Theta	Gain dBi	
1	29	794.3282
1.5	24.59772	288.2517
2	21.47425	140.4187
2.5	19.0515	80.38037
3	17.07197	50.95618
3.5	15.3983	34.66011
4	13.9485	24.82276
4.5	12.66969	18.49135
5	11.52575	14.20938
5.5	10.49093	11.19678
6	9.546219	9.007865
6.5	8.677166	7.374229
7	7.872549	6.127099

ANALYSIS OF NON-IONIZING RADIATION
FOR A 3.6 METER EARTH STATION
Completed: 6/10/10

This report analyzes the non-ionizing radiation levels for a 3.6 meter earth station. It is the purpose of this report to determine the power flux densities of the earth station at the antenna surface, near field, far field, and the transition region. Results are summarized in Table 1 on page 4.

The Office Engineering & Technology Bulletin, No. 65, August 1997, specifies the following Maximum Permissible Exposure (MPE) levels for non-ionizing radiation :

1. Occupational/Controlled Exposure is 5mW/cm² (five milliwatts per centimeter squared) over an average time of 6 (six) minutes.

2. General Population/Uncontrolled Exposure is 1mW/cm² (one milliwatt per centimeter squared) over an average time of 30 (thirty) minutes.

The following parameters were used to calculate the various power flux densities for this earth station:

Location:	Waterfall, Alaska	
Latitude:	55.3	°N
Longitude:	133.24	°W
Operating Frequency:	6175	MHz
Wavelength (λ)	0.0485	meters
Antenna Diameter (D):	3.6	meters
Antenna Area (A):	10.18	meters²
Transmit Antenna Gain:	45.6	dBi
Transmit Antenna Gain (G):	36307.8	numeric
Maximum 1° Off Axis Gain	41.8	dBi
Maximum 1° Off Axis Gain ($G_{1°}$)	15135.6	numeric
Antenna Efficiency (η):	0.669	numeric
Feed Power (P):	100	Watts

1. Antenna Surface

The power density in the main reflector region can be estimated by:

Power Density at Reflector Surface, $S_{surface} = 4P/A$
$= 39.30$ W/m²
$=$ **3.93 mW/cm²**

$S_{surface}$= maximum power density at antenna surface
P= power fed to the antenna
A= physical area of the antenna

2. Near Field Calculations

In the near field region, of the main beam, the power density can reach a maximum before it begins to decrease with distance. The magnitude of the on axis (main beam) power density varies according to location in the near-field.

The distance to the end of the near field can be determined by the following equation:

Extent of Near Field, $R_{nf} = D^2/4(\lambda)$
$= 66.74$ meters

R_{nf}= extent of near field
D= maximum dimension of antenna (diameter if circular)
λ= wavelength

The maximum near-field, on-axis, power density is determined by:

On Axis Near Field Power Density, $S_{nf} = 16\eta P/D^2\pi$
$= 26.29$ W/m²
$=$ **2.63 mW/cm²**

The maximum near-field, 1° off-axis, power density is determined by:

Power Density at 1° Off Axis $S_{nf\ 1°} = (S_{nf}/G)*G_{1°}$
$=$ **1.0960 mW/cm²**

S_{nf}= maximum near-field power density
$S_{nf\ 1°}$= maximum near-field power density (1° off axis)
η= aperture efficiency
P= power fed to antenna
D= maximum dimension of antenna (diameter if circular)

3. Far Field Calculations

The power density in the far-field region decreases inversely with the square of the distance.

The distance to the beginning of the far field region can be found by the following equation:

Distance to the Far Field Region, $R_{ff} = 0.6D^2/\lambda$
$= 160$ meters

R_{ff} = distance to beginning of far field
D= maximum dimension of antenna (diameter if circular)
λ= wavelength

The maximum main beam power density in the far field can be calculated as follows:

On-Axis Power Density in the Far Field, $S_{ff} = (P)(G)/4\pi(R_{ff})^2$
$= 11.26$ W/m²
$=$ **1.13 mW/cm²**

The maximum far-field, 1° off-axis, power density is determined by:

Power Density at 1° Off Axis $Sff_{1°} = (Sff/G)*G_{1°}$
$=$ **0.4695 mW/cm²**

S_{ff}= power density (on axis)
$Sff_{1°}$= power density (1° off axis)
P= power fed to antenna
G= power gain of antenna in the direction of interest relative to an isotropic radiator
R_{ff} = distance to beginning of far field

4. Transition Region Calculations

The transition region is located between the near and far field regions. The power density decreases inversely with distance in the transition region, while 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. The power density in the near field region, as shown above will not exceed:

S_t= **2.63 mW/cm².**
$S_{t\,1°}$ = **1.0960 mW/cm².**

Table 1

Summary of Expected Radiation Levels

Region	**Calculated Maximum Radiation Level (mW/cm²)**	**Maximum Permissible Exposure (MPE) Occupational**	**General Population**
1. Antenna Surface	$S_{surface}$= 3.93	Satisfies MPE	Potential Hazard
2. Near Field	S_{nf}= 2.63	Satisfies MPE	Potential Hazard
3. Far Field	S_{ff}= 1.13	Satisfies MPE	Potential Hazard
4. Transition Region	S_{t}= 2.63	Satisfies MPE	Potential Hazard
5. Near Field 1° Off Axis	$S_{nf\ 1°}$= 1.0960	Satisfies MPE	Potential Hazard
6. Far Field 1° Off Axis	Sff $_{1°}$= 0.47	Satisfies MPE	Satisfies MPE
7. Transition Region 1° Off Axis	$S_{t\ 1°}$ = 1.0960	Satisfies MPE	Potential Hazard

7. Conclusions

Based on the above analysis, it is concluded that there is a potential hazard to the public if/when the site transmits 100 Watts. When the transmit level out of the site exceeds 25 Watts a fence will be installed to protect the public from any potential hazard. At 1° off axis the radiation levels are well within limits. A 26° elevation angle will further protect the public from any exposure to radiation. The transmitter will be turned off during antenna maintenance to ensure safety of the earth station personnel.

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