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 system.

The hub facility will utilize an Andrew 3.7 m earth station antenna and a 200 watt power amplifier.

While the radiation hazard analysis for the hub antenna was conducted using the full output power of the power amplifier, it should be noted that in actual operation the output power will typically be reduced by several dB.

Analysis of Non-Ionizing Radiation for a 3.7 m Earth Station System

This report analyzes the non-ionizing radiation levels for a 3.7 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/cm^2.

The applicable exposure limit for the Occupational / Controlled environment at this frequency of operation is 5 mW/cm^2.

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

Pa = 200 W	power amplifier maximum output in Watts
Lfs = 0.45 dB	loss between amplifier and antenna input in dB
P = 180.314 W	power input to the antenna in Watts (200 W / 10^(0.45 dB / 10))
A = 10.752 m^2	physical area of the aperture antenna
G = 1.954 x 10^5	power gain relative to an isotropic radiator
D = 3.7 m	diameter of antenna in meters
F = 14,250	frequency in MHz
λ = 0.021 m	wavelength in meters ($300/F_{MHz}$)
η = 0.64	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:

$S_{surface} = (4 * P) / A$

$= (4 * 180.314) / 10.752\ m^2$

$= 67.08\ W/m^2$

$= 6.708\ mW/cm^2$

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):

$R_{nf} = D^2 / (4 * \lambda)$

$= 3.7^2 / (4 * 0.021)$

$= 162.681\ m$

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:

$S_{nf} = (16 * \eta * P) / (\pi * D^2)$

$= (16 * 0.65 * 283.178) / (\pi * 4.5^2)$

$= 42.93\ W/m^2$

$= 4.293\ mW/cm^2$

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:

$R_{ff} = (0.6 * D^2) / \lambda$

$= (0.6 * 3.7^2) / 0.021$

$= 390.435\ m$

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

$S_{ff} = (P * G) / (4 * \pi * R_{ff}^2)$

$= (180.314 * 1.954 \times 10^5) / (4 * \pi * 390.435^2)$

$= 0.78 \text{ W/m}^2$

$= 0.078 \text{ mW/cm}^2$

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:

$S_t = (S_{nf} * R_{nf}) / R$

$= (4.293 \text{ mW/cm}^2 * 162.681 \text{ m}) / R$

$= (698.416 \text{ m} * \text{mW/cm}^2) / R$ where R is the location of interest in meters

Summary of expected radiation levels for an Uncontrolled environment

Region	**Maximum Power Density**	**Hazard Assessment**
Far field (R_{ff}) = 390.435 m	0.078 mW/cm^2	Satisfies FCC MPE
Near field (R_{nf}) = 162.681 m	4.298 mW/cm^2	Potential Hazard
Transition region (R_t) (R_t) = $R_{nf} < R_t < R_{ff}$	4.293 mW/cm^2	Potential Hazard
Main Reflector Surface ($S_{surface}$)	6.708 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

Region	**Maximum Power Density**	**Hazard Assessment**
Far field (R_{ff}) = 390.435 m	0.078 mW/cm^2	Satisfies FCC MPE
Near field (R_{nf}) = 162.681 m	4.298 mW/cm^2	Satisfies FCC MPE
Transition region (R_t) (R_t) = $R_{nf} < R_t < R_{ff}$	4.298 mW/cm^2	Satisfies FCC MPE
Main Reflector Surface ($S_{surface}$)	6.708 mW/cm^2	Potential Hazard

Conclusions

The proposed earth station system will be located on a building rooftop with controlled access and will be serviced by trained personnel. The radio and amplifier system will be turned off when servicing the antenna system. Based on the above analysis it is concluded that harmful radiation levels will not exist in regions normally occupied by the public.

Note: The levels above are based on the full 200 W output power of the power amplifier system. In actual operation the amplifier output level will typically be reduced by several dB.