INTRODUCTION

The FCC adopted new guidelines and procedures in 1996 for evaluating environmental effects of radio frequency (RF) emissions. In order to provide assistance in determining whether proposed or existing transmitting facilities comply with the new guidelines, the FCC Office of Engineering and Technology revised OET Bulletin 65. The revised version updates limits for Maximum Permissible Exposure (MPE) in terms of electric and magnetic field strength and power density for transmitters operating at frequencies between 300 kHz and 100 GHz. This bulletin was adopted by the FCC in their General Docket No. 97-303 on August 25, 1997. In order to comply with the requirements of the Report and Order, calculations to determine the power flux densities in the far field, near field, and reflector regions of the earth station antenna have been made and are contained in this study.

The FCC guidelines incorporate two separate tiers of exposure limits that are dependent on the situation in which the exposure takes place and the status of the individuals who are subject to exposure. The earth station transmitting equipment and antenna are located within a controlled area and not accessible to the general public. Entry is restricted to employees who have been made fully aware of the potential for human exposure and can exercise control over their exposure. Therefore occupational / controlled exposure maximum power density limits are used in this study.

The FCC Office of Engineering and Technology suggests a method for calculating the maximum values of the power densities emanating from an aperture antenna in OET bulletin 65. This method is used to determine the power densities associated with the satellite antenna.

The General Dynamics Cassegrain Ka-Band satellite antenna will be equipped with an amplifier supplying a maximum output power, *P*, at the antenna flange of *P*= 280 Watts. The transmitter will feed the antenna with diameter *D* = 9.2 meters. Its efficiency is η=0.65. The highest frequency of the transmitted signal is 30,000 MHz, corresponding to a wavelength of λ = 0.01 m. Its peak gain is *G* = 66.6 dBi, and the radius of the feed horn is R_{feed} = 2.5 cm

Antenna Surface: The maximum power density at the antenna surface, $S_{surface}$ may be expressed as:

$$S_{surface} = \frac{4P}{A}$$

Using the parameters for the antenna:

$$\begin{aligned} A &= (\pi (D / 2)^2) \\ &= (\pi (9.2\ m / 2)^2) \\ &= 66.5\ m^2 \end{aligned}$$

$S_{surface}$ = 4 (280 W) / 66.5 m ^{2}
= 1120 W / 66.5 m ^{2}
= 16.8 W / m ^{2}
= 1.7 mW / cm ^{2}

Near- Field Region: In the near field of the main beam the power density can reach a maximum before it begins to decrease with distance. The extent of the near field, R_{nf} , can be described by the following equation:

$$R_{nf} = \frac{D^2}{4\lambda}$$

Using the parameters for this antenna:

R_{nf} = (9.2 m) ^{2} / 4(0.01 m)
= 84.6 / .04 m
= 2117.5 m

The magnitude of the on axis power density varies according to location in the near field. However, the maximum value of the near field, on axis, power density, S_{nf} , can be expressed by the following equation:

$$S_{nf} = \frac{16\eta P}{\pi D^2}$$

Using the parameters for this antenna:

S_{nf} = 16 (.65) (280 W) / π (9.2 m) ^{2}
= 2912 W / 265.9 m ^{2}
= 11.0 W / m ^{2}
= 1.1 mW / cm ^{2}

Far Field Region: For purposes of evaluating RF exposure, the distance to the beginning of the far field region, R_{ff} , can be approximated by the following equation:

$$R_{ff} = \frac{0.6D^2}{\lambda}$$

Using the parameters for this antenna:

R_{ff} = 0.6 (9.2 m) ^{2} / .01 m
= 5081.9 m

The power density in the far field region of the antenna pattern decreases inversely as the square of the distance. The on-axis power density, S_{ff} , in the far field region of the radiation pattern can be estimated by the equation:

$$S_{ff} = PG / 4\pi R^2$$

where *R* = distance to the point of interest

Using the parameters for this antenna, the maximum power in the far field, at *R* = 5081.9 m is:

S_{ff} = 280 W ($10^{(66.6\ \text{dBi}/10)}$) / 4 ($\pi$) (5081.9) ^{2}
= 2582617 /62406.2
= 1279846931 W / 324537419 m ^{2}
= 3.9 W / m ^{2}
= 0.4 mW / cm ^{2}

Region between Feed and Reflector: The RF energy radiated from the feed system is confined to a conical shape whose vertex is located at the feed subreflector and extends reflector surface. The power density at any point in this region, S_{feed}, is expressed by the equation:

$$S_{feed} = P/A_{feed}$$

where A_{feed} is the area of the feed subreflector:

$$A_{feed} = \pi R^2_{feed}$$

Using the parameters for this antenna, the power density is:

$$S_{feed} = 280 / (\pi (0.025)^2)$$
$$= 280/ 0.0019635$$
$$= 142602.8 \text{ W/m}^2$$
$$= 14260.3 \text{ mW / cm}^2$$

CONCLUSION

The results of the above calculations are summarized in the following table.

Region	Power Density	Remarks
Antenna Surface	1.7 mW/cm²	Safe Level
Reflector and Feed Region	14260 mW/cm²	**Hazardous**
Near Field **<** 2118 meters	1.1 mW/cm²	Safe Level
Far Field > 5082 meters	0.4 mW/cm²	Safe Level

Results of this hazard study indicate that the antenna does not exceed the 5 mW/cm² MPE limit for Occupational/Controlled Exposure in the 1500 – 100,000 MHz range in areas directly in front of the antenna in the near field, far field, and at the antenna surface. The region between the reflector and the feed horn exceeds the limit. To ensure there is no harmful exposure to personnel, they will not be in contact with this region while the antenna is operating. Whenever they are required to work on the radiating or reflecting parts of the antenna structure, the transmitter will be turned off.

Based on this study of predicted radio frequency levels, the conclusion is that the operation of this satellite earth station meets OET Bulletin 65 maximum permissible exposure limits and that no harmful effects will occur to station personnel or anyone within proximity of the station.

Therefore, in accordance with 47 CFR § 1.1307 (b) of the Commission's Rules, preparation and submission of an Environmental Assessment (EA) is not required.