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Safety Advice for Electromagnetic Fields (PDF)
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Health Precautions Science

Table of Effects by SAR or Power Density

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Effects by Power Density

Power Density	Reported Biological Effects	References: Primary/(Secondary)
0.00001 μW/m^2	Altered EEG in human subjects	Brise 1978 (Firstenberg, Bevington)
0.0001 μW/m^2	Effects on immune system in mice	Bundyuk 1994 (Firstenberg)
0.0002 μW/m^2	Stimulation of ovulation in chickens	Kondra 1970 (Firstenberg)
0.05 μW/m^2	Effect on cell growth in yeast	Grundler 1992 (Firstenberg)
0.1 μW/m^2	Conditioned “avoidance” reflex in rats	Kositsky 2001 (Firstenberg)
~7 μW/m^2	(0.05V/m) Adverse health effects around GSM 1800	Eger / Naila study (Bevington)
20 μW/m^2	Sleep disorders, abnormal blood pressure, nervousness, weakness, fatigue, limb pain, joint pain, digestive problems, fewer schoolchildren promoted—controlled study near a shortwave transmitter	Altpeter 1995, 1997 (Firstenberg)
20 to 7000μW/m^2	Behavior disorders, increased health problems, and reduced milk yield in cows near TV and cell phone transmission antenna	Loscher W, Kas G 1998 (Lai)
100 μW/m^2	A study of medical complaints of people with long-term exposure in their homes: Over 100 μW/m^2 only 5-6% of the sample (172 people) did not experience adverse health effects.	Oberfranken 2005
600 μW/m^2	Altered EEG, disturbed carbohydrate metabolism, enlarged adrenals, altered adrenal hormone levels, structural changes in liver, spleen, testes, and brain—in white rats and rabbits	Dumanskij 1974 (Firstenberg)
600 μW/m^2	Slowing of the heart, change in EEG in rabbits	Serkyuk, reported in McRee 1980 (Firstenberg)
1 mW/m^2	(0.6V/m) X3 cancer rate at <400m from a phone mast	Eger (Naila study) 2004 (Bevington)
1 to 18 mW/m^2	Decreased life span, impaired reproduction, structural and developmental abnormalities in duckweed plants	Magone 1996 (Firstenberg)
1.3 mW/m^2	Decreased cell growth (human epithelial amnion cells)	Kwee 1997 (Firstenberg)

1.68 – 10.53 mW/m^2	Irreversible infertility in mice after 5 generations of exposure to RFR from "antenna park"	Magras & Xenos, 1997 (Sage, Lai)
1.6 mW/m^2 (0.78V/m)	Skrunda radar (Latvia) affects children's memory, attention, motor function	Kolodynski, 1996 (Sage, Bevington)
<2.7 mW/m^2	(<1V/m) <350m phone mast: x4 cancer, x10 female cancer	Wolf & Wolf 2004 (Bevington)
<2.7 mW/m^2	(<1V/m) 3G phone mast: cognitive impairment, muscular pains, headaches, dizziness,	Zwamborn 2003 (Bevington)
~2.7mW/m^2 to 6.0 mW/m^2	(~1.0-1.5 V/m) < 400m phone mast : x3 risk of cancer 10 years	Navarro 2003, Oberfeld 2004, Santini 2002 (Bevington)
2 - 80 mW/m^2	Two-fold increase in childhood leukemia / RFR exposure to AM/FM towers	Hocking, 1996 (Sage, Lai)
3-16.4 mW/m^2	Children exposed to 154 to 162 MHz had a reduction in memory/attention, motor runction, and reflexes compared to controls	(Santini)
6 mW/m^2	Change in calcium ion efflux from brain tissue	Dutta 1986 (Firstenberg)
6 mW/m^2	Cardiac arrhythmias and sometimes cardiac arrest (frogs)	Frey 1968 (Firstenberg)
8 and 80 mW/m^2	Increased activity of alkaline phosphatase activity in guinea pigs (2375 MHz)	Pashovkina MS et al, 2000 (Lai)
10 mW/m^2	Whole body microwave irradiation of male mice caused a significant effect on the immune system	Fesenko, 1999 (Sage, Lai)
10 mW/m^2	Irradiation (5 hours) with low-power microwaves stimulates the immune potential of macrophages and T cells	Novoselova, 1999 (Sage, Lai)
10 mW/m^2	Headache, dizziness, irritability, fatigue, weakness, insomnia, chest pain, difficulty breathing, indigestion (humans —occupational exposure)	Simonenko 1998 (Firstenberg)
10 mW/m^2	Stimulation of white cells in guinea pigs	Shandala 1978 (Firstenberg)
10 – 24 mW/m^2	Chronic irradiation of American Embassy in Moscow of 600 MHz to 9.5 GHz resulted in increased risk of leukemia and uterine cancer	(Santini)
13 - 57 mW/m^2	Two-fold increase in leukemia in adults from AM RF exposure	Dolk, 1997 (Sage)
20 mW/m^2	"Microwave hearing"—clicking, buzzing, chirping, hissing, or high-pitched tones	Frey 1963, 1969,1971, 1973, 1988, Justeson 1979, Olsen 1980, Wieske 1963, Lin 1978 (Firstenberg)
25 mW/m^2	Breakdown of blood-brain barrier (used a digital cellular phone to provide the radiation)	Salford 1997 (Firstenberg)
-40 mW/m^2	Altered white blood cell activity in schoolchildren	Chiang 1989 (Firstenberg)
~20-40 mW/m^2	Direct effect of RFR on ion channels in cells/opening of acetycholine channels	D'Inzeo, 1988 (Sage)
40-100 mW/m^2	Visual reaction time in children is slowed//lower memory function in tests	Chiang, 1989 (Sage)
~50 – 100 mW/m^2	(4.3-6.1V/m) x10 leukaemia, x6 NHL	Szmigielski 1996 (Bevington)

50 mW/m^2	Exposure of pregnant rats to GSM-like 940 MHz radiation results in aberrant expression of bone morphogenetic proteins in the kidneys of newborn rats	Pyrpasopoulou et al, 2004 (Panagopoulos-Margaritis)
50-1200 mW/m^2	Increased mortality of avian embryos	Xenos and Magras, 2003 (Panagopoulos-Margaritis)
50 mW/m^2	Biochemical and histological changes in liver, heart, kidney, and brain tissue	Belokrinitskiy l982 (Firstenberg)
50 - 100 mW/m^2	Impaired nervous system activity	Dumansky, 1974 (Sage, Bevington)
50 mW/m^2	Leukemia, skin melanoma and bladder cancer near TV and FM transmitter	Dolk 1997 (Firstenberg)
66 mW/m^2	(5V/m) Decreased sperm count	Adey 1982 (Bevington)
100 mW/m^2	Decreased size of litter, increased number of stillborns in mice	Il'Chevich (reported in McRee 1980) (Firstenberg)
100 mW/m^2	Redistribution of metals in the lungs, brain, heart, liver, kidney, muscles, spleen, bones, skin, blood	Shutenko 1981 (Firstenberg)
100 mW/m^2 (0.0027 W/Kg SAR)	Changes in active avoidance conditioned reflex (behavioral change) after 0.5 hour exposure	Navakatikian, 1994 (Sage)
100-200 mW/m^2	Increase in micronuclei (abberant DNA form) found in workers chronically exposed to microwaves at 1250-1350 MHz.	Garaj-Vrhovac, 1999 (Sage, Bevington)
100 - 250 mW/m^2	Changes in the hippocampus of the brain	Belokrinitsky, 1982 (Sage)
200 mW/m^2	900 MHz pulsed with 217 Hz result in slight transient elevation in cortisol production	Mann, K et al 1998 (Lai)
300 mW/m^2 (0.015 W/Kg SAR)	Immune system effects - elevation of PFC count (antibody-producing cells)	Veyret, 1991 (Sage)
500 mW/m^2	An 18% reduction in REM sleep (important to memory and learning functions)	Mann, 1996 (Sage)
1000mW/m^2	Changes in immune system function	Elekes, 1996 (Sage)
1000 mW/m^2 (0.027 W/Kg SAR)	A 24% drop in testosterone after 6 hours exposure	Navakatikian, 1994 (Sage)
10,000.0 mW/m^2	FCC Exposure Limit	(Firstenberg)

Effects By SAR

SAR	Reported Biological Effects	References
0.000021- .0021 W/Kg	Changes in cell cycle and cell proliferation (960 MHz GSM cell phone signal)	Kwee, 1997 (Sage)
0.0004 W/Kg	Cell phone RF caused changes in blood-brain barrier that protects brain from outside harmful chemicals and toxins (915 MHz GSM cell phone)	Salford, 1997 (Sage)
0.0008 W/Kg	Increased DNA strand breaks in rat brain cells	Kesari and Behari, 2009 (Levitt/Lai)
0.0004-0.008 W/Kg	915 MHz cell phone RF caused leakage in bloodbrain barrier. Worst at lowest levels and worse with CW compared to PW with a maximum pathology around 8-50 Hz modulation. 55% of rats exposed to CW but not PW showed significant pathological changes in BBB at at higher SAR of 1.7-8.3 W/Kg	Persson, 1997 (Sage)

0.001 W/Kg	Non-thermal microwave disruption of weak bonds that maintain the active form of protein folding at 750 MHz continuous wave may increase free radicals causing DNA damage and interfere with cell signalling that controls cell growth. HSP effect is equivalent to a 3 degree C. heating of tissue.	de Pomerai, 2000 (Sage)
0.0027 W/Kg	Changes in active avoidance conditioned reflex (behavioral change) after 0.5 hour exposure	Navakatikian, 1994 (Sage)
0.0037 W/Kg	Changes in DNA repair mechanisms	Belyaev et al, 2009 (Levitt/Lai)
0.005 W/Kg	Increased calcium efflux in human neuroblastoma cells.	Dutta et al, 1989 (Levitt/Lai)
0.018-0.025 W/Kg	Increased serum testosterone in rats from GSM-like RFR.	Forgacs et al, 2006 (Levitt/Lai)
0.0024 W/Kg to 0.024 W/Kg	Digital cell phone signals at very low intensities cause DNA effects in human cells. DNA effects are direct DNA damage and the rate at which DNA is repaired.	Phillips, 1998 (Sage)
0.026 W/Kg	Activity of c-jun (oncogene product) was altered in cells after only 20 minutes exposure to cell phone signal (TDMA) showed an average 38% decrease	Ivaschuk, 1997 (Sage)
0.0317 W/Kg	Decrease in eating and drinking	Ray & Behari, 1990 (Sage)
0.3-0.44 W/Kg	Attention function of brain/responses are speeded up	Preece, 2000 Koivisto et al, 2000 (Sage)
0.3-0.44 W/Kg	Cellular phone use results in changes to cognitive thinking/ mental tasks relaqted to memory retrieval	Krause et al, 2000 (Sage)
0.037 W/Kg	Hyperactivity caused by nitric oxide synthase inhibitor is countered by ultra-wide band pulses - 600/sec, 30 min	Seamans, 1999 (Sage)
0.005 to 0.05 W/Kg	Increase in calcium efflux	Dutta et al, 1989 (Sage)
0.121 W/Kg	Cardiovascular system/significant decrease in arterial blood pressure (hypotension)	Lu et al, 1999 (Sage)
0.14 W/Kg	Elevation of immune response at 100 µW/cm2	Elekes, 1996 (Sage)
0.141 W/Kg	Structural changes in testes/smaller diameter of seminiferous tubules in rats exposed to cell phone on speech transmission (but not stand-by mode) with exposure at one minute 3 times per hour for two hours per day for one month	Dasdag, 1999 (Sage)
0.13 - 1.4 W/Kg	Lymphoma cancer rate is 2 times normal with two ½ hour exposures per dy of cell phone RFR for 18 months (pulsed digital mobile phone signal 900 MHz)	Repacholi, 1997 (Sage)
0.26 W/Kg	Harmful effects to the eye/certain drugs can sensitize eyes to RFR	Kues, 1992 (Sage)
0.15-0.4 W/Kg	Statistically significant increase in malignant tumors at 480 µW/cm2	Chou, 1992 (Sage)
0.58 - 0.75 W/Kg	Decrease in brain tumors (836 MHz TDMA digital cell phone signal)	Adey, 1996 (Sage)
to 1.0 W/Kg (max)	Sleep patterns and EEG are changed with 900 MHz cell phone exposure during sleep	Borbely et al, 1999 (Sage)
0.6 and 1.2 W/Kg	Increase in DNA single and double strand breaks from RFR exposure (2450 MHz)	Lai & Singh, 1996 (Sage)
2 - 3 W/Kg	Cancer acceleration in skin and breast tumors	Szmigielski, 1982 (Sage)

References

- **Bioinitiative RF Color Charts**
- **Cindy Sage**
- **Arthur Firstenberg**
- **Dimitris J. Panagopoulos and Lukas H. Margaritis**
- **Blake Levitt and Henry Lai**

For conversion tables, see **conversion formulas**.

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