Non-Ionizing Radiation Protection Standards and Policies

Introduction

The purpose of this chapter is to provide information on standards and policies in Latin American countries. This will inform government and other authorities about policies and regulations in the region and about international standards recommended by WHO.

Research on non-ionizing radiation (NIR), particularly radiofrequency (RF) fields, started in the 1950's, just after the Second World War, but regulations limiting their exposure began a long time after.

The first significant effort to establish international limits on NIR exposure was by the International Radiation Protection Association (IRPA), which formed a working group on NIR charged to examine radioprotection issues. In 1977 this working group became the International Non-ionizing Radiation Committee (INIRC).

Within the framework of WHO's Environmental Health Criteria Program, the IRPA/INIRC developed several environmental health criteria (EHC) documents on NIR, each of which included overviews of the physical characteristics, measurement and instrumentation, sources and applications of various NIR, a comprehensive review of the literature on biological effects, and an evaluation of the health risks of exposure to NIR. These EHCs have provided the scientific database for the subsequent development of exposure limits and codes of practice relating to protection from NIR exposure.

In 1992 IRPA/INIRC became the International Commission on Non- Ionizing Radiation Protection (ICNIRP), a new independent scientific organization to assess research and develop international guidelines on NIR exposure limits. ICNIRP works cooperatively with WHO and the last revision of the ICNIRP guidelines was published in 1998. The ICNIRP 1998 guidelines have been endorsed by WHO, the International Labour Office (ILO) and the International Telecommunications Union (ITU), and they have been adopted as their national standard by more than 50 countries worldwide.

ICNIRP assesses all the peer-reviewed scientific literature, including those reporting both thermal and non-thermal effects and are based on evaluations of biological effects that have been established to have health consequences. The main conclusion from the WHO and all rigorous national reviews is that EMF exposures below the limits recommended in the ICNIRP international guidelines do not appear to have any known consequence on health.

WHO's International Electromagnetic Fields (EMF) Project has been promoting the adoption of science – based international standards such as the ICNIRP (1998) guidelines.

One of the reasons for increasing public anxiety about EMF exposures has been the introduction of new technologies and the disparities in national EMF standards around the world. To encourage the development of exposure limits and other control measures that

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provide the same high level of health protection to all people, WHO has been promoting the harmonization of national standards.

In order to provide tools for the achievement of harmonization, WHO's International EMF Project has compiled a worldwide standards database [http://www.who.int/docstore/peh-emf/EMFStandards/who-0102/Worldmap5.htm] and has published two policy handbooks [WHO, 2007a, 2007b] that are very useful for countries developing NIR standards

The ITU has made recommendations on compliance of telecommunication systems with EMF exposure limits. At the regional level in Latin America the Inter-American Telecommunication Commission (CITEL) has compiled information and regulations of: the WHO, the Pan American Health Organization (PAHO), the ITU, the ICNIRP, the Mobile Manufacturers Forum (MMF), the Institute of Electrical and Electronics Engineers (IEEE) and the International Electrotechnical Commission (IEC), with respect to the effects of NIR and the established technical standards. CITEL has also compiled EMF regulations in force in Latin America and other Regions [Inter American Telecommunication Commission XXXX].

International Guidelines

We briefly review the major international guidelines published and adopted by many countries to protect against non-ionizing radiation. They are: ICNIRP (International Commission for Protection Against Non-Ionizing Radiation), ITU (International Telecommunications Union), IEEE (Institute of Electrical and Electronic Engineers), and U.S. Federal Communications Commission (FCC).

International Commission for Non Ionizing Radiation Protection (ICNIRP)

ICNIRP guidelines (ICNIRP, 1998) are the most accepted guidelines for NIR world wide. The complete text of ICNIRP Guidelines can be found at the ICNIRP website www.icnirp.org

Basic Restrictions

Basic Restrictions are restrictions on EMF exposure based on established health effects. These Basic Restrictions depend on the EMF frequency and are given in terms of current density, specific absorption rate (SAR) or power density. ICNIRP states that “protection against adverse health effects requires that these restrictions are not exceeded”

Following the determination of the threshold levels, the level of exposure at which the first established adverse health effects are produced, and dividing them by a safety factor of 10, leads to the value for the basic restrictions for workers. The basic restrictions for general public exposure are obtained by dividing the threshold levels by a factor of 50. That is general public exposure limits are five times stricter than for occupational exposure. Fig. 1 shows the relationship between adverse health effects threshold levels and ICNIRP basic restrictions.

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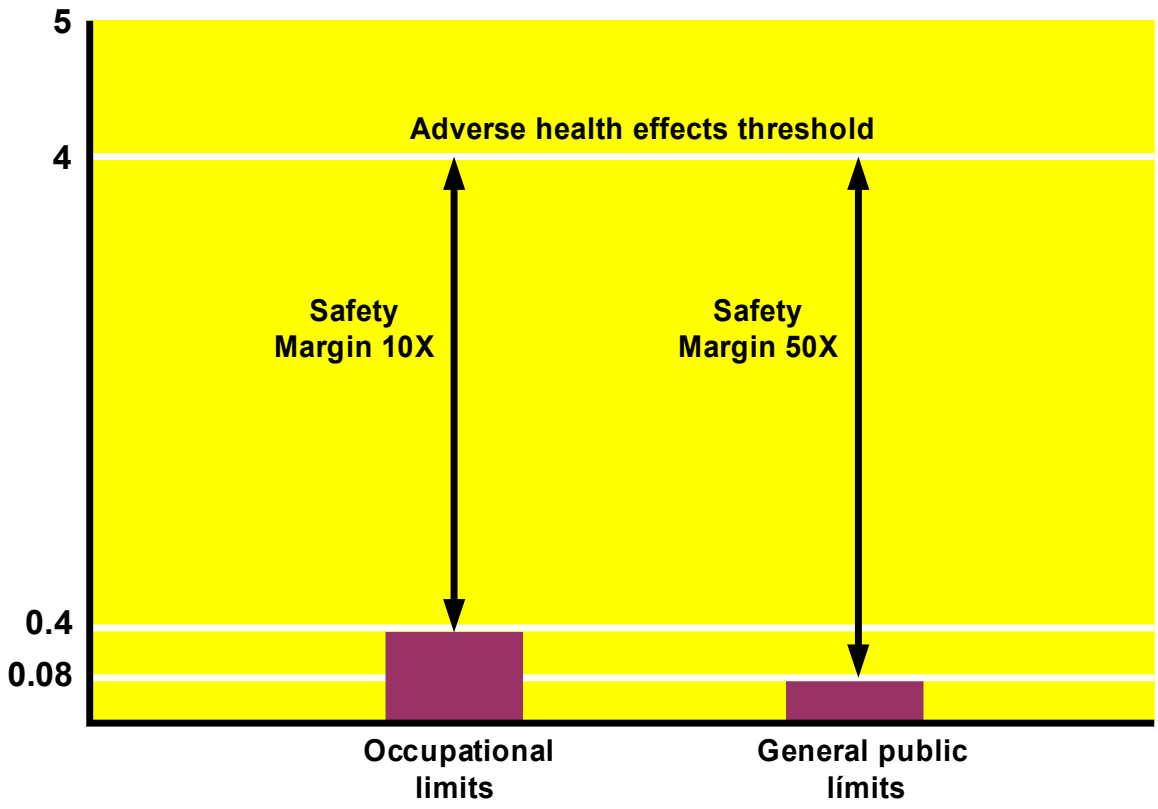

Figure 1 Safety factors for occupational and population ICNIRP basic restrictions in SAR

Reference levels for field measurement

The basic restrictions are physical quantities determined from the interaction mechanisms that produce adverse health effects. However they are difficult to measure in the field. This is why basic restrictions are related to equivalent reference levels that are easy to measure with instruments in the field. These reference levels are obtained from the basic restrictions by using computational models and measurement methods.

The reference levels are intended to be spatially averaged values over the entire body, but with the proviso that the basic restrictions on localized exposure are not exceeded.

For frequencies up to 10 GHz the basic restrictions are given in terms of the current density and whole-body and localized SAR. Their corresponding reference levels are provided in terms of the easily measurable quantities, electric and magnetic fields, the magnetic flux density and the power density. For frequencies from 10 to 300 GHz the reference levels are exactly the same as basic restrictions, given in terms of power density.

For frequencies below 10 MHz the electric and magnetic fields are uncoupled from each other when the EMF is measured within about one wavelength from the radiating antenna, so both fields should be measured to determine compliance. At distances greater than about one wavelength from the radiating antenna the electric and magnetic fields have a constant relationship, and so only the electric or magnetic field needs to be measured.

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Above 10 MHz the electric and magnetic fields are coupled and electric and magnetic field strengths are related by the medium impedance η_0 = E/H = 377 ohms, which is valid for the far field. In the near field electric and magnetic fields are uncoupled and as a conservative approach the levels for the far fields could be used since the levels of electric and magnetic fields can not independently exceed the SAR restrictions.

Simultaneous exposure to multiple frequency fields

In real situations the exposure to EMF includes more than one frequency, so ICNIRP has developed formulas to calculate both basic restrictions and reference levels to determine compliance for these exposure situations.

Basic restrictions for telecommunication services

The main RF services include radio broadcast and mobile telephony (including PCS), whose frequency range goes from 50 – 2000 MHz. However, as wireless systems will play a very important role in the near future this frequency range will expand. ICNIRP basic restrictions for the main telecommunication services are shown in Table 1

Table 1 ICNIRP basic restrictions for general public exposure to the main telecommunication services and systems

Services/systems	Frequency range (MHz)	Whole- body average SAR (Wkg^{-1})	Localized SAR (head and trunk) (Wkg^{-1})	Localized SAR (limbs) (Wkg^{-1})
FM broadcast	88- 108 MHz	0.08	NA	NA
VHF TV	54- 88 MHz 174- 216 MHz	0.08	NA	NA
UHF TV	407- 806 MHz	0.08	NA	NA
Trunking 800 MHz	806-869 MHz	0.08	2	4
Mobile Telephony 800 MHz	824-894MHz	0.08	2	4
Mobile Telephony 900 MHz	890-960 MHz	0.08	2	4
PCS 1800	1710- 1880 MHz	0.08	2	4
PCS 1900	1850- 1900 MHz	0.08	2	4

NA: Not applicable

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Reference levels for telecommunication services

ICNIRP reference levels for the main telecommunication services are given in Table 2 and illustrated in Fig. 2

Table 2 ICNIRP reference levels for general public exposure from the main telecommunication services

Services	Frequency range (MHz)	E- field strength (Vm^{-1})	H- field strength (Am^{-1})	B- field (□T)	Equivalent plane wave power density S_{eq} (Wm^{-2})
FM broadcast	88- 108 MHz	28.0	0.073	0.092	2.0
VHF TV	54- 88 MHz 174- 216 MHz	28.0	0.073	0.092	2.0
UHF TV	407- 806 MHz	29.8	0.08	0.099	2.0
Trunking 800 MHz	806-869 MHz	40.0	0.10	0.13	4.3
Mobile Telephony 800 MHz	824-894MHz	40.6	0.11	0.14	4.4
Mobile Telephony 900 MHz	890-960 MHz	41.0	0.11	0.14	4.5
PCS 1800	1710- 1880 MHz	56.9	0.15	0.19	8.6
PCS 1900	1850- 1900 MHz	60.5	0.16	0.20	9.7

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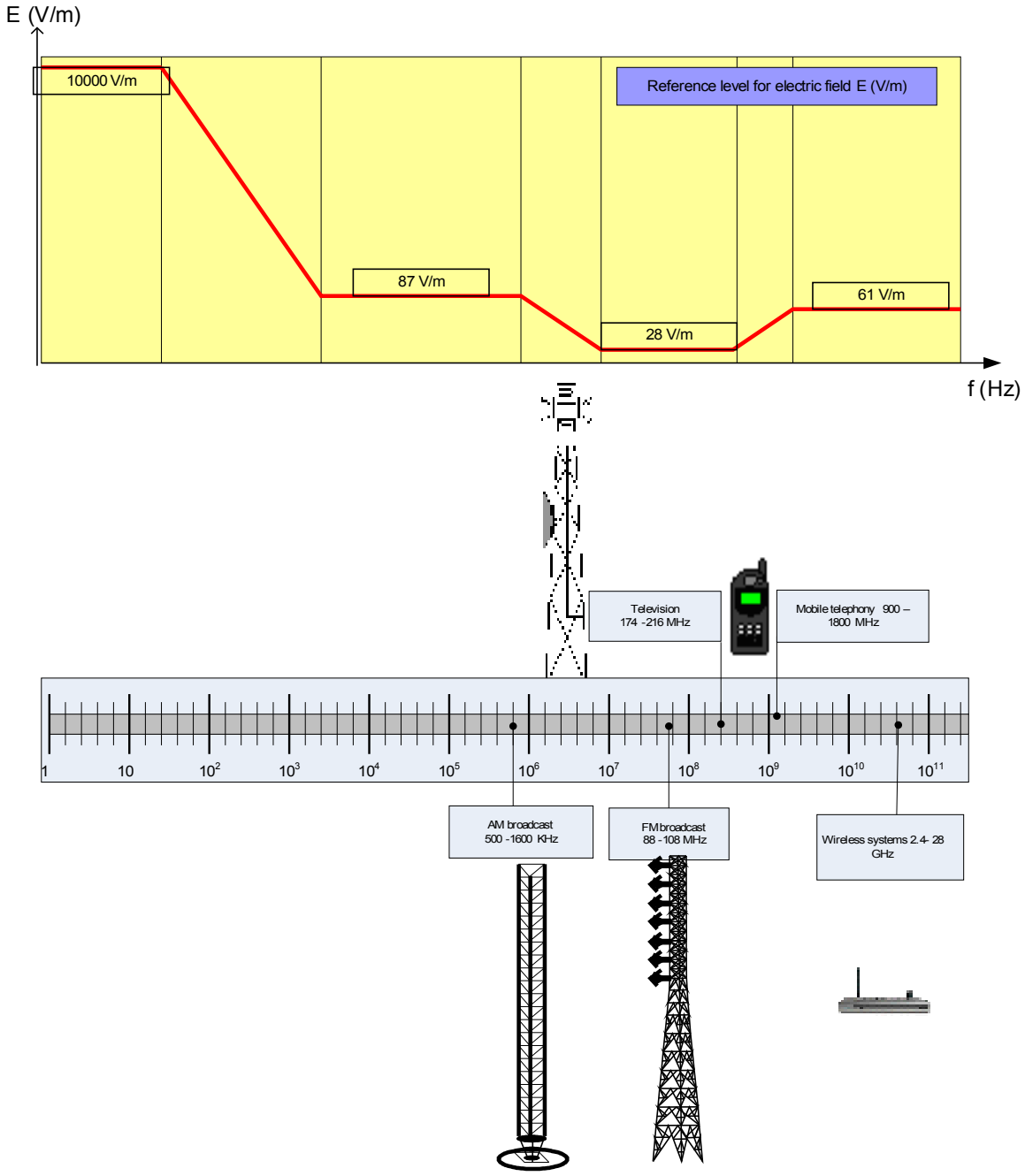

Figure 2 Electric field reference levels for the main telecommunication services

IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

The IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz (IEEE, 2006) is aimed to protect people against established adverse health effects in human beings exposed to electric, magnetic and electromagnetic fields in the frequency range of 3 kHz to 300 GHz. The IEEE Standard C95.1-2005 is the revision of IEEE Standard C95.1-1991.

These recommendations are expressed in terms of basic restrictions (BRs) and maximum permissible exposure (MPE) values.

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The basic restrictions are exposure restrictions to electromagnetic fields based on established health effects. The maximum permissible exposure values (MPEs) are derived from the BRs and are limits on external fields and induced and contact current. These recommendations are not intended to prevent interference with medical and other devices that may be susceptible to radiofrequency (RF) fields.

Generally speaking the IEEE Standard is less strict than the ICNIRP Guidelines although it is based on the same science

Details on how to purchase the IEEE Standard C95.1-2005 can be found on the web site of IEEE; www.ieee.org

Basic restrictions for telecommunication services

For the frequencies of important telecommunication systems the applicable IEEE basic restriction are given in Table 3.

Table 3 Basic restrictions for the main telecommunication services and systems

Services/systems	Frequency range (MHz)	Whole- body average SAR (Wkg^{-1})	Localized SAR (head and trunk) (Wkg^{-1})	Localized SAR (limbs) (Wkg^{-1})
FM broadcast	88- 108 MHz	0.08	NA	NA
VHF TV	54- 88 MHz 174- 216 MHz	0.08	NA	NA
UHF TV	407- 806 MHz	0.08	NA	NA
Trunking 800 MHz	806-869 MHz	0.08	2	4
Mobile Telephony 800 MHz	824-894MHz	0.08	2	4
Mobile Telephony 900 MHz	890-960 MHz	0.08	2	4
PCS 1800	1710- 1880 MHz	0.08	2	4
PCS 1900	1850- 1900 MHz	0.08	2	4

NA: Not applicable

Reference levels for telecommunication services

Reference levels for the main telecommunication services and systems are given in the Table 4.

Table 4. Reference levels for the main telecommunication services and systems

Service	Frequency range (MHz)	E_{rms} (V/m)	H_{rms} (A/m)	S_{rms} E field, H-field	Averaging time $[E]^2$, $[H]^2$ o S (min)

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VHF TV	54-88	27.50	0.13	2.00	6.27	30	6
FM broadcast	88-108	27.50	0.08	2.00	2.14	30	6
VHF TV	174-216	27.50	0.07	2.00	2.00	30	6
Trunking 800 MHz	806-869	-	-	4.19		30	
Mobile Telephony 800 MHz	824- 894	-	-	4.30		30	
Mobile Telephony 900 MHz	890-960	-	-	4.63		30	
PCS 1800 MHz	1710-1880	-	-	8.98		30	
PCS 1900 MHz	1850-1900	-	-	9.38		30	

ITU-T Recommendation K.52 “Guidance on complying with limits for human exposure to electromagnetic fields”.

The International Telecommunications Union (ITU) is the United Nations body with responsibility for telecommunication services and has issued recommendations on compliance with safety limits for EMF used in telecommunication systems. ITU-T Recommendation K.52 (ITU, 2004) helps determine compliance with safety limits for human exposure to EMF from telecommunication installations and mobile handsets or other RF emitting devices used against head. It presents general guidance, a calculation method, and an installation assessment procedure. The assessment procedure for telecommunication installations is based on safety limits provided by ICNIRP and helps users determine the likelihood of installation compliance based on accessibility criteria, antenna properties and emitter power. Recommendation K.52 proposes the IEC Standard for compliance measurement of mobile handsets [IEC, 2004]. ITU-T Recommendation K.52 is available from their web site: www.itu.int

Compliance of mobile handsets

ITU-T Recommendation K.52 states that compliance with the ICNIRP safety limits for mobile handsets or other RF devices operating in the frequency range of 300 MHz to 3 GHz used against the head, can be achieved by applying the measurement procedures for SAR in IEC 62209 (2004).

Compliance of radio stations

Telecommunications equipment is broadly defined as an intentional or unintentional RF emitter. For unintentional emitters it is assumed the fields produced are orders of magnitude below the safety limits, so it is not necessary to perform EMF assessment to assure compliance with safety limits. For an intentional emitter, it is recommended to determine an appropriate procedure for exposure assessment as a function of the operating power, antenna gain, frequency, orientation and directivity of the transmitting antenna and the operating environment of the installation.

According to Recommendation K.5 the steps to conduct the exposure assessment are:

a) To classify potential exposure to EMF as belonging to a compliance zone, occupational zone or an exceedance zone.

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b) To perform the e*xposure level assessment procedure* that considers as general criteria: the worst-case emission conditions and the simultaneous presence of several EMF sources, even at different frequencies.
c) To classify the installation as a function of a set of reference antennas and a set of accessibility conditions as inherently compliant, normally compliant or provisionally compliant and
d) Where necessary define mitigation techniques

USA FCC guidelines

The USA Federal Communications Commission guidelines (FCC, 1997) are use as guidance for some Latin American countries e.g. Bolivia and Peru.

General considerations

The revised OET Bulletin 65 issued by the Federal Communications Commission of the United States (FCC) in August 1997 includes the Maximum Permissible Exposure limits. These guidelines provide assistance in determining whether a transmitting facility or device complies with the limits adopted for FCC.

The limits adopted by FCC are generally based on “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Fields, 3 kHz to 300 GHz” ANSI/IEEE C95.1-1992. Tables 6 and 7 give the limits of exposure for the General Population and Workers

Table 6 Limits for General Population/ Uncontrolled Exposure

Frecuency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3 – 3.0	614	1.63	(100)*	30
3.0 – 30	824 / f	2.19 / f	($180 / f^2$)*	30
30 – 300	27.5	0.073	0.2	30
300 – 1 500	N/A	N/A	f / 1500	30
1500 – 100 000	N/A	N/A	1.0	30

Table 7 Limits for Occupational/ Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3 – 3.0	614	1.63	(100)*	6
3.0 – 30	1842 / f	4.89 / f	($900 / f^2$)*	6
30 – 300	61.4	0.163	1.0	6

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300 – 1 500	N/A	N/A	f / 300	6
1500 – 100 000	N/A	N/A	5.0	6

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

NOTE 1: Occupational/controlled limits apply to situations in which persons are exposed as consequence of their employment, provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational /controlled exposure also apply in situations when an individual is in transit through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2: General population/ uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

It's important to point out that the FCC's OET Bulletin 65 includes guidelines on how to comply with RF safety standards so it is used for some Latin American telecommunication administrations as a basis for compliance with their regulation.

Regulation and Standards in Latin America

Currently in Latin America there are 10 countries that have implemented non–ionizing radiation standards for telecommunication systems: Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Panama, Paraguay, Perú and Venezuela. Most of these standards are based on ICNIRP guidelines as can be seen in Table 8. Others are being developed, such as Costa Rica, Dominican Republic and Uruguay.

Table 8 Summary of main aspects on Latin American non-ionizing radiation regulations

COUNTRY	REFERENCE	FREQUENCY RANGE/SERVICES	SENSITIVE AREAS	MINIMUM DISTANCES
ARGENTINA	Before ICNIRP guidelines 1998 were issued, but are nearly the same levels	100 kHz- 300 GHz	There is no reference to sensitive areas	There is no reference to minimum distances in the national regulation, but in some cities like Rosario there is a limit of 800 m between towers. For tower height less than 5 m of the same service provider the limit is 100 m.
BOLIVIA	FCC	300 kHz- 100 GHz	There is no reference to sensitive areas	There is no reference to minimum distances in the

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				national regulation.
BRAZIL	ICNIRP	9 kHz- 300 GHz	There is to sensitive areas in the national regulation. In some towns there are stricter limits for sensitive areas	It was established, 50 m as the limit for sensitive areas There is no reference to minimum distances in the national regulation.
CHILE	ICNIRP	Mobile telephony and PCS	There is no reference to sensitive areas	There is no reference to minimum distances in the national regulation.

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COUNTRY	REFERENCE	FREQUENCY RANGE/SERVICES	SENSITIVE AREAS	MINIMUM DISTANCES
COLOMBIA	ICNIRP	9 kHz- 300 GHz	There is no reference to sensitive areas	There is no reference to minimum distances in the national regulation.
ECUADOR	ICNIRP	9 kHz- 300 GHz	There is no reference to sensitive areas	
PANAMA	IEEE	300 kHz – 100 GHz	There is no reference to sensitive areas	There is no reference to minimum distances in the national regulation.
PARAGUAY	ICNIRP	0 kHz- 300 GHz	There is no reference to sensitive areas	There is no reference to minimum distances in the national regulation
PERÚ	ICNIRP	9 kHz- 300 GHz	It is considered that places nearby schools and hospital must need an additional protection. In these areas are used half of the ICNIRP reference levels for public exposure	There is no reference to minimum distances in the national regulation
VENEZUELA	ICNIRP	3 kHz- 300 GHz	There is no reference to sensitive areas	There is no reference to minimum distances in the national regulation

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ARGENTINA

Argentina has the oldest regulation on NIR in the Latin American Region (Ministry of Public Health and Social Action of Argentina, 1995; Communications Secretariat of Argentina, 2000). When Maximum Exposure Levels (MEP) were established in Argentina the ICNIRP (1998) guidelines had not been published but the limits were known and so the Argentinean exposure limits are the same. The Argentinean regulation on MEP for NIR were based on earlier guidelines published by the ICNIRP predecessor committee INIRC/IRPA and research carried out by the Argentinean Ministry of Health in cooperation with State Secretariat for Science and Technology. The fifteen years of research was summarize in the "Handbook of safety standards for radiofrequencies and microwaves between 100 kHz and 300 GHz" and "Radiofrequency radiations: biophysics, biomedical considerations and criteria for establishing exposure standards".

In 1995 the Ministry of Public Health and Social Action, through Resolution Nº 202 MSyAS/95 established the MEP values for NIR. In 2000 by means of Resolution Nº 530 SC/2000 of the Communications Secretariat, the MPE limits from the Ministry of Health were adopted for telecommunication systems.

The National Communications Commission in Resolution CNC 3690/2004 **e**stablished that radio and broadcast station licensees must demonstrate that radiations generated by their radio-base-station antennae do not have adverse effects on nearby populations through compliance with the MEPs. This document also gives the measurement protocol for NIR.

According to Resolution Nº 269 CNC/2002, an exposure evaluation must be carried out to meet parameters recommended in Resolution N° 202/95 before installing antennae for telecommunications. Table 9 gives the Maximum Permissible Limits for Argentina

Table 9 Maximum Permissible Limits for general public exposure to non- ionizing - radiation power density, electric and magnetic fields

Frequency range f (MHz)	Equivalent plane wave power density S (W/m^2)	Electric Field E (V/m)	Magnetic Field H (A/m)
0.3-1	20	275	0,73
1-10	$20/f^2$	275/f	0.73/f
10-400	0,2	27,5	0,073
400-2000	f/2000	$1.375f^{1/2}$	-
2000-100000	1	61,4	-

BOLIVIA

On April 12, 2002, the Technical Committee of the Telecommunications Superintendent, in accordance with the Report COMTEC /2002/001, adopted the guidelines issued by the Federal Communications Commission of the United States (FCC).

The Telecommunications Superintendent through Nota Interna ST/NI/INT/33/2002 of April 19, 2002, based on the Technical Report COMTEC/2002/001 of April 12, 2002,

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recommended approval of the Technical standard “Human Exposure Limits for Radiofrequency Electromagnetic Fields”. This standard establishes the maximum permissible limits for the human exposure to radiofrequency electromagnetic fields in the frequency range of 300 kHz to 100 GHz.,

This Standard uses as reference the following documents:

- U.S. Federal Communications Commission 96-326: Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation.
- OET Bulletin 65 - “Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields”.
- Supplement A to OET Bulletin 65 – “Additional Information for Radio and Television Broadcast Stations”.
- Supplement B to OET Bulletin 65 – “Additional Information for Amateur Radio Stations”.
- Supplement C to OET Bulletin 65 – “Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions”
- “A Local Government Official’s Guide to Transmitting Antenna RF Emission Safety: Rules, Procedures, and Practical Guidance”. FCC Junio de 2000.

The Bolivian limits for general population and occupational exposure are presented in Tables 10 and 11

Table 10 Limits for General Population/ Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)
0.3 – 1.34	614	1.63	100
1.34 – 30	824 / f	2.19 / f	$180 / f^2$
30 – 300	27.5	0.073	0.2
300 – 1500	N/A	N/A	f / 1500
1500 – 100000	N/A	N/A	1.0

Table 11 Limits for Occupational/ Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)
0.3 – 3.0	614	1.63	100
3.0 – 30	1842 / f	4.89 / f	$900 / f^2$
30 – 300	61.4	0.163	1.0
300 – 1500	N/A	N/A	f / 300

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1500 – 100000	**N/A**	**N/A**	**5**

BRASIL

In July 1999, the regulatory body for telecommunications, the National Agency for Telecommunications (ANATEL: Agência Nacional de Telecomunicações) , decided to adopt the ICNIRP reference levels as a guide for the evaluation of human exposure to radiofrequency electromagnetic fields from telecommunication-services transmitter stations. The Brazilian limits for occupational and general public exposure are shown in tables 12 and 13 .

In July 2002 Brasil started the development of regulations for non-ionizing radiations through Resolución Nº 303 that approved the report “The Exposure Limits to Electric, Magnetic and Electromagnetic Fields in the frequency range of 9 kHz to 300 GHz” (ANATEL, 2002a, 2002b)

Table 12. Limits for occupational exposure to RF EMF in the radiofrequency band from 9 kHz to 300 GHz
(unperturbed rms values)

Frequency range	Electric field strength E (V/m)	Magnetic field Strength H (A/m)	Equivalent plane wave power density S_{eq} (W/m^2)
9 kHz – 65 kHz	610	24.4	–
0.065 MHz – 1 MHz	610	1.6 / *f*	–
1 MHz – 10 MHz	610 / *f*	1.6 / *f*	–
10 MHz – 400 MHz	61	0.16	10
400 MHz – 2000 MHz	3 □ 0.5	0.008 □ 0.5	□ / 40
2 GHz – 300 GHz	137	0.36	50

Table 13 Limits for general public exposure to RF EMF in the radiofrequency band from 9 kHz to 300 GHz
(unperturbed rms values)

Frequency range	Electric field strength E (V/m)	Magnetic field Strength H (A/m)	Equivalent plane wave power density S_{eq} (W/m^2)
9 kHz – 150 kHz	87	5	–
0.15 MHz – 1 MHz	87	0.73/ *f*	–
1 MHz – 10 MHz	87/ $f^{0.5}$	0.73/ *f*	–
10 MHz – 400 MHz	28	0.073	2
400 MHz – 2000 MHz	1.375□ 0.5	0.0037□ 0.5	□/ 200
2 GHz – 300 GHz	61	0.16	10

On May 5th, 2009 the President of Brazil issued the Law Nº 11.934 “ Dispõe sobre limites a exposição humana a campos elétricos, magnéticos e eletromagnéticos: altera a Lei Nº 4.771, de 15 de setembro de 1965; e dá outras providências”. This law, among others,

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enacts the following:

- Enforces ICNIRP guideline limits as Brazilian lìmits in the frequency range up to 300GHz, including SAR limits for occupational and general public exposures.

- The scope of this law includes electric energy service providers, telecommunication service providers that use radiocommunication transmitter stations and mobile phone manufacturers.

- It defines as critical areas those that located within 50 m from hospitals, clinics, schools and nurseries.

- It provides mechanisms for financing research on EMF and possible health effects from electric energy networks and telecommunication networks.

- It establishes monitoring of EMF for electric energy networks, telecommunications networks and mobile phone manufacturers. For telecommunications providers the monitoring data must be online.

- It also establishes that compliance results must be published on the web.

CHILE

On May 8, 2000, the regulatory body for telecommunications the Telecommunication Subsecretariat (SUBTEL, 2000) of the Ministry of Transports and Telecommunications, issued Resolución Nº 505/2000 “Norm on Safety Requirements for Telecommunication Installations“. Despite its title, this regulation only establishes requirements for mobile telephony systems. It requires that emissions from antennae for the Mobile Telephony Public Service are to be less than 435 μW/ cm^2 (4.35 W/m^2) in places accessible to the general public. The Mobile Telephony Public Service includes Mobile Cellular Telephony Public Service in the 800 MHz frequency band and the Digital Mobile Telephony Public Service in the 1900 MHz frequency band.

The limit values issued by SUBTEL are based on the ICNIRP reference levels for the 800 MHz frequency band so the reference levels for 1900 MHz frequency band are much stricter than ICNIRP. The frequency bands for Mobile Cellular and Digital Mobile Telephony Public Services are 820-920 MHz and 1850-1990 MHz respectively.

In December 2002 Resolución Nº 505/2000 (SUBTEL, 2002) was modified by adding the specific absorption rate (SAR) to the requirements to be met by mobile phones.

Table 14 gives a comparison of Chilean limits and the ICNIRP Guidelines

Table 14 Comparison between Chilean limits and ICNIRP reference levels for general public exposure

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Frequency range	General public ICNIRP reference levels, S [W/m^2]	Chilean limits [W/m^2]
	for the center frequency	
Cell Band	4,35	4.35
PCS Band	9,60	4.35

COLOMBIA

On January 31, 2005 the President of the Republic of Colombia issued the Decreto Nº 195 “Limits for Human Exposure to Electromagnetic Fields”, with the approval of the Ministry of Social Protection, Ministry of Telecommunications and the Ministry of Environment, Housing and Territorial Development..

This regulation is based on the ITU Recommendation K-52 “Guidance on complying with limits for human exposure to electromagnetic fields”, which in turn endorses ICNIRP reference levels. It is for telecommunication systems in the frequency range of 9 kHz to 300 GHz and includes the exposure limits, the requirements for persons or entities in charge of measuring EMF and the requirements for installation of radio electric stations for telecommunications**.** The Colombian limits are presented in the table 15

Table 15 Limits for Human Exposure to Electromagnetic Fields

Exposure Type	Frequency range	Electric field strength, E (V/m)	Magnetic field strength, H (A/m)	Equivalent plane wave power density, S (W/m^2)
Occupational Exposure	9 kHz – 65 kHz	610	24.4	–
	0.065 MHz – 1 MHz	610	1.6 / *f*	–
	1 MHz – 10 MHz	610 / *f*	1.6 / *f*	–
	10 MHz – 400 MHz	61	0.16	10
	400 MHz – 2000 MHz	3 □ $^{0.5}$	0.008 □ $^{0.5}$	□ / 40
	2 GHz – 300 GHz	137	0.36	50
General Public Exposure	9 kHz – 150 kHz	87	5	–
	0.15 MHz – 1 MHz	87	0.73/ *f*	–
	1 MHz – 10 MHz	87/ *f* $^{0.5}$	0.73/ *f*	–
	10 MHz – 400 MHz	28	0.073	2
	400 MHz – 2000 MHz	1.375□ $^{0.5}$	0.0037□ $^{0.5}$	□/ 200
	2 GHz – 300 GHz	61	0.16	10

ECUADOR

On January 11, 2005 the National Telecommunications Council (CONATEL), the administrator and regulatory body for telecommunications, issued Resolution 01-01-CONATEL-2005 “Regulation on Protection Against Non- ionizing Radiation Generated by using Radio Electric Spectrum” (CONATEL, 2005).

This regulation is based on ITU Recommendation K-52 “Guidance on complying with limits for human exposure to electromagnetic fields”, which in turn endorses ICNIRP reference levels. It is for telecommunication systems operating in the frequency range of 9 kHz to

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300 GHz and includes the exposure limits, the requirements for persons or entities in charge of measuring electromagnetic fields and requirements for the installation of radio electric stations for telecommunications.

The Ecuadorian limits are presented in table 16

Table 16 Maximum exposure limits per fixed radio electric station

Exposure Type	Frequency range	Electric field strength, E (V/m)	Magnetic field strength, H (A/m)	Equivalent plane wave power density, S (W/m^2)
Occupational Exposure	3 – 65 kHz	610	24.4	–
	0.065 – 1 MHz	610	1.6 / *f*	–
	1 – 10 MHz	610 / *f*	1.6 / *f*	–
	10 – 400 MHz	61	0.16	10
	400 – 2000 MHz	3 □ 0.5	0.008 □ 0.5	□ / 40
	2 – 300 GHz	137	0.36	50
General Public Exposure	3 – 150 kHz	87	5	–
	0.15 – 1 MHz	87	0.73/ *f*	–
	1 – 10 MHz	87/ $f^{0.5}$	0.73/ *f*	–
	10 – 400 MHz	28	0.073	2
	400 – 2000 MHz	1.375□ 0.5	0.0037□ 0.5	□/ 200
	2 – 300 GHz	61	0.16	10

PANAMA

On November 29, 2007 the Ministry of Health, through Resolution Nº 1056 established the regulation for location, installation and operation of antenna towers for mobile telephony, trunking and similar systems as well as antenna towers for radiofrequency repeaters. This document included the limits for power density in the frequency range of 0.3 MHz - 100 GHz that is based on the Action Levels of the IEEE Standard C95.1™-2005 Maximum Permissible Exposure limits but it is not the same. Resolution Nº 1056 was revoked on October 21, 2008 when the National Authority for Public Services (ASEP) assumed responsibility for the regulation and technical norms, installation systems and telecommunications antennas, and public services for telecommunications, radio and television.

On October 28, 2008 the National Authority for Public Services (ASEP) issued the Resolution AN Nº 2161 endorsing the standard which was given in the Resolution Nº 1056 (ASEP, 2008)

The Panamanian limits are presented in Table 17

Table 17 Power Density Limits

Power density mW/cm^2	Frequency (MHz)
100	0.3 a 3

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$180/f^2$,	3 – 30
0.2	30 – 300
f/1500	300- 1500
1	1500 – 100 000

NOTE: f is the frequency in MHz.

PARAGUAY

On March 2, 2007 the Ministry of Health and Social Wellfare, by means of Decreto Nº 10071, established the regulation for Maximum Permissible Limits for exposure of persons to NIR produced by activities that generate EMF in the frequency range of 0 Hz - 300 GHz. It endorses ICNIRP reference levels as their national NIR standard.

It states that licensees from the different services (including telecommunications) must adopt measures (including monitoring of EMF to ensure the compliance of the Maximum Permissible Limits (LMP) by stations or installations that emit radiations.

The authority in charge of the application is the Secretariat of the Environment and states that procedures and analytical methods to be used for telecommunications are those established in the International Union for Telecommunications (ITU) Recommendation K.52.

Table 18 gives the Paraguayan limits.

Table 18 ICNIRP reference levels
(0 Hz – 300 GHz unperturbed rms values)

Exposure Type	Frequency range	E- field strength (Vm^{-1})	H- field strength (Am^{-1})	B- field (μT)	Equivalent plane wave power density S_{eq} (Wm^{-2})
Occupational Exposure	up to 1 Hz	–	1.63×10^5	2×10^5	–
	1 – 8 Hz	20 000	$1.63 \times 10^5 / f^2$	$2 \times 10^5 / f^2$	–
	8 – 25 Hz	20 000	$2 \times 10^4 / f$	$2.5 \times 10^4 / f$	–
	0.025 – 0.82 kHz	500 / f	20 / f	25 / f	–
	0.82 – 65 kHz	610	24.4	30.7	–
	0.065 – 1 MHz	610	1.6 / f	2 / f	–
	1 – 10 MHz	610 / f	1.6 / f	2 / f	–
	10 – 400 MHz	61	0.16	0.2	10
	400 – 2000 MHz	$3 \square^{0.5}$	$0.008 \square^{0.5}$	$0.01 \square^{0.5}$	$\square$ / 40
	2 – 300 GHz	137	0.36	0.45	50
General Public Exposure	up to 1 Hz	–	3.2×10^4	4×10^4	–
	1 – 8 Hz	10 000	$3.2 \times 10^4 / f^2$	$4 \times 10^4 / f^2$	–
	8 – 25 Hz	10 000	4000/ f	5000/ f	–
	0.025 – 0. 8 kHz	250 / f	4/ f	5/ f	–
	0.8 – 3 kHz	250 / f	5	6.25	–
	3 – 150 kHz	87	5	6.25	–
	0.15– 1 MHz	87	0.73/ f	0.92 / f	–
	1 – 10 MHz	$87/ f^{0.5}$	0.73/ f	0.92/ f	–
	10 – 400 MHz	28	0.073	0.092	2
	400 – 2000 MHz	$1.375\square^{0.5}$	$0.0037\square^{0.5}$	$0.0046\square^{0.5}$	$\square$/ 200
	2 – 300 GHz	61	0.16	0.20	10

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PERU

Peru has since 2005 an environmental regulation “The Environmental Quality Standard for Non Ionizing Radiations” that establishes limits for the frequency range of 0-300 GHz, including all possible applications of electricity, medical devices, domestic appliances (microwave ovens) and of course telecommunications, but only for general public exposure (CONAM, 2005). Based on this environmental standard, limits for the different frequency ranges have been established. However, the regulation for telecommunications was established before the environmental standard.

The Environmental Quality Standard for Non Ionizing Radiations was issued by the National Council for the Environment in 2005 by means of the Supreme Decree Nº 010-2005-PCM. It is based on ICNIRP reference levels for general public exposure in the frequency range of 0 Hz to 300 GHz

The Peruvian standards are presented in Tables 19- 21

Table 19 Environmental Quality Standard for Non Ionizing Radiations

Frequency range	E- field strength (Vm^{-1})	H- field strength (Am^{-1})	B- field (μT)	Equivalent plane wave power density S_{eq} (Wm^{-2})	Main application (not restrictive)
Up to 1 Hz	–	3.2×10^4	4×10^4	–	Power lines for electric trains, magnetic resonance
1 – 8 Hz	10 000	$3.2 \times 10^4 / f^2$	$4 \times 10^4 / f^2$	–	
8 – 25 Hz	10 000	$4000 / f$	$5000 / f$	–	Power lines for electric trains
0.025 – 0. 8 kHz	$250 / f$	$4 / f$	$5 / f$	–	Electricity networks, power lines for electric trains, VDU
0.8 – 3 kHz	$250 / f$	5	6.25	–	VDU
3 – 150 kHz	87	5	6.25	–	VDU
0.15– 1 MHz	87	$0.73 / f$	$0.92 / f$	–	AM broadcast
1 – 10 MHz	$87 / f^{0.5}$	$0.73 / f$	$0.92 / f$	–	AM broadcast, diathermy
10 – 400 MHz	28	0.073	0.092	2	FM broadcast, VHF- TV, aeronautical radio navigation and radio mobile systems, wireless telephones, magnetic resonance, diathermy
400 – 2000 MHz	$1.375 f^{0.5}$	$0.0037 f^{0.5}$	$0.0046 f^{0.5}$	$f / 200$	UHF – TV, mobile telephony system, trunking, mobile satellite services, wireless telephones, personal communication services
2 – 300 GHz	61	0.16	0.20	10	Wíreless telephony networks, microwave and satellite communications, radars, microwaves ovens

1. f as indicated in the frequency range column.
2. For frequencies between 100 kHz and 10 GHz, S_{eq}, E^2, H^2 y B^2 are to be averaged over any 6- min period.
3. For frequencies between 100 kHz and 10 GHz, S_{eq}, E^2, H^2 y B^2 are to be averaged over any $68 / f^{1.05}$ -min period (f in GHz).

On July 6, 2003 the Ministry of Transports and Communications issued “The Maximum Permissible Limits (LMP) for Non-ionizing Radiations from Telecommunications” by means of Supreme Decree

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N° 038-2003-MTC. This is based on ICNIRP reference levels for general public and occupational exposure in the frequency range from 9 kHz to 300 GHz.

This Maximum Permissible Limits Supreme Decree N° 038-2003-MTC was modified in December 2006 by Supreme Decree N° 038-2006-MTC. The Peruvian Regulation for NIR from telecommunications has supplementary technical regulations to ensure compliance with the LMP.

- Ministerial Resolution N° 610-2004-MTC/03 issued on August 17, 2004 that approves the management over supervision and control procedures for the maximum permissible limits of non-ionizing radiations for telecommunications.
- Ministerial Resolution N° 612-2004-MTC/03 issued on August 18, 2004 that approves technical guidelines for the development of theoretical studies on non-ionizing radiations.
- Ministerial Resolution N° 613-2004-MTC/03 issued on August 19, 2004 that approves the technical guidelines on measurement protocols for non-ionizing radiations.
- Ministerial Resolution N° 120-2005-MTC/03 issued on February 28, 2005 that approves the technical guidelines on restrictions in areas of public use.
- Ministerial Resolution N° 965-2005-MTC/03 issued on December 29, 2005 that approves the procedures to certificate non-ionizing radiation equipment.

Table 20. Maximum Permissible Limits for occupational exposure to 9 kHz to 300 GHz

(unperturbed rms values)

Frequency range	Electric field strength E (V/m)	Magnetic field Strength H (A/m)	Equivalent plane wave power density S_{eq} (W/m^2)
9 kHz – 65 kHz	610	24.4	–
0.065 MHz – 1 MHz	610	1.6 / *f*	–
1 MHz – 10 MHz	610 / *f*	1.6 / *f*	–
10 MHz – 400 MHz	61	0.16	10
400 MHz – 2000 MHz	3 □ 0.5	0.008 □ 0.5	□ / 40
2 GHz – 300 GHz	137	0.36	50

Table 21 Maximum Permissible Limits for general public occupational exposure to 9 kHz to 300 GHz

(unperturbed rms values)

Frequency range	Electric field strength E (V/m)	Magnetic field Strength H (A/m)	Equivalent plane wave power density, S_{eq} (W/m^2)
9 kHz – 150 kHz	87	5	–
0.15 MHz – 1 MHz	87	0.73/ *f*	–
1 MHz – 10 MHz	87/ $f^{0.5}$	0.73/ *f*	–
10 MHz – 400 MHz	28	0.073	2
400 MHz – 2000 MHz	1.375□ 0.5	0.0037□ 0.5	□/ 200
2 GHz – 300 GHz	61	0.16	10

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VENEZUELA

In April 2005 the National Telecommunications Commission (CONATEL), the administrator and regulatory body for telecommunications issued the Administrative Provision (Decree) ”Safety Conditions against Radiofrequency Emissions from Fixed Radioelectric Stations in the Range of 3 kHz to 300 GHz” (CONATEL, 2005).

This regulation is based on ITU Recommendation K-52 “Guidance on complying with limits for human exposure to electromagnetic fields”, which in turn endorses ICNIRP reference levels. It is for telecommunication systems operating in the frequency range of 9 kHz to 300 GHz and includes the exposure limits, the requirements for persons or entities in charge of measuring electromagnetic fields and the requirements for the installation of radio stations for telecommunications.

Table 22 gives the Venezuelan limits.

Exposure category	Frequency Range	E – field strength (V/m)	H - field strength (A/m)	Equivalent planewave power density S (W/m^2)
Ocupational	3 - 65 kHz	610	24,4	–
	0,065 -1 MHz	610	1,6 /f	–
	1 - 10 MHz	610 /f	1,6 /f	–
	10- 400 MHz	61	0,16	10
	400 - 2000 MHz	$3f^{½}$	$0{,}008f^{1/2}$	f/40
	2 - 300 GHz	137	0,36	50
General public	3 - 150 kHz	87	5	–
	0,15 - 1 MHz	87	0,73 /f	–
	1 - 10 MHz	$87/f^{½}$	0,73 /f	–
	10 - 400 MHz	28	0,073	2
	400 - 2000 MHz	$1{,}375f^{½}$	$0{,}0037f^{1/2}$	f/200
	2 - 300 GHz	61	0,16	10

Conclusions

In general Latin American standards on NIR from telecommunications have endorsed the ICNIRP Guidelines with the exception of Bolivia that adopted the FCC standards and Panama that implemented standards based on the IEEE Standard C95.1-2005. The reasons for this situation is the lack of promotion of ICNIRP standards and the importance of the harmonization process

Table 23 Latin American Countries that have Adopted ICNIRP Standards

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References Standards

COUNTRY	FREQUENCY RANGE/SERVICES	DATE OF ADOPTION
BRAZIL	9 kHz- 300 GHz 0 Hz-300 GHz	2002 2009
CHILE	Mobile telephony and PCS	2000
COLOMBIA	9 kHz- 300 GHz	2005
ECUADOR	9 kHz- 300 GHz	2005
PARAGUAY	0 kHz- 300 GHz	2007
PERÚ	9 kHz- 300 GHz 0 Hz-300 GHz	2003 2005
VENEZUELA	3 kHz- 300 GHz	2005

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