Analysis of Non-Ionizing Radiation for an 1 meter Earth Station at Maximum EIRP

This report analyzes the Non-Ionizing radiation levels for an 1.0 meter Earth Station. The offices of Science and Technology Bulletin, Number 65, October 1985, specifies that the maximum level of Non-Ionizing radiation that a person may be exposed to over a six minute period is an average power density equal to 5 mW / cm^2. It is the purpose of this report to determine the power flux densities radiated by the Earth Station in the Far Field, the Near Field, Transition Region, Between the Feed Flange and the Reflector Surface, at the Reflector Surface, between the antenna edge and the ground, and on the other side of a steel reinforced concrete structure.

Calculation Parameters :

The following parameters were used to calculate the various power flux densities radiated by this Earth Station.

Antenna Manufacturer	**LEO1 Seatel**		
Antenna Model	**4412.000**	**value**	**units**
Antenna Diameter	**D =**	1.00	meters
Antenna Surface Area	**A =**	0.79	meters^2
Feed Flange Diameter	**Df =**	0.100	meters
Area of Feed Flange	**A_f =**	0.0079	meters^2
Wavelength at 31 GHz	**Lambda =**	0.010	meters
Transmit Power at HPA Flange	**HPA =**	16	Watts
Losses to Antenna Flange	**L =**	-0.500	dB
Transmit Power at Antenna Input Flange	**P =**	14.26	Watts
Antenna Gain at 31 GHz	**G =**	48.50	dBi
Antenna Gain (ratio using 10^(48.5/10))	**G =**	70,795	
PI	**PI =**	3.141593	
Antenna Aperture Efficiency	**n =**	0.67	

Summary of Expected Radiation Levels :

Far Field Calculations	**Calculated Value**		**Units**	**Hazard?**
Distance to Far Field Region	**Rf =**	62.00	meters	
Power Density in Far Field Region	**Wf =**	2.09	mW / cm^2	Satisfies ANSI
Near Field Calculations				
Extent of Near Field Region	**Rn =**	25.83	meters	
Power Density in Near Field Region	**Wn =**	4.88	mW / cm^2	Satisfies ANSI
Transition Region Calculations				
Power Density in Transition Region	**Wn =**	4.88	mW / cm^2	Satisfies ANSI
Region between Feed Flange and Reflector				
Power Density at Feed Flange	**Wfl =**	363.13	mW / cm^2	Potential Hazard
Reflector Region				
Power Density at Reflector Surface	**Wr =**	3.63	mW / cm^2	Satisfies ANSI
Region between Reflector and Ground				
Power Density at Edge of Reflector Surface	**Wg =**	0.036	mW / cm^2	Satisfies ANSI
Region on other side of Reinforced Concrete				
Transmitted Power Density	**Wt =**	0.00036	mW / cm^2	Satisfies ANSI

Note: Calculations are at the maximum allowable power level for an antenna this size.

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Calculation Details :

Far Field Calculations

This region is contained within a roughly conical volume having the same diameter as the antenna at the beginning of the far field. The value calculated below is the maximum power in the volume. The power density in this region decreases inversely with the square of the distance.

Distance to the beginning of the Far Field Regi	Rf = 0.60 * D^2 / Lambda (meters)
	Rf = 62.00 meters
Maximum Power Density in Far Field Region	Wf = G * P / 4 * PI *Rf^2 (mW / cm^2)
	Wf = 2.09 mW / cm^2

Near Field Calculations

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.

Distance to the end of the Near Field Region	Rn = D^2 / 4 * Lambda (meters)
(extent of the near field)	Rn = 25.83 meters
Power Density in Near Field Region	Wn = 16 * n * P / PI * D^2 (mW / cm^2)
	Wn = 4.88 mW / cm^2

Transition Region Calculations

The transition region is located between the near field 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 the 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 (4.88 mW/cm^2), as shown above.

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 maximum energy density between the feed and reflector surface is at the apex of the cone (at the feed horn flange) This power density can be calculated as follows:

Power Density at Feed Flange	Wfl = 2 * P / A_f (mW / cm^2)
	Wfl = 363.13 mW / cm^2

Reflector Region

The power density in the 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.

Power Density at Reflector Surface	Wr = 2 * P / A (mW / cm^2)
	Wr = 3.63 mW / cm^2

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Calculation Details (continued) :

Region between Reflector and Ground

Assuming uniform illumination of the reflector surface, the power density between the antenna and ground can be approximated using a formula from the Offices of Science and Technology Bulletin, Number 65, October 1985, Page 18, as follows:

Power Density between Reflector and ground	Wg = Wr * 10 ^(-20/10) (mW / cm^2)
	Wg = 0.036 mW / cm^2

Transmission through steel reinforced concrete

Assuming steel reinforced concrete of a thickness greater than 1/2 of the wavelength of the incident illumination, (0.48 cm.) the transmission attenuation is greater than 20 dB. This results in a transmitted power as follows:

Transmitted Power Density	Wt = Wg * (10 ^(-20/10)) (mW / cm^2)
	Wt = 0.00036 mW / cm^2

Conclusions :

Based on the analysis, it is concluded that harmful levels of radiation will not occur in the regions accessible by people. Fencing, padlocks, and/or signs will be used to restrict access of the public and operating personnel to areas where the radiation level exceeds the ANSI standard . The transmitter will be turned off during maintenance activities so that the ANSI standard of 5 mW / cm^2 will be complied with for those regions that exceed acceptable levels.