TELECOMMUNICATIONS ENGINEERING

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HUMAN EXPOSURE TO NON-IONIZING ELECTROMAGNETIC FIELDS

This office has been retained by Radio Bilingue, Inc.., to investigate the non-ionizing electromagnetic fields ("NIEF") in the vicinity of a Ku Band transmit/receive satellite earth terminal in order to determine whether these fields fall within the guidelines for human exposure spelled out in FCC Office of Engineering and Technology Bulletin 65, Edition 97-01 ("OET 65"); and to determine whether an Environmental Assessment needs to be prepared per 47 CFR 1.1307 for reasons of NIEF.

The standard set out in OET 65 is derived from standards promulgated by the IEEE/ANSI and the NCRP and was developed to limit the time-averaged absorption of radio frequency power by human beings. OET 65 recognizes two classes of exposure, "Occupational/Controlled" and "General Population/Uncontrolled." In general the General Population standard is more restrictive than the Occupational Standard. At the frequencies of interest here, the General Population/Uncontrolled Standard for power density is 1,000 $\mu W/cm^2$ and the Occupational/Controlled Standard is 5,000 $\mu W/cm^2$. Separate standards for the electric field strength and magnetic field strength are not specified. Occupational exposure may be time averaged over 6 minutes and General Population exposure may be averaged over a 30-minute period.

The subject satellite earth terminal operates at Ku Band frequencies, approximately 14,250 MHz., with a maximum licensed Effective Isotropic Radiated Power of 54.0 dBW. The maximum antenna input power is 3 watts. The antenna is a Prodelin Series 1244. This is an aperture antenna consisting of a circular paraboloid reflector of 2.4 meters diameter and an offset scalar feed. The gain of the antenna is 49.2 dBi at 14,250 MHz. and the calculated aperture efficiency, η, equals 0.66.

The antenna is mounted on the roof of a two-story building. The rooftop is not accessible to the general public. There are publicly accessible areas within the near field region of the antenna, as defined below.

Section 2 of OET 65 divides the electromagnetic environment relative to aperture antennas into four regions; the antenna surface; the near field region; the transition region; and the far field (Fraunhofer) region. Section 2 also suggests a series of calculations of the power density in each of these regions based on an empirical model for determining compliance with the exposure guidelines. While more detailed methods of analysis exist, the FCC has determined that the calculations set out in this section are of sufficient accuracy and are sufficiently conservative to demonstrate compliance with the standards for typical satellite uplinks using circular aperture antennas of parabolic cross section.

Near Field Region

The equation for the power density in the near field predicts the maximum power density that might occur in the near field region without regard to actual location. The radius of the boundary of the near field is defined by:

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

Where:
D is the diameter of the aperture antenna and
λ is wavelength

Therefore, the near field region of the antenna extends 68.4 meters from the antenna.

The maximum likely power density in the near field is defined by:

$$S_{nf} = \frac{16 \eta P}{\pi D^2}$$

Where:
η is the aperture efficiency of the antenna and
P is the input power to the antenna in watts

Substituting, we find that the maximum power density that is likely to occur in the near field from the proposed operation is 1.75 W/m^2.

Correcting for units, this is 175 $\mu W/cm^2$.

This value is well below the 1,000 $\mu W/cm^2$ General Population/Uncontrolled exposure standard.

Given a maximum allowable 1,000 $\mu W/cm^2$ exposure and solving for power in the above equation, we find that this facility can operate at up to 17.4 watts antenna input power without exceeding the exposure limit. This power corresponds to 61.7 dBW EIRP. Operation at power levels above this would require either a more detailed analysis of power density levels in the near field or field measurements to ascertain compliance with the General Population/Uncontrolled exposure standards in OET 65.

Transition Region

Power density in the transition region is expressed as a percentage of the maximum near field power density proportional to the ratio of the distance to the boundary of the near field to the distance of interest from the antenna. This ratio is always less than one, therefore the power density in the transition region is always less than the maximum power in the near field region.

Therefore fields in the transition region are well below the General Public/Uncontrolled exposure standard.

Far Field Region

The power density at the boundary between the transition region and far field region is the same whether calculated by the transition region formula or the far field region formula and the power density decreases with the distance squared in the far field region. Therefore, the power density in the far field region is always less than in the transition region and therefore less than in the near field region.

Therefore fields in the far field region are well below the General Public/Uncontrolled exposure standard.

Antenna Surface

The maximum power density at the surface of the antenna is defined by:

$$S_{surface} = \frac{4\,P}{A}$$

Where:

$A_{surface}$ is the surface area of the reflector (as a conservative approximation this is taken as equal to the aperture area of the reflector).

With an antenna input power of 5 watts, the maximum power density at the surface of the dish is 2.65 W/m^2. Correcting for units, this is 265 $\mu W/cm^2$.

This value is well below the 1000 $\mu W/cm^2$ general public/uncontrolled MPE standard.

Region Between Reflector and Feed

The point of highest power density in this region will occur at the face of the feed horn.

The power density at the face of the feed assembly is defined by

$$S_{feed} = \frac{4\,P}{A}$$

Where:

A_{feed} is the aperture area of the feed horn

The prodelin feed assembly has an aperture area of .0283 m^2

Therefore the power density at the face of the feed horn is equal to 424.0 W/m^2. Correcting for units this is 42,400 $\mu W/cm^2$.

This value exceeds both the general public/uncontrolled and occupational/controlled exposure standards by a considerable amount.

The applicant will erect signage in the vicinity of the antenna warning workers that the maximum permissible exposure standard is exceeded in areas between the feed assembly and the reflector . The applicant will institute a lock-out/tag-out procedure to be followed during maintenance of the antenna.

Conclusions

At no place accessible to the general public is the General Population/Uncontrolled exposure standard exceeded;

The Occupational/Controlled standard is exceeded only in a very limited area near the face of the feed assembly;

Access to this area can be controlled and safety procedures instituted to prevent exposure to NIEF which exceeds the Occupational/Controlled exposure standard;

This facility does not significantly affect the environment as defined in 47 CFR §1.1307(b);

And the preparation of an Environmental Assessment is, therefore, not required.

I, Gray Frierson Haertig, hereby affirm that:

I am principal of Gray Frierson Haertig and Assoc.;

This firm has been retained by Radio Bilingue, Inc., to investigate the NIEF levels in the vicinity of a transmit only satellite earth terminal and to prepare this report for submission to the Commission;

All materials contained herein, unless otherwise attributed, have been prepared by myself;

All statements made herein, unless otherwise attributed, are true to the best of my knowledge and reflect the actual facts of the matter;

I am a Broadcast Engineer of 39 years experience, and my qualifications are a matter of record with the Commission.

Respectfully submitted this 15st day of July 2005,

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Gray Frierson Haertig