RADIATION HAZARD ANALYSIS

Introduction

The Office of Engineering and Technology (OET) Bulletin 65 specifies a maximum exposure level at an average power level of 5 mW/cm^2 over a 6-minute period. The following analysis, prepared by GUSA Licensee LLC, estimates the radiation hazard that could potentially exist in the vicinity of a 5.2 GHz transmit/7.0 GHz receive gateway feeder link earth station using a 6-meter Cobham SATCOM antenna. A radiation hazard is potentially the greatest in the near-field, far-field, transition zone and at the edge of the main reflector. All of these areas are examined in this analysis.

Near-Field

The extent of the Fresnel region or near-field is defined by the equation $R_{nf} = D^2/(4*\lambda)$, where D is the antenna diameter of 6 meters and λ is the transmit frequency wavelength of 5.8 centimeters.

$$R_{nf} = (6m)^2/(4*0.058m) = 155 \text{ m.}$$

The maximum power density in the near-field is defined by the equation $S_{nf} = 16*\eta*P/(\pi*D^2)$, where η is the antenna aperture efficiency of 60%, P is the maximum power at the antenna input flange of 295 watts, and D is the antenna diameter of 6 meters.

$$S_{nf} = 16*0.60*295{,}000mW/(\pi*(600cm)^2) = \mathbf{2.5\ mW/cm^2},$$
which is below the maximum allowable exposure level of 5 mW/cm^2.

Far-Field

The distance to the point where the far-field begins is defined by the equation $R_{ff} = 0.6*D^2/\lambda$, where D is the antenna diameter of 6 meters and λ is the transmit frequency wavelength of 5.8 centimeters.

$$R_{ff} = 0.6*(6m)^2/0.058m = 372 \text{ m.}$$

The far-field on-axis power density is defined by the equation $S_{ff} = P*G/(4*\pi*R_{ff}^2)$, where P is the maximum power at the antenna input flange of 295 watts, G is the antenna transmit gain of 47.5 dBi and R_{ff} is the distance to the beginning of the far-field of 372 meters.

$$S_{ff} = 295{,}000mW*10^{4.75}/(4*\pi*(37{,}200cm)^2) = \mathbf{1\ mW/cm^2},$$
which is below the maximum allowable exposure level of 5 mW/cm^2.

Transition Zone

The maximum power density in the transition zone is defined by the equation $S_t = S_{nf}*R_{nf}/R_d$, where S_{nf} is the maximum near-field power density, R_{nf} is the near-field extent of 155 meters, and R_d is the distance to a point in the transition zone. Using a mean distance of 223 meters for R_d,

$$S_t = 2.5\text{mW/cm}^2*155\text{m}/223\text{m} = \mathbf{1.7\ mW/cm^2},$$

which is below the maximum allowable exposure level of 5 mW/cm^2.

Edge of Main Reflector

For even distributions, the power density at the edge of the main antenna reflector is defined by the equation $W = P/A$, where P is the maximum power at the antenna input flange of 295 watts and A is the main reflector area or $\pi*(D/2)^2$, where D is the antenna diameter of 6 meters.

$$W = 295{,}000\text{mW}/(\pi*(600\text{cm}/2)^2) = \mathbf{1\ mW/cm^2},$$

which is below the maximum allowable exposure level of 5 mW/cm^2.

Summary

The above analysis follows the OET 65 guidelines and shows that harmful levels of radiation above maximum allowable exposure level of 5 mW/cm^2 will not exist in areas normally occupied by anyone, including the gateway earth station's operation and maintenance personnel.

In addition, standard radiation hazard warnings will be posted around the earth station and on the antenna itself, alerting personnel to avoid the area in front of the main reflector during transmitter operation. Note that potentially hazardous radiation levels may still exist directly in the main antenna beam and between the antenna feed and subreflector, but these areas will only be accessible by authorized engineering personnel for maintenance purposes, and only after a transmitter power inhibit safeguard has been enabled in accordance with the maintenance procedures. This transmit inhibit will disable any amplifier input signal, thereby muting the power into the antenna, and will be activated by switches in the equipment building, at the antenna structure itself, or by interlock switches which will automatically be activated when opening equipment doors or panels. The antenna is enclosed in a radome which acts as a barrier to physical access, and which has a safety transmit mute switch on the entry door. For additional protection, the antenna will be surrounded by a 6-foot high perimeter safety fence encircling the antenna site. Only authorized trained personnel will have access, albeit limited, inside of the fenced enclosure.