ANALYSIS OF NON-IONIZING RADIATION
FOR AN 1.0 METER EARTH STATION
Completed 11/8/2011

This report analyzes the non-ionizing radiation levels for a Norsat Newslink 3200 1.0 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:	Various Locations in AK, HI, & CON-US	
Latitude:	Various	°N
Longitude:	Various	°W
Operating Frequency:	14250	MHz
Wavelength (λ)	0.0210	meters
Antenna Diameter (D):	1.0	meters
Antenna Area (A):	0.71	meters²
Transmit Antenna Gain:	42.0	dBi
Transmit Antenna Gain (G):	15848.9	numeric
Maximum 1.5° Off Axis Gain	24.6	dBi
Maximum 1.5° Off Axis Gain ($G_{1.5°}$)	288.3	numeric
Antenna Efficiency (η):	0.788	numeric
Feed Power (P):	40	Watts

1. Antenna Surface

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

Power Density at Reflector Surface, $S_{surface} = 4P/A$
= 225.73 W/m²
= **22.57 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, $R_{nf} = D^2/4(\lambda)$
= **10.72 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, $S_{nf} = 16\eta P/D^2\pi$
= 177.77 W/m²
= **17.78 mW/cm²**

The maximum near-field, 1.5° off-axis, power density is determined by:

Power Density at 1.5° Off Axis $S_{nf\ 1.5°} = (S_{nf}/G)*G_{1.5°}$
= **0.3233 mW/cm²**

S_{nf} = maximum near-field power density
$S_{nf\ 1.5°}$ = maximum near-field power density (1.5° 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, $R_{ff} = 0.6D^2/\lambda$
= **26 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, $S_{ff} = (P)(G)/4\pi(R_{ff})^2$
= 76.15 W/m²
= **7.61 mW/cm²**

The maximum far-field, 1.5° off-axis, power density is determined by:

Power Density at 1.5° Off Axis $Sff_{1.5°} = (Sff/G)*G_{1°}$
= **0.1385 mW/cm²**

S_{ff} = power density (on axis)
$Sff_{1.5°}$ = power density (1.5° 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= **17.78 mW/cm².**
$S_{t\ 1.5°}$ = **0.3233 mW/cm².**

Table 1

Summary of Expected Radiation Levels

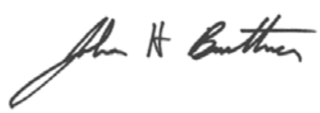
Region	**Calculated Maximum Radiation Level (mW/cm²)**	**Maximum Permissible Exposure (MPE) Occupational**	**General Population**
1. Antenna Surface	$S_{surface}$= 22.57	Potential Hazard	Potential Hazard
2. Near Field	S_{nf}= 17.78	Potential Hazard	Potential Hazard
3. Far Field	S_{ff}= 7.61	Potential Hazard	Potential Hazard
4. Transition Region	S_t= 17.78	Potential Hazard	Potential Hazard
5. Near Field 1.5° Off Axis	$S_{nf\ 1.5°}$= 0.3233	Satisfies MPE	Satisfies MPE
6. Far Field 1.5° Off Axis	$Sff_{\ 1.5°}$= 0.14	Satisfies MPE	Satisfies MPE
7. Transition Region 1.5° Off Axis	$S_{t\ 1.5°}$ = 0.3233	Satisfies MPE	Satisfies MPE

7. Conclusions

Based on the above analysis it is concluded that the risk of exposure to radiation levels are higher than the Maximum Permissible Exposure (MPE) limit at the surface of the antenna and in the near and far field at full transmitter power if the antenna is pointed directly at the horizon.

Table 1 shows that the MPE for the General Population is within the limits specified in OET Bulletin 65 (1997) at 1.5° off-axis. Since these antennas will not be deployed with elevation angles of less than 5°, the General Population will not be at risk for RF radiation. Further, GCI will restrict access to the General Population by installing appropriate RF Radiation Hazard placards and by erecting suitible barriers to keep members of the General Population away from the antenna.

Finally, the transmitter will be disabled during maintenance activities to protect personnel.



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