RADIATION HAZARD ANALYSIS
13.1 meter Ku-band antenna

This analysis calculates the non-ionizing radiation levels due to transmission from the earth station. The Office of Engineering and Technology (OET) Bulletin, No. 65 Edition, specifies that the Maximum Permissible Exposure (MPE) limit for persons in a Controlled environment to non-ionizing radiation averaged over a thirty minute period, is a power density equal to 5 milli-watt per centimeter squared.

The analysis estimates the maximum power density levels in the vicinity of the antenna for six regions: near field; far field; transition zone; near the reflector surface; between the reflector and the ground; and between the feed mouth and the reflector.

A brief discussion for each region is given below. The attached table shows the assumptions, formulae and calculations for all cases.

1. NEAR FIELD REGION

The near field (or Fresnel region) is essentially an elliptical volume with its axis co-incident with the antenna boresight. The base of this volume is the same as the aperture of the antenna. According to OET Bulletin No. 65, its length is equal to the square of the diameter divided by four times the wavelength. The larger dimension of the antenna (the width) is used in place of the diameter of a circular aperture as a worst case approximation. The maximum value of the on-axis power density is calculated using the equation given in the Bulletin by simply replacing the area of the circular aperture term with the area of the elliptical aperture antenna.

2. FAR FIELD REGION

The far field (or Fraunhofer region) extends outwards from a distance equal to 0.6 times the square of the reflector diameter divided by the wavelength, according to OET Bulletin No. 65. The larger dimension of the antenna (the width) is used in place of the diameter of a circular aperture. Power density varies inversely as the square of the distance. The maximum value of the power density is calculated using the equation given in the Bulletin.

3. TRANSITION REGION

The transition region between the near field and the far field regions will have a power density that essentially decreases inversely with increasing distance. In any case, the maximum power density will not exceed the maximum value calculated for the near field region, for the purpose of evaluating potential exposure.

4. REGION NEAR REFLECTOR SURFACE

The power density in the region near the reflector surface can be estimated as equal to four times the power divided by the area of the reflector surface, assuming that the illumination is uniform and that it would be possible to intercept equal amounts of energy radiated towards and reflected from the reflector surface.

5. REGION BETWEEN REFLECTOR AND GROUND

The power density in the region between the reflector and the ground can be estimated as equal to the power divided by the area of the reflector surface, assuming uniform illumination over the surface of the reflector.

6. REGION BETWEEN THE FEED MOUTH AND REFLECTOR

The radiation from the feed is essentially confined to a conical region whose vertex is located at the feed mouth and extends to the reflector. Power density is maximum at the feed mouth, and can be estimated as four times the output power divided by the area of the feed mouth.

7. RESULTS OF ANALYSIS

The radiation analyses in the following Tables were performed using the definitions from the previous sections and assuming worst case operating conditions. The radiation analysis for this worst case (see Table below) shows that the MPE Level is exceeded between the feed mouth and the reflector. This antenna will be mounted in a controlled area such that the area between the main reflector and sub-reflector. The applicant will comply with the MPE limits by one or more of the following methods:

- Radiation hazard signs will be posted while this earth station is in operation.
- The earth station is located in a secured teleport facility with secured access.
- All individuals having access to the teleport will be aware of the Radiation Hazard from the antenna, thus creating a controlled environment.
- The earth station's operational staff will not have access to the areas that exceed the MPE levels while the earth station is in operation. The transmitters will be turned off during antenna maintenance

RADIATION HAZARD ANALYSIS

Nomenclature	Formula	Value	Unit
INPUT PARAMETERS			
D = Antenna Diameter		13.1	meters
d = Diameter of Subreflector		1.33	meters
P = Max Power into Antenna		320	Watts
η = Apperture Efficiency		60.7	%
F = Frequency		14000	MHz
λ = Wavelength	300/F	0.0214	meters
CALCULATED VALUES			
A = Area of Reflector	pi*D^2/4	134.78	meters^2
a = Area of Subreflector	pi*d^2/4	1.39	meters^2
l = Length of Near Field	D^2/4λ	2002.12	meters
L = Beginning of Far Field	0.6D^2/λ	4805.08	meters
G = Antenna Gain @ F (n=100% max value)	η(pi*D/λ)^2	2238712.19	linear
Antenna Gain in dB	10*log(G)	63.50	dBi

POWER DENSITY CALCULATIONS

	Max Power Density In Region		Hazard Assessment
Region	Formula	Value (mW/cm^2)	(FCC MPE Limit=1 mW/cm^2)
1. Snf = Max Near Field Power Density	4*η*P/A	0.58	<FCC MPE Limit
2. Sff = Max Far Field Power Density	G*P/(4*pi*L^2)	0.25	<FCC MPE Limit
3. Max Transition Region Power Density	<= Nr Fld Region	0.58	<FCC MPE Limit
4. Near Main Reflector Surface	4*P/A	0.95	<FCC MPE Limit
5. Between Main Reflector and Subreflector	4*P/a	92.13	>FCC MPE Limit (See Text)
6. Between Main Reflector and Ground	P/A	0.24	<FCC MPE Limit