



Radiación No Ionizante



Radiación No Ionizante (RNI)

Es toda radiación electromagnética cuya energía no produce la ionización de la materia.

$$\text{Energía (RNI)} < 10 \text{ eV}$$

$$\text{Energía} = h \times f(\text{Hz}) \quad \text{y} \quad c = f(\text{Hz}) \times \lambda(\text{m})$$

- h (constante de Plank) = $4,14 \times 10^{-15}$ eV-seg.
- $c = 3 \times 10^8$ m/seg.

Es toda radiación electromagnética con:

$$f < 2,4 \times 10^{15} \text{ Hz} \quad \text{ó} \quad \lambda > 124 \text{ nm}$$

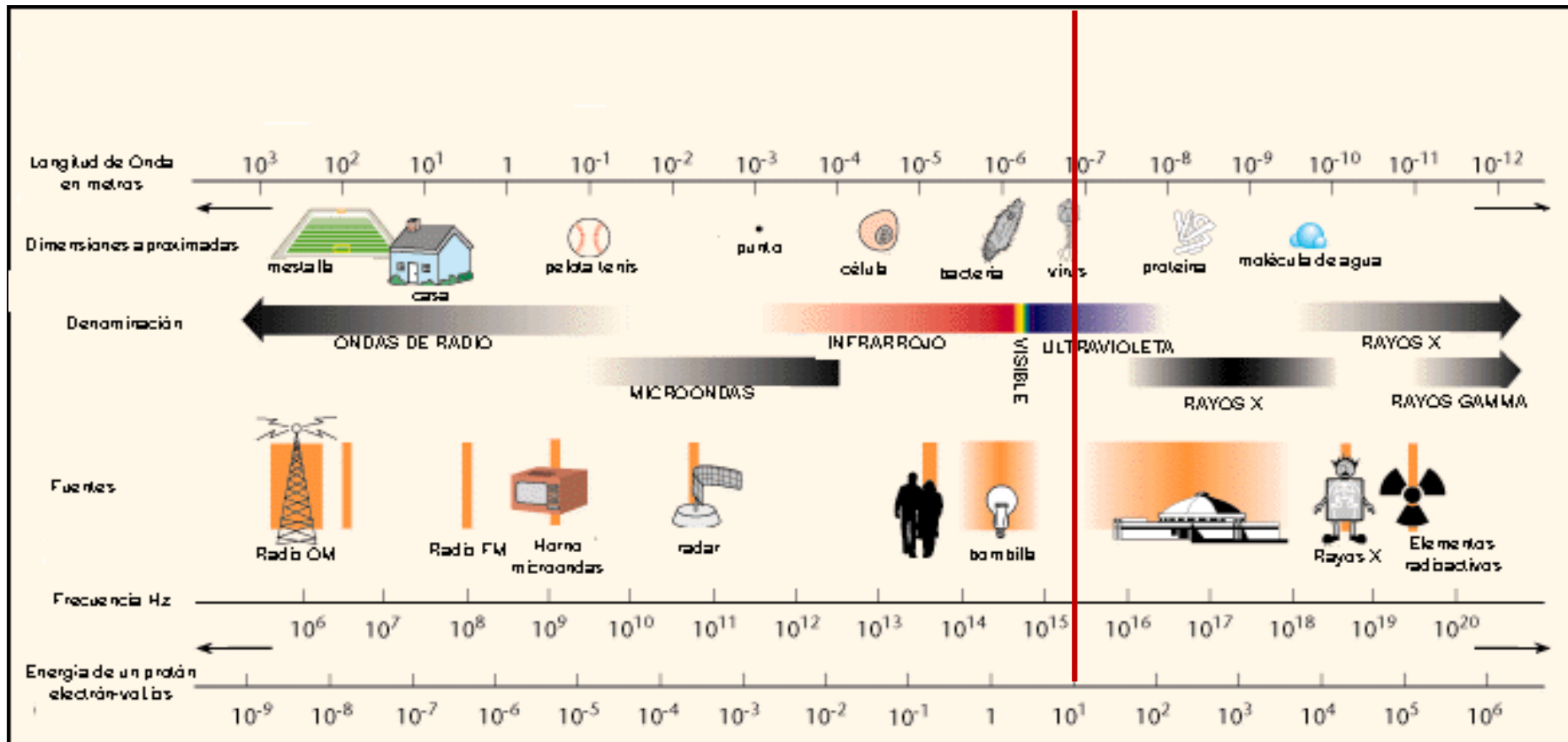
Espectro Electromagnético

■ Radiación Ionizante (RI)

$E > 10\text{eV}$ ($\lambda < 124\text{ nm}$)

■ Radiación No Ionizante (RNI)

$E < 10\text{eV}$ ($f < 2,4 \times 10^{15}\text{ Hz}$)



Radiación No Ionizante

Radiación Ionizante

Espectro Electromagnético

■ Radiación No Ionizante (RNI) $E < 10\text{eV}$ ($f < 2,4 \times 10^{15}$ Hz)

- Energía eléctrica
- Radios AM – FM – TV
- Celulares
- Microondas
- Comunicaciones Satelitales
- Infrarrojo
- Luz visible
- Ultravioleta Cercano

Radiación No Ionizante

Fuentes de Radiación No Ionizante

- Soldadoras por Radiofrecuencia*
- Calentamiento por inducción*
- Estaciones Transformadoras*
- Líneas de distribución de energía*
- Equipos de uso hogareño*



Fuentes de Radiación No Ionizante

- Hornos a Microondas*
- Alarmas Perimetrales*
- Detección Automática en Peajes*
- Alarmas en Comercios*



Fuentes de Radiación No Ionizante

- Antenas de Bases Celulares*
- Antenas de estaciones de FM, AM, TV*
- Celulares*
- Enlaces de microondas*

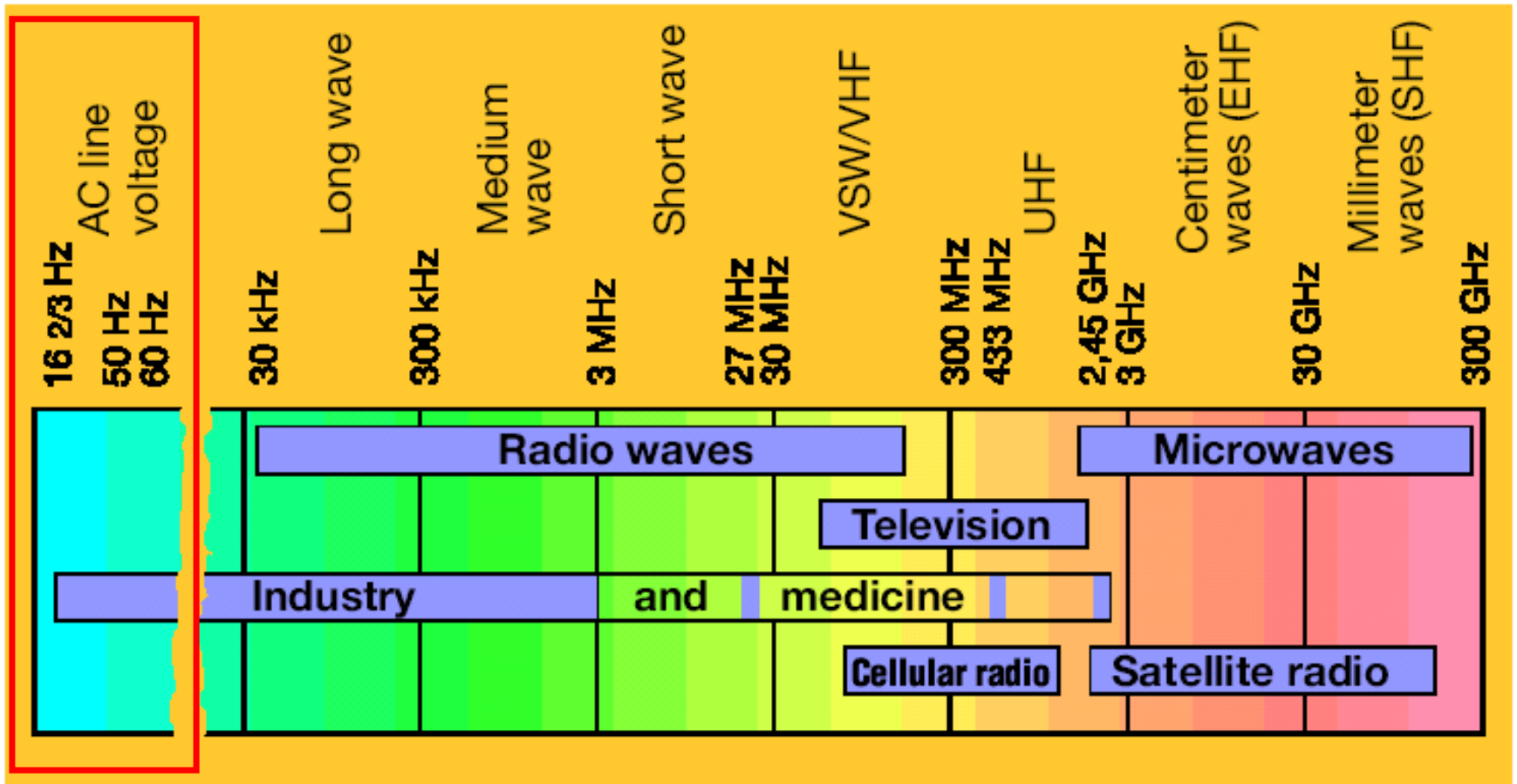


Fuentes de Radiación No Ionizante

- Lámparas Germicidas
- Curado de Tintas
- Equipos de Secado
- Fotolitografía
- Fototerapia
- Iluminación



Espectro Radioeléctrico



Campos Magnéticos y Eléctrico de Baja Frecuencia

Resolución No. 77/1998

Secretaría de Energía

Poblacional - Frecuencia 50 Hz

Campo	Límite
Magnético (B)	25 uT
Eléctrico (E)	3000 V/m

Valores típicos de B (uT) producidos por artefactos de uso habitual en el hogar

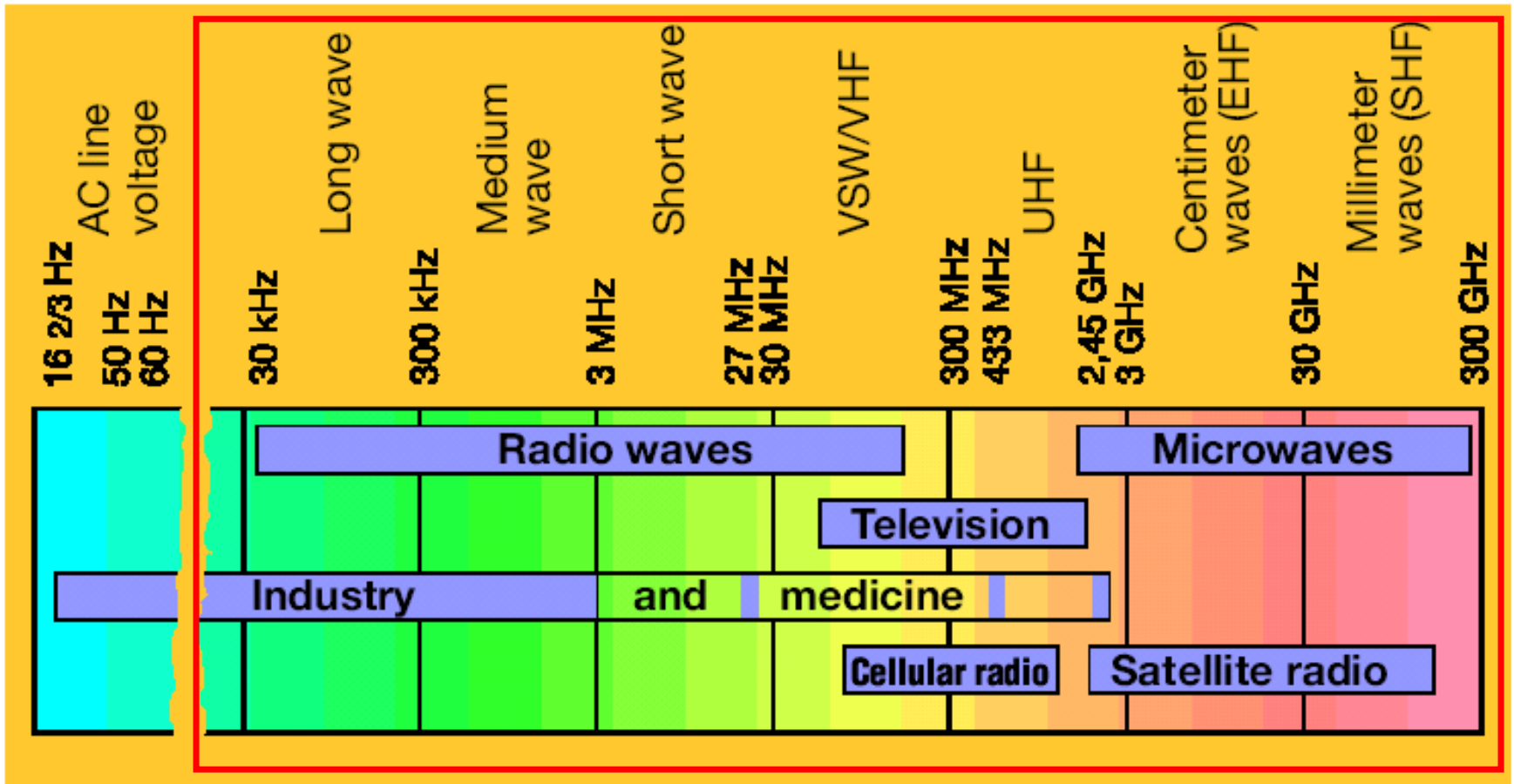
<u>Electrodoméstico</u>	<u>Intensidad del campo eléctrico a 30 cm</u> V/m
Receptor estereofónico	180
Plancha	120
Frigorífico	120
Batidora	100
Tostadora	80
Secador de pelo	80
Televisor de color	60
Cafetera eléctrica	60
Aspiradora	50
Horno eléctrico	8
Bombilla	5
Valor límite recomendado	3000

<u>Aparato eléctrico</u>	<u>A una distancia de 3 cm</u> μT	<u>A una distancia de 30 cm</u> μT	<u>A una distancia de 1 m</u> μT
Secador de pelo	6 – 2000	0,01 – 7	0,01 – 0,03
Máquina de afeitar eléctrica	15 – 1500	0,08 – 9	0,01 – 0,03
Aspiradora	200 – 800	2 – 20	0,13 – 2
Luz fluorescente	40 – 400	0,5 – 2	0,02 – 0,25
Horno de microondas	73 – 200	4 – 8	0,25 – 0,6
Radio portátil	16 – 56	1	< 0,01
Horno eléctrico	1 – 50	0,15 – 0,5	0,01 – 0,04
Lavadora	0,8 – 50	0,15 – 3	0,01 – 0,15
Plancha	8 – 30	0,12 – 0,3	0,01 – 0,03
Lavavajillas	3,5 – 20	0,6 – 3	0,07 – 0,3
Computadora	0,5 – 30	< 0,01	
Frigorífico	0,5 – 1,7	0,01 – 0,25	<0,01
Televisor de color	2,5 - 50	0,04 – 2	0,01 – 0,15

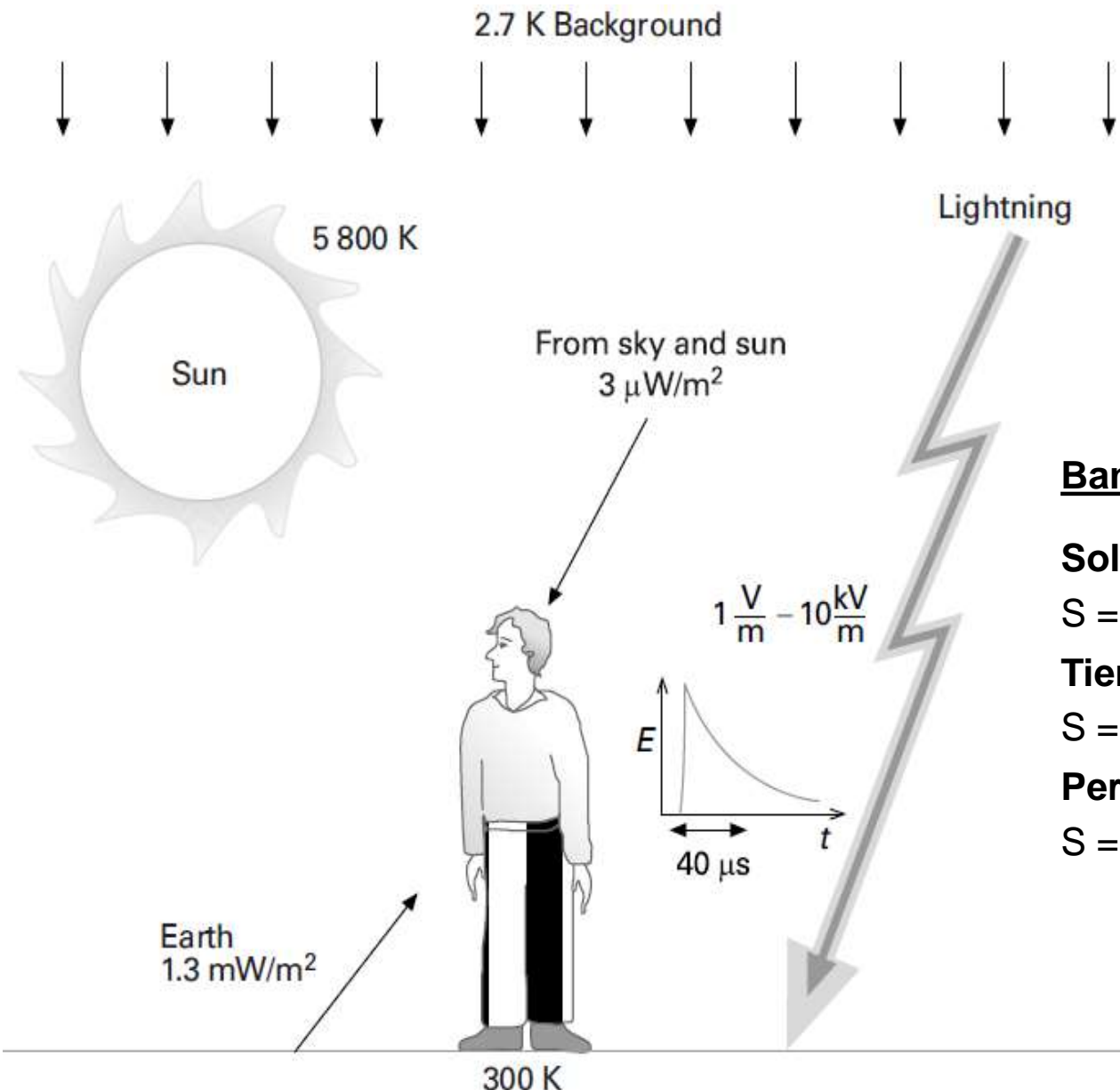
Valor Límite: 3000V/m

Valor Límite: 25uT

Espectro Radioeléctrico



Fuentes de Radiación No Ionizante



Radiación Natural

Banda de RF (30kHz a 300GHz)

Sol (5800°K) + Espacio (2725°K)

$S = 3 \mu\text{W}/\text{m}^2 = 0,3 \times 10^{-3} \text{ uW}/\text{cm}^2$

Tierra (300°K)

$S = 1,3 \text{ mW}/\text{m}^2 = 0,13 \text{ uW}/\text{cm}^2$

Personas (310°K)

$S = 2,5 \text{ mW}/\text{m}^2 = 0,25 \text{ uW}/\text{cm}^2$

Límite = 200 uW/cm²

MEP Poblacional - Ocupacional

Resolución 202/1995 - MS y AS

Res 202/1995		Ocupacional	
Frecuencia MHz	S mW/cm ²	E V/m	H A/m
1 - 3	100	614	1,63
3 - 30	$900/f^2$	$1842/f$	$4,9/f$
30 - 400	1	61,4	0,163
400 - 2000	$f/400$	$f^{1/2}/0,326$	
2000 - 300000	5	137	

Res 202/1995		Poblacional	
Frecuencia MHz	S mW/cm ²	E V/m	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	$f/2000$	$f^{1/2}/0,728$	
2000 - 300000	1	61,4	

Manual de Estándares de Seguridad para la Exposición a Radiofrecuencias comprendidas entre 100KHz y 300GHz (Adolfo Portela y otros)

Máximos Niveles Permisibles Densidad de Potencia - S (mW/cm²)

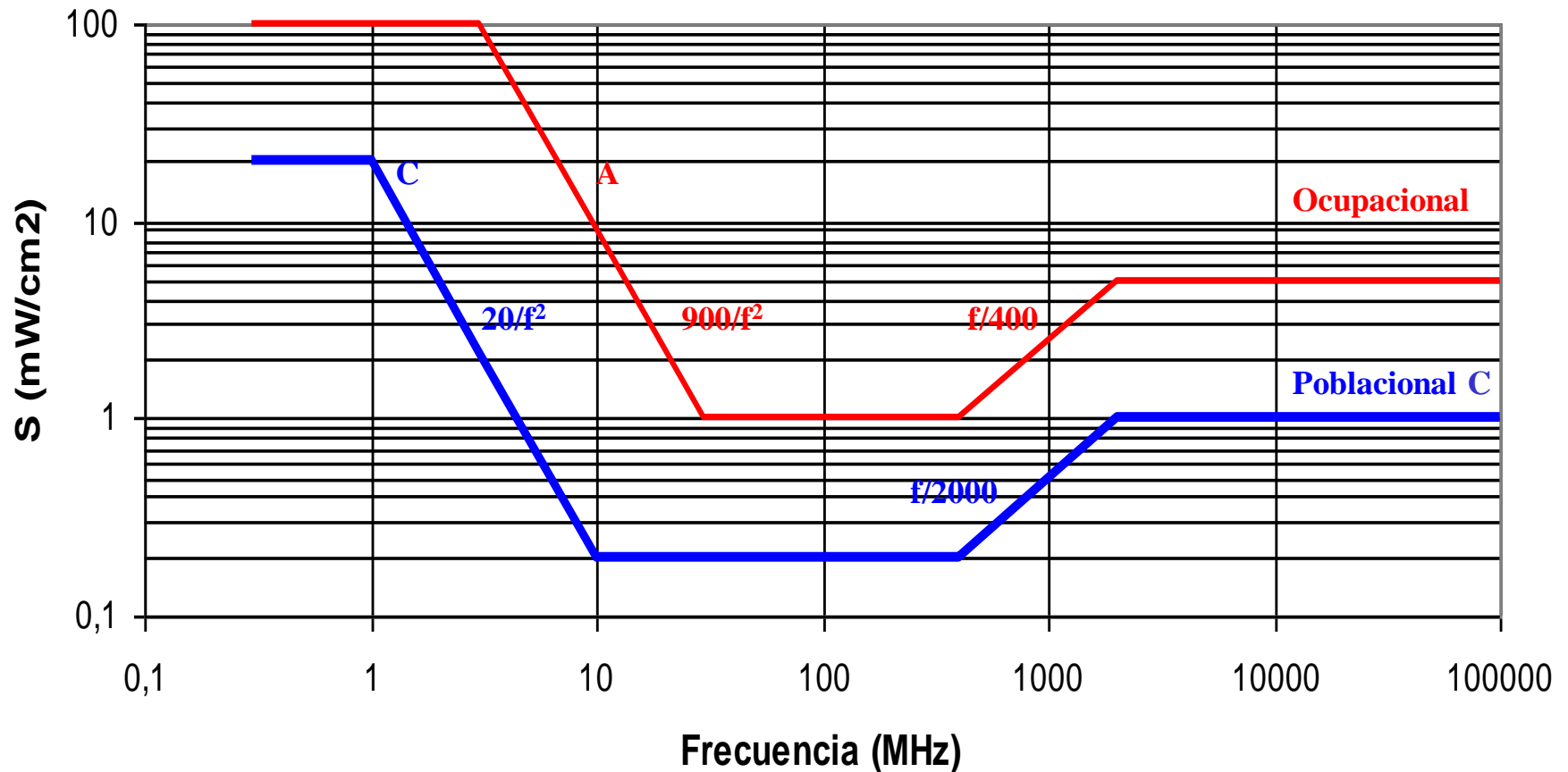


Table 1: Exposure limits for the general public for electromagnetic fields in inhabited areas in member states of the European Union and selected industrial nations outside the European Union (situation April 2011)

Country:	50 Hz (ELF)		900 MHz (GSM)			1800 MHz (GSM)			2100 MHz (UMTS)		
	electric field strength	magnetic flux density	electric field strength	magnetic flux density	equivalent plain wave power density	electric field strength	magnetic flux density	equivalent plain wave power density	electric field strength	magnetic flux density	equivalent plain wave power density
	(V/m)	(μ T)	(V/m)	(μ T)	(W/m ²)	(V/m)	(μ T)	(W/m ²)	(V/m)	(μ T)	(W/m ²)
Recommendation 1999/519/EC	5000	100	41	0.14	4.5	58	0.20	9	61	0.20	10
Austria	[5000]	[100]	[41]	[0.14]	[4.5]	[58]	[0.20]	[9]	[61]	[0.20]	[10]
Belgium (Flanders)	—	10	21 ⁽¹⁾	—	—	29 ⁽¹⁾	—	—	31 ⁽¹⁾	—	—
Bulgaria	— ⁽²⁾	— ⁽²⁾	—	—	0.1	—	—	0.1	—	—	0.1
Cyprus	[5000]	[100]	41	0.14	4.5	58	0.20	9	61	0.20	10
Czech Republic	5000	100	41	0.14	4.5	58	0.20	9	61	0.20	10
Denmark	— ⁽³⁾	— ⁽³⁾	—	—	—	—	—	—	—	—	—
Estonia	5000	100	41	0.14	4.5	58	0.20	9	61	0.20	10
Finland	[5000]	[100]	41	0.14	4.5	58	0.20	9	61	0.20	10
France	5000 ⁽⁴⁾	100 ⁽⁴⁾	41	0.14	4.5	58	0.20	9	61	0.20	10
Germany	5000	100	41	0.14	4.5	58	0.20	9	61	0.20	10
Greece	5000	100	32 ⁽⁵⁾	0.11 ⁽⁵⁾	2.7 ⁽⁵⁾	45 ⁽⁵⁾	0.15 ⁽⁵⁾	5.4 ⁽⁵⁾	47 ⁽⁵⁾	0.16 ⁽⁵⁾	6 ⁽⁵⁾
Hungary	5000	100	41	0.14	4.5	58	0.20	9	61	0.20	10
Ireland	[5000]	[100]	41	0.14	4.5	58	0.20	9	61	0.20	10
Italy	— ⁽⁶⁾	3 ⁽⁶⁾	6 ⁽⁷⁾	0.02 ⁽⁷⁾	0.1 ⁽⁷⁾	6 ⁽⁷⁾	0.02 ⁽⁷⁾	0.1 ⁽⁷⁾	6 ⁽⁷⁾	0.02 ⁽⁷⁾	0.1 ⁽⁷⁾
Latvia	—	—	—	—	—	—	—	—	—	—	—
Lithuania	500 ⁽⁸⁾	—	—	—	0.1	—	—	0.1	—	—	0.1
Luxembourg	5000 ⁽⁹⁾	100 ⁽⁹⁾	41 ⁽¹⁰⁾	0.14	4.5	58 ⁽¹⁰⁾	0.2	9	61 ⁽¹⁰⁾	0.20	10
Malta	[5000]	[100]	41	0.14	4.5	58	0.20	9	61	0.20	10
Netherlands	— ⁽¹¹⁾	— ⁽¹¹⁾	—	—	—	—	—	—	—	—	—
Poland	1000	75	7	—	0.1	7	—	0.1	7	—	0.1
Portugal	5000	100	41	0.14	4.5	58	0.20	9	61	0.20	10
Romania	5000	100	41	0.14	4.5	58	0.20	9	61	0.20	10
Slovakia	5000	100	41	0.14	4.5	58	0.20	9	61	0.20	10

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	(V/m)	(μ T)	(V/m)	(μ T)	(W/m ²)	(V/m)	(μ T)	(W/m ²)	(V/m)	(μ T)	(W/m ²)
Slovenia	500 ⁽¹²⁾	10 ⁽¹²⁾	13 ⁽¹²⁾	0.04 ⁽¹²⁾	0.45 ⁽¹²⁾	18 ⁽¹²⁾	0.06 ⁽¹²⁾	0.9 ⁽¹²⁾	19 ⁽¹²⁾	0.06 ⁽¹²⁾	1 ⁽¹²⁾
Spain	—	—	41	0.14	4.5	58	0.20	9	61	0.20	10
Sweden	— ⁽¹³⁾	— ⁽¹³⁾	[41]	[0.14]	[4.5]	[58]	[0.20]	[9]	[61]	[0.20]	[10]
United Kingdom	—	—	[41]	[0.14]	[4.5]	[58]	[0.20]	[9]	[61]	[0.20]	[10]
Australia	[5000] ⁽¹⁴⁾	[100] ⁽¹⁴⁾	41	0.14	4.5	58	0.20	9	61	0.20	10
Russia	500	10	—	—	0.1	—	—	0.1	—	—	0.1
Switzerland	—	1 ⁽¹⁵⁾	4 ⁽¹⁶⁾	—	—	6 ⁽¹⁶⁾	—	—	6 ⁽¹⁶⁾	—	—
U.S.A.	— ⁽¹⁷⁾	— ⁽¹⁷⁾	—	—	6	—	—	10	—	—	10

All limits are given as root mean square (rms) value. Where necessary magnetic flux density was calculated from magnetic field strength using a magnetic permeability of $4\pi \times 10^{-7}$ H/m. Normal typeface: reference level for the external field in the meaning of Recommendation 1999/519/EC, derived from basic restriction. Application is mandatory unless value is in square brackets. *Italic typeface*: mandatory exposure limit in terms of the external field outside the body.

Notes:

- 1) Regional regulation; maximum per antenna in Flanders or per site in Brussels: 3.0 V/m at 900 MHz, 4.2 V/m at 1800 MHz, 4.5 V/m at 2100 MHz; maximum per antenna in Wallonia: 3 V/m
- 2) Minimal distances to power lines and to electrical distribution systems, differentiated by voltage; separate regulation for video display units
- 3) For new developments: agreement between local government and electricity sector to examine measures to reduce magnetic fields if average yearly exposure above 0.4 μ T
- 4) For new or modified installations, technical conditions for electricity distribution
- 5) For antenna stations closer than 300 m to "sensitive" locations (schools, kindergartens, hospitals, care homes); elsewhere 35 V/m, 0.11 μ T, 3.1 W/m² at 900 MHz; 49 V/m, 0.16 μ T, 6.3 W/m² at 1800 MHz; 51 V/m, 0.17 μ T, 7 W/m² at 2100 MHz
- 6) For new installations near homes, schools, playgrounds; 10 μ T for existing installations near homes, schools, playgrounds; 1999/519/EC for all other places
- 7) Near homes and their outdoor annexes, in schools and playgrounds, in places with stay greater than 4 hours; elsewhere 20 V/m, 0.06 μ T, 1 W/m²
- 8) Limit inside homes; outside homes 1000 V/m; suburban green zone, roads 10000 V/m; uninhabited 15000 V/m
- 9) Security conditions for electricity lines; there are also voluntary minimal distances to power lines for new developments
- 10) Limit per antenna 3.0 V/m
- 11) Recommendation to local government: create no new situations of long-term stay of children in magnetic flux density greater than 0.4 μ T around power lines
- 12) Applies to homes, hospitals, health resorts, public buildings, tourism buildings, schools, nurseries, playgrounds, parks, recreational areas; otherwise limit for external electric and magnetic field strength equal to reference level in 1999/519/EC; for power frequency limits apply to new or reconstructed sources only
- 13) Reduce exposure radically deviating from natural background when possible at reasonable expense with reasonable consequences
- 14) For continuous exposure; for few hours per day 10000 V/m and 1 mT; for few minutes per day more than 10000 V/m or 1 mT, provided basic restriction is met
- 15) For new installations at places of sensitive use (buildings in which persons stay for longer periods, playgrounds); for existing installations limit for external electric field strength and magnetic flux density as reference level in 1999/519/EC, but optimise order of phases at places of sensitive use
- 16) Limit per location for new and existing antenna installations at places of sensitive use (buildings in which persons stay for longer periods, playgrounds); limit for aggregate exposure from multiple antenna locations equal to reference level in 1999/519/EC
- 17) No federal regulation; limits are set in some states, other states have prudent avoidance policy (measures to reduce exposure of the population at reasonable cost)

Gracias por su atención

Ing. Oscar J. Campastro

Comisión de RNI

www.copitec.org.ar/comisiones/rni/rni.htm

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