

EXHIBIT B

RADIATION HAZARD ANALYSIS AND REPORT

This exhibit contains a report of the analysis of the radio frequency (RF) hazard present during the operation of the proposed radio and antenna systems.

The test hub facility will utilize a Channel Master Model 180Tx 1.8 m earth station antenna and a 2 watt power amplifier.

The VSAT antennas at the test locations will be a 0.76 m Patriot Model TX-76Ku and will also utilize a 2 watt power amplifier.

Note that while for the purposes of this radiation hazard analysis the full 2 watt power output of the transmitter has been considered, when transmitting, the 0.76 m antenna will operate in a burst mode with a duty cycle of much less than 10%.

Analysis of Non-Ionizing Radiation for a 1.8 m Earth Station System

This report analyzes the non-ionizing radiation levels for a 1.8 m earth station system. The analysis and calculations performed in this report are in compliance with the methods described in the FCC Office of Engineering and Technology Bulletin No. 65.

Bulletin No. 65 specifies that there are two separate tiers of exposure limits that are dependant upon the situation in which the exposure takes place and/or the status of the individuals who are subject to the exposure. The two tiers are General Population / Uncontrolled environment, and an Occupational / Controlled environment.

The applicable exposure limit for the General Population / Uncontrolled environment at this frequency of operation is 1 mW/cm².

The applicable exposure limit for the Occupational / Controlled environment at this frequency of operation is 5 mW/cm².

Definition of terms

The terms are used in the formulas here are defined as follows:

S_{surface} = maximum power density at the antenna surface

S_{nf} = maximum near-field power density

S_{t} = power density in the transition region

S_{ff} = power density (on axis)

R_{nf} = extent of near-field

R_{ff} = distance to the beginning of the far-field

R = distance to point of interest

$P = 2 \text{ W}$ power fed to the antenna in Watts

$A = 2.545 \text{ m}^2$ physical area of the aperture antenna

$G = 4.696 \times 10^4$ power gain relative to an isotropic radiator

$D = 1.8 \text{ m}$ diameter of antenna in meters

$F = 14,250$ frequency in MHz

$\lambda = 0.021 \text{ m}$ wavelength in meters ($300/F_{\text{MHz}}$)

$\eta = 0.65$ aperture efficiency

Antenna Surface. The maximum power density directly in front of an antenna (e.g., at the antenna surface) can be approximated by the following equation:

$$\begin{aligned} S_{\text{surface}} &= (4 * P) / A \\ &= (4 * 2) / 2.545 \text{ m}^2 \\ &= 3.14 \text{ W/m}^2 \\ &= 0.314 \text{ mW/cm}^2 \end{aligned}$$

Near Field Region. In the near-field or Fresnel region, of the main beam, the power density can reach a maximum before it begins to decrease with distance. The extent of the near field can be described by the following equation (**D** and λ in same units):

$$\begin{aligned} R_{\text{nf}} &= D^2 / (4 * \lambda) \\ &= 1.8^2 / (4 * 0.021) \\ &= 38.502 \text{ m} \end{aligned}$$

The magnitude of the on-axis (main beam) power density varies according to location in the near field. However, the maximum value of the near-field, on-axis, power density can be expressed by the following equation:

$$\begin{aligned} S_{\text{nf}} &= (16 * \eta * P) / (\pi * D^2) \\ &= (16 * 0.65 * 2) / (\pi * 1.8^2) \\ &= 2.04 \text{ W/m}^2 \\ &= 0.204 \text{ mW/cm}^2 \end{aligned}$$

Far-Field Region. The power density in the far-field or Fraunhofer region of the antenna pattern decreases inversely as the square of the distance. The distance to the start of the far field can be calculated by the following equation:

$$\begin{aligned} R_{\text{ff}} &= (0.6 * D^2) / \lambda \\ &= (0.6 * 1.8^2) / 0.021 \\ &= 92.404 \text{ m} \end{aligned}$$

The power density at the start of the far-field region of the radiation pattern can be estimated by the equation:

$$\begin{aligned} S_{ff} &= (P * G) / (4 * \pi * R_{ff}^2) \\ &= (2 * 4.696 \times 10^4) / (4 * \pi * 92.404^2) \\ &= 0.88 \text{ W/m}^2 \\ &= 0.088 \text{ mW/cm}^2 \end{aligned}$$

Transition Region. Power density in the transition region decreases inversely with distance from the antenna, while power density in the far field (Fraunhofer region) of the antenna decreases inversely with the *square* of the distance. The transition region will then be the region extending from R_{nf} to R_{ff} . If the location of interest falls within this transition region, the on-axis power density can be determined from the following equation:

$$\begin{aligned} S_t &= (S_{nf} * R_{nf}) / R \\ &= (0.204 * 38.502) / R \\ &= (7.868 \text{ m} * \text{mW/cm}^2) / R \end{aligned} \quad \text{where } R \text{ is the location of interest in meters}$$

Summary of expected radiation levels for an Uncontrolled environment

<u>Region</u>	<u>Maximum Power Density</u>	<u>Hazard Assessment</u>
Far field (R_{ff}) = 92.404 m	0.088 mW/cm ²	Satisfies FCC MPE
Near field (R_{nf}) = 38.502 m	0.204 mW/cm ²	Satisfies FCC MPE
Transition region (R_t) (R_t) = $R_{nf} < R_t < R_{ff}$	0.204 mW/cm ²	Satisfies FCC MPE
Main Reflector Surface ($S_{surface}$)	0.314 mW/cm ²	Satisfies FCC MPE

Summary of expected radiation levels for a Controlled environment

<u>Region</u>	<u>Maximum Power Density</u>	<u>Hazard Assessment</u>
Far field (R_{ff}) = 92.404 m	0.088 mW/cm ²	Satisfies FCC MPE
Near field (R_{nf}) = 38.502 m	0.204 mW/cm ²	Satisfies FCC MPE
Transition region (R_t) (R_t) = $R_{nf} < R_t < R_{ff}$	0.204 mW/cm ²	Satisfies FCC MPE
Main Reflector Surface ($S_{surface}$)	0.314 mW/cm ²	Satisfies FCC MPE

Conclusions

Based on the above analysis it is concluded that harmful radiation levels will not exist in regions normally occupied by the public.

Analysis of Non-Ionizing Radiation for a 0.75 m Earth Station System

This report analyzes the non-ionizing radiation levels for a 0.75 m earth station system. The analysis and calculations performed in this report are in compliance with the methods described in the FCC Office of Engineering and Technology Bulletin No. 65.

Bulletin No. 65 specifies that there are two separate tiers of exposure limits that are dependant upon the situation in which the exposure takes place and/or the status of the individuals who are subject to the exposure. The two tiers are General Population / Uncontrolled environment, and an Occupational / Controlled environment.

The applicable exposure limit for the General Population / Uncontrolled environment at this frequency of operation is 1 mW/cm².

The applicable exposure limit for the Occupational / Controlled environment at this frequency of operation is 5 mW/cm².

Definition of terms

The terms are used in the formulas here are defined as follows:

S_{surface} = maximum power density at the antenna surface

S_{nf} = maximum near-field power density

S_{t} = power density in the transition region

S_{ff} = power density (on axis)

R_{nf} = extent of near-field

R_{ff} = distance to the beginning of the far-field

R = distance to point of interest

$P = 2 \text{ W}$ power fed to the antenna in Watts

$A = 0.442 \text{ m}^2$ physical area of the aperture antenna

$G = 8.153 \times 10^3$ power gain relative to an isotropic radiator

$D = 0.75 \text{ m}$ diameter of antenna in meters

$F = 14,250$ frequency in MHz

$\lambda = 0.021 \text{ m}$ wavelength in meters ($300/F_{\text{MHz}}$)

$\eta = 0.65$ aperture efficiency

Antenna Surface. The maximum power density directly in front of an antenna (e.g., at the antenna surface) can be approximated by the following equation:

$$\begin{aligned} S_{\text{surface}} &= (4 * P) / A \\ &= (4 * 2) / 0.442 \text{ m}^2 \\ &= 18.11 \text{ W/m}^2 \\ &= 1.811 \text{ mW/cm}^2 \end{aligned}$$

Near Field Region. In the near-field or Fresnel region, of the main beam, the power density can reach a maximum before it begins to decrease with distance. The extent of the near field can be described by the following equation (**D** and λ in same units):

$$\begin{aligned} R_{\text{nf}} &= D^2 / (4 * \lambda) \\ &= 0.75^2 / (4 * 0.021) \\ &= 6.684 \text{ m} \end{aligned}$$

The magnitude of the on-axis (main beam) power density varies according to location in the near field. However, the maximum value of the near-field, on-axis, power density can be expressed by the following equation:

$$\begin{aligned} S_{\text{nf}} &= (16 * \eta * P) / (\pi * D^2) \\ &= (16 * 0.65 * 2) / (\pi * 0.75^2) \\ &= 11.77 \text{ W/m}^2 \\ &= 1.177 \text{ mW/cm}^2 \end{aligned}$$

Far-Field Region. The power density in the far-field or Fraunhofer region of the antenna pattern decreases inversely as the square of the distance. The distance to the start of the far field can be calculated by the following equation:

$$\begin{aligned} R_{\text{ff}} &= (0.6 * D^2) / \lambda \\ &= (0.6 * 0.75^2) / 0.021 \\ &= 16.042 \text{ m} \end{aligned}$$

The power density at the start of the far-field region of the radiation pattern can be estimated by the equation:

$$\begin{aligned} S_{ff} &= (P * G) / (4 * \pi * R_{ff}^2) \\ &= (2 * 8.153 \times 10^3) / (4 * \pi * 16.042^2) \\ &= 5.04 \text{ W/m}^2 \\ &= 0.504 \text{ mW/cm}^2 \end{aligned}$$

Transition Region. Power density in the transition region decreases inversely with distance from the antenna, while power density in the far field (Fraunhofer region) of the antenna decreases inversely with the *square* of the distance. The transition region will then be the region extending from R_{nf} to R_{ff} . If the location of interest falls within this transition region, the on-axis power density can be determined from the following equation:

$$\begin{aligned} S_t &= (S_{nf} * R_{nf}) / R \\ &= (1.177 * 6.584) / R \\ &= (7.868 \text{ m} * \text{mW/cm}^2) / R \end{aligned} \quad \text{where } R \text{ is the location of interest in meters}$$

Summary of expected radiation levels for an Uncontrolled environment

<u>Region</u>	<u>Maximum Power Density</u>	<u>Hazard Assessment</u>
Far field (R_{ff}) = 16.042 m	0.504 mW/cm ²	Satisfies FCC MPE
Near field (R_{nf}) = 6.684 m	1.177 mW/cm ²	Potential Hazard
Transition region (R_t) (R_t) = $R_{nf} < R_t < R_{ff}$	1.177 mW/cm ²	Potential Hazard
Main Reflector Surface ($S_{surface}$)	1.811 mW/cm ²	Potential Hazard

Note, power density level in the area between the feed and the reflector surface is greater than the reflector surface and is assumed to be a potential hazard.

Summary of expected radiation levels for a Controlled environment

<u>Region</u>	<u>Maximum Power Density</u>	<u>Hazard Assessment</u>
Far field (R_{ff}) = 16.042 m	0.504 mW/cm ²	Satisfies FCC MPE
Near field (R_{nf}) = 6.684 m	1.177 mW/cm ²	Satisfies FCC MPE
Transition region (R_t) (R_t) = $R_{nf} < R_t < R_{ff}$	1.177 mW/cm ²	Satisfies FCC MPE
Main Reflector Surface ($S_{surface}$)	1.811 mW/cm ²	Satisfies FCC MPE

Note, power density level in the area between the feed and the reflector surface is greater than the reflector surface and is assumed to be a potential hazard.

Conclusions

The proposed earth station system will be located in a roof mount environment with controlled access and will be serviced by trained personnel. Based on the above analysis it is concluded that harmful radiation levels will not exist in regions normally occupied by the public. The earth station's transmitter will be turned off during antenna maintenance so that the FCC MPE limit of 5 mW/cm² will be complied with for those regions with close proximity to the reflector that exceed acceptable levels.