Analysis of Non-Ionizing Radiation for an AMT-50 INMARSAT Antenna

This report presents an analysis of the non-ionizing radiation levels for an AMT-50 INMARSAT Antenna. The calculations used in this analysis were derived from and comply with the procedures outlined in the Federal Communication Commission, Office of Engineering and Technology Bulletin Number 65, which establishes guidelines for human exposure to Radio Frequency Electromagnetic Fields. Bulletin 65 defines exposure levels in two separate categories, the General Population/Uncontrolled Areas limits, and the Occupational/Controlled Area limits. The Maximum Permissible Exposure (MPE) limit of the General Population/Uncontrolled Area is defined in Table (1), and represents a maximum exposure limit averaged over a 30 minute period. The MPE limit of the Occupational/Controlled Area is defined in Table (2), and represents a maximum exposure limit averaged over a 6 minute period. The purpose of this report is to provide an analysis of the earth station power flux densities, and to compare those levels to the specified MPE's. This report provides predicted density levels in the near field, far field, transition region, main reflector surface area, area between the main reflector and sub reflector or feed assembly, as well as the area between the antenna edge and ground.

MPE Limits for General Population/Uncontrolled Area

Frequency Range (MHz)	*Power Density (mW/cm^2)*
1500 – 100,000	1.0

Table 1

MPE Limits for Occupational/Controlled Area

Frequency Range (MHz)	*Power Density (mW/cm^2)*
1500 – 100,000	5.0

Table 2

AMT-50 INMARSAT

Table 3 contains formulas, equations and parameters that were used in determining the Power Flux Density levels for the AMT-50 INMARSAT Antenna:

Data Type	Data Symbol	Data Formula	Data Value	Unit of Measure
Power Input	P	Input	55	W
Antenna Size	D	Input	.254	M
Antenna Area	A	$A = (\Pi D^2) \div 4$	0.0507	M^2
Subreflector Size	Sub	Input	N/A	cm
Subreflector Area	A_{sub}	$A_{sub} = (\Pi Sub^2) \div 4$	N/A	cm^2
Gain dBi	G_{dbi}	Input	12	dBi
Gain Factor	G	$G = 10^{Gdbi/10}$	15.85	Gain Factor
Frequency	f	Input	1,643.5	MHz
Wavelength	λ	$299.79 / f$	0.182409	Meters
Aperture Efficiency	η	$\eta = [(G\lambda^2) \div (4\Pi)] \div A$	.83	n/a
Pi	Π	Input	3.14159	Numeric
Constant	M/Sec	Input	299,792,458	Numeric
Conversion W to mW	mW	mW = $W \times 1000$	n/a	n/a
Conversion M to cm	cm	cm = $M \times 100$	n/a	n/a
Conversion M^2 to cm^2	cm^2	$cm^2 = M^2 \times 10000$	n/a	n/a
Conversion W/M^2 to mW/cm^2	mW/cm^2	$mW/cm^2 = W / M^2 \div 10$	n/a	n/a

Table 3

1. Far Field Analysis

The distance to the far field can be calculated using the following formula:

$$R_{ff} = \frac{0.6D^2}{\lambda} = \quad 0.21 \text{ Meters}$$

The power density in the far field can be calculated using the following formula. Note: this formula requires the use of power in milliwatts and far field distance in centimeters, or requires a post calculation conversion from W/M^2:

$$S_{ff} = \frac{PG}{4\Pi R_{ff}^2} = \quad 157.305 \text{ mW/cm}^2$$

2. Near Field Analysis

The extent of the Near Field region can be calculated using the following formula:

$$R_{nf} = \frac{D^2}{4\lambda} = \quad 0.09 \text{ Meters}$$

The power density of the near field can be calculated using the following formula. Note: this formula requires the use of power in milliwatts and diameter in centimeters, or requires a post calculation conversion from W/M^2:

$$S_{nf} = \frac{16\eta P}{\Pi D^2} = \quad 360.366 \text{ mW/cm}^2$$

3. Transition Region Analysis

The transition region extends from the end of the near field out to the beginning of the far field. The power density in the transition region decreases inversely with distance from the antenna, while power density in the far-field decreases inversely with the square of the distance. However the power density in the transition region will not exceed the density in the near field, and can be calculated for any point in the transition region (R), using the following formula. Note: This formula requires the use of distance in centimeters, or requires a post calculation conversion from W/M^2.

$$S_t = \frac{S_{nf} R_{nf}}{R} = \quad 360.366 \text{ mW/cm}^2$$

4. Main Reflector Surface Area Analysis

The maximum power density at the antenna surface area can be calculated using the following formula. Note: this formula requires the use of Power in milliwatts and Area in centimeters squared, or requires a post calculation conversion from W/M^2.

$$S_{surface} = \frac{4P}{A} = \quad 433.925 \text{ mW/cm}^2$$

5. Subreflector Area Analysis

The area between the sub reflector and main reflector presents a potential hazard, with the highest density being located at the sub reflector area. The power density at the sub reflector can be calculated using the following formula. Note: this formula requires the use of Power in milliwatts and Area in centimeters squared, or requires a post calculation conversion from W/M^2.

$$Sub_{surface} = \frac{4P}{A_{sub}} = \text{N/A}$$

Tables 4 and 5 present a summary of the radiation hazard findings on the AMT-50 INMARSAT Antenna for both the General Population/Uncontrolled Area, as well as the Occupational/Controlled area environments.

MPE Limits for General Population/Uncontrolled Area

Area	***Range Meters***	***Power Density (mW/cm^2)***	***Finding***
Far Field	0.21	157.305 mW/cm^2	Potential Hazard
Near Field	0.09	360.366 mW/cm^2	Potential Hazard
Transition Region	0.09 – 0.21	360.366 mW/cm^2	Potential Hazard
Main Reflector Surface	N/A	433.925 mW/cm^2	Potential Hazard
Sub-reflector Surface	N/A	N/A	N/A

Table 4

MPE Limits for Occupational/Controlled Area

Area	***Range Meters***	***Power Density (mW/cm^2)***	***Finding***
Far Field	41.07	157.305 mW/cm^2	Potential Hazard
Near Field	17.11	360.366 mW/cm^2	Potential Hazard
Transition Region	17.11 – 41.07	360.366 mW/cm^2	Potential Hazard
Main Reflector Surface	N/A	433.925 mW/cm^2	Potential Hazard
Sub-reflector Surface	N/A	N/A	N/A

Table 5

Based on the above finding there is a potential hazard of radio frequency exposure with use of the AMT-50 INMARSAT Antenna. In order to mitigate the risk of these hazards, this terminal will only be operated in a controlled area on a building rooftop. Additionally, the unit will be shut down prior to performing maintenance in any of the occupational hazard areas.