U.S. Satellite Corporation
Radiation Hazard Assessment of Satellite Antennas and Fenced Areas

3 June, 1999

U.S. Satellite Corporation has performed a Radiation Hazard Assessment of all Satellite Antennas located within the confines of its compound. This incorporates all antennas referenced under callsigns E2595 (C-band) and E870499 (Ku-Band.)

Two surveys were complete on all antennas: The first survey was completed by Comsearch using Antenna Pattern data for each Satellite Antenna. A second survey was complete on 12 March, 1999 on-site using a Narda Radiation Hazard Meter by monitoring various points at each Antenna's edge, and at various points extending out in front, behind, and to the side of each antenna. These measurements and calibration data for the Radiation Hazard Meter are available for inspection.

None of the antennas were found to exceed the 1 mw/cm^2 ANSI MPE (Maximum Permissible Exposure) limit for Uncontrolled/Public environments (as specified in OET Bulletin, No. 65, Ed. 97-01) beyond the edge (reflector) of the antenna or at any point under or behind the antenna.

Furthermore, the physical locations of three of the C-Band antennas (one of the 10 meter and two of the 9.2 meter antennas) atop tall platforms make them inaccessible. The remaining C-band antennas (Re: E2595) and the Ku-band antennas (Re: E870499) are enclosed in fenced areas that restrict access to the general public.

Finally, additional testing was done to ascertain the possible *cumulative* effect of all antennas transmitting *simultaneously*. At no point did the exposure readings those areas accessible to the public approach 0.1 mw/cm^2 – a reading that is, were it attained, would be only 10% of the MPE. These readings were checked at the various extremes of antenna azimuth and elevations and at maximum transmit power levels.

E2595 9.2m

EXHIBIT E

RADIATION HAZARD ASSESSMENT

ANALYSIS OF NON-IONIZING RADIATION FOR A 9.2 METER EARTH STATION

This report analyzes the non-ionizing radiation levels for a 9.2 meter earth station. The Office of Science and Technology Bulletin, No. 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 (five milliwatts per centimeter squared). It is the purpose of this report to determine the power flux densities of the earth station in the far field, near field, transition region, between the subreflector and main reflector surface, at the main reflector surface, and between the antenna edge and the ground.

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

Antenna Diameter, (D)	= 9.2 meters	
Antenna surface area, (Sa)	= pi (D**2) / 4	= 66.48 m**2
Subreflector Diameter, (Ds)	= 107.5 cm	
Area of Subreflector, (As)	= pi (Ds**2) / 4	= 9076.26 cm**2
Wavelength at 6.1750 GHz, (lambda)		= 0.049 meters
Transmit Power at Flange, (P)	= 250.00 Watts	
Antenna Gain, (Ges)	Antenna Gain at 6.1750 GHz = 53.0 dBi Converted to a Power Ratio Given By: AntiLog (53.0 / 10)	= 0.200E+06
pi, (pi)	= 3.1415927	
Antenna aperture efficiency, (n)	= 0.55	

1. Far Field Calculations

The distance to the beginning of the far field region can be found by the following equation: (1)

$$\text{Distance to the Far Field Region, (Rf)} = \frac{0.60(D^{**}2)}{\text{lambda}}$$

$$= 1045.3 \text{ m}$$

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(1) Federal Communications Commission, Public Notice of January 28, 1986, "Further Guidance for Broadcasters Regarding Radiofrequency Radiation and the Environment", pp. 17 & 18.

The maximum main beam power density in the far field can be calculated as follows: (1)

$$\text{On-Axis Power Density in the Far Field, (Wf)} = \frac{(GES)\ (P)}{4\ pi\ (Rf^{**}2)}$$

= 3.63 W/m**2

= 0.36 mW/cm**2

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.

The distance to the end of the near field can be determined by the following equation: (1)

Extent of near field, (Rn) = D**2 / 4(lambda) = 435.54 m

The maximum power density in the near field is determined by: (1)

$$\text{Near field Power Density, (Wn)} = \frac{16.0(n)P}{pi(D^{**}2)}$$

= 8.27 W/m**2

= 0.83 mW/cm**2

3. Transition Region Calculations

The transition region is located between the near 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 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 in the near field region, as shown above, will not exceed 0.83 mW/cm**2.

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(1) IBID

4. Region Between Main Reflector and Subreflector

Transmissions from the feed horn are directed toward the subreflector surface, and are reflected back toward the main reflector. The energy between the subreflector and reflector surfaces can be calculated by determining the power density at the subreflector surface. This can be accomplished as follows:

Power Density at Subreflector, (Ws) = 2(P) / As

= 550.89 W/m**2

= 55.09 mW/cm**2

5. Main Reflector Region

The power density in the main reflector region is determined in the same manner as the power density at the subreflector, above, but the area is now the area of the main reflector aperture:

Power Density at Main Reflector Surface, (Wm) = (2(P) / Sa)

= 7.52 W/m**2

= 0.75 mW/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 calculated as follows:

Power density between Reflector and Ground, (Wg) = (P / Sa)

= 3.76 W/m**2

= 0.38 mW/cm**2

Table 1

Summary of Expected Radiation Levels

Region	Calculated Maximum Radiation Level (mW/cm**2)	Hazard Assessment
1. Far Field, (Rf)= 1045.3m	0.36	SATISFIES ANSI
2. Near Field, (Rn)= 435.54m	0.83	SATISFIES ANSI
3. Transition Region, (Rt) Rn < Rt < Rf	0.83	SATISFIES ANSI
4. Between Main Reflector and Subreflector	55.09	POTENTIAL HAZARD
5. Reflector Surface	0.75	SATISFIES ANSI
6. Between Antenna and Ground	0.38	SATISFIES ANSI

7. Conclusions

Based on the above analysis it is concluded that harmful levels of radiation will not exist in regions normally occupied by the public or the earth station's operating personnel. The transmitter will be turned off during antenna maintenance so that the ANSI Standard of 5.0 mW/cm**2 will be complied with for those regions with close proximity to the reflector that exceed acceptable levels.

E2595 10m

EXHIBIT E

RADIATION HAZARD ASSESSMENT

ANALYSIS OF NON-IONIZING RADIATION FOR A 10.0 METER EARTH STATION

This report analyzes the non-ionizing radiation levels for a 10.0 meter earth station. The Office of Science and Technology Bulletin, No. 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 (five milliwatts per centimeter squared). It is the purpose of this report to determine the power flux densities of the earth station in the far field, near field, transition region, between the subreflector and main reflector surface, at the main reflector surface, and between the antenna edge and the ground.

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

Antenna Diameter, (D)	= 10.0 meters	
Antenna surface area, (Sa)	= pi (D**2) / 4	= 78.54 m**2
Subreflector Diameter, (Ds)	= 121.9 cm	
Area of Subreflector, (As)	= pi (Ds**2) / 4	=11670.71 cm**2
Wavelength at 6.1750 GHz, (lambda)		= 0.049 meters
Transmit Power at Flange, (P)	= 250.00 Watts	
Antenna Gain, (Ges)	Antenna Gain at 6.1750 GHz = 53.5 dBi Converted to a Power Ratio Given By: AntiLog (53.5 / 10)	= 0.224E+06
pi, (pi)	= 3.1415927	
Antenna aperture efficiency, (n)	= 0.55	

1. Far Field Calculations

The distance to the beginning of the far field region can be found by the following equation: (1)

Distance to the Far Field Region, (Rf) = $\frac{0.60(D^{**}2)}{\text{lambda}}$

= 1235.0 m

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(1) Federal Communications Commission, Public Notice of January 28, 1986, "Further Guidance for Broadcasters Regarding Radiofrequency Radiation and the Environment", pp. 17 & 18.

The maximum main beam power density in the far field can be calculated as follows: (1)

$$\text{On-Axis Power Density in the Far Field, (Wf)} = \frac{(GES)\ (P)}{4\ pi\ (Rf**2)}$$

= 2.92 W/m**2

= 0.29 mW/cm**2

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.

The distance to the end of the near field can be determined by the following equation: (1)

Extent of near field, (Rn) = D**2 / 4(lambda) = 514.58 m

The maximum power density in the near field is determined by: (1)

$$\text{Near field Power Density, (Wn)} = \frac{16.0(n)P}{pi(D**2)}$$

= 7.00 W/m**2

= 0.70 mW/cm**2

3. Transition Region Calculations

The transition region is located between the near 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 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 in the near field region, as shown above, will not exceed 0.70 mW/cm**2.

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(1) IBID

4. Region Between Main Reflector and Subreflector

Transmissions from the feed horn are directed toward the subreflector surface, and are reflected back toward the main reflector. The energy between the subreflector and reflector surfaces can be calculated by determining the power density at the subreflector surface. This can be accomplished as follows:

Power Density at Subreflector, (Ws) = 2(P) / As

= 428.42 W/m**2

= 42.84 mW/cm**2

5. Main Reflector Region

The power density in the main reflector region is determined in the same manner as the power density at the subreflector, above, but the area is now the area of the main reflector aperture:

Power Density at Main Reflector Surface, (Wm) = (2(P) / Sa)

= 6.37 W/m**2

= 0.64 mW/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 calculated as follows:

Power density between Reflector and Ground, (Wg) = (P / Sa)

= 3.18 W/m**2

= 0.32 mW/cm**2

<u>Table 1</u>

<u>Summary of Expected Radiation Levels</u>

Region	Calculated Maximum Radiation Level (mW/cm**2)	Hazard Assessment
1. Far Field, (Rf)= 1235.0m	0.29	SATISFIES ANSI
2. Near Field, (Rn)= 514.58m	0.70	SATISFIES ANSI
3. Transition Region, (Rt) Rn < Rt < Rf	0.70	SATISFIES ANSI
4. Between Main Reflector and Subreflector	42.84	POTENTIAL HAZARD
5. Reflector Surface	0.64	SATISFIES ANSI
6. Between Antenna and Ground	0.32	SATISFIES ANSI

<u>7. Conclusions</u>

Based on the above analysis it is concluded that harmful levels of radiation will not exist in regions normally occupied by the public or the earth station's operating personnel. The transmitter will be turned off during antenna maintenance so that the ANSI Standard of 5.0 mW/cm**2 will be complied with for those regions with close proximity to the reflector that exceed acceptable levels.