Radiation Hazard Analysis for a 1.2-Meter Dish Transmitter

Introduction

This report considers the RF radiation levels involving a 1.2-meter dish antenna operating with a 25 Watt Block Upconverter. The utilized methods are consistent with those of FCC OET Bulletin, No. 65, Edition 97-01. The safety limits are in conformance with the FCC R&O 96-326.

Bulletin No. 65 establishes a two-tier exposure limit dependent on both (1) The circumstances of the exposure, and (2) The cognizance of the individuals subjected to it. The Maximum Permissible Exposure (MPE) limits for persons in a General Population/Uncontrolled environment, as well as those for persons in an Occupational/ Controlled environment are shown below.

Limits for General Population/Uncontrolled Exposure (30 minutes)

Frequency Range (MHz)	Power Density (mW/cm^2)
1500 - 100,000	1.0

Limits for Occupational/Controlled Exposure (6 minutes)

Frequency Range (MHz)	Power Density (mW/cm^2)
1500 - 100,000	5.0

This report's analysis determines the transmitter's power flux density levels in the far-field, near-field, transition region, between the feed and reflector surface, at the main reflector surface, and between the antenna edge and ground. It thereafter compares these levels to the specified limits.

Antenna and Block Upconverter Specifications

Antenna Diameter (D)	1.2 m
Feed Flange Diameter (Dfa)	9.0 cm
Frequency (F)	14250 MHz
Transmit Power (P)	25.0 W
Antenna Gain (Ges)	43.2 dBi

Various Calculations

Antenna Surface Area	$A_{surface}$	$\pi * (D^2) / 4$	1.13 m^2
Area of Feed Flange	A_{fa}	$\pi * (Dfa^2) / 4$	63.62 cm^2
Wavelength	λ	300 / F	0.021053 m
Antenna Gain (factor)	G	10^(Ges/10)	20893.0
Antenna Efficiency	η	$G\lambda^2/(\pi^2 D^2)$	0.65

Far Field Location

The distance of far field from the antenna is determined by the following:

$Rff = 0.60 * D^2 / \lambda$ = **41.04 m**

The maximum far-field power density (i.e., at nearest location in main beam) is determined by the following:

$Sff = G * P / (4 * \pi * Rff^2)$ = 24.68 W/m^2 = **2.468 mW/cm^2**

The distance at which a Power Density of 1.0 mW/cm^2 would be achieved is then **64.5 m**.

Near Field Calculation

In the Near Field, the Power Flux Density is treated as 'fixed' along its entire length, a region defined as a 'cylinder' of the same diameter as the antenna, projecting away from the antenna, with energy flowing uniformly across that diameter.

The extent of the near field is determined by the following:

$Rnf = D^2 / (4 * \lambda)$ = **17.10 m**

The power density at any location in the Near Field is determined by the following:

$Snf = 16.0 * \eta * P / (\pi * D^2)$ = 57.47 W/m^2 = **5.747 mW/cm^2**

Transition Region Calculation

The Transition Region is that between the Near Field and Far Field boundaries. The Power Density decreases from its value at the Near Field extent, to its value at the beginning of the Far Field.

The Power Density in the Near Field is the highest the antenna can produce in any region distant from the antenna. Its value will be assumed to apply for any distance within the Transition Region.

Max Transition Region Power Density **St = 5.747 mW/cm2**

Region between the Feed Assembly and the Antenna Reflector

Transmissions from the feed assembly directed toward the antenna reflector surface are considered to be confined within a 'cone-shape' defined by the type of feed assembly. The maximum energy between the feed assembly and reflector surface is calculated by considering the power density at the feed assembly surface. This is determined from the following:

(Power Density at the Feed Flange) $Sfa = 4 * P / Afa$ = 15,719.0 W/m^2 = **1,571.90 mW/cm2**

Main Reflector Region

The Power Density in the main reflector is determined similarly to that in the feed assembly. The area considered is the surface area of the reflector itself, and can be determined from the following (note that this differs from the Power Density in the Near Field only by the efficiency of the antenna)

(Power Density at the Reflector Surface) $Ssurface = 4 * P / Asurface$ = 88.42 W/m^2 = **8.842 mW/cm^2**

Region between the Reflector and the Ground

Assuming uniform illumination of the reflector surface, the Power Density between the antenna and the ground can be determined from the following:

(Power Density between Reflector and Ground) Sg = P / Asurface = 22.104 W/m^2 = **2.2104 mW/cm^2**

Summary of Calculations / Comparison to Limits

Location	Power Density	Uncontrolled Limit (1 mW/cm^2) / Safe Distance	Controlled Limit (5 mW/cm^2) / Distance
Far Field (41.04 m)	2.468 mW/cm2	Not satisfied / 64.5 m	Satisfies limit
Near Field (17.10 m)	5.747 mW/cm2	Not satisfied / N/A	Not satisfied / N/A
Transition Region	5.747 mW/cm2	Not satisfied / N/A	Not satisfied / N/A
Feed Assembly	1,571.90 mW/cm2	Not satisfied / N/A	Not satisfied / N/A
Main Reflector	8.842 mW/cm2	Not satisfied / N/A	Not satisfied / N/A
Reflector-Ground	2.2104 mW/cm2	Not satisfied / N/A	Satisfies limit

Conclusions

For Uncontrolled Exposure scenarios, for an individual standing in the direction of the main beam, the minimum distance of separation from the antenna is 64.5 meters.

For Controlled Exposure scenarios, for an individual standing in the direction of the main beam, the minimum distance of separation from the antenna is 41.04 meters.

For Controlled Exposure scenarios, an individual may remain in the area between the antenna and ground for the specified limit-duration.