BIOLOGICAL AND CANCER SAFETY LIMITS

FOR

ELECTRO-MAGNETIC RADIATION

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4 TABLES BY FREQUENCY

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TABLE	***PAGE***	***FREQUENCY***	***COMMON SOURCES***	***METRIC***	***BIOLOGICAL and CANCER SAFETY LIMITS***	***LOWEST ADVERSE HUMAN EFFECTS***	***HEATING and SHOCK SAFETY LIMITS***
A	2	30-300 Hz Extremely Low Frequency	power lines, domestic wiring, transformers	*Magnetic Field*	0.01 µT to 0.1 µT	0.007 µT	100 µT
B	3	4-100 kHz Low Frequency Voltage Transients	power lines, domestic wiring, energy saving lights	*Magnetic Field*	0.025 µT	…	6.25 µT
				Electrical Field	…	…	87 V/m
				Voltage Transients	50 GS	40 GS	
C	3	300 kHz – 300 MHz Radio Frequency	radio transmitters TV transmitters	*Magnetic Field*	…	…	0.092 µT
				Electrical Field	0.194 V/m	< 0.87 V/m	28 V/m
D	4	0.3 – 300 GHz Microwave Frequency	mobile phones and masts, DECT cordless phones, WiFi, WiMAX	*Electrical Field (peak pulse)*	0.02 V/m to 0.6 V/m	0.05 V/m to 0.06 V/m	41 V/M to 61 V/M

A.	**30-300 Hz** **Extremely Low Frequency**		
power lines, High Voltage Overhead Transmission Lines, domestic wiring, transformers			
1868: electricity linked with adverse health effects at biological levels 1979: power lines linked with childhood leukaemia 1996: 0.2 µT limit, Swedish Advisory bodies 2001: possibly carcinogenic, 2B, International Agency for Research on Cancer 2003: 0.01 µT limit, California Dept. Educat.; 2007: 0.1 µT limit BioInitiative Report			
µT micro Tesla	***source and distance (50/60 Hz,UK/US, unless stated)***	***health effects***	***authority or study***
1. Biological and cancer effects			
0.00005	Schumann waves	human brain entrainment	
0.001		birds detect magnetic changes	Wiltschko 2002
0.002-0.012	background, houses with electricity, UK		(MF levels in US are often higher with 110 volt system)
0.007	rapid change +0.005	fatigue, headaches in some people	
0.01	at 95% loading	proposed limit for schools	California Dept. Educat. 2003
	< 600m from HVOTL	+ 23% risk childhood leukaemia	Draper et al. 2005
0.04		muscular effects in some people	
0.07-.1	intermittent	DNA breaks, dose-response	Ivancsits 2002
0.09	rapid change +0.015	fatigue, headaches, dizziness, immune reaction in some people	
	< 200m from HVOTL	+ 69% risk childhood leukaemia	Draper et al. 2005
0.1	160 m from HVOTL		
0.1	homes and children	biological and cancer safety limit	BioInitiative Report 2007
> 0.1	> 12 years exposure	x 4.8 chronic lymphatic leukaemia	Verkasalo 1996
> 0.1		x 15.9 risk of severe depression	Verkasalo 1997
0.14	< 100 m power lines	DNA repair genes effect,c.ac.Leuk.	Yang 2008
0.2	all other buildings	biological and cancer safety limit	BioInitiative Report 2007
0.2		biological and cancer safety limit	Swedish Advisory Bodies 1996; Veneto, Emilia-Romagna and Tuscana, Italy, new installations 2000; US draft report for EPA 1995
0.2		x 2.7 risk of childhood leukaemia	Feychting & Ahlbom 1993
0.2-0.4		x 2 risk of childhood leukaemia	Wertheimer et al. 1979
> 0.25		x 1.5 risk of all childhood cancers	Olsen et al 1993
0.25	for 5 Hz – 2 kHz		Russian limit
0.3		x 3.8 risk of childhood leukaemia	Feychting & Ahlbom 1993
0.315	av. for 6000 people	increased risk of heart disease	Perry 1988
0.3-0.4		x 2 risk of childhood leukaemia	WHO 2007
	< 50 m for 5 years	x 1.51 risk Alzheimer's, sen.dem.	Huss et al. 2008
	< 50 m for 15 years	x 2.0 risk Alzheimer's, sen.dem.	Huss et al. 2008
0.4	60m 275 kV HVOTL		National Grid (Stoate, 2007)
> 0.4		x 5.6 risk of all childhood cancers	Olsen et al 1993
0.41	10 m electric railway		Electrosmog in the Environment (Swizt. 2005)
1.0	60m 380 kV full load		
1.0	intermittent 50 Hz sinusoidal, for 15hr	x3 micronuclei, x10 chromosomal aberrations, a clastogenic potential	Winker et al 2005
< 1.6		x6 miscarriage	Lee/Li 2002
2. Heating and shock effects			
100		thermal limit, heating & shock	ICNIRP 1998, UK HPA 2004
1600		induced currents, human body	UK 1993, investigation level

B.	**4-100 kHz** Low Frequency **Voltage Transients**				
domestic wiring, power lines, energy saving bulbs, compact fluorescent lights					
1970s: electronic devices producing Voltage Transients or 'dirty electricity' first common 1999: 30% of electricity in US flowing through electronic devices 2002: Professor Martin Graham & David Stetzer design GS Microsurge Meter and filters 2006-08: Voltage Transients at biological levels linked with diabetes and cancer					
µT micro Tesla	***V/m***	***GS units***	***source and distance***	***health effects***	***authority / study***
1. Biological and cancer effects					
		0	most household appliances		
		15-40+	dimmer switch, LCD TV, microwave oven		
		15-2000	compact fluorescent (energy saving) lights		
		25-50	average house		
		27-40		threshold for electro-sensitivity symptoms	Havas 2006, Tel-Oren
		50	maximum for building wiring	biological and cancer safety limit	Dept. of Health, Kazakhstan
0.025			for 2.0-400 kHz	biological safety limit	Russian limit
		> 2000	within building	increased diabetes, asthma, MS	Havas 2006
		> 2000	within classroom	21% increased risk of cancer after 1 year, x3 cancer risk	Milham & Morgan 2008
2. Heating and shock effects					
6.25	87			thermal limit, heating & shock	ICNIRP 1998

C.	**300 kHz – 300 MHz** **Radio Frequency (medium wave, short wave and VHF)** **(including Amplitude Modulated and Frequency Modulated)**			
AM and FM Radio and TV broadcast transmitter stations				
1932: Radio and TV transmissions linked with ill health at biological levels				
µT	***V/m***	***source and distance***	***health effects***	***authority / study***
1. Biological and cancer effects				
	0.194	indoors	biological safety limit	BioInitiative 2007
		<5 miles RF/TV tr.	increased brain tumours	Burch 2005
	0.614	outdoors	biological safety limit	BioInitiative 2007
	0.87-5.5	< 2 km from AM mast	x2 childhood leukaemia	Hocking 1996, Ha 2007
		near short wave transmitter	sleep disturbance	Abelin 1995 (Schwarzenburg)
		FM100MHz transmitters	increased skin, lung cancer	Hallberg et al. 2002 on
	2.2-4.6	AM exposure	x2 adult leukaemia	Dolk et al. 1997
	3.9-6.1	radio and radar	memory & sight impaired	Chiang 1989
2. Heating and shock effects				
0.092	28		thermal limit, heating & shock	ICNIRP 1998

D.	0.3 – 300 GHz Microwave (UHF) and pulsed electrical fields (peak pulse)		
mobile phone masts, mobile phones, DECT cordless phones, radar, WiFi, WiMAX			
1942: pulsed microwaves linked with ill health; 1948: linked with ill health at biological levels			
Volts/ metre	***source and distance***	***health effects***	***authority / study***
1. Biological and cancer effects			
0.00002		threshold of human sensitivity	Kositsky 2001
0.00003	minimum mobile phone operating strength		
0.00006		human EEG altered	Brise 1978
0.002	for 1800 MHz	indoor biological safety limit	Burgerforum 1999 proposed
0.02		indoor biological safety limit	Salzburg Public Health 2002
0.05	GSM 1800	adverse health effects	Eger (Naila study) 2004
0.06		outdoor biological safety limit	Salzburg Public Health 2002; NSW Australia 2001
0.06		electro-sensitivity symptoms in 30% of general population	Bamburger Doctors' appeal (Oberfranken) 2005
0.1-0.7	5 m WiFi public node		Electrosmog in the Environment (Swizt. 2005)
0.2	1m Bluetooth 1mW		
0.194	RF and MF	indoor biological safety limit	BioInitiative interim 2007
0.6		electro-sensitivity symptoms in 95% of general population	Bamburger Doctors' appeal (Oberfranken) 2005
0.6	<400m phone mast	x3 cancer rate	Eger (Naila study) 2004
0.6		biological safety limit	Liechtenstein 2013
0.614	RF and MF	outdoor biological safety limit	BioInitiative interim 2007
0.7	100m from phone mast; 2m WiFi node; 1.5m from DECT base; 1m downloading laptop		BBC1 Panorama 2007, Electrosmog in the Environment (Swizt. 2005)
0.78	Skrunda radar	children's memory, attention, motor function affected	Kolodynski 1996
< 1.0	<350m phone mast	x4 cancer, x10 female cancer	Wolf & Wolf 2004
< 1.0	3G phone mast	cognitive impairment, muscular pains, headaches, dizziness,	Zwamborn 2003
about 1.0-1.5	< 400m phone mast	x3 risk of cancer 10 years	Navarro 2003, Oberfeld 2004, Santini 2002
1.7	0.5m download'g laptop		BBC1 Panorama 2007
4.3-6.1		x10 leukaemia, x6 NHL	Szmigielski 1996
4.3-6.1		nervous system impaired	Dumanski 1974
5.0		decreased sperm count	Adey 1982
6.0	WiFi node maximum, DECT base maximum		
6.1-8.6		micronuclei (aberrant DNA)	Garj-Vrhovac 1999
19	GSM mobile max.output		
2. Heating and shock effects			
41.0	900 MHz	thermal limit, heating & shock	ICNIRP 1998, UK 2004
58.0	1.8 GHz	thermal limit, heating & shock	ICNIRP 1998, UK 2004
61.0	2.45 GHz	thermal limit, heating & shock	ICNIRP 1998, UK 2004
92.0	900 MHz	thermal limit, heating & shock	UK 1993
130.0	1.8 GHz	thermal limit, heating & shock	UK 1993

The international *BioInitiative Report* (2007) was based on an analysis of 2,000 scientific studies.

Michael Bevington, December 2008