

# RF Safety Evaluation for HPWREN licensed links

Todd Hansen \*

May 14, 2003

## 1 Introduction

This document describes the RF safety evaluation that was conducted for HPWREN's licensed links. It also has some additional calculations for theoretical unlicensed links. And finally, it explains some of the equations that were used. This is not an official document and may contain errors. It is only written to explain what was involved in the evaluation. More precise information can be obtained from <http://www.fcc.gov/oet/rfsafety/>. It appears that the RF safety guidelines developed by the FCC (which are updated occasionally) are based on the amount of radiation absorbed by the human body. For example, general human exposure is based on how much radiation would be absorbed over a 30 minute period, while controlled exposure is based on a 6 minute period. In the end, if you don't need to be around an antenna, go somewhere else. And if you do, then maximize your distance from the point of transmission.

Additionally these calculations only apply to certain microwave antennas with small beam patterns. It would be completely different for

different antennas. These calculations only account for someone standing directly in the main beam path of the antenna (which is usually only 1-5 degrees). If you are outside of the main beam path with these antennas the radiation level will be drastically different.

## 2 the Equation

$$Distance(cm) = \frac{\sqrt{\frac{P}{d\pi}}}{\tan \frac{\theta}{2}} \quad (1)$$

Where:

P = radiated power (mW)

d = Power Density from Bulletin 65, Appendix A, Table 1 (1.0 for general population, 5.0 for controlled exposure)  $mW/cm^2$

$\theta$  = the beam width of the antenna (radians or degrees, depending on your calculator)

The above equation gives you distance from the antenna at which the radiated power meets the power density requirements (only for freq > 1.5 GHz) for various populations. Any closer then that location and you will be violating FCC rules regarding exposure. The above equation is derived from the following equations.

$$A(circle) = \pi r^2 \quad (2)$$

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\*High Performance Wireless Research and Education Network, University of California, San Diego, San Diego Supercomputer Center, 9500 Gilman Dr., La Jolla, CA, 92093-0505

$$d = \frac{P}{A} \quad (3) \quad \text{your distance away from the radiation source and minimize your time in the vicinity of the source.}$$

$$\tan \phi = \frac{r}{D} \quad (4)$$

$$\phi = \frac{\theta}{2} \quad (5)$$

Equation (2) is the area of a circle with radius  $r$ . Equation (3) is the density of power distributed evenly over an area. Equation (4) is the relation of two sides of a right triangle when one of the angles is known. In this case, one of those sides represents the radius of the circle we will calculate the area for and the other variable is the distance from the point of origin. And finally, equation (5) is the fact that the beam width  $\theta$  is double the angle needed for the right triangle calculation.

### 3 Results

The calculations in Table 1 do not take into account, side lobes which in some cases (2.4 GHz grids) can be significant. The first calculation in Table 1 is for the MW-SDSC licensed link. The second calculation is for the MS-RM licensed link. The third calculation is for a theoretical 5.8 GHz unlicensed radio with an 8 ft dish at FCC power limit of 53 dBm EIRP. The last calculation is for a similar theoretical setup using a 24 dBi grid in the 2.4 GHz band.

### 4 Conclusions

The data support no conclusions at this time. However, from an old nuclear radiation handbook: There are only two ways to combat radiation sickness. 1) distance 2) time. So maximize

Antenna Beam width ( $\theta$ , degrees)	Power Radiated (P, mW)	Distance (General Public, Meters)	Distance (Controlled, Meters)
1.8	350 mW	6.7	3.0
1.0	350 mW	12.1	5.4
1.6	50 mW	2.9	1.3
8	250 mW	1.3	0.6

Table 1: Safe distance calculations for various transmitters