



Metricom, Inc.
980 University Avenue
Los Gatos, CA, 93030
(Tel) 408-399-8200
(Fax) 408-354-1024

Federal Communications Commission
Maximum Permissible Exposure Assessment
for the
Metricom Ethernet Radio, GNW 24000

In accordance with
FCC REPORT AND ORDER 96-326
Adopted: August 1, 1996

Prepared by David Waitt
Metricom, Inc.

Background:

Metricom has developed the second generation of its Microcellular Data Network (MCDN). In a broad sense this new network operates in a similar fashion to the current Metricom MCDN, (which is used to provide the Ricochet Wireless data service in the metropolitan areas of San Francisco, San Jose, Seattle and Washington D.C.) The most notable difference between the previous MCDN and the new MCDN is the speed of the network.

The network radio is a frequency hopping spread spectrum radio that operates within the 902-928 MHz and the 2.4–2.4835 MHz band. The peak transmit output power of the radio is 1 Watt on each band. The radio is capable of communicating with either Micro-Cellular Data Network (MCDN) microcell radios (GNW 21000) that make up the infrastructure of the MCDN network or Ricochet modems.

MPE Calculations.

The operating environment for the network radio (the top of a utility pole or streetlight) is a fixed, controlled environment. It is reasonable to assume that professional linesmen who work on utility poles and utility workers who work on streetlights will be aware, via their training, of the hazards of RF exposure. However, to yield a worst case analysis, the limits for an uncontrolled environment are used in this document. The definitions of controlled and uncontrolled environments are included below from the FCC Report and Order 96-326:

B. Definitions of Controlled and Uncontrolled Environments

35. The 1992 ANSI/IEEE guidelines specify two sets of exposure limits based on the "environment" in which the exposure takes place. These environments are classified as either "controlled" or "uncontrolled." **Controlled environments are defined as locations where "there is exposure that may be incurred by persons who are aware of the potential for exposure as a concomitant of employment, by other cognizant persons, or as the incidental result of transient passage through areas where analysis shows the exposure levels may be above [the exposure and induced current levels permitted for uncontrolled environment but not those permitted for controlled environments]."** Uncontrolled environments are defined as "locations where there is the exposure of individuals who have no knowledge or control of their exposure. The exposures may occur in living quarters or workplaces where there are no expectations that the exposure levels may exceed [the exposure and induced current levels permitted for uncontrolled environments]."

Duty Cycle correction: Even though the duty cycle of the MCDN Network radio is source-based, to yield a worst case MPE distance, a duty cycle of 100 % is used in the following MPE calculations. From Part 2(d)(2) of the FCC Report and Order 96-326, General Rules and Regulations:

(2) Time-averaging provisions may not be used in determining typical exposure levels for devices intended for use by consumers in general population/uncontrolled environments as defined in 1.1310 of this chapter. **However, "source-based" time-averaging based on an inherent property or duty-cycle of a device is allowed.** An example of this is the determination of exposure from a device that uses digital technology such as a time-division multiple-access (TDMA) scheme for transmission of a signal. In general, maximum average power levels must be used to determine compliance.

Fixed, Uncontrolled Environment:

Spec: 900 MHz: $f(\text{MHz})/1500 \text{ mW/cm}^2 = 902/1500 = .601 \text{ mW/cm}^2$
 2.4 GHz: **1.0 mW/cm²**

$$\text{Exposure (mW/cm}^2\text{)} = \text{Pout (mW)} * \text{Duty Cycle} * (\text{Antenna Gain (as a ratio)} / (4 * \pi * \text{Radius}^2(\text{cm})))$$

Solving the above for Radius, General MPE Calculation

$$\text{Radius} = \sqrt{\frac{\text{Pout (mw)} * \text{Duty Cycle} * (\text{Antenna Gain (as a ratio)})}{\text{Exposure (mW/cm}^2\text{)} * 4 * \pi}}$$

MPE Calculation for two bands

$$\text{Radius} = \sqrt{\frac{(\text{900MHzP(mw)} * \text{900MHzAnt Gain(ratio)}) + (\text{2.4GHzP(mw)} * \text{2.4GHzAnt Gain(ratio)}) * \text{Duty Cycle}}{\text{Exposure (mW/cm}^2\text{)} * 4 * \pi}}$$

$$\text{Radius} = \sqrt{\frac{(\text{900MHz EIRP(mw)} + \text{2.4GHz EIRP(mw)}) * \text{Duty Cycle}}{\text{Exposure (mW/cm}^2\text{)} * 4 * \pi}}$$

$$\text{Radius} = \sqrt{\frac{(\text{Total EIRP (mw)}) * \text{Duty Cycle}}{\text{Exposure (mW/cm}^2\text{)} * 4 * \pi}}$$

2.4 GHz EIRP:

$$\begin{aligned} 2.4 \text{ GHz EIRP} &= \text{Pout (dBm)} + \text{Antenna Gain (dBi)} \\ 27 \text{ dBm} + 15 \text{ dBi} &= 42 \text{ dBm EIRP} = 15848 \text{ mWatts EIRP} \end{aligned}$$

900 MHz EIRP

$$\begin{aligned} \text{EIRP} &= \text{Pout (dBm)} + \text{Antenna Gain (dBi)} \\ 30 \text{ dBm} + 6 \text{ dBi} &= 36 \text{ dBm EIRP} = 4000 \text{ mWatts EIRP} \end{aligned}$$

Total Watts EIRP

$$15848 \text{ mw EIRP} + 4000 \text{ mw EIRP} = 19848 \text{ mWatts EIRP}$$

900MHz & 2.4 GHz Combined MPE Distance Calculation:

(Note: The specification used in the calculation below is 900MHz specification, the lower of the two.)

$$\text{MPE Distance} = \sqrt{\frac{19848 \text{mW} * 1.0}{.601 * 4 * \pi}} \Rightarrow \sqrt{\frac{19848}{7.55}} \Rightarrow 51.27 \text{ cm}$$

$$\text{MPE Distance} = 20.18 \text{ Inches}$$

Conclusion:

The MCDN Ethernet radios are to be located on the top of commercial rooftops, most likely with other RF transmitting equipment. Metricom personnel installing the equipment will be made aware of the dangers of RF exposure via the Metricom Health and Safety program. As part of the Ethernet radio installation, signs warning of the dangers of RF radiation exposure will be installed to alert people who may have access to the rooftop of the danger.

Table 1. Limits for Maximum Permissible Exposure (MPE)

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (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

f = frequency in MHz

* = Plane-wave equivalent power density

(B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (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 TO TABLE 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 TO TABLE 1: 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.