Sea Tel Inc.
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California, 94520, USA
T: +1 (925) 798-7979
F: +1 (925) 798-7986

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
Sea Tel, Inc
Concord, CA

Cobham SATCOM, Sea Tel Products

2.4m Ku EIRPsd Data Table (0.5dB radome Loss)
Co Pol Azimuth, -180 to +180 Degrees

Angle Degree	EIRPsd dBW/4kHz	Mask dBW/4kHz
-180	-40.6	-14
-179	-45.1	-14
-178	-43.7	-14
-177	-39.7	-14
-176	-50.8	-14
-175	-39.5	-14
-174	-52.8	-14
-173	-51.3	-14
-172	-42.9	-14
-171	-42.3	-14
-170	-41.6	-14
-169	-39.5	-14
-168	-45	-14
-167	-40.4	-14
-166	-42.6	-14
-165	-43	-14
-164	-40	-14
-163	-38.5	-14
-162	-40.9	-14
-161	-42.1	-14
-160	-44.1	-14
-159	-41	-14
-158	-37.3	-14
-157	-36	-14
-156	-34.3	-14
-155	-37	-14
-154	-33	-14
-153	-31.7	-14
-152	-32.2	-14
-151	-31.1	-14
-150	-34	-14
-149	-34	-14
-148	-38.3	-14
-147	-40.9	-14
-146	-38.6	-14
-145	-36.3	-14
-144	-40.3	-14
-143	-34.1	-14
-142	-30.6	-14
-141	-31.8	-14
-140	-33.8	-14

Angle Degree	EIRPsd dBW/4kHz	Mask dBW/4kHz
0	33.3	
0.1	32.9	
0.2	31.8	
0.3	29.7	
0.4	26.8	
0.5	23.1	
0.6	18.4	
0.7	13.1	
0.8	7.7	
0.9	3.8	
1	3.2	
1.1	3.9	
1.2	3.1	
1.3	1.1	
1.4	1	
1.5	2.9	10.6
1.6	4	9.9
1.7	4.1	9.2
1.8	3.6	8.6
1.9	2.6	8
2	1.4	7.5
2.1	-0.5	6.9
2.2	-3.9	6.4
2.3	-7.4	6
2.4	-9.9	5.5
2.5	-10.3	5.1
2.6	-11	4.6
2.7	-12	4.2
2.8	-13.1	3.8
2.9	-15	3.4
3	-19.6	3.1
3.1	-23.4	2.7
3.2	-18.2	2.4
3.3	-14.4	2
3.4	-12.7	1.7
3.5	-12.5	1.4
3.6	-13.8	1.1
3.7	-16.1	0.8
3.8	-18.4	0.5
3.9	-21.1	0.2
4	-22.1	-0.1

-139	-29.8	-14
-138	-30.6	-14
-137	-28.9	-14
-136	-28.2	-14
-135	-28.8	-14
-134	-25.2	-14
-133	-26.9	-14
-132	-27.6	-14
-131	-29.3	-14
-130	-27.1	-14
-129	-26.9	-14
-128	-28.7	-14
-127	-26.3	-14
-126	-26.8	-14
-125	-26.8	-14
-124	-24.9	-14
-123	-26.4	-14
-122	-26.6	-14
-121	-25.4	-14
-120	-25.4	-14
-119	-23.8	-14
-118	-21.8	-14
-117	-23.5	-14
-116	-26.1	-14
-115	-26.5	-14
-114	-26.3	-14
-113	-24.3	-14
-112	-24.3	-14
-111	-23	-14
-110	-26	-14
-109	-24.9	-14
-108	-26.1	-14
-107	-27.4	-14
-106	-27.8	-14
-105	-29.1	-14
-104	-30.9	-14
-103	-28.5	-14
-102	-31.6	-14
-101	-28	-14
-100	-28.1	-14
-99	-32	-14
-98	-33.1	-14
-97	-37.6	-14
-96	-42.1	-14
-95	-34	-14
-94	-33.3	-14
-93	-40.7	-14

4.1	-20	-0.3
4.2	-15.5	-0.6
4.3	-12.4	-0.8
4.4	-10.6	-1.1
4.5	-10.2	-1.3
4.6	-10.6	-1.6
4.7	-10.8	-1.8
4.8	-10.4	-2
4.9	-9.8	-2.3
5	-9.3	-2.5
5.1	-9.4	-2.7
5.2	-10.4	-2.9
5.3	-11.7	-3.1
5.4	-13.1	-3.3
5.5	-14.1	-3.5
5.6	-15.3	-3.7
5.7	-16.3	-3.9
5.8	-17	-4.1
5.9	-17.6	-4.3
6	-17.8	-4.5
6.1	-18.3	-4.6
6.2	-20	-4.8
6.3	-21.1	-5
6.4	-21.5	-5.2
6.5	-22.4	-5.3
6.6	-24.4	-5.5
6.7	-32.3	-5.7
6.8	-34.7	-5.8
6.9	-23.3	-6
7	-19.1	-6
7.1	-16.7	-6
7.2	-15.8	-6
7.3	-14.9	-6
7.4	-14.4	-6
7.5	-14	-6
7.6	-13.4	-6
7.7	-12.5	-6
7.8	-12.4	-6
7.9	-12.3	-6
8	-13.3	-6
8.1	-14.9	-6
8.2	-16.9	-6
8.3	-17.5	-6
8.4	-16.7	-6
8.5	-16.6	-6
8.6	-17	-6
8.7	-18.6	-6

-92	-32.7	-14
-91	-36.3	-14
-90	-65.7	-14
-89	-31.3	-14
-88	-32.9	-14
-87	-31.9	-14
-86	-30.6	-14
-85	-34.5	-14
-84	-36.2	-24
-83	-34.9	-24
-82	-32.6	-24
-81	-31.2	-24
-80	-31.8	-24
-79	-31.8	-24
-78	-29.8	-24
-77	-43.6	-24
-76	-34.9	-24
-75	-29.8	-24
-74	-31	-24
-73	-34.8	-24
-72	-48.6	-24
-71	-28.1	-24
-70	-35.3	-24
-69	-34.7	-24
-68	-32.8	-24
-67	-30.1	-24
-66	-35.9	-24
-65	-32.9	-24
-64	-27.8	-24
-63	-27.6	-24
-62	-36.8	-24
-61	-42.4	-24
-60	-32.4	-24
-59	-30.5	-24
-58	-24.6	-24
-57	-27.3	-24
-56	-35.4	-24
-55	-28.9	-24
-54	-28	-24
-53	-34.7	-24
-52	-32.6	-24
-51	-30.4	-24
-50	-35.2	-24
-49	-34.9	-24
-48	-38.9	-24
-47	-28.1	-23.8
-46	-30.1	-23.6

8.8	-20.4	-6
8.9	-21.6	-6
9	-22.9	-6
9.1	-22.2	-6
9.2	-22.3	-6.1
9.3	-22.6	-6.2
9.4	-22.5	-6.3
9.5	-20	-6.4
9.6	-18	-6.6
9.7	-15.7	-6.7
9.8	-13.2	-6.8
9.9	-11.9	-6.9
10	-11.3	-7
11	-11.1	-8
12	-13.5	-9
13	-33.2	-9.8
14	-27.4	-10.7
15	-18.6	-11.4
16	-28.8	-12.1
17	-34.1	-12.8
18	-26.8	-13.4
19	-33.4	-14
20	-29.2	-14.5
21	-55.3	-15.1
22	-37	-15.6
23	-27.1	-16
24	-23.6	-16.5
25	-29	-16.9
26	-41	-17.4
27	-24.3	-17.8
28	-19.8	-18.2
29	-22.1	-18.6
30	-23.3	-18.9
31	-23.1	-19.3
32	-29.3	-19.6
33	-31	-20
34	-27.3	-20.3
35	-21.4	-20.6
36	-22.7	-20.9
37	-26.8	-21.2
38	-25.8	-21.5
39	-25.7	-21.8
40	-24.4	-22.1
41	-26.5	-22.3
42	-24.5	-22.6
43	-24.5	-22.8
44	-32.7	-23.1

-45	-26.3	-23.3
-44	-24.6	-23.1
-43	-29.1	-22.8
-42	-33.6	-22.6
-41	-25.2	-22.3
-40	-22.2	-22.1
-39	-23	-21.8
-38	-24.1	-21.5
-37	-23.2	-21.2
-36	-28.3	-20.9
-35	-26.3	-20.6
-34	-26	-20.3
-33	-24.5	-20
-32	-23.8	-19.6
-31	-25.3	-19.3
-30	-25.4	-18.9
-29	-25.7	-18.6
-28	-24.5	-18.2
-27	-28.8	-17.8
-26	-33.1	-17.4
-25	-25.1	-16.9
-24	-25.3	-16.5
-23	-26.8	-16
-22	-40.1	-15.6
-21	-27.3	-15.1
-20	-29.8	-14.5
-19	-27.2	-14
-18	-36.8	-13.4
-17	-28.5	-12.8
-16	-22.7	-12.1
-15	-25.6	-11.4
-14	-39.9	-10.7
-13	-30.9	-9.8
-12	-14.2	-9
-11	-17.6	-8
-10	-17.4	-7
-9.9	-20.6	-6.9
-9.8	-22.4	-6.8
-9.7	-19	-6.7
-9.6	-16	-6.6
-9.5	-14.4	-6.4
-9.4	-13.4	-6.3
-9.3	-13.2	-6.2
-9.2	-14.3	-6.1
-9.1	-15.6	-6
-9	-17.3	-6
-8.9	-18.6	-6

45	-35.9	-23.3
46	-34.3	-23.6
47	-28.1	-23.8
48	-33.4	-24
49	-29.6	-24
50	-27.6	-24
51	-33.7	-24
52	-33.8	-24
53	-27	-24
54	-25.1	-24
55	-33.3	-24
56	-51.9	-24
57	-31.3	-24
58	-28.5	-24
59	-30.7	-24
60	-35.5	-24
61	-29.6	-24
62	-39.4	-24
63	-30.4	-24
64	-30.8	-24
65	-31.7	-24
66	-38	-24
67	-39.7	-24
68	-38.7	-24
69	-47.8	-24
70	-37.9	-24
71	-30.6	-24
72	-30.7	-24
73	-32.4	-24
74	-28.9	-24
75	-29.6	-24
76	-31.1	-24
77	-36.2	-24
78	-38.7	-24
79	-31.9	-24
80	-31.9	-24
81	-43.3	-24
82	-39.4	-24
83	-39.4	-24
84	-32	-24
85	-30.6	-14
86	-29.3	-14
87	-32.8	-14
88	-33.7	-14
89	-47.9	-14
90	-31.1	-14
91	-36	-14

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-8.7	-18.4	-6
-8.6	-16.7	-6
-8.5	-14.8	-6
-8.4	-12.7	-6
-8.3	-11.1	-6
-8.2	-10.1	-6
-8.1	-9.2	-6
-8	-9	-6
-7.9	-9.3	-6
-7.8	-10	-6
-7.7	-10.9	-6
-7.6	-12.1	-6
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-7	-23.2	-6
-6.9	-26.1	-6
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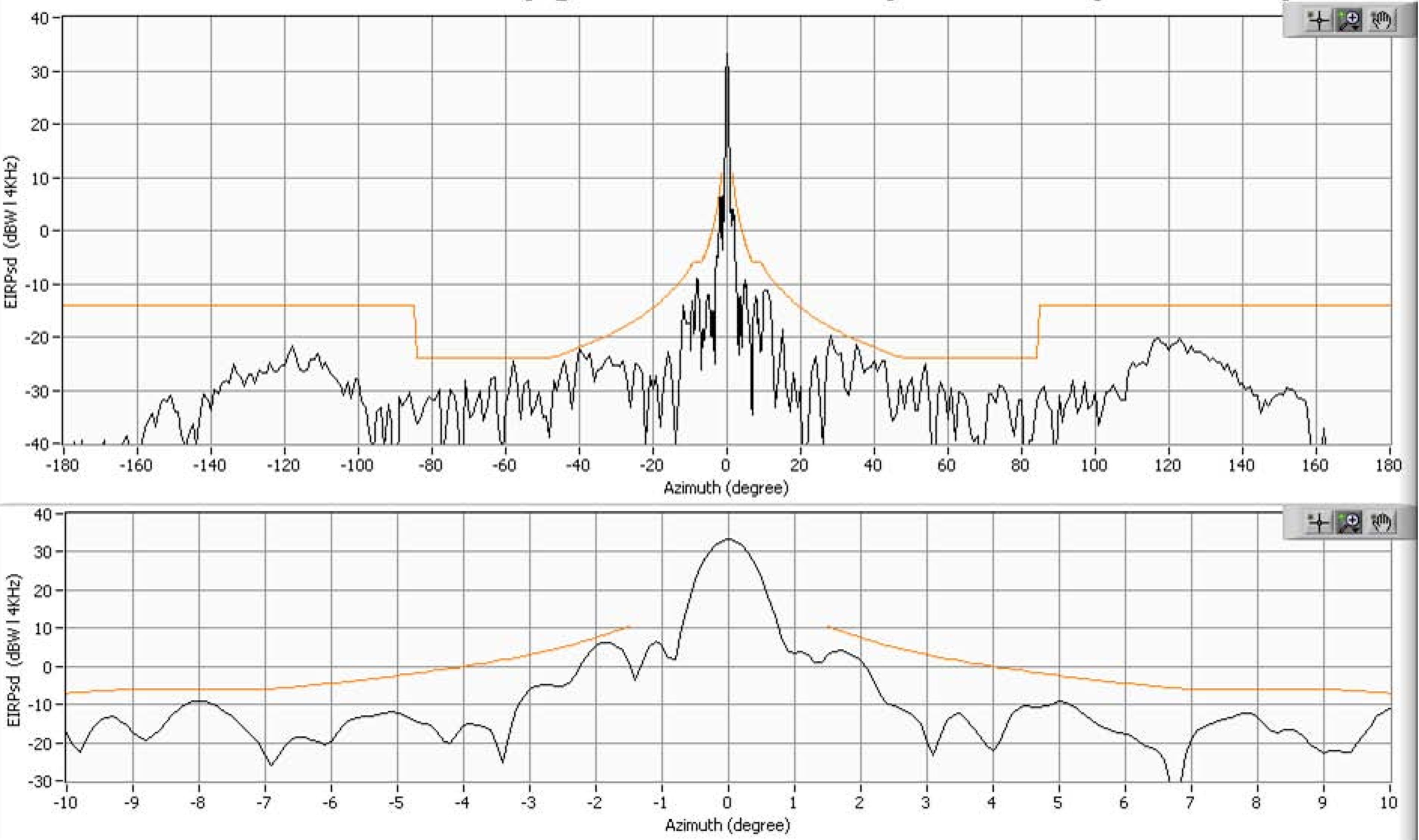
-6.7	-21.1	-5.7
-6.6	-18.9	-5.5
-6.5	-18.7	-5.3
-6.4	-18.8	-5.2
-6.3	-19.5	-5
-6.2	-19.8	-4.8
-6.1	-20.7	-4.6
-6	-19.6	-4.5
-5.9	-17.5	-4.3
-5.8	-15.2	-4.1
-5.7	-14	-3.9
-5.6	-13.4	-3.7
-5.5	-13	-3.5
-5.4	-13	-3.3
-5.3	-12.6	-3.1
-5.2	-12.2	-2.9
-5.1	-12.1	-2.7
-5	-12.1	-2.5
-4.9	-12.8	-2.3
-4.8	-13.8	-2
-4.7	-14.6	-1.8
-4.6	-15	-1.6
-4.5	-15.5	-1.3
-4.4	-17.1	-1.1
-4.3	-19.6	-0.8
-4.2	-20	-0.6

92	-32.8	-14
93	-31.4	-14
94	-28.1	-14
95	-34.3	-14
96	-33.3	-14
97	-28.3	-14
98	-33.6	-14
99	-32.6	-14
100	-30.4	-14
101	-36.6	-14
102	-33.5	-14
103	-30.3	-14
104	-30.1	-14
105	-29.1	-14
106	-31.1	-14
107	-31.9	-14
108	-31.8	-14
109	-26.2	-14
110	-24.7	-14
111	-25.5	-14
112	-25	-14
113	-24.8	-14
114	-25.3	-14
115	-22.4	-14
116	-20.4	-14
117	-20.4	-14
118	-21.1	-14
119	-21.4	-14
120	-22.6	-14
121	-21.4	-14
122	-21.1	-14
123	-20.2	-14
124	-21.4	-14
125	-23.2	-14
126	-21.7	-14
127	-22.9	-14
128	-22.9	-14
129	-23.2	-14
130	-23.7	-14
131	-24.5	-14
132	-23.8	-14
133	-24.7	-14
134	-24.8	-14
135	-26.1	-14
136	-25.2	-14
137	-27.4	-14
138	-26.1	-14

-4.1	-17.3	-0.3
-4	-15.4	-0.1
-3.9	-15.1	0.2
-3.8	-15.3	0.5
-3.7	-15.8	0.8
-3.6	-16.6	1.1
-3.5	-20.4	1.4
-3.4	-25.2	1.7
-3.3	-16.5	2
-3.2	-11	2.4
-3.1	-7.9	2.7
-3	-6.1	3.1
-2.9	-5	3.4
-2.8	-4.7	3.8
-2.7	-4.7	4.2
-2.6	-5	4.6
-2.5	-5.1	5.1
-2.4	-4.4	5.5
-2.3	-2	6
-2.2	1.1	6.4
-2.1	3.8	6.9
-2	5.4	7.5
-1.9	6.1	8
-1.8	6.1	8.6
-1.7	5.6	9.2
-1.6	4.2	9.9
-1.5	0.9	10.6
-1.4	-3.7	
-1.3	0.9	
-1.2	4.8	
-1.1	6.4	
-1	5.5	
-0.9	2.4	
-0.8	1.8	
-0.7	10.2	
-0.6	17.2	
-0.5	22.8	
-0.4	26.7	
-0.3	29.8	
-0.2	31.8	
-0.1	32.8	

139	-28.9	-14
140	-28.8	-14
141	-29.8	-14
142	-29.3	-14
143	-31.1	-14
144	-31.1	-14
145	-34.3	-14
146	-31.8	-14
147	-33	-14
148	-31.5	-14
149	-31.1	-14
150	-30.8	-14
151	-31.1	-14
152	-29.6	-14
153	-29.8	-14
154	-30.2	-14
155	-31.6	-14
156	-31.4	-14
157	-32	-14
158	-36.3	-14
159	-46.9	-14
160	-44.1	-14
161	-47.4	-14
162	-37.1	-14
163	-43.3	-14
164	-45.4	-14
165	-41.3	-14
166	-46.7	-14
167	-46	-14
168	-43.9	-14
169	-41.3	-14
170	-47	-14
171	-44.3	-14
172	-43.8	-14
173	-46.3	-14
174	-40.2	-14
175	-43.8	-14
176	-40.7	-14
177	-43.6	-14
178	-59.2	-14
179	-42.2	-14
180	-43	-14

14250 MHz Azimuth HH (Against FCC EIRP Mask) Pin=-14.0 (dBW | 4KHz)



DATE: September 2017
SUBJECT: Radiation Hazard Analysis

TO: FCC
FROM: Michael J. Durbin Ph.D. E.E.

Attached is the technical analysis (Exhibit C) that predicts the expected radio frequency radiation exposure to humans in the vicinity of the 1.2 Meter Satellite Up-Link Earth Station. The basis for this analysis was extracted from the following source:

> "Evaluating Compliance With FCC-Specified Guidelines for Human Exposure to Radio Frequency Radiation", OST Bulletin No. 65, October 1985, Federal Communications Commission, Office of Science and Technology, Washington, D.C. 20554

Please direct any questions to:

Michael J. Durbin Ph.D.
mike@k5mjd.us
214-801-7721

EXHIBIT C 1.2 Meter Ku

RADIATION HAZARD ANALYSIS

Prepared by:
Michael J. Durbin Ph.D.

Michael J. Durbin

RF RADIATION HAZARD ANALYSIS
1.2 METER SATELLITE UP LINK EARTH STATION

Because of the highly directional nature of parabolic antenna systems, the possibility of significant Human exposure to RF radiation is unlikely if precautions are taken to prevent incidental human access to those few areas where the existing power densities are in excess of those recommended for Human Exposure[1].

There are regions in the vicinity of the antenna that can generate substantial power density levels, such as the area between the feed and the sub reflector and the area directly in front and along the axis of the antenna. The antenna site layout is designed to limit the access to these areas. Therefore, the earth station operators and the general public will only be exposed to microwave radiation levels below and behind the antenna, and at various orientations off from the main axis of the antenna. The predicted radiation exposure levels are calculated below. They show that operations personnel and the general public will be exposed to radiation levels below the recommended values of 5 mw/cm^2 for short term or 1 mw/cm^2 for long term exposure.

The particular site parameters used in the analysis are as follows:

D = antenna diameter	= 1.2 Meter
F = frequency	= 14250 MHz.
λ = wavelength	= .0.02105
P = power into the feed	=60 Watts (max)
π = Pi	= 3.1416
A = physical aperture area($\pi D^2/4$	= 1.13 Sq. Meters
G = antenna transmit gain	= 85113.8 49.3 dBi
η = aperture efficiency	= 0.67

NEAR FIELD REGION

With a parabolic antenna the power density is greatest on the antenna axis in the near-field region of the antenna. This maximum occurs at a distance of 0.2 D^2/λ = 200.0833 Meters (656.2733 feet) from the antenna, however, conservatively, we consider that this maximum power density value occurs throughout the length of the near field region R, where R is as follows:

$$R = D^2/4\lambda = 13.68 \text{ Meters } (44.87\text{feet})$$

[1] "Evaluating Compliance With FCC-Specified Guidelines for Human Exposure to Radiation Frequency Radiation", OST Bulletin No. 65, October 1985, Federal Communications Commission, Office of Science and Technology, Washington, D.C. 20554

The power density within this region is equal to the following:

$$PD = (16\eta P)/(\pi D^2) = (4\eta P)/A$$

$$= 142.13\ W/m^2 = 14.213 mW/cm^2$$

<u>TRANSITION</u> <u>REGION</u>:
The power density in the transition region decreases inversely with distance from the antenna. For evaluating exposure in this region the distance to the beginning of the near field region is determined as follows:

$$R = (D^2)/4\lambda = 41.04 \text{ Meters (135.02 feet)}$$

The on-axis power densities in the transition region can be estimated as follows:

$$PD(trans) = (PD(near\ field)R(near\ field))/R$$

Where R is the point of interest.

The on-axis power density energy in both these regions is contained within a cylindrical volume of a diameter equal to the antenna's diameter and extends upward into space according to the antenna's elevation angle. Because of the elevated geometry of the main reflector and the rising edges of the cylindrical near field region of the antenna both these areas will be inaccessible by the public or personnel.

Off axis calculations in the near field and in the transition region can be made assuming a point of interest at least one antenna diameter from the center of the antenna main beam. The power density at that point will be at least a factor of 100 (20 dB) less than the value calculated for the equivalent distance in the main beam. Therefore, it maybe assumed that the power density will be at least 20 dB below the maximum level at a radial distance of D, 1.2 meters, from the center line axis of the antenna. At distances within the near field radiation density will be:

$$.03555\ mW/cm^2/100 = .1.386\ mW/cm^2 \text{ (and less for the transition region)}$$

<u>FAR</u> <u>FIELD</u> <u>REGION</u>
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. The on-axis power density in the far field is as follows:

$$PD = (PG)/4\pi R^2$$

$$= 221.9\ M/W^2 = 22.19\ mW/cm^2$$

The above value represents the maximum exposure level that the system can produce on-axis. Off-axis power densities will be considerably less (typically in excess of 30 dB at angles of one degree or more from beam center). Therefore , far field exposure will be less than:

$$PD = .0..022191\ mW/cm^2$$

BEHIND AND BELOW

For areas behind and below the antenna structure, where station personnel and working environment exist, the radiation level will be less than the tapered illumination level of the main reflector. This level is as follows:

PD (radiation level) < or = the transmitter power, P, divided by the area of the antenna reflector less a 6 dB taper factor.

$$= 1.325/M^2 = .1321 mW/cm^2.$$

This value would be expected directly at the edge of the main reflector, therefore, levels several feet below and behind the reflector would be even further reduced in level. We conclude then, the area around the antenna that can be accessed by station personnel will exhibit a radiation level slightly above the recommended 1 mW/cm^2 level. However actual access to the antenna system is restricted to authorized trained personell only, and only for short time durations. The actual operations personell are located in a steel building which provides more than adequate shielding for the long term operations.

In conclusion, no radiation hazard in excess of the recommended long term of 1 mW/cm^2 or short term exposure level of 5 mW/cm^2 will be present to the general public or the earth station personnel.

DATE: September 2017
SUBJECT: Radiation Hazard Analysis

TO: FCC
FROM: Michael J. Durbin Ph.D. E.E.

Attached is the technical analysis (Exhibit B) that predicts the expected radio frequency radiation exposure to humans in the vicinity of the 2.4 Meter Satellite Up-Link Earth Station. The basis for this analysis was extracted from the following source:

> "Evaluating Compliance With FCC-Specified Guidelines for Human Exposure to Radio Frequency Radiation", OST Bulletin No. 65, October 1985, Federal Communications Commission, Office of Science and Technology, Washington, D.C. 20554

Please direct any questions to:

Michael J. Durbin Ph.D.
Mike@k5mjd.us
214-801-7721

EXHIBIT B (Ku Band)

RADIATION HAZARD ANALYSIS

Prepared by:
Michael J. Durbin Ph.D.

Michael J. Durbin

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RF RADIATION HAZARD ANALYSIS
2.4 METER SATELLITE UP LINK EARTH STATION

Because of the highly directional nature of parabolic antenna systems, the possibility of significant Human exposure to RF radiation is unlikely if precautions are taken to prevent incidental human access to those few areas where the existing power densities are in excess of those recommended for Human Exposure[1].

There are regions in the vicinity of the antenna that can generate substantial power density levels, such as the area between the feed and the sub reflector and the area directly in front and along the axis of the antenna. The antenna site layout is designed to limit the access to these areas. Therefore, the earth station operators and the general public will only be exposed to microwave radiation levels below and behind the antenna, and at various orientations off from the main axis of the antenna. The predicted radiation exposure levels are calculated below. They show that operations personnel and the general public will be exposed to radiation levels below the recommended values of 5 mw/cm^2 for short term or 1 mw/cm^2 for long term exposure.

The particular site parameters used in the analysis are as follows:

D = antenna diameter	= 2.4 Meter
F = frequency	= 14250 MHz.
λ = wavelength	= .0.02105
P = power into the feed	=60 Watts (max)
π = Pi	= 3.1416
A = physical aperture area($\pi D^2/4$	= 4.53 Sq. Meters
G = antenna transmit gain	= 85113.8
	49.3 dBi
η = aperture efficiency	= 0.67

NEAR FIELD REGION

With a parabolic antenna the power density is greatest on the antenna axis in the near-field region of the antenna. This maximum occurs at a distance of $0.2\ D^2/\lambda$ = 200.0833 Meters (656.2733 feet) from the antenna, however, conservatively, we consider that this maximum power density value occurs throughout the length of the near field region R, where R is as follows:

$$R = D^2/4\lambda = 68.4 \text{ Meters (224.35feet)}$$

[1] "Evaluating Compliance With FCC-Specified Guidelines for Human Exposure to Radiation Frequency Radiation", OST Bulletin No. 65, October 1985, Federal Communications Commission, Office of Science and Technology, Washington, D.C. 20554

The power density within this region is equal to the following:

$$PD = (16\eta P)/(\pi D^2) = (4\eta P)/A$$

$$= 35.53\ W/m^2\ =\ 3.55 mW/cm^2$$

<u>TRANSITION</u> <u>REGION</u>:
The power density in the transition region decreases inversely with distance from the antenna. For evaluating exposure in this region the distance to the beginning of the near field region is determined as follows:

$$R = (D^2)/4\lambda = 164.16 \text{ Meters } (540.086 \text{ feet})$$

The on-axis power densities in the transition region can be estimated as follows:

$$PD(trans) = (PD(near\ field)R(near\ field))/R$$

Where R is the point of interest.

The on-axis power density energy in both these regions is contained within a cylindrical volume of a diameter equal to the antenna's diameter and extends upward into space according to the antenna's elevation angle. Because of the elevated geometry of the main reflector and the rising edges of the cylindrical near field region of the antenna both these areas will be inaccessible by the public or personnel.

Off axis calculations in the near field and in the transition region can be made assuming a point of interest at least one antenna diameter from the center of the antenna main beam. The power density at that point will be at least a factor of 100 (20 dB) less than the value calculated for the equivalent distance in the main beam. Therefore, it maybe assumed that the power density will be at least 20 dB below the maximum level at a radial distance of D, 2.4 meters, from the center line axis of the antenna. At distances within the near field radiation density will be:

$$.03555\ mW/cm^2/100 = .1.386\ mW/cm^2 \text{ (and less for the transition region)}$$

<u>FAR</u> <u>FIELD</u> <u>REGION</u>
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. The on-axis power density in the far field is as follows:

$$PD = (PG)/4\pi R^2$$

$$= 13.87\ M/W^2 = 1.38\ mW/cm^2$$

The above value represents the maximum exposure level that the system can produce on-axis. Off-axis power densities will be considerably less (typically in excess of 30 dB at angles of one degree or more from beam center). Therefore , far field exposure will be less than:

$$PD = .0.001387\ mW/cm^2$$

BEHIND AND BELOW

For areas behind and below the antenna structure, where station personnel and working environment exist, the radiation level will be less than the tapered illumination level of the main reflector. This level is as follows:

PD (radiation level) < or = the transmitter power, P, divided by the area of the antenna reflector less a 6 dB taper factor.

$$= 3.315/M^2 = 0.3315 \text{ mW/cm}^2.$$

This value would be expected directly at the edge of the main reflector, therefore, levels several feet below and behind the reflector would be even further reduced in level. We conclude then, the area around the antenna that can be accessed by station personnel will exhibit a radiation level slightly above the recommended 1 mW/cm^2 level. However actual access to the antenna system is restricted to authorized trained personell only, and only for short time durations. The actual operations personell are located in a steel building which provides more than adequate shielding for the long term operations.

In conclusion, no radiation hazard in excess of the recommended long term of 1 mW/cm^2 or short term exposure level of 5 mW/cm^2 will be present, and therefore there is no threat to the general public nor the earth station personnel.

DATE: September 2017
SUBJECT: Radiation Hazard Analysis

TO: FCC
FROM: Michael J. Durbin Ph.D. E.E.

Attached is the technical analysis (Exhibit A) that predicts the expected radio frequency radiation exposure to humans in the vicinity of the 2.4 Meter Satellite Up-Link Earth Station. The basis for this analysis was extracted from the following source:

> "Evaluating Compliance With FCC-Specified Guidelines for Human Exposure to Radio Frequency Radiation", OST Bulletin No. 65, October 1985, Federal Communications Commission, Office of Science and Technology, Washington, D.C. 20554

Please direct any questions to:

Michael J. Durbin Ph.D.
mike@k5mjd.us
214-801-7721

EXHIBIT A

RADIATION HAZARD ANALYSIS

Prepared by:
Michael J. Durbin Ph.D.

Michael J. Durbin

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RF RADIATION HAZARD ANALYSIS
2.4 METER SATELLITE UP LINK EARTH STATION

Because of the highly directional nature of parabolic antenna systems, the possibility of significant Human exposure to RF radiation is unlikely if precautions are taken to prevent incidental human access to those few areas where the existing power densities are in excess of those recommended for Human Exposure[1].

There are regions in the vicinity of the antenna that can generate substantial power density levels, such as the area between the feed and the sub reflector and the area directly in front and along the axis of the antenna. The antenna site layout is designed to limit the access to these areas. Therefore, the earth station operators and the general public will only be exposed to microwave radiation levels below and behind the antenna, and at various orientations off from the main axis of the antenna. The predicted radiation exposure levels are calculated below. They show that operations personnel and the general public will be exposed to radiation levels well below the recommended values of 5 mw/cm^2 for short term or 1 mw/cm^2 for long term exposure.

The particular site parameters used in the analysis are as follows:

D = antenna diameter	= 2.4 Meter
F = frequency	= 6125 MHz.
λ = wavelength	= .048980
P = power into the feed	= 250 Watts (max)
π = Pi	= 3.1416
A = physical aperture area($\pi D^2/4$	= 4.53 Sq. Meters
G = antenna transmit gain	= 14791.1
	41.7 dBi
η = aperture efficiency	= 0.67

NEAR FIELD REGION

With a parabolic antenna the power density is greatest on the antenna axis in the near-field region of the antenna. This maximum occurs at a distance of $0.2\ D^2/\lambda$ = 200.0833 Meters (656.2733 feet) from the antenna, however, conservatively, we consider that this maximum power density value occurs throughout the length of the near field region R, where R is as follows:

$$R = D^2/4\lambda = 29.4 \text{ Meters } (97.02 \text{ feet})$$

[1] "Evaluating Compliance With FCC-Specified Guidelines for Human Exposure to Radiation Frequency Radiation", OST Bulletin No. 65, October 1985, Federal Communications Commission, Office of Science and Technology, Washington, D.C. 20554

The power density within this region is equal to the following:

$$PD = (16\eta P)/(\pi D^2) = (4\eta P)/A$$

$$= 148.05 \text{ W/m}^2 = 14.8 \text{ mW/cm}^2$$

TRANSITION REGION:
The power density in the transition region decreases inversely with distance from the antenna. For evaluating exposure in this region the distance to the beginning of the near field region is determined as follows:

$$R = (D^2)/4\lambda = 29.4 \text{ Meters (97.02 feet)}$$

The on-axis power densities in the transition region can be estimated as follows:

$$PD(trans) = (PD(near\ field)R(near\ field))/R$$

Where R is the point of interest.

The on-axis power density energy in both these regions is contained within a cylindrical volume of a diameter equal to the antenna's diameter and extends upward into space according to the antenna's elevation angle. Because of the elevated geometry of the main reflector and the rising edges of the cylindrical near field region of the antenna both these areas will be inaccessible by the public or personnel.

Off axis calculations in the near field and in the transition region can be made assuming a point of interest at least one antenna diameter from the center of the antenna main beam. The power density at that point will be at least a factor of 100 (20 dB) less than the value calculated for the equivalent distance in the main beam. Therefore, it maybe assumed that the power density will be at least 20 dB below the maximum level at a radial distance of D, 2.4 meters, from the center line axis of the antenna. At distances within the near field radiation density will be:

$1.3923 \text{ mW/cm}^2/100 = .013923 \text{ mW/cm}^2$ (and less for the transition region)

FAR FIELD REGION
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. The on-axis power density in the far field is as follows:

$$PD = (PG)/4\pi R^2$$

$$= 61.56 \text{ M/W}^2 = 6.156 \text{ mW/cm}^2$$

The above value represents the maximum exposure level that the system can produce on-axis. Off-axis power densities will be considerably less (typically in excess of 30 dB at angles of one degree or more from beam center). Therefore , far field exposure will be less than:

$$PD = .6156/300\ .002052 \text{ mW/cm}^2$$

BEHIND AND BELOW

For areas behind and below the antenna structure, where station personnel and working environment exist, the radiation level will be less than the tapered illumination level of the main reflector. This level is as follows:

PD (radiation level) < or = the transmitter power, P, divided by the area of the antenna reflector less a 6 dB taper factor.

$$= 13.02/M^2 = .1302 \text{ mW/cm}^2.$$

This value would be expected directly at the edge of the main reflector, therefore, levels several feet below and behind the reflector would be even further reduced in level. We conclude then, the area around the antenna that can be accessed by station personnel will exhibit a radiation level slightly above the recommended 1 mW/cm^2 level. However actual access to the antenna system is restricted to authorized trained personell only, and only for short time durations. The actual operations personell are located in a steel building which provides more than adequate shielding for the long term operations.

In conclusion, no radiation hazard in excess of the recommended long term of 1 mW/cm^2 or short term exposure level of 5 mW/cm^2 will be present, and therefore there is no threat to the general public nor the earth station personnel.