RF Exposure Technical Brief

This Technical Brief calculates the minimum separation distance from an antenna, connected to the subject base station, such that the power density values listed in RSS-102, Radio Frequency (RF) Exposure Compliance of Radiocommunications Apparatus (All Frequency Bands) Table 4.2 and Table 4.4 are not exceeded. The analysis is for a typical installation using a structure mounted antenna.

Within the frequency range that the subject equipment operates, the maximum permitted exposure limit for uncontrolled environments is a power density of f/150 (W/m^2), where "f" is the frequency expressed in MHz, and measurements are averaged over a period of 6 minutes. The maximum permitted exposure limit for controlled environments is f/30 W/m^2, with measurements averaged over 6 minutes. For the above limits the lowest operating frequency of the equipment will be used for the calculations because minimizing f results in the largest separation distance. Table 1 lists the maximum permitted exposure limits by environment type for the lowest operating frequency of the equipment.

Table 1 - Maximum Permissible Exposure Limits

	Uncontrolled Environment	Controlled Environment
Frequency	935 MHz	935 MHz
Limit	6.23 W/m^2	31.2 W/m^2

Example Calculations for GTR8000, 900 MHz Band Transmitter:

The example configuration is a single frequency site, with no RF network losses between the transmitter output connector and the antenna input connector. The antenna is an omni directional type with the largest dimension of the antenna mounted in a vertical orientation. The antenna gain was selected to realize a short antenna length which results in a higher power density over the analyzed surface area. This configuration results in a conservative separation distance, i.e., larger distance.

Table 2 - Transmitter Configuration

Frequency	935 MHz
Base Station Output Power	120 W
RF Network Loss	0 dB
Antenna Type RFS P-1108-3	6 dBd / 8.14 dBi (Omni)
Antenna height	1.66 m

Using Equation 1 the spatially averaged plane-wave equivalent power densities parallel to the antenna may be estimated by dividing the net input power to the antenna by the surface area of an imaginary cylinder at a distance *R* from the antenna, with the height of the cylinder equal to the length of the antenna[1].

[1] Federal Communications Commission Office of Engineering & Technology, OET Bulletin 65, “Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields”, Edition 97-01, page 32, Tell’s cylindrical model.

$$S = \frac{Pnet}{2\pi Rh} \tag{1}$$

Where:

S = power density, W/m2

Pnet = net input power to the antenna, W

R = radial distance from the antenna, m

h = height of the antenna, m

The minimum separation distance can be found by solving Equation 1 for *R* and setting *S* to the maximum power density for the environment per Table 1.

Uncontrolled environment:

$$R = \frac{Pnet}{2\pi hS} = \frac{120}{2\pi \times 1.66 \times 6.23} = 1.9 \text{ m} \tag{2}$$

Controlled environment:

$$R = \frac{Pnet}{2\pi hS} = \frac{120}{2\pi \times 1.66 \times 31.2} = 0.4 \text{ m} \tag{3}$$

For the example site configuration the minimum separation distance for an uncontrolled environment is 1.9 m and the minimum separation distance for the controlled environment is 0.4 m.