

Radio Frequency Hazard:

Since the liberalization of the Telecommunication market from 1981, the technology trend is drifting from wired to wireless. The migration from wired to wireless have benefited the mankind on one hand, while the health of the individual has been jeopardized due to the polluted environment around him, in this case the Radio Frequency. The issue of potential hazard has been highlighted and for serious reading links to the world renowned safety organization has been added to quench the thirst. For the ready reference of the reader a table depicting the maximum permissible exposure limits set by FCC, USA has also been annexed.

The telecommunication products being used worldwide by the individuals and industry make use of some form of electromagnetic energy in the shape of radio frequency or 'RF'. RF emission and associated phenomena can be discussed in terms of energy, radiation or fields. Radiation is defined as the propagation of energy through space in the form of waves or particles. Electromagnetic radiation can best be described as waves of electric and magnetic energy moving together i.e., radiating through space. These waves are generated by the movement of electrical charges such as in a conductive metal object or antenna. For example, the alternating movement of charge i.e., current in an antenna used in a cellular base station antenna generates electromagnetic waves that radiate away from the transmit antenna and are then intercepted by a receive antenna integrated into a hand held cellular telephone. The term electromagnetic field is used to indicate the presence of electromagnetic energy at a given location. The RF field can be described in terms of the electric or magnetic field strength at that location.

There are many published reports in the scientific literature concerning possible biological effects resulting from animal or human exposure to RF energy. Biological effects that result from heating of tissues by RF energy are often referred to as thermal effect. It has been known for many years that exposure to high level of RF radiation can be harmful due to ability of RF energy to heat biological tissue rapidly. This is the principle by which microwave ovens cook food, and exposure to very high RF power can clearly result in heating of biological tissue and an increase in body temperature.

Two areas of body, the eyes and testes, are known to be particularly vulnerable to heating by RF energy because of the relative lack of available blood flow to dissipate the excessive heat load (blood circulation in one of the body's major mechanism for coping with excessive heat). Laboratory experiments have shown that short term exposure (e.g., 30 minutes to

one hour) to very high levels of RF radiation (100-200mW/cm²) can cause cataracts in rabbits. Temporary sterility, caused by such effects as changes in sperm count and in sperm motility, is possible after exposure of the testes to high level RF radiation.

In addition to intensity, the frequency of an RF electromagnetic wave can be important in determining how much energy is absorbed and, therefore, the potential for harm. The quantity used to characterize this absorption is called the **specific absorption rate** or **SAR**, and it is usually expressed in units of watt per kilogram or milliwatt per gram. In the far-field of a source of RF energy, whole-body absorption of RF energy by a standing human adult has been shown to occur at a maximum rate when the frequency of the RF radiation is between about 80 and 100 MHz, depending on the size, shape and height of the individual. In other words, the SAR is at a maximum under these conditions. Because of the resonance phenomenon, RF safety standards have taken account of the frequency dependence of whole-body human absorption, and the most restrictive limits on exposures are found in the VHF (Very High Frequency) range.

More recently, scientific laboratories have reported certain biological effects after exposure of animals and animal tissue to relatively low level of RF radiation. These reported effects have included certain changes in the immune system, neurological effects, behavior effects, evidence for a link between microwave exposure and the action of certain drugs and compounds, a 'calcium efflux' effect in brain tissue (exposed under very specific conditions), and effects on DNA.

Exposure standards and guidelines have been developed by various organizations and agencies over the past several decades. In North America and most of Europe exposure standards and guidelines generally based on exposure levels where effects considered harmful to humans occur. Safety factors are then incorporated to arrive at specific levels of exposure to provide sufficient protection for various segments of population.

Not all standards and guidelines throughout the world have recommended the same limits for exposure. For example, some published exposure limits in Russia and some eastern European countries have been generally more restrictive than existing or proposed recommendations for exposure developed in North America and other parts of Europe. This discrepancy may be due, at least in part; to the possibility that these standards were based on exposure levels where it was believed no biological effects of any type would occur. This philosophy is inconsistent with the approach taken by most other standard setting bodies

which base limits on levels where recognized hazard may occur and then incorporate appropriate safety margins to ensure adequate protection.

FCC Limits for Maximum Permissible Exposure (MPE)

(A) 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
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6

(B) 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)	Averaging Time E ² , H ² or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f ²)*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

f = frequency in MHz

*Plane-wave equivalent power density

NOTE 1: Occupational/controlled limits apply in situations in which persons are exposed as a 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 transient 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.

FCC Limits for Localized (Partial-body) Exposure

Specific Absorption Rate (SAR)	
Occupational/Controlled Exposure (100 kHz - 6 GHz)	General Uncontrolled/Exposure (100 kHz - 6 GHz)
< 0.4 W/kg whole-body	< 0.08 W/kg whole-body
≤ 8 W/kg partial-body	≤ 1.6 W/kg partial-body

INTERNET WEB SITES FOR FURTHER INFORMATION

American Radio Relay League: www.arrl.org
 American National Standards Institute: www.ansi.org
 Bioelectromagnetics Society: www.bioelectromagnetics.org
 COST 244 (Europe): www.radio.fer.hr/cost244
 DOD: www.brooks.af.mil/AFRL (select radiofrequency radiation)
 European Bioelectromagnetics Association: www.ebea.org
 Electromagnetic Energy Association: www.elecenergy.com
 Federal Communications Commission: www.fcc.gov/oet/rfsafety
 ICNIRP (Europe): www.icnirp.de
 IEEE: www.ieee.org
 IEEE Committee on Man & Radiation: www.seas.upenn.edu/~kfooster/comar.htm
 International Microwave Power Institute: www.impi.org
 Microwave News: www.microwavenews.com
 J.Moulder, Med.Coll.of Wisc.: www.mcw.edu/gcrc/cop/cell-phone-health-FAQ/toc.html
 National Council on Radiation Protection & Measurements: www.ncrp.com
 NJ Dept Radiation Protection: www.state.nj.us/dep/rpp (select non-ionizing radiation)
 Richard Tell Associates: www.radhaz.com
 US OSHA: www.osha-slc.gov/SLTC (select subject: radiofrequency radiation)
 Wireless Industry (CTIA): www.wow-com.com
 Wireless Industry (PCIA): www.pcia.com
 World Health Organization EMF Project: www.who.ch/peh-emf