Radiation Hazard Report

Analysis of Non-Ionizing Radiation for a 0.8 m Earth Station

This analysis provides the calculated non-ionizing radiation levels for a 0.8-meter earth station system.

The methods and calculations performed in this analysis are based on the FCC Office of Engineering and Technology Bulletin, No.65, October 1985 as revised in 1997 in Edition 97-01. The radiation safety limits used in the analysis are in conformance with the FCC R&O 96-326 (Summarized in Annex 1). There are separate exposure limits applicable to the General Population/Uncontrolled Environment and the Occupational/Controlled Environment. The Maximum Permissible Exposure (MPE) limits for persons in a General Population/Uncontrolled environment for the frequency band of this antenna, is 1 mW/cm2 for a 30 minute or lower time period as shown in Annex 1 (a). The MPE limit for persons in an Occupational/Controlled environment for the frequency band of this antenna is 5 mW/cm2 for a 6 minute time or lower period as shown in Annex 1 (b). The purpose of this analysis described is to determine the power flux density levels of the earth station at the main reflector surface, the near-field, transition region, far-field, between the sub-reflector or feed and, at the main reflector surface, and between the antenna edge and the ground and to compare these levels to the specified MPEs.

The parameters of the antenna that is the subject of this analysis are shown in Table 1.
Intermediate calculated values and constants are provided in Table 2.

Table 1. Input Parameters Used for Determining Power Flux Densities

Parameter	Symbol	Formula	Value
Antenna Diameter	D	Input	0.8
Frequency	F	Input	14250
Transmit Power	P	Input	16
Antenna Gain (dBi)	G_{es}	Input	39.6
Duty cycle	DTx		30%

Table 2. Calculated Values and Constants

Parameter	Symbol	Formula	Value
Antenna Surface Area	$A_{surface}$	$\pi D^2/4$	0.50
Wavelength	λ	300/F	0.021053
Antenna Gain (factor)	G	$10^{Ges/10}$	9120.11
Pi	π	Constant	3.1415927
Antenna Efficiency	η	$G\lambda^2/(\pi^2 D^2)$	0.64

1. Antenna Main Reflector Surface

The power density in the main reflector is determined from the Power level and the area of the main reflector aperture. This is determined from the following equation:

Power Density at the Main Reflector Surface:

$$S_{surface} = DTx \; 4P/A_{surface}$$
$$= 127.324 \quad W/m^2$$
$$= 3.820 \quad mW/cm^2$$

2. Near Field Calculation

Power Flux density is considered to be at a maximum value throughout the entire length of the defined Near Field region. The region is contained within a cylindrical volume having the same diameter as the antenna. Past the boundary of the Near Field region, the power density from the antenna decreases linearly with respect to increasing distance. The distance to the end of the Near Field is determined from the following equation:

Extent of the Near Field:

$$R_{nf} = D^2 / (4\lambda)$$
$$= 7.60 \quad m$$

The maximum power density in the Near Field is determined from the following equation:

Near Field Density:

$$S_{nf} = DTx \; 16 \, P / (\eta \pi D^2)$$
$$= 2.444 \quad mW/cm^2$$

3. Transition Region Calculation

The Transition Region is located between the Near and Far Field regions. The power density begins to decrease linearly with increasing 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 power density calculated in Section 1 is the highest power density the antenna can produce in any of the regions away from the antenna. The power density at a distance R_t is determined from the following equation:

Transition Region Power Density:

$$S_t = S_{nf} R_{nf} / R_t$$
$$= 2.444 \quad mW/cm^2$$

4. Far Field Distance Calculation

The distance to the Far Field Region is calculated using the following equation:

Distance to Far Field Region:

$$R_{ff} = 0.6\ D^2 / \lambda$$
$$= \quad 18.240 \quad \text{m}$$

The maximum main beam power density in the far field is determined from the following equation:

On-axis Power Density in the Far Field:

$$S_{ff} = DTx\ G\ P / (4\ \pi\ R_{ff}^2)$$
$$= \quad 1.047 \quad \text{mW/cm}^2$$

5. Region between the Main Reflector and the Ground

Assuming uniform illumination of the reflector surface, the power density between the antenna and the ground is determined from the following equation:

Power Density between Reflector and Ground:

$$S_g = DTx\ P / A_{surface}$$
$$= \quad 0.955 \quad \text{mW/cm}^2$$

7. Summary of Calculations

Table 3. Summary of Expected Radiation levels for Uncontrolled Environment

Region	Symbol	Calculated Maximum Radiation Power Density Level (mW/cm^2)
1. Main Reflector	$S_{surface}$	3.820
2. Near Field (R_{nf} = 7.6 m)	S_{nf}	2.444
3. Transition Region ($R_{nf} < R_t < R_{ff}$)	S_t	2.444
4. Far Field (R_{ff} = 18.24 m)	S_{ff}	1.047
5. Between Main Reflector and Ground	S_g	0.955

Table 4. Summary of Expected Radiation levels for Controlled Environment

Region	Symbol	Calculated Maximum Radiation Power Density Level (mW/cm^2)
1. Main Reflector	$S_{surface}$	3.820
2. Near Field (R_{nf} = 7.6 m)	S_{nf}	2.444
3. Transition Region ($R_{nf} < R_t < R_{ff}$)	S_t	2.444
4. Far Field (R_{ff} = 18.24 m)	S_{ff}	1.047
5. Between Main Reflector and Ground	S_g	0.955

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

8. Conclusion

Based upon the above analysis, it is concluded that the this terminal is not a radiation hazard as the radiation levels will not exceed the MPE standard of 5.0 mW/cm2 over an interval of six minutes in generally accessible areas.

These transportable terminals will be deployed nationwide and will not transmit while in motion.

The earth station will be marked with the standard radiation hazard warnings, as well as the area in the vicinity of the earth station to inform those in the general population, who might be working or otherwise present in or near the direct path of the main beam.

Additionally, any blockage (human or otherwise) will cause the transmitter to be disabled within milliseconds as the system does not transmit unless it can receive the downlink carrier from the satellite.

Finally, the earth station's operating personnel will not have access to areas that exceed the MPE levels, while the earth station is in operation. The transmitter will be turned off during those periods of maintenance, so that the MPE standard of 5.0 mW/cm2 will be complied with for those regions in close proximity to the main reflector, which could be occupied by operating personnel.

"The licensee shall take all necessary measures to ensure that the antenna does not create potential exposure of humans to radiofrequency radiation in excess of the FCC exposure limits defined in 47 CFR 1.1307(b) and 1.1310 wherever such exposures might occur. Measures must be taken to ensure compliance with limits for both occupational/controlled exposure and for general population/uncontrolled exposure, as defined in these rule sections. Compliance can be accomplished in most cases by appropriate restrictions such as fencing. Requirements for restrictions can be determined by predictions based on calculations, modeling or by field measurements. The FCC's OET Bulletin 65 (available on-line at www.fcc.gov/oet/rfsafety) provides information on predicting exposure levels and on methods for ensuring compliance, including the use of warning and alerting signs and protective equipment for workers."

ANNEX 1

(MPE Levels)

a) Limits for General Population/Uncontrolled Exposure (MPE)

Frequency Range (MHz)	Power Density (mW/cm^2)
30-300	0.2
300-1500	Frequency(MHz)*(4.0/1200)
1500-100,000	1

b) Limits for Occupational/Controlled Exposure (MPE)

Frequency Range (MHz)	Power Density (mW/cm^2)
30-300	1
300-1500	Frequency(MHz)*(4.0/1200)
1500-100,000	5