Raysat Antenna Systems, LLC
Application for Modification of Experimental License
Call Sign WF2XQF
ELS File No. 0506-EX-PL-2010

Raysat Antenna Systems, LLC ("RAS"), through its attorneys, hereby submits this application to modify its above-referenced experimental license to increase the transmit power of the authorized Land Mobile-Satellite Service ("LMSS") terminals. In order to maintain the power spectral density at permissible levels given the higher power levels, the terminals will transmit over a larger bandwidth.

I. BACKGROUND

On March 23, 2011, the Federal Communications Commission ("FCC") granted RAS a two-year experimental license (Call Sign WF2XQF), until March 23, 2013, to operate up to five (5) LMSS terminals in the 14.0-14.5 GHz and 11.7-12.2 GHz frequency bands and communicate with the AMC-5 and AMC-6 satellites at 79° W.L. and 72° W.L., respectively, as well as a Spacenet hub earth station in McLean, Virginia (Call Sign E860326).[1] Call Sign WF2XQF authorized RAS to test and demonstrate its SR-70 (re-designated as SR-71) earth terminal. Building on its proven antenna technology for mobile applications, RAS developed the SR-71 as a light, single-panel Ku-band array antenna designed with a low profile and small footprint, which allows it to be placed unobtrusively on vehicles. The antenna's full-motion tracking system provides broadband data access to users "on-the-move."

The SR-71 antenna was developed in connection with Department of Defense/Logistics Innovation Agency (DOD/LIA) operational requirements – prime contract #W31P4Q-05-A-

[1] The two-year experimental license followed two previous experimental Special Temporary Authorizations ("STAs") for these same terminals. *See* ELS File No. 0529-EX-ST-2009, Call Sign WE9XDH; ELS File No. 0286-EX-ST-2010, Call Sign WE9XKU.

0031/TO#0021. Call Sign WF2XQF authorizes RAS to conduct over-the-air testing to evaluate the antenna's performance and to demonstrations test and demonstrate the feasibility of the lighter weight, lower cost SR-71 antenna to potential US Government customers pursuant to this DOD/LIA contract. RAS' customers have indicated that they have a need for the SR-71 antenna to operate at higher power levels, thus resulting in RAS' instant application to modify Call Sign WR2XQF to permit testing and demonstration of the antenna using higher transmit power levels.

RAS hereby incorporates by reference all the technical and public interest information and analysis submitted in conjunction with its obtaining the prior experimental STAs (Call Signs WE9XDH and WE9XKU) and two-year experimental license (Call Sign WF2XQF). For the Commission's convenience, attached is a copy of RAS' narrative statement at Appendix A for Call Sign WE9XDH.

II. REQUESTED MODIFICATION

Call Sign WF2XQF authorizes a maximum authorized transmit power of 8 Watts EIRP (2426 ERP). Like other RAS antennas authorized by the Commission for experimental operations,[2] the SR-71 incorporates a block upconverter ("BUC"). To respond to potential customers' requests that the SR-71 antenna operate at higher power levels, RAS has paired the antenna with a larger BUC (using a 40 Watt amplifier), thus increasing the maximum EIRP to 36dBW (3891 Watts EIRP) or 33.85dBW ERP (2426.6 Watts ERP).

Under Call Sign WF2XQF, the SR-71 antenna is authorized to transmit over a 6.75 MHz bandwidth. In order to maintain the transmitted power density at or below the authorized -25.2 dBW/4kHz at the input flange, RAS proposes to transmit over a wider bandwidth, *i.e.*, 23.96 MHz, as demonstrated in Figure 1, below, and the proposed modification of Call Sign WF2XQF

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[2] See ELS File No. 0235-EX-RR-2010, Call Sign WE2XTX (the StealthRay™ 3000/40 terminal).

incorporates this change. This step will ensure that the input power spectral density is consistent with that currently permitted under Call WF2XQF and consistent with the Commission's two-degree spacing policies. No further technical modifications are sought to Call Sign WF2XQF.

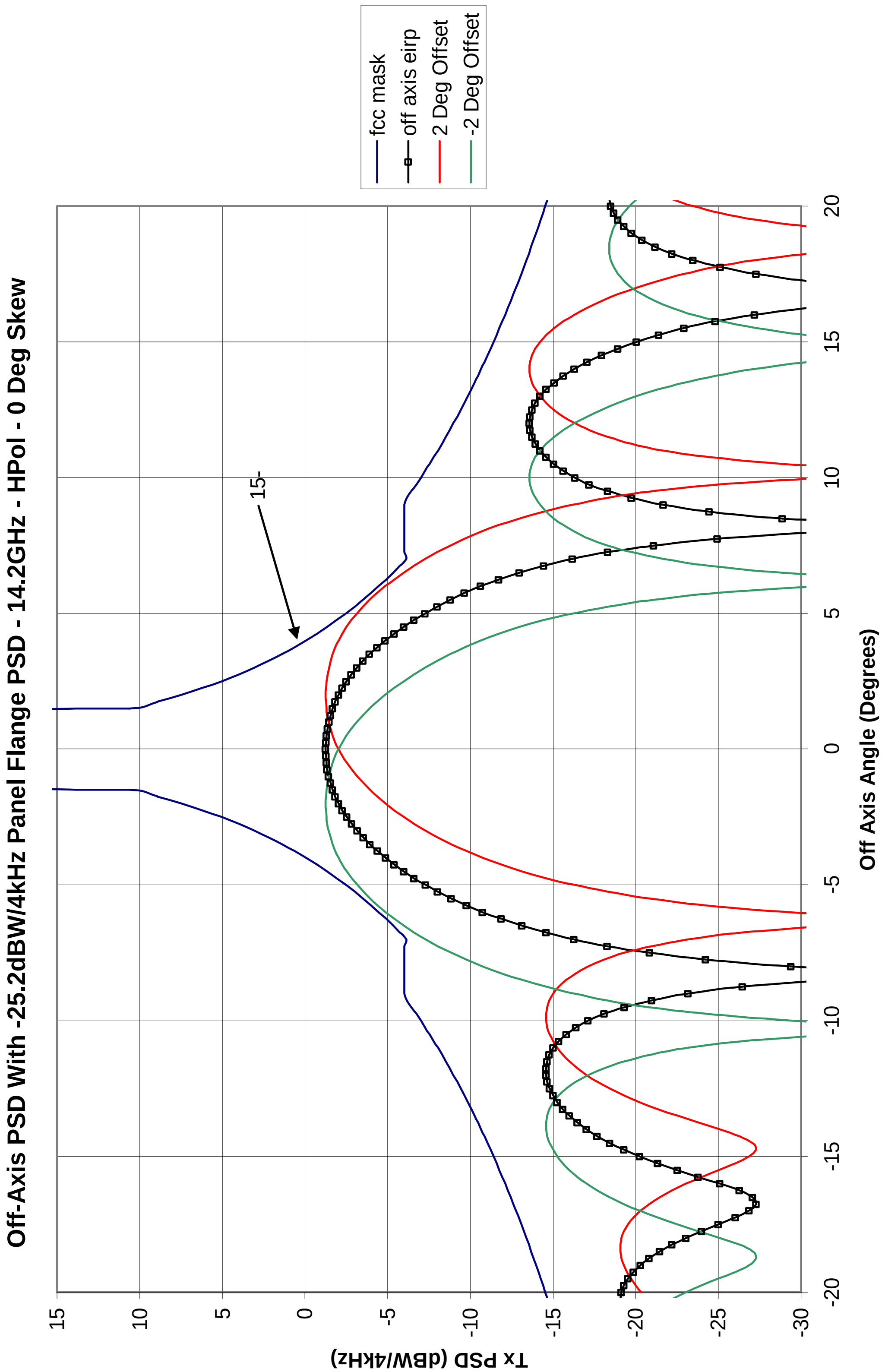

Figure 1 -- Off-Axis PSD with -25.2 dBW/4 kHz Panel Flange PSD

Consequently, operation of the SR-71 antenna will remain within the maximum emissions envelope currently authorized by the Commission in Call Sign WF2XQF, and be fully compliant with the Commission's requirements for Ku-band land mobile terminals (*see* 47 CFR § 25.226, vehicle-mount earth stations, or "VMES" rules) to protect adjacent satellites from interference. Moreover, RAS acknowledges, and will fully comply with, the Special Conditions attached to Call Sign WF2XQF and analogous requirements in the VMES rules. A link budget for the modified SR-71 antenna is included with this submission at Appendix B. Also attached at Appendix C is a new radiation hazard analysis.

Finally, Raysat seeks to add a new antenna location, Pismo Beach, CA, to the experimental license. The existing, authorized locations, Vienna, VA, and Petersburg, VA, are not changed.

III. CONCLUSION

RAS respectfully submits that grant of the requested modification of Call Sign would serve the public interest. Grant of the requested modification would enable RAS to test and demonstrate its SR-71 antenna at higher power levels to potential US Government customers. The proposed modification to incorporate a larger block upconverter will be accomplished without increasing the potential for interference to other users of Ku-band spectrum and maintain the required two-degree spacing.

APPENDIX A

RAYSAT ANTENNA SYSTEMS, LLC
NARRATIVE STATEMENT
File No. 0529-EX-ST-2009
Call Sign WE9XDH

Raysat SR-70 Antenna STA Application

1.0 Introduction

Raysat Antenna Systems, LLC ("RAS"), pursuant to Section 5.61 of the Commission's rules, 47 C.F.R. § 5.61, hereby requests an experimental special temporary authorization ("STA") to operate up to five (5) Land Mobile-Satellite Service ("LMSS") earth stations in the 14.0-14.5 GHz and 11.7-12.2 GHz frequency bands with the AMC-5 and AMC-6 satellites at 79° W.L. and 72° W.L., respectively. The satellites will communicate with the Spacenet hub earth station in McLean, Virginia (Call sign E860326).

RAS seeks to test and demonstrate the new SR70 earth terminal. RAS has developed the lighter SR70, a single-panel, Ku-band array antenna in connection with Department of Defense/Logistics Innovation Agency (DOD/LIA) operational requirements (prime contract # W31P4Q-05-A-0031/TO#0021) and seeks to operate the terminals pursuant to this government contract. The SR70 has a low profile and a small footprint, which allows it to be placed unobtrusively on vehicles. The full-motion tracking system provides broadband data access to users on-the-move. The antenna technology builds upon RAS's proven antenna technology for mobile applications.

Grant of the experimental STA would strongly serve the public interest by supplementing RAS's currently authorized LMSS operations with an additional lower-cost antenna, which will result in expanded service and equipment options for U.S. Government and ultimately other commercial customers.[1] RAS requires an STA to demonstrate the feasibility of the new lighter weight, lower cost antenna to potential U.S. government customers.

The operational requirements for the SR70 and the U.S. government objectives regarding the above referenced DOD/LIA contract have recently been finalized. Therefore, Raysat requests expeditious processing of this application by December 1, 2009.

2.0 Antenna

The SR-70 antenna technology builds upon RAS's proven antenna technology for mobile applications. The major enhancement is in the antenna panel which is capable of simultaneous Ku-band transmission and reception within the 14.0-14.5 GHz and 11.7-12.7 GHz bands, respectively. The antenna allows tracking in three axes, azimuth, elevation and polarization.

The antenna consists of a single 6 inch by 6 inch panel array which is mounted on a rotatable platform. The platform rotates in azimuth to orient the panel towards the satellite. The panel also tilts to set the elevation angle. Finally, the antenna has a

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[1] *See* ELS File Nos. 0203-EX-PL-2008, 0204-EX-PL-2008 and 0033-EX-ST-2009.

polarization control mechanism which sets the correct polarization angle for both transmit and receive.

A drawing of the antenna panel and the antenna assembly is shown in Figures 1 and 2, respectively.

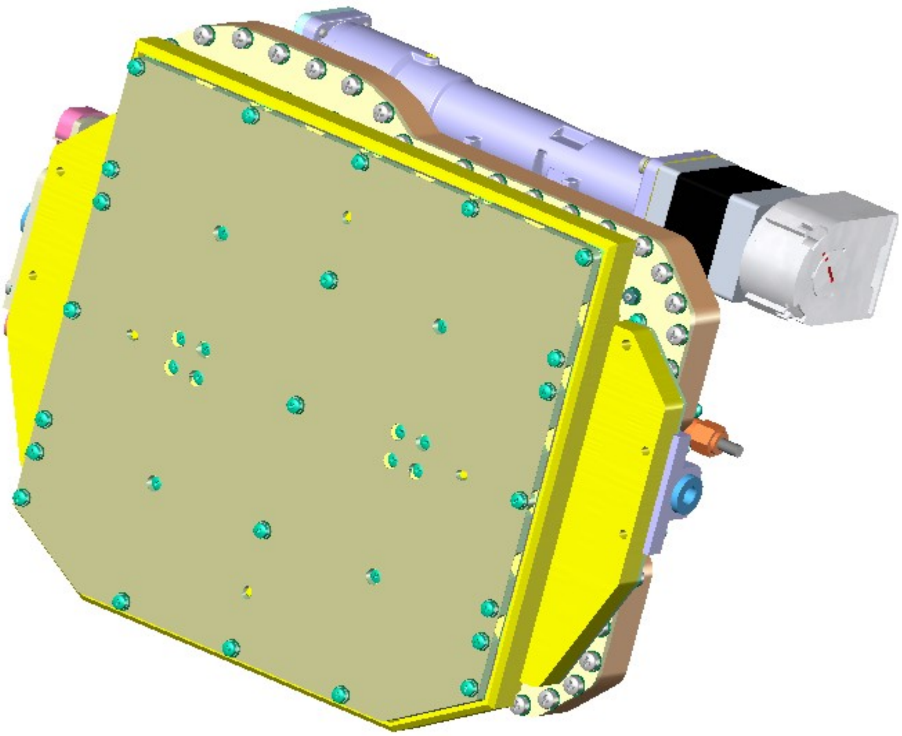

Figure 1
SR-70 Panel Array

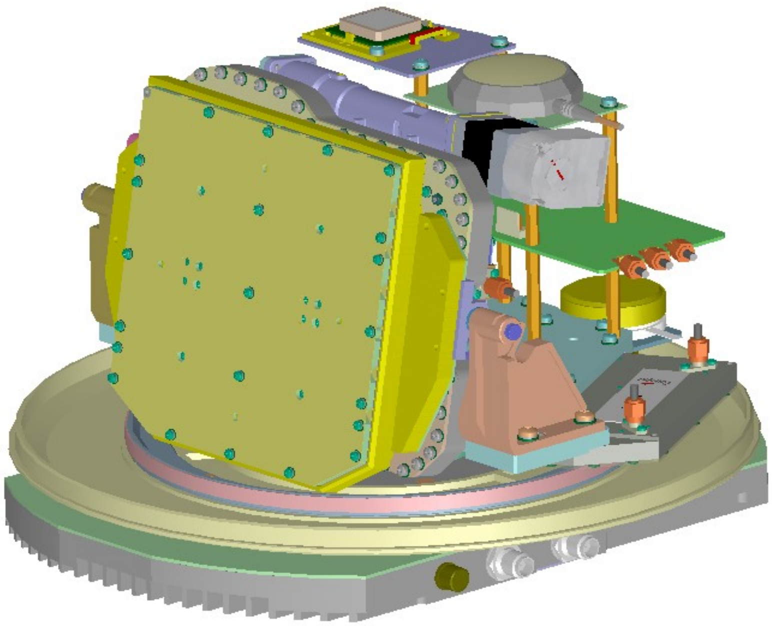

Figure 2
SR-70 Antenna

3.0 Antenna Operation

As with all RAS antennas, the SR70 has active control of the azimuth, elevation and polarization angles to maintain precise pointing towards the target satellite. The antenna scans mechanically in both azimuth and elevation.

For satellite acquisition and reacquisition, the proven principles implemented in existing RAS antennas will be applied. A simplified block diagram of the major components in the tracking and acquisition system is shown in Figure 3.

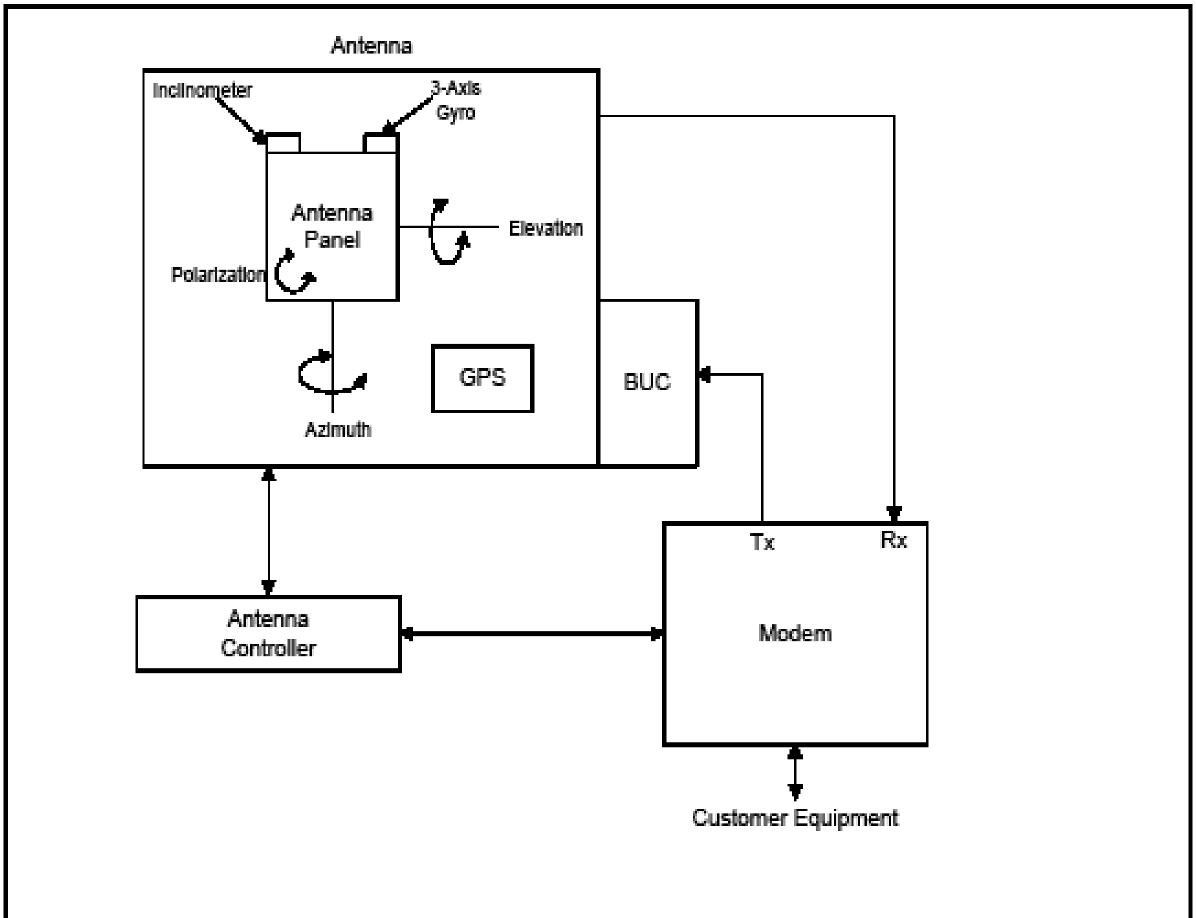

Figure 3
Typical Antenna Equipment Set-up

During operation, the antenna uses a built-in GPS receiver to determine its position on the earth. It then uses the geographical position and the longitudinal position of the satellite to determine the appropriate elevation angle. Once the elevation angle is set, the antenna rotates in azimuth. During the scanning process the antenna receives Eb/No information from the modem to verify that the target satellite has been acquired. Once the satellite is acquired, the antenna dithers in both azimuth and elevation by ±2.0° to maintain peaking on the satellite and the transmission is enabled. The antenna also has internal 3-axis gyroscopes and 2-axis inclinometers to help with the tracking while the antenna is in motion. The antenna will use the information from the gyros to determine when the pointing offset has reached 2.0° and will initiate transmit muting when this occurs within 100 milliseconds.

For purposes of protecting radio astronomy sites, in the absence of a coordination agreement with the National Science Foundation, Raysat terminals will not operate within line-of-sight vicinity of radio astronomy sites during observation periods.

Further, Raysat recognizes the utilization of the frequency band from 14.0-14.05 GHz and the possible use of the band from 14.05-14.2 GHz allocated to the National Aeronautics and Space Administration (“NASA”) Tracking and Data Relay Satellite System (“TDRSS”) for space research conducted at White Sands, New Mexico and Blossom Point, Maryland. Consistent with 47 C.F.R. §25.222(d), Raysat will cease transmit operations within 125 km of the operational facilities unless and until it reaches a coordination agreement with NASA permitting such operations. Raysat will operate the SR70 antennas within a 20 km radius of Vienna, VA and Petersburg, VA. Therefore, Raysat will not enter the 125 km TDRSS radius of White Sands or will reach a coordination agreement with NASA if it is operating within the 125 km radius of the Blossom Point, MD facility when that facility commences operations.

Raysat acknowledges that non-geostationary orbit (“NGSO”) systems are also permitted to operate in the Ku-band. However, no such systems are currently authorized or planned to operate within the period contemplated for the proposed experimental operations. To the extent such systems are ultimately deployed, Raysat will coordinate with NGSO FSS licensees to protect their systems from harmful interference.

4.0 Antenna Patterns

The transmit gain pattern shown in Figures 4 and 5 exceeds the Commission’s routine licensing guidelines, but by limiting the input power spectral density to -25.2dBW/4kHz the off axis EIRP density remains under the Section 25.222(a)(1) and 25.226(a)(1)(i) off-axis power spectral density (“PSD”) mask even with a 2.0 degree scanning offset in the GSO plane as shown in Figure 6. *See* 47 C.F.R. § 25.226(b)(1)(iv)(A). Thus, at all times transmissions from the SR70 antenna are compliant with the Commission’s two-degree spacing levels.

The maximum level of off-pointing is set to 2.0° in the plane of the GSO arc after which the transmissions are commanded to turn off within 100 milliseconds. *See* 47 C.F.R. § 25.226(b)(1)(iv)(B). In addition, reduced input power into the antenna ensures compliance with off-axis EIRP levels associated with two-degree spacing and the coordinated parameters of the serving satellite. RAS has performed detailed analysis and has confirmed that the adjacent satellite interference levels produced under the worst case operating conditions with a -25.2 dBW/4kHz at the input flange would be no worse than a Section 25.209 compliant antenna with -14dBW/4kHz at its input flange.

5.0 CONCLUSION

As demonstrated herein, grant of the requested experimental STA would strongly serve the public interest. Specifically, grant of the requested authority would permit RAS to add a new antenna to its already authorized LMSS operations and expand the range of mobile broadband options available to U.S. government users, without increasing the potential for interference to other users of Ku-band spectrum.

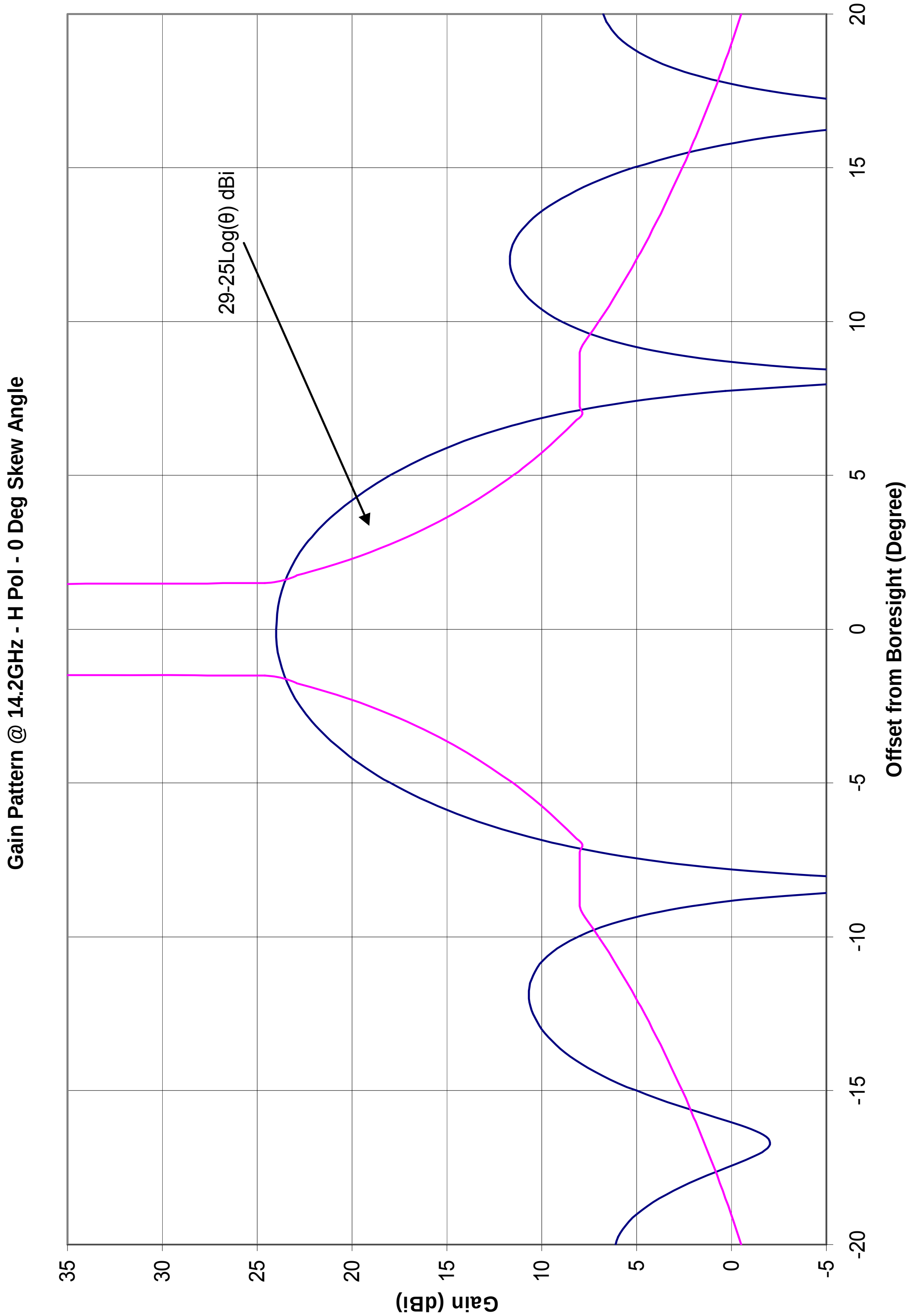

Figure 4
Close-In Gain Pattern

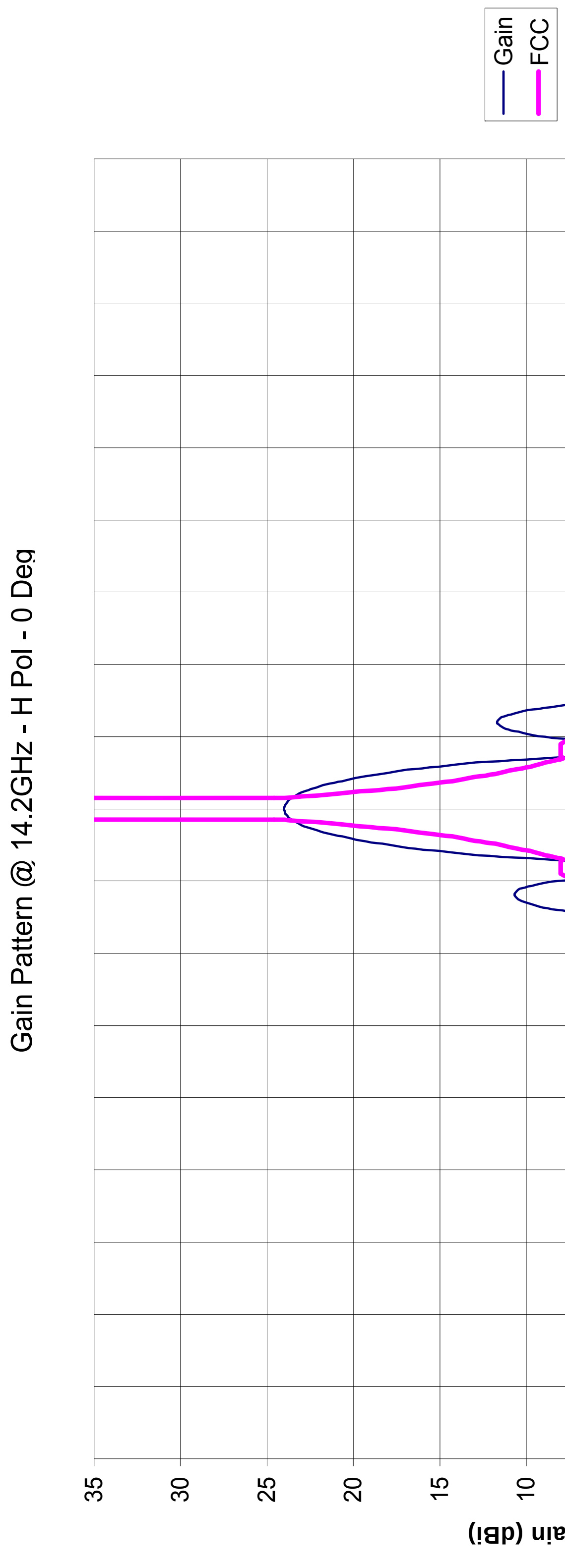

Figure 5
Wide Gain Pattern

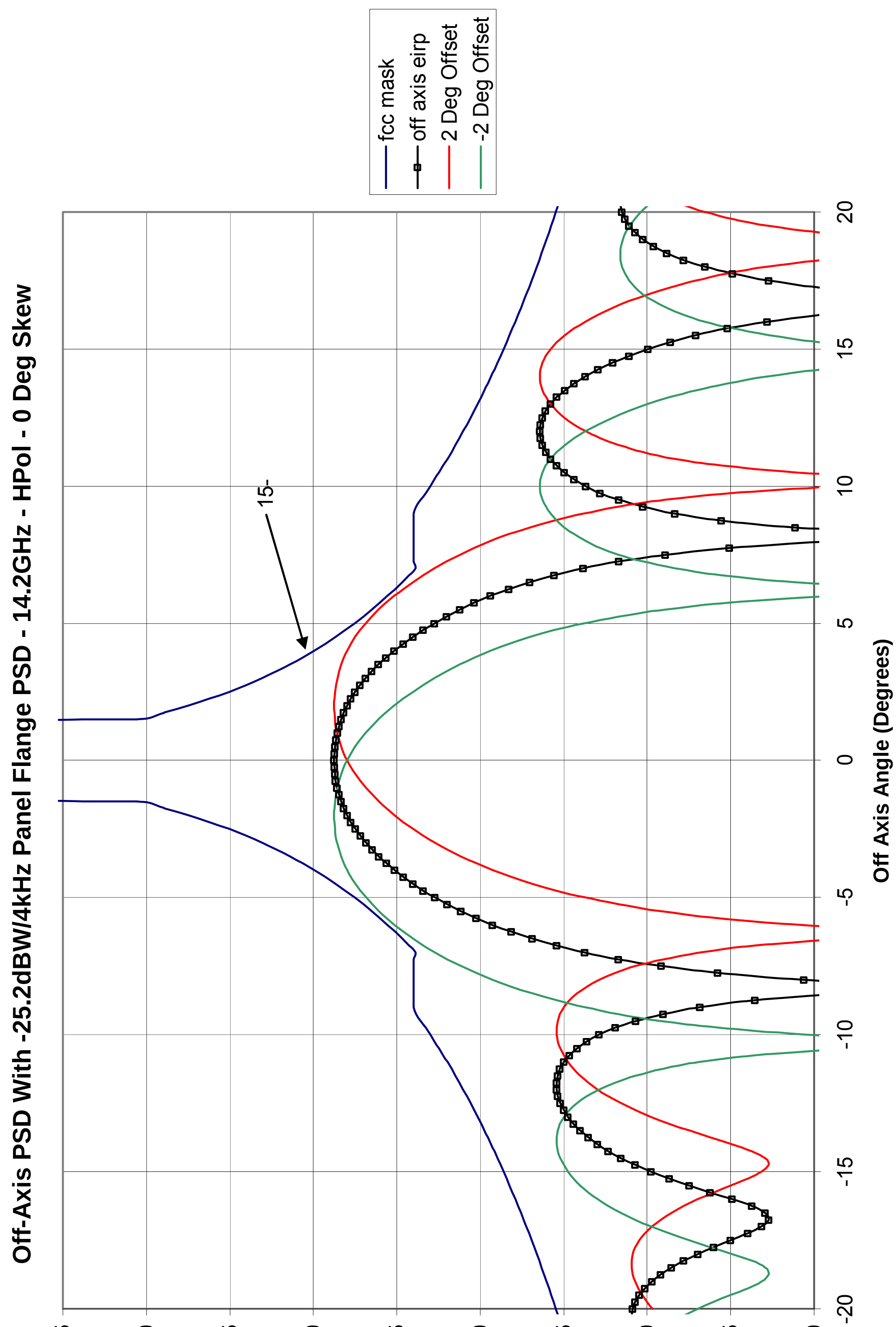

Figure 6
Off-Axis PSD Pattern

APPENDIX B

LINK BUDGET ANALYSIS

Data Parameters

Data Rate	512.0	kbps
FEC	1/4	Turbo
Modulation	bpsk	BPSK / QPSK
Threshold Eb/No	1.00	dB
Occ BW	1.30	
Spread Spectrum	y	(Y / N)
Chip Rate	16.38	Mchips/s
Total # of spread Links	1	
Beta Factor	1.00	

Satellite Parameters

Sat Name	Horizons1	
Sat Long.	127	deg
Sat Rx, G/T	4	dB/K
Sat Tx, EIRP	50	dBW
SFD	-93	dBW/m^2
IP / OP ratio	4	dB
U/L Freq	14.25	GHz
D/L Freq.	11.95	GHz

Rx Site Parameters

Rx Site Name	MCL Hub	
Rx Lat	39	deg
Rx Long	77	deg
Rx G/T	33.3	dB/K
Ant Gain	55.1	dBi
System Temp	150	K

Tx Site Parameters

Tx Site Name	Pismo Beach	
Tx Lat	35.2	deg
Tx Long	120.7	deg
Tx Ant Gain	24	dBi
Tx Loss	3	dB
Radome loss	1.2	dB
Pointing Loss	0.35	dB
Tx HPA	40.00	W

Interference Parameters

ASI U/L EIRP in our direction	2.7	dBW/4KHz
DL interferemce, dBW/4KHz	-22	dBW/4KHz

DownLink Fade	8.5	dB

Threshold C/N	-14.05	dB
C/Io Uplink WRT Saturation	34.1	dB/Hz
C/Io Downlink WRT Saturation	108.0	dB/Hz
Tx Slant Range	37280365.0	m
Tx FSL	206.9	dB
Uplink EIRP	35.5	dBW
Uplink C/No	60.4	dB-HZ
U/L C/N	-11.7	dB
G(1m^2) Tx	44.5	dBi
U/L flux density @ satellite	-127.7	dBW/m^2
IPBO	34.7	dB
C/I up	-3.4	dB
C/I dn	5.2	dB
Clear SkyC/(N+I) with 1 carrie	**-12.52**	**dB**
CS Eb/No with 1 carriers	**2.53**	**dB**
CS Margin with 1 carriers	**1.53**	**dB**
D/L Faded C/(N+I)	**-14.05**	**dB**
D/L Faded Eb/No with 1 carrie	**1.00**	**dB**
D/L Faded Margin	**0.00**	**dB**
Aggregate PSD @ ant Flange	-25.4	dBW / 4KHz
Occupied BW	21299.2	KHz
D/L PSD/4KHz	-17.9	dBW/4KHz

Rx Slant Range	39476263.0	m
Rx FSL	205.9	dB
OPBO	30.7	dB
D/L EIRP	19.3	dBW
D/L C/No	74.8	dB/Hz
D/L C/N	2.7	dB

NOTES & CALCULATIONS

Set CDMA margin to 0 to get correct UL pwr

COPBO	4	dB
Transponder BW	36	MHz
%PWR	0.22	%
PEB	0.08	MHz
Occupied BW	21.30	MHz
Percentage BW	59.16	%
Hub Dia/effec.	5.6	0.65
Rx Gain / G/T	55.04	33.28
Tx Gain	56.57	
Spread Factor	8	

	Tx Site	Rx Site	
Az Angle	190.84	242.16	deg
El Angle	48.57	21.91	deg
Pol Angle	8.84	43.41	deg

APPENDIX C

RADIATION HAZARD ANALYSIS

Radiation Hazard Analysis

SR-71

This analysis predicts the radiation levels around a proposed earth station complex, comprised of a single panel type antenna. 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, pp. 26-30. The maximum level of non-ionizing radiation to which employees may be exposed is limited to a power density level of 5 milliwatts per square centimeter (5 mW/cm^2) 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/cm^2) averaged over any 30-minute period in a uncontrolled environment. Note that the worse-case radiation hazards exist along the beam axis. Under normal circumstances, it is highly unlikely that the antenna axis will be aligned with any occupied area since that would represent a blockage to the desired signals, thus rendering the link unusable.

Earth Station Technical Parameter Table

Antenna Aperture Size	0.512m x 0.152m
Antenna Effective Diameter	0.172 meters
Antenna Surface Area	0.023 sq. meters
Antenna Isotropic Gain	24.0 dBi
Number of Identical Adjacent Antennas	1
Nominal Antenna Efficiency (ε)	38%
Nominal Frequency	14.25 GHz
Nominal Wavelength (λ)	0.0211 meters
Maximum Transmit Power / Carrier	40.0 Watts
Number of Carriers	1
Total Transmit Power	40.0 Watts
W/G Loss from Transmitter to Feed	2.0 dB
Total Feed Input Power	25.2 Watts
Radome Losses	1.2 dB
Effective RF Power at radome	19.15 Watts
Near Field Limit	$R_{nf} = D^2/4\lambda$ = 0.35 meters
Far Field Limit	$R_{ff} = 0.6\ D^2/\lambda$ = 0.84 meters
Transition Region	R_{nf} to R_{ff} = 0.35 meters to 84 meters

In the following sections, the power density in the above regions, as well as other critically important areas will be calculated and evaluated. The calculations are done in the order discussed in OET Bulletin 65.

1.0 At the Antenna Surface

The power density at the reflector surface can be calculated from the expression:

PD_{as} = 4P/A = **436.95** mW/cm^2 (1)

Where: P = total power at feed, milliwatts
A = Total area of reflector, sq. cm

In the normal range of transmit powers for satellite antennas, the power densities at or around the reflector surface is expected to exceed safe levels. This area will not be accessible to the general public.

This antenna will incorporate a radome which has 1.2 dB of loss. The worst case power density at the surface of the radome is shown below:

$PD_{radome}=4P_{rad}/A$ = **331.46** mW/cm² (2)
Where: Prad = total power at feed less radome losses, milliwatts
A = Total area of reflector, sq. cm (this would represent worst case)

Operators and technicians should receive training specifying this area as a high exposure area. Procedures must be established that will assure that all transmitters are rerouted or turned off before access by maintenance personnel to this area is possible.

2.0 On-Axis Near Field Region

The geometrical limits of the radiated power in the near field approximate a cylindrical volume with a diameter equal to that of the antenna. In the near field, the power density is neither uniform nor does its value vary uniformly with distance from the antenna. For the purpose of considering radiation hazard it is assumed that the on-axis flux density is at its maximum value throughout the length of this region. The length of this region, *i.e.*, the distance from the antenna to the end of the near field, is computed as Rnf above.

The maximum power density in the near field is given by:

$PD_{nf} = (16\varepsilon P)/(\pi D^2)$ = **127.10** mW/cm² (3)
from 0 to 0.35 meters

Evaluation
Uncontrolled Environment: **Does Not Meet Controlled Limits**
Controlled Environment: **Does Not Meet Uncontrolled Limits**

3.0 On-Axis Transition Region

The transition region is located between the near and far field regions. As stated in Bulletin 65, the power density begins to vary inversely with distance in the transition region. The maximum power density in the transition region will not exceed that calculated for the near field region, and the transition region begins at that value. The maximum value for a given distance within the transition region may be computed for the point of interest according to:

PD_{tr} = $(PD_{nf})(R_{nf})/R$ = dependent on R (4)
where: PD_{nf} = near field power density
R_{nf} = near field distance
R = distance to point of interest
PD_{tr} = **127.10** mW/cm²
For: 0.35 < R < 0.84 meters

We use Eq (4) to determine the safe on-axis distances required for the two occupancy conditions:

Evaluation

Uncontrolled Environment Safe Operating Distance, (meters), R_{safeu}: 8.88
Controlled Environment Safe Operating Distance, (meters), R_{safec}: 44.40

4.0 On-Axis Far-Field Region

The on- axis power density in the far field region (PD_{ff}) varies inversely with the square of the distance as follows:

$PD_{ff} = PG/(4\pi R^2)$ = dependent on R (5)
where: P = total power at feed
G = Numeric Antenna gain in the direction of interest relative to isotropic radiator
R = distance to the point of interest
For: $R > R_{ff} =$ 0.84 meters
$PD_{ff} =$ **54.44** mW/cm² at R_{ff}

We use Eq (5) to determine the safe on-axis distances required for the two occupancy conditions:

Evaluation

Uncontrolled Environment Safe Operating Distance,(meters), R_{safeu} : See Section 3
Controlled Environment Safe Operating Distance,(meters), R_{safec} : See Section 3

5.0 Off-Axis Levels at the Far Field Limit and Beyond

In the far field region, the power is distributed in a pattern of maxima and minima (sidelobes) as a function of the off-axis angle between the antenna center line and the point of interest. Off-axis power density in the far field can be estimated using the antenna radiation patterns prescribed for the antenna in use. Usually this will correspond to the antenna gain pattern envelope defined by the FCC or the ITU, which takes the form of:

$G_{off} = 32 - 25\log(\Theta)$
for Θ from 1 to 48 degrees; -10 dBi from 48 to 180 degrees
(Applicable for commonly used satellite transmit antennas)

Considering that satellite antenna beams are aimed skyward, power density in the far field will usually not be a problem except at low look angles. In these cases, the off axis gain reduction may be used to further reduce the power density levels.

For example: At two (2) degrees off axis At the far-field limit, we can calculate the power density as:

$G_{off} = 32 - 25\log(2) = 32 - 7.52$ dBi = 280.2 numeric

$PD_{2\ deg\ off\text{-}axis} = PD_{ff} \times 280.2/G =$ **60.73** mW/cm^2 **(6)**

6.0 Off-Axis power density in the Near Field and Transitional Regions

According to Bulletin 65, off-axis calculations in the near field may be performed as follows: assuming that the point of interest is at least one antenna diameter removed from the center of the main beam, the power density at that point is at least a factor of 100 (20 dB) less than the value calculated for the equivalent on-axis power density in the main beam. Therefore, for regions at least D meters away from the center line of the dish, whether behind, below, or in front under of the antenna's main beam, the power density exposure is at least 20 dB below the main beam level as follows:

$PD_{nf(off\text{-}axis)} = PD_{nf} /100 =$ **1.27** mW/cm^2 at D off axis (7)

See Section 7 for the calculation of the distance vs. elevation angle required to achieve this rule for a given object height.

7.0 Evaluation of Safe Occupancy Area in Front of Antenna

The distance (S) from a vertical axis passing through the dish center to a safe off axis location in front of the antenna can be determined based on the dish diameter rule (Item 6.0). Assuming a flat terrain in front of the antenna, the relationship is:

$S = (D/ \sin \alpha) + (2h - D - 2)/(2 \tan \alpha)$ (8)

Where: α = minimum elevation angle of antenna
D = dish diameter in meters
h = maximum height of object to be cleared, meters

For distances equal or greater than determined by equation (8), the radiation hazard will be below safe levels for all but the most powerful stations (> 4 kilowatts RF at the feed).

For	D =	0.569 meters
	h =	2.0 meters, delta between antenna and object >1 m
Then:		
	α	S
	10	0.5 meters
	15	0.3 meters
	20	0.3 meters
	25	0.2 meters
	30	0.2 meters

8.0 Summary of Results

The earth station site will be protected from uncontrolled access by virtue of the fact that it will be mounted on the roof of a vehicle. There will also be proper emission warning signs placed and all operating personnel will be aware of the human exposure levels at and around the earth station. The applicant agrees to abide by the conditions specified in Condition 18 provided below:

> *(18) - The Raysat Antenna Systems LLC shall take all reasonable and customary measures to ensure that the MET does not create potential for harmful non-ionizing radiation to persons who may be in the vicinty of the MET when it is in operation. At a minimum, permanent warning label(s) shall be affixed to the MET warning of the radiation hazard and including a diagram showing the regions around the MET where the radiation levels could exceed 1.0mW/cm2. The operator of the MET shall be responsible for assuring that individuals do not stray into the region around the MET where there is a potential for exceeding the maximum permissible exposure limits required by Section 1.1310 of the Commission's rules 47 C.F.R § 1.1310. This shall be accomplished by means of signs, caution tape, verbal warnings, placement of the MET so as to minimize access to the hazardous region and/or any other appropriate means*

The table below summarizes all of the above calculations.

Parameter	Abbr.		Units	Formula
Antenna Effective Diameter	Df	0.569	meters	
Antenna Centerline	h	2	meters	
Antenna Surface Area	Sa	0.254	$meter^2$	$(\pi*Df^2)/4$
Antenna Ground Elevation	GE	2	meters	
Frequency of Operation	f	14.25	GHz	
Wavelength	λ	0.0211	meters	
HPA Output Power	P_{HPA}	40	watts	
HPA to Antenna Loss	L_{Tx}	1	dB	
Radome Loss	L_{Rad}	0.25	dB	
Transmit Power at Flange	P	31.773129	watts	$P/10Log^{-1}(L_{Tx}/10)$
Effective Power after Radome		30.00	watts	$P/10Log^{-1}$(Radome Loss/10)
Antenna Gain	G_{es}	36	dBi	does not include radome loss
Antenna Aperature Efficiency	η	55%	n/a	
1. Reflector Surface Region Calculations				
Antenna Surface Power Density	Pdas	499.6	W/m^2	$(16 * P)/(\pi * D^2)$
		49.96	mW/cm^2	
Power at Radome Surface	Pdrad	471.6	W/m^2	$(16 * P)/(\pi * D^2)$
(outside radome)		47.16	mW/cm^2	**Does not meet controlled limits** **Does not meet uncontrolled limits**
2. On Axis Near Field Calculations				
Extent of Near Field	Rn	3.846	meters	$D^2 / (4 * \lambda)$
		12.620	feet	
Near Field Power Density	PDnf	260.3	w/m^2	$(16 * \eta * P)/(\pi * D^2)$
		26.03	mW/cm^2	**Does not meet controlled limits** **Does not meet uncontrolled limits**
3. On Axis Transition Region Calculations				
Extent of Transition Region (min)	R_{Tr}	3.846	meters	$D^2 / (4 * \lambda)$
Extent of Transition Region (min)		12.620	feet	
Extent of Transition Region (max)	R_{Tr}	9.231	meters	$0.6 * D^2 / \lambda$
Extent of Transition Region (max)		30.287	feet	
Worst Case Transition Region Power Density	PD_{tr}	260.3	w/m^2	
		26.03	mW/cm^2	**Does not meet controlled limits** **Does not meet uncontrolled limits**
Uncontrolled enviorment safe operating distance	Rsu	100.1	meters	$(PD_{nf})/(R_{nf})/Rsu$
Controlled enviorment safe operating distance	Rsc	20.0	meters	$(PD_{nf})/(R_{nf})/Rsc$
4. On Axis Far Field Calculations				
Distance to Far Field Region	Rf	9.23	meters	$0.6 * D^2 / \lambda$
		30.29	feet	
On Axis Power Density in the Far Field	PD_{ff}	111.5	W/m^2	$(G_{es} * P) / (4 * \pi * Rf^2)$
		11.15	mW/cm^2	**Does not meet controlled limits** **Does not meet uncontrolled limits**
5. Off-axis Power Density in the Far Field Limit and Beyond				
Antenna Surface Power Density	PDs	7.8	W/m^2	$(G_{es} * P) / (4 * \pi * Rf^2) * (Goa/Ges)$
Goa/Ges at a sample angle of θ=2 degrees		0.070		Goa = 32 - 25*log(θ)
		0.78	mW/cm^2	
6. Off Axis Power Density in the Near Field and Transitional Region Calculations				
Power Density of Wn/100 for 1 diameter	PDs	2.60	W/m^2	$[(16 * \eta * P)/(\pi * D^2)] / 100$
removed		0.260	mW/cm^2	**Meets controlled limits** **Meets Uncontrolled limits**
7.0 Off-axis Safe Distances from Earth Station				
minimum elevation angle of antenna	α	10	degree	
hieght of object to be cleared	h	2	meter	
Groun elevation delta antenna-obstacle elevation ang	**GD**	**S**		
	10	1.7	meter	S=(D/sinα) + (2h - D- 2) / (2tanα)
	15	1.1	meter	
	20	0.9	meter	
	25	0.7	meter	
	30	0.6	meter	

Note: Maximum FCC power density limits for 6GHz is 1mW/cm2 for general population exposure as per FCC OS&T Bulletin No. 65, Edition 97-01 August 1997, Appendix A page 67.