Attachment A
Radiation Hazard Analysis
TECOM KuStream 1500 Antenna

This exhibit presents the radiation hazard analysis for the TECOM KuStream 1500 antenna to be used in demonstration/validation testing. The analysis uses the procedure outlined in OET Bulletin No. 65, Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, Edition 97-01, pp 26-30.

The maximum level of non-ionizing radiation to which employees may be exposed is limited to a power density level of 5 milliwatts per square centimeter (5 mW/cm^2) averaged over any 6 minute period in a controlled environment. The maximum level of non-ionizing radiation to which the general public may be exposed is limited to a power density level of 1 milliwatt per square centimeter (1 mW/cm^2) averaged over any 30 minute period in an uncontrolled environment.

Note that the worst-case radiation hazards exist along the beam axis. Under normal circumstances, it is highly unlikely that the antenna beam axis will be aligned with an occupied area since that would represent a blockage to the desired signals, thus rendering the link unusable.

This analysis is done for exposure to radiation in the near field, the far field, and the transition region. Safe limits are computed for the controlled and uncontrolled exposure for both the antenna main beam and sidelobes.

The near field region for the main beam is defined in terms of the radius R_{nf} according to the relation

$$R_{nf} = D^2/4\lambda$$

where D is the antenna panel width and λ is the transmit wavelength. R_{nf}, D and λ all have units of cm, centimeters.

The maximum near field power density, S_{nf} (units mW/cm^2), is present at the face of the antenna and is determined from

$$S_{nf} = P_{PA}/A$$

where P_{PA} is the transmit power, in mW, (after cable losses are accounted for) and A is the surface area of the antenna panel, in cm^2. For a rectangular antenna such as the KuStream 1500, the surface area is A = D*h, where h is antenna height.

The far field region for the main beam is at any distance (R) away from the antenna greater than R_{ff} given by

$$R_{ff} = 0.60\ D^2/\lambda$$

The far field power density S_{ff} at distance R from the antenna is

$$S_{ff} = P_{EIRP}/4\pi R^2$$

where R is $\geq R_{ff}$ and P_{EIRP} is the Effective Isotropic Radiated Power of the antenna. The maximum far field power density is at $R = R_{ff}$.

Near Field Exposure from Main Antenna Beam

The KuStream 1500 antenna has dimensions D = 62.5 cm and h = 15.7 cm resulting in a surface area A = 981.25 cm^2. At a transmit frequency of 14.5 GHz, the wavelength is 2.053 cm. The near field radius is then

R_{nf} = 475 cm (4.75 m).

The maximum permitted antenna radiation is 44.0 dBW. The antenna has a transmit gain of 28.8 dB. Consequently, the maximum transmit power is P_{PA} = 15.2 dBW = 33.1 W = 33,113 mW. This results in a maximum near field power density of

S_{nf} = 33.7 mW/cm^2 at the surface of the antenna.

Far Field Exposure from Main Antenna Beam

The minimum far field radius is

R_{ff} = 11.4 m.

The maximum far field power density is at the minimum far field radius, R_{ff}. At the terminal's maximum transmit EIRP of 44.0 dBW, the far field power density at R_{ff} is

S_{ff} = 1.53 mW/cm^2.

Meeting Radiation Exposure Limits

The 5 mW/cm^2 power density for controlled exposure occurs in the near field. Assuming that the field density decreases linearly from S_{nf} of 33.7 mW/cm^2 at R = 0 m to S_{ff} of 1.53 mW/cm2 at R = 11.4m, the controlled exposure limit of 5 mW/cm^2 occurs at 10.2 m.

The 1 mW/cm^2 power density for uncontrolled exposure occurs in the far field. At distance R = 14.1m, the far field power density is S_{ff} = 1.00 mW/cm^2.

Both of these distances are at beam peak and assume the terminal is transmitting at maximum EIRP of 44.0 dBW.

Based on antenna sidelobes with 12 dB reduction from the main beam and using the far field expressions,

- to meet the limit of 5 mW/cm^2 power density for less than 6 minutes for controlled exposure, no individual shall be within 1.6 m of the antenna while it is transmitting
- to meet the limit of 1 mW/cm^2 power density for less than 30 minutes for uncontrolled exposure, no individual shall be within 3.6 m of the antenna while it is transmitting.

Summary

This document presents the radiation hazard analysis for TECOM KuStream 1500 antenna with a maximum EIRP of 44.0 dBW. If individuals are in the main beam of the antenna

- For a controlled exposure, they shall be at least 10.2 meters away and for no more than 6 minutes
- For an uncontrolled exposure, they shall be at least 14.1 meters away for no more than 30 minutes.

Intelsat shall ensure that no individuals shall be within the above-referenced distances of the antenna while it is transmitting. In particular, the antenna will be mounted to the top of a vehicle and Intelsat will control the area around the demonstration vehicle during stationary operations to ensure that no individuals are within the main beam or sidelobes at the specified distances. During in-motion operation, there is no possibility of human RF exposure since no individuals will be within the specified distances of the moving vehicle. Backlobe roll-off and attenuation from the antenna tracking system, mounting assembly and vehicle roof ensure that individuals inside the vehicle will not be exposed to RF radiation in excess of permissible levels.