Gilat North America
Application for Experimental STA

Gilat North America, ("GNA"), pursuant to Section 5.61 of the Commission's rules, 47 C.F.R. § 5.61, seeks experimental authority for ground and flight testing of up to five (5) earth stations to test and demonstrate the functionality of its authorized SR-71 Ku-band mobile satellite terminal in the aeronautical context. The SR-71 will be operating at the Fort Hunter-Liggett flight range and Yuma Proving Grounds on SES-2 at 87° West longitude. This testing would use the same SR-71 antenna previously authorized by the Commission, using the same configuration and technical specifications, but on a new platform. Specifically, GNA seeks experimental authority to test the SR-71 terminal for use with U.S. government unmanned aerial systems ("UAS"). Given the differing scope of proposed tests, GNA seeks a two-year experimental authority. As described herein, grant of such authority would strongly serve the public interest.

I. BACKGROUND

The SR-71 antenna, was developed in connection with a Department of Defense/Logistics Innovation Agency ("DOD/LIA") contract to evaluate and satisfy U.S. government satellite-based mobile communications needs. Building on GNA's proven antenna technology for mobile applications, the SR-71 is a light, single-panel Ku-band array antenna designed with a low profile, small footprint, and full-motion tracking system that provides broadband data access in the land mobile context.

On April 01, 2012, the Federal Communications Commission ("FCC") granted GNA a six month experimental license (Call Sign WF9XOP), until October 01, 2012, to operate up to five (5) SR-71 terminals in the 14.0-14.5 GHz and 11.7-12.2 GHz Ku-band 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]

GNA has been approached to test and demonstrate the SR-71 in the aeronautical context to support UAS operations. This testing is being performed in connection with the DOD and its contractors/integrators. This is a logical extension of the unique characteristics of the SR-71 – a low-profile, small-footprint and high-performance Ku-band satellite terminal. The same pointing accuracy, power control and other performance characteristics that ensure interference-free operation "on-the-move" in the land mobile context will apply equally to facilitate SR-71 aeronautical operations.

II. DESCRIPTION OF PROPOSED EXPERIMENTAL OPERATIONS

GNA seeks to conduct flight testing at Fort Hunter-Liggett (35.95°N, 121.23°W) and Yuma Proving Grounds (32.6° N, 114.6° W) subject to protection of U.S. Government radio astronomy and space research operations. GNA recognizes and accepts that any experimental authority will be conditioned upon coordination with and/or protection of these co-frequency operations.

The general objectives of the testing to be carried out under this experimental authority include: (i) integrating and testing the SR-71 terminals on the US Government's UAS network;

[1] See ELS File No. 0506-EX-PL-2010, Call Sign WF2XQF. 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. 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). Attached as Appendix A for the Commission's convenience is a copy of the Narrative Statement for the application for the original two-year experimental license ELS File No. 0506-EX-PL-2010 (Call Sign WF2XQF), which provides a more detailed description of the SR-71 antenna as well as its operational characteristics.

(ii) demonstrating two-way data service from an in-flight unmanned aeronautical platform; and (iii) validating the predicted performance of the system.

A. Flight Testing

GNA seeks authorization to conduct flight testing under the instant request for experimental authority. Initial testing will involve deploying the SR-71 on a single UAS. Additional flight testing, including installation of the SR-71 on multiple UASs, will be required but firm flight test plans have not yet been developed.

The SR-71 will be flight tested on a UAS operating at the Fort Hunter-Liggett flight range and Yuma Proving Grounds, which are outside the exclusion zones for radio astronomy sites (during observations) and NASA TDRSS sites, and in accordance with applicable coordination agreements and FCC rules.

The following performance objectives will be examined in connection with flight testing:

- geographic mapping
- reliability of data link;
- two-way data link performance and coverage;
- video link performance and coverage; and
- network management and operation.

This testing will be very limited in duration, depending on US Government requirements. In all cases, the terminals will operate in controlled test conditions under close supervision of GNA's network control personnel at all times.

III. TECHNICAL INFORMATION

Attached hereto as Appendix A is a copy of the Narrative Statement and supporting technical information. Appendix B and Appendix C include the Link Budget Analysis and Radiation Hazard Study, respectively. The SR-71 antenna to be tested will include the 40 Watt

BUC, with a maximum EIRP of 3820 Watts and ERP of 2328 Watts, emission designator of 23M9G1D, and a BPSK modulated signal in the 14.0-14.5 GHz transmit band.

VI. PROTECTION OF OTHER USERS IN THE 14.0–14.5 GHZ BAND

Protection of Fixed-Satellite Service. GNA's terminals operate in such a manner that the off-axis EIRP levels are no greater than the levels produced by routinely licensed VSAT earth stations. This is consistent with past FCC licensing conditions in the AMSS context. To the extent that any adjacent satellite operator experiences unacceptable interference from GNA's experimental operations, GNA will cease terminal transmissions immediately.[2]

Protection of Potential NGSO FSS Systems. GNA acknowledges that non-geostationary orbit ("NGSO") systems are also permitted to operate in the Ku-band. However, no such systems are currently authorized or plan to operate within the period contemplated for the proposed experimental operations.

Protection of Terrestrial Radio Services. GNA has examined current spectrum use in the 14.0-14.5 GHz band and has determined that there are no active FCC-licensed terrestrial services in this band in North America with which its proposed operations could conflict.

Protection of the Radio Astronomy Service. For purposes of this experimental application, GNA terminals will not operate within the vicinity of Radio Astronomy sites and during observation periods.

Protection of Space Research Service. GNA recognizes the use 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

---

[2] *See* 47 C.F.R. § 5.111(a)(2).

Point, Maryland. For purposes of this experimental application, GNA will not operate within the vicinity of these earth stations.

VII. SUPERVISION AND CONTROL

For purposes of these experiments, the SR-71 terminals will be operated under GNA's supervision and control. The technical point of contact information for the planned experimental operations is:

Kevin Bruestle
Office: 1-703-463-9884
Mobile: 1-517-262-1601
Email: kevin.bruestle@gilatna.com

This contact will have access to all network functions, and will have the ability and authority to cease all transmissions from the terminals wherever they are located.

VIII. CONCLUSION

Grant of this experimental authority will allow GNA to further develop and demonstrate the SR-71 terminal and confirm the operational characteristics of the terminal in the UAS context. These experiments are critical to the national security interest of the United States, by supporting US military operations, training and other applications. There is ample precedent for granting this experimental authority and it is clearly in the public interest to do so.

Appendix A

Gilat North America

Narrative Statement

Experimental License Application
Narrative Statement

I. Introduction

On April 1, 2012, GNA was granted a special temporary authorization (Call Sign WF9XOP) for these operations, which expired on October 1, 2012. Given the ongoing operational requirements, GNA seeks a two-year experimental license subject to the same terms and conditions included in its prior authority. Grant of the experimental authority would strongly serve the public interest by enhancing satcom-on-the-move service and equipment options for the U.S. Government.

II. Antenna

The SR-71 antenna technology builds upon GNA'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 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.

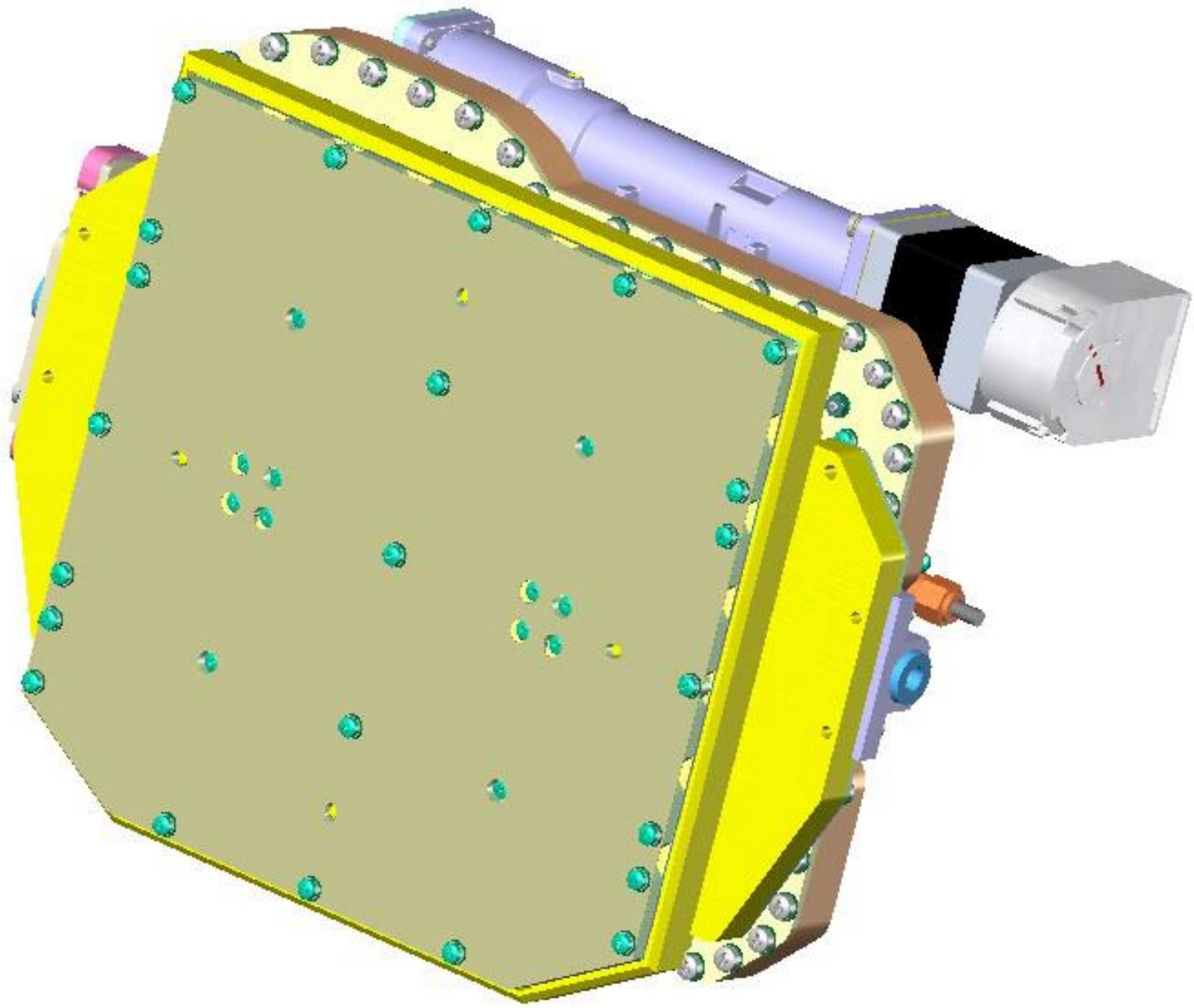

Figure 1

SR-71 Panel Array

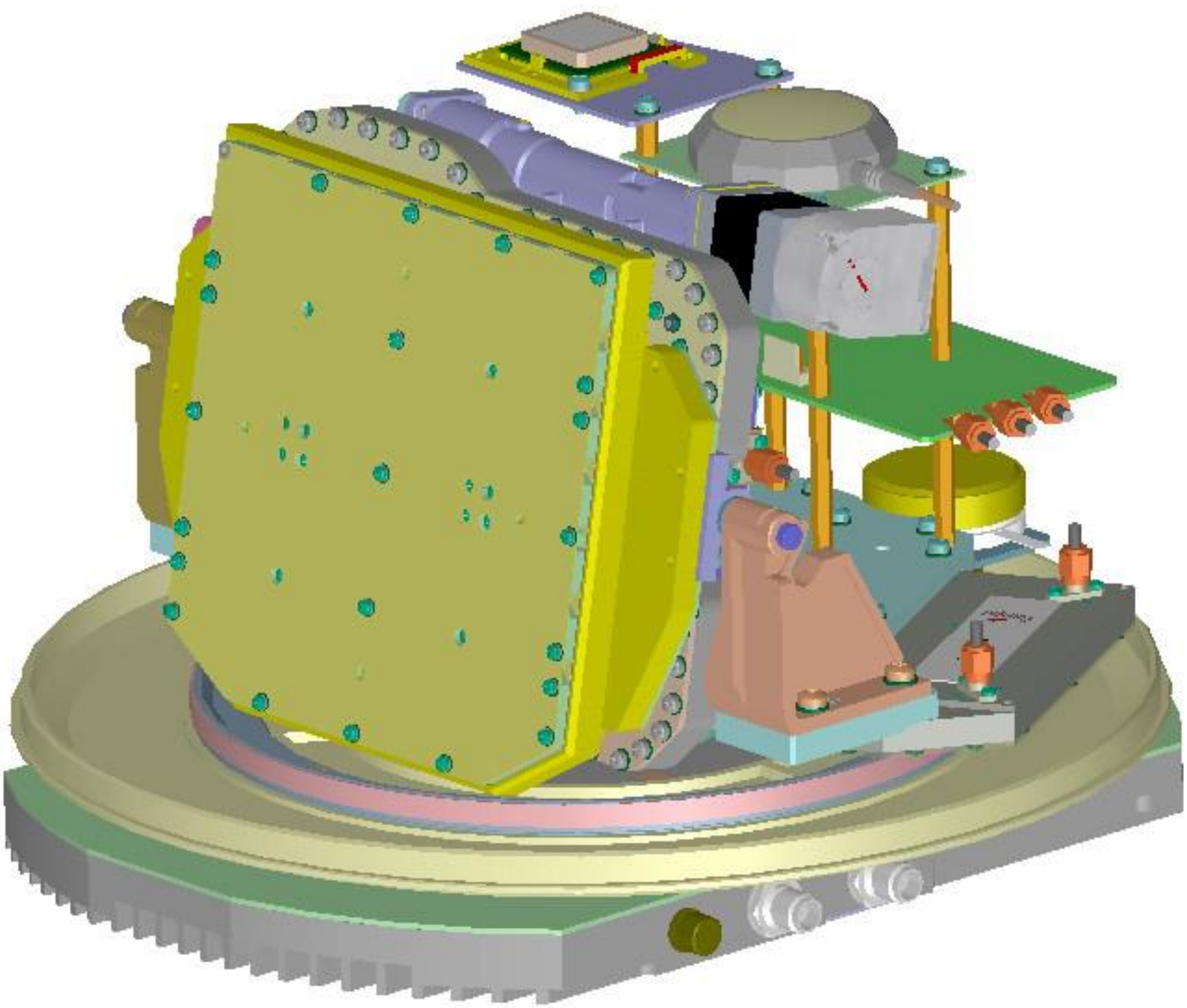

Figure 2
SR-71 Antenna

III. Antenna Operation

As with all GNA antennas, the SR71 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 GNA antennas will be applied. A simplified block diagram of the major components in the tracking and acquisition system is shown in Figure 3.

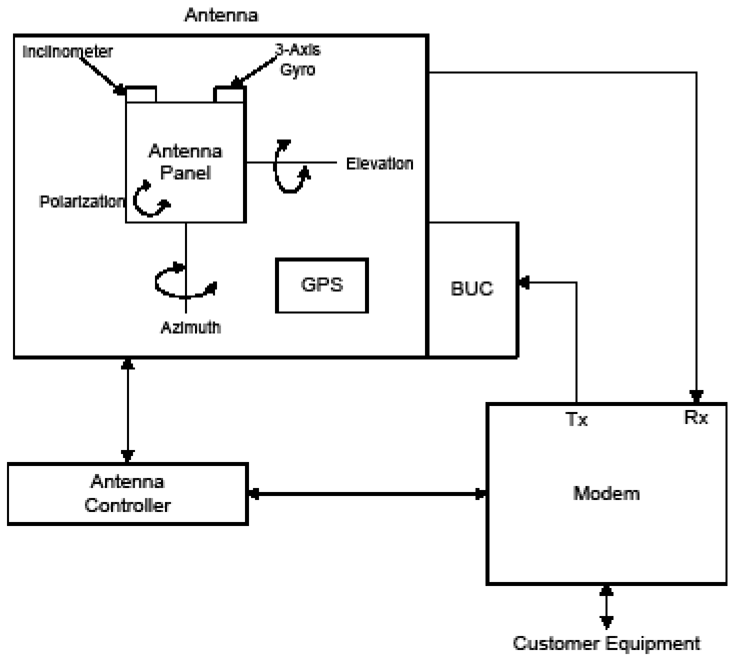

Figure 3
Typical Antenna Equipment Set-up

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.

Since the UAS will only be operating at the Fort Hunter-Liggett CA or the Yuma Proving Grounds site which are well over 125 km away from any radio astronomy sites, or 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 no coordination is required with either the NSF or with NASA

GNA acknowledges that non-geostationary orbit ("NGSO") systems are 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, GNA will coordinate with NGSO FSS licensees to protect their systems from harmful interference.

IV. 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 25.226(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 SR71 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. GNA 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.

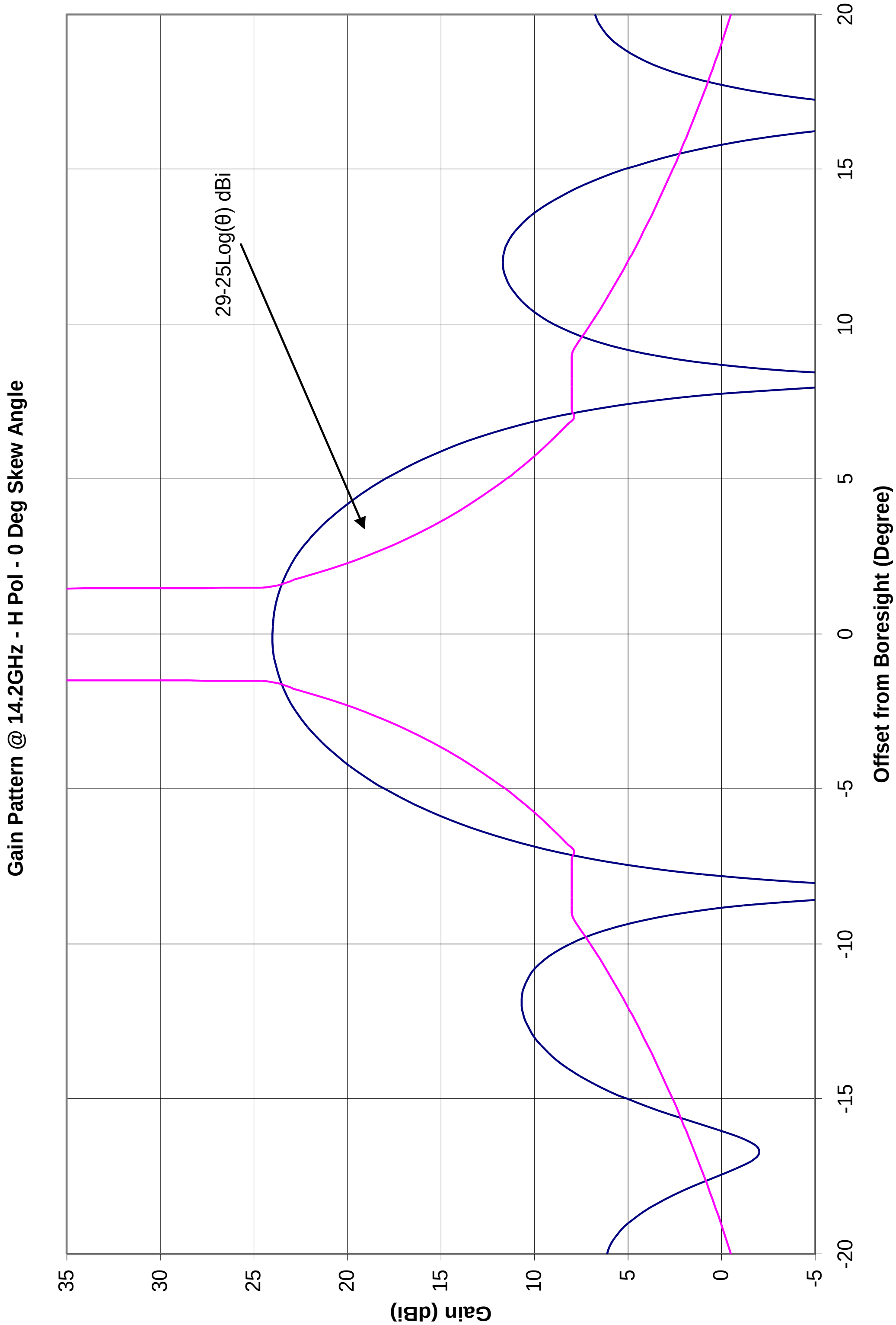

Figure 4 - SR-71 Gain Pattern

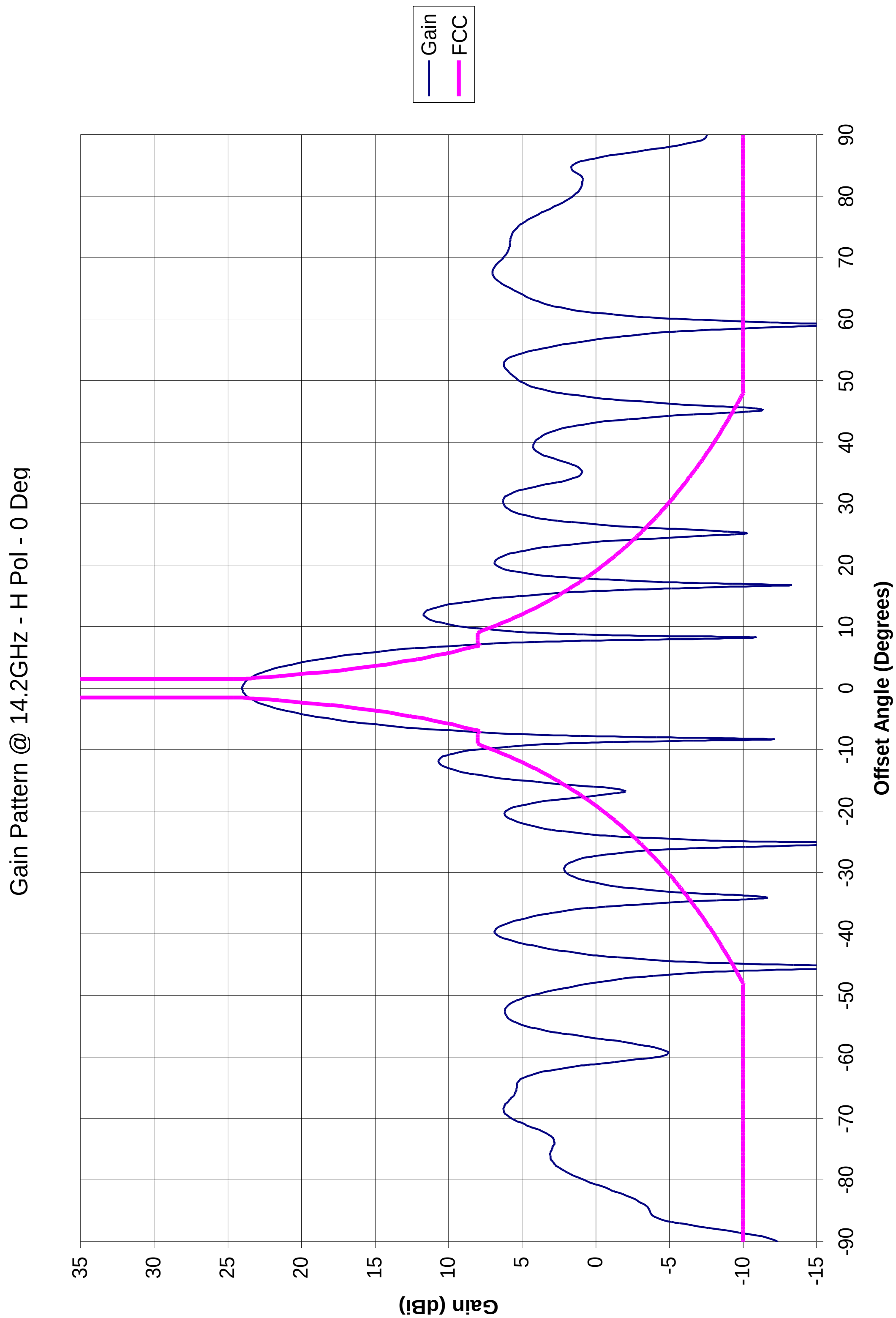

Figure 5 - Wide Gain Pattern

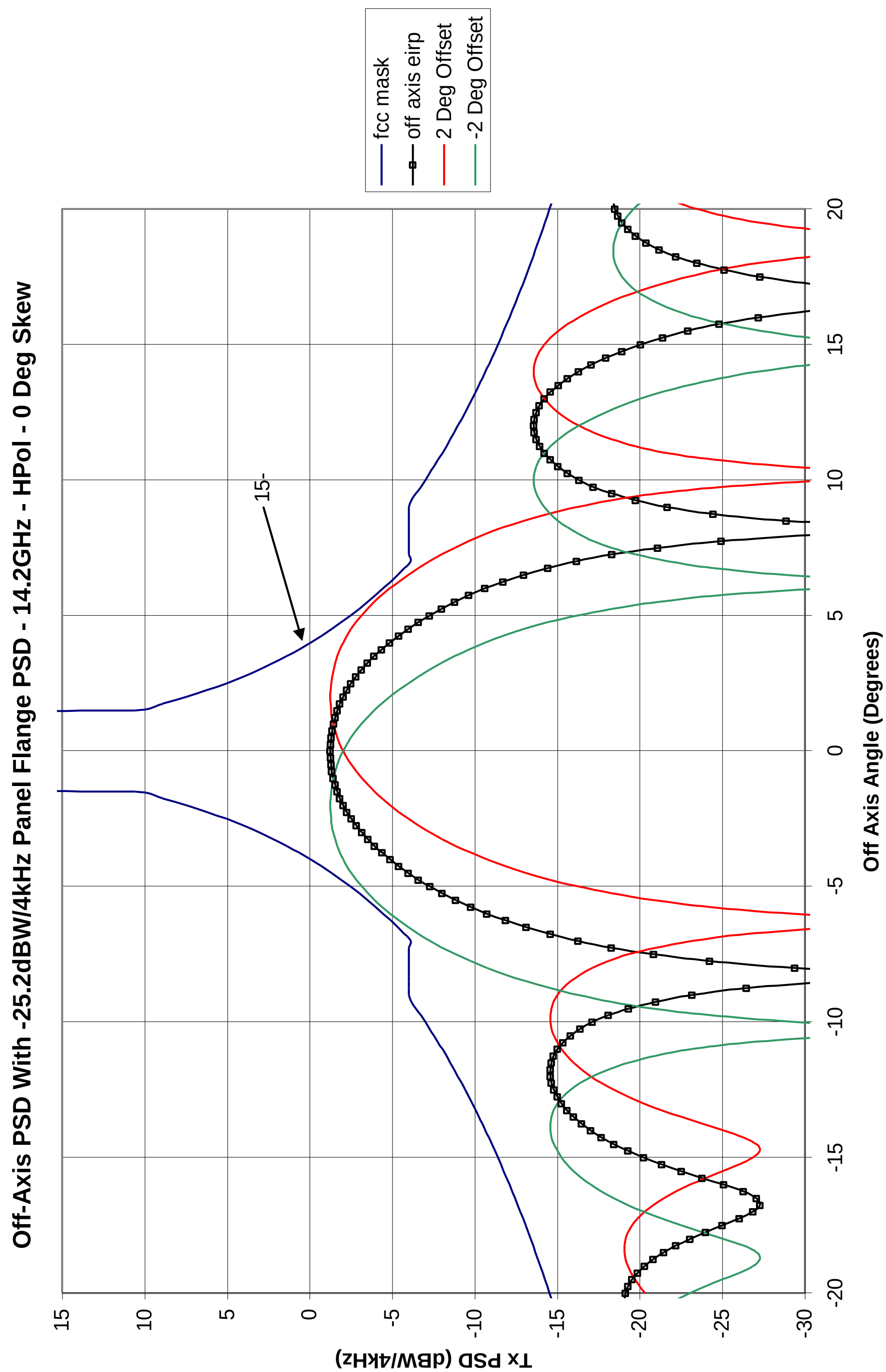

Figure 6 - Off-Axis PSD

Appendix B

Link Budget

Data Parameters				Satellite Parameters		
Data Rate	512.0	kbps		Sat Name	SES2	
FEC	1/4	Turbo		Sat Long.	87	deg
Modulation	bpsk	BPSK / QPSK		Sat Rx, G/T	5	dB/K
Threshold Eb/No	1.00	dB		Sat Tx, EIRP	50	dBW
Occ BW	1.30			SFD	-93	dBW/m^2
Spread Spectrum	y	(Y / N)		IP / OP ratio	4	dB
Chip Rate	16.38	Mchips/s		U/L Freq	14.25	GHz
Total # of spread Links	1			D/L Freq.	11.95	GHz
Beta Factor	1.00					

Rx Site Parameters				Tx Site Parameters		
Rx Site Name	MCL Hub			Tx Site Name	Ft Hunter-Ligget	
Rx Lat	39	deg		Tx Lat	36	deg
Rx Long	77	deg		Tx Long	121.3	deg
Rx G/T	33.3	dB/K		Tx Ant Gain	24	dBi
Ant Gain	55.1	dBi		Tx Loss	3	dB
System Temp	150	K		Radome loss	1.2	dB
				Pointing Loss	0.35	dB
Interference Parameters				Tx HPA	40.00	W
ASI U/L EIRP in our direction	2.7	dBW/4KHz				
DL interferemce, dBW/4KHz	-22	dBW/4KHz		DownLink Fade	9.8	dB

Threshold C/N	-14.05	dB				
C/Io Uplink WRT Saturation	33.9	dB/Hz				
C/Io Downlink WRT Saturation	108.0	dB/Hz				
Tx Slant Range	38306497.0	m		Rx Slant Range	37617708.8	m
Tx FSL	207.2	dB		Rx FSL	205.5	dB
Uplink EIRP	35.5	dBW		OPBO	30.9	dB
Uplink C/No	61.2	dB-HZ		D/L EIRP	19.1	dBW
U/L C/N	-11.0	dB		D/L C/No	75.0	dB/Hz
G(1m^2) Tx	44.5	dBi		D/L C/N	2.9	dB
U/L flux density @ satellite	-127.9	dBW/m^2				
IPBO	34.9	dB				
				NOTES & CALCULATIONS		
C/I up	-3.4	dB				
C/I dn	5.0	dB		Set CDMA margin to 0 to get correct UL pwr		
Clear SkyC/(N+I) with 1 carri	**-11.90**	**dB**		COPBO	4	dB
CS Eb/No with 1 carriers	**3.16**	**dB**		Transponder BW	36	MHz
CS Margin with 1 carriers	**2.16**	**dB**				
				%PWR	0.20	%
D/L Faded C/(N+I)	**-14.07**	**dB**		PEB	0.07	MHz
D/L Faded Eb/No with 1 carri	**0.98**	**dB**		Occupied BW	21.30	MHz
D/L Faded Margin	**-0.02**	**dB**		Percentage BW	59.16	%
				Hub Dia/effec.	5.6	0.65
Aggregate PSD @ ant Flange	-25.4	dBW / 4KHz		Rx Gain / G/T	55.04	33.28
Occupied BW	21299.2	KHz		Tx Gain	56.57	
D/L PSD/4KHz	-18.1	dBW/4KHz		Spread Factor	8	

Appendix C

SR-71 Radiation Hazard Study

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	0.152m 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	3 dB
Total Feed Input Power	20.05 Watts
Radome Losses	1.2 dB
Effective RF Power at radome	15.21 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 0.84 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:

$PD_{as} = 4P/A =$ **347.126** 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:

$PD_{radome}=4P_{rad}/A$ = **263.32** 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:

$PD_{nf} = (16\varepsilon P)/(\pi D^2)$ = **100.062** 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} = **100.062** 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}: 35
Controlled Environment Safe Operating Distance, (meters), R_{safec}: 7

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} = $PG/(4\pi R^2)$ and is dependent on R^2 ,(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} = **42.864** 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

$PD_{2\ deg\ off\text{-}axis} = PD_{ff} \times 280.2/G$ = **48.2442** 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:

$PD_{nf(off\text{-}axis)} = PD_{nf} /100 =$ **1.00** mW/cm² 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 =	0.172 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) – GNA shall take all reasonable and customary measures to ensure that the SR-71 does not create potential for harmful non-ionizing radiation to persons who may be in the vicinity of the SR-71 when it is in operation. At a minimum, permanent warning label(s) shall be affixed to the SR-71 warning of the radiation hazard and including a diagram showing the regions around the SR-71 where the radiation levels could exceed 1.0mW/cm2. The operator of the SR-71 shall be responsible for assuring that individuals do not stray into the region around the SR-71 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, and placement of the SR-71 so as to minimize access to the hazardous region and/or any other appropriate means*

The table below summarizes all of the above calculations.

Summary of All RadHaz Parameters		GNA SR-71		
Parameter	Abbr.	Value	Units	Formula
Dish #		SR-71		
Antenna Diameter (effective aperture)	Df	0.172	meters	
Antenna Centerline	h	2.0	meters	
Antenna Surface Area	Sa	0.023	$meters^2$	$(\pi * D^2) / 4$
Antenna Ground Elevation	GE	0.0	meters	
Frequency of Operation	f	14.25	GHz	
Wavelength	λ	0.0211	meters	c / f
HPA Output Power	P_{HPA}	40.00	watts	
HPA to Antenna Loss	L_{tx}	3.00	dB	does not include radome
Transmit Power at Flange	P	13.02	dBW	$10 * Log(P_{HPA}) - L_{tx}$
		20.05	watts	
Effective transmit Power at radome	Pr	15.21	watts	0.5 dB of radome loss
Antenna Gain	G_{es}	24.0	dBi	
		248.9	n/a	
PI	π	3.1415927	n/a	
Antenna Aperture Efficiency	eff	38%	n/a	$G_{es} / (PI * Df / \lambda)^2$
1. Reflector Surface Region Calculations				
Antenna Surface Power Density	PDas	3471.26	W/m^2	$(16 * P)/(\pi * D^2)$
		347.126	mW/cm^2	Reflector is protected by radome
Power at Radome Surface	PDrs	2633.22	W/m^2	$(16 * P)/(\pi * D^2)$
		263.322	mW/cm^2	
2. On-Axis Near Field Calculations				
Extent of Near Field	Rnf	0.35	meters	$D^2 / (4 * \lambda)$
		1.15	feet	
Near Field Power Density	PDnf	1000.62	W/m^2	$(16 * eff * P) / (\pi * D^2)$
		100.062	mW/cm^2	
3. On-Axis Transition Region Calculations				
Extent of Transition Region (min)	Rtr	0.35	meters	$D^2 / (4 x \lambda)$
Extent of Transition Region (min)		1.15	feet	
Extent of Transition Region (max)	Rtr	0.84	meters	$(0.6 * D^2) / \lambda$
Extent of Transition Region (max)		2.75	feet	
Worst Case Transition Region Power Density	PDtr	1000.62	W/m^2	$(16 * eff * P) / (\pi * D^2)$
		100.062	mW/cm^2	
Uncontrolled Environment Safe Operating D	Rsu	35.0	m	=(PDnf)*(Rnf)/Rsu
Controlled Environment Safe Operating Dis	Rsc	7.0	m	=(PDnf)*(Rnf)/Rsc
4. On-Axis Far Field Calculations				
Distance to the Far Field Region	Rff	0.8	meters	$(0.6 * D^2) / \lambda$
		2.75	feet	
On-Axis Power Density in the Far Field	PDff	428.64	W/m^2	$(G_{es} * P) / (4 * \pi * Rf^2)$
		42.864	mW/cm^2	
5. Off-Axis Levels at the Far Field Limit and Beyond				
Goa/Ges at example angle θ 2 degree		1.126		$Goa = 32 - 25*log(\theta)$
$PD_{2\ deg\ off\text{-}axis}$	Pdoa	482.442	W/m^2	$(G_{es} * P) / (4 * \pi * Rf^2)*(Goa/Ges)$
$PD_{2\ deg\ off\text{-}axis}$		**48.2442**	mW/cm^2	
6. Off-axis Power Density in the Near Field and Transitional Regions Calculations				
Power density 1/100 of Wn for one diameter removed	Pdnfoa	10.0062	W/m^2	$((16 * eff * P) / (\pi * D^2))/100$
		1.00062	mW/cm^2	
7. Region Between Antenna and Ground Calculations				
Reflector Surface Power Density	Pdag	658.31	W/m^2	$(4 * P)/(\pi * D^2)$
		65.831	mW/cm^2	
8. Safe Distances from Earth Station				$S = (D/ \sin \alpha) + (2h - D - 2)/(2 \tan \alpha)$
α = minimum elevation angle of antenna		10	deg	
h = maximum height of object to be cleared, meters		3	m	
elevation angle	10	0.5	m	
	15	0.3	m	
	20	0.3	m	
	25	0.2	m	
	30	0.2	m	

Note: Maximum FCC power density limits for 6 GHz is 1 mW/cm^2 for general population/uncontrolled exposure as FCC OE&T Bulletin No. 65, Edition 97-01 August 1997, Appendix A page 67.per