

STUDY PAPER

on

Monitoring of EMF
Radiation from Mobile
Towers

July, 2022

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Executive Summary

Telecommunications have been recognized the world-over as an important tool for socio-economic development of a nation. It has become core infrastructure required for rapid growth and modernisation of various sectors of the economy. There has been a phenomenal growth of the telecom sector in terms of subscribers and revenues over the past one and a half decades in India. Telecom towers are critical installations on which the backbone of mobile communication rests.

There is a public concern over possible health effects from Electromagnetic Field Radiation (EMR) exposure from diverse EMR sources especially Mobile BTS antennae and mobile. In this regard, several studies have been conducted in different countries, under the aegis of World Health Organization (WHO). WHO has referred to approximately 25,000 articles published around the world over past 30 years, and based on an in-depth review of scientific literature, has concluded: *"current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic field"*. Since the effects on human beings are to be studied over a long period of time, further studies are going on around the world.

WHO recommended that *'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.'* WHO has recommended adoption of international standards, namely International Commission for Non Ionizing Radiation Protection (ICNIRP)/ Institute of Electrical and Electronics Engineers (IEEE). The main conclusion from the WHO reviews is that EMF exposures below the limits recommended in the ICNIRP international guidelines do not appear to have any known consequence on health.

Government of India adopted the ICNIRP guidelines in the year 2008 for basic restriction and limiting reference levels of Electromagnetic radiation from Mobile towers. Based on the recommendations by Inter-Ministerial

Committee (IMC), these norms for exposure limit for the Radio Frequency Field (Base Station Emissions) have been further made stringent and reduced to 1/10th of the existing limits prescribed by International Commission on Non-Ionizing Radiation Protection (ICNIRP). Directions in this regard have been issued to the Mobile Operators on 30.12.2011.

Department of Telecom (DoT), Ministry of Communications has launched Tarang Sanchar, a web portal for Information sharing on Mobile Towers and EMF Emission Compliances, with a view to generate confidence and conviction with regard to safety and harmlessness from mobile towers, clearing any myths and misconceptions. The portal can be accessed at www.tarangsanchar.gov.in.

Although, there is no single standard adopted internationally defining limits of exposure to radiofrequency radiation, most of the countries are following the emission levels of mobile towers as per ICNIRP.

This paper discussed the practice adopted in India to ensure compliance of the EMF Norms by the Telecom Service providers. Paper also discusses the EMF norms adopted by various countries and steps taken to enhance confidence in the public that the EMF radiations emitted from the Mobile Towers are within safe limits and thus do not harm the public.

Electro Magnetic Field (EMF) Radiation

I. Introduction

1. EMF (Electro-magnetic Field) consists of waves of electric and magnetic energy moving together through space. In general, the term EMF (Electro-magnetic Field) is used to indicate the presence of electromagnetic radiation. Electromagnetic field exists in different forms in universe. Electromagnetic fields differ from each other by in relation to frequency only. Electric and Magnetic fields are part of Electro-magnetic spectrum which extends from static electric and magnetic fields to alternating electric and magnetic fields through radio frequency, infrared & visible light to X-ray and Gamma rays. Radio Frequency (RF) Electromagnetic Field is part of electromagnetic (EM) spectrum having frequencies in the range from 3 kHz to 300 GHz. Televisions, Radio transmitters including base stations as well as microwaves, mobile phones and radars produce radio frequency Electro-magnetic fields. Many Home devices such as cordless phones, modems, tablets, smart watches, IoT devices and other wireless devices also transmit EMF at radio frequency.

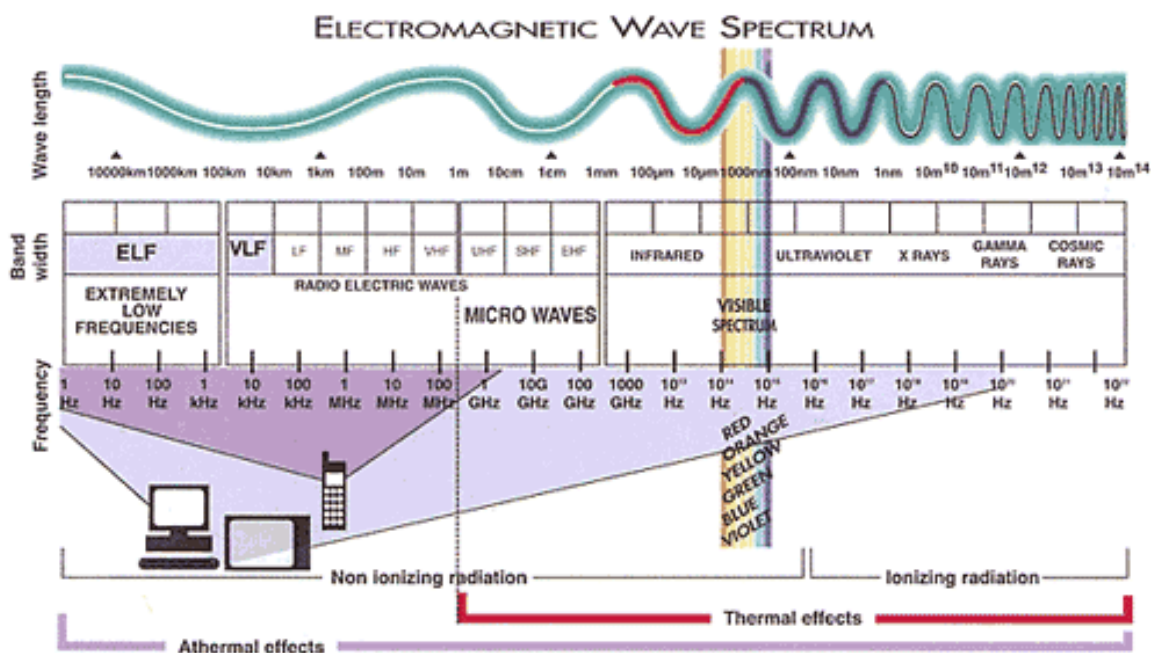


Fig 1: Electromagnetic wave Spectrum

A. Types of EMF radiation

2. EMF radiations are divided into two categories, ionizing and non-ionizing, depending on frequency and the power level. **Ionizing radiation** is electromagnetic radiation whose waves contain energy sufficient to overcome the binding energy of electrons in atoms or molecules, thus creating ions. e.g. Ultraviolet rays, X-rays, gamma rays and cosmic rays as shown in figure 1 above. EM emissions at higher frequencies consisting X-rays, gamma rays are termed as ionizing and have enough potential to alter the chemical bonds of human tissue and resulting in serious genetic damage on prolonged exposure.
3. Non-ionizing radiation refers to any type of electromagnetic radiation that does not carry enough energy per quantum to ionize atoms or molecules.e.g. Low frequency radiations like radio waves, microwaves, and infrared radiations as shown in figure 1 above. Non-ionizing EM emissions do not have enough energy to alter the chemical bonds of the human body. EMF health effects related to the non-ionizing radiation may include tissue heating at levels above the internationally prescribed limits.

B. Mobile Service and EMF Radiation

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

C. EMF Radiations – Recommended International safety standards

5. With regard to impact of Electromagnetic Field (EMF) emissions from mobile towers on health, World Health Organization (WHO) has referred to approximately 25,000 articles published around the world over past 30 years, and based on an in-depth review of scientific literature, has recommended that National Authorities should adopt international

standards to protect their citizens against adverse levels of RF fields and referred to the international Exposure Guidelines developed by the International Commission on Non-ionizing Radiation Protection (ICNIRP). The main conclusion from the WHO review is that EMF exposure below the limits recommended in the ICNIRP international guidelines do not appear to have any known consequence on health.

6. International Commission on Non-Ionizing Radiation Protection (ICNIRP) is a body of independent scientific experts covering areas of Epidemiology, Biology, Dosimetry and Optical Radiation and a number of consulting experts. This body studies possible adverse effects on human health from exposure to non-ionising radiation. ICNIRP's principal aim is to disseminate information and advice on the potential health hazards of exposure to non-ionizing radiation. As per the ICNIRP Guidelines, the present limits/levels for antennae (Base Station) EMF emissions for general public exposure are detail below –

Table 1: ICNIRP recommended limits/levels for antennae (Base Station) EMF emissions for general public exposure

Frequency Range	E-Field Strength (Volt/Meter (V/m))	H-Field Strength (Amp/Meter (A/m))	Power Density (Watt/Sq. Meter (W/Sq. m))
400MHz to 2000MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	$f/200$
2GHz to 300GHz	61	0.16	10

f- Frequency in MHz

7. Although, there is no single standard adopted internationally defining limits of exposure to radiofrequency radiation, most of the countries are following the emission levels for mobile towers prescribed by ICNIRP.
8. Apart from ICNIRP, guidelines on protection against risks of EMF have also been published by the Institute of Electrical and Electronics Engineers (IEEE), for both exposures of the general public and controlled environments (occupational exposure). For radiofrequency fields, IEEE basic restrictions are the same as those of ICNIRP and EU. The reference

levels of IEEE are less strict than those of ICNIRP and EU (for radiofrequency fields only at some frequencies). Differences in the limits between different guidelines are mainly caused by differences in the dosimetric models of the human body and in the use of safety factors. The limits advised by IEEE are used in national EMF legislation of some countries outside the EU.

II. EMF Radiation Norms in India for mobile towers (BTS):

9. In the year 2008, DOT adopted the ICNIRP guidelines that are recommended by WHO for basic restriction levels of electromagnetic emission from mobile towers. Further, based on media reports and public concerns, an Inter-Ministerial Committee (IMC) consisting of officers from DOT, Indian Council of Medical Research (Ministry of Health), Department of Biotechnology and Ministry of Environment and Forest was constituted on 24.08.2010 to examine the effect of EMF Radiation from base stations and mobile phones. Based on the recommendations by IMC, norms for exposure limit for the Base Station Emissions have been made further stringent and reduced to 1/10th of the existing limits prescribed by ICNIRP. Therefore, the present limits/levels for antennae (Base Station) EMF emissions for general public exposure are detail below:

Table 2: Present limits/levels for antennae (Base Station) EMF emissions for general public exposure in India

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

A. Compliance by TSPs

10. With the increasing concerns over harmful effects of Electro-magnetic radiation on human health, DoT in April-2010 issued instructions to TSPs that all BTSs should be ICNIRP compliant and instructed TSPs to

submit the self-certificates of all existing BTSs in accordance with TEC test procedure. All the new BTSs installed after 08-05-2010 should be self-certified by TSP before they start radiating. In case of shared sites, it is the individual as well as collective responsibility of all TSPs to keep the site EMF complaint.

11. DoT has a well-structured process for submission of self-certificate by Telecommunications Service Providers (TSPs) for conformity to EMF exposure at the following three instances:

- a. **At Installation:** Within 15 days of date of first radiation. All new BTS sites starts radiating commercially, only after self-certificate has been submitted to relevant LSA units through online portal.
- b. **At upgrade:** Within 15 days if any BTS Upgrade (both by Upgrading TSP and non-upgrading TSPs sharing the site)
- c. **At Triennial Cycle:** Once in three years of all the BTSs whose self-certificate has not been submitted in the three-year cycle.

B. Audits by LSA Field Units of DoT

12. With the increasing concerns over harmful effects of Electromagnetic Radiation on human health, in the year 2010, LSAs were entrusted with the work of cross checking the compliance of EMF radiation norms as prescribed by DoT from time to time. In case of non-compliance of EMF radiation norms by TSPs, penalty on the concerned TSP(s) is levied by LSAs. LSAs carry out the following activities:

C. Audit of Self-Certificates submitted by TSPs

13. The extensive audit of compliance of self-certificates being submitted by telecom service providers is carried out by LSA field units. LSAs check for the timely submission of self-certificates by TSPs. LSAs also check for completeness and correctness of the certificates as per the laid guidelines of DoT/TEC.

D. Physical audit

14. LSA units erstwhile TERM Cells were entrusted with work of physical inspection of BTSs in Nov-2010. LSA field units carry out physical audit upto 10% of total BTS sites randomly by the field units of DoT in accordance with the procedure laid down from TEC, to ensure that the TSPs strictly adhere to these prescribed norms. Additionally, the BTS sites against which there are public complaints are also tested by LSA units. Field units have conducted physical audit of 10.28 lakh number of BTSs as on 31.01.2022

E. Tarang Sanchar Portal (www.tarangsanchar.gov.in)

15. Dissemination and facilitation of information to the public regarding Electro Magnetic Fields (EMF) radiation in a transparent and convenient manner through Tarang Sanchar portal is an important initiative of DoT. This portal was operationalized in 2017. To allay the misconceptions and fear of general public on health issues due to EMF emissions from mobile towers is one of the prime objectives behind it.
16. The Portal enables anyone to check the status of combined EMF emissions levels at any place from BTSs located on mobile towers anywhere in the country. By clicking on any displayed tower/site on the map, one can view the details of the TSPs present at the tower, technologies used and the EMF compliance status of the site. One can also obtain additional information about the frequency bands used, latest certified EMF level for the site with the date of certification and the DoT prescribed EMF limit. The pan India BTSs database is based on the data pertaining to EMF emission compliance levels submitted by the TSPs to the LSAs.
17. Any citizen having any apprehension about any mobile tower emitting radio waves beyond the safe limit prescribed by the department, can request for EMF measurements/testing on Tarang Sanchar portal by

paying a nominal fee of Rs 4000/- online. The tests will be conducted by the local LSA field unit of DoT and the test report are provided to the requestor and also uploaded on the portal. The portal has 'Measurement by TERM' section which provides details of EMF Audit conducted by field units of DoT. It also provides details of the EMF measurement conducted by field units of DoT based on request by Citizens. Field units have conducted tests of 497 locations based on Public Measurement Requests

III. International Practices

18. There is no single standard adopted internationally defining limits of exposure to radiofrequency radiation; however, most of the countries are following the emission levels of mobile towers prescribed by ICNIRP. Certain countries in the world have specified their own radiation level view the environmental and physiological factors¹.
19. The European Union has a recommendation for the adoption of the 1998 ICNIRP Guidelines of the International Commission on Non-Ionizing Radiation Protection (ICNIRP 1998).
20. In Some member states, the EU recommendation has been transposed in binding national legislation or national policy. This means that the basic restrictions and reference levels must be applied. Member states in this group are Cyprus, Czech Republic, Estonia, Finland, France, Hungary, Ireland, Malta, Portugal, Romania and Spain. In Germany and Slovakia the reference levels have become de facto exposure limits. In France there is an additional legal obligation to provide information on options for exposure reduction when selling or promoting a mobile phone and to provide citizens with measurement results for the strength of radiofrequency EMF in their homes or in public buildings².

¹As per <https://www.gsma.com/publicpolicy/emf-and-health/emf-policy>, globally, 135 countries apply the international limit (ICNIRP 1998 or ICNIRP 2020), 11 follow the FCC 1996 limits, and 37 have other limits.

²<https://www.rivm.nl/sites/default/files/2018-11/Comparison%20of%20international%20policies%20on%20electromagnetic%20fields%202018.pdf>

21. In some of the member states, the national limits based on the EU recommendation or ICNIRP are not binding, there are more lenient limits or there is no regulation. Member states in this group are Austria, Denmark, Latvia, the Netherlands and Sweden. In some countries, for example the Netherlands and the United Kingdom, telecommunication companies have signed up to a voluntary code to respect the limits in the EU recommendation in places accessible to the public. In the United Kingdom the national planning policy framework for local government also requires that applications for expansion of base stations certify that these limits will not be exceeded. In some of member states, there are stricter reference levels and/or basic restrictions based on the precautionary principle and/or due to public pressure. The limits chosen are sometimes based on the principle ‘as low as reasonably achievable without endangering service’. Belgium, Greece, Italy, Lithuania are amongst such countries. In Greece, the law on electronic communications sets basic restrictions of 70% of those in the EU recommendation and 60% when antenna stations are located closer than 300 metres from the property boundaries of schools, kindergartens, hospitals or eldercare facilities. Installation of mobile phone antenna stations is not allowed within the property boundaries of aforementioned facilities. In *Poland*, the locations that are accessible to the public, frequency-dependent exposure limits lower than the reference levels in the EU recommendation are set for electrical field strength and power density. At 900 megahertz the limit for electrical field strength is 17% of the reference level in the EU recommendation (2% for power density). In Italy, the exposure limit for electric field strength at 900 megahertz is 49% of the reference level in the EU recommendation (22% for power density). In homes, schools, playgrounds and places where people may stay for longer than four hours, the ‘attention value’ for electric field strength is 15% of the reference level in the EU recommendation at 900 megahertz (2% for power density).

22. In China, the limits are lower than the reference levels in the EU recommendation, but the percentage varies with frequency. At 900 megahertz the limit for electric field strength is 29% of the reference level in the EU recommendation (9% for power density). The standard also cites the precautionary principle and encourages facility and equipment owners to take effective measures to reduce public exposure. In Japan, the ministerial radiofrequency radiation protection guidelines for human exposure to EMF contain a mandatory basic restriction for mobile phones which is identical to that in the EU recommendation. The guidelines also contain mandatory basic restrictions with reference levels for the strength of EMF from mobile phone base stations, which are almost identical to the reference levels in the EU recommendation. In Russia, the exposure limit for power density for EMF with frequencies between 300 megahertz and 300 gigahertz in and around residential buildings and inside public and industrial premises is 2% of the reference level in the EU recommendation. In USA, the basic restriction for whole body exposure in federal legislation for radio transmitters is identical to that in the EU recommendation. However, the reference levels are higher because a different model is used to calculate them. At 900 megahertz the difference is 15% and 14% for the electric and magnetic field strength respectively (33% for power density).
23. CS Wing of DoT has been following relevant international agencies/ organizations including World Health Organization (WHO), International Commission on Non-Ionizing Radiation Protection (ICNIRP) for monitoring global developments related to EMF emission norms. As per information available on public domain following are the norms adopted by some of key countries are summarized below (the norms of EU countries and select countries outside EU are given in Annexure-I):

S/N	Country	Power Density (W/M ²)	
		900 MHz	1800MHz
1	India	0.45	0.90
2	Australia	4.50	9.00

3	Brazil	4.50	9.00
4	United Kingdom	4.50	9.00
5	USA	6.00	10.00
6	Russian Federation	1.00	1.00
7	Bangladesh	4.50	9.00

A. UK

24. In the UK, Public Health England (PHE) takes the lead on public health matters associated with radiofrequency electromagnetic fields and has a statutory duty to provide advice to Government on any health effects that may be caused by exposure to EMF. PHE's main advice is that EMF exposure should comply with the Guidelines published by the International Commission for Non-Ionizing Radiation Protection (ICNIRP). The ICNIRP Guidelines include internationally recognized limits on EMF exposure for the protection of the general public.

25. Most spectrum licences issued by UK's communications regulator Ofcom include a condition (the EMF licence condition) requiring licensees to ensure compliance with the limits in the ICNIRP Guidelines on EMF exposure for the protection of the general public. These limits are referred to as the "general public EMF limits". The condition applies to licensees whose radio equipment is currently authorized to transmit at powers higher than 10 Watts EIRP³ or 6.1 Watts ERP. If the spectrum user does not transmit at powers higher than 10 Watts EIRP or 6.1

³Effective radiated power (ERP), synonymous with equivalent radiated power, is an IEEE standardized definition of directional radio frequency (RF) power, such as that emitted by a radio transmitter. It is the total power in watts that would have to be radiated by a half-wave dipole antenna to give the same radiation intensity as the actual source antenna at a distant receiver located in the direction of the antenna's strongest beam (main lobe). It is equal to the input power to the antenna multiplied by the gain of the antenna.

An alternate parameter that measures the same thing is effective isotropic radiated power (EIRP). Effective isotropic radiated power is the hypothetical power that would have to be radiated by an isotropic antenna to give the same ("equivalent") signal strength as the actual source antenna in the direction of the antenna's strongest beam. The difference between EIRP and ERP is that ERP compares the actual antenna to a half-wave dipole antenna, while EIRP compares it to a theoretical isotropic antenna. Since a half-wave dipole antenna has a gain of 1.64 (or 2.15 dB) compared to an isotropic radiator, if ERP and EIRP are expressed in watts their relation is $EIRP (W) = 1.64 ERP (W)$.

Watts ERP, it will not need to carry out an EMF assessment and will not need to demonstrate compliance with the general public EMF limits.

26. The EMF condition requires spectrum users to ensure the general public EMF limits are not breached in any area where a member of the general public is or can be expected to be present when transmissions are taking place. For simplicity, these areas are referred as areas where members of the general public may be present. Spectrum users do not need to comply with the general public EMF limits in any area where they are sure a member of the general public is not, and will not, be present when transmissions.

Guidance on EMF compliance and enforcement⁴

27. Spectrum users are required to consider Ofcom's "*Guidance on EMF Compliance and Enforcement*" when evaluating their compliance with the EMF licence condition. The guidance includes details of:

- When spectrum users are not required to comply with the general public EMF limits.
- The methods spectrum users may use to assess compliance.
- The records spectrum users should keep in order demonstrating compliance.
- What is meant by members of the general public and the areas in which spectrum users need to ensure the general EMF public limits are not breached.
- How to ensure compliance when a spectrum user has more than one piece of equipment on the same site.
- how to ensure compliance when a site is shared with another spectrum user; and
- The enforcement options available to Ofcom in the event of a breach of the EMF condition.

B. Australia

⁴https://www.ofcom.org.uk/__data/assets/pdf_file/0025/214459/guidance-emf-compliance-enforcement.pdf

28. The RF EME emissions from mobile phone base stations and other communications installations are regulated by the Australian Communications and Media Authority (ACMA). The ACMA's regulatory arrangements require base stations to comply with the exposure limits in the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) RF Standard. The ARPANSA RF Standard⁵ provides limits of exposure which must be complied with by all radio installations, including wireless base stations and small cells. The ACMA also requires base stations to comply with an industry code of practice which requires telecommunications carriers to inform and consult with the local community when planning, installing, or upgrading base stations.
29. The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) set the safe EME levels in the Standard for Limiting Exposure to Radiofrequency Fields – 100 kHz to 300 GHz. It is in line with international recommendations by the World Health Organization and the International Commission on Non-Ionizing Radiation Protection.

Table: Reference Levels for time averaged exposure for general public

Frequency Range	Power flux density (W/m ²)
400 MHz – 2 GHz	$f / 200$ Watts/Sq m. (f in MHz)
2 GHz – 300 GHz	10 Watts/Sq m

The limits specified in the Standard are based on the published 1998 Guidelines of the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

30. The calculations about maximum levels of exposure of RF from base stations are made available in the ARPANSA EME (Electromagnetic Energy reports) provided by the telecommunications companies on the

⁵<https://www.arpansa.gov.au/regulation-and-licensing/regulatory-publications/radiation-protection-series/codes-and-standards/rpss-1>

Radio Frequency National Site Archive (RFSNA) website, www.rfnsa.com.au. The environmental EME report is produced according to a methodology developed by ARPANSA⁶. RFNSA site enables search for Australian Mobile Network base stations by searching by postcode or town to find EME Reports, site locations, carrier contact details for existing sites and community consultation information for new sites.

31. The Environmental EME Report provides calculations of the maximum levels of radiofrequency (RF) electromagnetic energy (EME) around an existing and/or proposed wireless base station that may include mobile telephony, broadband and data services. The report is generally produced by a network operator (such as a mobile phone company) or consultants working on their behalf. The EME Report shows the maximum calculated levels for a specific installation and compares them against the exposure limits in the ARPANSA Standard.
32. The report gives the address of the installation, together with a list of the companies using the site and the types of mobile network currently installed and being proposed. It also includes details of calculated levels of RF EME. If the site already has antennas in place, the report includes separate information on the existing and the combined existing and proposed installations. The report estimates RF EME from all of the identified wireless transmitters at this site; it does not estimate RF EME from all surrounding sites. The calculated levels do not include RF EME from other types of radio transmitters which may be installed on the same structure, e.g. AM and FM radio, TV etc.
33. A sample environmental EME report is placed at Table-I.

Checks and enforcement by ACMA

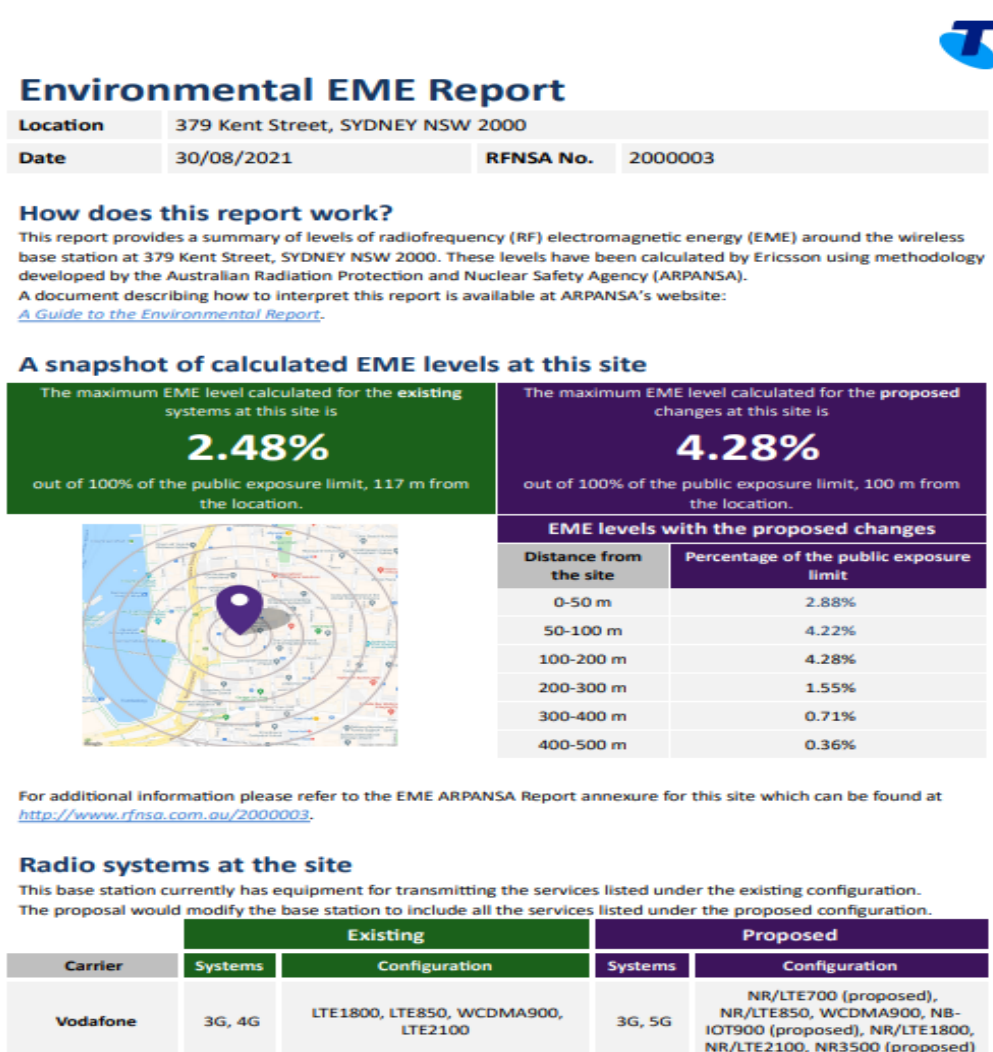
34. ACMA investigate complaints from the public as well as do their own audits. ACMA carry out checks as new technology comes onto the

⁶Radio frequency EME exposure levels - prediction methodologies technical report.

market. There are many ways ACMA check EME compliance and encourage industry to self-monitor. Site inspections are carried out and documents like laboratory test results are checked. Also, specific devices and equipment like base stations, mobile phones, Wi-Fi devices are audited. ACMA have awareness programs to educate suppliers and the community about the rules on EME.

35. **Enforcement**-ACMA conducts formal investigations into a supplier or licensee. If they haven't followed the rules, ACMA can get the licensee to test their equipment by using a registered National Association of Testing Authorities member, give a formal warning or take the matter to court.

Table-I



Findings of ACMA

36. ACMA has found a high level of compliance with safe levels of EME. Across the country and with different devices and suppliers, EME levels are within the safe levels set by the ARPANSA standard.
37. ACMA's recent compliance programs have focused on EME standards for network facilities, reporting on EME compliance for small cells in 2019–20 and 5G mobile base station deployments in 2020–21. The expanded rollout of 5G technology, including with the use of millimeter wave spectrum, continues to make EME emissions and 5G compliance a priority.

C. New Zealand⁷

Background

38. New Zealand has major three government agencies that deal with EMF exposure and regulations: the Ministry of Environment, the Ministry of Health, and the Ministry of Business, Innovation, and Employment. All three contribute to the development of EMF use by managing a plan that conserves their aims, developing a long-term smart city.
39. New Zealand uses the ICNIRP guidelines for limiting exposures to EMF, and it forms the basis of the New Zealand radiofrequency field exposure Standard NZS 2772.1:1999. The Standard sets out limits for exposure to the radiofrequency radiation produced by all types of radio transmitters, for people exposed at work and for the general public.
40. The standard also provides guidance on verification of compliance and ensures that exposures to EMF are minimized. This includes consideration of near and far fields, type testing, and mobile and portable transmitters. Though this standard has no formal legal status because it is not cited in any legislation, the Ministry of Health recommends strict application of the Standard as a means of controlling

⁷<https://www.who.int/peh-emf/meetings/southkorea/Martin.pdf>

exposures to RF fields, and the implementation of low or no cost measures to minimize exposures. The Ministry for the Environment has recommended that compliance with the Standard be a requirement in local authority planning rules for radio transmitters.

41. The New Zealand RF field exposure Standard (“the Standard”) is based closely on the ICNIRP 1998 guidelines, and all basic restrictions, reference levels, averaging times, treatments of pulsed and multi-frequency exposures etc are taken directly from ICNIRP. The Standard includes several clauses intended to aid implementation and verification. Amongst these are the following:
42. Spatial averaging – in order to take account of the fluctuations in field strength caused by interference and other effects, the Standard prescribes how exposures may be spatially averaged.
43. Verification of compliance – the Standard specifies the measurements required to verify compliance. This includes consideration of near and far fields, type testing, and mobile and portable transmitters. Clarifying how compliance should be verified, especially in respect of time averaging exposures, was one of the changes which led to final adoption of the Standard.
44. Protective measures – the Standard outlines the types of measures which should be used to ensure protection for both occupational and public exposures.

D. Malaysia

45. The telecommunications industry in Malaysia is governed by the Communications and Multimedia Act 1998 (Act 588) and its subsidiary legislations and the Malaysian Communications and Multimedia Commission (MCMC) is the regulatory agency. The energy industry in Malaysia is governed by the Electricity Supply Act 1990 and the

Electrical Supply Regulations 1993, where the Energy Commission (EC) is the enforcement body.

46. The robust growth of the mobile phone industry and the availability of mobile phones explicitly designed for young children together with the publicity generated by the mass media have caused great concern among the public, especially in regard to brain cancer and cognitive function in children.

47. In response to that, the Malaysian government has taken several steps which include:

- i) Continuously monitoring and reviewing the latest research findings and information published by recognized bodies such as WHO and ICNIRP.
- ii) Conducting a series of seminars on mobile phones to disseminate balanced and accurate information to the public.
- iii) Surveillance measurement on exposures from base stations, power lines and distribution lines.
- iv) Developing guidelines on ELF and RF.

48. Public Information –The Inter-Agency Advisory Scientific Committee on Non-Ionizing Radiation chaired by the Ministry of Health continues to monitor the local and foreign publications and findings and will report in the local media the latest findings on the health effects of EMF which may be useful to the Malaysian public. Dissemination of information to the public is achieved through the following means:

- i) Publications
 - A booklet on “Radiation, Mobile Phones, Base Stations and Your Health” which was first printed in 2003 in English was reprinted in 2005 in two languages (English and Malay).

- A pamphlet entitled “Make Safety Your Main Priority” gives general information about non-ionizing radiation and which addresses the issues pertaining to telecommunication towers.
- A pamphlet entitled “Guidelines on Ultraviolet Radiation in the Workplace” provides basic information on UV, its health effects and control measures to prevent overexposure.
- The Ministry of Housing and Local Government Malaysia is finalizing a guideline on installation of telecommunication towers and transmission structures.

ii) Seminar / Forum

Seminars / forums on non-ionizing radiation and a series of seminars / forums specifically designed to discuss mobile phones were organized.

E. France

49. Ministries and agencies dealing with the issue of EMF and Health-

Following is the list of Ministries and agencies which deals with the issue of EMF and Health

- DiGITIP (General Directorate of Industry, Information Technologies and Postal Services) within the Ministry of Economy, Finances and Industry (www.industrie.fr / www.telecom.gouv.fr)
- Information Technologies and Communication Department within the Ministry for Research(www.recherche.gouv.fr)
- DGS (General Directorate of Health) within the Ministry of Solidarity, Health and the Family(www.sante.gouv.fr)
- ANFR (National Frequencies Agency /www.ANFR.fr). The ANFR is a public administrative institution created by the

Telecommunications Regulation Act of 26 July 1996. It took up its duties on January 1, 1997. The Agency checks that transmitters operate in the frequency bands that they have been allocated and that they respect exposure limits. For each new site, the operator must file a statement of compliance concerning threshold values for public exposure with the ANFR.

- **ART** (Telecommunication Regulation Authority /www.art-telecom.fr). Since January 5, 1997, the ART has been responsible for the implementation of all legal, economic and technical provisions governing telecommunication activities.
- **AFSSE** (French Agency for Environmental and Health Safety /www.afsse.fr). The agency is a state administrative institution that was created in May 2001. It is under the supervision of the ministers in charge of health and the environment. With the aim of protecting human health, the agency's role is to contribute to health safety in the environmental domain. On April 16, 2003, at the request of Parliament and the Government, AFSSE published an opinion on mobile telephony and health.
- **UTE** (Electricity and Communication Technical Union /www.ute-fr.com). This association is in charge of the standardization of electrical equipment, in cooperation with CENELEC (European Committee for Electro-technical Standardization) at the European level for the preparation of harmonized European standards, and in cooperation with the CEI (International Electro-technical Commission) for the preparation of international standards. Aspects related to the preparation of standards concerning public exposure to electromagnetic fields are ensured by the Technical Committee 106.

50. Following Legislations & Regulations have been issued at different points of time.

- **Departmental order dated May 17, 2001 (Article 17 bis)**

concerning the technical conditions under which electric power is distributed. It transposes into French law the recommendation dated 12th July 1999, concerning electrical power lines.

- **Circular dated 16th October 2001** concerning the implantation of mobile radiotelephony base stations.
- **Decree no. 2002-775 dated 3rd May 2002:** Implementation of Article L. 32 of the Posts and Telecommunications Code concerning threshold values for public exposure to electromagnetic fields emitted by telecommunication networks equipment and wireless installations. It transposes into French law the July 12, 1999 recommendation concerning all types of radio frequency transmitters.
- **Decree no. 2003-293 dated 31st March 2003** concerning road safety, and modifying the Code of Criminal Procedure and the Highway Code.
- **Decree no. 2003-961 dated 8th October 2003** concerning the evaluation of the conformity of terminal telecommunication equipment and wireless equipment, as well as conditions for start-up and use. It modifies the Posts and Telecommunications Code and transposes into French law the 1999/5 CE Directive.
- **Departmental order dated 8th October 2003** setting technical specifications applicable to final wireless installations.
- **Departmental order dated 3rd November 2003** concerning *in situ* measurement protocol for checking that broadcast transmitting stations are in compliance with in terms of reference levels and public exposure to electromagnetic fields authorized by Decree no. 2002-775 dated May 3, 2002.
- **Law no. 2004-669 of 9th July 2004** concerning electronic communications and audio-visual communications service. The law introduces health safety into telecommunications legislation.
- **Decree of 10th January 2005** recognizing a foundation as a

public utility institution (Health and Radio Frequencies Foundation).

51. **Risk communication tools and initiatives** through information campaigns, workshops, studies, leaflets, newsletters, etc. The AFSSE and the DGS are public institutions which inform the public mainly via reports, informational documents, and their web sites (www.afsse.fr; www.sante.gouv.fr).
52. The three French operators have created an association, AFOM. One of the principal objectives of this association is to inform the public about mobile telephony and health. It publishes documents on its web site (www.afom.fr). In addition, the association publishes informational documents for the general public which are available at mobile telephony points of sale. In addition, the operators signed an agreement with major French cities in order to define conditions under which base stations may be deployed and how the public is to be informed. AFOM signed a protocol of agreement with the Association of French Mayors (AMF) that defines, for all three operators, conditions under which networks may be deployed and how the public is to be informed.
53. Base station locations and the results of electromagnetic field measurements can be consulted on a site run by the ANFR (www.cartoradio.fr). At the initiative of either the mayor or the operators, informational meetings can be organized when new base stations are installed. Finally, the operators commit themselves to respond by mail to requests for information related to base stations, proposed sittings and topics related to health and the environment.
54. **Academic and research institutions:** "Health and Radiofrequency Foundation", created at the initiative of the Ministry of Research, is responsible for managing public and private research funds for studies of the biological and medical effects of mobile telephony. These studies are carried out by research laboratories in universities and research institutions. The foundation also has a major role in informing the public

about radio frequencies and health. In addition, a CNRS research unit, the Centre for Organizational Sociology, is particularly interested in the public perception of risks related to mobile telephony base stations.

55. Databases on EMF sources and exposure- The National Frequencies Agency (ANFR) have created a web site with maps and data about radio frequency transmitters (www.cartoradio.fr). Cartoradio indexes and locates on a map all radio frequency transmitters present in France (except those for civil aviation and defence). It also contains complete results of the measurement of wireless fields.



56.

Measure sheet N° 158494 - Synthesis

Measured on : 07/05/2020 à : 101036

By the laboratory : EXEM

Location of the measuring point : 4 Place du Louvre PARIS 1ER ARRONDISSEMENT

Measurement done : à l'extérieur

Environment : Rue / Route / Parking

Measurement done according to the protocol ANFR/DR 15-4 (presentation of the protocol [here](#)).

Positioning of the visible transmitters of the measuring point



Conclusion of the measurement report

The measurement report concludes compliance with the exposure limit values set by the decree of 3 May 2002.

Result of the overall evaluation of the exposure (case A of the protocol)

The overall level of exposure is the result of the measurement of the electromagnetic fields emitted globally by all the emitters surrounding the measuring point, visible or not, which are in operation at the time of the measurement.

Overall level of exposure : 0.27 V/m

Reminder: the lowest limit value set by the decree of 3 May 2002 is 28 V / m.

57. Exposure monitoring and compliance measurements-

Approximately one thousand site measurements are carried out each year by independent inspection laboratories, according to a measurement protocol defined by the ANFR, in compliance with recommendation ECC 02(04) related to the measurement of non-ionizing electromagnetic radiation between 9 kHz and 300 GHz. The ANFR is the recipient of all these results, which are then published on the Cartoradio site and accessible to the public. These measurements are carried out either at the request of the public or randomly, within the framework of protocols of

agreement between operators and municipalities. Upon written request by anyone, the operators agree to carry out estimates of the level of electromagnetic fields created by the antenna in question.

Result of detailed exposure assessment (case B of the protocol)

As requested by the applicant, a detailed exposure assessment by frequency was performed. The result of these detailed measurements is presented aggregated by service (measure column), followed, if necessary, by the result of an extrapolation calculation. Only results above [0.05] V / m are mentioned.

SERVICE	FREQUENCY BAND(MHZ)	MEASURE	EXTRAPOLATION	LIMIT VALUE (REFERENCE LEVEL)
Services HF	0,1-30			28 V/m
PMR (Réseaux radio mobile professionnels)	30-87,5 (hors TV)			28 V/m
TV	47-68/470-790			28 V/m
Radiodiffusion sonore (FM – RNT)	87,5-108/174-223			28 V/m
PMR - balises	108– 880/921–925			28 V/m
TM 700 (Téléphonie Mobile en 700 MHz)	703-788			36 V/m
TM 800	791-821			39 V/m
TM 900	925-960			41 V/m
Radars - balises - FH	960-1710			42 V/m
TM 1800	1805-1880			58 V/m
DECT (Téléphone domestique)	1880-1900			59 V/m
TM 2100	2100-2170			61 V/m
Radar - BLR (Wimax)- FH	2200-6000 (hors Wi-Fi et TM)			61 V/m
Réseaux locaux radioélectriques ou Wifi	2400-2483/5150-5350/5470-5725			61 V/m
TM 2600	2620-2690			61 V/m
TM 3600	3400-3800			61 V/m

Sri Lanka⁸⁹

58. TRCSL formulated a cabinet approved policy named “National Policy on Antenna Structure” especially for the safety for the people from harmful radiation and protection of environment. Based on this policy, “Guidelines on Antenna Structure” was introduced to follow for construction of towers, BTSs and antennas. As per these guidelines, TRCSL will enforce and monitor maximum RF power density criteria defined by ICNIRP and adopted by TRCSL. Verification of compliance with stipulated standards will be carried out by TRCSL or a recognized institution immediately after commissioning of the site and at the stage of any modifications are done to the antenna installation or once in five years to ensure public safety. The TSP shall inform TRCSL for inspection, immediately after the site is commissioned or any modifications made to the antenna installation.

Baharain¹⁰

59. Electromagnetic emissions of any radiators may have harmful effect to human depend on emissions’ level and exposure time. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has established the threshold levels for exposure to electromagnetic fields for occupational and public areas. These thresholds were brought into force by the Order (Order No 4, 2009) of the Public Commission for the Protection of Marine Resources, Environment and Wildfire of the Kingdom of Bahrain.

60. The Telecommunications Regulatory Authority of the Kingdom of Bahrain obliged all public telecommunication operators of Bahrain to limit the emissions of their radio base stations’ emissions in public and occupational areas below the levels stated in above Order of the Public Commission for the Protection of Marine Resources, Environment and Wildfire of the Kingdom of Bahrain. To enforce above Order, the

⁸https://trc.gov.lk/images/pdf/guide_l.pdf

⁹[Microsoft Word - National Policy on Antenna Structures \(trc.gov.lk\)](#)

¹⁰<https://safetymeasurements.tra.org.bh/list/>

Telecommunications Regulatory Authority regularly measure the emissions in occupational and public areas of Bahrain located in close proximity to radio base stations of public operators and make the results of the measurement available to general public via its website. These threshold values correspond to public areas where humans may stay for 24/7. Threshold values for occupational areas are higher since the exposure time is less than 24 hours; normally, it is 8 hours per day.

61. All measurement results are available on TRA's website for public viewing. The TRA invites the public to visit this site to view the levels of radiating emissions measured in the different areas around the kingdom. These results reflect the number of measurements and not the number of towers. Results of measurement in each location are presented to general public in tabular and graphical ways. Public areas are safe if measured emissions are below the thresholds.

Date (dd/mm yyyy)	Address of measurement location (Building#, Road#, Block#, Area)	Average Field Strength, V/m			
		2G	4G	3G	4G/5G
March 29, 2021	<u>BLDG; RD; BLK;</u>	1.294	1.188	1.598	3.224
March 29, 2021	<u>BLDG; RD; BLK;</u>	1.461	0.955	0.999	3.161
March 29, 2021	<u>BLDG; RD; BLK;</u>	1.384	1.315	1.429	3.198

Figure 2 - Measurement results in Table format

62. Whenever new measurement data is available for the same location, old measurement data will be replaced to keep the data up to date. Measurement locations can be searched and located.

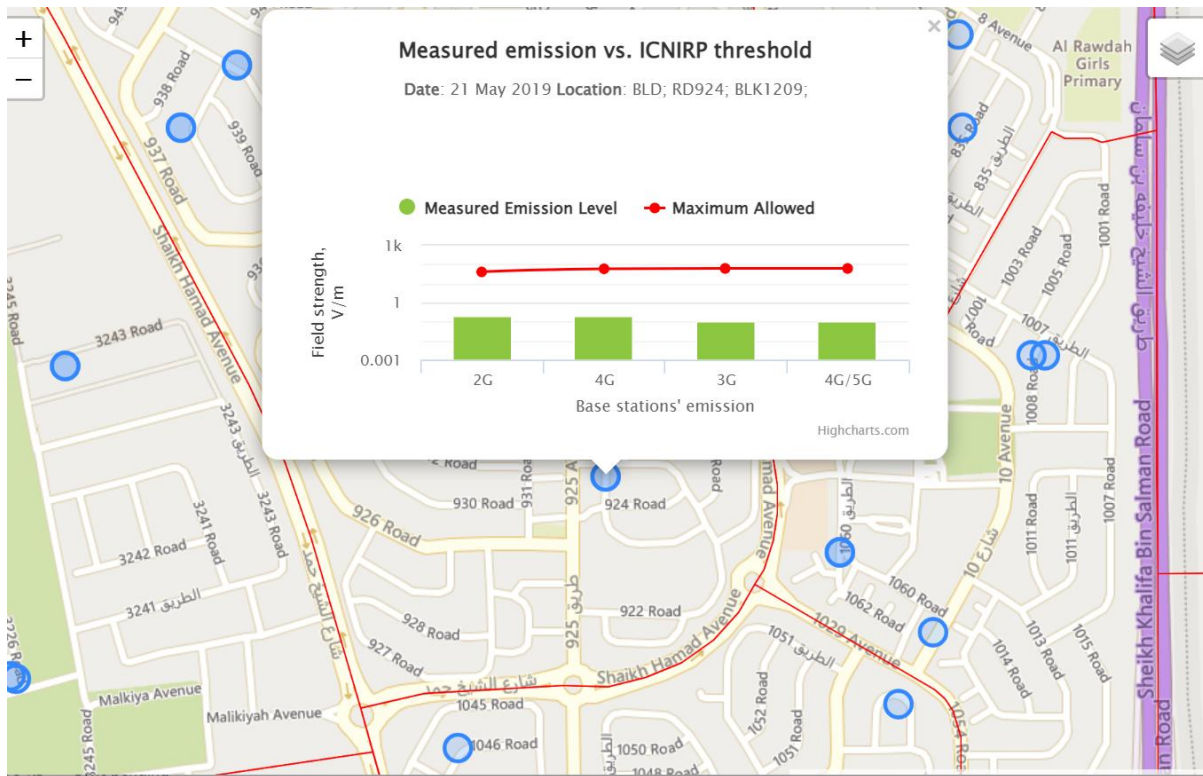


Table-Information available to public

63. As per the condition stated in licenses granted by the TRA in Bahrain, telecoms operators are required to ensure that emissions from each radio installation are within ICNIRP limits. They are also required to comply with any future radiation emission standards set by ICNIRP, or have been or will be adopted by the Kingdom of Bahrain

F. China

64. In China, there are two RF exposure standards in force with differing limit values: a national standard for electromagnetic radiation GB 8702-88 formulated by the national environmental protection agency and a second national standard GB 9175, formulated by the Ministry of Health.

65. In respect of base stations, the national standard GB 8702-88 is the legal requirement; however, in practice operators often design for compliance with the most restrictive Ministry of Health value from GB 9175, to minimise confusion by the public.

66. The Chinese general public exposure PD limit at all Radio Frequencies 30 MHz to 3,000 MHz is 0.4. W/m², according to GB 8702-88. To exemplify: the Chinese official level at 900 MHz is 0.4 W/m², relative to 4.5 W/m² ICNIRP 1998 Guidelines level; 9% of ICNIRP 1998 Power Density, and 0.8% of ICNIRP 1998 field strength.

67. SAR value of mobile phone handset is 2 Watt/kg averaged over 10 g of tissue.

G. Republic of Korea

68. In Korea, EMF exposure limits were established in 2001 and enforced since April 2002. Due to the public opinion, the more stringent limits were adopted among ICNIRP and IEEE standards. Regulations for the EMFs from the stationary installations (base stations, broadcasting transmitters, etc.) have been mandated from June 2007. The MSIP (Ministry of Science, ICT & Future Planning) shall establish the EMF limits to protect human body, the measurement method of specific absorption rate (SAR) and electromagnetic field, and the devices and installations for the application of the EMF exposure limits. EMF exposure limits for mobile base stations are given in Table below:

Frequency Range	E-Field Strength(Volt/Meter) (V/m)	H-Field Strength (Amp/Meter) (A/m)	Power Density (Watt/Sq.Meter) (W/m²)
400 MHz to 2000 MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	$f/200$
2GHz to 300GHz	61	0.16	10

f is frequency in MHz.

69. SAR value for mobile phone handset is 1.6 W/kg averaged over 1 g of tissue.

H. Japan

70. In Japan to pursue scientific studies of RF-EMF effects, the Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT) established, in 1998, "The Committee to Promote Research on the

Possible Biological Effects of Electromagnetic Fields" in cooperation with other relevant organizations and institutions, including medical and engineering experts. To implement safe and secure radio use, MPHPT regulations were established in accordance with these rules. These rules have been enforced since October 1999 and are applied mainly to the radio equipment of broadcasting radio stations and non-mobile radio stations, such as cellular phone base stations. These rules define values for electromagnetic field strength in the general environment in accordance with the standard values utilized by the Radio Radiation Protection Guidelines. EMF exposure limits for mobile base stations are given in Table below:

Frequency	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m²)	Average (minutes)
30 MHz to 300 MHz	27.5	0.0728	0.2	6
300 MHz to 1.5 GHz	$1.585 f^{0.5}$	$f^{0.5} / 237.8$	$f / 1500$	6
1.5 GHz to 300 GHz	61.4	0.163	1	6

71. For cellular phones and other RF devices, which are used close to the human head, MPHPT regulates the allowed value of 2 W/kg (10-gram tissue, 6-minute average value) of radio energy absorption by the human head, and requires telecommunications manufacturers (cellular phones, for example), to maintain this standard since June 2002.

I. Canada

72. Health Canada is the federal department responsible for protecting the health and safety of Canadians. Health Canada has set limits for human exposure, which are published in a document commonly known as Canada Safety Code 6. On 13 March 2015 Health Canada revised the 2009 limits (that were identical to the USA) and published new reference levels. The updated rigorous SC6 science-based limits include more restrictive reference levels in some frequency ranges, to take account of improved

modelling of the interaction of RF fields with the human body, and to ensure larger safety margins to protect all population, including newborn infants and children; see HC media release. For its part, Innovation, Science and Economic Development Canada is responsible for radio-communication, and has adopted HC's SC6 limits, in ISED's standards and regulations.

73. The Reference Levels for Electric Field Strength, Magnetic Field Strength and Power Density in Uncontrolled Environments is detailed in table below:

Frequency (MHz)	Electric Field Strength (E_{RL}), (V/m, RMS)	Magnetic Field Strength (H_{RL}), (A/m, RMS)	Power Density (W/m^2)	Reference Period (minutes)
300 – 6000	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000 -15000	61.4	0.163	10	6
15000 – 150000	61.4	0.163	10	$616000 / f^{1.2}$
150000 - 300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000 / f^{1.2}$

f is frequency and is in MHz.

74. SAR value for mobile phone handset is 1.6 W/kg averaged over 1 g of tissue.

J. USA

75. In the United States, the FCC has adopted and used recognized safety guidelines for evaluating Radio Frequency environmental exposure since 1985. Federal health and safety agencies, such as the EPA, FDA, the National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) have also been involved in monitoring and investigating issues related to RF exposure. The FCC guidelines for human exposure to RF electromagnetic fields were derived from the recommendations of two expert organizations, the National Council on Radiation Protection and Measurements (NCRP) and the Institute of Electrical and Electronics Engineers (IEEE). Both the NCRP exposure criteria and the IEEE standard were developed by expert scientists and engineers after extensive reviews of the scientific literature

related to RF biological effects. The exposure guidelines are based on thresholds for known adverse effects, and they incorporate prudent margins of safety. In adopting the current RF exposure guidelines, the FCC consulted with the EPA, FDA, OSHA and NIOSH, and obtained their support for the guidelines that the FCC is using. Many countries in Europe including India use exposure guidelines developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

The ICNIRP safety limits are generally similar to those of the NCRP and IEEE, with a few exceptions. For example, ICNIRP recommends somewhat different exposure levels in the lower and upper frequency ranges and for localized exposure due to devices such as hand-held cellular telephones.

One of the goals of the WHO EMF Project (see above) is to provide a framework for international harmonization of RF safety standards. The NCRP, IEEE and ICNIRP exposure guidelines identify the same threshold level at which harmful biological effects may occur, and the values for Maximum Permissible Exposure (MPE) recommended for electric and magnetic field strength and power density in both documents are based on this level.

76. EMF exposure limits for mobile base stations are given in Table below:

Frequency	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m²)	Average time (minutes)
30 MHz to 300 MHz	27.5	0.0728	0.2	30
300 MHz to 1.5 GHz	----	----	$f/1500$	30
1.5 GHz to 100 GHz	----	----	1	30

f is frequency in MHz

77. SAR value for mobile phone handset is 1.6 W/kg averaged over 1 g of tissue.

IV. DoT's Current/ Planned/ recent activities on the issue of EMF radiation from Mobile Tower:

78. DoT, through its CS wing, has been following relevant international agencies/ organizations such as World Health Organization (WHO), International Commission on Non-Ionizing Radiation Protection (ICNIRP), International Advisory Committee (IAC) on EMF, International Telecommunication Union (ITU) and various Study Groups under ITU for monitoring global developments related to EMF emission norms.
79. Department of Telecommunications (DoT) has initiated a nation-wide Awareness Programme on EMF Emissions & Telecom Towers to build a direct bridge of engagement between different stakeholders and to fill the information gap with scientific evidence. These Programmes have further been followed up at sub-state level by the LSA field units of DoT so that more and more people are made aware about the scientific facts on health effects of EMF emissions from mobile towers.
80. Pamphlets/ Information Brochures on various topics related to EMF have also been published and distributed in various regional languages.
81. Detailed information on EMF related issues and steps taken by Government of India in this regard have been made available on DoT website www.dot.gov.in in section "A Journey for EMF" (<http://www.dot.gov.in/journey-emf>).
82. DoT has issued Broad guidelines for issue of clearances for installation of Mobile Towers that were revised with effect from 01.08.2013 and forwarded to Chief Secretaries of all the State Governments. These guidelines require State Governments along with DoT to organize public awareness programmes involving civil society members.
83. Government has issued advertisement for ensuring safety from radiations of mobile towers & handsets which has been published in National & Regional Newspapers.

84. During EMF testing to check the compliance of EMF radiation norms, officers of LSA field units of DoT have been interacting with local resident of societies/localities and educating them about Mobile phone/Tower radiation and make aware about misconception of EMF radiation related health consequences.
85. A joint initiative has been launched by Science and Engineering Research Board (SERB) under Department of Science & Technology (DST) and Department of Telecommunications (DoT, CS Wing), wherein nineteen research proposals, have been initiated in the year 2015 to study possible impact of EMF exposure from mobile towers and handsets on life i.e. Humans, Living Organisms, Flora & Fauna and Environment. As per project outcome report submitted by SERB, the studies are non-conclusive because of very limited available data-set and short span of time of the conducted studies (information provided by SERB in August 2021).
86. DoT has released a press brief on 10th May 2021 to caution the general public at large not to be misguided by false messages related to 5G technologies and further clarified that Mobile towers emit non-ionizing Radio frequencies having very minuscule power and are incapable of causing any kind of damage to living cells including human beings.
87. Formation of a committee for EMF related content management on EMF Portal and DoT website and their regular updation is currently under consideration in CS Wing of DoT.

Annexure-I

Reference levels or exposure limits for the general public for electromagnetic fields in inhabited areas in member states of the European Union and selected industrial nations outside the European Union

Country	900 MHz			1800 MHz			2100 MHz		
	electric field strength (V/m)	magnetic flux density (μT)	equivalent plain wave power density (W/m ²)	electric field strength (V/m)	magnetic flux density (μT)	equivalent plain wave power density (W/m ²)	electric field strength (V/m)	magnetic flux density (μT)	equivalent plain wave power density (W/m ²)
Belgium	21			29			31		
Bulgaria			0.1			0.1			0.1
Croatia	17	0.055	0.72	23	0.078	1.4	25	0.084	1.7
Cyprus	41	0.14	4.5	58	0.2	9	61	0.2	10
Czech Republic	41	0.14	4.5	58	0.2	9	61	0.2	10
Estonia	41	0.14	4.5	58	0.2	9	61	0.2	10
Finland	41	0.14	4.5	58	0.2	9	61	0.2	10
France	41	0.14	4.5	58	0.2	9	61	0.2	10
Germany	41	0.14	4.5	58	0.2	9	61	0.2	10
Greece	32	0.11	2.7	45	0.15	5.4	47	0.16	6
Hungary	41	0.14	4.5	58	0.2	9	61	0.2	10
Ireland	41	0.14	4.5	58	0.2	9	61	0.2	10
Italy	6	0.02	0.1	6	0.02	0.1	6	0.02	0.1
Lithuania			0.45			0.9			1
Luxemburg	41	0.14	4.5	58	0.2	9	61	0.2	10
Malta	41	0.14	4.5	58	0.2	9	61	0.2	10
Poland	7		0.1	7		0.1	7		0.1
Portugal	41	0.14	4.5	58	0.2	9	61	0.2	10
Romania	41	0.14	4.5	58	0.2	9	61	0.2	10
Slovakia	41	0.14	4.5	58	0.2	9	61	0.2	10
Slovenia	13	0.04	0.45	18	0.06	0.9	19	0.06	1
Spain	41	0.14	4.5	58	0.2	9	61	0.2	10
Sweden	41	0.14	4.5	58	0.2	9	61	0.2	10
United Kingdom	41	0.14	4.5	58	0.2	9	61	0.2	10
Australia	41	0.14	4.5	58	0.2	9	61	0.2	10
China	12	0.04	0.4	12	0.04	0.4	12	0.04	0.4
India	13	0.041	0.45	18	0.058	0.9	20	0.063	1.1
Japan	48	0.16	6	61	0.2	10	61	0.2	10
Russia			0.1			0.1			0.1
Switzerland	4 23			6			6		
U.S.A.			6			10			10