The radiation is almost uniform in all directions with some minor irregularities in the spectral radiance at different angles of observation in the sky. Subsequent to the initial discovery of the CMBR, several cosmic microwave background experiments have been conducted to measure and characterize the signatures of the radiation. Some important examples are NASA Cosmic Background Explorer (COBE) satellite (1989–1996); ground-based Very Small Array, Degree Angular Scale Interferometer (DASI), and the Cosmic Background Imager (CBI); NASA WMAP (Wilkinson Microwave Anisotropy Probe*)* mission (from June 2001); and ESA Plank Surveyor (launched in May 2009) using HEMT radiometer and bolometer for more precise measurements.

Building biology (or Baubiologie as coined in Germany) is a field of building science investigating the indoor living environment for a variety of irritants affecting the health of the occupants, producing a restful or stressful environment, including effects of electromagnetic fields (EMFs) and radiation (EMR). Between 1987 and 1992, BAUBIOLOGIE MAES developed the Standard of Building Biology Testing Methods (SBM), most current Standard SBM-2008 is the seventh edition. These standards have also listed natural background fields – Low frequency AC Electric field: <0.001 V/m, Magnetic field: <-.0002 nT, High Frequency RF: <0.000001 $\mu W/m^2$, DC Electric: <100 V, DC Magnetic: Earth's 25-65 μT, eye 0.0001 nT, brain 0.001 nT, , heart 0.05 nT, animal navigation 1 nT.

Some recent studies and arguments emphasize that there no such thing as safe electromagnetic radiation level. Generally accepted 'safe levels' vary from 1 $\mu W/m^2$ for sleeping areas and 10 $\mu W/m^2$ for other living and working areas, to as much as 1000 $\mu W/m^2$ (as against ICNIRP reference level of $2W/m^2$).

CHAPTER 3
INTERNATIONAL EMF EXPOSURE STANDARDS

EMF exposure standards and guidelines issued by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Federal Communication Commission (FCC) of USA are the most comprehensive and generally accepted documents followed by most countries to control and limit Non-Ionizing Radiations emanating from wireless devices and systems. Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) have also issued quite comprehensive standards to promote practices which protect human health and the environment from the possible harmful effects of radiation. Building biology (or Baubiologie in Germany) has also developed Standards of Building Biology Testing Methods (SBM-2008) for EMFs, which are significantly more stringent than others standards.

3.1 ICNIRP (International Commission on Non-Ionizing Radiation Protection) [01, 02] is a publicly funded body scientific experts consisting of a main Commission of 14 members, its Scientific Expert Group and its Project Groups. It was established at the Eighth International Congress (Montreal, 18–22 May 1992) of the IRPA (International Radiation Protection Association), as an independent scientific organization to investigate the hazards that may be associated with the different forms of Non-Ionizing Radiation (NIR), develop international guidelines on NIR exposure limits, and deal with all aspects of NIR protection. ICNIRP Commission members do not represent either their countries of origin or their institutes nor can they be employed by industry. ICNIRP's principal aim is to disseminate information and advice on the potential health hazards of exposure to non-ionizing radiation and covers all radiations including, the optical radiations (ultraviolet, visible and infrared - and lasers), static and time-varying electric and magnetic fields and radiofrequency (including microwave) radiation, and ultrasound. The reviews and risk assessments are carried out in collaboration with the World Health Organization (WHO).

In April 1998, ICNIRP published guidelines, replacing earlier advice, for limiting exposure to time-varying electric, magnetic and electromagnetic fields in the frequency range up to 300 GHz. The main objective is to establish guidelines for limiting EMF exposure that will provide protection against known adverse health effects. An adverse health effect is defined by ICNIRP as one which 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. ICNIRP guidelines are gaining acceptance in most European countries and many countries of the world outside of North America. The limits for the electric and magnetic fields are very similar to the limits in the 1997 FCC Regulations of US.

3.1.1 Basic restrictions for time varying electric and magnetic fields for frequencies up to 10 GHz

Exposure characteristics	Frequency range	Current density for head and trunk (mA m^{-2}) (rms)	Whole-body average SAR (W kg^{-1})	Localized SAR (head and trunk) (W kg^{-1})	Localized SAR (limbs) (W kg^{-1})
Occupational exposure	up to 1 Hz	40	—	—	—
	1–4 Hz	40/f	—	—	—
	4 Hz–1 kHz	10	—	—	—
	1–100 kHz	f/100	—	—	—
	100 kHz–10 MHz	f/100	0.4	10	20
	10 MHz–10 GHz	—	0.4	10	20

General public exposure	up to 1 Hz	8	—	—	—
	1–4 Hz	8/f	—	—	—
	4 Hz–1 kHz	2	—	—	—
	1–100 kHz	f/500	—	—	—
	100 kHz–10 MHz	f/500	0.08	2	4
	10 MHz–10 GHz	—	0.08	2	4

3.1.2 Basic restrictions for power density for frequencies between 10 and 300 GHz

Exposure characteristics	**Power density (W/m^{-2})**	**Remarks**
Occupational exposure	50	Power densities are to be averaged over any 20 cm^2 of exposed area and any $68/F^{1.05}$-min period (F is in GHz) to compensate for shorter penetration depth as the frequency increases. Spatial maximum power densities, averaged over 1 cm^2, should not exceed 20 times these values.
General public exposure	10	

Notes:

1. f is the frequency in Hertz.

2. Because of electrical in-homogeneity of the body, current densities should be averaged over a cross-section of 1 cm^2 perpendicular to the current direction.

3. For frequencies up to 100 kHz, peak current density values can be obtained by multiplying the rms value by $\sqrt{2}$ (~1.414). For pulses of duration t_p the equivalent frequency can be calculated as $f = 1/(2\ t_p)$.

4. For frequencies up to 100 kHz and for pulsed magnetic fields, the maximum current density associated with the pulses can be calculated from the rise/fall times and the maximum rate of change of magnetic flux density. The induced current density can then be compared with the appropriate basic restriction.

5. All SAR values are to be averaged over any 6-min period.

6. Localized SAR averaging mass is any 10 g of contiguous tissue; the maximum SAR so obtained should be the value used for the estimation of exposure.

7. For pulsed exposures in the frequency range 0.3 to 10 GHz and for localized exposure of the head, in order to limit or avoid auditory effects caused by thermo-elastic expansion, an additional basic restriction is recommended: SAR should not exceed 10 mJ kg^{-1} for workers and 2 mJ kg^{-1} for the general public, averaged over 10 g tissue.

8. In frequency range from a few Hz to 1 kHz, for levels of induced current density above 100 mA m^{-2}, the thresholds for acute changes in central nervous system excitability and other acute effects such as reversal of the visually evoked potential are exceeded. In view of the safety considerations, for frequencies in the range 4 Hz to 1 kHz, occupational exposure should be limited to fields that induce current densities less than 10 mA m^{-2}, i.e. to use a safety factor of 10. For the general public an

additional factor of 5 is applied, giving a basic exposure restriction of 2 mA m^{-2}. Below 4 Hz and above 1 kHz, the basic restriction on induced current density increases progressively.

3.1.3 Reference levels for occupational exposure to time-varying electric and magnetic fields (unperturbed rms values)

Frequency range	E-field strength ($V\ m^{-1}$)	H-field strength ($A\ m^{-1}$)	B-field (μT)	Equivalent plane wave power density S_{eq} ($W\ m^{-2}$)
up to 1 Hz	—	1.63×10^5	2×10^5	—
1–8 Hz	20,000	$1.63 \times 10^5/f^2$	$2 \times 10^5/f^2$	—
8–25	20,000	$2 \times 10^4/f$	$2.5 \times 10^4/f$	—
0.025–0.82 kHz	500/f	20/f	25/f	—
0.82–65 kHz	610	24.4	30.7	—
0.065–1 MHz	610	1.6/f	2.0/f	—
1–10 MHz	610/f	1.6/f	2.0/f	—
10–400 MHz	61	0.16	0.2	10
400–2,000 MHz	$3f^{1/2}$	$0.008f^{1/2}$	$0.01f^{1/2}$	f/40
2–300 GHz	137	0.36	0.45	50

3.1.4 Reference levels for general public exposure to time-varying electric and magnetic fields (unperturbed rms values)

Frequency range	E-field strength ($V\ m^{-1}$)	H-field strength ($A\ m^{-1}$)	B-field (μT)	Equivalent plane wave power density S_{eq} ($W\ m^{-2}$)
up to 1 Hz	—	3.2×10^4	4×10^4	—
1–8 Hz	10,000	$3.2 \times 10^4/f^2$	$4 \times 10^4/f^2$	—
8–25 Hz	10,000	4,000/f	5,000/f	—
0.025–0.8 kHz	250/f	4/f	5/f	—
0.8–3 kHz	250/f	5	6.25	—
3–150 kHz	87	5	6.25	—
0.15–1 MHz	87	0.73/f	0.92/f	—
1–10 MHz	$87/f^{1/2}$	0.73/f	0.92/f	—
10–400 MHz	28	0.073	0.092	2
400–2,000 MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	$0.0046f^{1/2}$	f/200
2–300 GHz	61	0.16	0.20	10

Notes:

1. f as indicated in the frequency range column.

2. If basic restrictions are met and adverse indirect effects can be excluded, field strength values can be exceeded.

3. For frequencies between 100 kHz and 10 GHz, S_{eq}, E^2, H^2, and B^2 are to be averaged over 6-min period.

4. For peak values at frequencies up to 100 kHz see Note 3 of basic restrictions.

5. For peak values at frequencies between 100 kHz and 10 MHz, peak values for the field strengths are obtained by interpolation. For frequencies exceeding 10 MHz it is suggested that the peak equivalent plane wave power density, as averaged over the pulse width, does not exceed 1,000 times the S_{eq} restrictions, or that the field strength does not exceed 32 times the field strength exposure levels.

6. For frequencies above 10 GHz, S_{eq}, E^2, H^2 and B^2 are to be averaged over $68/f^{1.05}$-min period (f in GHz).

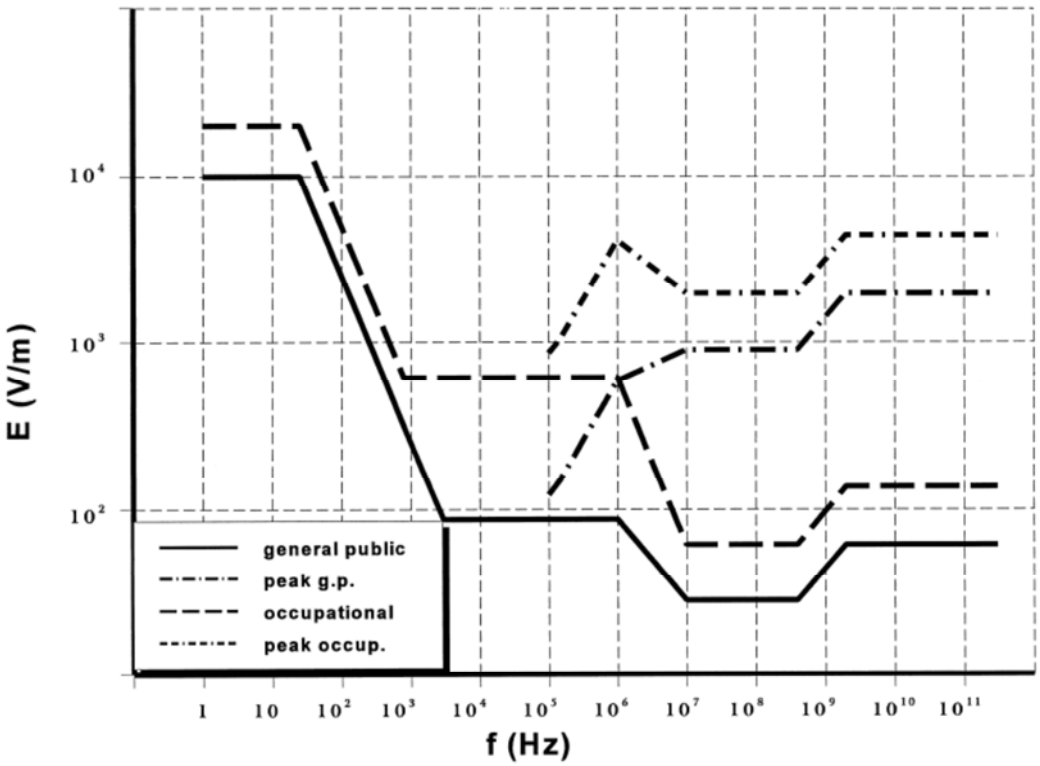
7. No E-field value is provided for frequencies <1 Hz, which are effectively static electric fields. Electric shock from low impedance sources is prevented by established electrical safety procedures for such equipment. Perception of surface electric charges will not occur at field strengths less than 25 kVm^{-1}. Spark discharges causing stress or annoyance should be avoided.

3.1.5 Reference levels for time varying contact currents from conductive objects

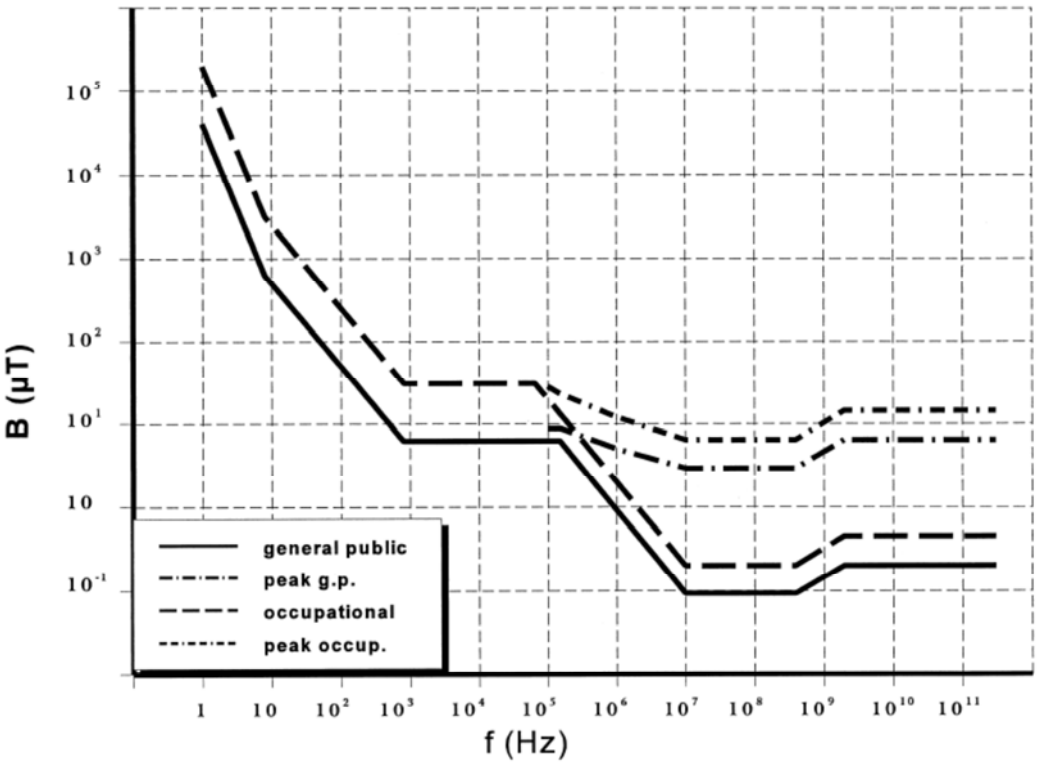
Exposure characteristics	**Frequency range**	**Maximum contact current (mA)**
Occupational exposure	up to 2.5 kHz 2.5–100 kHz 100 kHz–110 MHz	1.0 0.4f (kHz) 40
General public exposure	up to 2.5 kHz 2.5–100 kHz 100 kHz–110 MHz	0.5 0.2f (kHz) 20

3.1.6 Reference levels for current induced in any limb at frequencies between 10-110 MHz

Exposure characteristics	**Current (mA)**	**Remarks**
Occupational exposure General public exposure	100 45	Public reference level is occupational level divided by $\sqrt{5}$. For compliance with the basic restriction on localized SAR, the square root of the time-averaged value of the square of the induced current over any 6-min period forms the basis of the reference levels.



ICNIRP Reference levels for exposure to time varying electric fields



ICNIRP Reference levels for exposure to time varying magnetic fields

3.2 Federal Communication Commission (FCC) [03] of USA is required by the National Environmental Policy Act (NEPA) of 1969, among other things, to evaluate the effect of emissions from FCC-regulated transmitters on the quality of the human environment. There is no federally-mandated radio frequency (RF) exposure standard, however, several non-government American organizations such as the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), and the National Council on Radiation Protection and Measurements (NCRP) have issued recommendations for human exposure to RF electromagnetic fields. On August 1, 1996, the Commission adopted the NCRP's recommended Maximum Permissible Exposure limits for field strength and power density for the transmitters operating at frequencies of 300 kHz to 100 GHz. In addition, the Commission adopted the specific absorption rate (SAR) limits for devices operating within close proximity to the body. The Commission's limits for field strength and power density became effective on Oct 15, 1997 for all services except the Amateur Radio Service, for which it became effective on Jan 1, 1998. The FCC had been updating and revising the emission standards; the last revision was done in 2003. On March 27, 2013, the FCC voted to advance review of its various rules pertaining to the implementation of the NEPA requirements related to radiofrequency (RF) emissions from radio transmitters, and proposed to further update and revise its procedures beyond its earlier 2003 proposals. The proposals seek to streamline and harmonize many procedures to achieve equal treatment of RF-emitting sources based on their physical properties rather than service categories.

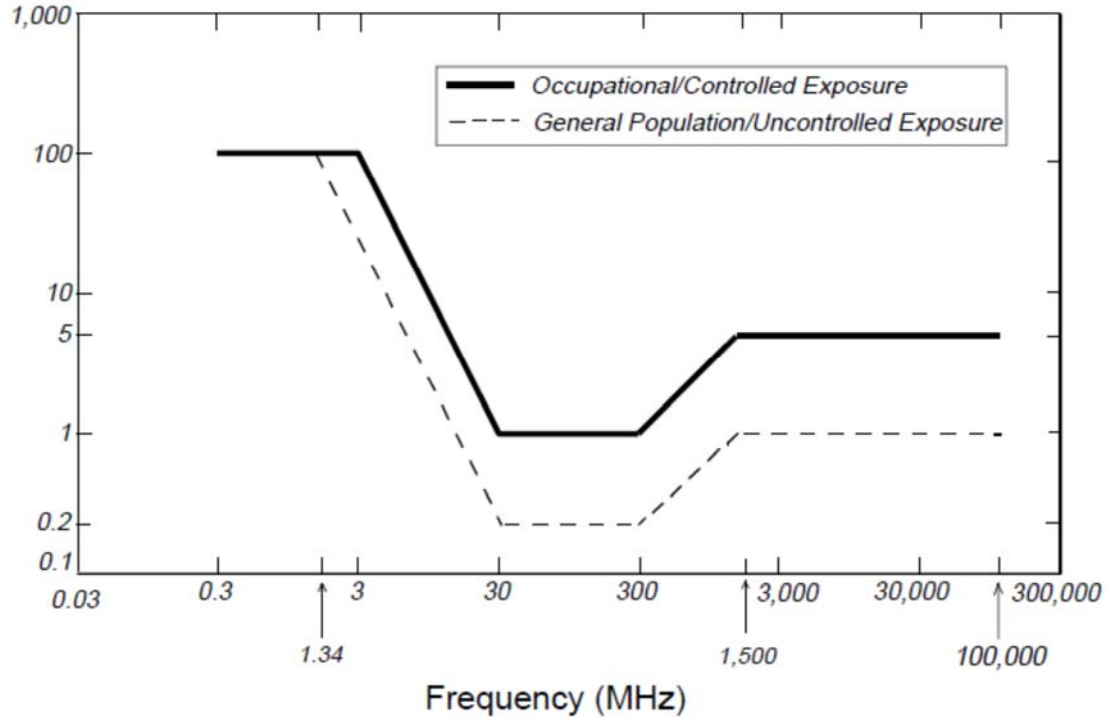
3.2.1 FCC (Proposed) Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field Strength (V/m)	Magnetic field Strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	100 *	6
3.0 – 30	1842/f	4.89/f	$900/f^2$ *	6
30 – 300	61.4	0.163	1.0	6
300 – 1,500	–	–	f/300	6
1,500 – 100,000	–	–	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3 – 1.34	614	1.63	100 *	30
1.34 – 30	824/f	2.19/f	$180/f^2$ *	30
30 – 300	27.5	0.073	0.2	30
300 – 1,500	–	–	f/1500	30
1,500 – 100,000	–	–	1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

Notes: Occupational/controlled exposure limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when a person is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure. The phrase *fully aware* in the context of applying these exposure limits means that an exposed person has received written and/or verbal information fully explaining the potential for RF exposure resulting from his or her employment. With the exception of *transient* persons, this phrase also means that an exposed person has received appropriate training regarding work practices relating to controlling or mitigating his or her exposure.

Such training is not required for *transient* persons, but they must receive written and/or verbal information and notification (for example, using signs) concerning their exposure potential and appropriate means available to mitigate their exposure. The phrase *exercise control* means that an exposed person is allowed to and knows how to reduce or avoid exposure by administrative or engineering controls and work practices, such as use of personal protective equipment or time averaging of exposure. General population/uncontrolled exposure limits apply in situations in which the general public may be exposed, or in which persons who are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.



FCC Limits for Maximum Permissible Exposure –Plane-Wave Equivalent Power Density (mW/cm^2)

3.2.2 Specific Absorption Rate (SAR) limits for portable devices (such as cell phones and other wireless communication devices) operating within close proximity to the body (within 20 centimeter of the body of the user), as specified within the ANSI/IEEE C95.1-1992 guidelines, is 1.6 W/kg within any 1 gram of human tissue for general population/uncontrolled exposure; and is 0.08 W/kg as averaged over the whole-body; exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue. The 1 gram tissue stipulation has been recommended for change (relaxation) by the IEEE in April of 2006. If adopted by the FCC, the resultant heating would be measured over 10 times as much tissue (10 grams) so that far higher heating is possible from these devices over small amounts of tissue (which would be far less strict than the current limit). More cell phones and related PDA devices would then be able to comply with the looser standard, and the public could potentially receive higher radiofrequency radiation exposures, but still remain compliant. The SAR limits for Occupational/ Controlled exposure is 0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue; exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over any 10 grams of tissue.

3.3 Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) [04] has published the Radiation Protection Standard for Maximum Exposure Levels to Radiofrequency Fields — 3 kHz to 300 GHz (2002), under the Radiation Protection Series, to promote practices which protect human health and the environment from the possible harmful effects of radiation. ARPANSA is assisted in this task by its Radiation Health and Safety Advisory Council. Australian Communications Authority (ACA) has progressively introduced regulations setting limits for human exposure to Electromagnetic Radiation (EMR) from Radio Frequency (RF) transmitters based upon ARPANSA recommendations. The related standards were made applicable for suppliers of mobile and portable transmitting equipment with effect from Mar 1, 2003. The ACA license holders were mandated to comply with the EMR health exposure conditions with effect from Jul 1, 2004.

3.3.1 Basic Restrictions for Whole Body Average SAR and spatial peak SAR

Exposure category	Frequency range	Whole-body average SAR (W/kg)	Spatial peak SAR in head & torso (W/kg)	Spatial peak SAR in limbs (W/kg)
Occupational	100 kHz – 6 GHz	0.4	10	20
General	100 kHz – 6 GHz	0.08	2	4

Notes:

1. For comparison with the limits, the measured or calculated SAR exposure level should be averaged over any six minute period.

2. Whole body average SAR is determined by dividing the total power absorbed in the body by the total mass of the body.

3. Spatial peak SAR averaging mass is any 10 g of contiguous tissue in the shape of a cube.

3.3.2 Basic Restrictions for Spatial Peak SA Applicable to Pulsed or Amplitude Modulated Exposure

Exposure category	Frequency range	Spatial peak SA in the head within any 50 μs interval (mJ/kg)
Occupational	300 MHz – 6	10
General Public	300 MHz – 6	2

Note: Spatial peak specific absorption (SA) is determined by evaluating the total energy delivered to any 10 g of contiguous tissue in the shape of a cube tissue within any 50 μs period.

3.3.3 Basic Restrictions for Instantaneous Spatial Peak SAR Applicable to Pulsed or Amplitude Modulated Exposure

Exposure category	Frequency range	Instantaneous Spatial peak SAR in the head and torso (W/kg)
Occupational	10 MHz – 6 GHz	10000
General Public	10 MHz – 6 GHz	2000

Note: Instantaneous spatial peak SAR is determined by evaluating the total energy delivered to any 10 g of contiguous tissue in the shape of a cube tissue within any 1 μs period. It is recognized that it is generally not practical to measure RF fields over such a short averaging time and that an estimate can be obtained through knowledge of the temporal characteristics of each specific source.

3.3.4 Basic Restrictions for Instantaneous Spatial Peak RMS Current Density in Head and Torso:

Exposure category	Frequency range	Current density in the head and torso (mA/m^2 rms)
Occupational	3 kHz – 10 MHz	10000
General Public	3 kHz – 10 MHz	2000

Notes:

1. *f* is the frequency in kHz.

2. Because of the electrical in-homogeneity of the body, current densities must be averaged over a circular cross-section of 1 cm^2 perpendicular to the current direction.

3. For pulsed magnetic field exposures spanning frequencies up to 100 kHz, the maximum current density associated with the pulses can be calculated from the maximum rate of change of magnetic flux density using Faraday's law of induction. For comparison with the above limits, the maximum current density so obtained should be divided by √2 at a frequency of $f = 1/(2000 \times tp)$, where tp is the duration of the pulse cycle such that $1/(2000 \times tp)$ corresponds to the second harmonic of the pulses.

3.3.5 Basic Restrictions for Time Averaged and Instantaneous Incident Power Flux Density

Exposure category	Frequency range	Time averaged power flux density (W/m^2)	Instantaneous power flux density (W/m^2)
Occupational	6 GHz – 300 GHz	50	50000
General Public	6 GHz – 300 GHz	10	10000

Notes:

1. Power flux densities may be averaged over an area no larger 20 cm^2.

2. The maximum spatial peak time averaged power flux density, spatially averaged over 1 cm^2, must not exceed 20 times the time averaged values indicated above.

3. For determination of time averaged values at frequencies below 10 GHz, an averaging time of six minutes applies and for frequencies above 10 GHz, an averaging time of $68/f$ 1.05 minutes (where *f* is the frequency in GHz) must be used. This approach compensates for progressively shorter penetration depth as the frequency increases.

4. Instantaneous power flux density is calculated over any 1 μs period. It is recognized that it is generally not practical to measure RF fields over such a short averaging time and that an estimate can be obtained through knowledge of the temporal characteristics of each specific source.

3.3.6 Reference Levels for Time Averaged Exposure to RMS Electric and Magnetic Fields (Unperturbed Fields)

Exposure category	Frequency range	E-field strength (V/m rms)	H-field strength (A/m rms)	Equivalent plane wave power flux density Seq (W/m2)
Occupational	100 kHz – 1 MHz	614	1.63/f	-
	1 MHz – 10 MHz	614/f	163/f	$1000/f^2$ (note 5)
	10 MHz – 400	61.4	0.163	10 (note 5)
	400 MHz – 2 GHz	$3.07xf^{0.5}$	$0.00814xf^{0.5}$	f/40
	2 GHz – 300 GHz	137	0.364	50
General Public	100 kHz – 150 kHz	86.8	4.86	-
	150 kHz – 1 MHz	86.8	0.729/f	-
	1 MHz – 10 MHz	$86.8/f^{0.5}$	0.729/f	-
	10 MHz – 400	27.4	0.0729	2 (note 5)
	400 MHz – 2 GHz	$1.37xf^{0.5}$	$0.00364xf^{0.5}$	f/200
	2 GHz – 300 GHz	61.4	0.163	10

Notes:

1. *f* is the frequency in MHz.

2. For frequencies between 100 kHz and 10 GHz, Seq, E^2 and H^2 must be averaged over any 6 minute period.

3. For frequencies exceeding 10 GHz, Seq, E^2 and H^2 must be averaged over any $9.6 \times 104 / f$ 1.05 minute period.

4. Spatial averaging of the time averaged reference levels should be performed over 20 cm^2.

5. For occupational exposure, E and H reference levels are given in plane wave ratio at frequencies greater than or equal to 1 MHz. However, for many occupational exposure situations, equivalent plane wave power flux density is not an appropriate metric if 'far-field' exposure conditions do not apply. Survey meters may be calibrated in terms of W/m2, but both E and H will generally require independent measurement and evaluation if measured in the near-field.

6. For general public exposure E and H reference levels are given in plane wave ratio at frequencies greater than or equal to 10 MHz. However, equivalent plane wave power flux density is not an appropriate metric if 'far-field' exposure conditions do not apply. Survey meters may be calibrated in terms of W/m2, but both E and H will generally require independent measurement and evaluation if measured in the near-field.

3.3.7 Reference Levels for Exposure to Instantaneous RMS Electric and Magnetic Fields (Unperturbed Fields)

Exposure category	Frequency range	E-field strength (V/m rms)	H-field strength (A/m rms)	Equivalent plane wave power flux density Seq (W/m2)
Occupational	3 kHz – 65 kHz	614	25.0	-
	65 kHz – 100 kHz	614	1.63/f	-
	100 kHz – 1 MHz	$3452xf^{0.75}$	$9.16/f^{0.25}$	-
	1 MHz – 10 MHz	$3452xf^{0.75}$	$9.16/f^{0.25}$	$(10^9/f)0.5$ (note 4)
	10 MHz – 400	1941	5.15	10000 (note 4)
	400 MHz – 2 GHz	$97xf^{0.5}$	$0.258xf^{0.5}$	25xf
	2 GHz – 300 GHz	4340	11.5	50000
General Public	3 kHz – 100 kHz	86.8	4.86	-
	100 kHz – 150 kHz	$488xf^{0.75}$	4.86	-
	150 kHz – 1 MHz	$488xf^{0.75}$	$3.47/f^{0.178}$	-
	1 MHz – 10 MHz	$488xf^{0.75}$	$3.47/f^{0.178}$	-
	10 MHz – 400	868	2.30	200 (note 5)
	400 MHz – 2 GHz	$43.4xf^{0.5}$	$0.115xf^{0.5}$	5xf
	2 GHz – 300 GHz	1941	5.15	10000

Notes:

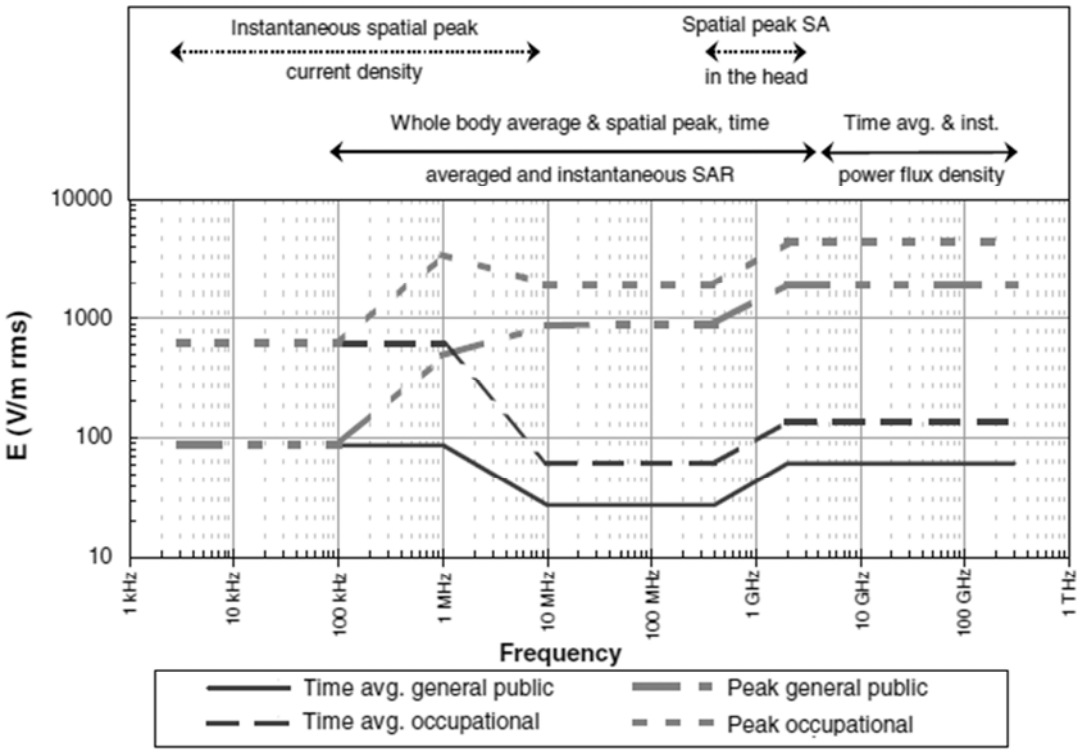
1. *f* is the frequency in MHz.

2. For the specific case of occupational exposure to frequencies below 100 kHz, and where adverse effects from contact with passively or actively energized conductive objects can be excluded, the derived electric field strength can be increased by a factor of 2.

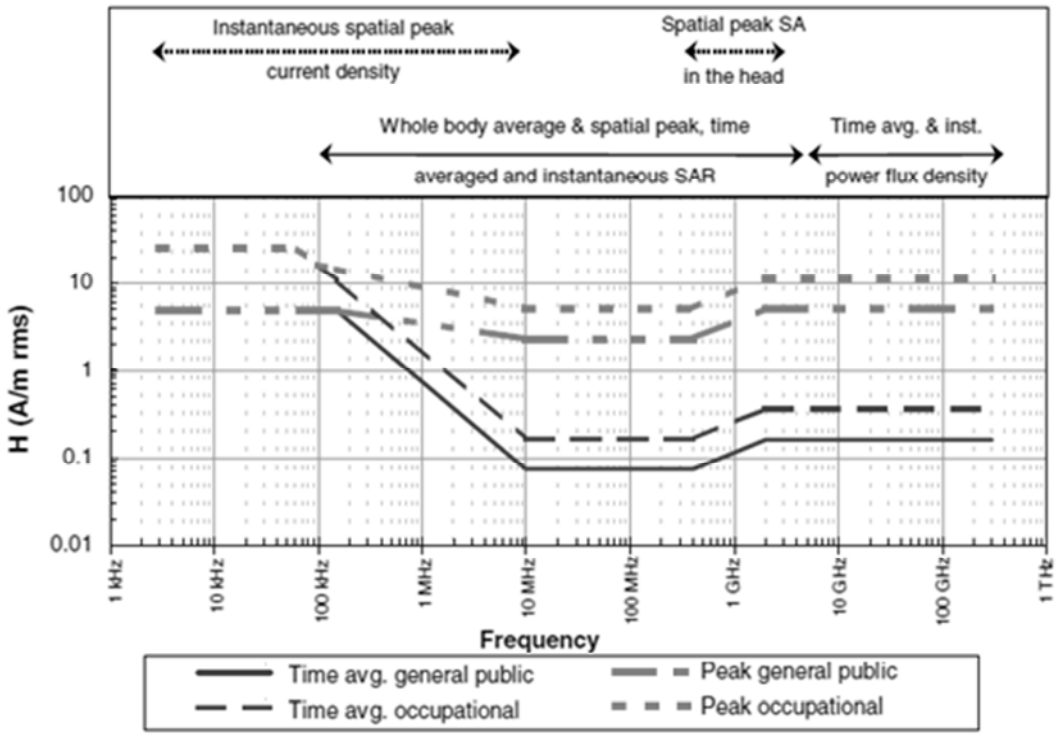
3. The E and H reference levels are instantaneous rms values and for purposes of compliance determination, measurements are to be rms averaged over any 1 μs period. However, at frequencies below 100 kHz, measurements may be rms averaged over any 100 μs period or, below 10 kHz, at least one single cycle of the carrier frequency.

4. For occupational exposure, E and H reference levels are given in plane wave ratio at frequencies greater than or equal to 1 MHz. However, for many occupational exposure situations, equivalent plane wave power flux density is not an appropriate metric if 'far-field' exposure conditions do not apply. Survey meters may be calibrated in terms of W/m2, but both E and H will generally require independent measurement and evaluation if measured in the near-field.

5. For general public exposure E and H reference levels are given in plane wave ratio at frequencies greater than or equal to 10 MHz. However, equivalent plane wave power flux density is not an appropriate metric if 'far-field' exposure conditions do not apply. Survey meters may be calibrated in terms of W/m2, but both E and H will generally require independent measurement and evaluation if measured in the near-field.



Reference levels for instantaneous and time averaged rms exposure to electric fields



Reference levels for instantaneous and time averaged rms exposure to magnetic fields

3.3.8 Spatial Averaging of E and H Fields

The E and H reference levels given above are unnecessarily conservative if applied as spatial peak limits. Consequently, time averaged E^2 and H^2 measurements may be spatially averaged provided that the basic restrictions on spatial peak SAR and instantaneous spatial peak rms current density are not exceeded. For frequencies below 100 MHz: Calculate the spatial average for a standing person by averaging four single measurements at the head, chest, groin and knees. The spatially averaged values so obtained should be compared to the field limits shown in above tables; none of the individual field strength spot measurements are allowed to exceed these limits by a factor of √20 (or a factor of 20 for S, E^2 or H^2). For frequencies in the range 100 MHz to 10 GHz: Conduct scanning measurements over the body and locate the spatial peak level. Make three measurements in a vertical line separated by $30 – 2.58 \times (f – 0.1)$ cm (1 GHz to 10 GHz, make four measurements at the corners of a vertical square with this as side lengths and centered at the location of the spatial peak). Average the measurements (including the value in the centre of the square) and check with reference levels. For frequencies above 10 GHz: Conduct scanning measurements over the body and locate the spatial peak level; Average the E or H measured levels over a square of 20 cm² (sides of 4.5 cm) centered at this location; Spatial maximum E or H averaged over 1 cm² should not exceed √20 times the reference levels.

3.3.9 Simultaneous exposure to multiple frequency fields

Combined effects of exposure to multiple frequency exposure sources may be additive. In general, electro-stimulatory effects that may result from exposure to frequencies below 10 MHz are not considered to be additive with heating effects produced by exposure to frequencies above 100 kHz and may be treated independently.

3.3.10 Reference Levels for Instantaneous RMS Contact Currents from Point Contact with Conductive Objects

Exposure category	Frequency range	Maximum contact current (mA rms)
Occupational	3 kHz – 100 kHz	0.4xf
	100 kHz – 110 MHz	40
General Public	3 kHz – 100 kHz	0.2xf
	100 kHz – 110 MHz	20

Notes:

1. *f* is the frequency in kHz.

2. For frequencies greater than or equal to 100 kHz, instantaneous contact currents must be rms averaged over any 1 µs period. However, at frequencies below 100 kHz, measurements must be rms averaged over any 100 µs period or, below 10 kHz, over at least one single cycle of the carrier frequency.

3. These reference levels are applicable only where there is a possibility of point contact with passively or actively energized conductive objects such that significant instantaneous spatial peak current densities are likely (e.g. where current is drawn through a finger rather than induced in an arm).

3.3.11 Reference Levels for Time Averaged RMS Current Induced in any Limb

Exposure category	Frequency range	Current (mA rms)
Occupational	10 MHz – 110MHz	100
General Public	10 MHz – 110MHz	45

Note: For compliance with the basic restriction on spatial peak SAR in limbs, induced limb current measurements are to be rms averaged over any 6-minute period.

3.4 Standard of Building Biology Testing Methods (SBM-2008) [05]

The SBM-2008 standard gives an overview of the physical, chemical and biological risks encountered in sleeping areas, living spaces, workplaces and properties. It offers guidelines on how to perform specific measurements and assess possible health risks. The objective is to create indoor living environments that are as exposure-free and natural as practicable. This holistic approach is accomplished by taking all subcategories into account and implementing all available diagnostic possibilities.

Between 1987 and 1992, BAUBIOLOGIE MAES developed these Standards of Building Biology with the support of the Institut für Baubiologie und Ökologie Neubeuern (IBN) and issued in May 1992. SBM-2008 is the seventh edition. The proposed limits are significantly stringent than other limits; as much as 3 orders of magnitude lower RF Power Density and LF Electric Field, and 6 orders of magnitude lower for LF Magnetic Field. It describes four different levels of concern and corresponding limits:

No Concern: Highest degree of precaution. It reflects the unexposed natural conditions or the common and nearly inevitable background level of our modern living environment.

Slight Concern: As a precaution and especially with regard to sensitive and ill people, remediation should be carried out whenever it is possible.

Severe Concern: Values in this category are not acceptable from a building biology point of view, they call for action. Remediation should be carried out soon. In addition to numerous case histories, scientific studies indicate biological effects and health problems within this reference range.

Extreme Concern: These values call for immediate and rigorous action. Here international guidelines and recommendations for public and occupational exposures may be reached or even exceeded.

	No Concern	**Slight Concern**	**Severe Concern**	**Extreme Concern**
AC Electric Fields (Low Frequency, ELF/VLF) * Field strength (V/m) Body voltage (mV) Natural background: < 0.0001 V/m	 < 1 < 10	 1 – 5 10 –100	 5 – 50 100 – 1000	 > 50 > 1000
AC Magnetic Fields (Low Frequency, ELF/VLF) * # Flux density (nT) (mG) Natural background: < 0.0002 nT	 < 20 < 0.2	 20 – 100 0.2 – 1	 100 – 500 1 – 5	 > 500 > 5

Radio Frequency Radiation (Electromagnetic Waves) $ Power density (μW/m²) (nW/cm²) Natural background:< 0.000001 μW/m²	 < 0.1 < 0.01	 0.1 – 10 0.01 – 1	 10 – 1000 1 – 100	 > 1000 > 100
DC Electric Fields (Electrostatics) Surface potential (V) Discharge time (s) Natural background: < 100 V	 < 100 < 10	 100 – 500 10 – 30	 500 – 2000 30 – 60	 > 2000 > 60
DC Magnetic Fields (Magnetostatics) Deviation of flux density (steel) (μT) Fluctuation of flux density (current) (μT) Deviation of compass needle (°) Natural background: Earth – Equator 25 μT, N/S pole 65 μT	 < 1 < 1 < 2	 1 - 5 1 - 2 2 - 10	 5 - 20 2 - 10 10 - 100	 > 20 > 10 > 100
Geological Disturbances Geomagnetic Field (nT) Terrestrial Radiation (%) Earth Magnetic Field: Temporal fluctuations 10-100 nT; Magnetic Storms/Solar eruptions: 100-1000 nT	 < 100 < 10	 100 - 200 10 - 20	 200 - 1000 20 - 50	 > 1000 > 50
Radioactivity (Gamma Radiation, Radon) Equivalent dose rate increase (%) Radon –Becquerel/cubic meter (Bq/m³) Average background radiation (mSv/y) (milli Severt/year–1Sv=1joule/kg tissue)	 < 50 < 30 2.4	 50 – 70 30 – 60	 70 – 100 60 – 200	 < 100 < 200

* Apply for 50 (60) Hz, higher frequencies/predominant harmonics should be assessed more critically.

Line current (50-60 Hz) and traction current (16.7 Hz) are recorded separately.

$ Peak measurements of single RF sources, e.g. GSM, WiMAX, Radio, TV, etc. Do not apply to radar signals. Pulsed signals should be assessed more seriously.

CHAPTER 4

INITIATION OF PUBLIC AWARENESS AND DEBATE IN INDIA

While the development of EMF exposure standards is quite recent, the need to understand the potentially harmful effects on human health has been addressed through several decades of scientific research all over the world. The growth of electric power generation and transmission, the development of wireless telecommunication systems and advances in medical and industrial applications, have brought in to focus the fact that biological systems and the environment are increasingly exposed to electromagnetic fields much larger than natural background radiation levels. The World Health Organization (WHO), realizing the importance of the subject and its close relationship with the area of environmental health, established the International EMF Project 1996 in response to general concern over health effects of EMF exposures. The project brought together over sixty countries to identify criteria for EMF standards and to develop the 'Framework for Developing Health-based EMF Standards'.

WHO brought out its first fact sheet on the subject (No. 193) in Jun 2000, entitled: 'Electromagnetic fields and public health: mobile telephones and their base stations'. It recommended: Precautionary measures, strict adherence to health-based guidelines, obeying local restrictions on mobile phone use to avoid EMF interference, an effective system of providing health information and communications among scientists, governments, industry and the public to raise the level of general understanding about mobile phone technology and reduce any mistrust and fears, both real and perceived. There was significant resistance from cell phone operators and telecommunication system manufacturers to accept restrictions on power levels, field strengths and radiation levels, as these were expected to have adverse impact on connectivity and fast growing telecommunication market.

Simultaneously, the environmentally conscious NGOs, individual activists and scientists started aggressive campaigns to sensitize the general public and Governmental agencies. In India, some of the related efforts were:

(i) Microwave and Millimeter Wave R & D in India, IETE Technical Review – Golden Jubilee Special Issue on 'R & D in Electronics in India', Vol 20, Number 2, Mar-Apr 2003 [06].

(ii) National Symposium on Advances in Microwaves and Light Waves, University of Delhi South Campus, New Delhi, Oct 13, 2003.

(iii) Asia Pacific Microwave Conference, University of Delhi, New Delhi, Dec 15, 2003.

(iv) International Conference on Electromagnetic Interference Compatibility (INCEMIC 2003), Society of EMC Engineers (India), Chennai, Dec 18, 2003.

(v) International Conference on Microwaves, Antenna, Propagation and Remote Sensing, International Centre for Radio Science (ICRS), Jodhpur, Dec 25, 2004.

(vi) National Seminar on 'Electromagnetic Waves and Applications', Microwave Applications Society of India (MASI), Jawaharlal Nehru University (JNU), New Delhi, Feb 21, 2005.

(vii) Filing of the Writ Petition in the Bombay High Court (2004), and the PIL in the Supreme Court (2005) by the by the Karma Jyot Seva Trust of Gugarat.

(viii) Jawaharlal Nehru University and University of Sydney Workshop on Recent Trends in Environmental Sciences, School of Environmental Sciences, JNU, New Delhi, Nov 23, 2005.

(ix) Special session on EMR health hazards and Panel Discussion on "EMI/EMC and EM Radiation Hazards – Specifications, Standards and Measurement Methods – in Indian Context", International Conference on Electromagnetic Interference and Compatibility (INCEMIC-2006), Bangalore, Feb24, 2006.

(x) Start up of Cogent EMR Solutions Ltd, New Delhi for Radiation Protection Solutions and Products, 2006.

(xi) 'Radio Frequency Interference or Electromagnetic Pollution', Edusat multicasting lecture, Vigyan Prasar, New Delhi, May 2, 2006 [07].

(xii) Workshop cum Symposium on Electromagnetic Fields in Environment: Implications and Solutions, Microwave Applications Society of India, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, Mar 23, 2007.

(xiii) Workshop cum Symposium on Electromagnetic Fields Bio-Interactions, Applications and Electromagnetic Pollution, Indian National Academy of Engineering (INAE) and Microwave Applications Society of India (MASI), JNU, New Delhi, March14, 2008.

(xiv) International Conference on Electromagnetic Interference and Compatibility (INCEMIC-2008), Society of EMC Engineers (India), Bangalore, Nov 26, 2008.

(xv) Start up of Voyager EMR Solutions Pvt Ltd, Secunderabad for Radiation Protection Solutions and Products, 2009.

(xvi) Workshop on Microwave Principals and Applications, Microwave Applications Society of India, JNU, New Delhi, Nov 5, 2009.

(xvii) International Conference on Electromagnetic Interference and Compatibility (INCEMIC-2010), Society of EMC Engineers (India), Bangalore, Nov 26, 2010.

(xviii) National Seminar on Microwave Field Measurements and Biological Effects, Microwave Applications Society of India, JNU, New Delhi, Mar 4, 2011.

(xix) International Conference on Electromagnetic Interference and Compatibility (INCEMIC 2012), Bangalore, Dec 6, 2012.

(xx) International (Hindi) Conference on Contributions of Science & Technology in Progress of the World, DESIDOC, New Delhi, Dec 5, 2013.

Publication of Radiation Guru Magazine by the Cogent Media and Entertainment Ltd to expose and sensitize general public about the hazards of electromagnetic fields and electromagnetic pollution; seven issues were brought out between Jun 2007- Jan 2008.

(i) May 2007: Special Issue on: 'Pregnancy and Microwave Oven', 'Menace of BTS Towers', 'Effect of Mobile Phones on Bees and Sperms' and 'Safe radios'.

(ii) Jun 2007: Special Issue on: 'Radiation from Power Transmission Lines', 'Effect of Mobiles on Children and Birds', 'Minimization of Cell Phone radiation' and 'Safety of Homes and Commercial Buildings'.

(iii) Jul 2007: Special Issue on: 'Effect of EMR on Heart', 'Radiation from Home Appliances', 'Controlling Cell Phone Radiation', 'EMR and Sleeping Well' and 'Neil Cherry, the Radiation Warrior'.

(iv) Aug 2007: Special Issue on: 'EMF Solutions', 'EMR from Computers', 'Army Facing EMR', 'Stringent Radiation Guidelines by TEC' and 'China Bringing Tougher EMR Policies'.

(v) Sep 2007: Special Issue on: 'Effects of EMF on Environment', 'E-Pollution', 'Cell Phone SAR', 'Cancer Risk from Mobile Phone Radiation', 'Harmful Radiation from Television' and 'WiFi Radiation'.

(vi) Nov 2007: Special Issue on: 'Brain's Interaction with Mobiles Phone Radiation', 'Occupational EMR Exposure of Police Force', 'Leukemia Growing Among Children', 'EMR Causes Miscarriage', 'EMR and Alzheimer' and 'Keeping Laptop Off Lap'.

(vii) Jan 2008: Special Issue on: 'Microwave Invasion', 'Electromagnetic Warfare', 'Measuring Cell Phone Radiation', 'Potential Effects on Pacemaker Systems' and 'Smaller Cities Facing Radiation Hazards'.

A series of lectures were organized in IITs, Universities, Colleges, Schools, NGOs, Medical Institutes, Hospitals, TV channels, etc to educate and inform public about harmful effects of electromagnetic radiation and to suggest protection methods and remedial solutions.

Dr APJ Abdul Kalam, when he was the President of India, included the subject in five of his public lectures during 2006-2008 (Appendix III):

(i) 'Connectivity for Billion People', Inauguration of 'India Telecom 2006 – Mapping the Road Ahead', New Delhi, Dec 14, 2006 [14].

(ii) 'Research Enhances Global Competitiveness in Communications', International Conference on 'Signal Processing, Communications and Networking', MIT, Chrompet, Anna University, Chennai, Feb 23, 2007 [15].

(iii) 'Great Minds Emanate from Creative Environment' Foundation Stone Laying Ceremony of the Dr. BC Roy Multi-Specialty Research Centre, IIT Kharagpur, May 17, 2007 [16].

(iv) 'Indian Railways: National carrier and the National Integrator', Conference on Railways Vision 2030, New Delhi, March 1, 2008 [17].

(v) 'Connectivity for Billion People', Anniversary Celebrations of Nokia–Siemens Network, New Delhi, April 11, 2008 [18].

Standing Committee on Information Technology (2013-14) presented its Fifty-third Report on 'Norms for setting up of telecom towers, its harmful effects and setting up of security standards in expansion of telecom facilities' relating to the Ministry of Communications and Information Technology (Department of Telecommunications), to Lok Sabha on Feb 12, 2014. To elicit wide opinion on the subject, the Committee had arranged a Press Communiqué through print and electronic media on Feb 18, 2013 seeking views/suggestions from experts/stakeholders/ organizations/public at large. In its report, the Committee made wide ranging recommendations on all related aspects:

(i) Need for clear defined role for setting up of telecom towers.

(ii) Need for an enforceable national guidelines for setting up of telecom towers.

(iii) Structural Safety for setting up of telecom towers.

(iv) Sharing of Telecom Towers.

(v) Health hazards from EMF emission.

(vi) Restrictions on setting up of mobile towers in residential areas.

(vii) Restrictions on setting up towers in schools, colleges and hospitals.

(viii) Need for India Specific long term Research.

(ix) International practices and countries having lower emission standards.

(x) Introduction of low power radiating antennae like Micro, Pico and Femto.

(xi) Need for Effective Grievance Redressal Mechanism.

(xii) Setting up of State/District Level Telecom Committees.

(xiii) Implementation of prescribed Specific Absorption Rate (SAR) Value for mobile handsets.

Coverage by News Papers played very important role in educating and sensitizing general public and decision makers on EMR Hazards, particularly effects of radiation from cell phone towers and international guidelines on limiting EMF. Some interesting sample news headlines are:

(i) 'Be Extra Careful when living near High Tension Lines – Because your family's safety is most important' – Times of India, Aug 8, 2013: Advertisement by the Department of Power,

Government of NCT of Delhi, advising minimum horizontal and vertical clearance from 400 KV and 220 KV power lines.

(ii) 'Cell towers radiation: SC to hear plea against HC order banning towers from public-use buildings' – Economic Times, Feb 6, 2013: "Beginning today, the country's highest court will hear petition filled by telecom industry lobbies challenging a recent Rajasthan High Court order that directed telecom companies to remove cell phone towers from schools, hospitals, jails and heritage buildings in the state amid claims that tower radiation was harmful. Officials of two leading industry associations, representing mobile operators and telecom tower companies, feel the Supreme Court's verdict in the case could set a precedent on where all towers can be located and how they operate...director general of the Towers & Infrastructure Providers Association said the 'arbitrary removal' of towers will create huge gaps in network coverage."

(iii) 'Biased, unscientific report on electromagnetic radiation' – The Hindu, Jan 16, 2013: "The recently released Bio-Initiative Report 2012 (BIR-2012) on standards for electromagnetic radiation is a perfect clone of a similar report published in 2007. According to many responsible agencies it is biased and unscientific. BIR-2012 claimed that the evidence for risks to health from wireless technologies and electromagnetic fields (EMFs) has substantially increased since 2007. The studies alleged a link between cell phone radiation and brain tumors."

(iv) 'Special drive by corporations to check illegal cell towers' – Times of India, Nov 29, 2012: "The three corporations will soon launch a special drive to crack down on illegal cell phone towers… there has been a sharp increase in the number of cell phone towers in the city, especially in residential colonies. There are 5,656 mobile towers in Delhi, of which 2,656 are illegal...While East Delhi Municipal Corporation has started sending notices to cellular companies for removal of these towers, the North corporation will start the process from Thursday…Due to growing awareness about the harmful radiation emitted from these towers, the civic agency has received several requests for their removal…The policy was revised to limit the number of towers in residential colonies. Under the new policy, first preference was given to municipal and government buildings (barring hospitals and schools) followed by non-residential areas — near drains and vacant land…But the policy was challenged by the Cellular Operators' Association of India in the Delhi high court, as the civic agency has increased the installation fee from Rs 1 lakh (one-time charge) to Rs 5 lakh for every five years. Though the HC struck down MCD's decision to increase the installation fee and its right to decide the site, it upheld the civic agencies' right to give permission for installing the towers. The court also made it clear that the operators can't install towers without the agencies' permission."

(v) 'Mumbai cell phone towers will need 70% residents' nod' – Times of India, Nov 17, 2012: "In a major relief to Mumbaikars who are fighting against installation of mobile towers on their buildings, the Brihanmumbai Municipal Corporation (BMC) has made it mandatory for mobile phone operators to get consent from 70% occupants of a housing society to install a tower. Several citizens were up in arms against their societies' managing committees for permitting towers without their consent, following growing concerns over health effects of radiation."

(vi) 'Mobile base station radiation limit will be cut from September 1' – The Hindu, Aug 28, 2012: "The Centre has told Parliament that the exposure limit for radio frequency fields (base station emissions) will be brought down to one-tenth of the existing level from September 1. This direction was to have been implemented from April 1. However, on an examination of the impact of the revised Electric and Magnetic Field (EMF) exposure limit on area coverage and exclusion zone, self-certification compliance with the new norms has been extended."

(vii) 'Radiation Alert' –Times of India, Jun 12, 2011: "It's not just mobile phones, every single domestic appliance gives off radiation. Are we all drowning in a sea of electromagnetic waves? Recently, the World Health Organization warned that cell phones are possibly carcinogenic to humans and placed them in the same category as the pesticide DDT and gasoline engine exhaust. Such studies prompt people to wonder what else could be lurking in their homes as a health risk…both electric and magnetic fields are found around electrical appliances and power lines. However, electric fields are shielded or weakened by walls and other objects, whereas magnetic fields can pass through buildings, humans, and most materials. So, most times you are being bathed in an electronic smog created by electrical devices.

(viii) 'Towering trouble' – Hindustan Times, Nov 16, 2010: "The DoT will start a random check of the radiation levels of telecom towers all over the country, though the extent of the damage is still being debated. A Committee led by the Indian Council of Medical Research has been formed to study the impact of mobile towers…it will not be dictated by what people say abroad. There are 450,000 telecom towers in India, with concentrations thicker in urban centres; 730 million mobile phone users, with 15 million being added every month; 12 players in the mobile tower business, with the biggies being Indus Towers, Reliance Infra, GTL Infrastructure, etc."

(ix) 'Cell phones may act up as tower sealing begins' – Times of India, May 12, 2010: "Cellular services are likely to be hit from Wednesday as MCD begins sealing illegal cellular towers, which account for more than half of those installed in the city…even as cellular operators filed a petition in the high court on Tuesday for a stay on the issue. Delhi has a total of 5,364 cell towers out of which permission has been granted to 2,412. A whopping 2,952 were erected without permission.

(x) 'Mobile Phones Banned in CBSE Schools' – News Headlines, Aug 4, 2009: " For any one: Students, Teachers, Staff…Distraction, lack of concentration, anxiety, fear, misuse of cameras…even if in silent mode, can disturb by SMS!"

(xi) 'Headphones May Interfere with Implantable Defibrillators & Pacemakers' – ITEM, Nov 13, 2008: "Research at Medical Device Safety Institute at Beth Israel Deaconess Medical Center (BIDMC) in Boston investigated the effects of MP3 player headphones (8 different models) on the operation of implanted cardiac devices (60 defibrillator and pacemaker patients). 14 (23 percent) patients noticed problem – field strength of 10 Gauss at the site of the pacemaker and defibrillator has the potential to interact with an implantable device."

(xii) 'Swiss Study Focuses on Alzheimer's Risk and Exposure to EM Fields' – Free Press Journal, Nov 11, 2008: "Doctors at the Institute for Social and Preventive Medicine at the University of Berne used census and mortality data from 4.7 million Swiss residents to investigate all deaths between 2000 and 2005. Those who lived within 50 meters of high-voltage electricity lines

were more likely to die from Alzheimer's disease and senile dementia…pointed out the limited public health implications of this study since less than 0.25 of a percent of Swiss actually reside within that range of high-power lines."

(xiii) 'DGSMC bans mobiles in schools' - The Indian Express, Nov13, 2007: Delhi Gurudwara Sikh Management Committee issued circular to 15 schools for strict action against both teachers and students (Guru Harikishan Public School)…Confiscation of Mobile Phone if found carrying – and Suspension if continue to carry or use."

(xiv) 'Garbled Sense - Cell use ban on teachers, not the taught' – Tribune (Chandigarh), Sep 19, 2007: "Education department imposed a ban on the use of cell phones by teachers in classrooms… ironically, no mention of the use of cell phones by students. The use and misuse of cell phones in schools has come under discussion following the Karnataka Government's latest strictures to ban mobile phones for kids under the age of 16 or students studying below Class IX. The notice, which has been sent by the DPI (S), has directed the principals of the schools to ensure the implementation of these instructions and to take necessary action against the teachers who flout it."

(xv) 'The Big Story - Call Barring' – The Asian Age, Sep 16, 2007: "Taking a balanced view of the entire debate on whether cell phones can cause serious health hazards – are scientists and experts in the field – pleading with the Centre, as well as the public, to take a balanced view. The government's decision to ban cell phone use among children is going a little too far since you can't stop today's generation from using cell phones. Problem comes not from cell phones, but cell phone towers, which emit very high radiation and are proliferating in residential areas and near schools and hospitals."

(xvi) 'No cell phones till you're 16 - Karnataka Bans Sale of Mobiles to Kids, cites Health Reasons' – Times of India, Sep 12, 2007: "Concerned over adverse health impact on children who are hooked on to cell phones, the state government on Tuesday (Sep 11) announced that it would direct traders not to sell mobile phones to children below 16 years. The government has also banned use of mobile phones in schools and colleges. Education department has also ordered ban for students and institutions up to 2nd-year pre-university. A circular to this effect is expected to be issued in a couple of days, which will be applicable for all state, central and private-run educational institutions across Karnataka."

(xvii) 'Ire over tower atop school – Parents Fear radiation' – The Telegraph, Aug 14, 2007: "A cell phone tower set up two months ago on the roof of Bally's Durgapur Pallimandir Balika Vidyamandir has local residents up in arms…they have sent letters to the state pollution control board, the district magistrate of Howrah and the authorities at various levels with signatures of more than 300 residents."

CHAPTER 5

PIL – THE LEGAL BATTLE WITH GOVERNMENT OF INDIA

Filing of the PIL in the Supreme Court by the Karma Jyot Seva Trust of Gugarat as the Writ Petition (Civil) No. 471 OF 2005 was an important milestone in the journey to achieve the objectives to control and regulate harmful electromagnetic radiations in India. While several court cases had been initiated by NGOs and individuals on the related issues, they all got consolidated under an order of the Supreme Court in response and during the conduct of proceedings under the above PIL.

A year earlier, the question of health hazards of radiations emanating from mobile base station towers came up for consideration before a Division Bench of the Bombay High Court in WP No. 2112 of 2004. The Bench directed the Ministry of Health and Family Welfare, Government of India to conduct a scientific study on the issue, which, then, constituted a Committee under the Chairmanship of Dr NK Ganguly, DG ICMR to evaluate:

(i) Whether it is advisable to frame and/or adopt the existing international guidelines pertaining to installation of Base Stations by mobile telephone service providers, so as to avoid any potential risk to health and safety to public at large.

(ii) Explore the possibility for studying the course of action and framing a research project.

While the proceedings under the above PIL of 2005 were progressing in the Supreme Court, the Ganguly Committee submitted its report and recommendations on May 29, 2006 (Appendix IV). The Committee also took in to account the recommendations of the World Health Organizations (WHO) on 'Electromagnetic fields and public health – Base stations and wireless technologies', updated in its Fact Sheet No. 304 of May 2006 (Appendix V), which recommended: "National Authorities should adopt international standards to protect their citizens against adverse levels of RF fields." The Ganguly Committee recommended:

(i) A precautionary approach should be adopted till further research data is available. It will not be amiss to adopt the ICNIRP guidelines for limiting EMF Exposure.

(ii) The protocols to be followed and necessary guidelines for siting of mobile phone base stations may need to be developed as per its applicability for India.

(iii) Periodic review of the status of knowledge in this area should be done and the recommendations may be revised accordingly.

(iv) Recognizing that there is not enough evidence, data be generated through appropriate epidemiological studies (covering urban/rural population & varied exposure levels). Appropriate funds should be made available to the Institutions conducting these studies.

Before filing the petition, the Karma Jyot Seva Trust had sent representations to the following Ministries of the Government of India on Aug 1 and Aug 18, 2005:

(i) Ministry of Communications (DoT)

(ii) Ministry of Defence

(iii) Ministry of Environment and Forests

(iv) Ministry of Health and Family Welfare

(v) Ministry of Home Affairs

(vi) Ministry of Human Resources

(vii) Ministry of Information and Broadcasting

(viii) Ministry of Civil Aviation

The Supreme Court Bench heard the petition on Sep 26, 2005, and Ordered (Appendix VI):

> "The 1earned counsel for the petitioner states that representations were made to various Ministries on the question of lack of guide1ines as also non-implementation on the question of erection of towers used by various mobile companies and bringing to the notice of the Government the health hazards involved. The petitioner is granted leave to place copies of all those representations within four weeks. The petitioner shall also send reminders to the Ministries and state therein that such a petition has been filed.
>
> List the petition after eight weeks."

As directed by the Supreme Court, reminders were sent to all the concerned Ministries on Sep 30, 2005 (Appendix VII) reiterating the issues raised in the PIL, summarized as follows:

(i) Safety, life and health from the dangerous Electro Magnetic Radiations (EMR) emitted from the Communication Towers/Base Stations erected on buildings throughout the county by Cellular Mobile Service Providers, in violation of concerned Rules/Regulations, as laid down and framed by Central/State Governments.

(ii) Since the introduction of cellular mobile phones in 1995-96, there has been extensive increase in the number of mobile users and proliferation of related towers.

(iii) The situation has worsened to an alarming state; entire population of the country is subjected to serious and hazardous ailments/diseases like cancer, mental disorders, epilepsy, etc. due to EMR.

(iv) Our nervous system responds to the electromagnetic pulses which induce electrical potentials in the nerve loops, which on repetition can actively intervene in cybernetic control circuits of the body. The nervous system gets adapted to the environment and resonates and interacts with balanced and natural energies around us for our heath, well-being and survival.

(v) Electromagnetic frequencies are manmade and therefore unnatural, chaotic, and disordered and disease occurs through disturbances of the EM field in the cells; they become disordered and incoherent.

(vi) Microwave radiation is has been found to affect a wide variety of brain functions. Other affects reported are sleep disruption, chronic fatigue, multiple allergies, premature menopause, irritability, depressive tendencies, memory loss, concentration difficulties, vertigo, headaches, skin problems, miscarriage, etc.

(vii) Long term effects of EMR are cancers, tumors, childhood leukemia, breast cancer, DNA stand breakage, abnormal cell division, nerve damage, Alzheimer and Parkinson disease, melatonin reduction, digestive problems, abdominal pain, enlarged thyroid, testicular/ovarian pain, dryness of lips, tongue, mouths, eyes, dehydration, nosebleeds, altered sugar metabolism, immune abnormalities, redistribution of metals within the body, pain in the teeth, impaired sense of smell, ringing in the ears, etc.

(viii) Sutherland Shire Council (Australia), on the sitting of Mobile Phone Towers, has suggested that base stations should ideally be located away from any residence unless the annual average at the nearest residence is less than $0.20 \pm 0.02\ \mu W/m^2$.

(ix) Paris Town Hall and the Mobile Phone Operators have reached an agreement that aims to limit public exposure to the electromagnetic waves generated by Base Station Antenna and the operators have committed themselves to lowering significantly the levels of exposure.

(x) Israel, which has high dependence on GSM Mobiles, is proposing to mount an enquiry into safety, and a Committee of the European Standards Body CENELEC has recommended a substantial reduction in their exposure standards.

(xi) The Wireless Planning & Coordination Wing of the Department of Telecommunication, Govt. of India has laid down various measures/procedure of sites for Wireless Stations and the SACFA (Standing Advisory Committee for Frequency Allocations) has been monitoring the position from time to time. In its recent meeting held on 14.3.2005, the committee has taken a serious view of the masts height violation by service providers. It was mentioned therein that Service Providers are establishing sites within 10 km from International Border and such type of the cases are liable to be rejected. It was also discussed during the said meetings, that some service providers erect antenna structures without even applying for site clearance to SACFA.

(xii) Public Trust Doctrine should be extended to include all eco systems operations in our natural resources. Right to health is an integral part of the right to life and the state is under a constitutional obligation to protect the same. Suggestive and advisory measure including guidelines be formulated and laid down by the Government. An independent agency should be constituted, including experts with specialty and experience in the concerned field, well versed with the technology and well equipped with such special instruments (meters) to check and

control the level of radiations, emitted by mobile towers and ensuring the avoidance of any breach or violations. If the mobile service providers fail to comply with the regulations, the authorities should cancel their licenses for providing services.

(xiii) The representation requested the concerned Ministries to furnish details, present or proposed, ensuring the precautionary and remedial measures, constitution and formulation of expert agency with multi-specialty expertise in the concerned field, to regulate and certify the norms and guidelines to be framed and adopted.

Like earlier, there was no response from any of the Ministries. The Supreme Court Bench again heard the petition on May 10, 2006, and Ordered (Appendix VIII):

> "The petitioner has filed document pursuant to the order dated 26th September, 2005. The main contention of the petitioner is that unlike various other nations, particularly developed countries, in India there are no norms for Electro Magnetic Radiation which are emitted by various instruments used by the Government and individuals.
>
> For the present, issue notice only to respondents 1 and 2 to file response on the question of norms, if any, that may have been fixed."

After about 9 months of deliberations within the concerned Governmental agencies and negatively motivated inputs from the Cellular Operators Association of India (COAI), a Counter Affidavit was filed in the Supreme Court on behalf of Respondents No. 1 and 2 (Ministry of Communications, Department of Telecommunications, and Ministry of Defence) on Feb 28, 2007, by Shri P Chandrasekharan, Assistant Wireless Adviser, Ministry of Communications and Information Technology (Appendix IX). The Counter Affidavit summarily rejected the petition and prayed for its dismissal arguing that there was no ground for granting any relief to the petitioner. Summary of excerpts of the Counter Affidavit is as follows:

(i) The Standing Advisory Committee on Frequency Allocation (SACFA), under the Union Ministry of Communications and Information Technology, examines all siting proposals for the erection of towers by mobile service providers. These proposals are required to be submitted to SACFA prior to the construction of any such tower at any site by the mobile service providers since they are to be circulated to the members for their comments/no objection who examine the siting cases with respect to aviation hazards, physical obstruction to any existing installations and the electromagnetic compatibility.

(ii) SACFA's inputs consist of the latest World Health Organization (WHO) studies on the electromagnetic radiation. In May 2006, WHO issued a fact sheet summing up its various studies concerning inter alia effects of radio frequency signals from Base Stations and Wireless Technologies, which is the subject matter of this petition. This fact sheet shows that the petition is baseless in its conjectures concerning the ill effects of radiation from base stations set up by mobile service providers.

(iii) The human body absorbs up to five times more of the radio frequency signal from FM radio and television broadcast stations than from base stations which have been in operation for the past 50 or more years without any adverse health consequences being established.

(iv) Most studies have focused on the Radio Frequency exposures of mobile phones. Human and animal studies examining brain wave patterns, cognition and behavior after exposure to Radio Frequency field, such as those generated by mobile phones, have not identified adverse effects. Radio Frequency exposures used in these studies were about 1000 times higher than those associated with general public exposures from base stations or wireless networks. No consistent evidence of altered sleep or cardiovascular function has been reported.

(v) From all the evidence accumulated so far, no adverse short term or long term health effects have been shown to occur from the Radio Frequency signals produced by base stations. Since wireless network produce generally lower Radio Frequency signals than base stations, no adverse health effects are expected from exposure to them.

(vi) Keeping in view the WHO May 2006 recommendation that national authorities should adopt international standards to protect their citizens against adverse levels of RF fields, and, also to answer the issues raised in W.P. 2112 of 2004 before the Hon'ble High Court of Mumbai, ICMR Committee gave inputs on the Health Hazards due to Mobile Telephone Towers on May 29, 2006 that the three completed human studies pertaining to base stations conducted by Santini R et al (2002), Bortkiewicz et al (2004) and Hunter & Kundi et al (2006) do not report any quantitative parameters related to health hazards; it recommended the adoption of international exposure guidelines developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998) and also the carrying out of epidemiological studies to develop the protocols and guidelines for siting of mobile phone base stations in the Indian context on the basis of a precautionary approach.

(vii) The entire area of electromagnetic radiation is now under the continuous study of a Committee constituted by the Telecom Engineering Centre (TEC), consisting of Members from various Ministries/Departments including inter alia Health Ministry and service providers.

(viii) The petitioner has not carried out any survey whatsoever on the health effects of mobile base stations/towers. Before filing of the petition the petitioner has also not exercised due care and caution of first contacting the relevant authorities and institutions on this subject.

(ix) Union Government and its agencies are ensuring the fundamental rights of the citizens to safe environment and health. Hence the concern of the petitioner on this score is misplaced through a petition that makes a large number of averments without any supporting material or on any cogent basis. The petition fails to recognize that mobile phones today are a critical input to socioeconomic development which ensures the fundamental rights of free speech, information flow and exchange of ideas that constitute a democracy. Hence the petition deserves to be dismissed.

(x) The petitioner speaks of violation of building bylaws which is a concern of the local municipal authorities in whose jurisdiction the base tower/station may fall. The service providers are required to follow strictly the stringent norms as laid down by local government bodies, for erection of towers including for those on the top of buildings. If there is a specific local violation in any particular case then the petitioner should seek a remedy before the competent local authority or in the concerned High Court.

(xi) No tower is permitted to be constructed without SACFA clearance. The few cases of violation as noted by the petitioner have been taken note of in the 14.3.2005 meeting of SACFA and corrective measures have been ordered. The Department of Telecommunications and its technical wing the Telecom Engineering Centre monitor all violations.

(xii) The guidelines are being formulated by the Telecom Engineering Centre of the Department of Telecommunications which will take care of the suggestions made.

(xiii) In view of the Submissions above there are no grounds for granting any relief to the petitioner. Hence the petition deserves to be rejected.

In response to the above Counter Affidavit, Karma Jyot Seva Trust filed the Rejoinder on Mar 30, 2007 (Appendix X). Summary of excerpts of the Rejoinder is as follows:

(i) The petitioner trust has filed a PIL under Article 32 of Constitution of India in the best interests of the public at large to ensure their safety from the dangerous Electromagnetic Magnetic Radiations emitted from various electronic gadgets and also the rampant erection/installation/fixation of Communication Towers/BaseStations on residential and other unsafe buildings throughout the country.

(ii) That the contentions raised and submitted in the counter affidavit filed by the respondents are completely false and frivolous and deserves to be rejected in toto and henceforth denied and refuted unless specifically required to be admitted. In fact, the authors of the counter affidavit have tried to mislead, misrepresent facts, distort the recommendations of WHO and the recommendations of ICMR committee just to discredit the petition and to shield their ulterior motives, unnecessary delays and non-action of respondents. Leaving aside this counter affidavit, there has not been any response from any of the respondents, on requests and reminders with specific directions of the Hon'ble Court. This demonstrates total disregard of the highest court of law and public interest proposed to be served by the PIL.

(iii) As it is, SACFA does not mention any thing about examination from radiation hazards point of view. SACFA was constituted on Feb 5, 1966, when mobile phones or cell phones were not even developed. The related harmful effects are the direct result of continuous exposure of electromagnetic radiation from related base stations. SACFA examines the siting cases primarily with respect to aviation hazard, obstruction to any existing/planned networks, and the Electromagnetic Interference/Compatibility. It is not sufficient and not fully truthful to just state that proposals for erection of towers by mobile service providers are required to be submitted to SACFA, prior to the construction of any such tower at any site. It is essential that respondents state in unambiguous terms whether all towers have specific clearances within the limits of existing procedures. There is no statement in the affidavit on how many such towers have been cleared in India, in Delhi, or even any specific colony in Delhi. Also there is no mention of any mechanism to identify towers which have been installed without SACFA clearance.

(iv) There is no data or truth in the statement that human body absorbs up to five times more of radio frequency signals from FM radio or TV station. No FM or TV station has been allowed to come up on any residential building or hospital. There seems to total mix up of facts and figures. In fact, frequency of mobile phones is 5 to 20 times higher than FM or TV stations and more

near to frequencies used in microwave ovens, which are known to be more efficient for 'cooking', a phenomena which changes physical condition of food permanently.

(v) There is no indications as to when the TEC Committee will submits its report or what is the plan of action. The statements that the entire area of Electromagnetic Radiation is now under continuous study by the Committee and that guidelines are being formulated/finalized is just an open ended admission of delayed action getting perpetually delayed.

(vi) As stated in the counter affidavit, service providers are required to follow strictly the stringent norms of building byelaws as laid down by local government bodies, for erection of towers including for those on the top of buildings. In Delhi, these clearances have to be sought from MCD, after structural safety certificate issued by a qualified structural engineer by one of the following five institutions (as per office order dated Nov 20, 2003).

(a) Indian Institute of Technology (IIT), Delhi.

(b) Central Building Research Institute (CBRI), Roorkee.

(c) Rail India Technical and Economic Services Ltd. (RITES), Delhi.

(d) National Council for Building Material, Faridabad.

(e) Indian Institute of Technology (IIT), Roorkee.

Of course, the affidavit has failed to identify even a single cell phone tower erected after formal clearance by any one of the above five institutions or by MCD. In any case it may not be easy for MCD to impose building byelaws on cell phone towers, when buildings are also being built without following the building byelaws.

(vii) Eminent scientist of the country and presently the President of India, Dr Abdul Kalam, in his address, has been frequently hammering on the ill effects of Electromagnetic Radiations and focusing on the urgent need to evolve reasonable standards, rules and regulations for telecom operations including health related restrictions and interference related measures.

(viii) PRAYER: Union of India and other respondents should be directed to take following actions within a specified time limit of, say, one month:

(a) Submission of action taken report with reference to prayers in the original PIL.

(b) Submission of responses to requests made by the petitioner on Sep 30, 2005.

(c) Submission of list of locations in the country (State/City/Locality wise) where cell phone towers have been erected with SACFA clearance, along with references of clearance by MCD or such local bodies. In the interim, this may be done for Delhi within 15 days.

(d) Submission of the mechanism to identify cell phone towers which don't have MCD or SACFA clearances. List of existing towers erected without clearances and steps taken or proposed to be taken to dismantle related base stations.

(e) Placement on appropriate web sites proposed guide lines, based upon national or international standards, for limits on electromagnetic radiations from electrical/electronic instruments/devices used in residential, industrial areas, so as to invite suggestions and comments from interested people or organizations. While this must include mobile phones, related accessories and base stations transmitters and antennas, the guide lines also have to include other potential sources of radiation such as microwave ovens, mixer-grinders, electric shavers, vacuum cleaners, hair dryers, overhead transmission lines for electrical power, power transformers/sub-stations, electric traction, lifts/escalators.

Following the hearings and directions of the Supreme Court in consideration of the PIL, hectic deliberations were initiated in and by the Telecom Engineering Centre (TEC) of the Department of Telecommunications. Action had already been taken to constitute an Expert Group for the Development of Guidelines on Electromagnetic Field on Jun 27, 2006 (Appendix XI) in response to the notice issued vide SC Order of May 10, 2006 and before filing the Counter Affidavit on Feb 28, 2007. Three meetings, in quick succession, were held to discuss issues and take decisions:

(i) Nov 23, 2007: Adoption of International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines in telecom sector in India for limiting EMF exposure (Appendix XII).

(ii) Dec 18, 2007: Meeting of the Expert Group to discuss Draft Guidelines for Complying with Limits for Human Exposure to Electromagnetic Fields (Base Station Antennas and Mobile Telephones/ Radio Terminals) (Appendix XIII).

(iii) Feb 18, 2008: Finalization of Guidelines for Complying with Limits for Human Exposure to Electromagnetic Fields: Base Station Antennas and Mobile Telephones/ Radio Terminals (Appendix XIV).

Further studies by the related experts and meetings of specialists committees, and several court cases (both proposing to tighten/relax the norms) have continued all through the last 6-7 years, increasing the knowledge base and awareness on the subject.

The Inter Ministerial Committee (IMC) of DoT, ICMR, DoB and MoEF, constituted on Aug 24, 2010 (Appendix XV), examined 90 international and national studies/reference papers and recommended lowering mobile towers' EMF exposure limits to $1/10^{th}$ of the ICNIRP prescribed limits as a matter of abundance precaution. These recommendations have been accepted by the Govt. and directions issued vide DoT letter no. 800-15/2010-VAS (pt.) dated Apr 10, 2012 making the new norms applicable from Sep 1, 2012; SAR limit of mobile hand-sets has also been reduced from 2.0 W/kg to 1.6 W/kg averaged over 1 gram of human tissue.

Another committee was set up by DoT on Jan 17, 2012 in compliance to the directions of Allahabad High Court, Lucknow Bench vide order dated Jan 10, 2012 with regard to writ petition No. 11275 (M/B) of 2010 (Appendix XVI). The committee submitted its report on Feb 27, 2014 and observed/concluded: The Department (DoT) has taken adequate steps to impose stricter precautionary limits for EMF radiation from mobile towers as well as from the mobile phones. Further, stricter 'SAR' values have been specified for mobile phones being sold in India, effective from Sep 1, 2013. Also, in order to make the deterrence stronger, the penalty for violation of prescribed stricter EMF norms from BTS tower by telecom service providers has been increased from Rs. 5 Lakhs to Rs. 10 Lakhs per BTS, per incidence per operator w.e.f.

Nov 20, 2013. It recommended that the Department of Science and Technology (DST) and Indian Council of Medical Research (ICMR) should carry out/facilitate extensive studies, on the Indian conditions with special focus on prolonged use of mobile phone, to conclusively determine sensitivity of EMF Radiation/possible health hazard risk of EMF radiation; Department of Telecom should create national EMF web portal to provide public access to the status of compliance, of the prescribed norms, of all BTSs/ mobile towers in the country and related relevant information.

CHAPTER 6

ELECTROMAGNETIC RADIATION FROM AC POWER TRANSMISSION LINES

Harmful effects of low frequency electromagnetic (ELF) radiations from power transmission lines on biological systems, particularly human beings, had been of concern for quite some time. Using underground electrical power distribution cables in the cities, or the use of metal conduits for electrical wiring in the buildings, are not just architectural niceties or ethics; these are some of the standard engineering methods to reduce unwanted radiations from power lines. Overhead power distribution lines, particularly high voltage transmission lines near sub stations, are notorious for creating high radio noise, electrical noise and electromagnetic interference. Electric Traction and related power transmission system also creates high level of low frequency EM radiation. While underground metro systems have an inbuilt protection against EM radiation, overhead metro lines through highly populated areas are of concern; they may have to consider 3rd rail for power transmission for reducing EM pollution.

In large commercial buildings and areas close to transmission lines, secondary feeders; near transformers, electrical panels, people are usually exposed to 50 Hz magnetic field levels of 10-1,000 mG; however, near the electrical source, exposure levels may go up to 1,000-100,000 mG. ELF Electric fields are of the order of 1kV/m under high voltage transmission lines; and about 50 V/m from unshielded household electrical wires, going to zero for wires in shielded conduits. ICNIRP guidelines for ELF exposures are:

ICNIRP Guidelines for ELF Exposures		
Occupational	**Electric Field**	**Magnetic (B) Field**
Whole working day	10 kV/m	5,000 mG
Short Term	30 kV/m	50,000 mG
For Limbs	--	250,000 mG
General Public		
Up to 24 hours per day	5 kV/m	1,000 mG
Few hours per day	10 kV/m	10,000 mG

There is very good evidence that exposure to EM fields greater than 16 mG increases the risk by a factor of 5, that a woman may have a spontaneous abortion within the first 10 weeks of pregnancy. Experts recommend that future developments should adopt a safety limit of 2 mG. Extensive research done in Sweden concluded that children living close to electrical transmission lines with a 2 mG exposure level were 2.7 times more likely to develop cancer as compared to unexposed children. It should be noted that fields below a 220 kV power transmission line may be as high as 200 mG, a good 100 times more than recommended safe limit. There are strict laws in Sweden regarding the construction of transmission lines close to residential areas.

Extremely low frequency (ELF) electromagnetic fields are likely to produce greater damage to the body systems for several reasons; these frequencies are close to those of physiological range and hence any overlap of these can perturb on-going biological processes. When in close contact with the body the generation of eddy currents and accompanied heating are added parameters. 50 Hz magnetic field exposure generate about 3-4 mG for waterbeds and about 15 mG for Electric Blankets; electric fields are of the magnitude 100 V/m. These EMF levels have the potential for providing excessive body heating, which may have adverse effect on sperm, leading to adverse effect on the process of embryogenesis; the high temperature could also be teratogenic in humans.

Tests at 12 mG or higher have demonstrated significant blocking of the inhibitory action of melatonin and Tamoxifen (a widely used Anti Cancerous medicine). A study of 60 workers (exposed to power frequency fields) at a Finnish garment factory found melatonin levels on weekday nights less than on Sunday nights when they were away from the factory. Recently, studies done on 20000 Swiss railway workers, particularly on train drivers (average annual exposure of 21 µT or 210 mG), found significant evidence of exposure-response association for myeloid (bone marrow related) leukemia and Hodgkin's disease (a type of lymphoma – one of the first cancers to be rendered curable by combination Chemotherapy).

6.1 Estimation of fields near electrical lines [12]

Electric field emanates out and down towards the ground diminishing in field strength at a linear rate of 1/r from unshielded transmission line (at $1/r^2$ from a point source like an appliance). Under mid-span of conventional 440 kV line, electric field is about 5 kV/m, one meter above the ground. Fortunately, grounded poles, trees and buildings reduce/shield such fields almost completely.

Magnetic Field (H) measured in A/m can be quite high under transmission lines, near motors, etc; and are extremely difficult to shield (except by using ferromagnetic and highly conducting materials. Normally, people may not be able to sense high magnetic fields of 1,000 mG; however, ectremely high levels of 100,000 mG may cause temporary visual flickring. When Magnetic field permeates though a medium of permeability µ, it converts to magnetic flux density B = µH. Geomagnetic (static) field is about 670 mG at the magnetic poles, 500 mG at mid latitudes, and 330 mG at the equator.

Magnetic field from a single conductor, such as overhead electric traction, trolley-bus system, third rail, etc is: B (mG) = 2 (I Amps)/r (meter); from dual conductors (opposing current pair), such as single phase power line, appliance cord, house wiring, etc, separated by distance d (meter), diminishes as per inverse square law and is: B (mG) = 2(I Amps)(d meters)/r^2; and from three-phase balanced AC transmission or distribution line, it is: B (mG) = 3.46(I Amps)(d meters)/r^2; for unbalanced or significant net ground current, the dominant magnetic field is: B (mG) = 2 (I Amps)/r. Thus if phase A and B carry 1000 A and phase C carries 1500 A, the net current of 500 A will produce 1000 mG field at 1 meter and 100 mG at 10 meters.

6.2 High Tension Lines – Safety

- **Government of NCT of Delhi (Department of Power) advertisement (TOI, Aug 2013)**

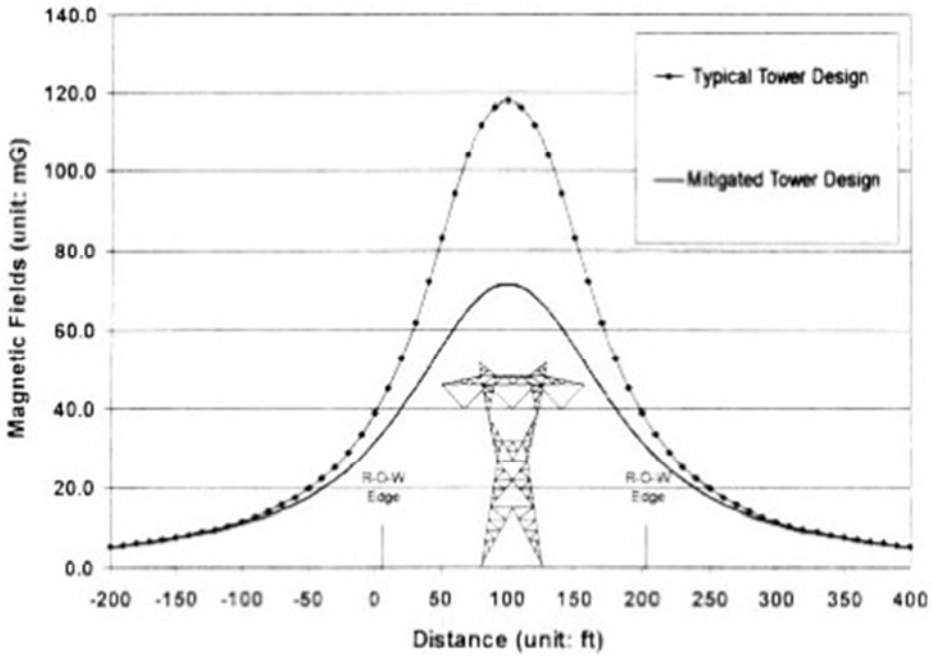
  - Be Extra Careful when living near High Tension Lines
  - Avoid building your house close to High Tension Lines

- Don’t extend your balcony/boundary wall towards High Tension Lines
- Never let your children play/fly kites near High Tension Lines
- Don’t keep inflammable articles near High Tension Lines
- While building your home, make sure you maintain the following minimum Vertical & Horizontal Clearance from High Tension Lines:

Clearance from Live conductor	400 kV Tower Line	220 kV Tower Line
Vertical Clearance	7.3 metres	5.5 metres
Horizontal Clearance	5.7 metres	3.8 metres
Right of way	52 metres	35 metres

- Failure to follow these rules can lead to power disruption besides being in violation of Indian Electricity Rules, 1956 and Indian Electricity Act 2003 and will attract relevant penalty. These rules are only for physical safety related to accidental contact with High Tension Lines, and not at all related to safety from ELF EM Radiation.

When New Delhi was built in 1930s, overhead High Tension Lines were not allowed; even overhead power distribution lines were avoided in the main city. Today, outside ring road, New Delhi and the entire NCR is haphazardly powered through overhead lines crisscrossing roads and colonies. Many other countries have strict laws on such overhead lines; so much so that continuous efforts are being made mitigate the EMR pollution. A major 500 kV power augmentation project in Southern California [13] has considered redesigning and increasing the heights of towers to as much as 250 feet; broadening to 80 feet and widening the right-of-way by 100 feet.



Magnetic field surrounding a typical single-circuit 500 kV tower with EMF mitigation design

CHAPTER 7

BIOLOGICAL EFFECTS OF ELECTROMAGNETIC RADIATION

Radio is just about 120 years old; impact of related radiations on the environment, particularly biological systems, is now only visible. Till recently, continuous exposure to non-ionizing electromagnetic radiations or waves was localized to areas near broadcasting stations, radars, radio communication terminals, etc. – the related radiations were not adversely affecting inhabited areas and general public in residential areas, hospitals, schools, etc. The situation has changed significantly during the last few years with the proliferation of cell phones, related base station towers and other EMR sources.

Scientific studies have demonstrated short term and medium term effects of EMR on animals and human beings; children, weak or sick persons, pregnant women and small animals are particularly vulnerable. Of course, debates are going on as to whether these effects are temporary or permanent. It is suspected that disappearance of butterflies and sparrows may also be related to the high level of electromagnetic pollution.

Common biological effects of EMR are headache and Migraines; eye irritations and Cataracts; loss of appetite; fatigue and exhaustion; giddiness or dizziness; vomiting sensation; loss of temper and fluctuation in BP; altered concentration and memory loss; anxiety and depression; sleep disruption or Insomnia; reduced REM sleep, altered EEG (brain wave), etc. Serious biological effects are brain tumors, Alzheimer's disease, Parkinson's disease, eye cancer, Epilepsy, Leukemia, stomach pain and digestive disorders; destabilization of the Lymphatic system, disturbances in the nervous system, interruption in the maintenance of hormones; brainwave disturbances in alpha, theta and delta wave signals, etc.

ICNIRP and other international guidelines have been evolved for limiting EMF exposure that will provide protection against known adverse health effects. An adverse health effect is defined as one which 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. The general primary 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. In most of the studies about harmful effects of EMR, the health effect 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 relatively low and, hence, the temperature increases may be insignificant from the point of view of human health. In the case of a person 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. The brain blood circulation is capable of disposing the excess heat by increasing the local blood flow. However, the cornea of the eye does not have this temperature regulation mechanism.

In addition to thermal effects caused by holding mobile phones close to the body, there could be non-thermal effects. The communication protocols used by mobile phone often result low frequency pulsing of the career signal. The non-thermal effects are attributed to the induced electromagnetic effects inside the biological cells of the body which is possibly more harmful. People who are chronically

exposed to low level wireless antenna emissions and users of mobile handsets have reported feeling several unspecific symptoms during and after its use: burning and tingling sensation in the skin of the head, fatigue, sleep disturbance, dizziness, lack of concentration, ringing in the ears, loss of memory, headache, disturbance in digestive system and heart palpitation, etc.

In 2011 the World Health Organization International Agency on Cancer Research (IARC) classified radiofrequency radiation as a Group 2B Possible Human Carcinogen, joining the IARC classification of ELF-EMF of 2001. The evidence for carcinogenicity for RFR was primarily from cell phone/brain tumor studies but by IARC rules, applies to all RFR exposures, from all sources including household appliances and power transmission lines.

The effects of long term exposure to wireless emissions from cell phones and whole body exposure to RF transmission from cell tower antenna is not known yet with certainty. The hot tropical climate of India, low body mass index (BMI), low fat content of an average Indian as compared to European countries may place Indians under higher risk of RF radiation's adverse effect.

7.1 Effect of Radiofrequency Electromagnetic Field on Human DNA

Soma Sarkar, DIPAS/DRDO et al [21] performed their study on healthy Indian male army *jawans*: radar operators, radio operators, and gunners who were occupationally exposed to EMF during their entire tenure of service. Immediately prior to this study, the personnel were on exercise duty in the field area where they worked daily for two hours in the morning for one month on the radar or the radio signaling equipment. The gunners worked 50 m away from the radar working at 8.6 GHz to 9.5 GHz, amplitude modulated with average power output of 115 W. Near-field power density of the radar was approximately 1.3 W/m^2 at 10 m and the distance of the radar operator from the source was between 1-10 m. The carrier frequency for radio set was 30 MHz to 75 MHz, frequency modulated and with average power output of 15mW to 20 mW with booster. DNA was isolated from 5 ml blood (drawn into heparinised vacutainers) according to the standardized method. Approximately 5 µg DNA was used for digestion with different restriction enzymes. The data indicated DNA modulation in the lymphocytes of workers working on the radar and the workers exposed to radiofrequency electromagnetic field. However, results could not conclude whether in the long run, such effects are deleterious or beneficial, reversible or permanent and/or heritable.

7.2 Electromagnetic Field Exposure Effects (ELF-EMF and RFR) on Fertility and Reproduction

Jitendra Behari, JNU et al (BioInitiative-2012) [11, 22, 23] have comprehensively reviewed and consolidated evidence from human and animal studies on sperm and male fertility factors, noting that there are also studies showing adverse effects on fertility and miscarriage in women. Use of electronic household items and cell phones are reported to decrease fertility potential in men by decreasing sperm count, motility, viability, inducing pathological changes in sperm and testes morphology, etc. Several researchers and authors focused mainly on the male reproduction patterns. It involves the development from undifferentiated diploid stem cells to highly differentiated haploid stem cells. Spermatogenesis is a complex process and it is influenced by many genes and hormones. It takes place in the testis, which may be exposed to various microwave frequencies which are currently in use. Among various factors of infertility, oxidative stress has become the main focus of interest as a potential cause of male infertility.

Male infertility is commonly associated with high rates of DNA damage in the spermatozoa and such damage is correlated with a wide range of adverse clinical outcomes. Several studies, especially at power frequency 50/60 Hz magnetic field have found an association of exposure to human health, with emphasis on a range of clinical conditions including childhood leukemia, brain tumors, genotoxicity and neurodegenerative disease, infertility, birth defects, increased risk of miscarriage, childhood morbidity and de novo mutations. Sperm DNA damage is therefore regarded as a potential risk factor to the development of normal human embryos leading to impaired embryonic development. While, exposure of male adult rats to 50 Hz sinusoidal magnetic field (25 μT or 250 mG) for 18 consecutive weeks reported no significant effects on the absolute body weight and the weight of the testis, the weight of the seminal vesicles and preputial glands were significantly reduced, along with significant reduction in sperm count; there was no significant effect on the serum levels of male follicle stimulating hormone (FSH) during the 18 weeks of exposure period; on the other hand there was a significant increase in the serum levels of male luteinizing hormone (LH) while testosterone levels were significantly decreased. These results suggest that long term exposure of ELF could have adverse effects on mammalian fertility and reproduction.

Extremely low frequency (ELF) electromagnetic fields are likely to produce greater damage to the body systems for several reasons; these frequencies are close to those of physiological range and hence any overlap of these can perturb on-going biological processes. When in close contact with the body the generation of eddy currents and accompanied heating are added parameters. ELF-EMF effects induced due to Electric Blankets generate eddy currents in the body. 60 Hz magnetic field exposure generate about 3-4 mG for waterbeds and about 15 mG for Electric Blankets; electric fields are of the magnitude 100 V/m. These EMF levels have the potential for providing excessive body heating, which may have adverse effect on sperm, leading to adverse effect on the process of embryogenesis; the high temperature could also be teratogenic in humans. It is obvious that either the heat or the electromagnetic fields produced by electric or bed heating might affect the fetus.

Both prolonged gestation and fetal loss have been shown to be associated with high blanket settings used by the mother.

Exposure to 2.45 GHz continuous wave (CW) microwave at 2mW/cm^2 power density for 90 min decreased uteroplacental blood flow, increased progesterone and PGF_2 α in pregnant rats. Exposure to 890-915 MHz GSM with 0.141 W/kg whole body SAR decreased seminiferous tubule diameter in male rat testes. after exposure. Similarly, exposure of mice to 900 MHz, 12 hr a day for 7 days, resulted in significant damage to mitochondrial and nuclear genome in epididymal spermatozoa. Several studies have pointed out that carrying the mobile phones near reproductive organs for longer time may have negative effects on the sperm motility and male fertility.

Studies demonstrate that human sperms can be damaged by cell phone radiation at very low intensities (0.00034 – 0.07 μW/cm^2). There is a veritable flood of new studies reporting sperm damage in humans and animals, leading to substantial concerns for fertility, reproduction and health of the offspring (unrepaired de novo mutations in sperm). Exposure levels are similar to those resulting from wearing a cell phone on the belt, or in the pants pocket, or using a wireless laptop computer on the lap. Sperm lack the ability to repair DNA damage.

7.3 Fetal and Neonatal Effects

Effects on the developing fetus from in-utero exposure to cell phone radiation have been observed in both human and animal studies. Sources of fetal and neonatal exposures of concern include cell phone

radiation (both paternal use of wireless devices worn on the body and maternal use of wireless phones during pregnancy); Exposure to whole-body RFR from base stations and WiFi, use of wireless laptops, use of incubators for newborns with excessively high ELF-EMF levels resulting in altered heart rate variability and reduced melatonin levels in newborns, fetal exposures to MRI of the pregnant mother, and greater susceptibility to leukemia and asthma in the child where there have been maternal exposures. It is found that children born of mothers who used cell phones during pregnancy develop more behavioral problems by the time they have reached school age than children whose mothers did not use cell phones during pregnancy. It has been observed that that cell phone radiation significantly altered fetal brain development and produced ADHD-like behavior in the offspring of pregnant mice. Exposed mice had a dose-dependent impaired glutamatergic synaptic transmission onto Layer V pyramidal neurons of the prefrontal cortex; offspring of mice were hyperactive and had impaired memory function and behavior problems, much like the human children. A new study from Greece reports altered development of the cranial bones of the fetus from low intensity (0.6 to 0.9 W/kg) in-utero 900 MHz cell phone radiation; even modest exposure (6-min daily for 21 days) is sufficient to interfere with the normal mouse developmental process.

7.4 Biological and behavioral effects of prenatal and postnatal exposure to 2450 MHz electromagnetic radiation in the squirrel monkey

Kaplan J et al [24] exposed pregnant monkeys at second trimester – 3 hr/day and 5 days per week – continued to be exposed for 6 months post-natally – at 0.34 mW/g, and 3.4 mW/g. 3 of the 33 mothers died a few days after birth of fetuses and without any prior indication. 9 died during first few months after birth. 2 of them were exposed only pre-natally (at lowest exposure of 0.034 mW/g). 6 of the animals that were exposed post-natally also died (2 were from the 0.34 mW/g exposure limit group and 4 were from 3.4 mW/g group).

7.5 Vulnerability of Children to EM Radiation

Many studies demonstrate that children are more sensitive to environmental toxins of various kinds, including chemicals and ionizing radiation.
The US Environmental Protection Agency (EPA) proposes a 10-fold risk adjustment for the first 2 years of life exposure to carcinogens, and a 3-fold adjustment for years 3 to 5. Radio frequency energy is absorbed more efficiently at resonance. In adults, the resonance frequency is usually about 35 MHz, if the person is grounded, and about 70 MHz, if insulated from ground. Different human body parts may be resonant from 30 to 3000 MHz. Adult head is resonant at around 400 MHz, while a baby's smaller head resonates near 700 MHz, which makes children more vulnerable to exposures at microwave frequencies. Children are also at special risk due to their smaller body mass and rapid physical development, both of which magnify their vulnerability to known carcinogens, including radiation. The differences in bone density and the amount of fluid in a child’s brain compared to an adult’s brain could allow children to absorb greater quantities of RF energy deeper into their brains than adults.

7.6 Childhood Leukemia

As many as 42 published epidemiological studies on power frequency EMFs, among the most comprehensively studied environmental factors, have established that except ionizing radiation no other environmental factor has been as firmly established to increase the risk of childhood leukemia; sufficient

evidence exists from epidemiological studies on exposure to EMF (power frequency magnetic fields) that cannot be attributed to chance, bias or confounding.
Therefore, according to the rules of IARC such exposures can be classified as a Group 1 Carcinogen (Known Carcinogen). It has been suggested that urgent steps should be taken for precautions and measures to guarantee that exposure due to transmission and distribution lines is below an average of about 1 mG.

7.7 Effects on Autism (Autism Spectrum Disorders)

Several studies point to serious biological effects and health harm from EMF and RFR and report genotoxicity, single and double-strand DNA damage, chromatin condensation, loss of DNA repair capacity in human stem cells, reduction in free-radical scavengers (particularly melatonin), abnormal gene transcription, neurotoxicity, carcinogenicity, damage to sperm morphology and function, effects on behavior, and effects on brain development in the fetus of human mothers that use cell phones during pregnancy. Cell phone exposure has been linked to altered fetal brain development and ADHD-like behavior in the offspring of pregnant mice. At the cellular and molecular level many studies of people with ASDs have identified oxidative stress and evidence of free radical damage, as well as deficiencies of antioxidants such as glutathione. Elevated intracellular calcium in ASDs can be associated with genetic mutations but more often may be downstream of inflammation or chemical exposures. Lipid peroxidation of cell membranes, altered brain wave activity and consequent sleep, behavior and immune dysfunction, pathological leakage of critical barriers between gut and blood or blood and brain may also occur. Mitochondria may function poorly, and immune system disturbances of various kinds are common. Changes in brain and autonomic nervous system electrophysiology can be measured and seizures are far more common than in the population at large.

7.8 Effects on the Blood-brain Barrier (BBB)

The BBB is a protective barrier that prevents the flow of toxins into sensitive brain tissue. Increased permeability of the BBB caused by cell phone RFR may result in neuronal damage. Research studies (mostly animal studies) show that very low intensity exposures to RFR can also affect the BBB. It is more probable than unlikely that non-thermal EMF from cell phones and base stations do have effects upon biology. A single 2-hr exposure to cell phone radiation can result in increased leakage of the BBB, and 50 days after exposure, neuronal damage can be seen, and at the later time point also albumin leakage is demonstrated. The levels of RFR needed to affect the BBB have been shown to be as low as 0.001 W/kg, or less than holding a mobile phone at arm's length, which is about 1000 times lower RFR exposure levels than the US and ICNIRP limits.

7.9 Brain Tumors caused by microwave/radio frequency radiation

Based on epidemiological studies there is a consistent pattern of increased risk for glioma and acoustic neuroma associated with use of mobile phones and cordless phones. However, no consistent pattern of an increased risk is seen for meningioma. Supportive evidence comes also from anatomical localization of the tumor to the most exposed area of the brain, cumulative exposure in hours and latency time that all add to the biological relevance of an increased risk. There is reasonable basis to conclude that RF-EMFs are bioactive and have a potential to cause health impacts; epidemiological evidence also suggests that these should be classified as a human carcinogen.

7.10 Protein Kinase C Activity in Rats Brain Exposed to Low Intensity 2.45 GHz Microwave Radiation

Jitendra Behari, JNU et al [25, 26] performed their study on 30 day old Wistar rats (male, 60-65 gms), kept in air-conditioned room and provided with standard food pellets, exposed for 2 hrs/day for 35 days at power density of 0.344 mW/cm^2 in an anechoic chamber. Six rats were kept simultaneously in a cage and placed inside the chamber. Immediately after the exposure period the animals were sacrificed and brain dissected out of cranial cavity. In these samples PKC was measured in: (i) whole brain, (ii) hippocampus, (iii) whole brain with hippocampus removed. PKC activity (in whole brain) in the exposed group reduced significantly ($p< 0.05$) to 3804.25 ± 471/ mg protein as against 6944.5 ± 193/mg protein in the control group. In the hippocampus group the experimental results also show significant decline ($p< 0.05$). However in rest of the brain the experimental data do not show a significant difference. This is suggestive that the hippocampus is probably a preferential site for EMF-bio-interaction and is in line with many other reports that a chronic exposure of electromagnetic radiation affects learning and memory functions. It is apparent that phenomenon is non thermal in nature.

7.11 Genotoxic Effects (Genotoxicity) - Genetic Damage

There are several published papers that report EMF affects cellular oxidative processes (oxidative damage). Increased free radical activity and changes in enzymes involved in cellular oxidative processes are the most consistent effects observed in cells and animals after EMF exposure. Aging may make an individual more susceptible to the detrimental effects of ELF EMF from oxidative damage, since anti-oxidants may decline with age. The preponderance of genetic studies report DNA damage and failure to repair DNA damage.

7.12 Melatonin, Breast Cancer and Alzheimer Disease

Melatonin, basically a natural neurohormone – helps healthy sleep, maintains body temperature, reduces cholesterol, blood pressure, growth of breast cancer, and tendency for blood clots – a scavenger of free radicals and is anti-cancerous. Tests at 12 mG or higher have demonstrated significant blocking of the inhibitory action of melatonin and Tamoxifen (a widely used Anti Cancerous medicine). Published epidemiologic residential and occupational studies are considered to provide (positive) evidence that high ELF MF exposure can result in decreased melatonin production. Research indicates that ELF MF exposure, in vitro, can significantly decrease melatonin activity through effects on MT1, an important melatonin receptor. There is increasingly strong longitudinal evidence that low melatonin production is a risk factor for at least post-menopausal breast cancer. There is now evidence that high levels of peripheral amyloid beta are a risk factor for Alzheimer Disease; and medium to high ELF MF exposure can increase peripheral amyloid beta; high brain levels of amyloid beta are also a risk factor for Alzheimer Disease. There is considerable in vitro and animal evidence that melatonin protects against Alzheimer Disease. A study of 60 workers (exposed to power frequency fields) at a Finnish garment factory found melatonin levels on weekday nights less than on Sunday nights when they were away from the factory.

7.13 Electromagnetic hypersensitivity (ESH)

In multiple trials with the fields, the subject experienced and reported temporal pain, feeling of unease, skipped heartbeats, muscle twitches and/or strong headache when the pulsed field (100 ms, duration at

10 Hz) was on, but no or mild symptoms when it was off. Electromagnetic hypersensitivity is a neurological syndrome, and statistically reliable somatic reactions could be provoked in patients by exposure to 60 Hz electric fields at 300 V/m. EHS patients have demonstrated a disturbed pattern of circadian rhythms of HRF and showed a relatively 'flat' representation of hourly-recorded spectral power of the HF component of HRV; dysbalance of the autonomic nervous system regulation with a trend to hyper-sympathotonia, as measured by heart rate and electrodermal activity, and a hyperreactivity to different external physical factors, as measured by brain evoked potentials and sympathetic skin responses to visual and audio stimulation.

7.14 Stress, Stress Proteins and DNA as a Fractal Antenna

Any agent (EMF, ionizing radiation, chemicals, heavy metals, etc) that continuously generates stress proteins is not adaptive, and is harmful, if it is a constant provocation. Studies have established that stress proteins are produced by ELF-EMF and RFR at levels far below current safety standards. Further, it is felt that DNA is actually a very good fractal RF antenna which is very sensitive to low doses of EMF, and may induce the cellular processes that result in chronic 'unrelenting' stress. Chronic exposures can result in chronic ill-health**.** It appears that the DNA molecule is particularly vulnerable to damage by EMF because of the coiled-coil configuration of the compacted molecule in the nucleus. The unusual structure endows it with the self similarity of a fractal antenna and the resulting sensitivity to a wide range of frequencies. Many EMF frequencies in the environment can and do cause DNA changes. The EMF-activated cellular stress response is an effective protective mechanism for cells exposed to a wide range of EMF frequencies. EMF stimulates stress proteins (indicating an assault on the cell).
EMF can efficiently harm cells at a billion times lower levels than conventional heating. Recent studies have also exploited the properties of stress proteins to devise therapies for limiting oxidative damage and reducing loss of muscle strength associated with aging.

7.15 Effects of Weak-Field Interactions on Non-Linear Biological Oscillators and Synchronized Neural Activity

A unifying hypothesis for a plausible biological mechanism to account for very weak field EMF bioeffects other than cancer may lie with weak field interactions of pulsed RFR and ELF-modulated RFR as disrupters of synchronized neural activity. Electrical rhythms in our brains can be influenced by external signals. Biological systems of the heart, brain and gut are dependent on the cooperative actions of cells that function according to principles of non-linear, coupled biological oscillations for their synchrony, and are dependent on exquisitely timed cues from the environment at vanishingly small levels. The key to synchronization is the joint actions of cells that co-operate electrically-linking populations of biological oscillators that couple together in large arrays and synchronize spontaneously. Synchronous biological oscillations in cells (pacemaker cells) can be disrupted by artificial, exogenous environmental signals, resulting in desynchronization of neural activity that regulates critical functions (including metabolism) in the brain, gut and heart and circadian rhythms governing sleep and hormone cycles.

7.16 Abelmoschus Exposed to Electromagnetic Radiation

Mahapatra S et al [27] exposed plants of commonly known Ladies finger, Okra or *Bhendi* plant to radiation from Nokia 6030, RM-74 mobile phone with 200 calls per day for 10 weeks, and then, 50 calls per day for one week. Earlier, two saplings were planted and nursed for 2 weeks, then only one was exposed to radiation from the mobile kept attached to the stem. After 3 weeks, ant-infection was

noticed in the normal plant, but not in the exposed plant, but some leaf spots appeared in the zones near the phone, and during flowering, buds dried and turned brown. It was noticed that the exposed plant grew much taller than the normal plant – it has been suggested that this is because of normal plant being in the reproductive stage, but the exposed plant continuing longer in the vegetative stage.

7.17 Most Vulnerable People

- Children
- Women During Pregnancy
- Sick people
- Senior Citizens
- ATC Staff
- Radar Operators
- Radio Station Staff
- Electrical Power Station Staff

7.18 Most Sensitive Elements in Humans

- Eyes
- Brain
- Heart
- Groin
- Testicles
- Reproductive Organs

7.19 Most Vulnerable Locations

- Hospitals, particularly ICUs
- Maternity Homes
- Schools and Nurseries
- Residential buildings, particularly sleeping areas
- Hotels and guest houses
- Old age homes

CHAPTER 8

ELECTROMAGNETIC RADIATION FROM BASE STATION TOWERS

In India, there are over 700,000 Base Transceiver Stations (BTS), serving needs of over 900 million mobile phones, each with specific coverage area (cell). There are three types of cells: (i) Macro-cells provide the primary infrastructure for a service area, and use few tens of watts of RF power feeding to antennas with gains of 15 to 20 dB, to cover an area of 5-15 km radius, (ii) Micro-cells are used to fill the gaps and improve the main network, especially where the volume of calls is high. The micro-cell base stations radiate 5-20 W of power and their range is from a few hundred meters up to 1 km, and (iii) Pico-cell base stations have power output of a few 100 mW to about 5 W, and generally cover small areas like an office or a buildings.

Based on international guidelines & best practices, Telecommunication Engineering Centre (TEC), Dot has issued comprehensive revised guidelines on Aug 1, 2013 [31, 32, 33] for siting, installation and clearance of BTS Towers: In general, a base station antenna should be at least 20 m away from the nearby building and should not face any floor of the nearby building at the same height as that of the antenna, which is not more than 20 m away; lower end of the antenna should be at least 3 m above the roof. Wherever the antenna is mounted on the wall of building or pole on/along the road, its height should be at least 5 m above ground level /road level. Sharing of common tower and related infrastructure, by mobile service providers, has also been recommended.

Number of antenna(e) pointed in the same direction	**Building/Structure safe distance from the antenna(e) at the same height (in meters)**
1	20
2	35
4	45
6	55

The mobile service providers are required to self-certify compliance of radiation norms on EMF exposure from BTS antenna, based upon regular field measurements and after comparison with predicted/estimated radiation levels. As per Unified Access Service Licence Agreement: 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 for conforming to limits/levels for antennae (Base Station Emissions) for general public exposure as prescribed by International Commission on Non-Ionizing Radiation Protection (ICNIRP).

The instructions, inter-alia, includes the following: If a site fails to meet the Electro Magnetic Radiation criterion, there is a provision of penalty of Rs 5 lakh per BTS per service provider; Service providers must meet the criterion within one month of the report of TERM Cell (Telecom Enforcement Resource & Monitoring Cell) in such cases, after which site will be shut down. TERM Cells are required to check the

self certified BTS sites on random basis. Periodicity of submission of self-certificate by Telecom Service Provider is once in two years.
The EMF exposure limit (Base Station Emissions) in India has been lowered to 1/10th of the existing ICNIRP exposure level (from 400-1000 µW/cm^2 to 40-100 µW/cm^2 in the primary frequencies of interest) effective from Sep 1, 2012. Indian standards are now 10 times more stringent than more than 90% countries in the world.

For a BTS using 20W power and 17 dB antenna, power density at 10 m = 80 µW/cm^2, at 5 m = 318 µW/cm^2, at 3 m = 884 µW/cm^2, and at 1 m = 7960 µW/cm^2; indicating safe distances beyond 10 m.

For a single radiating antenna, prediction for power density in the far-field can be made by use of the following general Equations:

$$S = \frac{PG}{4\pi R^2}$$

Where, S = power density (in appropriate units, eg, mW/cm^2)

P = power input to the antenna (in appropriate units, eg, mW)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of the antenna (in appropriate units, eg, cm)

Or,

$$S = \frac{EIRP}{4\pi R^2}$$

Where, EIRP = equivalent (or effective) isotropic radiated power

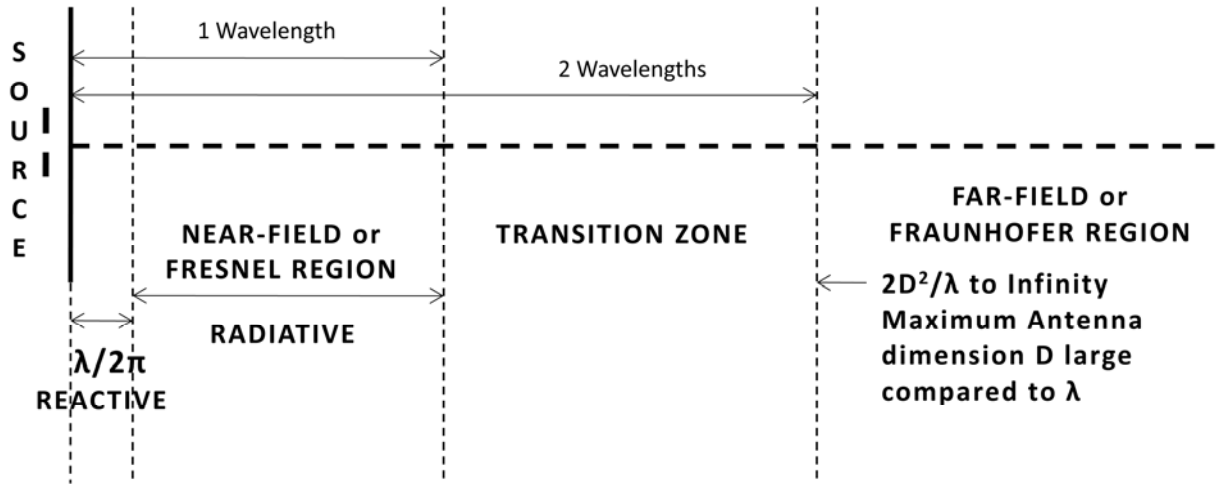
Operating power may be expressed in terms of 'effective radiated power' (ERP) instead of EIRP. ERP is power referenced to a half-wave dipole radiator instead of to an isotropic radiator. The gain of a half-wave dipole relative to an isotropic radiator is 1.64. Therefore,

$$S = \frac{EIRP}{4\pi R^2} = \frac{1.64\ ERP}{4\pi R^2} = \frac{0.41\ ERP}{\pi R^2}$$

For a worst-case prediction of power density at ground level or on a rooftop, reflection from structures can be taken in to account by 2-3 fold increase of the above far-field equivalent power density.

For distance less than the far-field region starting at $2D^2/\lambda$, called the transition region, the power density decreases inversely with distance from the antenna, as against decreasing as per inverse square law in far-field region.

In the near-field, up to one wavelength, the power density can reach a maximum before it begins to decrease with distance. In the region immediately surrounding the antenna (up to $\lambda/2\pi$) where reactive field predominates, measurements of both E and H field components are required, and SAR limits become more relevant. Beyond $\lambda/2\pi$, radiating field begins to become important.



CHAPTER 9

ELECTROMAGNETIC RADIATION FROM MOBILE PHONES

Mobile phones or cell phones are one kind of wireless handheld devices; others being cordless phones, tablet computers, PDAs, walkie-talkies, Bluetooth & WiFi devices, etc. The radio waves emitted by GSM (Global System for Mobile) handset have a peak power of 2 W and other digital mobile technologies such as CDMA (Code Division Multiple Access) and D-AMPS (Digital-Advanced Mobile Phone Service – TDMA service used in USA) use lower output power, typically below 1 W. In most systems the cell phone and the base station check reception quality, signal strength and the power level is increased or decreased automatically, within a certain span, to accommodate for different situations such as inside or outside the buildings and vehicles. As the phone moves closer to the base stations, the power emitted from the phone antenna is reduced.

ICNIRP and other international guidelines have been evolved for limiting EMF exposure that will provide protection against known adverse health effects of radiation from handheld wireless devices such as mobile phones. An adverse health effect is defined as one which 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 most of the studies about harmful effects of EMR, the health effect identified in scientific reviews has been related to an increase in body temperature (> 1 °C) from EMF exposures. In the case of a person 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. The brain blood circulation is capable of disposing the excess heat by increasing the local blood flow. However, the cornea of the eye does not have this temperature regulation mechanism.

In addition to thermal effects caused by holding mobile phones close to the body, there could be non-thermal effects. The communication protocols used by mobile phone often result low frequency pulsing of the career signal. The non-thermal effects are attributed to the induced electromagnetic effects inside the biological cells of the body which is possibly more harmful. People who are chronically exposed to low level wireless antenna emissions and users of mobile handsets have reported feeling several unspecific symptoms during and after its use: burning and tingling sensation in the skin of the head, fatigue, sleep disturbance, dizziness, lack of concentration, ringing in the ears, loss of memory, headache, disturbance in digestive system and heart palpitation, etc.

Specific Absorption Rate (SAR) is a measure to know the levels of exposure to electromagnetic fields from mobile handsets. It the rate at which human body absorbs electromagnetic power radiated from mobile phones. India had earlier adopted the following ICNIRP guidelines as standard for safety limits of exposure to radiofrequency energy produced by mobile handsets:

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

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

In the USA, the FCC has set a SAR limit of 1.6 W/kg averaged over a volume of 1 gram of tissue, for the head. In Europe the limit is 2 W/kg, averaged over a volume of 10 gram of tissue. SAR values are heavily dependent on the size of the averaging volume. As the costs of mobile phone technology have fallen, their use has increased dramatically and the overall levels of exposure of the population as a whole have therefore increased drastically. Keeping in view of the fact, the high population density, body mass index of a common Indian is lower that the European countries, and the fat content of an average Indian is also lower as compared to these countries, Indians are more susceptible towards the EMF radiation. Further when the handset operates at full transmitter power because of a long distance to the next base station, the local SAR values are reported to be in the range of 1 W/kg. Hence, SAR limits have since been revised for India, with effect from Sep 1, 2012, to 1.6 W/kg within 1 gram of human tissue. The mobile handsets with existing designs which are compliant with 2.0 W/kg averaged over 10 gram of human tissue, may continue to co-exist up to Aug 31, 2013. From Sep 1, 2013, only the mobile handsets with revised SAR value of 1.6 W/kg would be permitted to be manufactured or imported in India.

Mathematically, the SAR (W/kg) at any point in the human head is defined as:

$$SAR = \frac{\sigma E^2}{2\rho}$$

Where, E is the peak amplitude of the electrical field in the human head tissue (V/m), σ is the tissue conductivity (S/m) and ρ is the tissue density (kg/m^3). Generally, the SAR over a mass of 10g and 1g in the head and the other parameters of the mobile antenna are determined for each case.

For experimental assessment of SAR, human head phantoms are used to simulate and model different sizes of heads, with shells of skin tissue filled with liquids of equivalent brain tissue properties like conductivity σ (S/m), relative permittivity ε_r and density ρ (kg/m^3). Parameters and results of a 2010 SAR study [34] on simulated mobile handset consisting of a quarter-wavelength monopole (of radius 0.0025m at 900MHz and 0.001m at 1800MHz) mounted on a metal box of size 1.8cmx4cmx10cm) and radiated power of 0.125 watt, are:

Properties of Tissues		Dielectric Permittivity ε_r	Conductivity σ (S/m)	Mass Density ρ (kg/m^3)
Shell (Skin)	900 MHz	43.8	0.86	1000
	1800 MHz	38.87	1.19	1000
Liquid (Brain)	900 MHz	45.8	0.77	1030
	1800 MHz	43.5	1.15	1030

Calculated Parameters of the human Head		Human Head Size as a percent from an adult one				
		100%	95%	90%	85%	80%
900 MHz	SAR(point)	1.134	1.206	1.124	1.122	1.214
	SAR 1g	0.812	0.805	0.785	0.769	0.769
	SAR 10g	0.593	0.590	0.584	0.580	0.572
	Absorbed Power (W_{rms})	0.089	0.087	0.085	0.082	0.079
	Total SAR (W/kg)	0.016	0.018	0.020	0.023	0.027
1800 MHz	SAR(point)	4.149	3.078	2.404	2.319	2.282
	SAR 1g	1.590	1.530	1.482	1.399	1.312
	SAR 10g	0.922	0.887	0.848	0.805	0.764
	Absorbed Power (W_{rms})	0.064	0.062	0.060	0.058	0.056
	Total SAR (W/kg)	0.011	0.012	0.014	0.016	0.019

The 'SAR 10 grams' is the maximum SAR value averaged on 10g (by averaging the SAR around each point in the volume). The 'contiguous SAR 1 gram' is estimated by averaging the local maximum SAR, adding the highest SAR volume in a given tissue till a mass of 1g is reached. The SAR (point) is the local value of SAR at every point inside the head model. The results show that by decreasing the head size the peak SAR 1g and peak SAR 10g decrease, however, the percentage of absorbed power in the human head increases. So, the local SAR (point) and total SAR in children's heads increase as children's heads decreased. Also, the total SAR at 1800MHz is less than that at 900MHz; the human body works as a barrier, mainly in high frequencies, because of skin depth.

CHAPTER 10

RECOMMENDED GUIDELINES, PRECAUTIONS AND PROTECTION METHODS

The most important guideline to protect human beings from the harmful effects of EMF is education of users and the general public. While using mobile handsets, following general precautions and guidelines are recommended:

(i) Keep phone as far from body as possible.

(ii) Do not press the phone handset against your head; use index finger to work as a one-cm spacer between the phone and the ear to reduce RF coupling. This practice is also good from health point of view, to avoid infection when sharing phone with a friend or family member.

(iii) Use speakerphone or loud option as much as possible.

(iv) Use hands-free option, preferably with an air-tube; in conventional hand-free option or head set, connecting cable or wires can act as antenna to pick up radiation; however, use of ferrite beads on headset wires can help to filter RF energy. The hand-free option is not recommended while driving.

(v) Use of Bluetooth wireless headset can be worst; its long term use in the ear can increase RF exposure in a cumulative way. Bluetooth was developed as a wireless protocol for short-range data transmission between fixed and mobile/transportable devices, creating wireless personal area networks (PANs). Bluetooth was named after a tenth-century king, Harald Bluetooth, King of Denmark and Norway, who was known for his unification of previously warring tribes; Bluetooth likewise was intended to unify different technologies, such as personal computers and mobile devices.

(vi) Whenever there is an option, use landline phone; and keep the mobile off.

(vii) Limit the length of mobile calls to barest minimum and turn off when not essential.

(viii) Use text and SMS instead of voice, wherever possible.

(ix) Try using your cell phone only when the signal quality is good; if possible, by coming out into open, from inside of building or vehicle.

(x) Avoid using a mobile phone while wearing metal-framed glasses or having wet hair; metal & water are good conductors of radio waves.

(xi) People having active medical implants should keep their cell phone at least 30 cm away from the implant.

(xii) Let the call connect before putting the handset on your ear or start speaking and listening – a mobile phone first makes the communication at higher power and then reduces power to an adequate level; more power is radiated during call connecting time and also during regular (once in a minute or so) hand-shaking with the BTS in non-functional and standby mode, or even in silent mode.

(xiii) Do not use mobile phone as an alarm clock near or under pillow.

(xiv) Restrict use of mobile phone by children and adolescents, particularly long duration use; younger children are more susceptible to harmful effects of RF radiation.

(xv) Keep mobile phones away from infants; and also from pregnant women.

(xvi) When buying a cell phone, check its SAR, and make sure it is a low as possible, in any case less than 1.6 W/kg.

(xvii) When mobile phone is ON, avoid carrying it in breast or pant pocket. If essential, try using protective pouch, shield or holster. A simple breast pocket shield consists of laminated, 8 cm x 10 cm sandwich of thin aluminum foil, conducting/graphite impregnated cloth, and brass mesh – providing 20 to 30 dB shielding; while shielding heart, it may also provide better connectivity if the BTS is facing in front. Shielded pouch consists of single or double pockets, one providing one-sided shielding, and the other providing complete shielding from both sides. The shielded holster is for strapping on waist-belt; however, being fully shielded from all sides, it significantly reduces the connectivity in standby mode and for incoming calls, especially in fringe areas.

CHAPTER 11

FUTURE PROSPECTS AND CONCLUDING REMARKS

Because of the proliferation of cell phones, related base station towers and other EMR sources, Govt. of India, in the year 2008, adopted the International Commission for Non Ionizing Radiation Protection (ICNIRP) Guidelines; which were further tightened to 1/10th of the prescribed limit (from 400-1000 $\mu W/cm^2$ to 40-100 $\mu W/cm^2$ in the primary frequencies of interest) with effect from Sep 1, 2012. Indian standards are now 10 times more stringent than more than 90% countries in the world.

SAR limits have also been revised for India, with effect from Sep 1, 2012, to 1.6 W/kg within 1 gram of human tissue. The mobile handsets with existing designs which are compliant with 2.0 W/kg averaged over 10 gram of human tissue, may continue to co-exist up to Aug 31, 2013. From Sep 1, 2013, only the mobile handsets with revised SAR value of 1.6 W/kg would be permitted to be manufactured or imported in India.

A SAR Testing Laboratory has been set up in the Telecom Engineering Centre (TEC), New Delhi for testing of SAR value of mobile handsets imported/manufactured in India; where measurements can be done on CDMA, GSM 2G and 3G mobile handsets in the frequency bands of 800, 900, 1,800 and 2,100 MHz.
Related further studies are now being undertaken jointly by the Department of Telecommunications (DoT) and the Department of Science & Technology (DST) in collaboration with Indian Council of Medical Research (ICMR) and Ministry of Environment and Forests (MoEF) to drive norms based on credible scientific evidence taking into account the diversity of Indian social context. Telecommunication Engineering Centre (TEC) of DoT, and Wireless Planning and Coordination (WPC) Wing of the Ministry of Communications and Information Technology provide the technical advice on related matters.
Based on international guidelines & best practices, Telecommunication Engineering Centre (TEC), Dot has issued comprehensive revised guidelines on Aug 1, 2013 for siting, installation and clearance of BTS Towers.
Sharing of towers by various service providers has been recommended to optimize infrastructure and cost of service. This will also improve the ghastly looking skyline by reducing the number of towers.

The service providers are required to report compliance of radiation limits and radiation levels through self certification of their BTS (Base Transceiver Station) to Telecom Enforcement Resource & Monitoring (TERM) of DoT. TERM Cells are required to carry out the compliance monitoring of radiation levels on random basis for 10% of BTS towers.

DoT has issued comprehensive revised instructions on Nov 20, 2013 on system of penalties to levied for non compliance of standards of EMF exposure control: For delayed submission of self certificate for a BTS, penalty is Rs 5,000 for delay up to 15 days, Rs 20,000 for delays of 15-30 days, and Rs 50,000 for delays of 30 to 60 days; the BTS shall be shut down on expiry of 60 days. In case of non compliance of EMF radiation norms, a penalty of Rs 10 lakh per BTS per incident shall be imposed.

Despite recommendations made by the Inter-Ministerial Committee to impose restrictions on installations of mobile towers within the premises of schools, colleges, hospitals, etc, and some States

like Rajasthan and Madhya Pradesh imposing restrictions on setting up of telecom towers in such places based upon court directions, Government of India have not yet issued any directions. Government must frame a comprehensive policy and fix stringent norms with regard to setting up of telecom towers in residential areas in densely populated cities, schools, colleges, hospitals, maternity homes, nursing homes, children playgrounds, senior citizen homes, etc. Such policy framework should be made uniformly applicable to all across the country, irrespective of the prevailing local laws of the concerned States/UTs/local municipal bodies, by mandatory involvement of public/Resident Welfare Association/NGOs/residents of the nearby buildings or areas before installing telecom towers.

In order to address public grievances regarding excessive EMF radiations and location of cell phone towers, TERM (Telecom Enforcement Resource and Monitoring) Cell is required to handle complaints under the management of Telecom Consultants India Ltd. State Governments have been directed to set up State/District level Telecom Committees with officers of TERM Cells, Administration, representatives of service providers, public persons, etc to effectively address related complaints and grievances.

There is an urgent need to incorporate appropriate amendments to the Indian Telegraph Act and other related laws so as to give enforcement powers to DoT to test and control radiations emanating from wireless systems. It is also essential that Govt. of India tightens control on unlawful radiations emanating from all other electrical and electronics devices and instruments, including electrical power generation and transmission systems so as to save the environment and make it suitable for healthy living.

Some recent studies and arguments emphasize that there no such thing as safe electromagnetic radiation level. Generally accepted 'safe levels' vary from 1 $\mu W/m^2$ for sleeping areas and 10 $\mu W/m^2$ for other living and working areas, to as much as 1000 $\mu W/m^2$ (as against ICNIRP reference level of 2W/ m^2 – which is the upper limit for operations of normal wireless devices), recommending that significantly less – minimum possible – levels should be used for practical applications.

There is some misconception that ICNIRP guidelines for limiting EMF exposure (and consequent Indian guidelines) recommending reference levels (EM fields) and basic restrictions (SAR) are to guarantee and ensure safe operations. These are only precautionary guidelines; radiations above the reference levels are not permitted because such levels are sufficient for efficient wireless communications in normal circumstances and higher levels are not necessary at all; so much so that at lower EM fields, communications may not be satisfactory within the limits of present technology. With continuously improving technology over the years and more sensitive wireless receivers, it has become possible to operate at lower level of EM fields. The situation may further improve in the future with better technology, and then, it may be possible to live with lower reference levels. Similarly, SAR basic limit has been recommended by estimating the increase in temperature as a result of thermal effects of EM fields; it does not take into account non-thermal effects, nor does it take into account improper uses. In fact, a mobile phone using 1W transmitter power, shall produce 100 $\mu W/cm^2$ (the recommended power density as per reference levels) at a distance of about 30 cm ($1/4\pi R^2$) – suggesting that mobile phone should be kept away from year by as much as 30 cm – making it useful only in loud option or hands-free option.

To reduce congestion in 800, 900, 1800 and 2100 MHz bands, MM Wave bands in 20-70 GHz may be considered along with low power radiating Micro, Pico and Femto BTSs to reduce EMF exposures. MM Wave bands may also become essential for meeting the future needs beyond fourth-generation (4G) and fifth-generation (5G) cellular systems, such as for multi-gigabits per second (Gb/s) throughputs [35].

Harmful effects of low frequency Electromagnetic radiations from power transmission lines on human beings had been of concern for quite some time. Overhead power distribution lines, particularly high voltage transmission lines near sub stations, are notorious for creating high radio noise, electrical noise and Electromagnetic interference. Electric Traction and related power transmission system also creates high level of low frequency EMR. While underground metro systems have an inbuilt protection against EMR, overhead metro lines through highly populated areas are of concern; to address this, as is the practice in other developed countries, the recent new metro lines in Gurgaon have used 3rd rail for reducing Electromagnetic pollution.

When New Delhi was built in 1930s, overhead High Tension Lines were not allowed; even overhead power distribution lines were avoided in the main city. Today, outside ring road, New Delhi and the entire NCR is haphazardly powered through overhead lines crisscrossing roads and colonies; the situation is worst in other cities and towns in India. Many other countries have strict laws on such overhead lines; so much so that continuous efforts are being made mitigate the EMR pollution. Experts recommend that future developments should adopt ELF safety limit of 2 mG (0.2 μT).

Some studies have linked global warming to excessive RF radiation emanating from increasing number of sources, such as broadcast TV & Radio transmitters, radars, microwave communication links, satellites, power transmission lines, cell phones & base station towers, etc. The arguments are based upon the fact that the EM fields have started to significantly increase since 1950s because of the proliferation of RF sources, and have increased beyond the natural background by as much as 6 orders of magnitude – much more than the increase in CO_2 levels and greenhouse gases by burning of fossil fuels [36, 37]. The arguments are also justified and linked to similarity with microwave & induction cooking, and the physics of RF, dielectric or diathermy heating.

The subject of High Power Microwaves (HPS) is also quite important from the point of view of biological effects. The use of HPM as an electronic warfare aid has become quite debatable in the recent times – there is a strong feeling that if HPM is likely to maim or cause permanent damage to humans, as against temporary disorientation/blinding measures for riot-control, its use should be controlled under international laws and treaties. Similar worries had been emerging regarding suggestions to use space based systems to convert Solar Energy to Microwave Power for beaming down to ground/sea based receiving systems (Rectenna); specially the effect on intervening atmospheric medium, flying birds, etc. Such subjects fall outside the scope of the present study, which is addressing low level non-ionizing radiation effects.

Science and Engineering Research Board of DST has initiated campaign mode studies and R&D on possible Impact of EMF radiation exposure from Cell Phone Towers and Mobile Handsets on human life, living organism, flora & fauna and environment. Some important R&D issues and aspects identified are: physiological, genetic, ecological, growth, development, morphogenetic, etc; at the level of cellular, sub-cellular, molecular, sub-molecular, Biochemical, etc; in any model system including humans, plants, animals, birds, fishes and microbes; including related aspects of epidemiology, social behaviour, safety, etc. There is strong need for taking up India Specific long term Research in this important area.

Electromagnetic waves are nature's gift to mankind. It is essential that appropriate steps are taken to protect this natural resource; its equitable, cost-effective and safe utilization is very important for the efficient sharing of the spectrum and for ensuring health of all living things by using minimum possible radiations and controlling resultant pollution levels.

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Appendix I

ELECTROMAGNETIC SPECTRUM

Frequency	Designation	Abbreviation	Remarks
< 3 Hz	Sub-Hertz	Sub Hz	Natural EM Waves from Earth, Sun, etc.
3-30 Hz	Sub-Audio Frequency Extremely Low Freq.	SAF ELF	Schumann Resonance: 7.83 Hz (Earth's Atmosphere – λ of 38,000 km). Nuclear Submarine Communications
30-300 Hz	Super Low Frequency	SLF	50/60 Hz Power Lines
300-3000 Hz	Voice Frequency Ultra Low Freq.	VF ULF	
3-30 kHz	Very Low Freq.	VLF	Acoustic/Ultrasonic (above 20 kHz) – not EM Waves. Submarine Communications
30-300 kHz	Low Frequency	LF	Long Wave AM Broadcasts. RFIDs
300-3000 kHz	Medium Frequency	MF	Medium Wave Broadcasts. Amateur Radio
3-30 MHz	High Frequency Short Waves	HF	Broadcasting, Amateur Radio, OTH, Radio/ Aircraft/Marine Communications
30-300 MHz	Very High Frequency	VHF	TV, FM Radio, Mobile Communications
300-3000 MHz	Ultra High Frequency Microwaves	UHF	Cell Phones, Microwave Oven, WiFi, WiMax, Bluetooth, Cordless Phones
3-30 GHz	Super High Frequency	SHF, L, C, X, Ku, K	Satellite Communications, Radars
30-300 GHz	Extremely High Freq. Millimeter Waves	EHF, Ka, Q,U,V,E, W,F,D,G, MMW	Military Satellite Communications, Radio Astronomy, Missile Seekers Heads
300-3000 GHz	Sub-Millimeter Wave Terahertz	Sub MMW THz	Terahertz Imaging, Spectroscopy
3-430 THz 430-790 THz	Infra Red Visible	IR	
790-30000 THz	Ultra Violet	UV	Upper Frequencies (> 2500 THz) – Ionizing Radiations
30-30000 PHz > 30 EHz > 30000 EHz	X-Rays Gamma Rays Cosmic Rays		Ionizing Radiations

CELL PHONE FREQUENCIES:

- CDMA – 869-890 MHz
- GSM 900 – 935-960 MHz
- GSM 1800 – 1805-1880 MHz
- 3G – 2110-2170 MHz

Appendix II

INCEMIC-2006 RECOMMENDATIONS

Recommendations of the Panel Discussion on "EMI/EMC and EM Radiation Hazards – Specifications, Standards and Measurement Methods – in Indian Context" held on 24th February 2006 at National Science Seminar Complex, Indian Institute of Science, Bangalore, as the concluding event of the International Conference on Electromagnetic Interference and Compatibility (INCEMIC-2006) under the Chairmanship of Prof RP Shenoy, Distinguished Scientist, and former Director, LRDE, Bangalore.

1. Awareness has to be brought in general public about the EMI/EMC requirements and Electromagnetic (EM) Radiation Hazards.

2. Applicable Standards & Specifications for EMI/EMC and EM Radiation Hazards are to be generated and implemented.

3. The EMI/EMC standards developed by Bureau of Indian Standards for electrical & electronic equipments should be made mandatory.

3. Since there is no standard applicable in India for giving out Maximum Permissible Exposure Levels for the Non Ionizing Electromagnetic Radiations (NI-EMR), it is proposed that the existing International Regulations on the subject to be studied, and rational safety guidelines to be prepared. At the later stage these guidelines can be made mandatory regulations.

5. A survey of EM Radiation Levels available in all cities may be carried out by authorized and capable agencies under aegis of the Ministry of Environment and Pollution and the Ministry of Communication and Information Technology with a view to judge levels with reference to Maximum Permissible Exposure Limits so that general public could be made safe from the biological effects of the NI-EMR. If the radiation levels are found to be exceeding the specified levels, the suitable precautionary measures are to be taken.

6. Ministry of Health and Family Welfare authorized for environment protection and Ministry of Communication and Information Technology be asked to allocate and spend sufficient funds for bringing out awareness in general public on the harmful biological effects of these NI-EMR and also on scientific research on the subject.

7. Biological effects of HT Power Lines, Railway Power Lines may also be studied and Maximum Permissible Levels be arrived at to keep general public under safe limits.

8. Societies like "Society for Electromagnetic Compatibility Engineers (India) (SEMCEI)", "Microwave Applications Society of India (MASI)" and "Society for Electromagnetic Radiation Hazards and Bio Electromagnetic Studies (SEMBEMS)" be consulted along with Research Institutions/Academic Institutes, and authorized to make guidelines for NI-EMR Safety.

9. A yearly "National Level Science Award" may be constituted towards NI-EMR Safety Inventions /Researches.

10. The awareness campaign to be instituted on the subject at various levels like at academic level by introducing undergraduate courses on the biological hazards of NI-EMR, provisioning of more funds for research and also through the Press, TV, Radio and other Electronic Media.

11. The study is required to be carried out on the following: -

    (a) The generation of more data addressing frequency and power level effects and limiting exposure levels.

    (b) Guidelines of EMC Standards for household equipments.

    (c) Study on development of shielding material and Nano Metal Paints, etc.

12. It was also brought out by number of delegates that the simple reading materials on EMI/EMC and NI-EMR to be written for the general public. In addition “do it yourself kits” could be brought out for further education.

13. It was also felt that student participation should be encouraged for such events.

14. Recommendations of Dr. VP Kodali Committee of August 1996, Department of Electronics, Government of India on Standards Regarding Electromagnetic Emissions can be immediately adopted and followed.

Appendix III

Public lectures on EMR by Dr APJ Abdul Kalam, when he was the President of India

Excerpts:

(i) 'Connectivity for Billion People', Inauguration of 'India Telecom 2006 – Mapping the Road Ahead', New Delhi, Dec 14, 2006:

"Radio frequency utilization and pollution:

There are problems related to excessive utilization of radio or electromagnetic wave frequencies, particularly congestion on popular frequency bands, related electro-magnetic interference or pollution and electro-magnetic radiation hazards. India has adopted some rules and regulations to control the radio spectrum but a lot has yet to be done. Earlier, only radio operators or radar operators were exposed to significant electromagnetic radiation effects, prompting regulators to introduce legislation for location and shielding of human beings from potential hazards. In the recent times, increased use of mobile phones, using high power radiation towers, has brought in suspicion among the users about the harmful effects of electro- magnetic waves, particularly for children, senior citizens and people needing healthcare. There is an urgent need to evolve reasonable standards, rules and regulations and legislations for proper use of radio frequencies for telecom operations, including health related restrictions and interference related measures."

(ii) 'Research Enhances Global Competitiveness in Communications', International Conference on 'Signal Processing, Communications and Networking', MIT Chrompet, Anna University, Chennai, Feb 23, 2007:

"Mobile Phones:

In the recent years the growth of mobile phone market has been phenomenal. In the last 20 years, half of the people on our planet have got connected through cell phones. Out of 200 million total phones in India, 80% are mobile phones, which are continuing to increase at the rate of 6 million new mobile phones per month. The current global mobile subscriber base is 2.6 billion. In 2006, 1 billion new users were added. It took 12 years to reach the first billion; the second billion came in two and a half years; and the third billion is expected to be achieved in just one year. Of course, the growth rate has slowed down and may saturate. The voice traffic may begin to decline, giving way to mobile data services, which will demand faster and faster throughput, and higher bandwidth. Mobile WiMAX will demand significant increase in radio spectrum and innovative networking solutions. These are priority problems for the signal processing and communication community to address."

"Radio Spectrum Utilization and Electromagnetic Pollution Hazards From Mobiles:

Increased use of radio frequencies because of ever increasing number of mobile phones and expansion of mobile communication networks have brought in new problems and concerns. The

situation is also getting complicated because of alarming increase in other wireless devices and systems. WiFi, WiMAX, Bluetooth, WIL and cordless phones are also competing for appropriate allocation of frequency bands. Communication systems have to share the available electromagnetic spectrum with other users such as Walkie Talkies, terrestrial TV, FM stations, Radars, Microwave Ovens, etc. There is significant congestion on some of the popular frequency bands. In addition to creating mutual electromagnetic interference, these are causing excessive electromagnetic pollution and electromagnetic radiation hazards. In the recent times, overwhelming increase in the number of mobile phones and the number of service providers competing with each other, have created such a situation that we see cell phone towers everywhere; even on residential buildings, schools, hostels and hospitals. These towers are radiating high power radio waves, continuously exposing children, senior citizens and people needing health care to harmful electromagnetic radiations. These towers should be located away from residential and other such vulnerable areas and should use minimum essential radio power. Several operators could share towers, saving on space, rentals and costs. Simultaneously, communication, electronics and signal processing scientists and engineers should work out innovative strategies for improving on efficient use of electromagnetic spectrum and bandwidth. There is an urgent need to evolve reasonable standards, rules and regulations and legislations for proper use of radio frequencies for telecom operations, including health related restrictions and interference related measures."

(iii) 'Great Minds Emanate from Creative Environment' Foundation Stone Laying Ceremony of the Dr. BC Roy Multi-Specialty Research Centre, IIT Kharagpur, May 17, 2007:

"Safety of Health Care and Medical Electronics Products:

Medical electronics products are increasingly being purchased and used in the home environment by average consumers or patients, sometimes subjecting themselves to high risk by using what are being called 'self care products'. It is better if such products are produced within the country, with indigenous technology and with local regulatory mechanisms on cost, quality and after-sales maintenance. This, at least, will ensure some control on safety measures and availability of quick antidotes.

Health care products needing concerted R&D effort are: Optoelectronics devices such as light sensors and color sensors that can be used in a variety of different medical applications—all the way from pulse oximetry and blood glucose monitors to drug delivery systems and other kinds of chemical analysis systems. These have to be seamlessly integrated with radio transmission and reception devices which are getting integrated into embedded medical chips. These may further get linked to feed back signals from automatic monitoring systems and devices for controlled release of drugs. But, are these wireless devices safe enough? I am sure the members of this research centre will work and establish safety norms and protection methods for safe use of wireless products."

(iv) 'Indian Railways: National Carrier and the National Integrator', Conference on Railways Vision 2030, New Delhi, March 1, 2008:

"Environmental Effects:

I am happy that the conference during the last two days has discussed various issues pertaining to future strategies, high speed technologies, rail infrastructure, signaling, safety, track maintenance, mass transportation and environmental effects of rail transportation…..I have noticed that presently

railways have over 43,000 hectares of vacant land. So far, they have planted two crore Jatropha plants in the vacant land in certain areas…..This action will have five fold benefits of: reducing the operational cost, reducing atmospheric pollution, reducing noise pollution, reducing electromagnetic pollution and providing productive employment for rural sector…..In respect of metro system, wherever there is underground operation, there is an inbuilt protection against electro-magnetic radiation. However, when we have to use over headlines for metro transportation we should plan for electro-magnetic radiation protection systems."

(v) 'Connectivity for Billion People', Anniversary Celebrations of Nokia–Siemens Network, New Delhi, April 11, 2008:

"Radio frequency utilization and pollution:

There are problems related to excessive utilization of radio or electromagnetic wave frequencies, particularly congestion on popular frequency bands, related electro-magnetic interference or pollution and electro-magnetic radiation hazards. India has adopted some rules and regulations to control the radio spectrum but a lot has yet to be done. Earlier, only radio operators or radar operators were exposed to significant electromagnetic radiation effects, prompting regulators to introduce legislation for location of radio stations away from cities and residential areas for shielding of human beings from potential hazards. In the recent times, increased use of mobile phones and resultant expansion of mobile networks, using large number of high power base station towers, has brought in new problems and concern among the users about the harmful effects of electromagnetic waves, particularly for children, senior citizens and people needing healthcare. The situation is further getting complicated because of alarming increase in other wireless devices and systems such as WiFi, WiMAX, Bluetooth, Cordless Phones, Walkie Talkies, FM Radio and even Microwave Ovens. There are also proposals to share the popular C-Band used for satellite communications for mobile applications. There is an urgent need to evolve reasonable standards, rules and regulations and legislations for proper use of radio frequencies for telecom operations, including health related restrictions and interference related measures. I am glad to learn that, with cooperation from all cell phone operators, the Govt. of India has initiated steps to draft guide lines for this purpose and for acceptance of internationally recognized standards and restrictions for limiting exposure of public to electromagnetic waves. Equitable and efficient use of electromagnetic spectrum for wireless telecom, in a democratic, healthy and safe way, is also very important."

Appendix IV

MINUTES OF ICMR COMMITTEE

Minutes of the Committee on "Health Hazards due to Mobile phone Towers", meeting held on May 29, 2006 at ICMR Hqrs Office.

Members Present

Dr. N.K. Ganguly,	DG, ICMR……Chairman
Dr. A.K. Mahapatra	Prof & HOD, Department of Neurosurgery, AIIMS
Dr. S.K. Jindal	Representing Director, PGIMER
Dr. A.K. Ananthanarayan	Representing DGHS
Mr. R.N. Padukone	Representing Department of Telecommunications

Special Invitee

Ms. Maya Sexena	DDG (R), Department of Telecommunications

lCMR Secretariat

Dr. Bela Shah	Sr. DDG & Chief, Division of NCD
Dr. R.S. Dhaliwal	ADG
Dt. Tripti Khanna	ADG

This Committee was constituted with reference to a PIL filed at Mumbai on health hazards due to mobile phone base stations. The Mumbai High Court had ordered the Ministry of Health and Family Welfare, Govt. of India, to examine the issue. Subsequently, the Ministry of Health and Family Welfare had constituted a Committee under the Chairmanship of Dr. N.K. Ganguly, DG ICMR to evaluate:

1. Whether it is advisable to frame and/or adopt the existing international guidelines pertaining to installation of Base Stations by mobile telephone service providers, so as to avoid any potential risk to health and safety to public at large.

2. Explore the possibility for studying the course of action and framing a research project.

Dr. N.K. Ganguly, D.G. lCMR welcomed all the members to the meeting. Background papers related to Guidelines and Publications on Health effects of Base Stations were circulated to all the members prior to the meeting. He then requested Dr Dhaliwal (ADG, Division of Non Communicable Diseases) to make a brief presentation based on the available material.

The Committee had extensive discussions and deliberations for 2 hours and observed the following:

- There are multiple sources of exposures to Electromagnetic fields including radio, FM radio, Television and other household gadgets. There is a need to acknowledge the confounding effects of these sources of RF.
- There are different types of Mobile Base Stations depending on the requirements of a particular system (GSM or CDMA) prevalent in India, however GSM systems outnumbers CDMA.
- RF exposures from Mobile Base Stations are much less than from radio, FM radio and television transmissions.

- The height of Mobile Base Station antenna is nominally 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. 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.
- There are two main types of effects of electromagnetic waves : thermal and non-thermal which includes electrophysiological/ behavioural effects. These can be sleep disorders, cognitive disorders, mernory disturbances, hearing disorders, etc.
- Factors like urbanization, siting of base stations, distance from the towers, existence of multiple towers and multiple service providers, etc. all may have confounding effects which could be difficult to quantify.
- Subjective symptoms such as sleep disorders, cognitive disorders, memory disturbances, hearing disorders, etc. have been reported. However, the three completed 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.
- ICNIRP Guidelines in respect of restriction on Specific Absorption Rate (SAR) are available internationally and have been adopted by various European countries, such as UK, Australia, Malaysia and Korea. But China has adopted more stringent criteria.
- Various studies conducted across the world on RF from Mobile Base Stations have shown that the exposures are of a much lower magnitude than the internationally accepted levels.
- At the moment there is no concrete evidence of any health hazard and WHO has the same opinion as mentioned in the latest Fact Sheet modified in May 2006. The Committee felt that more objective research is needed in the above disorders to quantify the effect on human health.
- WHO in its Fact Sheet No. 304 regarding EMF in relation to Base Stations and wireless technology which has been updated in May 2006 recommends: "National Authorities should adopt international standards to protect their citizens against adverse levels of RF fields."

Taking the above mentioned into account, the Committee opined that overall there is not enough evidence to show direct health hazards of RF exposures from Mobile Base Stations.

Based on the above observations and the discussions, the Committee recommends that:

(i) A precautionary approach should be adopted till further research data is available. It will not be amiss to adopt the ICNIRP guidelines for limiting EMF Exposure.
(ii) The protocols to be followed and necessary guidelines for siting of mobile phone base stations may need to be developed as per its applicability for India.
(iii) Periodic review of the status of knowledge in this area should be done and the recommendations may be revised accordingly.
(iv) Recognizing that there is not enough evidence, data be generated through appropriate epidemiological studies (covering urban/rural population & varied exposure levels). Appropriate funds should be made available to the Institutions conducting these studies.

Appendix V

World Health Organization (WHO)

Fact sheet N°304
May 2006

Electromagnetic fields and public health
Base stations and wireless technologies

Mobile telephony is now commonplace around the world. This wireless technology relies upon an extensive network of fixed antennas, or base stations, relaying information with radiofrequency (RF) signals. Over 1.4 million base stations exist worldwide and the number is increasing significantly with the introduction of third generation technology.

Other wireless networks that allow high-speed internet access and services, such as wireless local area networks (WLANs), are also increasingly common in homes, offices, and many public areas (airports, schools, residential and urban areas). As the number of base stations and local wireless networks increases, so does the RF exposure of the population. Recent surveys have shown that the RF exposures from base stations range from 0.002% to 2% of the levels of international exposure guidelines, depending on a variety of factors such as the proximity to the antenna and the surrounding environment. This is lower or comparable to RF exposures from radio or television broadcast transmitters.

There has been concern about possible health consequences from exposure to the RF fields produced by wireless technologies. This fact sheet reviews the scientific evidence on the health effects from continuous low-level human exposure to base stations and other local wireless networks.

Health concerns

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.

The strength of RF fields is greatest at its source, and diminishes quickly with distance. Access near base station antennas is restricted where RF signals may exceed international exposure limits. Recent surveys have indicated that RF exposures from base stations and wireless technologies in publicly accessible areas (including schools and hospitals) are normally thousands of times below international standards.

In fact, due to their lower frequency, at similar RF exposure levels, the body absorbs up to five times more of the signal from FM radio and television than from 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.

Cancer: Media or anecdotal 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.

Other effects: Few studies have investigated general health effects in individuals exposed to RF fields from base stations. This is because of the difficulty in distinguishing possible health effects from the very low signals emitted by base stations from other higher strength RF signals in the environment. Most studies have focused on the 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 general public exposure from base stations or wireless networks. No consistent evidence of altered sleep or cardiovascular function has been reported.

Some individuals have reported that they experience non-specific symptoms upon exposure to RF fields emitted from base stations and other EMF devices. As recognized in a recent WHO fact sheet "Electromagnetic Hypersensitivity", EMF has not been shown to cause such symptoms. Nonetheless, it is important to recognize the plight of people suffering from these symptoms.

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. Since wireless networks produce generally lower RF signals than base stations, no adverse health effects are expected from exposure to them.

Protection standards

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.

Public perception of risk

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.

Conclusions

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.

WHO Initiatives

WHO, through the International EMF Project, has established a programme to monitor the EMF scientific literature, to evaluate the health effects from exposure to EMF in the range from 0 to 300 GHz, to provide advice about possible EMF hazards and to identify suitable mitigation measures. Following extensive international reviews, the International EMF Project has promoted research to fill gaps in knowledge. In response national governments and research institutes have funded over $250 million on EMF research over the past 10 years.

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.

The International Agency for Research on Cancer (IARC), a WHO specialized agency, is expected to conduct a review of cancer risk from RF fields in 2006-2007 and the International EMF Project will then undertake an overall health risk assessment for RF fields in 2007-2008.

Appendix VI

S U P R E M E C O U R T O F I N D I A
RECORD OF PROCEEDINGS

WRIT PETITION (CIVIL) No(s). 471 OF 2005

KARMA JYOT SEVA TRUST OF GUJARAT — Petitioner (s)

VERSUS

UNION OF INDIA & ORS. — Respondents (s)

With appln (s) for ex-parte stay and exemption from filinq (O.T.)

Date: 26/09/2005 This Petition was called on for hearing today.

CORAM:

HON'BLE MR. JUSTICE Y.K. SABHARWAL
HON'BLE MR. JUSTICE S.H. KAPADIA
HON'BLE MR. JUSTICE C.K. THAKKER

For Petitioner (s):
Mr. Mukul Rohtagi, Sr. Adv.
Mr. 5udhir Kumar Gupta, Adv.
Mr. Sheetal Aggarwal, Adv.
Mr. Anurag Pandey, Adv.
Mr. Mihir Chowdhary, Adv.
Mr. Sushil K. Tekriwa1, Adv.

For Respondent (s):

UPON hearing counsel the Court made the following
O R D E R

The 1earned counsel for the petitioner states that representations were made to various Ministries on the question of lack of guide1ines as also non-implementation on the question of erection of towers used by various mobile companies and bringing to the notice of the Government the health hazards involved. The petitioner is granted leave to place copies of all those representations within four weeks. The petitioner shall also send reminders to the Ministries and state therein that such a petition has been filed.

List the petition after eight weeks.

Appendix VII

KARMA JYOT SEVA TRUST OF GUJRAT

Service to mankind is service to God

30th September 2005

To,
The Chief Secretary,
The Ministry of Health & Family Welfare,
Nirman Bhawan,
New Delhi-110001

Dear Sir/Madam,

We are a Public Charitable Trust duly registered under Bombay Public Trust Act, 1950 bearing registration No. E/10970/96 and having its Office at 216/B-5, Lower Ground Floor, Gautam Nagar, New Delhi-110049. The said Trust has been formed for the welfare of the society, promotion of educational and academic activities, up-liftment of women, downtrodden, infirm and weaker sections, preservation of environment and ecology, securing protection of safe and healthy life of the human being against health hazards and also to safeguard the flora and fauna of the country and has played a pivotal role in serving the example of the same.

The said trust has invited your wisdom and necessary information on the point of public safety and health with respect to emission of EMRs installation of communication towers communicated to you on 1st of August, 2005 and 18th of August, 2005, but the organization is yet to receive any acknowledgement of the Same.

The Trust has filed a writ petition No. 471/2005, under Article 32 of the Constitution of India invoking the extraordinary civil writ jurisdiction of the Hon'ble Supreme Court, in the best interests of the public at large, to ensure their safety regarding life and health from the dangerous Electro Magnetic Radiations (EMR) consistently and continuously emitted from the Communication Towers/Base Stations/Antennas/Masts/ Hubs, erected/installed/fixed on buildings throughout the county by Cellular Mobile Service Providers, in violation of concerned Rules/Regulations/Guidelines, as laid down and framed by Central/State Governments. Life and health of millions of citizen of this country is at stake, as the situation has worsened to an alarming state, since the entire population of the country is subjected to serious and hazardous ailments/diseases like cancer, mental disorders, epilepsy, etc. duo to the said emission of EMR. The erection/installation/fixation of the Communication Towers/Base Stations/Antennas/Masts/Hubs is in flagrant violation of the building rules/guidelines/bye-laws framed by the Standing Advisory Committee on Frequency Allocation (SACFA), Airport Authority of India, building bye-laws and other concerned Departments. Moreover, increase of building height due to erection/installation/fixation of Communication Towers/Base Stations/ Antennas/Masts/Hubs, shall adversely affect the entire structure of not only the concerned buildings, but also the surrounding buildings resulting in possible collapse of the same, further endangering human life and property as well in the event of natural calamities like earthquake, cyclones, heavy rains, heavy storm, thunderstorms, etc. Moreover, Communication Towers/Base Stations/Antennas/Masts/Hubs are also erected/installed/fixed on the buildings which are very old, cracked, creviced and dilapidated, which may not be able to resist the weight of the said Communication Towers/Base

Stations/Antennas/Masts/Hubs and this may result into the collapse of the same, endangering thousands and thousands of lives of innocent people and their property. The Communication Towers/Base Stations/ Antennas/Masts/Hubs are also erected/ installed/fixed in the “Green Belts", forest areas, hilly areas or so, which may lead to the destruction of flora and fauna of the country having far reaching consequence on the environment and ecology as well. The Communication Towers/Base Stations/Antennas/Masts/Hubs are also erected/ installed/fixed on the historical monuments and buildings of archaeological importance severely effecting the aesthetic and antique significance of, the historical monuments. The Communication Towers/Base Stations/Antennas/Masts/Hubs are also erected/installed/fixed on the places, which are hypersensitive and prone to natural calamities like earthquakes, cyclone, thunderstorm, flood and this may cause the collapse of such Towers, within a fraction of seconds, could lead to destruction and cause irreparable loss and injury to life and property.

The said petition came up for hearing before the Hon’ble Supreme Court of India on 25.09.2005 and it was directed to the petitioner to send reminders to all the concerned ministries on the question of lack of guidelines as also non-implementation on the question of erection of towers used by various mobile companies and bringing to the notice of the government the health hazards involved. The petition, as directed by the Hon’ble court shall come up for hearing after eight weeks.

Since the introduction of cellular mobile phones in 1995-96, there has been extensive increase in the level of its users. According to the Survey Report of June 2005, conducted by TRAl, there are approximately 4.11 Crores of mobile users across the nation. According to the tentative estimation, based on the research conducted by the petitioner, and in the light of the average growing mobile users per year in the country since its inception, the numbers of mobile users is expected to grow to 30 Crores in the next 10 years.

FINDINGS OF PHYSICISTS

Professor Smith of Salford University in England discovered that “Favorable information is absorbed by the body very quickly. Whereas unfavorable information such as chaotic EMF’s, microwaves and radio waves is blocked for some time, i.e., for ten to fifteen seconds, and may only cause damage after a longer (chronic) period of exposure. We obviously have sufficient external pathogenic factors over which we primarily do not have any influence. Amongst these contaminants such as heavy metals, we have radioactivity and microwave pollution. The body does not become ill because it has been infected but because the defense system the energy filed has become weakened. Professor Popp discovered that the cells of living organisms store and emit light (photons) and this light controls vital processes. If this mechanism does not function correctly, the organism is diseased.”

The science of biophysics has established that all life is firmly imprinted with the stamp of the environment. “The body is thus, firmly integrated into our environment is in constant exchange with it and is controlled by it, i.e., all our various biorhythms, our organ and metabolic functions (normally) run synchronously with the pulse rhythm of the universe. If this coordination is disturbed, disease and possibly death occur.” Control pulses come firstly from what are referred to as Schumann waves, arising in the ionosphere with a frequency of 7.83Hz that corresponds precisely with the frequency of the hippocampus in the brain of all mammals. The hippocampus in humans is responsible for our memory and survival among other factors.

Our nervous system also responds to the electromagnetic pulses of the Schumann waves. These induce miniature potentials in the nerve loops, which on repetition add up to action potentials and can actively

intervene in cybernetic control circuits of the body. The autonomic nervous system is autonomic but adapted to the environment and resonates with it. It becomes very clear that we are an electrical or energy system and depend on and interact with balanced and natural energies around us for our heath, well-being and survival. The importance of this and the importance of the Earths Schumann waves are evidenced by the fact that NASA builds Schumann wave generators into its manned space flights to keep their astronauts physiological and psychologically healthy.

The science of biophysics has established that we are not designed to become ill. We only become ill when the defense mechanism of body is weakened and living in close proximity to mobile phone masts (or electricity pylons) gradually weakens the body's defense mechanism leading to illness and disease.

All biochemical functions processes are regulated by our body's own electro-magnetic fields The fact that magnetic fields enter body's own energy fields is well-documented by biophysicists and can easily be measured. Electromagnetic frequencies are manmade and therefore unnatural, chaotic, and disordered and biophysics has established that "Every kind of frequency combination which is not in order produces disease. Disease occurs through a disturbance of the EM field in the cells; they become disordered and incoherent."

Dr. David Carpenter Dean of the State of New York School of Public Health observed and said:

"I am now convinced that EMF's pose a health hazard. There's statistical association between magnetic fields and cancer that goes beyond the shadow of reasonable doubt. I think there is clear evidence that exposure to EMF's increases the risk of cancer. And we are just beginning to have a whole body of evidence that reproductive cancers are increased by exposure."

It is quite worthy to point out that leading insurance group have refused to offer "Product Liability Cover" to mobile phone manufacturers for the damages to users. The Litigation cases are increasing in the USA against mobile phone companies and by giving approval for the construction of a mobile phone tower, mast, (property owners, land owners, or councils) may be risking litigation in the event
that radio frequency radiation is later proven under British Law to cause health problems. This will be proven and has already been substantially proven in other countries to date.

According to the study conducted by Prof. G. J. Hyland, associate fellow, University of Warwick – U.K. and also an Executive Member, International Institute of Biophysics, Germany stated that the hypersensitivity of the active organism to ultra weak Microwave radiation is reflected in the ways in which this kind of radiation has been found to affect a wide variety of brain functions. Sleep disruption are consistent with the effect of GSM radiation on Rapid Eye Movement (REM) sleep and on Melatonin levels. It is, therefore, stated by different scientists that persons exposed in their homes, which are situated at 200 M from a base station complain of symptoms that recall those described in radio frequency subjects; chronic fatigue, multiple allergies, sleep disturbances and premature menopause, in comparison to persons situated at 300 meters or are not exposed to hubs or base stations. They thus, conclude that in the frequency of certain complaints at a distance of 100 meters for irritability, depressive tendencies, memory loss concentration difficulties, vertigo, 200 meters for headaches, sleep disturbances, feelings of discomfort, skin problems and up to 300 meters for fatigue. The danger depends on how close you are to the pole. If you are within 200 meters of a typical Mobile Phone Tower, it may be associated with an increased low risk range of cancer and miscarriage, and a higher risk of sleep disturbance and chronic fatigue, which may lead to learning difficulties. The risk increases, the closer you are to the tower.

The said situation has reached its worst and academic debate is on regarding exploring mechanism in dealing with the problems created by the mobile service providers due to the erection/ installation/fixation of communication towers as a whole. The international efforts and guidelines in tackling and dealing with the gravity of the situation is also been surveyed by the petitioner herein and mentioned herein below.

INTERNATIONAL EFFORTS AND GUIDELINES IN TACKLING AND DEALING THE SITUATION

Sutherland Shire Council's Policy (Australia) on the sitting of Mobile Phone towers has suggested that microwave base stations should ideally be located away from any residence unless the annual average at the nearest residence is less than 0.20 ± 0.02 $\mu W/m^2$. At present the hubs and towers have been erected and installed without a proper duty of care and due diligence and without complying with even present laid down standards.

The Telecom giant "Orange" has suspended operations at a School Phone Mast site in Paris after 8 cases of cancer were confirmed among children in the district. Over the past few months parents have become increasingly concerned at the presence of two transmitters on the roof of the Ernest-Bizet School complex in the Sain-Cyrl Ecole quarter. Local Mayor, Phillippne Lavoucl, who has ordered the on-going health investigation to be extended to the whole district, described the suspension as a "victory for the PRECAUTIONARY PRINCIPLE". The local Council recently prohibited the siting of Base Station within a 300 meters radius and is also seeking to cancel contracts with telecom operators agreed by the previous administration.

Because in the Paris, after a long process of discussion, the Paris Town Hall and the Mobile Phone Operators have reached an agreement that aims to limit public exposure to the electro-magnetic waves generated by Base Station Antenna and the Operators finally have committed themselves to lowering significantly the levels of exposure.

Because in Wishaw, a small village where a Base Station Antenna has been erected right in the center of inhibited property, the Director of Public Health is assisting the cases going on with co-ordination of voluntary blood test to check neutrophil level of inhabitants. Evidence worldwide is stacking of against Mobile Phone Industries Policies for do not following the preventive measures. The evidence in Warsaw is extremely valid. They have huge amount support from people highly regarded in this field. They have also Medical Data to bolster the case and reinforce the scientist's predictions. However, it was recommended by investigating scientists on spot, to shift the Base Station Antenna away from inhabitant properties as far as minimum 500 meters, while reducing the emissions to a therapeutic level.

Because that in Israel, which has high dependence on GSM Mobiles, is proposing to mount an enquiry into safety, and a Committee of the European Standards Body CENELEC has recommended a substantial reduction in their exposure standards.

That the health hazards of millions of citizens of this nation could have been controlled if the concerned authorities would have taken proper steps and made rules and regulations for issuing the licenses and also installation, erection and maintenance of Towers/Mast Height and the instruments/accessories to be installed/fixed. The Wireless Planning & Coordination Wing of the Department of Telecommunication, Govt. of India has laid down various measures/procedure of sites for Wireless Stations and the SACFA has been monitoring the position from time to time. In its recent meeting held on 14.3.2005, the committee has taken a serious view of the masts height violation by service

providers. It was mentioned therein that Service Providers are establishing sites within 10 km from International Border and such type of the cases are liable to be rejected. It was also discussed during the said meetings, that some service providers erect antenna structures without even applying for site clearance to SACFA. Thus, it is submitted, on behalf of the petitioners that quite apart from the negative impact of EMR on the health and well being of the public, as well as on the ecological balance the guidelines promulgated by SACFA with regard to radial distance from sensitive installations.

The various Long Term effects of EMR are adults' cancers, tumors, childhood leukemia, breast cancer, DNA stand breakage, abnormal cell division, nerve damage, Alzheimer and Parkinson disease, brain-damage disease, melatonin reduction and miscarriage. Other problems are digestive problems, abdominal pain, enlarged thyroid, testicular/ovarian pain, dryness of lips, tongue, mouths, eyes, great thirst, dehydration, nosebleeds, internal bleeding, altered sugar metabolism, immune abnormalities, redistribution of metals within the body, pain in the teeth, deteriorating feeling, impaired sense of smell, ringing in the ears.

The mobile service providers have been using communication towers/antennas/hubs for providing the networking interconnectivity to the mobile users by erecting/installing/fixing the same illegally not only on the old, weak, dilapidated, cracked and creviced buildings, buildings of historical, national and archaeological importance, but also in the forest areas and green belts, near aerodromes, commercial centers and many hyper sensitive zones which is not only against the concerned Building Bye-Laws but also against the guidelines as framed by the concerned authorities like SACFA. It is further stated that the said mobile towers/antennas/hubs erected/installed/fixed on the old, weak, dilapidated, cracked and creviced buildings may not only endanger the safety of human beings, adversely affecting the aesthetic and antique nomenclature of the same, but also may prove to be hazardous to health and life of the public The weight of such towers/antennas/hubs may also lead to the collapse of such building badly affecting the buildings in surroundings, endangering the human life in the event of any natural calamities like earthquake, thunderstorm, heavy rain, cyclone, etc.

The safety of a common man has always been a matter of concern to this Trust and hence, in fact, the Mobile Communication Towers/ Base Stations/Antennas/Hubs, etc., illegally erected/ installed/fixed at various residential and commercial buildings by the mobile companies are continuously and consistently emitting and spreading EMR, which is seriously affecting the health and life of the citizen of the country fostering/leading to many serious health diseases like cancer, infertility, mental disorders, physical infirmity, etc, including genetical, biological, environmental and ecological problems.

The Petition filed in the Apex Court has raised various issues of health hazards and the related diseases like cancer, brain tumor, sleep disorders, etc. caused due to the emission of EMR from the communication towers as used by various mobile service providers. It is pertinent to mention that recently on 22nd June 2005, one mobile tower, which was erected by BSNL, collapsed in Vastral locality (Ahmedabad), due to which 2 persons were killed and 1 was injured.

It is further submitted that the public has a right to expect certain lands and natural areas to retain their natural characteristic is finding it way into the law of the land. The Public Trust Doctrine primarily rests upon the principle that certain resources like sea, air, water, forests have such a great importance to the people as a whole that it would be wholly unjustified to make them a subject of private ownership. The said resources being gift of the nature these should be made freely available to everyone irrespective of status in life. There is no reason why the Public Trust Doctrine should not be extended to include all eco systems operation in our natural resources. In fact, right to health is an integral part of the right to life

and the state is under a constitutional obligation to protect the same. The Petitioners, without any prejudice, submit suggestive and advisory measure including guidelines to be formulated or laid down. Constitute an independent agency including the experts with specialty and experience in the concerned field, well versed with the technology and well equipped with such special instruments (meters) to check and control the level of radiations, emitted by these mobile towers, which may include the member of the Petitioner Trust as well, carrying out a Herculean task of research and development and massive survey conducted for months and months detecting the deficiencies as per the norms laid down and ensuring the avoidance of any breach or violations there in after. Moreover, the appropriate authority may kindly be directed to call upon the service providers on regular intervals to furnish Audit report regarding the towers which shall include the EMR emitted from these towers, the structural audit of the towers and report regarding the maintenance of gen-sets, fuel used for gen-sets, tail-lights, sign-boards, etc. If the mobile service providers fail to submit the said Report, the authorities should cancel their licenses for providing the said services.

In various other countries, including the US, Australia and New Zealand, the Governments have all taken this issue seriously at both national and local level and have adopted the precautionary measures and have framed policies of prudence. They have effectively banned the erection of these masts on the school buildings and residential areas and in other densely populated areas,

We hereby request you to kindly furnish the details, present or proposed, ensuring the precautionary and remedial measures of the same, constitution and formulation of any expert agency with multi specialty expertise dealing in the concerned field, mechanism to regulate and certify the same and also the norms and guidelines to be framed and adopted in the said matter at the aforesaid address earliest enabling the organization to conclude and update its information on the same. We would also like to extend our hand with you and to work together. Let India be the trendsetter on this issue and the world shall follow.

Kindly acknowledge the same.

Thanking You

Yours sincerely

F. Raj Thanvi
Trustee(s)
Karma Jyot Seva Trust of Gujarat

Appendix VIII

S U P R E M E C O U R T O F I N D I A
RECORD OF PROCEEDINGS

WRIT PETITION (CIVIL) No(s). 471 OF 2005

KARMA JYOT SEVA TRUST OF GUJARAT — Petitioner (s)

VERSUS

UNION OF INDIA & ORS. — Respondents (s)

With appln (s) for ex-parte stay and exemption from filinq (O.T.)

Date: 10/05/2006 This Petition was called on for hearing today.

CORAM:
HON'BLE THE CHIEF JUSTICE
HON'BLE MR. JUSTICE C.K. THAKKER
HON'BLE MR. JUSTICE R.V. RAVEENDRAN

For Petitioner (s):
Mr. Mukul Rohtagi, Sr. Adv.
Mr. Vishwajit Bhattacharya, Adv.
Mr. Sushil Kumar Tekriwa1, Adv.
Mr. 5udhir Kumar Gupta, Adv.
Mr. Anurag Pandey, Adv.

For Respondent (s):

UPON hearing counsel the Court made the following
O R D E R

The petitioner has filed document pursuant to the order dated 26th September, 2005. The main contention of the petitioner is that unlike various other nations, particularly developed countries, in India there are no norms for Electro Magnetic Radiation which are emitted by various instruments used by the Government and individuals.

For the present, issue notice only to respondents 1 and 2 to file response on the question of norms, if any, that may have been fixed.

Appendix IX

Excerpts of the Counter Affidavit filed on behalf of the Government of India

Counter Affidavit on behalf of Respondents No. 1 and 2 (Ministry of Communications, Department of Telecommunications, through its Secretary, Sanchar Bhawan, 20 Ashoka Road, New Delhi, and, the Ministry of Defence, through its Secretary, Sena Bhawan, New Delhi) filed on 28th February, 2007 in the Supreme Court of India.

I, P. Chandrasekharan, working as the Assistant Wireless Adviser in the Union Ministry of Communications and Information Technology, do hereby solemnly state and affirm as under:

1. That in my capacity as the Assistant Wireless Adviser in the Union Ministry of Communications and Information Technology, I am authorized to file this reply to the petition raising the basic issue of construction of mobile phone towers and possible effects of electromagnetic radiation from the towers erected by the mobile telephone service providers after approval by the Inter-Ministerial Standing Advisory Committee on Frequency Allocation (SACFA), which functions under the Chairmanship of Secretary, Ministry of Communications and Information Technology. I am conversant with the records of SACFA and hence I am competent to swear this affidavit in reply.

2. Preliminary Submission:

   2.1. The Standing Advisory Committee on Frequency Allocation (SACFA), under the Union Ministry of Communications and Information Technology, examines all siting proposals for the erection of towers by mobile service providers. These proposals are required to be submitted to SACFA prior to the construction of any such tower at any site by the mobile service providers since they are to be circulated to the members for their comments/no objection who examine the siting cases with respect to aviation hazards, physical obstruction to any existing installations and the electromagnetic compatibility. A copy of the application proforma to SACFA is annexed as Annexure R1. A copy of the SACFA norms is annexed as Annexure R2. A copy of the Cellular Mobile Telephone Service Guidelines is annexed as Annexure R3 (Annexures not included).

   2.2. SACFA is an inter-ministerial body which includes members from major wireless user Ministries and Administrative Departments of the Government of India. The committee may co-opt other advisers/members as necessary when specialized questions are discussed. The Office Memorandum constituting SACFA and declaring its composition is annexed as Annexure R4 (not included).

3. SACFA's inputs consist of the latest World Health Organization (WHO) studies on the electromagnetic radiation. In May 2006, WHO issued a fact sheet summing up its various studies concerning inter alia effects of radio frequency signals from Base Stations and Wireless Technologies, which is the subject matter of this petition. This fact sheet shows that the petition is baseless in its conjectures concerning the ill effects of radiation from base stations set up by mobile service providers. The fact sheet points out:

   3.1 The human body absorbs up to five times more of the radio frequency signal from FM radio and television than from base stations and concludes that, "Further radio and television broadcast

stations have been in operation for the past 50 or more years without any adverse health consequences being established."

3.2 "Most studies have focused on the Radio Frequency exposures of mobile phones. Human and animal studies examining brain wave patterns, cognition and behavior after exposure to Radio Frequency field, such as those generated by mobile phones, have not identified adverse effects. Radio Frequency exposures used in these studies were about 1000 times higher than those associated with general public exposures from base stations or wireless networks. No consistent evidence of altered sleep or cardiovascular function has been reported."

3.3 "From all the evidence accumulated so far, no adverse short term or long term health effects have been shown to occur from the Radio Frequency signals produced by base stations. Since wireless network produce generally lower Radio Frequency signals than base stations, no adverse health effects are expected from exposure to them."

Hence it is clear from this fact sheet of WHO that radiations from base stations do not constitute a health danger. SACFA is keeping itself abreast of the WHO findings in this regard. A copy of the WHO fact sheet dated May 2006 is annexed as Annexure R5 (Appendix V).

4. Keeping in view the WHO May 2006 recommendation in it fact sheet that national authorities should adopt international standards to protect their citizens against adverse levels of RF fields and also to answer the issues raised in W.P. 2112 of 2004 before the Hon'ble High Court of Mumbai, the Union Health Ministry requested the Indian Council of Medical Research (ICMR) to give its inputs on the Health Hazards due to Mobile Telephone Towers. In meeting on May 29, 2006 the ICMR pointed out that the three completed human studies pertaining to base stations conducted by Santini et al (2002), Bortkiewicz et al (2004) and Hunter & Kundi et al (2006) do not report any quantitative parameters related to health hazards. It recommended the adoption of international exposure guidelines developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998) and the Institution of Electrical Engineers (IEE, 2005) as also the carrying out of epidemiological studies to develop the protocols and guidelines for siting of mobile phone base stations in the Indian context on the basis of a precautionary approach. A copy of the minutes of the Committee on Health Hazards due to Mobile Telephone Towers dated May 29, 2006 held at the ICMR Headquarters, is annexed as Annexure R6 (Appendix IV).

5. That in view of the May 29, 2006 recommendations of the aforesaid Committee the entire area of electromagnetic radiation is now under the continuous study of a Committee constituted by the Telecom Engineering Centre (TEC), consisting of Members from various Ministries/ Departments including Health Ministry and service providers. A copy of the composition of the Committee and its terms of reference is annexed as Annexure R7 (Appendix XI).

6. The petitioner has not carried out any survey whatsoever on the health effects of mobile base stations/towers. This is self-evident from its Survey Report at Page 188 of the petition in which Para 22 makes a broad sweeping statement of health effects without any supporting material which the Survey has revealed. Before the filing of the petition the petitioner has also not exercised the due care and caution of first contacting the relevant authorities and institutions on this subject. The petitioners Survey Report at Page 188 shows that the petitioner is aware of SACFA but it never

bothered to get in touch with SACEA before filing this petition. The Survey Report only has photographs of the towers located in various places without a single medical study done in the Survey by the petitioner about its bald allegation of the serious health effects of the electromagnetic radiation from the mobile base stations/towers.

7. In view of the above, the Union Government and its agencies are ensuring the fundamental rights of the citizens to safe environment and health. Hence the concern of the petitioner on this score is misplaced through a petition that makes a large number of averments without any supporting material or on any cogent basis. The petition fails to recognize that mobile phones today are a critical input to socioeconomic development which ensures the fundamental rights of free speech, information flow and exchange of ideas that constitute a democracy. Hence the petition deserves to be dismissed.

II. Para-wise reply (only significant ones):

8. The Synopsis makes alarmist statements about the ill effects on human health of the electromagnetic radiation from mobile base towers/stations without reference to a single study done by the petitioner or any material of such study being referred to or produced. The petitioner speaks of violation of building bylaws which is a concern of the local municipal authorities in whose jurisdiction the base tower/station may fall. The service providers are required to follow strictly the stringent norms as laid down by local government bodies, for erection of towers including for those on the top of buildings. If there is a specific local violation in any particular case then the petitioner should seek a remedy before the competent local authority or in the concerned High Court. The same applies to its statements concerning any particular base station/tower being located atop a heritage building and the provision of a red light atop a tower. Copies of norms/guidelines as laid down in this regard, by the Municipal Corporation of Delhi (MCD), Chief Administrator, HUDA, Panchkula and the Government of Uttaranchal are at Amnexure-R8 (not included).

9, 10, 11, 12.

13. Para 5 is denied concerning the ill effects of mobile base stations radiation since once again statement have been made without a single study or material being produced by the petitioner's Survey. It is significant that the annexure at the end of this Para shows only the photographs of the location of mobile base stations/lowers. The licensing claue-36 quoted by the petitioner is already taken care of by the stringent norms laid down by the local government bodies, which are followed by the service providers strictly. The Preliminary Submissions, particularly Para 8 are reiterated.

14. Para 6 is denied in so far as it consists of statements without any material whatsoever in support thereof. The Preliminary Submissions are reiterated and for particular base stations in particular municipalities the petitioner can approach the local competent authorities or the relevant High Court. The Para tries to explain the technicality/working principles of mobile communications. The radiation issues are only repetitions. The allegations by the petitioner about ignoring the building conditions before erecting the towers at various places are without any truth and denied. Preliminary Submissions are reiterated.

15. Para 7, 8 and 9 are denied in view of the Preliminary Submissions, particularly, Para 4. Foreign studies have been cited without showing how the petitioner applied these in its Survey and what were the results of the same?

16. Para 10 denied as no tower is permitted to be constructed without SACFA clearance. The few cases of violation as noted by the petitioner have been taken note of in the 14.3.2005 meeting of SACFA

and corrective measures have been ordered. The Department of Telecommunications and its technical wing the Telecom Engineering Centre monitor all violations. Cyclones and other force-majeure events are beyond anyone's control.

17. Para 11 denied as there are 8 towers already cleared by SACFA and are erected/operating in the Saket area. Apart from SACFA clearance permission from local body, in this case Municipal Corporation of Delhi, is required to be obtained before erection of any tower. Preliminary Submission, particularly Para 8 is reiterated. List of the above sites is at Annexure-R9 (not included).

18, 19, 20, 21.

22. Para 16: The guidelines being formulated by the Telecom Engineering Centre of Department of Telecommunications will take care of the suggestions made in para (a). The guidelines are being finalized.

    (b) & (c): The maintenance of towers are periodically done by the service providers themselves without which, the system may not function properly and coverage falls, which comes to their notice immediately.

    (d) to (l).

    (m) to (w): Already taken care of by SACFA procedures and the other maintenance of towers are taken care of by the service providers themselves in their own interest.

23. Para 17: It is submitted that the guidelines being formulated by the Telecom Engineering Centre of Department of Telecommunications will take of the issues.

24. Para 18: Preliminary submissions are reiterated.

25. Para 19-21: In view of the Submissions above there are no grounds for granting any relief to the petitioner. Hence the petition deserves to be rejected.

Deponent

VERIFICATIQN:

Verified on 28th February, 2007 at New Delhi, that the contents of the above affidavit are true to my knowledge and belief being based on the records and nothing material has been concealed there from.

DEPONENT

Appendix X

Rejoinder Affidavit by Fathehraj Thanvi a Trustee in the Petitioner Trust

Excerpts:

1. That the petitioner trust has filed a PIL under Article 32 of Constitution of India in the best interests of the public at large to ensure their safety from the dangerous Electromagnetic Magnetic Radiations emitted from various electronic gadgets and also the rampant erection/installation/fixation of Communication Towers/Base/Stations/Antennas on residential and other unsafe buildings throughout the country.

PRELIMINARY SUBMISSIONS

2. That the contentions raised and submitted in the counter affidavit filed by the respondents are completely false and frivolous and deserves to be rejected in toto and henceforth denied and refuted unless specifically required to be admitted. In fact, the signatory and authors of the counter affidavit dated 28th Feb, 2007 have tried to mislead, misrepresent facts, distort the recommendations of internationally reputed agency, WHO and the recommendations of a ICMR committee just to discredit the petition and to shield their ulterior motives, unnecessary delays and non-action of respondents. Leaving aside this counter affidavit, there has not been any response from any of the respondents, on requests and reminders sent on 1st Aug, 2005 & 18th Aug, 2005 and again on 30th Sep, 2005 & 3rd Oct, 2005 with specific directions of the Hon'ble Court on 26th Sep, 2005. This demonstrates total disregard of the highest court of law and public interest proposed to be served by the PIL.

PARA WISE REPLY/REJOINDER TO PRELIMINARY SUBMISSIONS MADE IN COUNTER AFFIDAVIT

3. Para 2 is not a true reflection of the position in relation to the clearance, installation, erection and operations of cell phone towers and base stations. As it is, SACFA does not mention any thing about examination from radiation hazards point of view. SACFA was constituted on 5th Feb, 1966, when mobile phones or cell phones were not even developed. The related harmful effects are the direct result of continuous exposure (24x7) of electromagnetic radiation, particularly from related base stations. Also, it is clearly mentioned in the SACFA procedures that it examines the siting cases primarily with respect to aviation hazard, obstruction to any existing/planned networks, and the Electromagnetic Interference/Compatibility. It is not sufficient and not fully truthful to just state that "proposals for erection of towers by mobile service providers are required to be submitted to the Standing Advisory Committee on Frequency Allocation (SACFA), prior to the construction of any such tower at any site. The proposals have to be circulated to the members for their comments/no objections." It is essential that respondents state in unambiguous terms whether all towers have specific clearances within the limits of existing procedures. There is no statement in the affidavit on how many such towers have been cleared in India, in Delhi, or even any specific colony in Delhi. Also there is no mention of any mechanism to identify towers which have been installed without SACFA clearance.

4. Para 3 of the Affidavit wrongly interprets and misleadingly concludes that the WHO fact sheet of May, 2006 shows that the petition is baseless, without any logic or reference to any specific Para or

line in the sited documents. In fact, the WHO fact sheet is clearly supportive of the PIL and related original prayers.

5. Para 3.1 is distorting and wrongfully commenting on scientific data. There is no data or truth in the statement that "human body absorbs up to five times more of radio frequency signals from FM radio or television." No FM or TV station has been allowed to come up on any residential building or hospital. There seems to total mix up of facts and figures. In fact, frequency of mobile phones is 5 to 20 times higher than FM or TV stations and more near to frequencies used in microwave ovens, which are known to be more efficient for 'cooking', a phenomena which changes physical condition of food permanently.

6. Para 3.2 is not a true reflection of data published in the reputed journals after detailed research. For example, Kaplan J, Polson P, Robert C, Lunan K and Gage M have reported in Radio Science (pp 135S-144S, 1982) on adverse biological and behavioral effects of prenatal and postnatal exposure to Electromagnetic Radiation in the squirrel monkey after performing experiments at 0.34 mW/g, and 3.4 mW/g, which are levels of radiations similar to those generated by mobile phones kept near human ear.

7. Para 5 gives no indications as to when the Committee will submits its report or what is the plan of action. The statement that the entire area of Electromagnetic Radiation is now under continuous study by the Committee constituted by the Telecom Engineering Centre (TEC) is just an open ended admission of delayed action getting perpetually delayed.

8. Para 8 states that the service providers are required to follow strictly the stringent norms of building byelaws as laid down by local government bodies, for erection of towers including for those on the top of buildings. In Delhi, these clearances have to be sought from MCD, after structural safety certificate issued by a qualified structural engineer by one of the following five institutions (as per office order dated 20th Nov, 2003).

   (a) Indian Institute of Technology (IIT), Delhi.

   (b) Central Building Research Institute (CBRI), Roorkee.

   (c) Rail India Technical and Economic Services Ltd. (RITES), Delhi.

   (d) National Council for Building Material, Faridabad.

   (e) Indian Institute of Technology (IIT), Roorkee.

   Of course, the affidavit has failed to identify even a single cell phone tower erected after formal clearance by any one of the above five institutions or by MCD. In any case it may not be easy for MCD to impose building byelaws on cell phone towers, when buildings are also being built without following the building byelaws.

9. Para 20 is an admission that there is no mechanism to even know the location of sites of cell phone towers, leave aside whether they are cleared or not.

10. Para 22 is another open ended set of statements such as 'guidelines being formulated' and 'guidelines are being finalized' without giving any indication on schedule of action.

JUSTIFICATIONS FOR PIL

11. Eminent scientist of the country and presently the President of India Mr. A.P. J. Abdul Kalam, in his address, has been frequently hammering on the ill effects of Electromagnetic Radiations and focusing on the urgent need to evolve reasonable standards, rules and regulations for telecom operations including health related restrictions and interference related measures. References: Inauguration of 'India Telecom 2006—Mapping the Road Ahead' at New Delhi on 14.12.2006, International Conference on Signal Processing Communications and Networking at Chennai on 23.02.2007, pertaining to Electromagnetic Pollution Hazards (Excerpt at Appendix III)

12. Specific observations and recommendations of the ICMR (Indian Council of Medical Research) committee dated 29th May, 2006, which are clearly supportive of the PIL, are:

    12.1 There are multiple sources of exposures to Electromagnetic fields including radio, FM Radio, Television and other household gadgets. There is a need to acknowledge the confounding effects of these sources of RF.

    12.2 There are two main types of effects of Electromagnetic Waves: Thermal and Non-thermal, which includes Electro-physiological/behavioral effects. These can be sleep disorders, cognitive disorders, memory disturbances, hearing disorders, etc.

    12.3 Factors like urbanization, siting of base stations, distance from towers, existence of multiple towers and multiple service providers, etc. all may have confounding effects which could be difficult to quantify.

    12.4 Subjective symptoms such as sleep disorders, cognitive disorders, memory disturbances, hearing disorders, etc. have been reported. However, the three completed 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.

    12.5 ICNIRP Guidelines in respect of restriction on Specific Absorption Rate (SAR) are available internationally and have been adopted by various European countries, such as UK, Australia, Malaysia and Korea. But China has adopted more stringent criteria.

    Based on the above observations and discussions, the ICMR committee recommends that:

    12.6 A precautionary approach should be adopted till further research data is available. It will not be amiss to adopt the ICNIRP guidelines for limiting EMF Exposure.

    12.7 The protocols to be followed and necessary guidelines for siting of mobile phone base stations may need to be developed as per its applicability for India.

    12.8 Periodic review of the status of knowledge in this area should be done and the recommendations may be revised accordingly.

    12.9 Recognizing that there is not enough evidence, data be generated through appropriate epidemiological studies (covering urban/rural population & varied exposure levels). Appropriate funds should be made available to the Institutions conducting these studies.

13. Similarly, the WHO (World Health Organization) Fact sheet No. 304 of May, 2006 states specifically the following, clearly in favor of and in support of the PIL:

13.1 Recent surveys have shown that the RF exposures from base stations range from 0.002% to 2% of the levels of international exposure guidelines, depending on a variety of factors such as proximity to the antenna and the surrounding environment.

13.2 There has been concern about possible health consequences from exposure to the RF fields produced by wireless technologies. This fact sheet reviews the scientific evidence on the health effects from continuous low-level human exposure to base stations and other local wireless networks.

13.3 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).

13.4 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.

13.5 WHO, through the International EMF Project, has established a programme to monitor the EMF scientific literature, to evaluate the health effects from exposure to EMF in the range from 0 to 300 GHz, to provide advice about possible EMF hazards and to identify suitable mitigation measures. Following extensive international reviews, the International EMF Project has promoted research to fill gaps in knowledge. In response national governments and research institutes have funded over $250 million on EMF research over the past 10 years.

PRAYER

Union of India and other respondents should be directed to take following actions within a specified time limit of, say, one month:

(i) Submission of action taken report with reference to prayers in the original PIL.

(ii) Submission of responses to requests made by the petitioner on 30th Sep, 2005 and 3rd Oct, 2005 as per directions of the Hon'ble Court on 26th Sep, 2005.

(ii) Submission of list of locations in the country (State/City/Locality wise) where cell phone towers have been erected with SACFA clearance, along with references of clearance by MCD or such local bodies. In the interim, this may be done for Delhi within 15 days.

(iii) Submission of the mechanism to identify cell phone towers which don't have MCD or SACFA clearances. List of existing towers erected without clearances and steps taken or proposed to be taken to dismantle related base stations.

(v) Placement on appropriate web sites proposed guide lines, based upon national or international standards, for limits on electromagnetic radiations from electrical/electronic instruments/devices used in residential, industrial areas, so as to invite suggestions and comments from interested people or organizations. While this must include mobile phones, related accessories and base stations transmitters and antennas, the guide lines also have to include other potential sources of radiation such as microwave ovens, mixer-grinders, electric shavers, vacuum cleaners, hair dryers, overhead transmission lines for electrical power, power transformers/sub-stations, electric traction, lifts/escalators, etc.

Appendix XI

Expert Group Members for Development of Guidelines on Electromagnetic Field and its Effects on Public Health constituted with reference to TBRR/F/EMF & Pub Health/TNC/13.Tec/2006 of Telecommunication Engineering Centre (TEC), Department of Telecommunications (DoT), dated Jun 27, 2006.

1. Ms Priya S Mohindru Primary member (COAI)
2. Mr Akash khosla Alternate member (COAI)
3. Mr Sanjay Singhal DGM (Tech), Corporate Office, MTNL
4. Mr D Singaravelu Dy.Wireless Advisor (WPC)
5. Dr Nilesh Dhoptey, Reliance Infocomm
6. Mr IK Sharma, Director DIT
7. Mr Sanjay Baisakhia, Scientist 'D', SAMEER, Chennai
8. Dr AK Harit, CMO, Directorate General of Health Services
9. Dr Bela Shah, Sr. DDG (NCD), ICMR
10. Mr BB Sehgal, ADG, BSNL
11. Cdr JP Gupta (AUSPI)
12. Mr Sunil Sharma, Alternate member (AUSPI)
13. Ms Netrika Sharma (AUSPI)
14. Dr Rakesh Mehrotra (AUSPI)
15. Mr Anand Dalal, Alternate member (AUSPI)
16. Mr Sukhjit Singh (HFCL)
17. Mr Shyam Kaushal (ITU APT Foundation)
18. Mr JP Garg, Sr. Advisor, Telecom, Nokia India
19. Mr Nafis Kazim, Joint GM (Products), Bharti Teltech
20. Mr Bharat Bhatia, Director, Motorola India

Terms of reference:

1. To study and develop expertise in area of Electromagnetic Radiation from Telecom infrastructure and its effects on public health.

2. To prepare precautionary guide lines for protection of public from Electromagnetic Radiation from Mobile towers and Mobile Phones within time frame of four months.

Appendix XII

Telecommunication Engineering Centre
(Department of Telecommunications)
Khurshid Lal Bhawan, Janpath, New Delhi-110 001
(Radio Division)

No. TBRR/F/EMF/ Pub. Health/TNC/13/2007 **Dated: 26.11.2007**

Subject: Minutes of the meeting for adoption of International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines in telecom sector in India for limiting EMF exposure

A meeting was held on 23.11.2007 in TEC, New Delhi under the Chairmanship of Sr. DDG, TEC to consider the proposal for adoption of International Commission on Non Ionizing Radiation Protection (ICNIRP) guidelines for limiting EMF exposure in Telecom Sector. The above proposal is under consideration of the Department of Telecom.

The following attended the meeting:

I. Invitees:

1. Shri V.P. Sandlas, Ex. CC (R&D), DRDO
2. Prof. J. Behari, JNU
3. Dr. V.S. Tripathi, Ex. Joint Director, DRDO
4. Shri N.K. Goyal, TEMA
5. Shri R.K. Vohra, Tata Telecom (AUSPI)
6. Ms. Priya Sawhney Mohindru, COAI
7. Shri Bhanu Chaddha, COAI

II. TEC Officers:

1. Sh. R.N. Padukone, Sr. DDG, TEC
2. Sh. Ashok Kumar, DDG (R), TEC
3. Sh. Arun Agarwal, Director (R), TEC
4. Sh. O.P. Agarwal, ADG (R), TEC
5. Sh. B.K. Gandhi, ADG (R), TEC

2. Sr. DDG welcomed the participants and gave a brief background about the ICNIRP guidelines and its importance and relevance to human health. Sr. DDG, TEC further mentioned that these guidelines have been adopted in many countries and the proposal under discussion is to adopt the same in telecom sector in India. Sr. DDG, TEC invited the views of the participants on this subject.

3. After detailed discussion on this subject, it was unanimously agreed upon by all to adopt the ICNIRP guidelines in telecom sector in India for limiting EMF exposure.

4 In the end Sr. DDG, TEC thanked all the participants for their views and co-operation during the discussion.

The meeting ended with a vote of thanks to the Chair.

(Arun Agarwal)

Director (R)

Appendix XIII

Telecommunication Engineering Centre
K.L.Bhawan, Janpath, New Delhi 110001
(Radio Division)

TBR/ F/EMF & Pub Health/TNC 13.TEC/2003 **Dt. 18-01-2008**

Subject: Summary Record of Joint meeting of Sub-DCC and Expert Group on Guidelines for Complying with Limits for Human Exposure to Electromagnetic Fields (Base Station Antennas and Mobile Telephones/ Radio Terminals)

A Joint meeting of Sub-DCC and Expert Group to discuss Draft Guidelines for Complying with Limits for Human Exposure to Electromagnetic Fields (Base Station Antennas and Mobile Telephones/ Radio Terminals) was held on 18th December, 2007 at 14.00 Hrs in the New Committee Room, 3rd Floor, Telecommunication Engineering Centre, New Delhi.

2. The following participated in the meeting:

1. Sh. P. K. Pandey, Jt. DDG (R), BSNL HQ, New Delhi
2. Shri J.P Gupta, Reliance, New Delhi
3. Shri Bhanu Chaddha, COAI, New Delhi
4. Sh. Bharat Bhatia, Motorola & TEMA, New Delhi
5. Sh. Shayam Kaushal, WiMax Forum, New Delhi
6. Sh. R K Vohra, Tata Teleservices, New Delhi
7. Shri U K Srivastava, DDG (R & Sat), TEC, New Delhi.
8. Shri Arun Agarwal, Director (R), TEC, New Delhi.
9. Sh. O.P. Agarwal, ADG(R), TEC, New Delhi.

DDG (R & Sat), TEC welcomed the members and briefed them on the agenda of the meeting. This was followed by a brief introduction by the participants. The members were requested to send their comments, if any, on the draft guidelines for further discussion.

3. The summary record of the discussion in the meeting is as follows:

4. Clause 1.0: Scope

COAI asked about the mode for making the guidelines operational as well conducting the measurements for compliance. It was discussed that the guidelines would be made operational as per the decision of the DoT HQ. Regarding measurements, Clause No. 1.7 of this document provides details of Conformance Assessment Body (CAB) in this matter.

5 Clause 1.1: Introduction

The committee observed that this sub-clause is not directly related to guidelines & provides only background. Thus, it may be suitably modified & updated.

6 Clause 1.3: Cellular Mobile Telephone System N/W Architecture

It was discussed that the brief detail of sub systems from (a) to (d) may be deleted as they do not constitute a part of these guidelines as such.

7 Clause 1.4: Handsets

COAI suggested that the last sentence of this sub-clause may be deleted.

8 Clause 1.7:Concept of Conformity Assessment Body (CAB)

It was agreed upon to provide more details of CAB for measurement & testing purposes. Further, it was also suggested that Test Procedures may be developed separately for evaluating compliance with emission safety limits. TEC informed that ITU-T K.52, K.61 and IEC 62209 provide basic framework for testing.

9 Clause 2.1.2.1: Unintentional Emitters - Telecom Equipment

In the 3rd line, "emission" may be replaced with "spurious emission" for more clarity.

10 Clause 2.2: Base Station Antenna Siting practice

Mr. Bharat Bhartia, Motorola & TEMA and COAI suggested to use "Malaysian EMF Guidelines" as reference for Base Station Sitings (i.e. all types of BTS including Macro, Micro & Pico antennas), and modification to points 2.2 (i) and 2.2 (iv) may be considered accordingly.

11 Clause 4: Safety procedures for operators, Public & maintenance personnel from EMF.

COAI suggested to:

(a) replace "sufficient" with "suitable" in point (vi)

(b) delete point (viii) as it is related to "health surveillance" and not telecom.

12 Clause 7: Use of mobile phones/terminals in different operating environment

Mr. Bharat Bhatia, Motorola & TEMA suggested that the display of "SAR" value as a menu option on the screen of the phone may be deleted as it is not as per international practice. As a norm, the SAR value is provided in the user's manual & on manufacturers' website.

13 Other issues

COAI representative said that they would require 4 weeks time to provide detailed submission on the draft guidelines.

14 As their was no other item for discussion, Director (R), TEC thanked all the participants for their active participation and contribution in the meeting.

(Arun Agarwal)

Director (R)

To: 1. All Sub-DCC & Expert Group Members
2. All Participants

Appendix XIV

Telecommunication Engineering Centre
(Department Of Telecommunications)
K.L. Bhawan, Janpath, New Delhi – 110 001
(Radio Division)

No. : TBR/ F/EMF & Pub Health/TNC 13.TEC/2003 Dated: 29.02.2008

Sub: Minutes of the DCC meeting for the finalization of "Guidelines for complying with limits for human exposure to Electromagnetic Fields: Base Station Antennas and Mobile Telephones/ Radio Terminals"

A DCC meeting was held on 18.02.2008 at 14.00 hrs in the New committee Room, TEC, New Delhi for finalizing the **"Guidelines for complying with limits for human exposure to Electromagnetic Fields: Base Station Antennas and Mobile Telephones/ Radio Terminals Transmission (Radio Products)."**

2. The list of participants is placed at Annex-1.

3. DDG (R) welcomed the participants and briefed them on the agenda of the meeting. The summary record of the discussion is given below. Further, it is requested to send your comments, if any, on the minutes of the DCC meeting by 11.03.2008. In case, no comments are received by the due date, the minutes would be presumed to be approved.

4. Summary Record of the meeting:

Clause 1.0: Scope

It was agreed upon by the DCC that a separate document on "Action Plan for evaluating compliance with the EMF Guidelines" would be prepared by involving all the stakeholders. It was further discussed that whereas the "Guidelines" under consideration would provide details about 'what is to be done for limiting EMF exposure', the "Action Plan" would deliberate on "How it is to be done", i.e. assessment / measurement methodology. It was again mentioned by COAI that they need some more time to provide detailed submission on the draft guidelines.

Clause 1.3: Cellular Mobile Telephone system Network Architecture

DCC agreed to shift to this clause as an Annex to this document as it is primarily informative in nature for reference only.

Clause 1.4: Regarding Handsets

COAI proposed and it was agreed upon by DCC that the last sentence i.e. " Therefore, the RF exposure to a user of a mobile phone located 10s of centimeters from the head (using a "hands free" appliance) is far lower than to a user who places the headset against the head." may be deleted.

Clause 1.6.3: Multiple sources and frequencies

DCC considered that Power density calculation for compliance with ICNIRP limits may also be included in the Guidelines to check that the safe distance calculated is valid. The brief details are as below:

$$W = EIRP/ (4 \text{ pie } r^2)$$
$$= P_T G/(4 \text{ pie } r^2)$$

Where,

W is the safe Power density limit as per ICNIRP
EIRP is the effective isotropically radiated power, in watts (W);
r is the distance from the antenna, in meters (m), i.e. Exclusion Zone Distance
P_T is the net power delivered to the antenna, in watts (W);
G is the antenna gain (power ratio) with respect to an isotropic antenna; and
Pie 3.14

The equation above represents the estimation of the Power density on the main beam axis. The related details may be suitably included for compliance.

Clause 1.7: Concept of Conformity Assessment Body (CAB)

COAI said that self certification may be accepted in place of "Compliance Testing" by CAB as presently no such testing infrastructure exists in India. Sh. V.P. Sandlas, Ex CC (R & D), DRDO suggested that in view of the observations of COAI , the first para may be modified as: "Recognizing the importance of scientific measurements to establish that EMF safety guidelines are being followed to this effect, it is required to evolve the concept of Conformity Assessment which will perform the measurement functions & provide certification thereof. "

COAI suggested that the 2nd paragraph of 1.7 regarding mandatory testing may be deleted.

Clause 2.1: Evaluation of compliance with EMF safety limits - Measurement at Site

It was considered to suitably include the following details for measurement at site for more clarity:

i) The electromagnetic fields being measured shall use, in first step, isotropic probes because the electromagnetic fields are usually from multiple sources and from various directions. Then the actual measurements may be with directional, and/or frequency sensitive/narrowband probes.

ii) The measurement of the fields shall be taken at several locations around the antenna. The FF is used as an indicator to establish suitable measuring instruments and selection of measuring locations around the antenna.

iii) The duration of the readings taken shall be averaged over at least 6 minutes per location or as per actual requirements.

iv) The time of day when the readings are taken is important because during heavy traffic the level of RF radiation from the transmitting antenna naturally increases. Therefore as a guide, readings should be taken at the site's busiest period of the day, which is defined as the site's busy hour. A site's busy hour can be determined from daily traffic recordings commonly obtainable from the operator's mobile switch.

Clause 2.1.2.1: Unintentional emitters - telecommunication equipment

DCC agreed that in the 3rd line, "emission" may be replaced with "spurious emission" for more clarity.

Clause 2.1.4.3: Calculation methods for compliance with ICNIRP limits

DCC considered that 'Power density' may also be included as an alternative parameter wherever applicable, along with electric & magnetic fields for compliance with limits. Further, a radio site's exclusion zone may be determined based on theoretical calculations till adequate "Measurement & testing infrastructure", for the same, is available. However, actual site measurements to be used to verify the accuracy of the theoretical calculations and final compliance.

Clause 2.2: Measures for Base Station Antenna Siting

2.2(i): Exclusion zone distance

It was discussed to mention that the distance of 3 m, given in this sub-clause, may be considered for reference only as normally BTS antennas have an EIRP of 1 kW. However, the actual exclusion zone/distance will depend on the calculated value as per the applicable site parameters of the RF system under consideration. Further, in case of sharing of infrastructure(i.e. in a multi-operator scenario), the custodian of that RF station would be responsible for the provision of exclusion zone through fences or barriers or other protective measures to restrict access to areas due to cumulative EMFs of multiple RF antenna emissions.

2.2 (iv): Sign boards/ Warning Signs at antenna sites

DCC considered that information about signage placement at antenna sites should be mentioned in a more explicit manner and accordingly, the following may be suitably added:

"The signage is recommended to be placed at a visible position in close proximity of the radio antenna and at the antenna's mounting structure. This signage is specifically meant for the attention of the worker who will be working within the exclusion zone of the transmitting radio antenna. It should be placed at the boundary of the exclusion zone to warn the worker and public of a nearby RF antenna.

In certain places such as where mobile antennas are installed inside the building, signage is not necessary as RF safe level distance does not normally exceed 10s of centimeters from the antenna and is moreover installed at ceiling height.

Therefore, the signage placement may be as below:

a) At the boundary of the exclusion zone.

b) If signage is placed on an antenna mounting structure, the signage needs to be clearly readable at the boundary of the exclusion zone.

c) The operators can, at their own discretion, implement additional measures as necessary for the safely of workers and public at the site.

2.2 (viii): Site Record Keeping

DCC considered that it is imperative to keep the "Site radio equipment installation record" at the site. The network operator would make information on the site RF emission database available.

The following information would be included in the "on the site RF emission database":

a) Radio equipment layout plan.
b) Antenna layout plan.
c) Brief details of Radio equipment technical specifications
d) Antenna technical specifications
e) RF emission levels showing the details of exclusion zone, fencing etc. relative to the site make up along with associated calculation for conformance with the ICNIRP/ITU-T K.52 emission limits
f) Operator's contact number contactable 24 hours 7 days a week.
g) Date of last update of Site Records book.

Clause 4.0: Safety procedure for operators, Public and maintenance personnel from Electromagnetic fields

4 (vi): It was agreed upon that "sufficient" may be replaced with "suitable", i.e. the sub-clause may be read as: "Suitable training should be imparted to personnel working in EMF area."

4 (viii): This point regarding "Appropriate health surveillance by the employer' was agreed for deletion as not related to telecommunication as such.

Clause 7.0: Measures for use of mobile phones/Terminal in different operating environments

7.0 (i): Regarding provisioning of SAR value for each handset

TEMA suggested & DCC agreed that the display of "SAR" value as a menu option on the screen of the phone may not be required since as a norm followed world-wide, the SAR value is provided in the user's manual & on manufacturers' website.

The meeting ended with a vote of thanks.

(Arun Agarwal)
Director (R)

To:

1. All Participants
2. Members of DCC

Annex-1

List of Participants: DCC Meeting of Radio Division Dt. 18-02-2008 on "EMF Guidelines"

i) Sh. Ram Krishna, GM (A/T), T&D Circlr, BSNL, New Delhi
ii) Sh. V.K. Chopra, GM (QA), BSNL, New Delhi.
iii) Sh. V.P. Sandlas, Ex CC (R & D), DRDO, New Delhi
iv) Sh. N.K. Goyal, TEMA, New Delhi.
v) Sh. Bharat Bhatia, TEMA, New Delhi.
vi) Sh. T.R. Dua, COAI, New Delhi
vii) Ms. Kanupriya Bhardwaj, Manager Regulatory Affairs, Bharti Airtel
viii) Ms. Priya Sawney, COAI, New Delhi
ix) Sh. Bahnu Chaddha, COAI, New Delhi
x) Sh. Sanjeev Arora, Vodafone, New Delhi
xi) Sh. S.S. Sharma, Vodafone, New Delhi
xii) Sh. Gajendra Upadhyay, IDEA, New Delhi.
xiii) Sh. Rajesh Gupta, AirTel, New Delhi
xiv) Sh. U.K. Srivastava, DDG (Sat) TEC, New Delhi.
xv) Sh. Arun Golas, DDG (T) TEC, New Delhi.
xvi) Sh. Ashok Kumar, DDG (R), TEC, New Delhi.
xvii) Sh. Arun Agrawal, Director (R), TEC, New Delhi
xviii) Sh. Ajay Kumar , AD (R), TEC, New Delhi
xix) Sh. M.C Sharma, AD (R), TEC, New Delhi

Appendix XV

Report of the Inter-ministerial committee (IMC)

An Inter-ministerial committee (IMC) consisting of officers from Department of Telecom (DoT), Indian Council of Medical research (ICMR), Ministry of Health, Department of Biotechnology (DoB) and Ministry of Environment and Forest (DoEF) was constituted on Aug 24, 2010 to examine the effect of EMF Radiation from base stations and mobile phones.

i)	Advisor (Technology)	Chairman
ii)	Sr. DDG (BW), DoT	Member Secretary
iii)	Scientist ICMR, Ministry of Health	Member
iv)	Advisor, Dept. of Bio-technology	Member
v)	Scientist 'E', MOEF	Member
vi)	DDG (R) TEC, DoT	Member
vii)	Jt. Wireless Adviser, WPC, DoT	Member
viii)	DDG (CS), DoT	Member

Terms of Reference:

1. Effect of RF radiation emitted by cell phone towers and mobile hand-sets on human health at levels below the existing standards.

2. Proliferation of electromagnetic field on environment.

3. Examination of the scientific evidence and research on the effect of electromagnetic radiation exposure from cell phone tower and from Mobile handsets conducted by Medical Council or other bodies in India and abroad.

4. Adoption of reference levels for power density from base stations in mobile frequencies of IMT bands for limiting electromagnetic field exposure in telecom sector in India.

5. Adoption of safety limits for exposure to radio frequency energy produced by mobile hand-sets, i.e. Specific Absorption Rate (SAR) levels of exposure from a mobile hand-set and disclosure of information for the hand-set.

6. Any other suggestions/measures to be taken on EMF radiation from cell phone towers and mobile hand-set.

The IMC examined 90 international and national studies/reference papers and recommended lowering mobile towers' EMF exposure limits to $1/10^{th}$ of the ICNIRP prescribed limits as a matter of abundance precaution. These recommendations have been accepted by the Govt. and directions issued vide DoT letter no. 800-15/2010-VAS (pt.) dated Apr 10, 2012 making the new norms applicable from Sep 1, 2012;

SAR limit of mobile hand-sets has also been reduced from 2.0 W/kg to 1.6 W/kg averaged over 1 gram of human tissue.

Excerpts of the IMC Report:

During the deliberations of the Committee, presentations were also made by ICMR Scientists; Prof. J. Behari, School Of Environment Sciences, JNU; Representative of Telecom Equipment Manufacturers Association (TEMA), Cellular Operators Association of India (COAI), Telecom Users Group Of India (TUGI), Consumer Care Society (CCS), Bangalore; Prof. Girish Kumar, IIT Bombay; and Scietists of MoEF (Wild Life Division).

The Radio Frequency (R.F.) sources in India:

S. No.	RF Source	Frequency	Tx Power	Numbers
1	AM/FM Tower	540 KHz-108 MHz	1 KW-300 KW	380
2	TV Tower	48 MHz-814 MHz	10–500 W	1200
3	WiFi	2.4-2.5 GHz	10-100 mW	-
4	Cell Towers	800, 900, 1800, 2450 MHz	20 W	5.4 Lakhs
5	Mobile Phones	GSM-1800/CDMA GSM-900	1 W 2W	700+ Million

There are many different types of base stations: 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. The maximum power for individual macro cellular base station transmitter is 20 watt. 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 very 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 watt and have fewer transmitters because of their smaller coverage area.

For installation of mobile towers the Standing Advisory Committee on Radio Frequency Allocations (SACFA) clearances are issued by the wireless monitoring organization, DOT after getting no objection from Defence & airport authority considering aviation hazards, obstruction to line of sight of existing/ planned networks and interference EMI/EMC. In India, there is no restriction on the location of the towers leading to a situation of jumble of towers/antennas all throughout. There is mushroom growth of mobile tower infrastructure seen which is contrary to the practice in developed countries.

Studies have shown that human beings are bio electrical systems. The heart and the brain are regulated by internal bioelectrical signals. Environmental exposures to EMF can interact with fundamental biological processes in the human body and in some cases this may cause discomfort as reported in literature. There have been growing public concern of possible adverse health effects due to EMF Radiation. The area of concern is the radiation emitted by the fixed infrastructure used in mobile

telephony such as base stations and their antennas, which provide the link to and from mobile phones. This is because, in contrast to mobile handsets, it is emitted continuously and is more powerful at close quarters. The field intensities drop rapidly with distance away from the base of the antenna because of the attenuation of power with the square of distance. Following the enormous increase in the use of wireless telephony, mobile phone radiation and health concerns are being raised from time to time.

There are two distinct possibilities by which the Radio Frequency Radiation (RFR) exposure may cause biological effects. There are thermal effects caused by holding mobile phones close to the body. Secondly, there could be possible non-thermal effects from both phones and base stations. One effect of microwave radiation is dielectric heating, in which any dielectric material (such as living tissue), is heated by rotation of polar molecules induced by the electromagnetic field. The thermal effect has been largely referred to the heat that is generated due to absorption of EMF radiation. In the case of a person 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. The brain blood circulation is capable of disposing the excess heat by increasing the local blood flow. However, the cornea of the eye does not have this temperature regulation mechanism. The Thermal effect leads to increase in body temperature.

The communication protocols used by mobile phone often result low frequency pulsing of the career signal. The non-thermal effects are attributed to the induced electromagnetic effects inside the biological cells of the body which is possibly more harmful. People who are chronically exposed to low level wireless antenna emissions and users of mobile handsets have reported feeling several unspecific symptoms during and after its use, ranging from burning and tingling sensation in the skin of the head, fatigue, sleep disturbance, dizziness, lack of concentration, ringing in the ears, reaction time, loss of memory, headache, disturbance in digestive system and heart palpitation, etc. There are reports indicating adverse health effects of cell phones which emit electro-magnetic radiation, with a maximum value of 50% of their energy being deposited when held close to the head.

The effects of long term exposure to wireless technology including emissions from cell phones and whole body exposure to RF transmission from cell tower antenna is simply not known yet with certainty. Scientific studies as yet have not been able to confirm a cause-and-effect relationship. The research has not so far separated these symptoms from electromagnetic radiation hence all the above symptoms can also be attributed to stress. 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 risk of radio frequency radiation adverse effect.

Some Studies reported that mortality at communication towers over 200 ft may be a threat to the healthy population of birds, and electromagnetic radiation from cell phone towers may probably be the reasons for the vanishing butterflies, bees, insects and sparrows. Some other Studies have also shown that there seems to be effects on birds exposed to the electromagnetic field radiation and losing navigational ability.

A number of studies have reported the link between exposure to radio frequency radiation and occurrence of health disorder, i.e. effect on cell growth, cell differentiation, DNA, immune system, hormonal effects, reproduction, neurological, cardiovascular systems, blood brain barrier, interference with gadgets, stress proteins, skin, sleep disorder etc. As these studies were not well designed and the number was not statistically significant, these observations have not been considered conclusive.

India has adopted the following ICNIRP guidelines for basic restrictions and reference levels for limiting Electromagnetic fields exposure in the Telecom Sector:

Type of exposure	Frequency range	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power density (W/m^2)
General Public	400-2000 MHz	$1.375f^{½}$	$0.0037f^{½}$	f/200
	2-300 GHz	61	0.16	10

The existing standards are based on thermal (heating) limits and do not address non-thermal (or low intensity) exposures which are reported to cause Biological effects. The present ICNIRP/FCC limits are insufficiently protective of public health and require reconsideration.

International Exposure limits for RF fields (1800 MHz):

12 W/m^2	USA, Canada and Japan
9.2 W/m^2	ICNIRP and EU recommendation 1998 – Adopted in India
9 W/m^2	Exposure limit in Australia
2.4 W/m^2	Exposure limit in Belgium
1.0 W/m^2	Exposure limit in Italy, Israel
0.5 W/m^2	Exposure limit in Auckland, New Zealand
0.45 W/m^2	Exposure limit in Luxembourg
0.4 W/m^2	Exposure limit in China
0.2 W/m^2	Exposure limit in Russia (since 1970), Bulgaria
0.1 W/m^2	Exposure limit in Poland, Paris, Hungary
0.1 W/m^2	Exposure limit in Italy in sensitive areas
0.095 W/m^2	Exposure limit in Switzerland, Italy
0.09 W/m^2	ECOLOG 1998 (Germany) Precaution recommendation only
0.001 W/m^2	Exposure limit in Austria

Reference levels for the general public at 900 & 1800 MHz:

Country or Organization	Document	900 MHz		1800 MHz	
		Electric field (V/m)	Power density W/m	Electric field (V/m)	Power density W/m
International health based guidelines					
International commission of non ionizing radiation protection	ICNIRP 1998	41.25	4.5	58.3	9.0
Institute of Electrical and Electronics Engineers	IEEE,1999 USA	47.6	6.0	67.3	12
European Committee for Electro-technical Standardization (Technical committee)	CENELEC,1995	41.1	4.5	58.1	9.0
National health based guidelines					
Standard Association of Australia	AS/NSZ, 1998	27.5	2.0	27.5	2.0
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, 1998b	20	1.0	20	1.0
Italy/ Ministry of Environment	Italy 2, 1998b	6	0.1	6	0.1
Switzerland/Schweizer Bunndesrat	NISV, 1999	4	0.04	6	0.1
Austria Local	SvorGW 1998	0.6	0.001	0.6	0.001

Bio-initiative report published in US contains biologically based public exposure standards for electromagnetic fields at different radio frequencies. Bio-initiative report 2007 recommended 1000 $\mu W/m^2$ for outdoor cumulative RF exposure and power density limit up to 50 $\mu W/m^2$ with upper limit as 100 $\mu W/m^2$.

Stricter radiation norms are being followed in different countries and they have specified their own radiation level keeping in view the environmental and physiological factors varying from 0.001 W/m^2 to 2.4 W/m^2 at 1800 MHz operating frequency where as in India the prescribed reference level at 1800 MHz is 9.2 W/m^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 prescribe reference level. 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 radio waves emitted by GSM handset have a peak power of 2 W and other digital mobile technologies such as CDMA and D-AMPS use lower output power, typically below 1 W. In most systems the cell phone and the base station check reception quality, signal strength and the power level is increased or decreased automatically, within a certain span, to accommodate for different situations such as inside or outside the buildings and vehicles. As the phone moves closer to the base stations, the power emitted from the phone antenna is reduced.

Specific Absorption Rate (SAR) is a measure to know the levels of exposure to electromagnetic fields from mobile handsets. It the rate at which human body absorbs electromagnetic power radiated from mobile phones. India has adopted the following ICNIRP guidelines as standard for safety limits of exposure to radiofrequency energy produced by mobile handsets:

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

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

In the USA, the FCC has set a SAR limit of 1.6 watt per kg averaged over a volume of 1 gram of tissue, for the head. In Europe the limit is 2 watt per kg, averaged over a volume of 10 gram of tissue. SAR values are heavily dependent on the size of the averaging volume. As the costs of mobile phone technology have fallen, their use has increased dramatically and the overall levels of exposure of the population as a

whole have therefore increased drastically. Keeping in view of the fact, the high population density, body mass index of a common Indian is lower that the European countries, and the fat content of an average Indian is also lower as compared to these countries, Indians are more susceptible towards the EMF radiation. Further when the handset operates at full transmitter power because of a long distance to the next base station, the local SAR values are reported to be in the range of 1 watt / kg. Hence we may consider adopting stringent standards in India i.e. the absorption of radio frequency radiation limited to 1.6 Watt/Kg with in 1 gram of human tissue as per the FCC norms of United States.

Recommendations:

Mobile Handsets:

1. 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.

2. SAR value information is to be embossed and displayed in the handset.

3. Information on SAR values for mobile handsets should be readily available to the consumer at the point of sale so that one can make sure of the SAR value of the handset while buying a cell phone.

4. 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.

5. Mobile hand set manufactured and sold in India or Imported from other countries should be checked for compliance of SAR limit and no hand sets of SAR value above the prescribed standard adopted in India should be manufactured or sold in the country.

6. SAR data information of the mobile handsets should be available on the manufacturer's web site and in the manufacturer's handset's manual.

7. The manufacturer's mobile handset booklet should contain the following for safe use:

    a) Use a wireless hands-free system (headphone, headset) with a low power Bluetooth emitter to reduce radiation to the head.

    b) When buying a cell phone, make sure it has a low SAR.

    c) Either keep your calls short or send a text message (SMS) instead. This advice applies especially to children, adolescents and pregnant women.

    d) Whenever possible, use cell phone when the signal quality is good.

    e) People having active medical implants should keep their cell phone at least 30 cm away from the implant.

8. Information on Government website with list of SAR values of different mobile phones.

Mobile Base Stations:

9. 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.

10. To provide static continuous testing /measuring centers for online monitoring of radiation level at prominent places in metro/cities and the data to be sent to the central server for information.

11. Apart from self certification for compliance of radiation norms on EMF exposure as is presently being done, the mobile service providers should also measure the radiation level of certain prominent places and display it for information of the general public. They should also have mobile unit for its measurement wherever necessary.

12. 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.

13. Impose restrictions on installation of mobile towers near high density residential areas, schools, playgrounds and hospitals.

14. For the future expansion of telecom network in the country use low power micro cell transmitters with in-building solutions in place of the present trend of using high power transmission over mobile towers/high rise buildings.

15. To conduct the long term scientific research related to health aspect of EMF radiation exposure and associated technologies in India in the following areas:

    - Health effect of RF exposure in children.
    - Health effect of RF exposure in Foetus, mothers and elderly persons.
    - Combined electromagnetic field radiation effect exposure from multiple antennas of a shared infrastructure sites.

16. It is recommended for use of hands free and ear phone technologies such as blue tooth handsets and ear phone so as to minimize the contact of head with cell phone.

17. 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.

Appendix XVI

Report of the 13-Member Committee

Allahabad High Court, Lucknow Bench in order dated 10.01.2012 in writ petition No. 11275 (M/B) of 2010, issued following direction:

"We direct the Government of India to constitute a Committee of five members of Electrical Engineering Department of the IITs of Mumbai, Kharagpur, Kanpur, Delhi, Roorkee, including Prof. (Dr) Girish Kumar and four other prominent persons of other scientific institutions of the country like AIIMS (Delhi), Indian Council of Medical Research, etc to submit a report so that the Government of India may take necessary precaution while granting permission for establishment of mobile towers as well as to regulate sales of mobile with necessary precautions."

In compliance of above court order, a committee was constituted vide DoT letter No. 17-63/2011-CS-III dated Aug 20, 2013. Nominations were asked from the heads of the respective organizations. Based on the nominations received from IIT Mumbai, IIT Delhi, IIT Kharagpur, IIT Kanpur, IIT Roorkee, AIIMS Delhi, Indian Council of Medical Research, New Delhi, Indian Institute of Toxicology Research Lucknow, Science & Engineering Research Board (SERB) under the Department of Science & Technology (DST), members have been included in the Committee. Further, Department of Telecom has nominated four officers working in the field of EMF Radiation. Following is the constitution of the committee, consisting of thirteen members:

1. Shri S. S. Sirohi**,** Senior Deputy Director General, Telecom Enforcement, Resource & Monitoring (TERM), DoT – Chairman

2. Dr. (Prof.) Ajoy Chakraborty**,** Professor, Department of Electronics & Electrical Communication Enginneering, IIT Kharagpur – Member

3. Dr. (Prof.) Ajit Kumar Chaturvedi, Dean of Research & Development, IIT Kanpur – Member

4. Dr. (Prof.) Ranjan Mallik, Department of Electrical Engineering, IIT Delhi – Member

5. Dr. (Prof.) S.N. Sinha, Emeritus Fellow, Department of Electronics & Communication Engineering, IIT Roorkee –Member

6. Dr. (Prof.) Girish Kumar, Electrical Engineering Department, IIT Mumbai – Member

7. Dr. R. S. Sharma, Deputy Director General (SG) Division of RCH, Indian Council of Medical Research (ICMR) – Member

8. Dr. Sarat P. Chandra AIIMS, New Delhi – Member (Dr. P. P. Kotwal and Dr Vivek Tandon from AIIMS attended the meetings as alternate Member)

9. Dr. R.C. Murthy, Chief Scientist and Head, Analytical Chemistry, Indian Institute of Toxicology Research, Lucknow -- Member

10. Shri S. S. Kohli, Director/Sc. 'F', SERC Division, Science & Engineering Research Board (SERB), Department of Science & Technology (DST) – Member

11. Shri U. K. Srivastava, Deputy Director General, Telecom Engineering Center (TEC), New Delhi, DoT—Member

12. Shri Nitin Jain, Deputy Director General (CS), New Delhi, DoT—Member

13. Director (CS-III), DOT-- Member Convenor/Shri Rama Shankar Ram, Director (CS-TP), DoT– Alternate Member, Convenor

The Committee submitted its report on Jan 17, 2014 observing that DoT had taken adequate steps to impose stricter precautionary limits for EMF radiation (reduction of EMF radiation limits from Base Stations to $1/10^{th}$ of ICNIRP limits, and SAR level of 1.6 W/Kg for mobile handsets, averaged over 1 gram of human tissue); which was accepted by the Ministry of Communications & Information Technology, Government of India vide DoT Office Memorandum dated Feb 27, 2014, specifically highlighting and notifying the following recommendations of the Committee as:

(i) The Department of Telecom should continue the extensive audit of the self-certificates being submitted by the Telecom Service Providers in order to ensure compliance to the prescribed stricter norms of EMF radiation from BTS tower.

(ii) The Department of Science and Technology and Indian Council of Medical Research (ICMR) should carry out/facilitate extensive studies, on the Indian conditions with special focus on prolonged use of mobile phone, to conclusively determine sensitivity of EMF Radiation/ possible health hazard risk of EMF radiation, which at present is not proven. These Indian specific scientific studies should aim at generating scientifically credible data and evidences by involving Ministry of Science and Technology, ICMR, Ministry of Environment & Forest, DoT and other relevant organisation. The Government of India should make available funds to ensure extensive long term/short term research and studies on possible health effects of EMF radiation on humans.

(iii) Department of Telecom has already taken measures to create awareness among public by issuing “Precautionary guidelines for the mobile users” and publishing advertisements in National & Regional Newspapers for ensuring safety from EMF radiations emitted from Mobile Towers & handsets for the information of the general public.

(iv) A hand book on “Mobile Communication - Radio Waves & Safety” has also been issued by Department of Telecom. These measures, inter-alia, include:

- Frequently asked questions (FAQ)
- Myths and Facts
- Precautionary guidelines for Mobile Users

These precautionary guidelines, inter-alia, include the following precautions:

- Keep distance – Hold the cell phone away from body to the extent possible.
- Use a headset (or ear bud) to keep the handset farther from your head.
- Do not press the phone handset against your head.
- Use a wired headset.
- Limit the length of mobile calls.
- Use text as compared to voice wherever possible.
- Put the cell phone on speaker mode.

(v) Committee recommends that there is a need to step up effort by DOT to spread public awareness and allay undue apprehensions in regard to possible health effects of EMF radiation. This can be done through print media/electronic media and other communications channels and tools along with conducting market research/survey, workshops and seminars.

(vi) Annual discussion, meetings/seminars should be conducted by the Government by inviting experts from various academic and research institutions for continual evaluation of scientific evidence published worldwide with an aim to monitor the progress in research on the effects of EMF radiation.

(vii) In order to get latest updates on EMF radiation related issues, DoT should actively participate in the deliberations of various International standards bodies, including WHO, involved in the study of EMF radiation.

(viii) Department of Telecom should create national EMF web portal to provide public access to the status of compliance, of the prescribed norms, of all BTSs/mobile towers in the country and related relevant information.

Indian National Academy of Engineering

The Indian National Academy of Engineering (INAE), founded in 1987, comprises India's most distinguished engineers, engineer-scientists and technologists covering the entire spectrum of engineering disciplines. INAE functions as an apex body and promotes the practice of engineering & technology and the related sciences for their application to solving problems of national importance. The Academy provides a forum for futuristic planning for country's development requiring engineering and technological inputs and brings together specialists from such fields as may be necessary for comprehensive solutions to the needs of the country. INAE is an autonomous institution supported partly through grant-in-aid by Department of Science & Technology, Government of India. INAE represents India at the International Council of Academies of Engineering and Technological Sciences (CAETS), USA and is one of the member-academies of CAETS.

Among other activities, Academy organizes Symposia/Seminars/Workshop/Conferences at national/international levels on topics of national importance. Based on the deliberations, INAE invariably brings out policy recommendations for suitable follow-up action by the concerned Ministry/Department/agency(ies).

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