Analysis of Non-Ionizing Radiation for a 9.0 Meter Earth Station System

This report analyzes the non-ionizing radiation levels for a 9.0 meter earth station system. The analysis and calculations performed in this report are in compliance with the methods described in the FCC Office of Engineering and Technology Bulletin, No. 65 first published in 1985 and revised in 1997 in Edition 97-01. The radiation safety limits used in the analysis are in conformance with the FCC R&O 96-326. Bulletin No. 65 and the FCC R&O specifies that there are two separate tiers of exposure limits that are dependant on the situation in which the exposure takes place and/or the status of the individuals who are subject to the exposure. The Maximum Permissible Exposure (MPE) limits for persons in a General Population/ Uncontrolled environment are shown in Table 1. The General Population/ Uncontrolled MPE is a function of transmit frequency and is for an exposure period of thirty minutes or less. The MPE limits for persons in an Occupational/Controlled environment are shown in Table 2. The Occupational MPE is a function of transmit frequency and is for an exposure period of six minutes or less. The purpose of the analysis described in this report is to determine the power flux density levels of the earth station in the far-field, near-field, transition region, between the subreflector or feed and main reflector surface, at the main reflector surface, and between the antenna edge and the ground and to compare these levels to the specified MPEs.

Table 1. Limits for General Population/Uncontrolled Exposure (MPE)

Frequency Range (MHz)	Power Density (mWatts/cm**2)
30-300	0.2
300-1500	Frequency(MHz)*(0.8/1200)
1500-100,000	1.0

Table 2. Limits for Occupational/Controlled Exposure (MPE)

Frequency Range (MHz)	Power Density (mWatts/cm**2)
30-300	1.0
300-1500	Frequency(MHz)*(4.0/1200)
1500-100,000	5.0

Table 3 contains the parameters that are used to calculate the various power densities for the earth stations.

Table 3. Formulas and Parameters Used for Determining Power Flux Densities

Parameter	Abbreviation	Value	Units
Antenna Diameter	D	9.0	meters
Antenna Surface Area	Sa	II * D**2/4	meters**2
Subreflector Diameter	Ds	116.8	cm
Area of Subreflector	As	II * Ds**2/4	cm**2
Frequency	Frequency	17550	MHz
Wavelength	lambda	300/frequency(MHz)	meters
Transmit Power	P	250.00	Watts
Antenna Gain	Ges	62.0	dBi
Pi	II	3.1415927	n/a
Antenna Efficiency	n	0.58	n/a

1. Far Field Distance Calculation

The distance to the beginning of the far field can be determined from the following equation:(1)

Distance to the Far Field Region,(Rf) = 0.60 * D**2 / lambda (1)
= 2843.1 meters

The maximum main beam power density in the Far Field can be determined from the following equation:(2)

On-Axis Power Density in the Far Field,(Wf) = Ges * P / 4 * II * Rf**2 (2)
= 3.901 Watts/meters**2
= 0.390 mWatts/cm**2

2. Near Field Calculation

Power flux density is considered to be at a maximum value throughout the entire length of the defined Near Field region. The region is contained within a cylindrical volume having the same diameter as the antenna. Past the boundary of the Near Field region the power density from the antenna decreases linearly with respect to increasing distance.

The distance to the end of the Near Field can be determined from the following equation:(3)

Extent of the Near Field,(Rn) = D**2 / (4 * lambda) (3)
= 1184.6 meters

The maximum power density in the Near Field can be determined from the following equation:(4)

Near Field Power Density,(Wn) = 16.0 * n * P / II * D**2 (4)
= 9.106 Watts/meters**2
= 0.911 mWatts/cm**2

3. Transition Region Calculations

The Transition region is located between the Near and Far Field regions. The power density begins to decrease linearly with increasing distance in the Transition region. While the power density decreases inversely with 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. The power density calculated in Section 1 is the highest power density the antenna can produce in any of the regions away from the antenna. The power density at a distance Rt can be determined from the following equation:(5)

Transition region Power Density, (Tt) = Wn * Rn / Rt (5)
= 0.911 mWatts/cm**2

4. Region between Main Reflector and Subreflector

Transmissions from the feed assembly are directed toward the subreflector surface, and are reflected back toward the main reflector. The most common feed assemblies are waveguide flanges, horns or subreflectors. The energy between the subreflector and the reflector surfaces can be calculated by determining the power density at the subreflector surface. This can be determined from the following equation:(6)

Power Density at Feed Flange, (Ws) = 4 * P / As (6)
= 93.331 mWatts/cm**2

5. Main Reflector Region

The power density in the main reflector is determined in the same manner as the power density at the subreflector. The area is now the area of the main reflector aperture and can be determined from the following equation:(7)

Power Density at the Main Reflector Surface, (Wm) = 4 * P / Sa (7)
= 15.719 Watts/meters**2
= 1.572 mWatts/cm**2

6. Region between Main Reflector and Ground

Assuming uniform illumination of the reflector surface, the power density between the antenna and ground can be determined from the following equation:(8)

Power Density between Reflector and Ground, (Wg) = P / Sa (8)
= 3.930 Watts/meters**2
= 0.393 mWatts/cm**2

Table 4. Summary of Expected Radiation levels for Uncontrolled Environment

Region	Calculated Maximum Radiation Power Density Level (mWatts/cm**2)	Hazard Assessment
1. Far Field (Rf) = 2843.1 meters	0.390	Satisfies FCC MPE
2. Near Field (Rn) = 1184.6 meters	0.911	Satisfies FCC MPE
3. Transition Region Rn < Rt < Rf, (Rt)	0.911	Satisfies FCC MPE
4. Between Main Reflector and Subreflector	93.331	Potential Hazard
5. Main Reflector	1.572	Potential Hazard
6. Between Main Reflector and Ground	0.393	Satisfies FCC MPE

Table 5. Summary of Expected Radiation levels for Controlled Environment

Region	Calculated Maximum Radiation Power Density Level (mWatts/cm**2)	Hazard Assessment
1. Far Field (Rf) = 2843.1 meters	0.390	Satisfies FCC MPE
2. Near Field (Rn) = 1184.6 meters	0.911	Satisfies FCC MPE
3. Transition Region Rn < Rt < Rf, (Rt)	0.911	Satisfies FCC MPE
4. Between Main Reflector and Subreflector	93.331	Potential Hazard
5. Main Reflector	1.572	Satisfies FCC MPE
6. Between Main Reflector and Ground	0.393	Satisfies FCC MPE

It is the applicant's responsibility to ensure that the public and operational personnel are not exposed to harmful levels of radiation.

7. Conclusions

Based on the above analysis, it is concluded that the FCC MPE guidelines have been exceeded (or met) in the regions of Table 4 and 5. The applicant proposes to comply with the MPE limits by one or more of the following methods:

Means of Compliance

_X_ Restrict Access, _X_ Fencing, _X_ Posting/Warnings

Applicant Certification:

Name: Brent Gale

Company: EchoStar Satellite Corporation

Signature: ______________________

Date: November 4, 2002

DECLARATION

I, Brent Gale, Vice President of EchoStar Satellite Corporation ("EchoStar"), a Colorado corporation, hereby declares as follows:

In connection with the attached FCC Form 312 application filed with the Federal Communications Commission ("FCC") by EchoStar, this declaration serves as an assurance that the proposed earth station will operate in a controlled environment. I understand that, under the FCC's rules, "controlled exposure" standards apply in cases where, while persons are exposed as a consequence of their employment, those persons are fully aware of their exposure and can exercise control over it, and situations where any transient individual is aware of the potential for exposure.

Under those rules, EchoStar's earth station facility in Gilbert, Arizona already qualifies as a "controlled exposure" environment. Specifically, EchoStar has taken the following safeguards to protect the general public and EchoStar's workers from exposure to radiation generated by the power flux densities of the proposed earth station:

- The uplink center is located on 15 acres of a 36 acre parcel of land in the Northwestern edge of Gilbert, Arizona. The closest commercial occupant in the area is located approximately 1/4 mile to the West.

- The perimeter of the uplink facility is protected by a 10 foot rod iron link fence, top with tilt out spikes spaced at 5 inch intervals. There are also motion sensors on the outside of the perimeter.

- There is also a 4 foot interior fence around all antenna fields.

- The facility is monitored 24 hours per day by EchoStar's security staff. Nineteen security cameras are located at the outer perimeter of the facility with monitors at the security desk. Access to the facility is allowed only through card key access or by the 24-hour security staff.

- All visitors to the facility are required to check in with security before access is granted.

In sum, EchoStar has taken more than adequate measures to prevent any exposure of the general public to radiation from the proposed earth station and provides all requisite notice for operational personnel and authorized transient individuals.

Finally, EchoStar has taken precautions to ensure that there will not be <u>any</u> human exposure to radiation in the region between the main reflector and sub-reflector of the proposed station. That region will not be occupied by the earth station's operating personnel, except when necessary to conduct maintenance activities. At all such times, the transmitter will be turned off.

DECLARATION

I, Brent Gale, hereby declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Brent Gale
Vice President, Broadcast Operations
EchoStar Satellite Corporation

Dated: November 4, 2002

8. Certification

I hereby certify that I am the technically qualified person responsible for the preparation of the radiation hazard assessment, and that it is complete and correct to the best of my knowledge.

By: ______________________________

Gary Edwards
Senior Manager
Microwave and Satellite Services
Comsearch

Dated: _November 4, 2002_