Annex 3

O3b Radiation Hazard Site Studies

Two Radiation Hazard studies for the General Dynamics 2.4 meter antenna are provided on the following pages. O3b has conducted a radiation hazard study for transmissions in each of its contiguous transmission bands, 27.6-28.4 GHz and 28.6-29.1 GHz. The results of those studies are included in this annex. As noted in each study, O3b will take steps to mitigate the potential for harmful exposure to radiation frequency radiation in accordance with the Federal Communications Commission's Office of Engineering and Technology (OET) Bulletin, No. 65.

Radiation Hazard Analysis

2.4 Meter - General Dynamics GSO 40
Manassas, Virginia 20109

Introduction

A radiation hazard anaylsis is presented for a 2.4 meter Ka band aperture antenna to be installed in Manassas Virginia at the O3b Networks Global Operations Center. This Radiation Analysis calculates the non-ionizing radiation levels expected to be emitted from the earth station on a worse cases basis and is performed in accordance with the Federal Communications Commissions Office of Engineering and Technology (OET) Bulletin, No. 65.

Requirements

OET 65 outlines the maximum permissible exposure limits in two cases for operation in this frequency range.

1. The first case is the maximum level that a person may be exposed to in the general population. The exposure limit is defined as a non-ionizing power level equal to 1 milliwatt per centimeter squared averaged over a thirty minute period.
2. The second case is a controlled environment where the maximum permissible exposure limit must not exceed 5 milliwatts per centimeter squared averaged over any six minute period.

Summary

The results indicate that no significant hazard will be presented to the general population and will be fully mitigated in the controlled area by the use of procedures that require the removal of transmit power before accessing the area around the main reflector.

Analysis

This analysis was performed on seven zones. The results of this is shown in Radiation Hazard Zones. The Table labeled Input Values provides the input data used to perform the analysis. The table labeled OET 65 Calculated Values provides the intermediate calculation used to perform the assessment in accordance with OET 65. The Analysis is performed for each of the seven radiation zones as shown in figure 1 – Analysis Zones. These zones are:

1. Point between the feed and the sub-reflector
2. The power at the surface of the antenna
3. The power level between the main reflector and ground
4. The near-field or Fresnel region in which the maxima can be reached before the field starts to diminish with distance
5. The Transition region where power begins to decrease inversely with distance from the antenna
6. The Far Field or Fraunhofer region where power decreases inversely with the square of the distance. This is the point at which the antenna beam is fully collimated
7. The off axis level in the near field. This is defined as the area outside of the main beam removed and at least one antenna diameter removed from the main beam

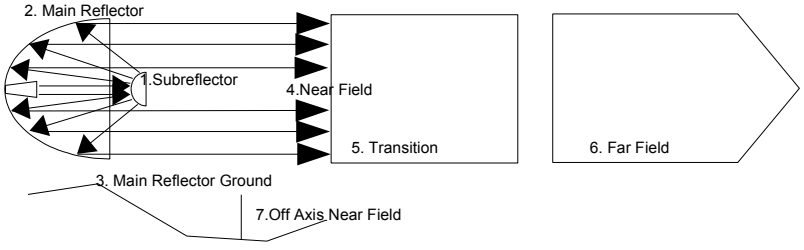

Figure 1 – Analysis Zones

Radiation Hazard Analysis

Operator:	***O3b Networks***	*FCC ID:*	
Location Designation:	***Global Operations Center***	*O3b ID:*	*General Dynamics GSO 40*
County:	***Prince William***	*STA:*	
Town:	***Manassas***		
State/Zip:	***Virginia 20109***		

Input Values	*Value*	*Unit*
D = Aperture Diameter	*2.4*	*Meters*
d = Subreflector Diameter	*0.1*	*Meters*
η = Apperture Efficeny	*67%*	*percentage*
FCC Designation	*Ka*	*Band*
F = Frequency	*27652*	*MHz*
P = Transmitter Power Watts:	*40*	*Watts*
p = Number Transmitters:	*1*	
R_{ua} = closest point to uncontrolled area	*20*	*meters*
Elevation angle at closest point R_{ua}	*7*	*Degrees*

Band	*Frequency GHz*
L	*1000-2000*
S	*2000-4000*
C	*4000-8000*
X	*8000-12500*
Ku	*12500-18000*
K	*18000-25500*
Ka	*26500-40000*
O	*40000-50000*
V	*50000-75000*

OET 65 Calculated Values	*Formula*	*Value*	*Unit*
λ= Wavelength	c/F	*0.0108*	*meters*
P_1= Total Antenna Input Power	$P*p$	*40*	*watts*
G = Antenna Gain	$G=\frac{4\pi\eta A}{\lambda^2}$	*323271.31*	*linear*
Antenna Gain dB	$10\log_{10}(G)$	*55.1*	*dBi*
A = Area of reflector	$\pi(\frac{D}{2})^2$	*4.52*	*meters²*
a = area of subreflector or feed	$\pi(\frac{d}{2})^2$	*0.01*	*meters²*
R_{nf} = Near-Field Region	$R_{nf}=\frac{D^2}{4\lambda}$	*132.73* *16*	*meters* *Meters AGL*
Transition Region	$>R_{nf}<R_{ff}$	*132.73* *318.55*	*>meters* *<meters*
R_{ff} = Far Field Region	$R_{ff}=\frac{0.6\,D^2}{\lambda}$	*318.55* *39*	*meters* *Meters AGL*

	Radiation Analysis Zone	*Formula*	*Level*	*Value*	*Exposure Limits* *General Public* *<1mW/cm²*	*Exposure Limits* *Occupational* *<5mW/cm²*
1	*Power Subreflector*	$\frac{4P_t}{a}$	*2038.217*	*mW/cm²*	*>FCC MPE See Note 1*	*>FCC MPE See Note 2*
2	*Antenna Surface*	$\frac{4P_t}{A}$	*3.539*	*mW/cm²*	*>FCC MPE See Note 1*	*<FCC MPE*
3	*Main Reflector Ground*	$\frac{P_t}{A}$	*0.885*	*mW/cm²*	*<FCC MPE*	*<FCC MPE*
4	*Snf =Near-Field Power Density*	$S_{nf}=\frac{16\eta P_t}{pi\,D^2}=4\eta(\frac{P_t}{A})$	*4.742*	*mW/cm²*	*>FCC MPE See Note 1*	*<FCC MPE*
5	*Max Transition Power Density*	$S_t=\frac{S_{nf}R_{nf}}{R_{nf}}$	*4.742*	*mW/cm²*	*>FCC MPE See Note 1*	*<FCC MPE*
6	*Max Far field Power Density*	$S_{ff}=\frac{P_tG}{4\pi R^2}$	*1.015*	*mW/cm²*	*>FCC MPE See Note 3*	*<FCC MPE*
7	*Off Access Level Near Field*	$S_{ua}=S_{nf}-20\text{dB}$	*0.04742*	*mW/cm²*	*<FCC MPE*	*<FCC MPE*

Notes

1. *The antenna is installed in a controlled location access is restricted to authorized personnel only. The area is marked with RF Radiation Hazard signage. Area not accessible to the general public.*
2. *Inside the controlled area, MPE levels exceed the MPE exposure for occupational levels. The levels will be reduced to safe MPE by removing power to the transmitters when work is performed on or around the antenna. This area can only be accessed by qualified personnel.*
3. *The far field develops 39 meters above ground level at the minimum elevation angle which is not accessable to the general public.*

Radiation Hazard Analysis

2.4 Meter - General Dynamics NGSO 40
Manassas, Virginia 20109

Introduction

A radiation hazard anaylsis is presented for a 2.4 meter Ka band aperture antenna to be installed in Manassas Virginia at the O3b Networks Global Operations Center. This Radiation Analysis calculates the non-ionizing radiation levels expected to be emitted from the earth station on a worse cases basis and is performed in accordance with the Federal Communications Commissions Office of Engineering and Technology (OET) Bulletin, No. 65.

Requirements

OET 65 outlines the maximum permissible exposure limits in two cases for operation in this frequency range.

1. The first case is the maximum level that a person may be exposed to in the general population. The exposure limit is defined as a non-ionizing power level equal to 1 milliwatt per centimeter squared averaged over a thirty minute period.
2. The second case is a controlled environment where the maximum permissible exposure limit must not exceed 5 milliwatts per centimeter squared averaged over any six minute period.

Summary

The results indicate that no significant hazard will be presented to the general population and will be fully mitigated in the controlled area by the use of procedures that require the removal of transmit power before accessing the area around the main reflector.

Analysis

This analysis was performed on seven zones. The results of this is shown in Radiation Hazard Zones. The Table labeled Input Values provides the input data used to perform the analysis. The table labeled OET 65 Calculated Values provides the intermediate calculation used to perform the assessment in accordance with OET 65. The Analysis is performed for each of the seven radiation zones as shown in figure 1 – Analysis Zones. These zones are:

1. Point between the feed and the sub-reflector
2. The power at the surface of the antenna
3. The power level between the main reflector and ground
4. The near-field or Fresnel region in which the maxima can be reached before the field starts to diminish with distance
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7. The off axis level in the near field. This is defined as the area outside of the main beam removed and at least one antenna diameter removed from the main beam

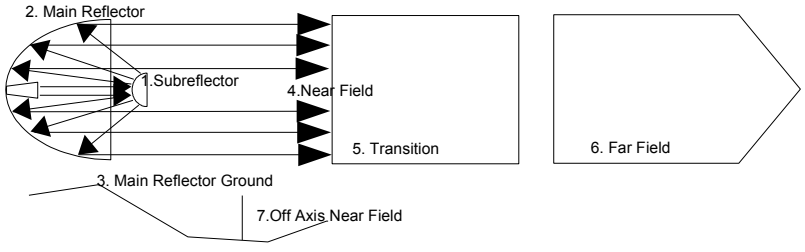

Figure 1 – Analysis Zones

Radiation Hazard Analysis

Operator:	***O3b Networks***	*FCC ID:*	
Location Designation:	***Global Operations Center***	*O3b ID:*	*General Dynamics NGSO 40*
County:	***Prince William***	*STA:*	
Town:	***Manassas***		
State/Zip:	***Virginia 20109***		

Input Values	*Value*	*Unit*
D = Aperture Diameter	*2.4*	*Meters*
d = Subreflector Diameter	*0.1*	*Meters*
η = Apperture Efficeny	*67%*	*percentage*
FCC Designation	*Ka*	*Band*
F = Frequency	*28850*	*MHz*
P = Transmitter Power Watts:	*40*	*Watts*
p = Number Transmitters:	*1*	
R_{ua} = closest point to uncontrolled area	*20*	*meters*
Elevation angle at closest point R_{ua}	*7*	*Degrees*

Band	*Frequency GHz*
L	*1000-2000*
S	*2000-4000*
C	*4000-8000*
X	*8000-12500*
Ku	*12500-18000*
K	*18000-25500*
Ka	*26500-40000*
O	*40000-50000*
V	*50000-75000*

OET 65 Calculated Values	*Formula*	*Value*	*Unit*
λ = Wavelength	c/F	*0.0104*	*meters*
P_t = Total Antenna Input Power	$P*p$	*40*	*watts*
G = Antenna Gain	$G=\frac{4\pi\eta A}{\lambda^2}$	*351889.01*	*linear*
Antenna Gain dB	$10\log_{10}(G)$	*55.46*	*dBi*
A = Area of reflector	$\pi(\frac{D}{2})^2$	*4.52*	*meters²*
a = area of subreflector or feed	$\pi(\frac{d}{2})^2$	*0.01*	*meters²*
R_{nf} = Near-Field Region	$R_{nf}=\frac{D^2}{4\lambda}$	*138.48* *17*	*meters* *Meters AGL*
Transition Region	$>R_{nf}<R_{ff}$	*138.48* *332.35*	*>meters* *<meters*
R_{ff} = Far Field Region	$R_{ff}=\frac{0.6D^2}{\lambda}$	*332.35* *41*	*meters* *Meters AGL*

	Radiation Analysis Zone	*Formula*	*Level*	*Value*	*Exposure Limits* *General Public* *<1mW/cm²*	*Occupational* *<5mW/cm²*
1	*Power Subreflector*	$\frac{4P_t}{a}$	*2038.217*	*mW/cm²*	*>FCC MPE See Note 1*	*>FCC MPE See Note 2*
2	*Antenna Surface*	$\frac{4P_t}{A}$	*3.539*	*mW/cm²*	*>FCC MPE See Note 1*	*<FCC MPE*
3	*Main Reflector Ground*	$\frac{P_t}{A}$	*0.885*	*mW/cm²*	*<FCC MPE*	*<FCC MPE*
4	*Snf =Near-Field Power Density*	$S_{nf}=\frac{16\eta P_t}{pi\,D^2}=4\eta(\frac{P_t}{A})$	*4.742*	*mW/cm²*	*>FCC MPE See Note 1*	*<FCC MPE*
5	*Max Transition Power Density*	$S_t=\frac{S_{nf}R_{nf}}{R_{nf}}$	*4.742*	*mW/cm²*	*>FCC MPE See Note 1*	*<FCC MPE*
6	*Max Far field Power Density*	$S_{ff}=\frac{P_tG}{4\pi R^2}$	*1.015*	*mW/cm²*	*>FCC MPE See Note 3*	*<FCC MPE*
7	*Off Access Level Near Field*	$S_{ua}=S_{nf}-20dB$	*0.04742*	*mW/cm²*	*<FCC MPE*	*<FCC MPE*

Notes

1. *The antenna is installed in a controlled location access is restricted to authorized personnel only. The area is marked with RF Radiation Hazard signage. Area not accessible to the general public.*
2. *Inside the controlled area, MPE levels exceed the MPE exposure for occupational levels. The levels will be reduced to safe MPE by removing power to the transmitters when work is performed on or around the antenna. This area can only be accessed by qualified personnel.*
3. *The far field develops 41 meters above ground level at the minimum elevation angle which is not accessable to the general public.*