

APT REPORT

ON

Asia-Pacific Regional Activities on Human Exposure to EMF

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APT REPORT ON

Asia-Pacific Regional Activities on Human Exposure to EMF

**Background:**

On the ASTAP-23 meeting, a new term was coined for EG GICT&EMF in order to add on the topic of human exposure to Electromagnetic Fields (EMF). The decision came upon EG GICT&EMF. The meeting also mentioned a new proposal to develop a status report on the activities of EMF exposure. The Republic of Korea identified which parts were necessary to be reviewed for the status report and prepared a structural backbone for the draft report (ASTAP-24/OUT-25). APT members and affiliates were welcomed to contribute to the report.

It’s important to regulate and determine the relationship between EMF activities and domestic/international safety for each country. With the development of the status report, we will not only be able to promote sharing information and find new pathways for development, but also find out future study areas for GICT and EMF working group. The draft status report on human exposure to EMFs was prepared by the rapporteur Dr. Junoh An in collaboration with participants to GICT&EMF EG meeting. The input and information documents helped to update the status report were listed as a reference of this report. At the meeting of ASTAP 29, the status report was updated with some input documents and with the efforts of editors and chairman of EG GICT&EMF.

At the meeting of ASTAP 30 and ASTAP 31, the EG GICT&EMF had input and inform documents and it was agreed to include these documents to update the current APT/ASTAP/REPT-29 during the ASTAP-31 meeting. The documents which used to update the report are as follows;

* ASTAP-30/INPUT-47: Revised on the recent EMF policies and regulation on Korea of status report
* ASTAP-30/INPUT-51: Introduction to the ITU and IEC recent activities on EMF assessment and proposal to update the status report on EMF by including the related contents
* ASTAP-31/INPUT-54: Introduction to the ITU activities on EMF and proposal to updated the status report of Asia Pacific regional activities on human exposure to EMF by including the related contents
* ASTAP-31/INF-08: An overview of ITU’s activities on EMF assessment

At the meeting of ASTAP 33 and ASTAP 34, the EG GICT&EMF had input and information documents and it was agreed to include these documents to update the current report, APT/ASTAP/REPT-29 during the ASTAP-34 meeting. The documents which used to update the report are as follows;

* ASTAP-33/INPUT-32: Revised with the recent ICNIRP exposure standards (chapter 3. International Regulations and Guidelines on Human Exposure to EMF / 3.1.1 ICNIRP (International Commission on Non-Ionizing Radiation Protection)
* ASTAP-34/INPUT-23: Revised with the recent IEC and ITU-T standards (chapter 4. Standard Developing Organizations / 4.1.1 ITU-T and 4.1.2 IEC)
* ASTAP-34/INPUT-22: Added as an appendix of the report 29 with the title “5G electromagnetic wave intensity measurements and calculations”

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# Scope

The status report’s primary aim is to provide information on:

* Information on International Regulations and Guidelines
* Related international activities of EMF
* National Policy, Regulation and Guideline for EMF in Asia-Pacific Countries
* Awareness and Education Outreach Activities of EMF in the Asia-Pacific Countries

The report also intends to help government agencies, telecommunication operators, equipment manufacturers, and the general public understand the notion of EMF, EMF Exposure, and public safety.

# Terms and Definition

For the purposes of this document, the following terms and definitions apply.

## adverse health effect

An effect detrimental to an individual’s health and physical well-being due to overexposure (hazardous) to an electric, magnetic, or electromagnetic field or to induced or contact currents or voltages.

## antenna

A device designed for radiating (or receiving) electromagnetic energy.

## averaging time (Tavg)

The appropriate time period over which exposure is averaged for purposes of determining compliance with a maximum permissible exposure (MPE) or reference level.

## basic restrictions (BRs)

Exposure restrictions that are based on established adverse health effects that incorporate appropriate safety factors and are expressed in terms of the in situ electric field (3 kHz to 5 MHz), specific absorption rate (100 kHz to 3 GHz), or incident power density (3 GHz to 300 GHz). Depending upon the frequency of the electromagnetic field, the physical quantities used to specify these restrictions are internal electric field strength (Eint), current density (J), specific absorption rate (SAR), specific absorption (SA) and power density (S). They are formulated in metrics that quantify RF field induced inside the body, which consequently provide a more accurate measure of harmful exposure compared to derived limits based only on ambient field-strength (E and H) exposures. However, BR quantities are often difficult and impractical to measure.

## biological effect

An effect caused by, or in response to, exposure to a biological, chemical, or physical agent, including electromagnetic energy.

## controlled environment

An area where the occupancy and activity of those within is subject to control and accountability as established by an RF safety program for the purpose of protection from RF exposure hazards.

## current density

The ratio of the current flowing to the cross-sectional area perpendicular to the direction of the current, expressed in units of ampere per square meter (A/m2).

## electric field

A fundamental component of electromagnetic waves, which exists when there is a voltage difference between two points in space.

## electric field strength(E)

Force exerted by an electric field on an electric point charge, divided by the electric charge. Electric field strength is expressed in newton per coulomb (N/C) or volt per meter (V/m).

## EMF

electric, magnetic or electromagnetic field

## exposure

Being in the presence of electric, magnetic, or electromagnetic fields or in contact with a current source.

## exposure limit

The root-mean-square (rms) or peak electric and magnetic field strengths, their squares, or the plane-wave equivalent power densities associated with these fields, and the induced and contact currents and contact voltages that are used to define the exposure categories and to which a person may be exposed without harmful effect and with an acceptable safety factor.

## ionizing radiation

Any electromagnetic (EM) or particulate radiation capable of producing ions directly or indirectly in its passage through matter. Examples are X-rays and gamma rays.

## limbs

The entire leg or arm.

## magnetic field

A fundamental component of electromagnetic waves produced by a moving electric charge.

## 

## magnetic field strength(H)

The magnitude of the magnetic field vector; expressed in units of ampere per meter (A/m).

## maximum permissible exposure (MPE)

Derived limits in RF exposure standards for time averaged and peak exposures to ambient electric (E) and magnetic (H) fields, e.g., the root-mean-square (rms) or peak electric and magnetic field strengths, their squares, or the plane-wave equivalent power densities associated with these fields, and the induced and contact currents and contact voltages to which a person may be exposed without harmful effect due to the effects identified in the standard, and with an acceptable safety factor for protection from such effects as described in the standard.

## occupational exposure

RF exposure of persons induced as a consequence of their employment who have been made fully aware of the potential for exposure and can exercise control over their exposure such as through the use of administrative or engineering controls or safe work practices (e.g., use of personal protective equipment or time averaging of exposures).

## plane wave

An electromagnetic wave characterized by mutually orthogonal electric and magnetic fields that are related by the impedance of free space (377 ohms).

## power density

The ambient field exposure (E or H), or power density (S) averaged over a number of spatial locations. Different spatial averaging schemes are defined in various standards and guidelines. For frequencies up to 3 GHz, the average of the field strength squared or equivalent power density over an area equivalent to the vertical cross section of the adult human body, as applied to the measurement of electric or magnetic fields in the assessment of whole-body exposure.

## reference level

Limits for the exposure field strength and contact current values derived or estimated from the BRs. The reference levels associated with direct effects are electric field strength (E), magnetic field strength (H), magnetic flux density (B), power density (S), and currents flowing through the limbs (IL).

## risk

The probability of a specific adverse outcome associated with an acute (short-term) or chronic (long-term) exposure scenario.

## specific absorption rate (SAR)

The time derivative of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of given density (ρ). SAR is expressed by the unit of watt per kilogram (W/kg).

# International Regulations and Guidelines on Human Exposure to EMF (EMF Impact to Humans)

This chapter describes the two types of international standards of both regulations and guidelines for humans, occupational and the general public.

## 

## Exposure standards

Exposure standards are specifications that limit the exposure of people to the electromagnetic fields (EMFs). The purpose of exposure standards is to establish the maximum radio frequency energy level know as Specific Absorption rate (SAR) in watts per kilogram (W/kg) that can be safely absorbed by people.

* + 1. **ICNIRP (International Commission on Non-Ionizing Radiation Protection)**

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) provides scientific advice and guidance on the health and environmental effects of non-ionizing radiation (NIR) to protect people and the environment from detrimental NIR exposure. Exposure of people to EMFs are measured by SAR (Specific energy Absorption Rate) and regulated by the ICNIRP, if a local or national regulatory agency does not cover the limitations on exposures. The following table refers to EMF exposure from 100 kHz to 300 GHz.

**ICNIRP basic restrictions for electromagnetic field exposure from 100 kHz to 300 GHz, for averaging intervals ≥ 6 min**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Exposure scenario | Frequency range | Whole-body average SAR (W kg−1) | Local Head/Torso SAR (W kg−1) | Local Limb SAR (W kg−1) | Local Sab (W m−2) |
| Occupational | 100 kHz to 6 GHz | 0.4 | 10 | 20 | NA |
| > 6 to 300 GHz | 0.4 | NA | NA | 100 |
| General public | 100 kHz to 6 GHz | 0.08 | 2 | 4 | NA |
| > 6 to 300 GHz | 0.08 | NA | NA | 20 |

Notes (from [ICNIRP 2020](https://www.icnirp.org/cms/upload/publications/ICNIRPrfgdl2020.pdf)):

NOTE 1 – "NA" signifies "not applicable" and does not need to be taken into account when determining compliance.

NOTE 2 – Whole-body average SAR is to be averaged over 30 min.

NOTE 3 – Local SAR and Sab exposures are to be averaged over 6 min.

NOTE 4 – Local SAR is to be averaged over a 10-g cubic mass.

NOTE 5 – Local Sab is to be averaged over a square 4-cm2 surface area of the body. Above 30 GHz, an additional constraint is imposed, such that exposure averaged over a square 1-cm2 surface area of the body is restricted to two times that of the 4-cm2 restriction.

The following two tables detail reference levels for exposure, to ‘electromagnetic fields from 100 kHz to 300 GHz (unperturbed rms values)’.

**Reference levels, averaged over 30 minutes and the whole body**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Exposure scenario | Frequency range | Incident E-field  strength;  Einc (V m-1) | Incident H-field  strength;  Hinc (A m-1) | Incident power density;  Sinc (W m-2) |
| Occupational | 0.1 – 30 MHz | 660/*f*M0.7 | 4.9/*f*M | NA |
| >30 – 400 MHz | 61 | 0.16 | 10 |
| >400 – 2000 MHz | 3*f*M0.5 | 0.008*f*M0.5 | *f*M/40 |
| >2 – 300 GHz | NA | NA | 50 |
| General Public | 0.1 – 30 MHz | 300/*f*M0.7 | 2.2/*f*M | NA |
| >30 – 400 MHz | s27.7 | 0.073 | 2 |
| >400 – 2000 MHz | 1.375*f*M0.5 | 0.0037*f*M0.5 | *f*M/200 |
| >2 – 300 GHz | NA | NA | 10 |

Notes (from [ICNIRP 2020](https://www.icnirp.org/cms/upload/publications/ICNIRPrfgdl2020.pdf)):

1. ‘NA’ signifies ‘not applicable’ and does not need to be taken into account when determining compliance.

2. *f*M is frequency in MHz.

3. Sinc, Einc and Hinc are to be averaged over 30 minutes over the whole-body space. Temporal and spatial averaging of each of Einc and Hinc must be conducted by averaging over the relevant square values (see Eqn. 8 in Appendix A for details).

4. For frequencies of 100 kHz to 30 MHz, regardless of the far-field/near-field zone distinctions, compliance is demonstrated if neither Einc or Hinc exceeds the above reference level values.

5. For frequencies of >30 MHz to 2 GHz: (a) within the far-field zone: compliance is demonstrated if either Sinc, Einc or Hinc does not exceed the above reference level values (only one is required); Seq may be substituted for Sinc; (b) within the radiative near-field zone, compliance is demonstrated if either Sinc, or both Einc and Hinc do not exceed the above reference level values; and (c) within the reactive near-field zone: compliance is demonstrated if both Einc and Hinc do not exceed the above reference level values; Sinc cannot be used to demonstrate compliance, and so basic restrictions must be assessed.

6. For frequencies of >2 GHz to 300 GHz: (a) within the far-field zone: compliance is demonstrated if Sinc does not exceed the above reference level values; Seq may be substituted for Sinc; (b) within the radiative near-field zone, compliance is demonstrated if Sinc does not exceed the above reference level values; and (c) within the reactive near-field zone, reference levels cannot be used to determine compliance, and so basic restrictions must be assessed.

**Reference levels for local exposure, averaged over 6 minutes**

| Exposure scenario | Frequency range | Incident E-field  strength;  Einc (V m-1) | Incident H-field  strength;  Hinc (A m-1) | Incident power density;  Sinc (W m-2) |
| --- | --- | --- | --- | --- |
| Occupational | 0.1 – 30 MHz | 1504/*f*M0.7 | 10.8/*f*M | NA |
| >30 – 400 MHz | 139 | 0.36 | 50 |
| >400 – 2000 MHz | 10.58*f*M0.43 | 0.0274*f*M0.43 | 0.29*f*M0.86 |
| >2 – 6 GHz | NA | NA | 200 |
| >6 – <300 GHz | NA | NA | 275/*f*G0.177 |
| 300 GHz | NA | NA | 100 |
| General  Public | 0.1 – 30 MHz | 671/*f*M0.7 | 4.9/*f*M | NA |
| >30 – 400 MHz | 62 | 0.163 | 10 |
| >400 – 2000 MHz | 4.72*f*M0.43 | 0.0123*f*M0.43 | 0.058*f*M0.86 |
| >2 – 6 GHz | NA | NA | 40 |
| >6 – 300 GHz | NA | NA | 55/*f*G0.177 |
| 300 GHz | NA | NA | 20 |

Notes (from [ICNIRP 2020](https://www.icnirp.org/cms/upload/publications/ICNIRPrfgdl2020.pdf)):

1. ‘NA’ signifies ‘not applicable’ and does not need to be taken into account when determining compliance.

2. *f*M is frequency in MHz; *f*G is frequency in GHz.

3. Sinc, Einc and Hinc are to be averaged over 6 minutes, and where spatial averaging is specified in Notes 6-7, over the relevant projected body space. Temporal and spatial averaging of each of Einc and Hinc must be conducted by averaging over the relevant square values (see Eqn. 8 in Appendix A for details).

4. For frequencies of 100 kHz to 30 MHz, regardless of the far-field/near-field zone distinctions, compliance is demonstrated if neither peak spatial Einc or peak spatial Hinc, over the projected whole-body space, exceeds the above reference level values.

5. For frequencies of >30 MHz to 6 GHz: (a) within the far-field zone, compliance is demonstrated if one of peak spatial Sinc, Einc or Hinc, over the projected whole-body space, does not exceed the above reference level values (only one is required); Seq may be substituted for Sinc; (b) within the radiative near-field zone, compliance is demonstrated if either peak spatial Sinc, or both peak spatial Einc and Hinc, over the projected whole-body space, does not exceed the above reference level values; and (c) within the reactive near-field zone: compliance is demonstrated if both Einc and Hinc do not exceed the above reference level values; Sinc cannot be used to demonstrate compliance; for frequencies >2 GHz, reference levels cannot be used to determine compliance, and so basic restrictions must be assessed.

6. For frequencies of >6 GHz to 300 GHz: (a) within the far-field zone, compliance is demonstrated if Sinc, averaged over a square 4-cm2 projected body surface space, does not exceed the above reference level values; Seq may be substituted for Sinc; (b) within the radiative near-field zone, compliance is demonstrated if Sinc, averaged over a square 4-cm2 projected body surface space, does not exceed the above reference level values; and (c) within the reactive near-field zone, reference levels cannot be used to determine compliance, and so basic restrictions must be assessed.

7. For frequencies of >30 GHz to 300 GHz, exposure averaged over a square 1-cm2 projected body surface space must not exceed twice that of the square 4-cm2 restrictions.

* + 1. **IEEE (Institute of Electrical and Electron Engineers)/ICES (International Committee on Electromagnetic Safety)**

The IEEE is the world’s largest professional association advancing innovation and technological excellence for the benefit of humanity. Its core purpose is to foster technological innovation and excellence for the benefit of humanity. The International Committee on Electromagnetic Safety (ICES) is responsible for development of standards for the safe use of electromagnetic energy in the range of 0 Hz to 300 GHz.

**IEEE/ICES Maximum Permissible Exposure Limits, RF EMF**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Type of Exposure | Frequency Range (MHz) | RMS Electric Field Strength (V/m) | RMS Magnetic Field Strength (A/m) | RMS Power Density (E-field, H-field) (W/m2) | Averaging Time (min) | |
| E2 | S or H2 |
| Controlled Environment | 0.1 – 1.0 | 1842 | 16.3/fM | (9000, 100,000/fM2) | 6 | |
| 1 – 30 | 1842/fM | 16.3/fM | (9000/fM2, 100,000/fM2) | 6 | |
| 30 – 100 | 61.4 | 16.3/fM | (10, 100,000/fM2) | 6 | |
| 100 – 300 | 61.4 | 0.163 | 10 | 6 | |
| 300 – 3000 | - | - | fM/30 | 6 | |
| 3000 – 30,000 | - | - | 100 | 19.63/fG1.079 | |
| 30,000 – 300,000 | - | - | 100 | 2.524fG0.476 | |
| General Public | 0.1 – 1.34 | 614 | 16.3/fM | (1000, 100,000/fM2) | 6 | |
| 1.34 – 3.0 | 823.8/fM | 16.3/fM | (1800//fM2, 100,000/fM2) | fM2/0.3 | 6 |
| 3 – 30 | 823.8/fM | 16.3/fM | (1800/fM2, 100,000/fM2) | 30 | 6 |
| 30 – 100 | 27.5 | 158.3/fM1.668 | (2, 9,400,000//fM3.336) | 30 | 0.0636 fM1.337 |
| 100 – 400 | 27.5 | 0.0729 | 2 | 30 | 30 |
| 400 - 2000 | - | - | fM/200 | 30 | |
| 2000 – 5000 | - | - | 10 | 30 | |
| 5000 – 30,000 | - | - | 10 | 150/fG | |
| 30,000 – 100,000 | - | - | 10 | 25.24/fG0.476 | |
| 100,000 –300,000 | - | - | (20/fG – 7000)/200 | 5048/[(9fG- 7000) fG0.476] | |

* + 1. **NRPB**

The National Radiological Protection Board (NRPB) was a public authority in the UK created by the Radiological Protection Act 1970. Its statutory functions were to conduct research on radiological protection and provide advice and information on the subject to Government Departments and others. It was also authorized to provide technical services and charge for them. Originally NRPB dealt only with ionizing radiation, but its functions were extended in 1974 to non-ionizing radiation.

**NRPB investigation levels for exposure to electric and magnetic fields in the frequency range 12 MHz to 300 GHz**

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | Electric Field Strength  (V m-1) | Magnetic Field Strength  (A m-1) | Power Density |
| 12 – 200 MHz | 50 | 0.13 | 6.6 |
| 200 – 400 MHz | 250 *f* | 0.66 *f* | 165 *f 2* |
| 400 – 800 MHz | 100 | 0.26 | 26 |
| 0.8 – 1.55 GHz | 125 *f* | 0.33 *f* | 41 *f*2 |
| 1.55 – 300 GHz | 0.52 | 0.52 | 100 |

[f is in frequency in GHz]

* + 1. **FCC (Federal Communications Commission)**

The Federal Communications Commission (FCC) regulates interstate and international communications by radio, television, wire, satellite and cable in all 50 states, the District of Columbia and U.S. territories. An independent U.S. government agency overseen by Congress, the commission is the United States' primary authority for communications law, regulation and technological innovation.

**Limits for Maximum Permissible Exposure [Occupational/Controlled]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency Range (MHz) | Electrical Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density  (mW/cm2) | Averaging Time  (min) |
| 0.3 – 3.0 | 614 | 1.63 | \*100 | 6 |
| 3.0 – 30 | 1842/f | 4.89/f | \*900/f2 | 6 |
| 30 – 300 | 61.4 | 0.163 | 1.0 | 6 |
| 300 – 1,500 | - | - | f/300 | 6 |
| 1,500 – 100,000 | - | - | 5 | 6 |

**Limits for Maximum Permissible Exposure [General Public/Uncontrolled]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency Range (MHz) | Electrical Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density  (mW/cm2) | Averaging Time  (min) |
| 0.3 – 1.34 | 614 | 1.63 | \*100 | 30 |
| 1.34 – 30 | 842/f | 2.19/f | \*180/f2 | 30 |
| 30 – 300 | 27.5 | 0.073 | 0.2 | 30 |
| 300 – 1,500 | - | - | f/1500 | 30 |
| 1,500 – 100,00 | - | - | 1.0 | 30 |

f = Frequency in MHz; \* = Plane-wave equivalent power density

## Emission standards

Emission standards are specifications that limit the emission of electromagnetic field (EMFs) from the electric devices. The purpose of emission standards is to regulate the amount of radio frequency emission from a device to minimize the possibility of interference to other services or nearby equipment.  Emission standards are often part of an Electromagnetic Compatibility (EMC) framework.

* + 1. **IEEE/IEC (International Electrotechnical Standardization)**

The International Electrotechnical Commission (IEC) is the leading global organization that publishes consensus-based International Standards and manages conformity assessment systems for electric and electronic products, systems and services, collectively known as electro technology.

* + 1. **CENELEC (European Committee for Electrotechnical Standardization)**

The European Committee for Electrotechnical Standardization (CENELEC) is responsible for standardization in the electrotechnical engineering field. CENELEC prepares voluntary standards, which help facilitate trade between countries, create new markets, cut compliance costs and support the development of a Single European Market.

# Related International Activities of EMF

This chapter describes international standards and activities of EMF.

## Standard Developing Organizations

* + 1. **ITU**

ITU holds the World Telecommunication Standardization Assembly (WTSA) every four years, and on 2012 (WTSA-12), they approved Resolution 72: Measurements concerning human exposure to EMFs. Since the enacting of the Resolution, ITU has continuously developed studies and researches that were necessary for radio communication development and now is the leading force behind future development. Now the ITU regulates world radio communications, and satellite communications. They also established standard regulations for city development regarding telecommunications.

ITU splits into three major divisions: ITU-Radiocommunication (ITU-R), ITU-Standardization (ITU-T), and ITU-Development (ITU-D) and under each division, they each have study groups (SG) that focus on a particular aspect of study. They conduct experiments, find information and publish it to the open for agencies, governments, and the public to see. They also hold numerous events (public and private) where they would present new information, discuss/debate conflicts, and finally establish a conclusion from their meeting.

* + - 1. **ITU-T**

The ITU Standardization division is the leading researcher for EMF exposure and health. They currently have a study group (SG5) researching various questions on EMFs. One of the questions (Q3) concerns “Human exposure to electromagnetic fields (EMFs) from information and communication technologies (ICTs).” SG5 provides a high-level framework for managing human exposure to EMFs and also offer guidelines for assessing exposure based on existing recommendations + other standards.

They have started and finished numerous studies and analysis, and they now focus on building guidance for environmental management of EMF radiation and exposure. These guidelines will and have helped developing countries structure their telecommunication infrastructure efficiently and safely. ITU-T SG5 develops Recommendations, supplements and other publications related to the assessment of human exposure to electromagnetic fields (EMF) produced by ICT installations and devices. Keeping in mind the electromagnetic fields (EMF) aspects, ITU-T SG5 will take into consideration that the deployment of 5G will see the evolution and expansion of existing 4G networks and the introduction of new radio access networks within the millimeter wave bands. These networks will include a range of installations, including smaller cell deployments and advanced antenna technologies, such as massive MIMO antennas that will allow the use of very narrow beams which will follow the user and may impact the surrounding exposure levels. In conjunction with the growth of 5G, the number of wireless devices will dramatically increase. However, at the same time, new technologies will allow the use of more efficient systems that require lower level signals for communication. It will also involve software defined radio (SDR) and band aggregation that will improve communication efficiency.

So ITU-T SG5 should contribute to the process on standardization for 5G by considering EMF aspects related to:

* the impact of 5G technologies on the compliance assessment methodology;
* the deployment of smart antennas;
* the use of Software Defined Radio;
* the communication and understanding among stakeholders and general public related to the effect on human health.

Taking to consideration the development of 5G system, ITU-T SG5 is developing a series of technical reports and international standards that study the following environmental aspects, electromagnetic fields (EMF) of 5G:

* ITU-T K.Suppl.1: Guide on electromagnetic fields and health
* ITU-T K.Suppl.4: Electromagnetic field considerations SSCs
* ITU-T K.Suppl.9: 5G technology and human exposure to RF EMF
* ITU-T K.Suppl.14: The impact of RF-EMF exposure limits stricter than the ICNIRP or IEEE guidelines on 4G and 5G mobile network deployment
* ITU-T K.Suppl.16: Electromagnetic field compliance assessment for 5G wireless networks

K series Recommendations on human exposure to electromagnetic fields are listed in the table.

|  |  |  |
| --- | --- | --- |
| Number | Approval Date | Title |
| K. 52 | 2021. 6. 29 | Guidance on complying with limits for human exposure to electromagnetic fields |
| K. 61 | 2018.01.13 | Guidance on measurement and numerical prediction of electromagnetic fields for compliance with human exposure limits for telecommunication installations |
| K. 70 | 2020.12.14 | Mitigation techniques to limit human exposure to EMFs in the vicinity of radiocommunication stations |
| K. 83 | 2022.01.13 | Monitoring of electromagnetic field levels |
| K. 90 | 2018.07.14 | Evaluation techniques and working procedures for compliance with exposure limits of network operator personnel to power-frequency electromagnetic fields |
| K. 91 | 2022.01.13 | Guidance for assessment, evaluation and monitoring of human exposure to radio frequency electromagnetic fields |
| K. 100 | 2021.06.29 | Measurement of radio frequency electromagnetic fields to determine compliance with human exposure limits when a base station is put into service |
| K. 113 | 2015.11.29 | Generation of radiofrequency electromagnetic field level maps |
| K. 121 | 2018.05.25 | Guidance on the environmental management for compliance with radio frequency EMF limits for radio communication base stations |
| K. 122 | 2016.12.14 | Exposure levels in close proximity of radio communication antennas |
| K. 145 | 2020.12.14 | Assessment and management of compliance with radio frequency electromagnetic field exposure limits for workers at radiocommunication sites and facilities |
| K Suppl. 1 | 2021.05.20 | ITU-T K.91 – Guide on electromagnetic fields and health |
| K Suppl. 4 | 2018.09.21 | ITU-T K.91 - Electromagnetic field considerations in smart sustainable cities |
| K Suppl. 9 | 2019.05.22 | [5G technology and human exposure to RF EMF](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=13473) |
| K Suppl. 13 | 2021.12.10 | Radiofrequency electromagnetic field (RF-EMF) exposure levels from mobile and portable devices during different conditions of use |
| K Suppl. 14 | 2019.09.20 | The impact of RF-EMF exposure limits stricter than the ICNIRP or IEEE guidelines on 4G and 5G mobile network deployment |
| K Suppl. 16 | 2018.09.21 | Electromagnetic field compliance assessments for 5G wireless networks |
| K Suppl.19 | 2019.09.20 | Electromagnetic field (EMF) strength inside underground railway trains |
| K Suppl.20 | 2021.12.10 | ITU-T K.91 – Supplement on radiofrequency exposure evaluation around underground base stations |

The following revised Recommendations on EMF were recently approved:

* ITU-T K.70 – Mitigation techniques to limit human exposure to EMFs in the vicinity of radiocommunication stations

What is new? This new version includes example of parameters of the typical radiocommunication systems including 5G.

* ITU-T K.91 – Guidance for assessment, evaluation and monitoring of human exposure to radio frequency electromagnetic fields

What is new? This new version includes information concerning 5G mobile system and new WHO, ICNIRP and IEEE guidelines.

* ITU-T K.145 – Assessment and management of compliance with radio frequency electromagnetic field exposure limits for workers at radiocommunication sites and facilities

What is new? This new version includes information on conditions of the warning alarms and a new appendix of an RF exposimeter (RF personal monitor) during telecommunication tower maintenance.

The version of ITU-T K.Suppl.1 to ITU-T K.91 on Guide on electromagnetic fields and health is now available. The Supplement is a great tool to answer questions commonly posed by the public on the electromagnetic field (EMF) phenomenon and to address related concerns. This new version of the Supplement includes information concerning 5G mobile systems and new WHO, ICNIRP and IEEE guidelines.

The work programes of ITU-T Q3/5 are listed in the table.

| Work item | Timing | Version | Status | Subject / Title | Editor(s) |
| --- | --- | --- | --- | --- | --- |
| [K.peak](http://www.itu.int/itu-t/workprog/wp_item.aspx?isn=14666) | 2019-12 | New | Under study | Comparison between peak and real exposure in the long term considerations | [Fryderyk Lewicki](mailto:fryderyk.lewicki@orange.com) |
| [K.reflection](http://www.itu.int/itu-t/workprog/wp_item.aspx?isn=14667) | 2019-12 | New | Under study | Impact of the metallic structures for the EMF exposure level | [Fryderyk Lewicki](mailto:fryderyk.lewicki@orange.com) |
| [K.Small](http://www.itu.int/itu-t/workprog/wp_item.aspx?isn=14668) | 2019-12 | New | Under study | Small base stations - impact on the overall exposure level | [Fryderyk Lewicki](mailto:fryderyk.lewicki@orange.com) |
| [K.workers](http://www.itu.int/itu-t/workprog/wp_item.aspx?isn=14665) | 2020 | Rev. | Under study | Assessment and management of compliance with RF EMF exposure limits for workers at radiocommunication sites | [Ernest Cid](mailto:ernest-cid@wavecontrol.com), [Fryderyk Lewicki](mailto:fryderyk.lewicki@orange.com), [Mike Wood](mailto:mike.wood@team.telstra.com) |
| [K.Zones](http://www.itu.int/itu-t/workprog/wp_item.aspx?isn=14669) | 2019-12 | New | Under study | Guidance on Determining the Compliance Boundaries (the exclusion zone) of a Live Antenna | [Fryderyk Lewicki](mailto:fryderyk.lewicki@orange.com), [Christer Törnevik](mailto:christer.tornevik@ericsson.com) |
| [KSTR.EMF\_assess](http://www.itu.int/itu-t/workprog/wp_item.aspx?isn=14862) | 2019 | New | Under study | Case studies of RF-EMF assessments | [Junoh An](mailto:juno@ifre.re.kr), [Fryderyk Lewicki](mailto:fryderyk.lewicki@orange.com), [Vijay Kumar Roy](mailto:vk.roy@gov.in), [Mike Wood](mailto:mike.wood@team.telstra.com) |
| K.devices | 2021 | New | Under study | RF EMF exposure assessment of the wireless radiocommunication devices operating close to the human body | Fryderyk Lewicki |

* + 1. **IEC**

The International Electro-technical Commission (IEC) has been working on their own project on health effects from exposure to radio EMFs since before the WHO initiated theirs. They are the world leading organization for the publication and preparation of international standards for all electronic related technologies and have worked with numerous companies, industries, and governments to discuss about development and safety. They also work with major international organizations, like the ITU and ISO, to ensure the international standards fit together and are credible. They do so by jointly cooperating with experts of all relevant fields.

IEC’s International Advisory Committee (IAC) plays another large role in supporting the IEC’s research and study on health effects. They are in charge of managing and supervising IEC’s projects; some general projects are:

* Providing forums for coordinating responses on health concerns raised by EMF exposure
* Reviewing and commenting on information related to public and occupational health along with environmental management of the EMF issue.
* Recommending research areas which needs scientific research improvements.
* Overseeing and regulating the conduct of the project
  + - 1. **IEC TC106**
* Purpose:
* To prepare international standards on measurement and calculation methods to assess human exposure to electric, magnetic and electromagnetic fields (0 Hz to 300 GHz).
* IEC/IEEE Joint Working Group:
* JWG 11 Computational Methods to assess the power density in close proximity to the head and body linked to IEEE
* JWG 12 Measurement Methods to assess the power density in close proximity to the head and body linked to IEEE
* JWG 13 Measurement Procedures to Determine the Specific Absorption Rate (SAR) linked to IEEE
* IEC/IEEE Joint Maintenance Team
* JMT 62209-3 Maintenance of IEC 62209-3: "Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 3: Vector measurement-based systems (Frequency range of 600 MHz to 6 GHz)" linked to IEEE
* JMT 62704-1 Maintenance of IEC/IEEE 62704-1: “Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 1: General requirements for using the finite difference time-domain (FDTD) method for SAR calculations” linked to IEEE
* JMT 62704-2 Maintenance of IEC/IEEE 62704-2: “Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 2: Specific requirements for finite difference time domain (FDTD) modelling of exposure from vehicle mounted antennas” linked to IEEE
* JMT 62704-3 Maintenance of IEC/IEEE 62704-3: “Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 3: Specific requirements for using the finite difference time domain (FDTD) method for SAR calculations of mobile phones" linked to IEEE linked to IEEE
* JMT 62704-4 Maintenance of IEC/IEEE 62704-4: "Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communication devices, 30 MHz to 6 GHz - Part 4: General requirements for using the finite element method for SAR calculations" linked to IEEE
* IEC Maintenance Team
* MT 3 Maintenance Team for IEC 62232 : To prepare in international standards on measurement and calculation methods to assess human exposure to electric magnetic and electromagnetic field
  + - 1. **IEC TC 106 update**

The revision of IEC 62232 (Ed.3) to be published in Oct. 2022. TC106 established a project team to develop a standard titled: Determination of RF field strength, power density and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure

* Mobile Devices Compliance Assessment Activities

Following working groups, project teams and sub-committees have been involved to develop of compliance assessment standards for terminal devices used close to the human body:

* IEEE/IEC JMT(Joint Maintenance Teams) 62209-3
* IEEE/IEC JMT(Joint Maintenance Teams) 62704-1, IEEE/IEC 62704-2, IEEE/IEC 62704-3 & IEEE/IEC 62704-4
* IEEE/IEC JWG(Joint Working Group)11
* IEEE/IEC JWG(Joint Working Group)12
* IEEE/IEC JWG(Joint Working Group)13
* IEC/IEEE 62209-1528 Ed.1: was published on Oct. 2020 (SAR std).
* IEC/IEEE 62209-1528:2020 specifies protocols and test procedures for the reproducible and repeatable measurement of the conservative exposure peak spatial average SAR (psSAR) induced inside a simplified model of the head and the body by radio-frequency (RF) transmitting devices, with a defined measurement uncertainty. These protocols and procedures apply to a significant majority of the population, including children, during the use of hand-held and body-worn wireless communication devices.
* IEC/IEEE 63195-1 Ed.1: to be published in May 2022 (Measurement Power Density std). Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body (Frequency range of 6 GHz to 300 GHz) - Part 1: Measurement procedure
* IEC/IEEE 63195-2 Ed.1: to be published in May 2022 (Measurement Power Density std). Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body (Frequency range of 6 GHz to 300 GHz) - Part 2: Computational procedure
* IEC 62209-3 Ed.1: was published on Sep. 2019 (Fast SAR technique) Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 3: Vector measurement-based systems (Frequency range of 600 MHz to 6 GHz)
* IEC/IEEE 62704-1 Ed.2: to be published in Mar. 2023 (SAR FDTD Numerical std). Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 1: General requirements for using the finite difference time-domain (FDTD) method for SAR calculations
* IEC/IEEE 62704-2/AMD Ed.2: to be published in Dec. 2023 (Vehicle SAR Numerical std). Amendment 1 - Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 2: Specific requirements for finite difference time domain (FDTD) modelling of exposure from vehicle mounted antennas
* IEC/IEEE 62704-3 Ed.2: to be published in Dec. 2023 (Mobile phone SAR Numerical std). Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 3: Specific requirements for using the finite difference time domain (FDTD) method for SAR calculations of mobile phones
* IEC/IEEE 62704-1 Ed.2: to be published in Sep. 2023 (SAR FEM Numerical std). Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communication devices, 30 MHz to 6 GHz - Part 4: General requirements for using the finite element method for SAR calculations
  + 1. **IEEE**

The Institute of Electrical and Electronics Engineers is another major contributor to the development of EMF technology. They are the world’s largest association for technological innovation and development and have cooperated with many major companies throughout their campaign, like the ICES to build a guideline for RF emissions limitation.

The IEEE’s Engineering in Medicine and Biology Society (EMBS), the largest international society of biomedical engineers, have set their focus on studying EMF’s exposure on the human body. Therefore, establishing a research committee for that purpose; the Committee on Man and Radiation (COMAR). COMAR’s research became of large importance in this field of research, since they focused more on identifying quality sources of scientific information to provide readers, institutes, and companies with references to expert and reliable sources. One example of their works particularly talks about the Bio Initiative Report’s (BIR) research on EMF exposure. COMAR stated that BIR’s scientific evidence did not support the safety limits BIR recommended and concluded the use of the ICNIRP’s standards were most efficient/safe.

The table includes recent updated publications and information statements in Health reports.

|  |  |
| --- | --- |
| Publication  Date | Title |
| 2015.03 | Radiofrequency Safety and Utility Smart Meters |
| 2009.08 | COMAR Technical Information Statement: Expert Reviews on Potential Health Effects of Radiofrequency Electromagnetic Fields and Comments on the Bio Initiative Report(BIR) |
| 2005.12 | COMAR Technical Information Statement:  Exposure of medical personnel to electromagnetic fields from open magnetic resonance imaging systems. Health Physics 89(6):684-689 |
| 2005.03 | COMAR Technical Information Statement:  The IEEE exposure limits for radiofrequency and microwave energy. IEEE Eng. Med. Biol. Mar/Apr 114-121 |
| 2002.09 | COMAR Technical Information Statement:  Electromagnetic Hypersensitivity |

## Non-SDOs

* + 1. **ICNIRP**

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is a NGO that aims to protect the commonwealth against any adverse effects of non-ionizing radiation. They have developed and advised many agencies and governments on the limitation of exposure to radiation. ICNIRP works with many experts from different countries to assess the risk of radiation exposure and establish guidelines regulating these exposures. Executing both direct and indirect studies, ICNIRP studies non-ionizing radiation exposure on various parts of the human body which includes:

* Neurobehavioral System
* Neuroendocrine System
* Cardiovascular System
* Dosimetry

These studies would be used to update their basic standards for emissions and limitations of EMFs.

Table includes recent publication by ICNIRP.

|  |  |
| --- | --- |
| Publication  Date | Title |
| 2017.03 | ICNIRP STATEMENT ON DIAGNOSTIC DEVICES USING NON-IONIZING RADIATION: EXISTING REGULATIONS AND POTENTIAL HEALTH RISKS |
| 2014.03 | ICNIRP GUIDELINES FOR LIMITING EXPOSURE TO ELECTRIC FIELDS INDUCED BY MOVEMENT OF THE HUMAN BODY IN A STATIC MAGNETIC FIELD AND BY TIME‐VARYING MAGNETIC FIELDS BELOW 1 HZ |
| 2013.10 | WORKSHOP REPORT ICNIRP/WHO International Workshop on Non‐Ionizing Radiation (NIR) Protection in Medicine |
| 2013.09 | ICNIRP GUIDELINES ON LIMITS OF EXPOSURE TO LASER RADIATION OF WAVELENGTHS BETWEEN 180 nm AND 1,000 μm |
| 2011.07 | ICNIRP SCI REVIEW : Mobile Phones, Brain Tumours and the Interphone Study: Where Are We Now? |

* + 1. **WHO**

The World Health Organization (WHO) is the international health organization focusing on the well-being of the common people. They hold leadership, shape research agendas, set norms and standards, and provide standards for public safety. In 1996, they initiated the International EMF Project under the charter to protect public health from EMF exposure and have successfully establish a master plan, ever since the initiation, the WHO worked with numerous telecommunication agencies and have conducted research and studies to figure and fill up knowledge gaps we don’t yet know about EMF radiation and exposure. WHO also developed fact sheets for agencies, governments, and the public to utilize and learn about EMFs.

* WHO Fact Sheet 193 – Electromagnetic fields and public health: mobile phones
* WHO Fact Sheet 304 – Base stations and wireless networks
* WHO Standards and Guidelines

The international EMF project has published the annual reports since 2002. The annual report is composed of the research and risk management activities. The list of recent progress reports of WHO international EMF project is included in the table.

|  |  |
| --- | --- |
| Publication  Date | Title |
| 2014.06 | Progress Report 2013-2014 |
| 2013.06 | Progress Report 2012-2013 |
| 2012.06 | Progress Report 2011-2012 |

* + 1. **Other Research Institutes**
* International Agency for Research on Cancer (IARC)
* United Nations Environment Program (UNEP)
* International Labor Office (ILO)
* European Commission (EC)

# ASTAP-25 Questionnaire and Results

During the ASTAP-24 meeting, GICT & EMF EG agreed to develop a survey questionnaire as a status report on APT countries. Their main focus is to survey the EMF exposure situation in each APT country who participates and present information about their country.

## Questionnaire

|  |  |  |
| --- | --- | --- |
| **Part 1: General** | | |
| **No.** | **Questions** | **Responses**  **(examples are given below only for better understanding)** |
| 1 | Name of organization who responds to the Questionnaire and details of contact person(s). | Name:.  Country:  Organization:.  Address:.  Tel. :  Fax: .  E-mail: |
| 2 | Role and responsibility of respondent.  Note: May check more than one item | Government – policy maker ( )  Equipment Manufacturer ( )  NGO / Activist / Environmentalist ( )  R&D institution ( )  Others ( X ) please specify : \_Mobile network operator trade association |

|  |  |  |
| --- | --- | --- |
| **Part 2 : Regulations** | | |
| 3 | In your country, which agency is responsible for EMF regulations, standards and guidelines  Note: When you have more one agency please add more lines |  |
| 4 | Does your country have any regulation, standards or guidelines for human protection from EMF exposure?  Note: When you have more than one regulation, please add more lines |  |
| 5 | If your country does not currently have any regulations, standards and guidelines, please state your future plans.  Also please state the challenges that you are facing to implement your future plans. | . |
| 6 | For SAR (Specific Absorption Rate), does your country adopt the international limits, such as ICNIRP or IEEE? If not, what sort of limits do you apply? | . |
| 7 | For Exposure limit, does your country adopt the international limits, such as ICNIRP or IEEE? If not, what sort of limits do you apply? |  |
| 8 | If you apply the SAR or EMF Safety limits, please describe whether it is a compulsory or voluntary system? | . |
| 9 | For enforcement, is there a mandatory requirement to submit reports to authorities? |  |
| 10 | For the EMF values of the Base Stations, what methodologies does your country use? |  |

|  |  |  |
| --- | --- | --- |
| **Part 3 : Communications** | | |
| 11 | Does your country have any awareness and education outreach activities of EMF (communication activities)? |  |
| 12 | In 2011, IARC announced the inclusion of Radio Frequency including mobile communications to be categorized as Group 2B classification and is declared to be possibly carcinogenic. Does the government agencies and public understands what this means? Which of the following are NOT classified as Group 2B? |  |

## Questionnaire Results

| **Country** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** | **Q11** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Afghanistan |  |  |  |  |  |  |  |  |  |
| Australia |  |  |  |  |  |  |  |  |  |
| Bangladesh | - | - | - | - | - | - | - | - | - |
| Bhutan | - | - | - | - | - | - | - | - | - |
| Brunei |  |  |  |  |  |  |  |  |  |
| Burma (Myanmar) |  |  |  |  |  |  |  |  |  |
| Cambodia | - | - | - | - | - | - | - | - | - |
| China |  |  |  |  |  |  |  |  |  |
| Cook Islands |  |  |  |  |  |  |  |  |  |
| Fiji |  |  |  |  |  |  |  |  |  |
| Hong Kong | Office of the Telecommunications Authority | - | - | ICNIRP | ICNIRP | yes | - | mixed | <http://www.ofta.gov.hk/en/ca_bd/rf_safety.html> |
| India | Department of Telecommunications | - | - | FCC | 10% of ICNIRP | yes | - | mixed | <http://www.dot.gov.in/access-services/journey-emf> |
| Indonesia | MCIT | MCIT | No | - | - | ICNIRP | - | No | mixed |
| Iran |  |  |  |  |  |  |  |  |  |
| Japan |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| Korea | RRA  (government) | MSIT | Radio Acts  (ordinance) | - | IEEE | ICNIRP | compulsory | one time | measurement |
| Laos |  |  |  |  |  |  |  |  |  |
| Macau |  |  |  |  |  |  |  |  |  |
| Malaysia |  |  |  |  |  |  |  |  |  |
| [Kiribati](http://en.wikipedia.org/wiki/Kiribati) |  |  |  |  |  |  |  |  |  |
| Maldives |  |  |  |  |  |  |  |  |  |
| Marshall Islands |  |  |  |  |  |  |  |  |  |
| FS Micronesia |  |  |  |  |  |  |  |  |  |
| Mongolia |  |  |  |  |  |  |  |  |  |
| Nauru |  |  |  |  |  |  |  |  |  |
| Nepal | Nepal telecommunications authority  (government) | Nepal telecommunications authority | No  (under consideration) | - | ICNIRP | ICNIRP | compulsory | No | No |
| New Zealand |  |  |  |  |  |  |  |  |  |
| Niue |  |  |  |  |  |  |  |  |  |
| Pakistan |  |  |  |  |  |  |  |  |  |
| Palau |  |  |  |  |  |  |  |  |  |
| Papua New Guinea |  |  |  |  |  |  |  |  |  |
| Philippines |  |  |  |  |  |  |  |  |  |
| Samoa |  |  |  |  |  |  |  |  |  |
| Singapore |  |  |  |  |  |  |  |  |  |
| Solomon Islands |  |  |  |  |  |  |  |  |  |
| Sri Lanka |  |  |  |  |  |  |  |  |  |
| Thailand | NBTC | NBTC | NTC TS 5001-2550 | Conduct campaign | ICNIRP | ICNIRP | compulsory | One time only  (all sites) | mixed |
| Tonga |  |  |  |  |  |  |  |  |  |
| Tuvalu |  |  |  |  |  |  |  |  |  |
| Vanuatu |  |  |  |  |  |  |  |  |  |
| Vietnam | For stadards: Ministry of Science and Technology  For Regulation and Guidelines: Ministry of Information and Communications | Standards: TCVN 3718-1:2005  Regulation:  Base Station: QCVN 08:2010/BTTTT  Broadcasting Radio and Television Station: QCVN 78:2014/BTTTT | - | We do not apply SAR limit | ICNIRP | Compulsory | - | Mixed | Information Booklet  <http://www1.binhduong.gov.vn/trangchu/print.php?id=16568>  <http://www.baobinhdinh.com.vn/viewer.aspx?macm=23&macmp=23&mabb=38168>  Others : Video clips, Interview on Television |

# National Policy, Regulation and Guideline for EMF in Asia-Pacific Countries

This chapter focuses on the APT country’s regulations of EMF. Information includes:

* Basic background information about the country governance on EMFs
* National Policy and Strategy + National Regulation and Guideline used
* Implementation Status updates + Future Plans
* Obstacles and Challenges

## Australia

* + 1. **Background**

The Australian Communication and Media Authority (AMCA) and Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) are the two leading agencies that deal with EMF radiation and exposure. AMCA aims to support growth of the mobile broadband and actively try to engage with the Department of Communications’ review of Australia’s spectrum policy and management framework, which would give Australia the necessary resources to continue their studies on spectrum management.

ARPANSA, on the other hand, aims to protect the commonwealth and environment from radiation. They execute so by:

* Maintaining expertise in measurements of radiation and assessment of health impacts
* Advising the government and other agencies by providing information to the public regarding radiation protection
* Ensuring the safety of radiation facilities and sources that operate them
* Leading development of standards, guidelines, and limitations to support protection
* Undertaking research and development in radiation protection
  + 1. **National Policy + Regulations and Guidelines**

Australia’s Radiation Protection Series is the overall legal document on regards to the protection of human health and the environment from possible hazards of radiation. The series have four categories: [1] Radiation Protection Standards, [2] Codes of practice, [3] Recommendations, and [4] Safety Guides. Starting off with [1], this category sets the standard requirements for safety. It contains information on procedural requirements such as exposure limits. [2] contains information on “practice-specific requirements” that must be achieved to ensure a safe level of radiation exposure. [3] provides guidance on ensuring radiation protection, and [4] provides practice-specific guidance on achieving the requirements explained in [1] and [2].

Australia’s Radiocommunications License Conditions (Apparatus License) Determination law regulates the use of radio frequencies and decides who has the right to operate. Developing standards for who can use radio emissions, they are able to limit the exposure of EMFs and also limit the chance of interference around the area. For their standards and guidelines regarding SAR and exposure limits, they use the ICNIRP international standard.

* + 1. **Status Update and Future Plans**

ARPANSA’s Strategic Directions FY2014-17 is their general plan on how they will approach their goal. It explains their new program (Radiation Protection and Nuclear Safety Program) which is made up of four components or methods they will execute to achieve their goal:

* Component 1: Protect the public, workers, and the environment from radiation exposure.
* Component 2: Promote radiological and nuclear safety and security and emergency preparedness
* Component 3: Promote the effective use of ionizing radiation in medicine
* Component 4: Ensure effective and proportionate regulation and enforcement activities

So far, ARPANSA have engaged in many activities primarily focusing on the protection of the commonwealth and the environment. They have categorized their activities into six: Expertise, Advice, Regulate, Best Practice, Serve, and Research. All of these categories all pertain to the safety and protection against radiation exposure. They have also worked with the government and community to maintain and ensure safe exposure levels are kept.

The Agency Strategic Management Committee also contributes the ARPANSA’s aim by managing and monitoring the reports ARPANSA presents.

* + 1. **Obstacles and Challenges**

Due to planned down-sizing and voluntary redundancies, a reduction in staffing has led the Agency to a sustainable financial position, but now they need due to continuously high needs and expectations from the government, agencies, and the general public.

## China

* + 1. **Background**

China has numerous organizations and government agencies that contribute to ASTAP and the research for EMF activities. Many of them now focus their research on bio-effects of ELF, RFs and EMFs and their possible health consequences. The Ministry of Environmental Protection of China is the main agency that regulates the policies for EMF emissions and safety for the general public.

* + 1. **National Policy + Regulations and Guidelines**

Though each of China’s corporations has their own set of laws concerning EMFs, the Ministry of Health and Ministry of Environmental Protection have set two major policies for EMF limitations. The Ministry of Health’s GB 8702-88 and the Ministry of Environmental Protection’s GB 21288 are the major laws Chinese corporations follow under.

**Comparison of Limit Value [China]**[[1]](#footnote-1)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Public Exposure Limits | 900MHz Band | | 1800MHz Band | | Remark |
| µW/cm2 | V/m | µW/cm2 | V/m |
| ICNIRP | 450 | 41 | 900 | 58 | ICNIRP |
| GB 8702 | 40 | 12 | 40 | 12 | National Standards |
| GB 9175 | 10 | 6 | 10 | 6 | Ministry of Health |
| HJ/T 10.3-1996 | 8 | 5.4 | 8 | 5.4 | Ministry of Environmental Protection |
| The Most Strict Limits | 8 | 5.4 | 8 | 5.4 | Used in China |

China’s regulations and guidelines regarding EMF exposure limitations are based upon the international ICNIRP regulations for SAR (Specific Absorption Rate), but use their own limits regarding Exposure Limits. In 2003, they proposed to set their own draft of regulations for Exposure Limits based on their 2001 “Limiting and test methods for exposure to EMF Radiation [study]”[[2]](#footnote-2)

* + 1. **Status Update and Future Plans**

China launched a 4 year National EMF Bioeffects Project (2011-2015) concerning six main topics:

* Electromagnetic biophysics
* Bioelectromagnetics
* Neuroscience
* Reproductive Biology
* Genetic Toxicology
* Epidemiology and Occupational health

12 universities and 30 investigators have come together with various institutions to work on the project. Not only that, but China has the largest and fastest growing telecommunication market in the world right now. Though growth rate may have slowed down, the market for apps and advertising will boom and double in size by 2018; from $7.1 billion (2014) to &15.7 billion. (London-based analysis firm IHS). With this new source of revenue, more funds for tech development will be available building a “potent cycle of growth”[[3]](#footnote-3) This new development for technology have given the Chinese more opportunities to settle on their own trends and construct their own innovations.

* + 1. **Obstacles and Challenges**

Some challenges China may face due to rapid expansion of market and technology are [1] Online censorship and [2] Data security. “China is already home to the most hacking attacks in the world – some 48% in the third quarter of 2014 (Akamai’s State of the Internet report)”[[4]](#footnote-4) and have already encountered challenges due to the Hong Kong riots: many smartphone manufacturers had to be shut out in the US due to fear of hackers exploiting flaws or spyware contained in these smartphones.

These challenges may indicate that China may not be ready to intervene in the international communications tech.

## Japan

* + 1. **Background**

The Ministry of Internal Affairs and Communications (MIC) are the main regulators of telecommunications and overview many areas regarding radio/telecommunications. They split off into different divisions, which all focus on a particular area: policy, safety, communications, and monitoring.

* + 1. **National Policy + Regulations and Guidelines**

Though Japan does not have specific laws regarding safety and protection from EMF exposure, they do have regulations specific for EMF exposure limitations (Radio Radiation Protection Guidelines for Human Exposure to Electromagnetic Fields (RRPG).

* + 1. **Status Update and Future Plans**

MIC has started on a few research activities and changed a lot of old policies they used to have. Now with more information, they updated their RRPG and renewed them to harmonize with the international scale guideline. Now they use the ICNIRP guidelines. They have also established a new “Committee on the Possible Adverse Health Effects of RF Electromagnetic Fields” to advise the MIC on new research/studies related to Epidemiology, Human Voluntary, Animal studies, Cellular studies and Dosimetry.

They have updated their agenda too:

* Research and analysis on various mobile phones and usage habits on health cooperating with international research projects
* Study on biological effects of THz radiation exposure
* Study of frequency dependency of contact sensitivity
* Evaluation on health effects of local exposure to radio wave above 6 GHz
* Study on ocular exposure to RF-EMF

## 

## Korea (Republic of)

* + 1. **Background**

Republic of Korea’s main regulatory agency responsible for managing EMF regulations and standards is the Ministry of Science and ICT (MSIT). Behind them are several research institutes that provide the Ministry with studies and recommendations, such as the RRA, National Radio Research Agency (RRA). They aim to develop next generation radio wave resources and facilitate upgraded technology. Recently, Republic of Korea started to promote telecommunication modernization with a safe radio wave environment across the country.

* + 1. **National Policy + Regulations and Guidelines**

Korea’s policy for EMF and radio frequency use are regulated under the Radio Waves Act. In Article 47, it states that all radio facilities shall be installed and modified with accordance with safety guidelines ensuring the safety and protection from EMF exposure. Under Clause 1 of Article 47-2, the MSIT must establish limitation on EMF emissions to protect the human body, and manage the measurements method of SAR, electromagnetic fields emitted, and the devices used. Under Clause 2, manufacturers along with the installer must ensure the facilities comply with the EMF limitations, plus the owner of the radio station must report an evaluation of EMF level radiated to MSIT (Clause 3) for insurance. If not in compliance, MSIT may order the radio facility to install a safety facility to restrict or check operations. (Clause 6)

The EMF exposure limits of SAR in Korea are referred to the international standards developed by IEEE (FCC guideline). Until Dec. 2012, only the limit of local SAR for head had been mandated. The SAR limits for workers and for body, limbs and whole-body average were adopted and effective from January 2013. The limits of electromagnetic field level are referred to the international standards developed by ICNIRP in 1998. The new ELF EMF guideline adopted by ICNIRP in 2010 is not adopted yet in Korea.

RRA notifies each measurement standards for electromagnetic field strength and SAR (RRA Notifications No. 2017-7, 2017-8). The devices and installations regulated for SAR and electromagnetic field strength are described in the separate notification (MSIT Notification No. 2017-7). The assessment results for the electromagnetic field level shall be reported for the broadcasting stations (aggregated antenna power > 60 W) and the base stations (aggregated antenna power > 30 W or 60 W, depending on the type of the communication system) before putting into service or during the periodic inspection (5-year terms) (Clause 65 of Presidential Decree of Radio Wave Act).

The regulation for EMF rating and labelling was enforced from August 1, 2014 (MSIT Notification No. 2017-20). The operators of radio stations should affix the labels for EMF strength rating in an appropriate place. For portable devices used in direct contact with the user’s ear, those who manufacture or import such devices should affix the labels for SAR rating, and/or display the highest SAR values appropriately.

High power radio station over 500 W is mandated to report immediately as soon as the owner of the facility received the certificate (Clause 66 of Presidential Decree of Radio Wave Act). The standard and assessment method is added and amended, so we’re currently considered, whether to apply human body protection standards and prepared the assessment method.

* + 1. **Status Update and Future Plans**

In 2013, two new projects were introduced: [1] “A study on EMF exposure control in smart society” and [2] “a study on health effects and protection of EMF”. In 2015, the two projects merged together. Funded by the MSIT and under surveillance of ETRI (Electronics and Telecommunications Research Institute), the project is jointly operated by numerous universities and academic societies (KIEES, Korean Institute of Electromagnetic Engineering and Science). The unified project, named “Study on the EMF exposure Control in Smart Society” focuses research on:

* Epidemiology Research
* Full body research on the effects of wearable devices/phones
* Assessment on carcinogenic effects of childhood and adolescent exposure to RF
* Behavioral cognitive development of pregnant women and children
* Investigation of biological effects of combined RF-EMF exposure
* Measurement and assessment of human exposure to EMF for occupational

For the next four years, KEPCO Korea also plans to launch a new project focusing on the investigation of worker exposure to 60 Hz magnetic field working environment. They aim to develop an ELF EMF management system for workers.

* + 1. **Obstacles and Challenges**

Some challenges Korea faces are public concerns of EMF exposure. 400-500 public appeals have been submitted to government offices in a year and around 170 complaints regarding power lines and substations have been filed to KEPCO (Korea Electric Power Corporation).

## Nepal

* + 1. **Background**

Nepal Telecommunications Authority (NTA) holds the largest role in the development/regulation of the Telecommunication service in Nepal. Providing suggestions to the government, the NTA is the decision maker behind the government on radio frequency safety regulations and emission policy.

Though still very underdeveloped, the NTA is trying to create a regulated telecommunication service acceptable by the general public at an economic standpoint.

* + 1. **National Policy + Regulations and Guidelines**

The Nepalese government believes that the telecommunication services is an essential prerequisite for future development and have given the market rights to collaborate with the private sector. Reason being, it will help support social and economic development for radio and telecommunications. Under the Telecommunication Policy, 2056 (2004), the government aims to create a “favorable environment…[for]…telecommunication service [to become] reliable and accessible to all people at the reasonable cost throughout the Kingdom.”[[5]](#footnote-5) Recently they have developed new laws and policies under the name “NTA 2010 Guidelines on Infrastructure” in order to reform and unify the use of infrastructure, cutting costs, maintain their employees and add value to their services, increasing economy growth.

On regards to exposure limits and protection for the general public, both the Ministry of Physical Planning and Works and corporations can place restrictions on radio stations/towers if they pose a health hazard to the general public.

Nepal uses the ICNIRP regulations for both SAR and Exposure Limits.

* + 1. **Status Update and Future Plans**

Nepal is planning to develop a regulatory framework in the context of NGN (Next Generation Networks). Technology and market influences are driving network operators and service providers to move their network to an all-IP based network (NGN). This will provide a unified service base for communication services, but will raise challenges to regulators. Others believe this will significantly reduce their network operating costs and complexity changing/revolutionizing the model of the entire communication network.

* + 1. **Obstacles and Challenges**

Nepal’s rough terrain and mountainous ranges makes it hard for the NTA to establish radio towers and cells to provide radio connection in remote areas. The terrains can also always disrupt/break the cells and towers making it almost impossible for connectivity to spread throughout all of Nepal.

Not only that, but the competition and argument for infrastructure use is still an issue for Nepal since they find a competitive advantage over the control of infrastructure. This lack of infrastructure-sharing culture may be a hindrance to the spread of services and can only bring high prices in the market. It also develops an unfair competition between carrier companies; the more infrastructures the company has, the more power and domination they hold in the market.

## New Zealand

* + 1. **Background**

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’[[6]](#footnote-6).

* + 1. **National Policy + Regulations and Guidelines**

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 also provides guidance on verification of compliance and ensures that exposures to EMF are minimized. Though this standard has no formal legal status, because it is not cited in any legislation, the Ministry of Health recommends strict guidance to control exposures. According the WHO, the standard NZS is based closely on the ICNIRP 1998 guidelines; restrictions, reference levels, averaging times, and treatments of frequency exposures are all directly from ICNIRP.

* + 1. **Status Update and Future Plans**

Though there have been no changes to policies, there is a new Radiation Safety Bill trying to replace the Radiation Protection Act of 1965 at the moment. Along changing the law, there are also updating the *Resource Management (National Environmental Standards for Telecommunication Facilities) Regulations 2008* and mandating new regulations on exposure levels, like the NZS 2772.1:1999.

* + 1. **Obstacles and Challenges**

According to the status update report (WHO), there has been no major concerns regarding EMF exposure due to the efficiency of Ministry upgrading EMF technology.

## Thailand

* + 1. **Background**

The Office of National Broadcasting and Telecommunications Commissions (NBTC) is the leading group for developing and conducting regulations regarding telecommunications throughout Thailand. They have been formulating a master plan to regulate and modernize all telecommunication services throughout the country, along with building and enforcing criteria regarding the use of EMFs and safety for the general public from exposure.

* + 1. **National Policy + Regulations and Guidelines**

Thailand has been actively developing and modernizing their policies and regulations regarding to safety standards of EMF exposure and emission. Thailand has three major acts pertaining to EMFs: the Organization to Assign Radio Frequency and to Regulate Broadcasting and Telecommunication Services Act, B.E. 2543 (2000), the Telecommunications Business Act, B.E. 2544 (2001), and the Radiocommunications Act, B.E. 2498 (1955). First, the Telecommunication Services Act contains the base policies that build the NBTC and all the sub-commissions. It also contains information on their telecommunication regulations and guidelines for planning. Second, the Telecommunications Business Act only contains regulations and information on the use of radio frequencies. Third, the Radio Communications Act contains information on the rights to use radio frequencies.

On regards to EMF exposure safety regulations, Thailand has two Regulations issued in 2007, which are

* NTC Notification on Health and Safety Standard for the Usage of Radiocommunication Equipment
* NTC Notification on Rules and Measures to Regulate Health and Safety form the Usage of Radiocommunication Equipment
* The Basic restrictions (limits) of the regulations are based on the exposure guidelines recommended by International Commission on Non-Ionizing Radiation Protection (ICNIRP) for both SAR and exposure limits, for both Occupational Exposure and General Public Exposure. The regulations categorize radiocommunication equipment (Telecommunication equipment which intentionally radiate radio frequencies) into three types as follows Type 1. Radiocommunication equipment operating within 20 cm from human body in normal operating condition. (e.g. handheld cellular mobile terminal)
* EMF exposure assessment requirements: Radiation exposure must be assessed by the Specific Absorption Rate (SAR) measurement Type 2. Radiocommunication equipment operating further away (more than 20 cm) from human body during normal operating condition (e.g. cellular mobile terminal installed in vehicle)
* EMF exposure assessment requirements: Radiation exposure must be assessed (by EMF testing, or calculation) Type 3. Radiocommunication equipment that has been permanently installed in fixed location and has wide area of radiation coverage (e.g. cellular base station).
* EMF exposure assessment requirements: EMF assessment must be conducted and results must be submitted to NBTC before installation.
* Exempted equipment. Following are radiocommunication equipment which are exempted from radiation exposure assessment requirement.
* Radiocommunication equipment which are subjected to be use for national security
* Two-way radio push-to-talk radiocommunication equipment which are subjected to be used by trained professional such as emergency personals, firemen, polices, military units, etc
* Radiocommunication equipment on board ship or aircraft
* Point-to-point fixed link station operating higher than 2GHz with transmission power not higher than 2 W
* Radiocommunication equipment which has transmission power not higher than 100 mW e.i.r.p.
  + 1. **Status Update and Future Plans**

Currently the office of NBTC is in the process on establishing a SAR testing Laboratory, the Laboratory will be used for conformity assessment, market surveillance, with the possibility for research and studie in the field of radiation exposure. It is expected that the Laboratory will be operational by the end of 2017.

* + 1. **Obstacles and Challenges**
* Public concerns due to biased/unreliable information from media
* Lacks of clear mechanisms to raise public understanding and awareness
* Ineffective local community explanation/consultation mechanism

## Vietnam

* + 1. **Background**

The Vietnamese Ministry of Information and Communications (MIC) is the main regulatory body in various fields such as, publishing, telecommunications, radio frequency, information technology, electronics, media, foreign/domestic information, communication infrastructure, and management of related public services. They work with the government to come up long-term projects and agendas that supports and enforces the development of Vietnam. MIC also submits drafts of laws, policies to the National Assembly for review and approval. These laws will be the main regulatory guidelines that companies, related to the field, have to follow.

In particular with telecommunications, the ministry holds a large role in the management and regulations of usage and development. They construct new policies and laws regarding the usage and safety of telecommunications and provide guidance for companies and agencies to enforce the legislation. They also organize and implement master plans for future development of technology or policy, plus they manage programs on providing public utility of technologies/infrastructures. They also address general issues on radio frequencies. Finally, they also provide study reports of programs and projects on investment and the development of telecommunications for review and construct new plans based on that review.

* + 1. **National Policy + Regulations and Guidelines**

Regarding safety regulations, the MIC worked with the government to develop laws focusing that area in particular. TCVN 3718-1:2005 or “Management of radio frequency radiation fields hazards. Part 1: Maximum exposure levels 3 kHz to 300 GHz” is the main standard that focus on the safety of the public from EMF exposure. The regulation is based on the ICNIRP international regulation for SAR and exposure limits. There are also other technical regulations stipulates testing methods (QCVN 8:2010/BTTTT) and regulation of procedure for verifying the compliance of radio station (including BTS) with EMF exposure limit (Circular 16/2011/TT-BTTTT).

# Awareness and Education Outreach of EMF in Asia-Pacific Countries

Public communication and outreach to the general public is most important in ensuring safety and keeping the people calm and satisfied. This information era makes access to information easy and swift making people more knowledgeable and the more knowledge people have, the more concerns they make. To ensure and calm these concerns, communication with the people is most important and efficient.

This chapter will include activities each country do to share information and what measurement activities they do.

## Australia

ARPANSA has improved its website to become easier to navigate around for the common public. They made a new “For the Public” section on the website purposed to provide information and advice most relevant to the community. They also added a “Frequently Asked Question” section too. Research on EMF exposure has also started in two Research Centers (ACEBR & PRESEE) funded under the National Health and Medical Research Council (NHMRC) regarding EMF bio-effects and health research.

Australia would also often hold conferences and meetings to discuss issues regarding to EMF exposure and RFs. Last year, the University of Wollongong hosted an international workshop where ICNIRP, ACEBR, and ARPANSA jointly discussed the latest studies of EMF health effects from exposure to RF fields. The workshop was also open to the public. Another annual public event hosted by the ACEVR (Australian Centre for Electromagnetic Bio-effects Research) is the Science and Wireless event where experts would give presentations focused on “Living in a wireless world of mobile phone, base stations & Wi-Fi: Health & electro-hypersensitivity (EHS).”

## China

China believes sharing of information should be regulated and limited to a certain point. They continue to tightly control and own the information network. The television industry of China, especially, is strictly regulated and restricted, because of ideology concerns. They implement old-fashioned administration practices that feature one-sided, top-down policy-making procedures and ambiguous policies. In the cable industry, there is a direct conflict between the government and cable development, due to a difference in interest (Y. Liu 1994). The government aims for direct control of the media industry for ideological concerns, but other factors aims for ‘deideologization’ and marketization of the media industry, causing a large central disparity between the two (Xing, Hanhui, & Chong, 2009).

## Japan

MIC has constructed a nationwide lecture on the safety of citizens and businesses with regard to EMFs and RFs. Cooperating with the government; they aim to disseminate truthful information to the general public. In total, more than 20,000 participated in seminars. For mobile base stations, MIC demanded operators to inform local residents the safety of the radio waves emitted from the station so the people would feel secured. MIC also provides brochures, websites, and consultants to distribute information on the safety of RF-EMF.

## Republic of Korea

The public concerns about EMF are still very high in Korea. 400-500 public appeals against the radiation of electro-magnetic energy from base stations have been submitted to government offices and operators in a year. Regarding power lines and substations, about 170 complaints have been filed to KEPCO (Korea Electric Power Corporation). Government offices, operators and KEPCO are actively taking care of such complaints.

EMF web sites for interactive and bilateral communication (www.emf.go.kr, www.emf.or.kr, www.emf60hz.com, home.kepco.co.kr) have been providing EMF related information, including the guidelines for the safe use of home appliances and mobile phones. KEPCO also operates the Public Information Dissemination Center since 2006. From 2004, two kinds of Newsletters, one for EMF measurement standards and the other one for biological effects, exposure limits and policies are published biannually. Every other year, a survey on “perception for EMF exposure and its hazard” for general public or experts is performed. From 2012, the information on the SAR values of each mobile-phone model was opened to the public through the RRA website ([www.rra.go.kr](http://www.rra.go.kr)).

## Nepal

Due to the lack of telecommunication radio throughout the country, not many Nepalese people have the liberty to leisurely check the news or search for information; neither do they hold seminars, have booklets, or have any websites to spread information on EMFs, but they are in the process of making one**.**

## New Zealand

The Ministry of Health periodically updates and adds new studies and topics of interest on the website to continuously inform the general public about EMFs and exposure. They also add links of relevant website for extra information.

## Thailand

Thailand often holds dialogue sessions to allow concerned residents to have a better understanding on RF radiation. They also publish pamphlets and booklets, as well as using multimedia and internet (radio spot, video clips, facebook, etc.) to provide general information on exposure to the general public.

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# Appendix

**9.1 ELECTROMAGNETIC FIELD STRENGTH MEASURED AND CALCULATED FOR 5G BASE STATIONS**

Currently, 5G base stations are being widely installed in Korea, which have raised concerns about the impact of electromagnetic fields (EMFs) on the human body. Measurements at the various sites have been carried out to assess the EMF strength generated from the 5G NR base stations. To substitute the measurement for an analysis, a numerical analysis method can be used to obtain the EMF strength of the 5G base station. This contribution document introduces a comparison between the measured and simulated results.

At the meeting of EG GICT&EMF, ASTAP 33, it was agreed to revise the APT report on Asia-Pacific Regional Activities on Human Exposure to EMF from the ASTAP 34 meeting. I propose the information of electromagnetic field strength measured and calculated for 5G base stations in Rep. of Korea to be included as an appendix of the report.

1. **5G base station for measurement and simulation**

Figure 1 shows the location of the 5G base station selected for measurement and simulation. This base station is located in Daejeon City, South Korea and it is installed on the roof of a commercial building in an apartment complex. The detailed information for the base station and site is as follows:



Figure 1. 5G base station located at a residential area of an apartment complex

o Base station located at Sambu Plaza building in Daejeon City (36.3232, 127.3935)

- Height above the sea level: 26 m

- Transmission power: 80 W

- Transmission frequency: 3.5 GHz

- Antenna gain: 22 dBi

o Measurement points for evaluation

- Measurement distance: 28 m from the base station antenna in the horizontal direction

- Measurement points with height: 1.1 m, 1.5 m, and 1.7 m

Figure 2 shows a numerical model of the base station and the surrounding buildings used for calculation based on the base station information and actual configuration of the buildings. To get the input data of the numerical model for major buildings at the site, the Open Street Map (OSM) data for the building properties were used. OSM is an open source, participatory free map service operated by the OpenStreetMap Foundation, a non-profit organization in the UK established in 2005. To simplify the numerical analysis, the direct and single reflected propagation waves were considered disregarding propagation wave caused by the diffraction effect.



Figure 2. The numerical model of the measurement site for the numerical analysis

The permittivity and conductivity we used for the building and ground are 5.31 and 0.0548 S/m, respectively. For the radiation pattern of the 5G base station antenna, the radiation pattern defined in Section 8.5, ITU-R M.2412 was applied and is shown in Table 1.

Table 1. ITU-R M.2412 antenna radiation pattern

|  |  |
| --- | --- |
| Parameters | Values |
| Antenna element vertical radiation pattern (dB) |  |
| Antenna element horizontal radiation pattern (dB) |  |

1. **Measurement and calculation results of electric field strength of the base station**

The electric field strength was measured using an isotropic probe and a spectrum analyzer for the 5G base station. The numerical simulation was carried out with the aforementioned conditions. The results of measurement and calculation are compared as shown in Table 2.

Table 2. Comparison of measurement and calculation results

|  |  |  |  |
| --- | --- | --- | --- |
| Rx height | 1.1 m | 1.5 m | 1.7 m |
| Calculation results using the RTM (V/m) | 1.45 | 1.45 | 1.53 |
| Measured results  (V/m) | 1.51 | 1.52 | 1.62 |

There was a slight difference between the measurement and the simulation results due to the lack of information such as the actual antenna output, antenna tilt, and radiation pattern, but it shows there are generally similar trend. Since the antenna pattern changes depending on the installation environment, it is difficult to apply an accurate radiation pattern. From this result, the simulation method is expected to have the advantage of calculating the maximum exposure point and human protection ratio in the worst-case situation (maximum output power), which is difficult to obtain in actual measurement.

**9.2 RF-EMF MEASUREMNT RESULTS FOR 5G-NR BASE STATION ACCORDING TO MEASUREMENT METHOD OF SSB LEVEL**

**Abstract**

This report compares the RF-EMF results according to the SSB level measurement method of 5G-NR base stations operating in Korea (Rep. of) and describes the differences.

**Introduction**

Measuring the SSB (Synchronization Signal Burst) level is an important factor in RF-EMF (Radio Frequency – Electromagnetic Field) measurement of a 5G-NR BS (Base Station). There are two methods of measuring the SSB signal from the BS, the zero-span method and the code-select method. The zero-span can be easily measured with an existing general spectrum analyzer, while the code-select measurement requires the use of a specialized receiver equipped with a function to extract SSB signals. Recently, general spectrum analyzers capable of measuring RF-EMF of 5G-NR BS are usually equipped with the SSB signal measurement functions. In the code-select method, it is easy to target and measure a specific base station in an environment where several base stations exist around the measurement point, which the zero-span method cannot perform, thus the code-select method is preferred in general. In the Rep. of Korea, both methods are allowed for RF-EMF measurement of 5G-NR BS. This paper compares the RF-EMF measurement results of 5G base stations in Korea where both methods are applied.

**RF-EMF Results for 5G-NR BS in Korea**

In Korea, 5G-NR services have been provided since 2019. The code-select and/or zero-span method are applied to measure the RF-EMF strength of 5G-NR BS. Table 1 describes the differences between zero-span and code-selection methods. In fact, in Korea, both methods are applied for RF-EMF measurement of 5G-NR BSs.

Table 2 and Figure 1 show the RF-EMF measurement results of 5G-NR BS from 2019 to 2022. In the initial stage of 5G introduction, the number of 5G-NR BSs was few, thus, there was little difference in the measurement results between the two methods as shown in Figure 1. However, the number of 5G BSs has increased in the past two years, hence, the difference in the measurement results between the two methods was evident. The strength of the RF-EMF measurement result with code-select method is lower than zero-span method. This can be presumed due to the difference in their functions of which the code-select method can separate signals from multiple BSs and measure SSB signals of a specific BS, but the zero-span method cannot separately measure signals from multiple BSs.

Table 1. Comparison of SSB level measurement methods

|  |  |  |
| --- | --- | --- |
| Index | Zero-Span | Code-Select |
| Measurement equipment | Spectrum analyzer (General) | Spectrum analyzer with 5G-NR demodulation |
| Requirements | Max. traffic environment | Synchronize with BS |
| Measurement for SSB | Measure the time-domain signal | Automatically measure from 5G-NR demodulation |
| Measurement for multiple BSs environment | Measure the maximum level | Measure the signal of the selected BS |

Table 2. The 5G-NR RF-EMF results [unit: V/m]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Area | Method | 2019 | 2020 | 2021 | 2022 |
| Nationwide | Zero-Span | 1.48 | 1.75 | 2.19 | 2.73 |
| Code-Select | 1.49 | 1.75 | 1.62 | 1.71 |
| Seoul | Zero-Span | 1.42 | 1.56 | 1.82 | 3.21 |
| Code-Select | 1.54 | 1.53 | 1.65 | 1.89 |

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Figure 1. The 5G-NR RF-EMF results in S.Korea (2019 – 2022)

**The Comparative analysis of RF-EMF according to SSB measurement method**

In order to compare the difference in RF-EMF results using the two SSB level measurement methods, the RF-EMF measurement data from 2021 to 2022 were analyzed. Table 3 shows the number of 5G-NR BS according to the installation environment from 2021 to 2022. The number of measurement results of the zero-span was about 2.5 times more than that of the code-select method. In order to analyze the measurement results of the two methods, we randomly extracted equal numbers of samples, 500 data each, by classifying them into residential and commercial areas.

Table 4 and Figure 2 show the analyzed results after randomly extracting 500 data from the total measurement results from 2021 to 2022.According to the analyzed results, the RF-EMF strength by the zero-span method was higher than that of the code-select method with a relatively large variation as shown in Figure 2 in both residential and commercial areas. Even though the two methods for 5G-NR BS measurement were applied in a similar environment during the same period, there was a significant difference in the measurement result. In order to analyze the regional characteristics of the measurement results, the data for Seoul was analyzed separately as shown in figure 3. Measurement results in Seoul were slightly higher than the national average, where the zero-span showed a little higher level with deviation than the results of the code-select method. This was the same trend as the national measurement results shown in Table 4.

Table 3. Total number of 5G-NR measurement in Korea

|  |  |  |
| --- | --- | --- |
| Method | Residence Area | Commercial Area |
| Zero-Span | 19,948 | 12,545 |
| Code-Select | 663 | 561 |

Table 4. The RF-EMF analysis after randomly extracting 500 data according to each method [unit: V/m]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Index | Method | Residence | | Commercial | |
| Zero-Span | Code-Select | Zero-Span | Code-Select |
| Nationwide | Mean | 1.96 | 1.31 | 2.85 | 2.01 |
| Median | 0.73 | 0.69 | 1.49 | 1.19 |
| Seoul | Mean | 1.93 | 1.46 | 3.08 | 2.06 |
| Median | 0.75 | 0.65 | 1.43 | 1.19 |

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Figure 2. The RF-EMF Measurement results according to each metering method (Nationwide)

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Figure 3. The RF-EMF Measurement results according to each metering method (in Seoul)

**Conclusion**

In this report, we analyzed the differences in RF-EMF measurement results according to SSB level measurement methods which are used to measure and evaluate the RF-EMF level of 5G-NR BS. According to the analysis of the 5G-NR RF-EMF level results measured from 2021 to 2022, the results by the zero-span method were higher than those by the code selection. This seems to be caused by the functional differences of the measuring equipment used such as the code selection method can measure the SSB level of a particular BS, whereas the zero-span method cannot distinguish the SSB signal from any particular BS.

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