APPLICATION

O3b Limited ("O3b") operates a U.K.-authorized, non-geostationary orbit ("NGSO") Fixed-Satellite Service ("FSS") system in the Ka-band that has been granted U.S. market access.[1] In this application, O3b seeks a new earth station license permitting it to operate two AvL 2.4 meter antennas[2] in Naalehu, Hawaii (the "Hawaii Diversity Earth Station").

Public Interest Showing

The Hawaii Diversity Earth Station will be used by O3b and an O3b customer as a long-term equipment testing facility to develop new service offerings that will be implemented in the U.S. market and globally. Granting this application will serve the public interest by facilitating the development of innovative services for O3b's customers in the U.S. and abroad.

U.S. Market Access

The International Bureau has authorized O3b to serve the United States with its existing NGSO constellation of twelve satellites under a single consolidated market access grant. O3b hereby incorporates by reference the Market Access Application and Market Access Grant, which demonstrate compliance with the requirements of Section 25.137 of the Commission's rules for earth station applicants proposing to operate with non-U.S. licensed space stations.[3]

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[1] *See* O3b's Petition for Declaratory Ruling, File Nos. SAT-LOI-20141029-00118 and SAT-AMD-20150115-00004, Call Sign S2935 (the "Market Access Application"), granted Jan. 22, 2015 (the "Market Access Grant"). O3b's existing constellation consists of twelve satellites, launched in groups of four on June 25, 2013, July 10, 2014 and December 18, 2014. Upon grant of a pending application to modify the Market Access Grant, the constellation would expand to include eight additional satellites, four of which are expected to be launched in Q1 2018. *See* Modification Application of O3b Limited, Call Sign S2935, File No. SAT-MOD-20160624-00060 (June 24, 2016). Additional changes proposed in pending amendments would further expand the constellation to add satellites and frequencies. *See* Amendments of O3b Limited, Call Sign S2935, File Nos. SAT-AMD-20161115-00116; SAT-AMD-20170301-00026 & SAT-AMD-20171109-00154.

[2] The Commission has previously granted O3b authority to operate AvL 2.4 meter terminals. *See, e.g.,* O3b Limited, File No. SES-LIC-20160712-00640, Call Sign E160129, granted Nov. 7, 2016.

[3] 47 C.F.R. § 25.137.

Frequency Plan

The Hawaii Diversity Earth Station will communicate with O3b's NGSO satellite system.

The frequencies to be used by the Hawaii Diversity Earth Station are:

- 27.5- 28.4 GHz and 28.6 - 29.1 GHz (uplink)
- 17.8 - 18.6 GHz and 18.8 - 19.3 GHz (downlink)

The Hawaii Diversity Station antennas will be mounted on fixed platforms. Although the pointing angle of the antenna will change as O3b's in-orbit satellites are tracked, each platform will remain stationary. In the 28.6 - 29.1 GHz and 18.8 – 19.3 GHz bands, NGSO FSS operations have sole primary status. In the remaining frequency bands, which are shared with other services, O3b's proposed Hawaii Diversity Earth Station will operate in a manner consistent with the Commission's rules and policies. O3b addresses each of these shared bands below.

Uplink

27.5 - 28.35 GHz – Secondary FSS uplink band shared with primary terrestrial stations

In the 27.5 - 28.35 GHz band, the Upper Microwave Flexible Use Service ("UMFUS") has a primary allocation, and FSS operations are secondary. In a decision last year, the Commission adopted changes to Section 25.136(a)(4), which allows deployment of earth stations that are not required to provide interference protection to future UMFUS operators if certain conditions are met.[4] Attachment 3 to this application demonstrates that the Hawaii Diversity Earth Station will meet all the criteria of Section 25.136(a)(4) as revised by the Commission in the Second Spectrum Frontiers Order. O3b below seeks waiver of the existing version of Section 25.136(a)(4) in the event that the rule changes have not taken effect prior to Commission action on this application.

The Comsearch coordination report (Attachment 1 hereto) demonstrates that O3b can operate its Hawaii Diversity Earth Station without causing harmful interference to existing terrestrial deployments and has coordinated with UMFUS licensees in compliance with 47 C.F.R. § 101.103(d). Comsearch sent a coordination notice to all existing terrestrial licensees within the Comsearch coordination contours of the Hawaii Diversity Earth Station site. No objections were received from any of the licensees.

[4] *See Use of Spectrum Bands Above 24 GHz For Mobile Radio Services,* Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order (rel. Nov. 22, 2017) (the "Second Spectrum Frontiers Order") at Appendix A.

27.5 - 28.4 GHz – Secondary NGSO FSS uplink band shared with GSO FSS stations

NGSO FSS systems are required to protect GSO FSS systems throughout the 27.5 - 28.4 GHz band. Both NGSO and GSO FSS systems are secondary to UMFUS in the 27.5 - 28.35 GHz band, but the Commission has also specified that NGSO FSS systems in this spectrum must operate on an unprotected, non-interference basis with respect to GSO FSS networks.[5] In the 28.35 - 28.4 GHz band, there is a primary allocation for GSO FSS systems and a secondary allocation for NGSO FSS systems.[6]

O3b's Hawaii Diversity Earth Station transmissions in the 27.5 - 28.4 GHz band will be consistent with their status vis-à-vis GSO FSS transmissions. The Commission has allowed secondary use of frequencies in the Ka-band uplink allocated to GSO FSS on a primary basis where applicants are prepared to accept interference from primary operations and can demonstrate that their proposed operations are not likely to cause harmful interference to primary operations.[7] O3b satisfies both of these standards.

As a secondary user of the 27.5 - 28.4 GHz band in the United States, O3b makes no claim of protection from interference from U.S.-licensed GSO FSS networks in this band segment. As for O3b's uplink operations in the 27.5 - 28.4 GHz band, the ITU has developed uplink equivalent power flux density ("$EPFD_{up}$") limits to protect co-frequency GSO FSS operations from unacceptable interference from NGSO FSS systems operating in the same frequencies. Specifically, in accordance with Article 22 of the ITU Radio Regulations, if the applicable $EPFD_{up}$ limits are met, the NGSO FSS satellite system is considered to have met its obligations to protect GSO FSS networks from unacceptable interference.

O3b previously demonstrated that earth stations operating above 13° N.L. when operating at the authorized power levels will meet the applicable ITU $EPFD_{up}$ limits in all frequency ranges where these limits apply, due to the inherent angular separation between the O3b and geostationary orbits when viewed from the Earth at latitudes away from the equator.[8] The Hawaii Diversity Earth Station is located further north, above 19° N.L.,[9] which results in an even greater angular separation between the O3b and geostationary orbits as viewed from the Earth.

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[5] *See Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters,* Report and Order and Further Notice of Proposed Rulemaking (rel. Sept. 27, 2017) (the "NGSO Order") at ¶ 23 and Appendix B, Adopted Ka-band Plan.

[6] *See id.* at Appendix B.

[7] *Northrop Grumman Space & Missions Systems Corporation*, 24 FCC Rcd 2330, at ¶¶ 72-73 (Int'l Bur. 2009); *contactMEO Communications*, LLC, 21 FCC Rcd 4035, at ¶¶ 23-24, (Int'l Bur., 2006).

[8] *See* Market Access Application, Technical Annex at 15-18 and 25-28.

[9] The Hawaii Diversity Earth Station latitude is 19° 0' 51.35"N.L.

The proposed Hawaii Diversity Earth Station operations, therefore, also will meet the applicable ITU $EPFD_{up}$ limits.

Downlink

17.8 - 18.3 GHz – Secondary FSS downlink band shared with primary terrestrial systems

The 17.8 – 18.3 GHz band is allocated on a primary basis to the terrestrial fixed service ("FS"), and there is a secondary allocation for FSS in the band.[10] O3b's space stations transmit in this band. These transmissions have been authorized in O3b's Market Access grant.

As O3b has previously demonstrated, secondary use of the 17.8 - 18.3 GHz frequency band for downlink operations will not cause harmful interference to FS operations in the same band because O3b meets the PFD limits at the earth's surface prescribed by the ITU for the protection of terrestrial services in this band.[11] In addition, as a secondary user, O3b is required to accept interference from FS operations in the band. Moreover, the Interference Analysis Report (Attachment 2 hereto) from Comsearch indicates that there will be no restrictions on O3b's operations due to interference considerations in this band.

18.3 - 18.6 GHz – Secondary downlink band shared with primary GSO FSS stations

The 18.3 - 18.6 GHz band is allocated in the United States on a primary basis to GSO FSS and on a secondary basis to the NGSO FSS.[12] In the 18.3 - 18.6 GHz downlink band, the ITU has developed downlink equivalent power flux density ("$EPFD_{down}$") limits to protect GSO FSS networks from unacceptable interference from NGSO FSS systems operating in the same frequencies. Specifically, in accordance with Article 22 of the ITU Radio Regulations, if the applicable $EPFD_{down}$ limits are met, the NGSO FSS satellite system is considered to have met its obligations to protect GSO FSS networks from unacceptable interference.

O3b's system meets the applicable ITU $EPFD_{down}$ limits in all frequency ranges where these limits apply.[13] As an example of how these limits are satisfied, O3b provided $EPFD_{down}$ calculations for transmissions in its Market Access Application.[14] O3b also showed how the $EPFD_{down}$ limits can be satisfied at all latitudes.[15] O3b is able to satisfy the limits by taking

[10] NGSO Order at ¶¶ 7-8 and Appendix B.

[11] *See* Market Access Application, Technical Annex at 13-14.

[12] *See* NGSO Order at ¶ 10 and Appendix B.

[13] *See* ITU Radio Regulations, Article 22. *See also* Market Access Application, Technical Annex at 15-25 for a discussion of O3b's compliance with the operational limits in Article 22 of the ITU Radio Regulations.

[14] Market Access Application, Technical Attachment at 18-25.

[15] *See id.*

advantage of the inherent angular separation of the O3b and the GSO orbits when viewed from the surface of the Earth at latitudes away from the equator.[16] Based on these prior showings, it can be seen that transmissions to the Hawaii Diversity Earth Station will be within the $EPFD_{down}$ limits.

Waiver Request

As discussed above, the Commission's Second Spectrum Frontiers Order modified the requirements of Section 25.136(a)(4) regarding the specifications of earth stations that can be authorized in the 27.5 - 28.35 GHz frequencies without being required to protect future UMFUS stations, and O3b has demonstrated its compliance with the rule provisions as revised. Because the rule changes have not yet taken effect, O3b requests any necessary waiver of the current terms of Section 25.136(a)(4) to permit this application to be evaluated under the updated provisions.

Grant of the requested waiver is consistent with Commission precedent, which specifies that waiver is appropriate "if the relief requested would not undermine the policy objective of the rule in question and would otherwise serve the public interest."[17] In the Second Spectrum Frontiers Order, the Commission considered a range of positions advocated by the parties and determined that its policy objectives would be better served by altering the population limits for earth station coverage specified under Section 25.136(a)(4)(ii) and clarifying the scope of other provisions limiting earth station deployment.[18] Thus, the revised rule provisions better align with the Commission's goals than the original language.

Under these circumstances, there is no justification for requiring O3b to comply with rule specifications that have been revised on reconsideration and will be nullified once the procedural steps necessary to implement the updated rule are complete. Instead, the Commission should waive the requirements of the current version of Section 25.136(a)(4) in the event they are still in effect when this application is acted on, thereby giving effect to the Commission's finding that updating the rule is in the public interest.

Radiation Hazard Study

Attachment 4 is the radiation hazard analysis for the Hawaii Diversity Earth Station.

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[16] *See id.*

[17] *PanAmSat Licensee Corp.*, 17 FCC Rcd 10483, 10492 (Sat. Div. 2002) (footnotes omitted).

[18] *See* Second Spectrum Frontiers Order at ¶¶ 124-133.

Conclusion

O3b has demonstrated that the Hawaii Diversity Earth Station will enhance the service provided by the O3b System. Grant of O3b's application, therefore, is in the public interest

Attachment 1
Comsearch Coordination Report

Ka-Band Earth Station – Naalehu, HI

Frequency Coordination Report

28 GHz

Prepared on Behalf of
O3b Networks USA, LLC

December 4, 2017

COMSEARCH®
A CommScope Company

Table of Contents

1. Summary of Results

On behalf of Ob3 Networks, Comsearch performed a coordination notice for all existing and proposed terrestrial licenses within the coordination contours of their proposed Ka-Band earth station in Naalehu, HI, which will transmit at 28 GHz[1]. Prior-notification letters were sent to the licensees and a copy of the notification data is provided in section four of this report. The earth station coordination was finalized on December 1, 2017.

No objections were received from any of the incumbent 28 GHz licensees. Our notification to the incumbents was performed under the assumption that the earth station would be operating on a secondary basis to LMDS Block A operations and a contact at O3b Networks has been provided in case any concerns may arise in the future.

2. 28 GHz Common Carrier and LTTS Coordination

In accordance with FCC Rules and Regulations, the Ka-Band earth station in Naalehu, HI was prior-coordinated by Comsearch. A notification letter and datasheets for this earth station were sent to the following 28 GHz common carrier fixed microwave licensees. These licensees are authorized to operate temporary fixed operations from 27.5 – 29.5 GHz on a nationwide basis or local basis.

Licensee	Authorized Geographic Area
Frontier Southwest Incorporated	Nationwide
Hawaiian Telcom, Inc	Statewide: Hawaii

A notification letter and datasheets for the Ka-Band earth station in Naalehu, HI were also sent to the following 28 GHz local television transmission licensee. This licensee is authorized to operate temporary fixed operations from 27.5 – 29.5 GHz on a nationwide basis.

Licensee	Authorized Geographic Area
Information Super Station, LLC	Continental US

No objections were received from the common carrier or local television transmission service incumbents.

[1] The proposed earth station will operate in the 27.6 – 28.35 GHz portion of the Ka-Band.

3. 28 GHz LMDS Coordination

There were no 28 GHz LMDS licensees identified within the coordination area. The proposed earth station will operate on frequencies that overlap Block A of the LMDS service. The total frequency allocation for Block A of the LMDS spectrum appears below.

Block A: 27.500-28.350 GHz
29.100-29.250 GHz
31.075-31.225 GHz

4. Earth Station Coordination Data

This section presents the data pertinent to the proposed Ka-Band earth station in Naalehu, HI. This data was circulated to all incumbent licensees in the shared 28 GHz frequency ranges.

COMSEARCH
Earth Station Data Sheet
19700 Janelia Farm Boulevard, Ashburn, VA 20147
(703)726-5500 http://www.comsearch.com

Date:	11/27/2017
Job Number:	171110COMSGE01

Administrative Information	
Status	ENGINEER PROPOSAL
Call Sign	
Licensee Code	O3BNET
Licensee Name	O3b Networks USA, LLC.

Site Information	**NAALEHU, HI**
Venue Name	
Latitude (NAD 83)	19° 0' 51.4" N
Longitude (NAD 83)	155° 39' 46.5" W
Climate Zone	B
Rain Zone	4
Ground Elevation (AMSL)	354.71 m / 1163.8 ft

Link Information	
Satellite Type	Medium Earth Orbit
Mode	TR - Transmit-Receive
Modulation	Digital
Minimum Elevation Angle	5.0°
Azimuth Range	0.0° to 360°
Antenna Centerline (AGL)	2.74 m / 9.0 ft

Antenna Information		**Receive - FCC32**		**Transmit - FCC32**	
Manufacturer		AVL		AVL	
Model		2.4M-O3B		2.4M-O3B	
Gain / Diameter		51.3 dBi / 2.4 m		54.7 dBi / 2.4 m	
3-dB / 15-dB Beamwidth		0.14° / 0.32°		0.23° / 0.60°	
Max Available RF Power	(dBW/4 kHz)			-27.3	
	(dBW/MHz)			-3.3	
Maximum EIRP	(dBW/4 kHz)			27.4	
	(dBW/MHz)			51.4	
Interference Objectives:	Long Term	-156.0 dBW/MHz	20%	-151.0 dBW/4 kHz	20%
	Short Term	-146.0 dBW/MHz	0.01%	-128.0 dBW/4 kHz	0.0025%

Frequency Information	**Receive 18.0 GHz**	**Transmit 28.0 GHz**
Emission / Frequency Range (MHz)	216MG7D / 17800.0 - 18300.0	216MG7D / 27600.0 - 28350.0
Max Great Circle Coordination Distance	216.3 km / 134.4 mi	100.0 km / 62.1 mi
Precipitation Scatter Contour Radius	100.0 km / 62.1 mi	100.0 km / 62.1 mi

COMSEARCH

Earth Station Data Sheet

19700 Janelia Farm Boulevard, Ashburn, VA 20147
(703)726-5662 http://www.comsearch.com

Coordination Values	**NAALEHU, HI**			
Licensee Name	O3b Networks USA, LLC.			
Latitude (NAD 83)	19° 0' 51.4" N			
Longitude (NAD 83)	155° 39' 46.5" W			
Ground Elevation (AMSL)	354.71 m / 1163.8 ft			
Antenna Centerline (AGL)	2.74 m / 9.0 ft			
Antenna Model	AVL 2.4 meter			
Antenna Mode	Receive 18.0 GHz		Transmit 28.0 GHz	
Interference Objectives: Long Term	-156.0 dBW/MHz	20%	-151.0 dBW/4 kHz	20%
Short Term	-146.0 dBW/MHz	0.01%	-128.0 dBW/4 kHz	0.0025%
Max Available RF Power		-27.3 (dBW/4 kHz)		

			Receive 18.0 GHz		Transmit 28.0 GHz	
Azimuth (°)	Horizon Elevation (°)	Antenna Discrimination (°)	Horizon Gain (dBi)	Coordination Distance (km)	Horizon Gain (dBi)	Coordination Distance (km)
0	0.00	74.81	-10.00	100.00	-10.00	100.00
5	0.00	72.98	-10.00	100.00	-10.00	100.00
10	0.00	71.27	-10.00	100.00	-10.00	100.00
15	0.00	69.68	-10.00	100.00	-10.00	100.00
20	0.00	68.25	-10.00	100.00	-10.00	100.00
25	0.00	66.97	-10.00	100.00	-10.00	100.00
30	0.00	65.87	-10.00	100.00	-10.00	100.00
35	0.00	64.96	-10.00	100.00	-10.00	100.00
40	0.00	64.24	-10.00	100.00	-10.00	100.00
45	0.00	63.74	-10.00	113.30	-10.00	100.00
50	0.00	63.44	-9.98	150.50	-9.98	100.00
55	0.00	63.37	-8.83	155.80	-8.83	100.00
60	0.00	63.51	-7.55	160.40	-7.55	100.00
65	0.00	63.87	-6.11	165.60	-6.11	100.00
70	0.00	64.44	-4.47	171.50	-4.47	100.00
75	0.00	65.22	-2.60	175.50	-2.60	100.00
80	0.00	66.19	-0.46	183.80	-0.46	100.00
85	0.00	67.34	1.97	194.50	1.97	100.00
90	0.00	68.67	4.45	206.80	4.45	100.00
95	0.00	70.15	6.17	216.30	6.17	100.00
100	0.00	71.77	5.89	214.60	5.89	100.00
105	0.00	73.53	3.87	203.80	3.87	100.00
110	0.00	75.39	1.35	191.70	1.35	100.00
115	0.00	77.35	-1.01	181.60	-1.01	100.00
120	0.00	79.39	-3.09	176.50	-3.09	100.00
125	0.00	81.51	-4.89	170.00	-4.89	100.00
130	0.00	83.67	-6.43	164.40	-6.43	100.00
135	0.00	85.87	-7.77	159.60	-7.77	100.00
140	0.00	88.10	-8.94	155.40	-8.94	100.00
145	0.00	90.34	-9.97	151.70	-9.97	100.00
150	0.00	92.58	-10.00	151.60	-10.00	100.00
155	0.00	94.80	-10.00	151.60	-10.00	100.00
160	0.00	96.99	-10.00	151.60	-10.00	100.00
165	0.00	99.14	-10.00	151.60	-10.00	100.00
170	0.00	101.24	-10.00	151.60	-10.00	100.00
175	0.00	103.26	-10.00	151.60	-10.00	100.00
180	0.00	105.19	-10.00	151.60	-10.00	100.00
185	0.00	107.02	-10.00	151.60	-10.00	100.00

COMSEARCH

Earth Station Data Sheet

19700 Janelia Farm Boulevard, Ashburn, VA 20147
(703)726-5662 http://www.comsearch.com

Coordination Values	**NAALEHU, HI**			
Licensee Name	O3b Networks USA, LLC.			
Latitude (NAD 83)	19° 0' 51.4" N			
Longitude (NAD 83)	155° 39' 46.5" W			
Ground Elevation (AMSL)	354.71 m / 1163.8 ft			
Antenna Centerline (AGL)	2.74 m / 9.0 ft			
Antenna Model	AVL 2.4 meter			
Antenna Mode		Receive 18.0 GHz		Transmit 28.0 GHz
Interference Objectives: Long Term		-156.0 dBW/MHz	20%	-151.0 dBW/4 kHz 20%
Short Term		-146.0 dBW/MHz	0.01%	-128.0 dBW/4 kHz 0.0025%
Max Available RF Power			-27.3 (dBW/4 kHz)	

			Receive 18.0 GHz		Transmit 28.0 GHz	
Azimuth (°)	Horizon Elevation (°)	Antenna Discrimination (°)	Horizon Gain (dBi)	Coordination Distance (km)	Horizon Gain (dBi)	Coordination Distance (km)
190	0.00	108.73	-10.00	151.60	-10.00	100.00
195	0.00	110.32	-10.00	151.60	-10.00	100.00
200	0.00	111.75	-10.00	151.60	-10.00	100.00
205	0.00	113.03	-10.00	151.60	-10.00	100.00
210	0.00	114.13	-10.00	117.50	-10.00	100.00
215	0.00	115.04	-9.90	100.00	-9.90	100.00
220	0.00	115.76	-8.85	100.00	-8.85	100.00
225	0.00	116.26	-7.64	100.00	-7.64	100.00
230	0.00	116.56	-6.26	100.00	-6.26	100.00
235	0.00	116.63	-4.64	100.00	-4.64	100.00
240	0.00	116.49	-2.72	100.00	-2.72	100.00
245	0.00	116.13	-0.43	100.00	-0.43	100.00
250	0.00	115.56	2.45	100.00	2.45	100.00
255	0.00	114.78	5.91	100.00	5.91	100.00
260	0.00	113.81	9.70	100.20	9.70	100.00
265	0.00	112.66	10.72	136.00	10.72	100.00
270	0.00	111.33	7.60	100.00	7.60	100.00
275	0.00	109.85	3.84	100.00	3.84	100.00
280	0.00	108.23	0.70	100.00	0.70	100.00
285	0.00	106.47	-1.84	100.00	-1.84	100.00
290	0.00	104.61	-3.94	100.00	-3.94	100.00
295	0.00	102.65	-5.71	100.00	-5.71	100.00
300	0.00	100.61	-7.25	100.00	-7.25	100.00
305	0.00	98.49	-8.60	100.00	-8.60	100.00
310	0.00	96.33	-9.81	100.00	-9.81	100.00
315	0.00	94.13	-10.00	100.00	-10.00	100.00
320	0.00	91.90	-10.00	100.00	-10.00	100.00
325	0.00	89.66	-10.00	100.00	-10.00	100.00
330	0.00	87.42	-10.00	100.00	-10.00	100.00
335	0.00	85.20	-10.00	100.00	-10.00	100.00
340	0.00	83.01	-10.00	100.00	-10.00	100.00
345	0.00	80.86	-10.00	100.00	-10.00	100.00
350	0.00	78.76	-10.00	100.00	-10.00	100.00
355	0.00	76.74	-10.00	100.00	-10.00	100.00

5. Contact Information

For questions or information regarding the 28 GHz Frequency Coordination Report, please contact:

Contact person:	Dennis Jimeno
Title:	Engineer III, Telecommunications
Company:	Comsearch
Address:	19700 Janelia Farm Blvd., Ashburn, VA 20147
Telephone:	703-726-5858
Fax:	703-726-5599
Email:	DJimeno@Comsearch.com
Web site:	www.comsearch.com

Attachment 2
Interference Analysis Report

FREQUENCY COORDINATION AND INTERFERENCE ANALYSIS REPORT

Prepared for
O3b Networks USA, LLC.
NAALEHU, HI
Satellite Earth Station

Prepared By:
COMSEARCH
19700 Janelia Farm Boulevard
Ashburn, VA 20147
December 4, 2017

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1. CONCLUSIONS

An interference study considering all existing, proposed and prior coordinated microwave facilities within the coordination contours of the proposed earth station demonstrates that this site will operate satisfactorily with the common carrier microwave environment. Further, there will be no restrictions of its operation due to interference considerations.

2. SUMMARY OF RESULTS

A number of great circle interference cases were identified during the interference study of the proposed earth station. Each of the cases, which exceeded the interference objective on a line-of-sight basis, was profiled and the propagation losses estimated using NBS TN101 (Revised) techniques. The losses were found to be sufficient to reduce the signal levels to acceptable magnitudes in every case.

3. SUPPLEMENTAL SHOWING

Pursuant to Part 25.203(c) of the FCC Rules and Regulations, the satellite earth station proposed in this application was coordinated by Comsearch using computer techniques and in accordance with Part 25 of the FCC Rules and Regulations.

Coordination data for this earth station was sent to the below listed carriers with a letter dated 11/10/2017.

Company
Coral Wireless Licenses, LLC
Hawaii State
Hawaiian Telcom, Inc.
T-Mobile License LLC

4. EARTH STATION COORDINATION DATA

This section presents the data pertinent to frequency coordination of the proposed earth station that was circulated to all carriers within its coordination contours.

COMSEARCH

Earth Station Data Sheet

19700 Janelia Farm Boulevard, Ashburn, VA 20147
(703)726-5500 http://www.comsearch.com

Date:	11/27/2017
Job Number:	171110COMSGE01

Administrative Information

Status	ENGINEER PROPOSAL
Call Sign	
Licensee Code	O3BNET
Licensee Name	O3b Networks USA, LLC.

Site Information — NAALEHU, HI

Venue Name	
Latitude (NAD 83)	19° 0' 51.4" N
Longitude (NAD 83)	155° 39' 46.5" W
Climate Zone	B
Rain Zone	4
Ground Elevation (AMSL)	354.71 m / 1163.8 ft

Link Information

Satellite Type	Medium Earth Orbit
Mode	TR - Transmit-Receive
Modulation	Digital
Minimum Elevation Angle	5.0°
Azimuth Range	0.0° to 360°
Antenna Centerline (AGL)	2.74 m / 9.0 ft

Antenna Information		Receive - FCC32		Transmit - FCC32	
Manufacturer		AVL		AVL	
Model		2.4M-O3B		2.4M-O3B	
Gain / Diameter		51.3 dBi / 2.4 m		54.7 dBi / 2.4 m	
3-dB / 15-dB Beamwidth		0.14° / 0.32°		0.23° / 0.60°	
Max Available RF Power	(dBW/4 kHz)			-27.3	
	(dBW/MHz)			-3.3	
Maximum EIRP	(dBW/4 kHz)			27.4	
	(dBW/MHz)			51.4	
Interference Objectives:	Long Term	-156.0 dBW/MHz	20%	-151.0 dBW/4 kHz	20%
	Short Term	-146.0 dBW/MHz	0.01%	-128.0 dBW/4 kHz	0.0025%

Frequency Information	Receive 18.0 GHz	Transmit 28.0 GHz
Emission / Frequency Range (MHz)	216MG7D / 17800.0 - 18300.0	216MG7D / 27600.0 - 28350.0
Max Great Circle Coordination Distance	216.3 km / 134.4 mi	100.0 km / 62.1 mi
Precipitation Scatter Contour Radius	100.0 km / 62.1 mi	100.0 km / 62.1 mi

COMSEARCH

Earth Station Data Sheet

19700 Janelia Farm Boulevard, Ashburn, VA 20147
(703)726-5500 http://www.comsearch.com

Coordination Values	**NAALEHU, HI**			
Licensee Name	O3b Networks USA, LLC.			
Latitude (NAD 83)	19° 0' 51.4" N			
Longitude (NAD 83)	155° 39' 46.5" W			
Ground Elevation (AMSL)	354.71 m / 1163.8 ft			
Antenna Centerline (AGL)	2.74 m / 9.0 ft			
Antenna Model	AVL 2.4 meter			
Antenna Mode	Receive 18.0 GHz		Transmit 28.0 GHz	
Interference Objectives: Long Term	-156.0 dBW/MHz	20%	-151.0 dBW/4 kHz	20%
Short Term	-146.0 dBW/MHz	0.01%	-128.0 dBW/4 kHz	0.0025%
Max Available RF Power			-27.3 (dBW/4 kHz)	

			Receive 18.0 GHz		Transmit 28.0 GHz	
Azimuth (°)	Horizon Elevation (°)	Antenna Discrimination (°)	Horizon Gain (dBi)	Coordination Distance (km)	Horizon Gain (dBi)	Coordination Distance (km)
0	0.00	74.81	-10.00	100.00	-10.00	100.00
5	0.00	72.98	-10.00	100.00	-10.00	100.00
10	0.00	71.27	-10.00	100.00	-10.00	100.00
15	0.00	69.68	-10.00	100.00	-10.00	100.00
20	0.00	68.25	-10.00	100.00	-10.00	100.00
25	0.00	66.97	-10.00	100.00	-10.00	100.00
30	0.00	65.87	-10.00	100.00	-10.00	100.00
35	0.00	64.96	-10.00	100.00	-10.00	100.00
40	0.00	64.24	-10.00	100.00	-10.00	100.00
45	0.00	63.74	-10.00	113.30	-10.00	100.00
50	0.00	63.44	-9.98	150.50	-9.98	100.00
55	0.00	63.37	-8.83	155.80	-8.83	100.00
60	0.00	63.51	-7.55	160.40	-7.55	100.00
65	0.00	63.87	-6.11	165.60	-6.11	100.00
70	0.00	64.44	-4.47	171.50	-4.47	100.00
75	0.00	65.22	-2.60	175.50	-2.60	100.00
80	0.00	66.19	-0.46	183.80	-0.46	100.00
85	0.00	67.34	1.97	194.50	1.97	100.00
90	0.00	68.67	4.45	206.80	4.45	100.00
95	0.00	70.15	6.17	216.30	6.17	100.00
100	0.00	71.77	5.89	214.60	5.89	100.00
105	0.00	73.53	3.87	203.80	3.87	100.00
110	0.00	75.39	1.35	191.70	1.35	100.00
115	0.00	77.35	-1.01	181.60	-1.01	100.00
120	0.00	79.39	-3.09	176.50	-3.09	100.00
125	0.00	81.51	-4.89	170.00	-4.89	100.00
130	0.00	83.67	-6.43	164.40	-6.43	100.00
135	0.00	85.87	-7.77	159.60	-7.77	100.00
140	0.00	88.10	-8.94	155.40	-8.94	100.00
145	0.00	90.34	-9.97	151.70	-9.97	100.00
150	0.00	92.58	-10.00	151.60	-10.00	100.00
155	0.00	94.80	-10.00	151.60	-10.00	100.00
160	0.00	96.99	-10.00	151.60	-10.00	100.00
165	0.00	99.14	-10.00	151.60	-10.00	100.00
170	0.00	101.24	-10.00	151.60	-10.00	100.00
175	0.00	103.26	-10.00	151.60	-10.00	100.00
180	0.00	105.19	-10.00	151.60	-10.00	100.00
185	0.00	107.02	-10.00	151.60	-10.00	100.00

COMSEARCH

Earth Station Data Sheet

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Coordination Values	**NAALEHU, HI**			
Licensee Name	O3b Networks USA, LLC.			
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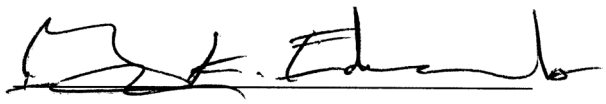
Antenna Model	AVL 2.4 meter			
Antenna Mode	Receive 18.0 GHz		Transmit 28.0 GHz	
Interference Objectives: Long Term	-156.0 dBW/MHz	20%	-151.0 dBW/4 kHz	20%
Short Term	-146.0 dBW/MHz	0.01%	-128.0 dBW/4 kHz	0.0025%
Max Available RF Power			-27.3 (dBW/4 kHz)	

			Receive 18.0 GHz		Transmit 28.0 GHz	
Azimuth (°)	Horizon Elevation (°)	Antenna Discrimination (°)	Horizon Gain (dBi)	Coordination Distance (km)	Horizon Gain (dBi)	Coordination Distance (km)
190	0.00	108.73	-10.00	151.60	-10.00	100.00
195	0.00	110.32	-10.00	151.60	-10.00	100.00
200	0.00	111.75	-10.00	151.60	-10.00	100.00
205	0.00	113.03	-10.00	151.60	-10.00	100.00
210	0.00	114.13	-10.00	117.50	-10.00	100.00
215	0.00	115.04	-9.90	100.00	-9.90	100.00
220	0.00	115.76	-8.85	100.00	-8.85	100.00
225	0.00	116.26	-7.64	100.00	-7.64	100.00
230	0.00	116.56	-6.26	100.00	-6.26	100.00
235	0.00	116.63	-4.64	100.00	-4.64	100.00
240	0.00	116.49	-2.72	100.00	-2.72	100.00
245	0.00	116.13	-0.43	100.00	-0.43	100.00
250	0.00	115.56	2.45	100.00	2.45	100.00
255	0.00	114.78	5.91	100.00	5.91	100.00
260	0.00	113.81	9.70	100.20	9.70	100.00
265	0.00	112.66	10.72	136.00	10.72	100.00
270	0.00	111.33	7.60	100.00	7.60	100.00
275	0.00	109.85	3.84	100.00	3.84	100.00
280	0.00	108.23	0.70	100.00	0.70	100.00
285	0.00	106.47	-1.84	100.00	-1.84	100.00
290	0.00	104.61	-3.94	100.00	-3.94	100.00
295	0.00	102.65	-5.71	100.00	-5.71	100.00
300	0.00	100.61	-7.25	100.00	-7.25	100.00
305	0.00	98.49	-8.60	100.00	-8.60	100.00
310	0.00	96.33	-9.81	100.00	-9.81	100.00
315	0.00	94.13	-10.00	100.00	-10.00	100.00
320	0.00	91.90	-10.00	100.00	-10.00	100.00
325	0.00	89.66	-10.00	100.00	-10.00	100.00
330	0.00	87.42	-10.00	100.00	-10.00	100.00
335	0.00	85.20	-10.00	100.00	-10.00	100.00
340	0.00	83.01	-10.00	100.00	-10.00	100.00
345	0.00	80.86	-10.00	100.00	-10.00	100.00
350	0.00	78.76	-10.00	100.00	-10.00	100.00
355	0.00	76.74	-10.00	100.00	-10.00	100.00

5. CERTIFICATION

I HEREBY CERTIFY THAT I AM THE TECHNICALLY QUALIFIED PERSON RESPONSIBLE FOR THE PREPARATION OF THE FREQUENCY COORDINATION DATA CONTAINED IN THIS APPLICATION, THAT I AM FAMILIAR WITH PARTS 101 AND 25 OF THE FCC RULES AND REGULATIONS, THAT I HAVE EITHER PREPARED OR REVIEWED THE FREQUENCY COORDINATION DATA SUBMITTED WITH THIS APPLICATION, AND THAT IT IS COMPLETE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

BY: _ 

Gary K. Edwards
Senior Manager
COMSEARCH
19700 Janelia Farm Boulevard
Ashburn, VA 20147

DATED: December 4, 2017

Attachment 3
47 C.F.R. §25.136 Analysis

Attachment 3 – Compliance with 47 C.F.R. § 25.136(a)(4)

As demonstrated below, the Hawaii Diversity Earth Station will comply with each element of Section 25.136(a)(4) of the Commission's rules, as revised in the Second Spectrum Frontiers Order.[1] Pursuant to the showing below, the Commission should authorize the Hawaii Diversity Earth Station and should not require O3b to provide any additional interference protection to future stations in the Upper Microwave Flexible Use Service in Hawaii County.

§ 25.136(a)(4)(i)

Based on a search of the International Bureau Filing System as of January 22, 2018, there are no other earth stations in the 27.5 – 28.35 GHz band in Hawaii County. Therefore, the Hawaii Diversity Earth Station complies with § 25.136(a)(4)(i).

§ 25.136(a)(4)(ii)

As revised in the Second Spectrum Frontiers Order, Section 25.136(4)(ii) provides that the area over which an earth station's PFD contour is equal to or exceeds −77.6 dBm/m^2/MHz must not cover more than a specified proportion of a county's population.[2] Under the new rule, in a county in which there are between 6,000 and 450,000 residents, an earth station may cover up to 450 people within its PFD contour without having to provide interference protection to future UMFUS operators. As demonstrated below, the Hawaii Diversity Earth Station will meet the Commission's new requirements.

According to the 2010 census, Hawaii county has a population of 185,326,[3] permitting an earth station to cover up to 450 people in the county. The below analysis shows that the PFD contour will cover only 239 people and therefore complies with the revised population limits for Hawaii county.

In this analysis, we have assumed the ITU-R P.452-15 propagation model and used 1-arc second resolution SRTM data. The population data for each census block within the PFD contour is from the 2010 U.S. census data. The proportional method was used to assess how many people in a given census block are within the PFD contour.

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[1] *See Use of Spectrum Bands Above 24 GHz For Mobile Radio Services,* Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order (rel. Nov. 22, 2017) ("Second Spectrum Frontiers Order") at Appendix A. Exhibit A to this application seeks any necessary waiver of the current language of Section 25.136(a)(4) in the event the changes to that rule section have not yet taken effect when this application is considered.

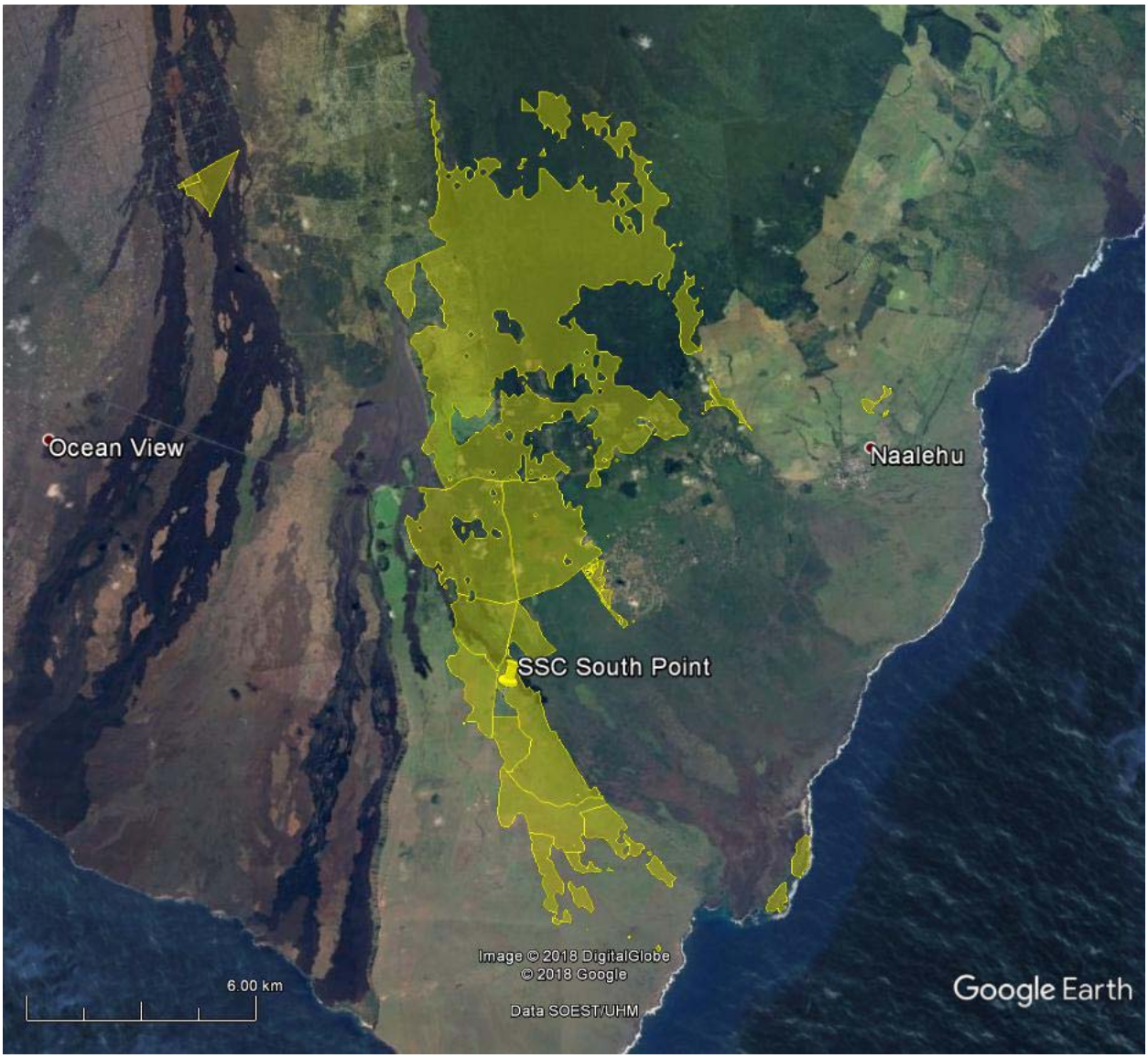
[2] Second Spectrum Frontiers Order at Appendix A.

[3] *See* QuickFacts Hawaii County, Hawaii, United States Census Bureau, available at: https://www.census.gov/quickfacts/fact/table/hawaiicountyhawaii/PST045216.

The earth station parameters are shown in the following table.

Parameter	**Units**	**Value**
ES latitude	°N	19.0144
ES longitude	°W.L.	155.662911
ES antenna size	m	2.4
ES input power spectral density	dBW/MHz	−5.4
ES antenna pattern	n/a	ITU-R S.580
ES minimum elevation angle	°	5

The Visualyse PRO software by Transfinite was used to develop a composite PFD contour using the above assumptions. The earth station input power spectral density used in the simulation differs from the value contained in the application. This is to account for nominal operations under clear-sky conditions and also assumes that the antenna pattern will achieve at least 1 dB better discrimination than the ITU antenna pattern and 2 dB of additional losses due to clutter near the transmitting FSS earth station and/or the victim UMFUS station. Once the contour was developed, Matlab was used to read the PFD contour, the census block contours and census block population to determine the intersection of the PFD contour with each census block. The percent of the intersecting area of a given census block was multiplied by the total population of that census block to determine the proportional population within the PFD contour. The resulting contour of intersecting PFD and census blocks with population greater than 0 were exported to KML format and imported to Google Earth for visualizing the final contour. The following graphic illustrates this contour.



Also exported from Matlab was the population within the PFD contour for each intersecting census block. That data is shown below.

Block ID: 150010212022003; Population: 17.5

Block ID: 150010212022300; Population: 0

Block ID: 150010212022281; Population: 0

Block ID: 150010212022296; Population: 0

Block ID: 150010212022377; Population: 0

Block ID: 150010212022303; Population: 0

Block ID: 150010212022378; Population: 0

Block ID: 150010212022351; Population: 0

Block ID: 150010212022344; Population: 3.2

Block ID: 150010212022422; Population: 0

Block ID: 150010212022766; Population: 0

Block ID: 150010212022078; Population: 0

Block ID: 150010212024009; Population: 0

Block ID: 150010212023112; Population: 6.1

Block ID: 150010212023152; Population: 0.3

Block ID: 150010212022054; Population: 0

Block ID: 150010212023117; Population: 28.3

Block ID: 150010212023160; Population: 20

Block ID: 150010212023162; Population: 0

Block ID: 150010212022306; Population: 0

Block ID: 150010212022301; Population: 0

Block ID: 150010212022297; Population: 0

Block ID: 150010212022280; Population: 0

Block ID: 150010212022291; Population: 0

Block ID: 150010212022295; Population: 0

Block ID: 150010212022309; Population: 0

Block ID: 150010212022345; Population: 0

Block ID: 150010212022417; Population: 0

Block ID: 150010212024034; Population: 0

Block ID: 150010212023151; Population: 40.9

Block ID: 150010212023129; Population: 8

Block ID: 150010212023153; Population: 0.9

Block ID: 150010212023187; Population: 0

Block ID: 150010212022283; Population: 0

Block ID: 150010212022310; Population: 0

Block ID: 150010212022285; Population: 0

Block ID: 150010212022274; Population: 0

Block ID: 150010212022286; Population: 0

Block ID: 150010212022380; Population: 0

Block ID: 150010212022356; Population: 0

Block ID: 150010212022341; Population: 0

Block ID: 150010212022307; Population: 0

Block ID: 150010212022357; Population: 0

Block ID: 150010212022355; Population: 0

Block ID: 150010212024026; Population: 0.1

Block ID: 150010212022776; Population: 0.6

Block ID: 150010212024021; Population: 0

Block ID: 150010212022416; Population: 0

Block ID: 150010212023161; Population: 2

Block ID: 150010212023158; Population: 0

Block ID: 150010212022266; Population: 0

Block ID: 150010212022278; Population: 0

Block ID: 150010212022279; Population: 0

Block ID: 150010212022284; Population: 0

Block ID: 150010212022273; Population: 0

Block ID: 150010212022282; Population: 0

Block ID: 150010212022292; Population: 0

Block ID: 150010212022358; Population: 0

Block ID: 150010212022346; Population: 0

Block ID: 150010212022342; Population: 0

Block ID: 150010212024050; Population: 2.1

Block ID: 150010212023188; Population: 10

Block ID: 150010212022691; Population: 0.1

Block ID: 150010212022046; Population: 0

Block ID: 150010212022779; Population: 0

Block ID: 150010212022289; Population: 15.2

Block ID: 150010212023191; Population: 11.6

Block ID: 150010212024040; Population: 0

Block ID: 150010212022401; Population: 6.8

Block ID: 150010212022276; Population: 0

Block ID: 150010212022294; Population: 0

Block ID: 150010212022298; Population: 0

Block ID: 150010212022349; Population: 0

Block ID: 150010212022313; Population: 0

Block ID: 150010212022314; Population: 0

Block ID: 150010212022005; Population: 0

Block ID: 150010212023114; Population: 0.9

Block ID: 150010212024035; Population: 0

Block ID: 150010212023189; Population: 0

Block ID: 150010212023126; Population: 0

Block ID: 150010212023165; Population: 0

Block ID: 150010212024062; Population: 0.4

Block ID: 150010212022064; Population: 0

Block ID: 150010212022033; Population: 0

Block ID: 150010212022063; Population: 0

Block ID: 150010212022275; Population: 0

Block ID: 150010212022302; Population: 0

Block ID: 150010212022304; Population: 0

Block ID: 150010212022312; Population: 0

Block ID: 150010212022311; Population: 0

Block ID: 150010212024001; Population: 1.1

Block ID: 150010212022421; Population: 0

Block ID: 150010212022769; Population: 0

Block ID: 150010212023164; Population: 0

Block ID: 150010212022415; Population: 0

Block ID: 150019901000002; Population: 0

Block ID: 150010212023128; Population: 0

Block ID: 150010212022299; Population: 1.7

Block ID: 150010212022277; Population: 0

Block ID: 150010212022287; Population: 0

Block ID: 150010212022379; Population: 0

Block ID: 150010212022362; Population: 0

Block ID: 150010212022350; Population: 0

Block ID: 150010212022343; Population: 0

Block ID: 150010212022305; Population: 0

Block ID: 150010212022778; Population: 0

Block ID: 150010212022419; Population: 0

Block ID: 150010212022018; Population: 0

Block ID: 150010212022004; Population: 0

Block ID: 150010212023182; Population: 0

Block ID: 150010212023116; Population: 14.2

Block ID: 150010212022414; Population: 0.8

Block ID: 150010212023132; Population: 1.9

Block ID: 150010212022021; Population: 0

Block ID: 150010212023159; Population: 0

Block ID: 150010212022308; Population: 0

Block ID: 150010212022040; Population: 0

Block ID: 150010212022288; Population: 0

Block ID: 150010212022376; Population: 0

Block ID: 150010212022352; Population: 0

Block ID: 150010212022354; Population: 0

Block ID: 150010212022353; Population: 0

Block ID: 150010212022315; Population: 0

Block ID: 150010212022029; Population: 0

Block ID: 150010212022770; Population: 0

Block ID: 150010212024088; Population: 0

Block ID: 150010212022420; Population: 0

Block ID: 150010212023192; Population: 0

Block ID: 150010212023120; Population: 23

Block ID: 150010212023127; Population: 6

Block ID: 150010212023163; Population: 6

Block ID: 150010212023166; Population: 0

Block ID: 150010212023121; Population: 9.1

Based on these calculations, the total population covered by the Hawaii Diversity Earth Station's PFD Contour is 239.

§ 25.136(a)(4)(iii)

Based on a search in Google Earth, there are no major event venues, urban mass transit routes, passenger railroads or cruise ship ports within the Hawaii Diversity Earth Station's PFD contour. The PFD contour does overlap with portions of Route 11 in Hawaii County, but Route 11 is not identified as an Interstate, Other Freeway and Expressway, or Other Principal Arterial by The Federal Highway Administration Office of Planning, Environment, and Realty Executive Geographic Information System map.[4] The Hawaii Diversity Earth Station therefore meets the requirements of § 25.136(a)(4)(iii) as updated in the Second Spectrum Frontiers Order.

§ 25.136(a)(4)(iv)

The coordination report in Attachment 1 demonstrates that O3b has completed coordination in compliance with Section 101.103(d) of the Commission's rules.

[4] *See* U.S. Department of Transportation, Federal Highway Administration, National Highway System map. available at: https://hepgis.fhwa.dot.gov/fhwagis/.

Attachment 4
Radiation Hazard Report

Radiation Hazard Analysis

2.4 Meter -
Naalehu, Hawaii 96772

Introduction

A radiation hazard anaylsis is presented for a 2.4 meter Ka band aperture antenna to be installed in Naalehu, Hawaii at the SES Networks Gateway Diversity. 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

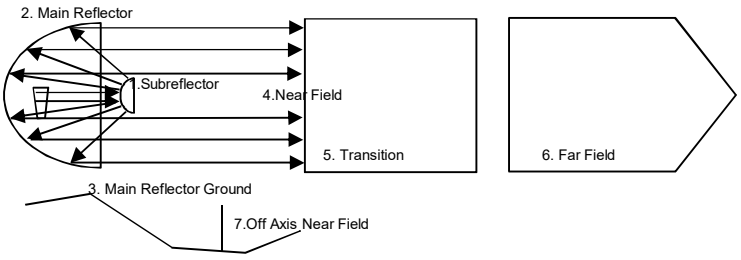


Figure 1 – Analysis Zones

Radiation Hazard Analysis

Operator:	**SES Networks**		
Location Designation:	**Gateway Diversity**	FCC ID:	
County:	**Hawaii**	SES ID:	
Town:	**Naalehu**	STA:	
State/Zip:	**Hawaii** **96772**		

Input Values	Value	Unit
D = Aperture Diameter	2.4	Meters
d = Subreflector Diameter		Meters
η = Apperture Efficeny	67%	percentage
FCC Designation	Ka	Band
F = Frequency	28709	MHz
P = Transmitter Power Watts:	100	Watts
p = Number Transmitters:	1	
R_{ua} = closest point to uncontrolled area	20	meters
Elevation angle at closest point R_{ua}	5	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_I = Total Antenna Input Power	P*p	100	watts
G = Antenna Gain	$G=\frac{4\pi\eta A}{\lambda^2}$	348457.8105	linear
Antenna Gain dB	$10\log_{10}(G)$	55.42150203	dBi
A = Area of reflector	$\pi(\frac{D}{2})^2$	4.5216	meters ^{2}
a = area of subreflector	$\pi(\frac{d}{2})^2$	N/A	meters ^{2}
R_{nf} = Near-Field Region	$R_{nf}=\frac{D^2}{4\lambda}$	137.80	meters
Transition Region	$>R_{nf}<R_{ff}$	137.8032 330.72768	>meters <meters
R_{ff} = Far Field Region	$R_{ff}=\frac{0.6\,D^2}{\lambda}$	330.72768 29	meters Meters AGL

	Radiation Analysis Zone	Formula	Level	Value	Exposure Limits	
					General Public	Occupational
					<1mW/cm ^{2}	<5mW/cm ^{2}
1	Power Subreflector	$\frac{4P_t}{a}$	N/A	mW/cm ^{2}	N/A	N/A
2	Antenna Surface	$\frac{4P_t}{A}$	8.846	mW/cm ^{2}	>FCC MPE See Note 1	>FCC MPE See Note 2
3	Main Reflector Ground	$\frac{P_t}{A}$	2.212	mW/cm ^{2}	>FCC MPE See Note 1	<FCC MPE
4	Snf =Near-Field Power Density	$S_{nf}=\frac{16\eta P_t}{\pi^2 D^2}=4\eta(\frac{P_t}{A})$	5.927	mW/cm ^{2}	>FCC MPE See Note 1	>FCC MPE See Note 2
5	Max Transition Power Density	$S_t=\frac{S_{nf}R_{nf}}{R_{nf}}$	5.927	mW/cm ^{2}	>FCC MPE See Note 1	>FCC MPE See Note 2
6	Max Far field Power Density	$S_{ff}=\frac{P_t G}{4\pi R^2}$	2.536	mW/cm ^{2}	>FCC MPE See Note 3	<FCC MPE
7	Off Access Level Near Field	$S_{ua}=S_{nf}-20dB$	0.05927	mW/cm ^{2}	<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 29 meters above ground level at the minimum elevation angle which is not accessable to the general public.*