

EXHIBIT *B*

Microwave Antenna Radiation Hazards Analysis

ANALYSIS OF NON-IONIZING RADIATION
FOR A 4.1 METER EARTH STATION

This report analyzes the non-ionizing radiation levels for a 4.1 meter earth station. The Office of Engineering and Technology Bulletin, No. 65, Edition 97-01, specifies that there are two separate tiers of exposure limits that are dependent on the situation in which exposure takes place and/or the status of the individuals who are subject to the exposure. The Maximum Permissible Exposure (MPE) limit for persons in a Uncontrolled/Public environment to non-ionizing radiation over a thirty minute period is a power density equal to 1 mW/cm**2 (one milliwatts per centimeter squared). The Maximum Permissible Exposure (MPE) limit for persons in a Controlled/Occupational environment to non-ionizing radiation over a six minute period is a power density equal to 5 mW/cm**2 (five milliwatts per centimeter squared). It is the purpose of this report to determine the power flux densities of the earth station in the far field, near field, transition region, between the subreflector and main reflector surface, at the main reflector surface, and between the antenna edge and the ground.

The following parameters were used to calculate the various power flux densities for this earth station:

| | | | |
|------------------------------------|---|----------------------|----------------|
| Antenna Diameter, (D) | = | 4.1 meters | |
| Antenna surface area, (Sa) | = | $\pi (D^{**2}) / 4$ | = 13.20 m**2 |
| Feed Flange Diameter, (Df) | = | 18.1 cm | |
| Area of Feed Flange, (Fa) | = | $\pi (Df^{**2}) / 4$ | = 257.30 cm**2 |
| Wavelength at 6.1750 GHz, (lambda) | | | = 0.049 meters |
| Transmit Power at Flange, (P) | = | 80.00 Watts | |
| Antenna Gain, (Ges) | | Antenna Gain at | = 3.890E+04 |
| | | 6.1750 GHz | = 45.9 dBi |
| | | Converted to a Power | |
| | | Ratio Given By: | |
| | | AntiLog (45.9 / 10) | |
| pi, (pi) | = | 3.1415927 | |
| Antenna aperture efficiency, (n) | = | 0.55 | |

1. Far Field Calculations

The distance to the beginning of the far field region can be found by the following equation: (1)

$$\begin{aligned} \text{Distance to the Far Field Region, (Rf)} &= 0.60(D^{**2}) / \text{lambda} \\ &= 207.6 \text{ m} \end{aligned}$$

(1) Federal Communications Commission, Office of Engineering & Technology, Bulletin No. 65, pp. 17 & 18.

The maximum main beam power density in the far field can be calculated as follows: (1)

$$\begin{aligned}\text{On-Axis Power Density in the Far Field, } (W_f) &= \frac{(G_{ES}) (P)}{4(\pi)(R_f^{**2})} \\ &= 5.75 \text{ W/m}^{**2} \\ &= 0.57 \text{ mW/cm}^{**2}\end{aligned}$$

2. Near Field Calculation

Power flux density is considered to be at a maximum value throughout the entire length of the defined region. The region is contained within a cylindrical volume having the same diameter as the antenna. Past the extent of the near field region the power density decreases with distance from the transmitting antenna.

The distance to the end of the near field can be determined by the following equation: (1)

$$\text{Extent of near field, } (R_n) = D^{**2} / 4(\lambda) = 86.50 \text{ m}$$

The maximum power density in the near field is determined by: (1)

$$\begin{aligned}\text{Near field Power Density, } (W_n) &= \frac{16.0(n)P}{\pi(D^{**2})} \text{ mW/cm}^{**2} \\ &= 13.33 \text{ W/m}^{**2} \\ &= 1.33 \text{ mW/cm}^{**2}\end{aligned}$$

3. Transition Region Calculations

The transition region is located between the near and far field regions. As stated above, the power density begins to decrease with distance in the transition region. While the power density decreases inversely with distance in the transition region, the power density decreases inversely with the square of the distance in the far field region. The maximum power density in the transition region will not exceed that calculated for the near field region. The power density in the near field region, as shown above, will not exceed 1.33 mW/cm^{**2}.

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4. Region Between Feed Flange and Reflector

Transmissions from the feed horn are directed toward the reflector surface, and are confined within a conical shape defined by the feed. The energy between the feed and reflector surface can be calculated by determining the power density at the feed flange. This can be accomplished as follows:

$$\begin{aligned} \text{Power Density at Feed Flange, } (W_f) &= 2(P) / F_a \\ &= 621.83 \text{ mW/cm}^2 \end{aligned}$$

5. Main Reflector Region

The power density in the main reflector region is determined in the same manner as the power density at the feed flange, above, but the area is now the area of the reflector aperture:

$$\begin{aligned} \text{Power Density at Reflector Surface, } (W_s) &= (2(P) / S_a) \\ &= 12.12 \text{ W/m}^2 \\ &= 1.21 \text{ mW/cm}^2 \end{aligned}$$

6. Region between Reflector and Ground

Assuming uniform illumination of the reflector surface, the power density between the antenna and ground can be calculated as follows:

$$\begin{aligned} \text{Power density between Reflector and Ground, } (W_g) &= (P / S_a) \\ &= 6.06 \text{ W/m}^2 \\ &= 0.61 \text{ mW/cm}^2 \end{aligned}$$

Table 1

Summary of Expected Radiation Levels

Based on (5 mW/cm**2) MPE for Controlled Environment

| <u>Region</u> | <u>Calculated Maximum Radiation Level (mW/cm**2)</u> | | <u>Hazard Assessment</u> |
|--|--|--------|--------------------------|
| 1. Far Field, (Rf)= | 207.6 | m 0.57 | SATISFIES ANSI |
| 2. Near Field, (Rn)= | 86.50 | m 1.33 | SATISFIES ANSI |
| 3. Transition Region, (Rt) Rn < Rt < Rf | | 1.33 | SATISFIES ANSI |
| 4. Between Reflector and feed | | 621.83 | POTENTIAL HAZARD |
| 5. Reflector Surface | | 1.21 | SATISFIES ANSI |
| 6. Between Antenna and Ground | | 0.61 | SATISFIES ANSI |

It is the applicants responsibility to ensure that the public and operational personnel are not exposed to harmful levels of radiation.

Table 2

Summary of Expected Radiation Levels

Based on (1 mW/cm**2) MPE for Uncontrolled Environment

| <u>Region</u> | <u>Calculated Maximum Radiation Level (mW/cm**2)</u> | | <u>Hazard Assessment</u> | |
|--|--|---|--------------------------|------------------|
| 1. Far Field, (Rf)= | 207.6 | m | 0.57 | SATISFIES ANSI |
| 2. Near Field, (Rn)= | 86.50 | m | 1.33 | POTENTIAL HAZARD |
| 3. Transition Region, (Rt) Rn < Rt < Rf | | | 1.33 | POTENTIAL HAZARD |
| 4. Between Reflector and feed | | | 621.83 | POTENTIAL HAZARD |
| 5. Reflector Surface | | | 1.21 | POTENTIAL HAZARD |
| 6. Between Antenna and Ground | | | 0.61 | SATISFIES ANSI |

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RADIATION HAZARD STUDY