DRS TECHNICAL SERVICES, INC

FCC Maximum Permissible Exposure Analysis

Tx/Rx Multi-Band 2.4 VSAT Antenna Series 1251

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Radiation Hazard Analysis for Prodelin 2.4m VSAT Antenna

This report analyzes the non-ionizing radiation levels for the Prodelin 2.4m VSAT antenna fed with a 45 Watt block up-converter. This report is developed in accordance with the prediction methods contained in OET Bulletin No. 65, Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, Edition 97-01. Bulletin No. 65 specifies that there are two separate tiers of exposure limits that are dependent on the situation in which the exposure takes place and/or the status of the individuals who are subject to the exposure -- the General Population/ Uncontrolled Environment and the Controlled Environment, where the general population does not have access. The maximum level of non-ionizing radiation to which individuals may be exposed is limited to a power density level of 5 milliwatts per square centimeter (5 mW/cm2) averaged over any 6 minute period in a controlled environment, and the maximum level of non-ionizing radiation to which the general public is exposed is limited to a power density level of 1 milliwatt per square centimeter (1 mW/cm2) averaged over any 30 minute period in a uncontrolled environment. In the normal range of transmit powers for satellite antennas, the power densities at or around the antenna surface are not expected to exceed safe levels. This area will not be accessible to the general public. Operators and technicians will receive training regarding the exposure area.

Near Field Exposure

The Prodelin 2.4m VSAT antenna fed by a 45 Watt Ku-band block up-converter does not exceed exposure limits in the near field within the parabolic area directly in front of the reflector (.99 mW/cm2). For this calculation, it was assumed that all 45 watts from the SSPA module is uniformly distributed across the surface area of the reflector. This is a reasonable assumption for a uniform waveguide fed parabolic reflector antenna. The extent of the near field region is defined by the following[1]:

$R_{nf} = 0.62*(D^3 /\lambda)^{.5}$ $_{nf} = .62*(2.4\text{m}^3 /.021\text{m})^{.5} = 15.9\text{m}$

(D is the width of the parabolic reflector, 2.4 meters and $\lambda = 2.1\text{cm}$)

The maximum power density in the Near Field can be determined by the following equation:

$S_{nf} = Power/(Aperture\ Area) = (45{,}000mW)/(\pi*120^2\ cm^2) = .9947mW/cm^2$

Where A is the circular surface area of the panel and P is the power available from the SSPA. In normal operation, this antenna is mounted with the main beam pointed toward the sky with a lock at a minimum elevation angle of 10 degrees above the horizon.

[1] Balanis, Constantine, Antenna Theory, Wiley & Sons, New York, 1997, p 32-34

Far Field Exposure (in sidelobe)

The far field may be calculated as[2]:

$R_{ff} = 2*D^2/\lambda = 2*(2.4\text{m})^2 / .021\text{m} = 548.6\text{m}$

Since the antenna main beam will be elevated a minimum of 10°, the energy is reduced by the side lobe equation for gain at angles between 100* λ/D and 20° (which is 0.875° and 20°)[3]:

29 – 25*Log(theta)dBi

Since theta = 10°, Log(theta) = 1. Therefore, the 10° side lobe gain is 4dBi which is an apparent gain of 2.512. The exposure level of the side lobe signal in the far field (548.6m) is[4]:

$$S = \frac{P*G}{4\pi R^2} = 45{,}000*2.512\text{mW} / (4*\pi*54860^2\ ^c\text{m}^2) = 2.9889*10^{-6}\ \text{mW/cm}^2$$

Where, S = Power Density
P = Power Input to Antenna (From Buc) = 45w = 45,000 mW
G = Antenna Sidelobe Gain = 2.5119
R = Far field distance to the center of radiation of the antenna = 54,860cm

Transition Region Exposure

Within a distance of 15.9 m from the antenna, maximum exposure in the main beam is just under 1mW/cm^2. In the far field antenna 10° sidelobe, the power density is about $3*10^{-6}$ mW/cm^2. The transition region between these two calculated exposure points is generally assumed to decrease linearly with distance[5].

Conclusion

According to the FCC guidelines for Occupational/Controlled Exposure and General Population/Uncontrolled Exposure for operations at 1,500 to 100,000 MHz, a person may stand where power density totals 1.0mW/cm^2 for no more than 30 minutes[6]. According to the calculations, a person standing in the near field (up to 15.9m) is exposed to a power density just under this limit. A person in the far field (greater than 548.6m), at the minimum sidelobe angle of 10°, is significantly under the limit. A person between these two points is also under the dictated limit of exposure.

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[2] Ibid, p 32-34
[3] Prodelin 2.4m (Series 1251) antenna specification sheet on September 4, 2012
[4] Op cit, Balanis, p34
[5] Ibid, p32-33
[6] Federal Communications Commission OET Bulletin No. 65, Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, Edition 97-01