RigNet SatCom, Inc.
Modification of ESV Blanket License (Call Sign E980235)

Technical Appendix

I. Area of Operations Map

II. Radiation Hazard Studies

  a. Sea Tel USAT-24
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III. Updated ESV Satellite Arcs

IV. FCC Declaration of Conformity

I. Area of Operations Map

As indicated in the map, the dark areas illustrate the outer contours of the areas of operation for the ESVs. Operations may also occur in inland waterways.

II.a. Radiation Hazard Study

SeaTel USAT24

This study analyzes the potential Radio Frequency (RF) human exposure levels caused by the Electro Magnetic (EM) fields of the above-captioned 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 Permisible 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 1.5 GHz 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 following input parameters were used in the calculations:

Parameter	Value	Unit	Symbol
Antenna Diameter:	0.6	m	D
Antenna Transmit Gain:	36.00	dBi	G
Trasmit Frequency:	14000	MHz	f
Feed Flange Diameter:	7.20	cm	d
Power Input to the Antenna:	6.80	W	P

Calculated Parameters

The following values were calculated using the above input parameters and the corresponding formulas.

Parameter	Value	Unit	Symbol	Formula
Anenna Surface Area:	0.28	m^2	A	$\pi D^2/4$
Area of Feed Flange:	40.72	cm^2	a	$\pi d^2/4$
Antenna Efficiency:	0.51		η	$G\lambda^2/(\pi^2 D^2)$
Gain Factor:	3981.07		g	$10^{G/10}$
Wavelength:	0.0214	m	λ	$300/f$

Behavior of EM Fields as a Function of Distance

The behavior of the characteristics of EM fields varies depending on the distance from the radiating antenna. These characteristics are analyzed in three primary regions: the near-field region, the far-field region and the transition region. Of interest also are the region between the antenna main reflector and the subreflector, the region of the main reflector area and the region between the main reflector and ground.

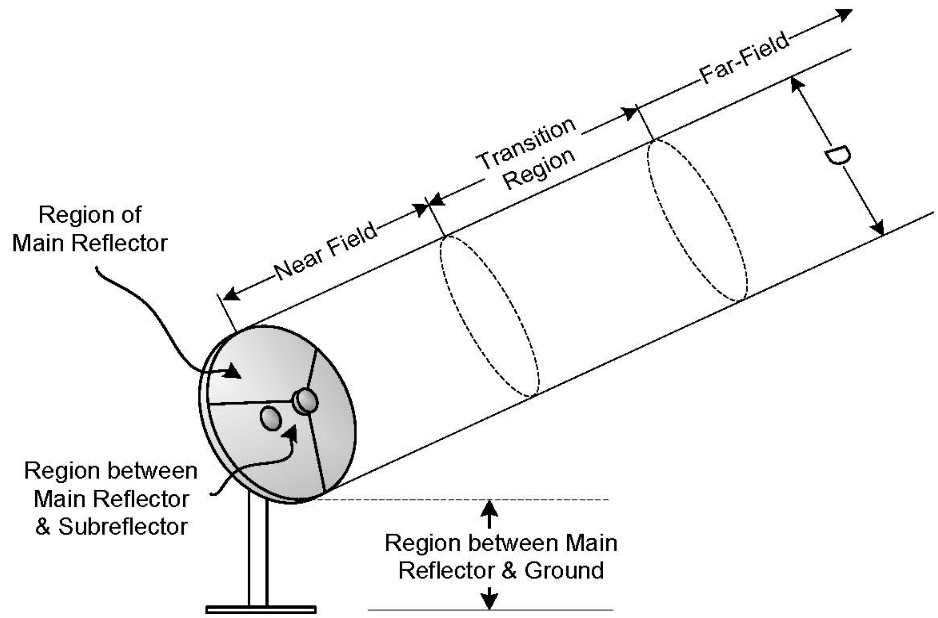

Figure 1. EM Fields as a Function of Distance

For parabolic aperture antennas with circular cross sections, such as the antenna under study, the near-field, far-field and transition region distances are calculated as follows:

Parameter	Value	Unit	Formula
Near Field Distance:	4.200	m	$R_{nf} = D^2/(4\lambda)$
Distance to Far Field:	10.080	m	Rff = 0.60D2/(λ)
Distance of Trasition Region	4.200	m	Rt = Rnf

The distance in the transition region is between the near and far fields. Thus, Rnf ≤ Rt ≤ Rff . However, the power density in the transition region will not exceed the power density in the near-field. Therefore, for purposes of the present analysis, the distance of the transition region can equate the distance to the near-field.

Power Flux Density Calculations

The power flux density is considered to be at a maximum through the entire length of the near-field. This region is contained within a cylindrical volume with a diameter, D, equal to the diameter of the antenna. In the transition region and the far-field, the power density decreases inversely with the square of the distance. The following equations are used to calculate power density in these regions.

Parameter	Value	Unit	Symbol	Formula
Power Density in the Near-Field	4.949	mW/cm^2	S_{nf}	$16.0\ \eta\ P/(\pi D^2)$
Power Density in the Far-Field	2.120	mW/cm^2	S_{ff}	$GP/(4\pi\ R_{ff}^2)$
Power Density in the Trans. Region	4.949	mW/cm^2	S_t	$S_{nf}\ R_{nf}\ /(R_t)$

The region between the main reflector and the subreflector is confined within a conical shape defined by the feed assembly. The most common feed assemblies are waveguide flanges. This energy is determined as follows:

Parameter	Value	Unit	Symbol	Formula
Power Density at the Feed Flange	668.1	mW/cm^2	S_{fa}	$4P\ /\ a$

The power density in the main reflector is determined similarly to the power density at the feed flange; except that the area of the reflector is used.

Parameter	Value	Unit	Symbol	Formula
Power Density at Main Reflector	9.620	mW/cm^2	$S_{surface}$	$4P\ /\ A$

The power density between the reflector and ground, assuming uniform illumination of the reflector surface, is calculated as follows:

Parameter	Value	Unit	Symbol	Formula
Power Density between Reflector and Ground	2.405	mW/cm^2	S_g	$P\ /\ A$

Table 1 summarizes the calculated power flux density values for each region. In a controlled environment, the only regions that exceed FCC limitations are shown below. These regions are only accessible by trained technicians who, as a matter of procedure, turn off transmit power before performing any work in these areas.

Power Densities	**mW/cm2**	**Controlled Environment (5 mW/cm2)**
Far Field Calculation	2.120	Satisfies FCC Requirements
Near Field Calculation	4.949	Satisfies FCC Requirements
Transition Region	4.949	Satisfies FCC Requirements
Region between Main and Subreflector	668.1	Exceeds Limitations
Main Reflector Region	9.620	Exceeds Limitations
Region between Main Reflector and Ground	2.405	Satisfies FCC Requirements

Table 1. Power Flux Density for Each Region

In conclusion, the results show that the antenna, in a controlled environment, and under the proper mitigation procedures, meets the guidelines specified in 47 C.F.R. § 1.1310.

II.b. Radiation Hazard Study

SeaTel USAT30

This study analyzes the potential Radio Frequency (RF) human exposure levels caused by the Electro Magnetic (EM) fields of the above-captioned 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 Permisible 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 1.5 GHz 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 following input parameters were used in the calculations:

Parameter	Value	Unit	Symbol
Antenna Diameter:	0.75	m	D
Antenna Transmit Gain:	39.00	dBi	G
Trasmit Frequency:	14250	MHz	f
Feed Flange Diameter:	7.20	cm	d
Power Input to the Antenna:	8.00	W	P

Calculated Parameters

The following values were calculated using the above input parameters and the corresponding formulas.

Parameter	Value	Unit	Symbol	Formula
Anenna Surface Area:	0.44	m^2	A	$\pi D^2/4$
Area of Feed Flange:	40.72	cm^2	a	$\pi d^2/4$
Antenna Efficiency:	0.63		η	$G\lambda^2/(\pi^2 D^2)$
Gain Factor:	7943.28		g	$10^{G/10}$
Wavelength:	0.0211	m	λ	$300/f$

Behavior of EM Fields as a Function of Distance

The behavior of the characteristics of EM fields varies depending on the distance from the radiating antenna. These characteristics are analyzed in three primary regions: the near-field region, the far-field region and the transition region. Of interest also are the region between the antenna main reflector and the subreflector, the region of the main reflector area and the region between the main reflector and ground.

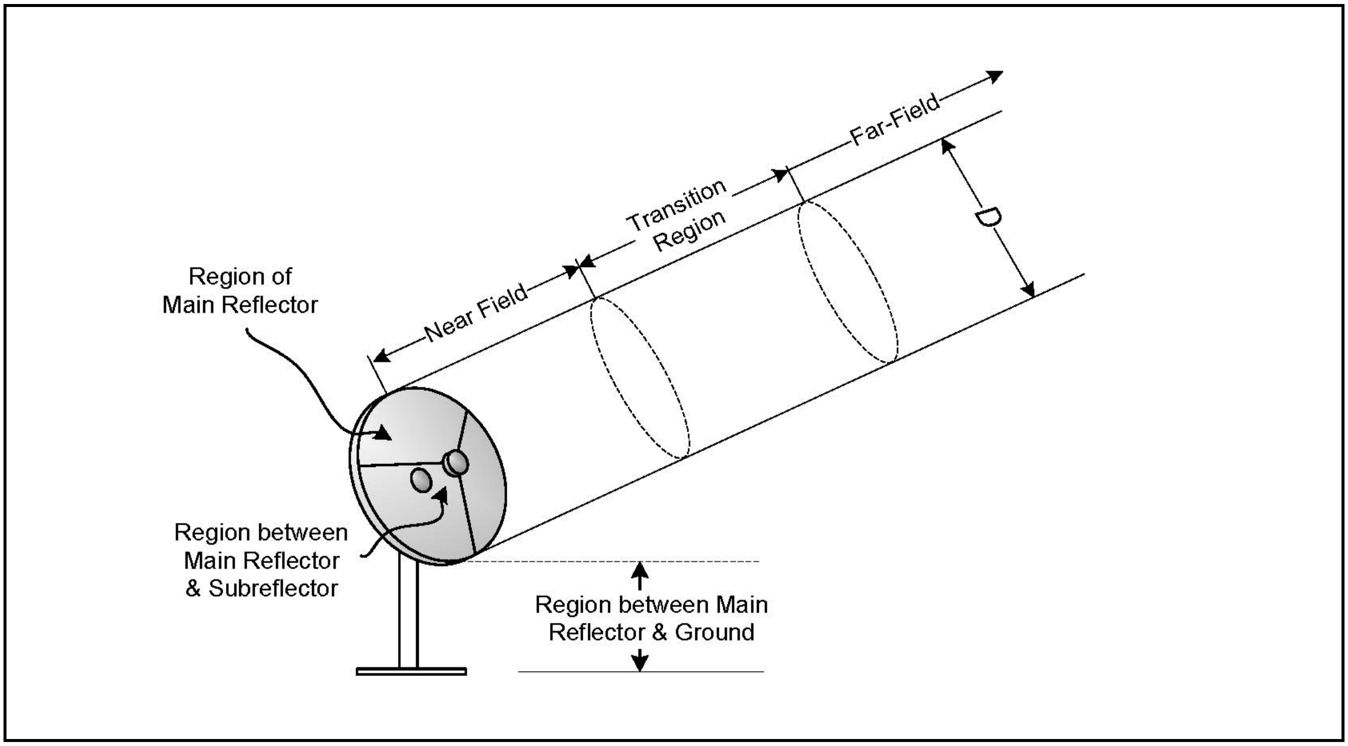

Figure 1. EM Fields as a Function of Distance

For parabolic aperture antennas with circular cross sections, such as the antenna under study, the near-field, far-field and transition region distances are calculated as follows:

Parameter	Value	Unit	Formula
Near Field Distance:	6.680	m	$R_{nf} = D^2/(4\lambda)$
Distance to Far Field:	16.031	m	Rff = 0.60D2/(λ)
Distance of Trasition Region	6.680	m	Rt = Rnf

The distance in the transition region is between the near and far fields. Thus, Rnf ≤ Rt ≤ Rff . However, the power density in the transition region will not exceed the power density in the near-field. Therefore, for purposes of the present analysis, the distance of the transition region can equate the distance to the near-field.

Power Flux Density Calculations

The power flux density is considered to be at a maximum through the entire length of the near-field. This region is contained within a cylindrical volume with a diameter, D, equal to the diameter of the antenna. In the transition region and the far-field, the power density decreases inversely with the square of the distance. The following equations are used to calculate power density in these regions.

Parameter	Value	Unit	Symbol	Formula
Power Density in the Near-Field	4.593	mW/cm^2	S_{nf}	$16.0\ \eta\ P/(\pi D^2)$
Power Density in the Far-Field	1.968	mW/cm^2	S_{ff}	$GP/(4\pi R_{ff}^2)$
Power Density in the Trans. Region	4.593	mW/cm^2	S_t	$S_{nf} R_{nf} /(R_t)$

The region between the main reflector and the subreflector is confined within a conical shape defined by the feed assembly. The most common feed assemblies are waveguide flanges. This energy is determined as follows:

Parameter	Value	Unit	Symbol	Formula
Power Density at the Feed Flange	786.0	mW/cm^2	S_{fa}	$4P / a$

The power density in the main reflector is determined similarly to the power density at the feed flange; except that the area of the reflector is used.

Parameter	Value	Unit	Symbol	Formula
Power Density at Main Reflector	7.243	mW/cm^2	$S_{surface}$	$4P / A$

The power density between the reflector and ground, assuming uniform illumination of the reflector surface, is calculated as follows:

Parameter	Value	Unit	Symbol	Formula
Power Density between Reflector and Ground	1.811	mW/cm^2	S_g	P / A

Table 1 summarizes the calculated power flux density values for each region. In a controlled environment, the only regions that exceed FCC limitations are shown below. These regions are only accessible by trained technicians who, as a matter of procedure, turn off transmit power before performing any work in these areas.

Power Densities	**mW/cm2**	**Controlled Environment (5 mW/cm2)**
Far Field Calculation	1.968	Satisfies FCC Requirements
Near Field Calculation	4.593	Satisfies FCC Requirements
Transition Region	4.593	Satisfies FCC Requirements
Region between Main and Subreflector	786.0	Exceeds Limitations
Main Reflector Region	7.243	Exceeds Limitations
Region between Main Reflector and Ground	1.811	Satisfies FCC Requirements

Table 1. Power Flux Density for Each Region

In conclusion, the results show that the antenna, in a controlled environment, and under the proper mitigation procedures, meets the guidelines specified in 47 C.F.R. § 1.1310.

III. Updated ESV Permitted List Satellite Arcs

Antenna ID	Existing Satellite Arc	Update Satellite Arc
ESV R-1	43° W.L.-143° W.L.	1° W.L.-180° W.L.
ESV R-2	43° W.L.-143° W.L.	1° W.L.-180° W.L.
ESV R-3	43° W.L.-143° W.L.	1° W.L.-180° W.L.
ESV R-4	43° W.L.-143° W.L.	1° W.L.-180° W.L.
ESV R-5	32° W.L.-139° W.L.	1° W.L.-180° W.L.
ESV R-6	43° W.L.-143° W.L.	1° W.L.-180° W.L.
ESV R-7	43° W.L.-143° W.L.	1° W.L.-180° W.L.
ESV R-8	43° W.L.-143° W.L.	1° W.L.-180° W.L.
ESV R-9	43° W.L.-143° W.L.	1° W.L.-180° W.L.
ESV R-10	43° W.L.-143° W.L.	1° W.L.-180° W.L.
ESV R-11	43° W.L.-143° W.L.	1° W.L.-180° W.L.
ESV R-12	43° W.L.-143° W.L.	1° W.L.-180° W.L.
ESV R-13	43° W.L.-143° W.L.	1° W.L.-180° W.L.

IV.

Sea Tel
COBHAM

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FCC Declaration of Conformity

1. Sea Tel, Inc. designs, develops, manufactures and services marine stabilized antenna systems for satellite communication at sea. These products are in turn used by our customers as part of their Ku-band Earth Station on Vessels (ESV) networks.
2. FCC regulation 47 C.F.R. § 25.222 defines the provisions for blanket licensing of ESV antennas operating in the Ku Band. This declaration covers the requirements for meeting § 25.222 (a)(1) by the demonstrations outlined in paragraphs (b)(1)(i) and (b)(1)(iii). The requirements for meeting § 25.222 (a)(3)-(a)(7) are left to the applicant. The paragraph numbers in this declaration refer to the 2009 version of FCC 47 C.F.R. § 25.222.
3. Sea Tel hereby declares that the antennas listed below will meet the off-axis EIRP spectral density requirements of § 25.222 (a)(1)(i) with an N value of 1, when the following Input Power spectral density limitations are met:

*0.6 Meter Ku Band, Models 2406 and USAT-24 are limited to	-21.6 dBW/4kHz
*0.75 Meter Ku Band, Models 3011 and USAT-30 are limited to	-21.6 dBW/4kHz
0.9 Meter Ku Band, Model 3612 is limited to	-20.3 dBW/4kHz
1.0 Meter Ku Band, Models 4003/4006/4009/4010 are limited to	-16.3 dBW/4kHz
1.0 Meter Ku Band Model 4012 is limited to	-16.6 dBW/4kHz
1.2 Meter Ku Band, Models 4996/5009/5010/5012 are limited to	-14.0 dBW/4kHz
1.5 Meter Ku Band, Models 6006/6009/6012 are limited to	-14.0 dBW/4kHz
2.4 Meter Ku Band, Models 9797 and 9711QOR are limited to	-14.0 dBW/4kHz

4. Sea Tel hereby declares that the antennas referenced in paragraph 3 above, will maintain a stabilization pointing accuracy of better than 0.2 degrees under specified ship motion conditions, thus meeting the requirements of § 25.222 (a)(1)(ii)(A). Those antennas marked with * will maintain a stabilization pointing accuracy of better than 0.3 degrees. The Input Power spectral density limits for these antenna have been adjusted to meet the requirements of§ 25.222 (a)(1)(ii)(B).
5. Sea Tel hereby declares that the antennas referenced in paragraph 3 above, will automatically cease transmission within 100 milliseconds if the pointing error should exceed 0.5 degrees and will not resume transmission until the error drops below 0.2 degrees, thus meeting the requirements of § 25.222 (a)(1)(iii).
6. Sea Tel maintains all relevant test data, which is available upon request, to verify these declarations.

Peter Blaney, Chief Engineer
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Concord, CA

24-Jan-2013