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Radiation Hazard Report

Advent Mantis 240 C-Band Antenna System

The purpose of this report is to examine the potential human exposure to radio frequencies (RF) emitted in the form of electro magnetic (EM) radiation from an Advent Mantis 2.4m C-Band satellite antenna. The mathematical analysis performed below complies with the methods described in the Federal Communications Commission Office of Engineering and Technology Bulletin No. 65 (1985 rev. 1997) R&O 96-326.

Maximum Permissible Exposure

There are two separate levels of exposure limits. The first applies to persons in the general population who are in an uncontrolled environment. The second applies to trained personnel in a controlled environment.

According to 47 C.F.R. § 1.1310, the Maximum Permissible Exposure (MPE) limits for frequencies above 1.5GHz are as follows:

• General Population / Uncontrolled Exposure 1.0 mW/cm2
• Occupational / Controlled Exposure 5.0 mW/cm2

The purpose of this study is to determine the power flux density levels for the earth station under study as compared with the MPE limits. This comparison is done in each of the following regions:

1. Far-field region
2. Near-field region
3. Transition region
4. The region between the feed and the antenna surface
5. The main reflector region
6. The region between the antenna edge and the ground

Input Parameters

The values below are used in the calculations detailed in this report

Parameter	**Value**	**Unit**	**Symbol**
Antenna Diameter	2.4	m	*D*
Antenna Transmit Gain	42.1	dBi	*G*
Transmit Frequency	6200	MHz	*f*
Feed Flange Diameter	9.8	cm	*d*
Power Input to Antenna	260	W	*P*

Calculated Parameters

The following values are calculated from the input parameters from there corresponding formulas.

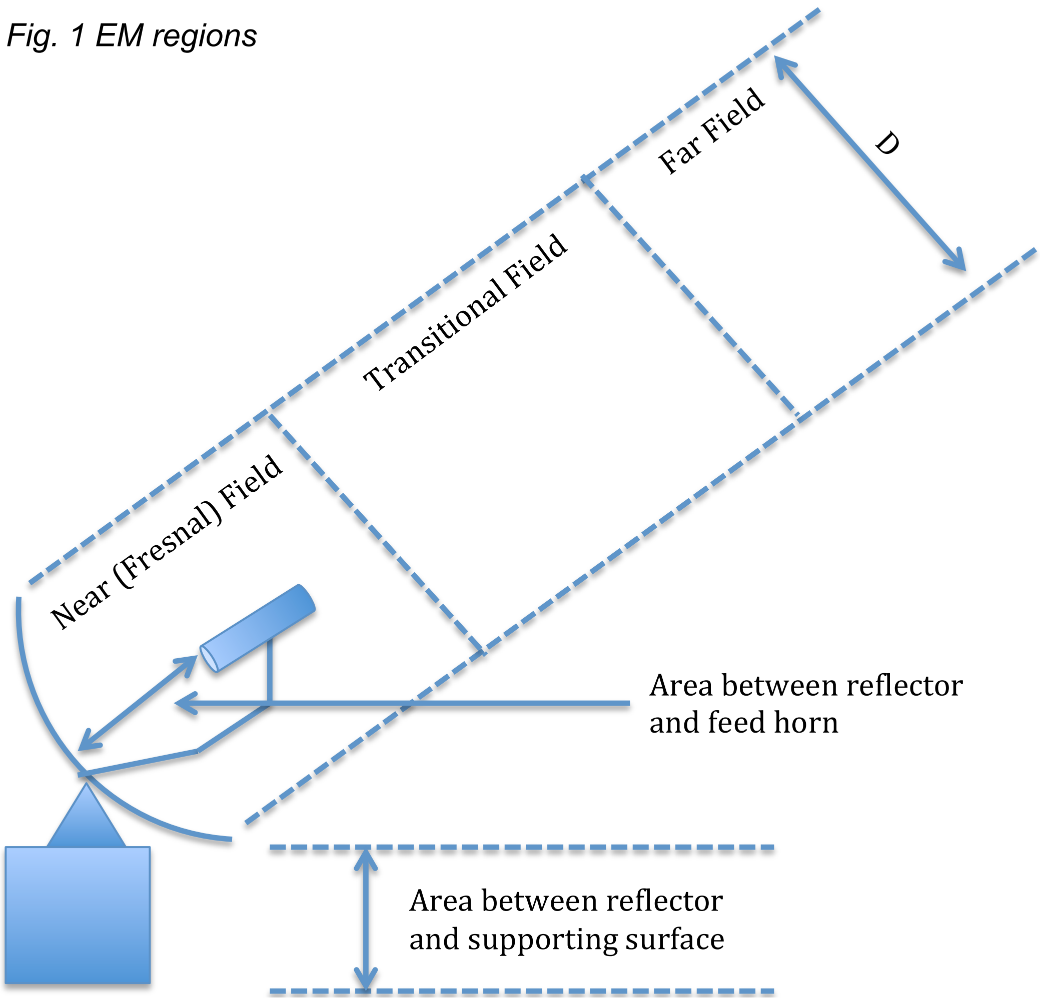
(All values rounded to two decimal places)

Parameter	Value	Unit	Symbol	Formula
Antenna Surface Area	4.52	m^2	A	$\pi D^2/4$
Feed Flange Surface Area	75.43	cm^2	a	$\pi d^2/4$
Antenna Efficiency	0.67		η	$G\lambda^2/(\pi^2 D^2)$
Gain Factor	16218.10		g	$10^{G/10}$
Wavelength	0.048	m	λ	300/ʃ

Regions of EM fields, Characteristics and there Behavior

EM radiation emitting from a parabolic antenna has different behavioral and characteristics depending on the distance from the reflector surface. This distance from the reflector can be catagorised in three regions, Near (Fresnal) Field Region, Transitional Region and Far Field Region. Additional areas of interest are also the area between the feed horn and the reflector, the area between the supporting surface and the reflector, and the main reflector area.

Fig. 1 EM regions



Parabolic antennas with circular reflectors, such as the dish under analysis in this report, have the Near, Transitional and Far Field distances calculated with the formulas below

Parameter	Value	Unit	Formula
Near Field Distance	30	m	$R_{nf}=D^2/(4\lambda)$
Distance to Transitional Field	30	m	$R_t=R_{nf}$
Distance to Far Field	72	m	$R_{ff}=0.60D^2/\lambda$

The distance within the transition region is between the near and far fields. This allows for the following rule, $R_{nf} \le R_t \le R_{ff}$. However, the power density in the transition region cannot exceed the power density in the near field.

Power Flux Density Calculations

Power flux density is the rate of transfer the EM moves through space. Flux density is at it strongest through the entire length of the near field and is concentrated through a cylinder proportional to the surface diameter of the reflector (*D*). Within the transitional and far field, the power density decreases at an opposite rate. Power density with in the three regions is calculated below.

Parameter	Value	Unit	Symbol	Formula
Power Density in the Near Field	1.54	mW/cm^2	S_{nf}	$16\eta P/(\pi D^2)$
Power Density in the Trans. Field	1.54	mW/cm^2	S_t	$GP/(4\pi R_{ff}^2)$
Power Density in the Far Field	0.79	mW/cm^2	S_{ff}	$S_{nf}R_{nf}/(R_t)$

The area between the feed horn and the reflector surface is confined within a conical shape, this is due to the aperture of the feed assembly. The Power density is defined below.

Parameter	Value	Unit	Symbol	Formula
Power Density at Feed Flange	1378.76	mW/cm^2	S_{fa}	$4P/a$

The above formula also applies when working out the power density at the reflector surface.

Parameter	Value	Unit	Symbol	Formula
Power Density at the Reflector	2.30	mW/cm^2	$S_{surface}$	$4P/A$

Assuming there is uniform spread across the reflector, the power density between the surface and reflector is shown below.

Parameter	Value	Unit	Symbol	Formula
Power Density Between the Surface and the Reflector	1.22	mW/cm^2	S_g	P/A

The table below shows the results of this report and if they meet the FCC limitations for EM exposure. It can be seen that only the area between the feed horn and the reflector exceeds the limitations set out by the FCC. This area is only accessed by experienced engineers who are trained to cease the transmission before accessing this area.

Area of exposure	mW/cm^2	FCC Limitation (<5 mW/cm^2)
Power Density in the Near Field	1.54	Within FCC Limitation
Power Density in the Trans. Field	1.54	Within FCC Limitation
Power Density in the Far Field	0.79	Within FCC Limitation
Power Density at Feed Flange	1378.76	Exceeds FCC Limitation
Power Density at the Reflector	2.30	Within FCC Limitation
Power Density Between the Surface and the Reflector	1.22	Within FCC Limitation

In conclusion to this report it can be seen that the antenna, with appropriate controls, and operation by a trained engineer, meet the guidelines set out in 47 C.F.R. § 1.1310.

Additional Information

Fig. 2 Advent Mantis 2.4m C-Band Antenna

Fig. 3. Advent Mantis 2.4m C-Band Antenna off axis gain meets requirements for the following standards

ITU-R S.580-6
ITU-R S.465-5
INTELSAT IESS-601
EUTELSAT ESS-502
MIL STD 188-164A
STANAG 4484