Baron Services, Inc.
FCC ID NX5XDD-250C
731 Confirmation Number: EA99418

Response to question #3
Correspondence Reference Number: 18434

Compliance with the RF Exposure Limitations under Section 1.1310

Peak power = 250 KW.
Pulse width = 2 microseconds.
PRF = 250 Hz
P = average power = 125 W
λ = 5.6 cm (C-Band wavelength)
D = antenna diameter = 240 cm (8')
η = antenna aperture efficiency = 0.55 (thus gain = 9970 or 40 dB)

Given that the above parameters are fixed, then power density is a function of range and location with regard to the axis of the main beam. The power density is greatest along the axis of main beam, so all calculations will be made for this condition.

Three different methods are used to estimate power density, depending on whether the point of interest is in the near-field region, the transition region, or the far-field region. For λ = 5.6, the near-field region starts at the antenna and extends to about 26 m (85 ft). The transition region starts at 26 m and extends to about 62 m (200 ft). Beyond this distance is the far-field region.

Within the near-field region, the power density can reach a maximum of 6.1 mw/cm^2.

The power density decreases inversely with distance from the antenna within the transition region. At the start of the transition region, the power density is 6.1 mw/cm^2. Near the end, (about 200 ft), the power density is 2.6 mw/cm^2.

Beyond 62 m (200 ft), the power density can be calculated using the following:

$$S = PG \;/\; (4 \pi R^2) \qquad (1)$$

where S is power density, P is power, G is antenna gain and R is distance from antenna.

Rearranging equation (1), we can solve for the distance at which the power density is below the FCC uncontrolled exposure limit of 1 mw/cm^2. This distance is about 100 m or 328 ft.

If the point of interest is beyond 328 ft, then the power density is such that it is below the uncontrolled exposure limit. **This is even if the point of interest remains on-axis at all times because the antenna is not turning.** At around 1000 ft, it is about 10 times below the limit.

If the point of interest is at least one antenna diameter (8 ft) off-axis in the near-field or transition region, then the power density at that point is at least a factor of 100 less than the values calculated above. To be conservative, the tower height should be such that the main beam is over 10 m above ground at 100 m distance when the main beam is pointing 2 degrees below the horizon. Therefore the tower should be at least 10 + 3.5 + 2.4 = 15.9 m (55 ft) high. Then all points along the ground (near-field distance included) will have power densities below the FCC uncontrolled limit.

One thing we have not considered is that exposure limits may be time averaged - over a 6 minute period for the controlled limit and over a 30 minute period for the uncontrolled limit. The fact that the antenna is moving and a fixed point of interest is on-axis for only a brief point of time greatly reduces the average power density. Thus **all** points of interest not on the antenna surface are below both exposure limits when the antenna is turning.

In conclusion, a radar system with the above characteristics can be well within compliance with FCC uncontrolled exposure limit guidelines by mounting the antenna 55 ft or higher above any occupied areas within 328 feet of the antenna. Since these systems are usually located in unoccupied areas and on towers more than 55 feet, we do not feel a warning statement is necessary.

Ted Simmons
Radar Engineer

Reference

[1] Cleveland Jr., R.F., D.M. Sylvar and J.L. Ulcek. "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", OET Bulletin 65, Edition 97-01. August 1997. FCC, Office of Engineering and Technology, Washington DC 20554. Online at http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf.