

## **RADIATION HAZARD ANALYSIS**

### **3.5 meter EARTH STATION**

This analysis calculates the non-ionizing radiation levels due to transmission from the earth station. The Office of Engineering and Technology (OET) Bulletin, No. 65 Edition, specifies that the Maximum Permissible Exposure (MPE) limit for persons in a General Population/Uncontrolled environment to non-ionizing radiation is a power density equal to 1 milli-watt per centimeter squared averaged over a thirty minute period, and for a controlled environment is 5 milli-watts per centimeter squared averaged over a six minute period.

The analysis estimates the maximum power density levels in the vicinity of the antenna for six regions: near field; far field; transition zone; near the reflector surface; between the reflector and the ground; and between the sub-reflector and the main reflector.

A brief discussion for each region is given below and the results of the analysis are summarized. The attached table shows the assumptions, formulae and calculations for all cases.

#### **1. NEAR FIELD REGION**

The near field (or Fresnel region) is essentially a cylindrical volume with its axis co-incident with the antenna boresight. The base of this volume is the same as the aperture of the antenna. According to OET Bulletin No. 65, its length is equal to the square of the diameter divided by four times the wavelength. Past the boundary of the Near Field region, the power density from the antenna decreases linearly with respect to increasing distance.

#### **2. TRANSITION REGION**

The transition region between the near field and the far field regions will have a power density that essentially decreases inversely with increasing distance. In any case, the maximum power density in this region will not exceed the maximum value calculated for the near field region, for the purpose of evaluating potential exposure.

#### **3. FAR FIELD REGION**

The far field (or Fraunhofer region) extends outwards from a distance equal to 0.6 times the square of the reflector diameter divided by the wavelength, according to OET Bulletin No. 65. Power density varies inversely as the square of the distance. The maximum value of the power density is calculated using the equation given in the Bulletin.

#### **4. REGION BETWEEN THE MAIN REFLECTOR AND SUB-REFLECTOR**

Transmissions from the feed assembly are directed toward the sub-reflector surface, and are reflected back toward the main reflector. The most common feed

assemblies are waveguide flanges, horns or sub-reflectors. The energy between the sub-reflector surfaces can be calculated by determining the power density at the sub-reflector surface. This is done by taking four times the power divided by the sub-reflector surface area.

## **5. REGION NEAR MAIN REFLECTOR SURFACE**

The power density in the region near the main reflector surface can be estimated as equal to four times the power divided by the area of the main reflector surface, assuming that the illumination is uniform and that it would be possible to intercept equal amounts of energy radiated towards and reflected from the reflector surface.

## **6. REGION BETWEEN MAIN REFLECTOR AND GROUND**

The power density in the region between the main reflector and the ground can be estimated as equal to the power divided by the area of the reflector surface, assuming uniform illumination over the surface of the reflector.

## **7. RESULTS OF ANALYSIS**

The radiation analyses in the following Table was performed in accordance with the discussion from the previous sections and assuming worst case operating conditions. Based on the analysis contained therein it is concluded that levels of radiation in excess of 1 mW/cm<sup>2</sup> will exist in regions in close proximity to the antenna main reflector. Therefore, a perimeter fence will be constructed around the antenna to create a controlled environment for areas that could otherwise be occupied by the general public. As can be seen, the analysis further demonstrates that the calculated radiation levels exceed the controlled environment level of 5 mW/cm<sup>2</sup> near the reflector surface and between the feed mouth and the reflector. As such, appropriate signage will be posted and the transmitter will be disabled whenever station personnel need to occupy these areas.

### RADIATION HAZARD ANALYSIS

Nomenclature	Formula	Value	Unit
<b>INPUT PARAMETERS</b>			
D = Antenna Diameter		3.5	meters
d = Diameter of Feed Mouth		0.031	meters
P = Max Power into Antenna		500	Watts
$\eta$ = Aperture Efficiency		56	%
Frequency		25	GHz
$\lambda$ = Wavelength @ 30 GHz		0.012	meters
<b>CALCULATED VALUES</b>			
A = Area of Reflector	$\pi \cdot D^2/4$	9.62	meters <sup>2</sup>
l = Length of Near Field	$D^2/4\lambda$	255.21	meters
L = Beginning of Far Field	$0.6D^2/\lambda$	612.50	meters
G = Antenna gain at 25 GHz	$\eta(\pi \cdot D/\lambda)^2$	470176.99	linear
Antenna Gain in dB	$10 \cdot \log(G)$	56.72	dBi
a = Area of Feed Mouth	$\pi \cdot d^2/4$	0.0008	meters <sup>2</sup>
<b>POWER DENSITY CALCULATIONS</b>			
Region	Max Power Density In Region		Hazard Assessment (FCC MPE Limit=1mW/cm <sup>2</sup> )
	Formula	Value (mW/cm <sup>2</sup> )	
1. Near Field	$4 \cdot \eta \cdot P/A$	11.64	>FCC MPE Limit (See Text)
2. Far Field	$G \cdot P/(4 \cdot \pi \cdot L^2)$	4.99	>FCC MPE Limit (See Text)
3. Transition	<= Nr Fld Region	11.64	>FCC MPE Limit (See Text)
4. Near Reflector Surface	$4 \cdot P/A$	20.79	>FCC MPE Limit (See Text)
5. Between Reflector and Ground	P/A	5.20	>FCC MPE Limit (See Text)
6. Between feed mouth and reflector	$4 \cdot P/a$	264982.22	> FCC MPE Limit (See Text)