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Guidance on the environmental management for compliance with radio frequency EMF limits for radiocommunication base stations

Recommendation ITU-T K.121

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Summary

Recommendation ITU-T K.121 gives guidance on how to manage the compliance with RF-EMF limits in areas near to radiocommunication installations and how to establish processes for responding to public concern about exposure to RF-EMF.

History

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Environmental management, public concern, radiocommunication base stations, RF-EMF.

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1 Scope

With the rapid development of radiocommunication technology, radiocommunication base station (RBS) facilities are widely installed in areas close to people's living environment. Base stations which are installed in residential areas might be the objects of complaint and protest because of concerns mainly about possible health risks from exposure to RF-EMF. Community opposition also brings challenges to the telecommunications operators in respect of construction, operation and maintenance. So the environmental management of compliance with RF-EMF limits is increasingly important, not only for governments but also for operators.

The purpose of this Recommendation is:

– to provide guidance on the environmental management of compliance with RF-EMF human exposure standards for radiocommunication base stations;

– to promote the harmonization of environmental management for RF-EMF emissions for telecommunications operators, and give advice on its effective management;

– to proactively identify the RF-EMF environment in areas surrounding radiocommunication base stations, and also promote the sustainable development of wireless communication technology.

Portable RF-EMF transmitters are outside the scope of this Recommendation.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T K.52] Recommendation ITU-T K.52 (2004), *Guidance on complying with limits for human exposure to electromagnetic fields*.

[ITU-T K.61] Recommendation ITU-T K.61 (2003), *Guidance to measurement and numerical prediction of electromagnetic fields for compliance with human exposure limits for telecommunication installations*.

[ITU-T K.70] Recommendation ITU-T K.70 (2007), *Mitigation techniques to limit human exposure to EMFs in the vicinity of radiocommunication stations.*

[ITU-T K.83] Recommendation ITU-T K.83 (2011), *Monitoring of electromagnetic field levels.*

[ITU-T K.91] Recommendation ITU-T K.91 (2012), *Guidance for assessment, evaluation and monitoring of human exposure to radio frequency electromagnetic fields.*

[ITU-T K.97] Recommendation ITU-T K.97 (2014), *Lightning protection of distributed base stations*.

[ITU-T K.100] Recommendation ITU-T K.100 (2014), *Measurement of radio frequency electromagnetic fields to determine compliance with human exposure limits when a base station is put into service*.

[ITU-T K.113] Recommendation ITU-T K.113 (2015), *Generation of radiofrequency electromagnetic field (RF-EMF) level maps.*

[ITU-T K Suppl. 1] K Supplement 1 (2014), ITU-T K.91 – *Guide on electromagnetic fields and health*.

[ITU-T K Suppl. 4] K Supplement 4 (2015), ITU-T K.91 – *Electromagnetic field considerations in smart sustainable cities*.

[IEC 62232] IEC 62232 (2011), *Determination of RF field strength and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 antenna [ITU-T K.70]: Device that serves as a transducer between a guided wave (e.g., coaxial cable) and a free space wave, or vice versa. It can be used to emit or receive a radio signal. In this Recommendation the term antenna is used only for emitting antenna(s).

3.1.2 assessment domain boundary (ADB) [ITU-T K.100]: Boundary surrounding an antenna of the equipment under test (EUT) outside of which measurements do not need to be conducted. The ADB defines the maximum possible measurement area where the source is considered to be relevant.

3.1.3 exposure [ITU-T K.52]: Exposure occurs wherever a person is subjected to electric, magnetic or electromagnetic fields or to contact currents other than those originating from physiological processes in the body or other natural phenomena.

3.1.4 exposure level [ITU-T K.52]: Exposure level is the value of the quantity used when a person is exposed to electromagnetic fields or contact currents.

3.1.5 exposure limits [ITU-T K.70]: Values of the basic restrictions or reference levels acknowledged, according to obligatory regulations, as the limits for the permissible maximum level of the human exposure to the electromagnetic fields.

3.1.6 electric field strength (E) [ITU-T K.83]: Magnitude of a field vector at a point that represents the force (F) on a small test charge (q) divided by the charge:

$$E = \frac{F}{q}$$

The electric field strength is expressed in units of volt per metre (V/m).

3.1.7 electromagnetic field (EMF) [ITU-T K.91]: A field determined by a set of four interrelated vector quantities that characterizes, together with the electric current density and the volumic electric charge, the electric and magnetic conditions of a material medium or of a vacuum.

3.1.8 power density (S) [ITU-T K.52]: Power flux-density is the power per unit area normal to the direction of electromagnetic wave propagation, usually expressed in units of watts per square metre (W/m^2). In this Recommendation, this term is commonly used to refer to equivalent plane wave power density.

NOTE – For plane waves, power flux-density, electric field strength (*E*), and magnetic field strength (*H*) are related by the intrinsic impedance of free space, $Z_0 \approx 377$ or 120 $\pi\Omega$. In particular,

$$S_{eq} = \frac{E^2}{Z_0} = Z_0 H^2 = EH$$

Where *E* and *H* are expressed in units of V/m and A/m, respectively, and *S* in units of W/m^2. Although many survey instruments indicate power density units, the actual quantities measured are *E*or*H*.

3.1.9 power density, plane-wave equivalent (S_{eq}) [ITU-T K.52]: The equivalent plane-wave power density is a commonly used term associated with any electric or magnetic field, that is equal in magnitude to the power flux-density of a plane wave having the same electric (*E*) or magnetic (*H*) field strength.

3.1.10 radiocommunication base station (RBS) [ITU-T K.97]: Installation intended to provide access to the telecommunication system by means of radio waves.

3.1.11 radio frequency (RF) [ITU-T K.70]: Any frequency at which electromagnetic radiation is useful for telecommunication.

NOTE – In this Recommendation, radiofrequency refers to the frequency range of 9 kHz – 300 GHz allocated by ITU-R Radio Regulations.

3.1.12 reference levels [ITU-T K.70]: Reference levels are provided for the purpose of comparison with exposure quantities in air. The reference levels are expressed as electric field strength (*E*), magnetic field strength (*H*) and power density (*S*) values. In this Recommendation the reference levels are used for the exposure assessment.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 RF-EMF compliance assessment (RCA): The procedure used to assess the RF-EMF compliance of a proposed RBS or modification to existing RBS and to respond effectively to public concern.

The formal process may differ between countries and this Recommendation does not replace national requirements. It may be used to update existing policies or develop new requirements.

The purpose of the RCA is to ensure that the operator of the RBS can demonstrate compliance with RF-EMF limits and that they have responded to public concerns about the proposal.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ADB	Assessment Domain Boundary
EIRP	Effective Isotropic Radiated Power
EM	Electromagnetic
EMF	Electromagnetic Field
EUT	Equipment Under Test
FG-SSC	ITU-T Focus Group on Smart Sustainable Cities
ICNIRP	International Commission on Non-Ionizing Radiation Protection
RBS	Radiocommunication Base Station
RCA	RF-EMF Compliance Assessment

RF Radio Frequency

SAR Specific Absorption Rate

5 General guidance

In different countries or different regions, the process for obtaining authorization for a new or modified RBS may be different. This Recommendation focuses on RF-EMF compliance and addressing public concern. It does not deal with civil works or other aspects on RBS siting.

In general the RF-EMF Compliance Assessment (RCA) process for low power RBS, small cells, repeater antennae mounted away from public access areas and indoor distribution systems, should be simpler and based on [ITU-T K.100].

Where countries have adopted national RF-EMF limits it is recommended that a clear policy statement or other regulatory instrument is used to ensure that local authorities or municipalities cannot reject an RBS proposal on RF-EMF grounds (i.e., from a compliance to EMF exposure limits point of view) if it complies with the national limits.

Mobile networks evolve in response to the growth of voice, data traffic, new technologies and new usages and this may require modifications to existing sites, such as capacity expansions including new operating channels and frequencies, changes to transmitter powers, antenna orientations or antenna types. Policies should be adopted that allow for these modifications. Modifications to existing sites shall ensure that the site remains compliant with RF-EMF exposure limits.

In regard to RF-EMF compliance guidance on criteria for RBS, site assessments are included in [ITU-T K.52], [ITU-T K.100] and the FG-SSC technical report [ITU-T K Suppl. 4].

RF-EMF levels decrease when a person moves further away from the source, (for example, a transmitting antenna). For each antenna, the RF-EMF exposure level can be calculated based on its emission characteristics, or measured using appropriate methods [ITU-T K.61]; [IEC 62232]; [ITU-T K.100]. Before undertaking measurements the assessment domain boundary (ADB) should be evaluated to determine where measurements may be needed [ITU-T K.100].

In some countries, a low power RBS may be assessed for compliance as a class of radio transmitters with defined installation (for example, height above public areas) and RF-EMF compliance (for example, maximum transmit power) requirements. In such a case, it should be sufficient to provide approval for all equipment of the same type subject to the specified requirement without reviewing individual installations. An example would be installing small cell base stations on street light poles where the equipment operator would be responsible for the details for each particular installation.

NOTE – The RBS should comply with the requirements of urban planning and environmental protection. Consideration of visual design integration may be necessary for antennae placed on major urban buildings, landmark buildings, scenic or historical areas. When planning a new RBS the potential for joint construction and shared physical infrastructure should be considered, to avoid duplication where there are no technical barriers, and subject to commercial terms.

In the case of shared RBS sites involved parties should determine the responsibility for the management of compliance assessment and communication to the relevant authority.

The basic example of shared physical infrastructure is to use a common building, land, power supply facility and build one supporting structure to set up the antennae of the participating operators. The scope to be shared may also include telecommunication lines, roads and additional facilities, such as heating and cooling facilities, ventilating systems and emergency systems.

6 Environmental RF-EMF compliance management system

6.1 Operator environmental RF-EMF compliance management system

Mobile network operators should manage compliance with relevant regulations for RF-EMF compliance of RBS.

RF-EMF compliance activities should be integrated with the processes for RBS site selection, construction, commissioning and maintenance. A well-designed system will ensure the efficient management of RF-EMF compliance, provide evidence for regulatory authorities and be a basis for resolving public questions or concerns.

6.2 Municipality environmental RF-EMF compliance competence

It is recommended that municipal authorities are provided with information and policy guidance by national authorities on RF-EMF compliance. This should be sufficient to allow the municipal authorities to understand operator RF-EMF compliance assessments, to approve (if required) RBS applications that comply with national requirements and to respond to public concerns. Municipal authorities should not adopt RF-EMF related policies that are more restrictive than national requirements.

It is generally not necessary for municipalities to own the specialized equipment needed for RF-EMF compliance measurement. If a municipality intends to purchase such equipment, guidance on important selection characteristics is provided in [ITU-T K.61].Training in the correct use of such equipment should also be obtained.

7 RCA procedure for RBS

The entity responsible for environmental RF-EMF compliance should assess the RBS proposal according to national procedures or using the methods in [ITU-T K.52], [ITU-T K.61], [ITU-T K.91], [ITU-T K.100] or [IEC 62232].

The RF-EMF assessment should take note of any potentially accessible areas within the boundaries of the compliance and occupational zones [ITU-T K.52].

Depending on national requirements the results of the RCA may be communicated in full or in part as part of the site approval process. Some countries require declarations of compliance while other countries require complete assessments. Provided the techniques used for the RCA are based on the technically validated techniques in [ITU-T K.52], [ITU-T K.61], [ITU-T K.100] or [IEC 62232] there shall be no general requirement for post-installation assessment.

8 Site RF-EMF compliance assessment at the design stage

This section describes the process for conducting the RF-EMF compliance assessment for the proposed RBS at the design stage. Evaluation of the pre-existing RF-EMF environment is required to ensure that the additional proposed site will be in compliance with exposure limits.

8.1 Investigation method

The selection of a sample of RBSs to be investigated for their RF-EMF environment should be undertaken to be representative with consideration of the construction type (single-site single-station, multi-station co-located, etc.) and the coverage area category (urban, suburban, rural, mountainous, scenic areas, along the highway, railway, etc.).

The number of RBSs to be assessed should be determined by considering the variety of RBS types within the mobile network, the level of community interest and the available resources.

The assessment of the current RF-EMF environment should include investigation of existing background RF-EMF signals. A report of the RF-EMF survey results should be prepared.

The RF-EMF environment status of similar RBS can be evaluated by reference to the environmental RF-EMF surveys for the sampled RBS.

The RF-EMF exposure assessment may be generally applied by the theoretical calculation method, RF-EMF measurements of existing similar sites or a combination of these methods.

8.2 Theoretical calculation methods

The RF-EMF exposure levels produced by the proposed or modified RBS can be calculated using the techniques described in [ITU-T K.52], [ITU-T K.70], [ITU-T K.100] or [IEC 62232]. Before undertaking the assessment consider whether the RBS is exempt according to the criteria given in [ITU-T K.100].

The results of the RF-EMF assessment can be used to determine if mitigation measures according to [ITU-T K.70] are required to ensure that RF-EMF compliance is achieved for the site.

8.3 Assessment method based on similar RBS

For a new RBS it may be possible to use existing data on RF-EMF exposure from a similar site to facilitate prediction and evaluation. If the data does not exist then it may be convenient to select a similar RBS and installation environment (such as power, frequency, carrier frequency configuration, antenna height, antenna polarization and surrounding environment) to conduct on-site measurements.

9 Influence of the surrounding environment on RF-EMF compliance

The local environment near an RBS, including nearby buildings, may change and the influence on RF-EMF compliance should be considered. The following steps are important:

– Take into account the current situation and the future development planning of the surrounding environment to minimize the potential impact of changes on RF-EMF compliance.

– Carry out RCAs and note areas where RF-EMF compliance boundaries extend into publicly accessible areas.

The choice of the RBS technical parameters used for the RCA should be consistent with service objectives and ensure RF-EMF compliance.

10 Information procedure to the community in the process of deployment of RBS

Exchange of information with the community is an important part of ensuring acceptance of RBS proposals. By collecting information on public questions and providing information on the operation of mobile network RBSs and compliance with RF-EMF limits it is possible to reduce the potential for public disputes. Clause 13 describes how the techniques of risk communication can be applied to RF-EMF concerns.

Authorities should publish appropriate information about the project in accordance with national requirements, for example, on a government, local authority or operator website or via local media. Examples of approaches are RF-EMF monitoring systems [ITU-T K.83] and maps [ITU-T K.113].

If the base station is built in a residential area, it may need more communication to improve public acceptance.

11 RF-EMF compliance management for operating RBS

The compliance assessment should be reviewed if RBS parameters are modified outside the scope of the original site RCA. If the compliance assessment is updated it should be available to the relevant stakeholders.

RBSs that satisfy the simplified assessment criteria set out in [ITU-T K.100] shall be exempt from further RF-EMF assessment.

Notwithstanding the provisions in clause 9, periodic updates of the RCA are not required unless RBS parameters or assessment environments are modified outside the scope of the original site RCA.

Regulatory bodies may conduct a periodic audit.

The results of the RF-EMF assessment can be used to determine if mitigation measures according to [ITU-T K.70] are required to ensure that RF-EMF compliance is achieved for the site.

11.1 Selection of RBS for measurement

The majority of RBS sites can be assessed for RF-EMF compliance through calculation only. In some cases it may be necessary to conduct in situ measurements to confirm compliance (for example, many nearby reflective surfaces) or to improve public confidence in the RF-EMF assessment and compliance management procedures. The number of in situ assessments should be determined in an objective manner that considers the costs and benefits and takes into account the criteria presented in [ITU-T K.100] and [IEC 62232].

The following criteria may be used to select RBS sites for measurements:

1) RBS located in areas of community concern;
2) representative RBS using the typical antennae and tower structure used by the operator;
3) representative RBS with the scenario of co-location and of sole-operator sites;
4) representatives of reconstructed and enlarged base stations;
5) RBS for assessment with unusual antenna/transmitter configurations.

11.2 Management of RF-EMF compliance

Management may be conducted for the purposes of ensuring compliance with regulatory RF-EMF requirements or for communication to increase public confidence and trust. Management may be undertaken by review of the RCA documentation, calculations, measurements of a sample of RBSs, or RF-EMF monitoring systems.

Authorities responsible for monitoring should have suitably qualified personnel and access to appropriate equipment.

12 Report of RCA

Results of the RCA assessment should be presented in accordance with national regulations and international standards such as [ITU-T K.91] and [IEC 62232].

Recording of the RBS information should include the name of the base station, the latitude and longitude, the location, types of mobile communication base station, the transmit frequency range, the EIRP, the height of antenna erected, the type of antenna mounted, the characteristics of the area around the RBS, including other RF-EMF transmitters and nearby structures (see clause 9), and other relevant parameters.

13 RF-EMF protection measures

According to the RF-EMF evaluation results, mitigation measures should be recommended, such as determining the site location, erected form, mounting height, measures to prevent the public from approaching the antenna and other aspects of protection requirements.

According to the site planning, design conditions and characteristics of RBSs, in the process of the construction and operation the operators may adopt various measures to minimize the impact on the surrounding areas:

1) fully taking into account the current situation and future development plans of the surrounding environment, to ensure that the site can meet the public RF-EMF exposure standards, not only in the initial construction period but also in quite a long time;
2) reasonable choice of base station transmit power, carrier frequency, half-power angle, lower angle, mounting height, direction angle and other parameters, to minimize the actual transmission power in the premise of meeting the signal coverage;
3) consider the visual integration of the antennae to reduce the impact on the environmental landscape.

13.1 Measures to prevent public access close to the antennae

In order to prevent public access close to the antenna (roof), the following measures could be considered:

1) Without prejudice to the premise of the implementation of fire safety measures, lock the roof where the antenna's mounted, to prevent close public access to the antenna.
2) The area where the RF-EMF level is beyond the limit value can be designated as a controlled area with additional barriers to avoid close public access to these areas.
3) Set up RF-EMF warning signs on the roof where the antenna's mounted, to remind the public to avoid access close to the antenna.

13.2 Management measures for the zones exceeding the general public limit values

If there are zones close to the transmitting antennae accessible to the public where the assessed RF-EMF level exceeds the general public exposure limit then it is necessary to strengthen the management of the RF-EMF compliance with the following:

– Set the barrier, warning signs, marking or locked door, to control access by personnel to the region where the limit is exceeded.
– In occupational zones, public access should be not allowed.
– When staff must enter the RF-EMF exceeded region, protection measures should be taken, such as the temporary reduction of transmit power, control of exposure time and wearing protective clothing, etc.

14 RF-EMF risk communication

With the widespread construction of RBSs and the increased public awareness of environmental protection, concerns about the RF-EMF signals produced by RBS have increased in some countries and decreased in others.

While many people recognize the personal benefits of mobile services, local officials and the public may have concerns about possible risks emerging from the RF-EMF used for mobile services. These concerns may lead to delays in acquiring new antenna sites, to negative media stories and to heightened pressure on policymakers to adopt further restrictions, amongst others.

Exchange of information with communities is crucial in order to ensure that people who may have an interest or be affected by the deployment of new or updated RBSs are well informed. If people feel that their personal well-being or that of their family is being negatively affected in some way, their opposition to the new development can turn to anger or frustration with those responsible. Guidance on effective communication is available in [K Suppl. 1], [K Suppl. 4], [ITU-T K.83] and [ITU-T K.113] and from the World Health Organization handbook on effective communication related to EMF [b-WHO].

The WHO handbook defines risk communication as:

– "An interactive process of exchange of information and opinion among individuals, groups and institutions. It involves multiple messages about the nature of risk and other messages, not strictly about risks, that express concerns, opinions, or reactions to risk messages, or to legal and institutional arrangements for risk management."

The handbook further explains that:

– "Unless an effective system of public information and communication among scientists, governments, the industry and the public is established, new EMF technologies will be mistrusted and feared."

Effective risk communication is based on anticipating possible reactions, understanding the audience and conveying clear information that addresses people's concerns and establishes trust [b-GSMA and MMF].

Risk communication involves consideration of [WHO]:

– When to communicate?

– With whom to communicate?

– What to communicate?

– How to communicate?

Detailed guidance on the process of communication on EMF issues may be found in other publications [b-WHO], [b-GSMA and MMF].

Appendix I

RF-EMF exposure limits

(This appendix does not form an integral part of this Recommendation.)

I.1 Introduction

The exposure limits in most countries are, as recommended by the World Health Organization (WHO), based on the national adoption of the guidelines set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). ICNIRP guidelines are based on known adverse health effects. At frequencies relevant to mobile communications the specific absorption rate (SAR) in tissue and the incident power density represent the basic restriction of exposure to RF-EMF. The ICNIRP guidelines have been designed to protect all members of the community including the ill, elderly and children and include a 50-fold safety margin [b-ICNIRP].

For practical assessments, ICNIRP also provides the equivalent frequency dependent reference levels, expressed as electric field (V/m), magnetic field (A/m) and power density (W/m^2), so that RF measurement equipment can be used to determine compliance. While the reference levels can be used to show compliance with SAR limits, exceeding the reference levels does not necessarily mean the SAR limit has been exceeded. In this case, further assessments would need to be conducted to determine whether the basic restriction (SAR) has been exceeded.

I.2 ICNIRP exposure limits

The limits for the basic restriction and for the reference levels are shown in Tables I.1 and I.2.

Table I.1 – ICNIRP basic restrictions limits (10 MHz – 300 GHz)

Type of exposure	**Frequency range**	**Current density for head and trunk (mA/m^2) (rms)**	**Whole-body average *SAR* (W/kg)**	**Localized *SAR* (head and trunk) (W/kg)**	**Localized *SAR* (limbs) (W/kg)**	**Power density (W/m^2)**
Occupational	10 MHz-10 GHz		0.4	10	20	
Occupational	10 GHz-300 GHz					50
General public	10 MHz-10 GHz		0.08	2	4	
General public	10 GHz-300 GHz					10
NOTE 1 – All *SAR* values are to be averaged over any six-minute period. NOTE 2 – The localized *SA*R averaging mass is any 10 g of contiguous tissue; the maximum *SAR* so obtained should be the value used for the estimation of exposure.						

Table I.2 – ICNIRP reference levels (unperturbed rms values) limits (f > 10 MHz)

Type of exposure	Frequency range	Electric field strength (V/m)	Magnetic field strength (A/m)	Equivalent plane wave power density S_{eq} (W/m^2)
Occupational exposure	10-400 MHz	61	0.16	10
	400-2 000 MHz	3 $f^{1/2}$	0.008 $f^{1/2}$	f/40
	2-300 GHz	137	0.36	50
General public	10-400 MHz	28	0.073	2
	400-2 000 MHz	1.375 $f^{1/2}$	0.0037 $f^{1/2}$	f/200
	2-300 GHz	61	0.16	10

NOTE 1 – f is as indicated in the frequency range column.

NOTE 2 – For frequencies between 100 kHz and 10 GHz, S_{eq} and the magnetic and electric field strength are to be averaged over any six-minute period.

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

NOTE 4 – Between 100 kHz and 10 MHz, peak values for the field strengths are obtained by interpolation from the 1.5-fold peak at 100 MHz to the 32-fold peak at 10 MHz. For frequencies exceeding 10 MHz it is suggested that the peak equivalent plane-wave power density, as averaged over the pulse width, does not exceed 1 000 times the S_{eq} limit, or that the field strength does not exceed the 32 times field strength exposure levels given in the table.

NOTE 5 – For frequencies exceeding 10 GHz, the averaging time is $68/f^{1.05}$ minutes (f in GHz).

I.3 Implications of arbitrary exposure limits

Regardless of the fact that WHO strongly discourages the implementation of the arbitrary safety factors that have no basis in scientific data, some countries have enforced legislation on the maximum permissible limit value for people in the living environments that include lower limit values without any detailed impact assessment analysis.

The World Health Organization has published a database of EMF policies:

http://www.who.int/gho/phe/emf/legislation/en/

The public exposure limits in different countries are also available in the following links on the GSMA website:

– For devices: http://www.gsma.com/publicpolicy/mobile-and-health/devices-map

– For networks: http://www.gsma.com/publicpolicy/mobile-and-health/networks-map

Analysis of the impacts of restrictive RF exposure limits was published by GSMA:

– Arbitrary Radio Frequency exposure limits: Impact on 4G network deployment (2014) available at http://www.gsma.com/publicpolicy/wp-content/uploads/2014/03/Arbitrary-Radio-Frequencyexposure-limits_Impact-on-4G-networks-deployment_WEB.pdf

– Economic Impact of stricter EMF limits on the Rollout of Mobile Broadband Networks – Calculations from Italy and Poland available at http://www.gsma.com/gsmaeurope/wp-content/uploads/2014/11/Arbitrary-Radio-Frequencyexposure-limits_Impact-on-4G-networks-deployment_Annex_FINAL.pdf

Bibliography

[b-GSMA and MMF] GSMA and MMF (2009), *Risk Communication Guide for Mobile Phones and Base Stations.*

[b-ICNIRP] ICNIRP (1998), *ICNIRP Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (up to 300 GHz)*, Health Physics, Vol. 74, No. 4; pp. 494-522. <http://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf>

[b-WHO] World Health Organization (2002), *WHO Handbook on Establishing a Dialogue on Risks from Electromagnetic Fields.* <http://www.who.int/peh-emf/publications/risk_hand/en/>

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