Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Astronics AeroSat Corporation	)	File No.
	)	Call Sign
Application for Blanket License to Operate	)	
1000 Technically Identical Ku-Band Transmit/	)	
Receive Earth Stations Aboard Aircraft	)	

APPLICATION FOR BLANKET LICENSE

Astronics AeroSat Corporation ("Astronics AeroSat") hereby respectfully requests that the Federal Communications Commission ("FCC" or "Commission") grant a blanket license authorizing Astronics AeroSat to operate 1000 technically identical Ku-band transmit/receive earth stations aboard aircraft ("ESAAs") on domestic and international flights to meet the unique needs of the business aviation and VVIP aircraft market. Grant of the requested authority would be consistent with Commission rules and precedent, and would serve the public interest by enhancing competition in the in-flight connectivity market and by allowing Astronics AeroSat to expand service to this underserved market segment.

I. Introduction

Astronics AeroSat is a leader in aeronautical communications solutions for commercial aircraft and business jets. For more than a decade, Astronics AeroSat has designed and manufactured antenna systems used to provide in-flight broadband Internet connectivity and video services for aircraft passengers and crew. Astronics AeroSat has launched FliteStream™ VVIP, a satellite broadband service designed for the VVIP market. FliteStream™ is the aviation industry's first dedicated global connectivity solution for the VVIP fleet.

Astronics AeroSat will employ its proven HR6400 Ku-band antenna system paired with iDirect modem and network management technology to provide a worldwide in-flight communications solution. The Commission previously approved operation of the HR6400 Ku-band antenna system in blanket licenses issued to Gogo, LLC and Row 44, Inc.[1]

The FliteStream™ network will use Ku-band fixed-satellite service ("FSS") capacity on various satellites around the world to provide global coverage. As the Commission has recognized, authorizing ESAA terminals to communicate with FSS space stations promotes efficient spectrum use and facilitates the provision of in-flight communications services to passengers and crew.[2] The Commission adopted Section 25.227 to govern ESAA operations and revised the U.S. Table of Frequency Allocations to specify that Ku-band ESAA operations are an application of the FSS.[3]

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[1] *See, e.g.*, Gogo LLC, File Nos. SES-MFS-20131114-01015, SES-AMD-20131226-01208, Call Sign E120106 (granted May 13, 2014); SES-LIC-2012061900574, SES-AMD-20120731-00709, Call Sign E120106 (granted March 8, 2013) (hereinafter "Gogo License"); Row 44 Inc., File Nos. SES-LIC-20080508-00570, SES-AMD-20080619-00826, SES-AMD-20080819-01074, SES-AMD-20080829-01117, SES-AMD-20090115-00041, SES-AMD-20090416-00501, Call Sign E080100 (granted Aug. 5, 2009) (hereinafter "Row 44 License").

[2] *Revisions to Parts 2 and 25 of the Commission's Rules to Govern the Use of Earth Stations Aboard Aircraft Communicating with Fixed-Satellite Service Geostationary-Orbit Space Stations Operating in the 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz and 14.0-14.5 GHz Frequency Bands,* IB Docket No. 12-376, *Service Rules and Procedures to Govern the Use of Aeronautical Mobile Satellite Service Earth Stations in Frequency Bands Allocated to the Fixed Satellite Service,* IB Docket No. 05-20, Notice of Proposed Rulemaking and Report and Order (FCC 12-161) (rel. Dec. 28, 2012) (hereinafter "ESAA NPRM and R&O"); *Revisions to Parts 2 and 25 of the Commission's Rules to Govern the Use of Earth Stations Aboard Aircraft Communicating with Fixed-Satellite Service Geostationary-Orbit Space Stations Operating in the 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz and 14.0-14.5 GHz Frequency Bands,* IB Docket No. 12-376, Second Report and Order and Order on Reconsideration (FCC 14-45) (rel. Apr. 18, 2014) (hereinafter "ESAA Second R&O").

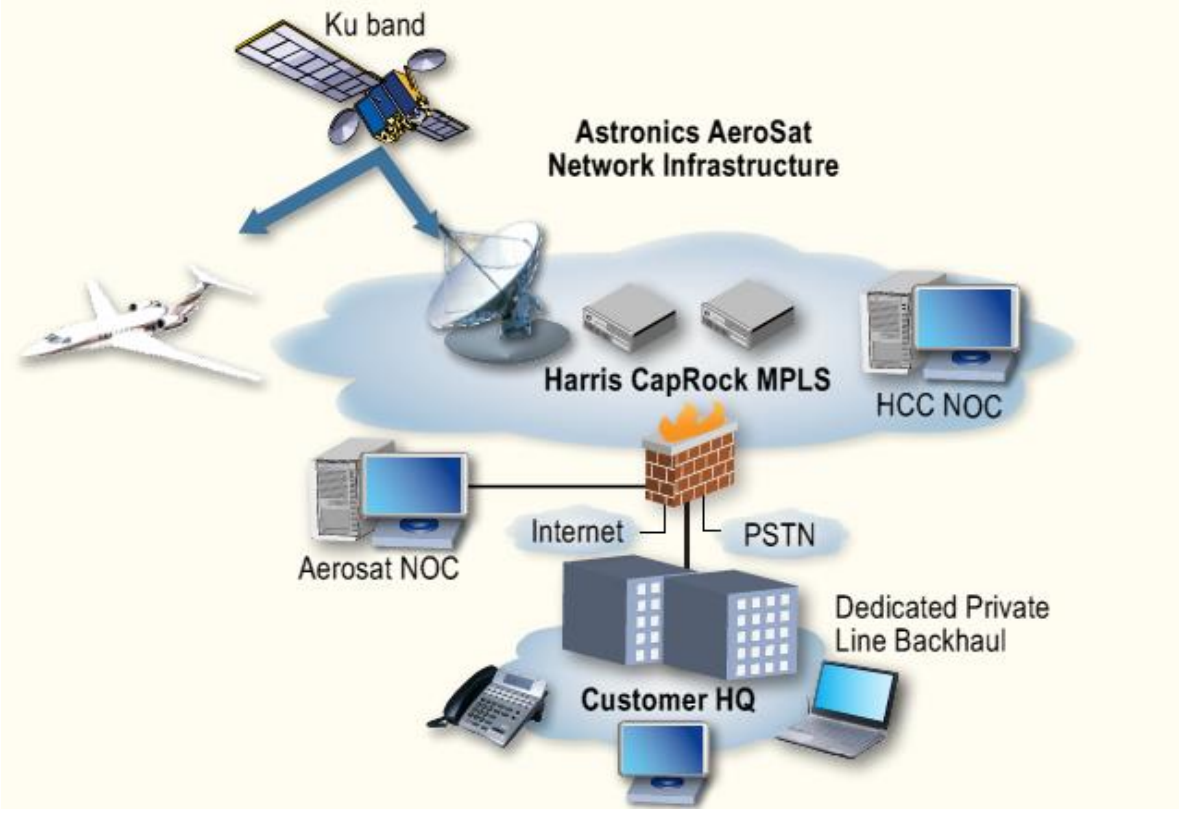
[3] *See id.*

Grant of an ESAA blanket license to Astronics AeroSat would be consistent with the Commission rules and precedent, and would serve the public interest. The introduction of FliteStream™ would enable Astronics AeroSat to provide expanded service to customers in an underserved portion of the market and would promote competition among in-flight connectivity providers.

II. Network Description

The Astronics AeroSat ESAA system consists of three elements: (i) the antenna system; (ii) the space segment; and (iii) the ground segment. An overview of each element is provided below, and additional detailed information is attached hereto in the Technical Appendix.

Figure 1. Network Configuration

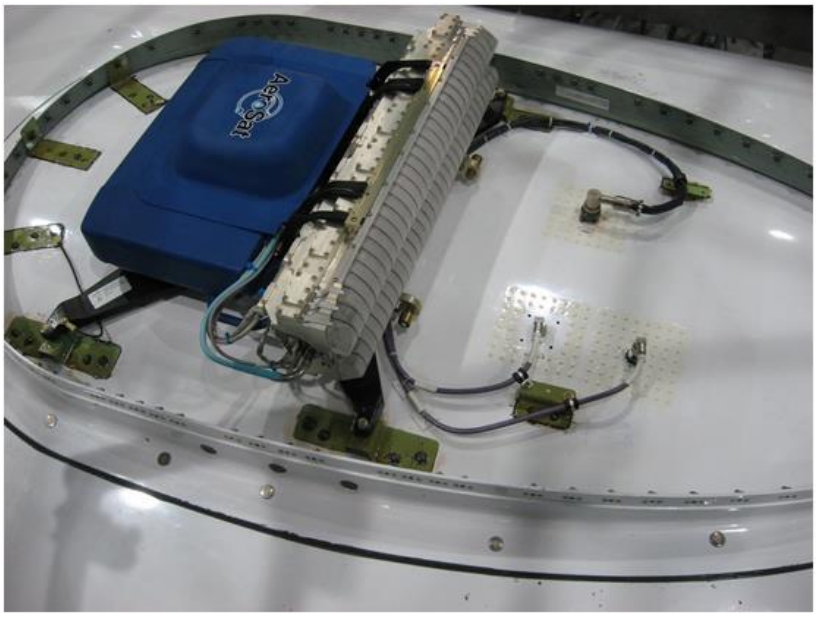


A. Antenna System

The HR6400 antenna system will be used to provide broadband Internet access and connectivity to passengers and crew aboard business aviation and VVIP aircraft. Each antenna system is comprised of an antenna subsystem, an internally mounted antenna control modem unit ("ACMU"), and a high power transceiver ("HPT"), which are connected through radio frequency ("RF") cabling.

The antenna and a radome are mounted externally on the top of the aircraft fuselage. The radome is transparent to the Ku-band radio waves and protects the HR6400 Ku-band antenna system from the outside environment. The HR6400 antenna system includes a mechanically steered antenna array that receives and transmits signals and a low noise block amplifier ("LNA"). It is mounted on a positioner with an elevation over azimuth gimbal, and a polarization converter unit ("PCU") is installed inside the antenna. *See* Figure 2.

Figure 2: HR6400 AES, Installed on an Aircraft



The ACMU controls the antenna pointing accuracy to within 0.2° between the target satellite and the axis of the antenna. The ACMU continuously monitors the pointing error and will mute the antenna transmitter within 100 milliseconds if the pointing error exceeds 0.5° and will not re-enable transmissions until the pointing error is within 0.2°. The ACMU relies on the aircraft position and attitude information, as well as signal strength data, to ensure proper antenna pointing. The Commission has issued blanket licenses to Gogo and Row 44 for operation of the HR6400,[4] and Astronics AeroSat is aware of no interference incidents involving the HR6400 antenna.

B. Space Segment

Astronics AeroSat requests authorization to utilize commercial FSS capacity on the satellites included in the following table. Astronics AeroSat provides an overview and brief description of each of the proposed satellite points of communication below. Additional information regarding each proposed satellite point of communication is included in the attached Technical Appendix at Annex 1, including coverage maps, link budgets and satellite operator letters. Because Astronics AeroSat seeks authority to operate with certain satellites at power levels in excess of those specified in Section 25.227(a)(1) of the FCC Rules, it is applying for authority to operate under Section 25.227(a)(2) and has provided satellite operator letters and other technical information required by Section 25.227(b) and other relevant provisions of the ESAA rules.

[4] *See* Gogo License, Row 44 License.

Table 1: Proposed Satellite Points of Communication

Satellite	Licensing Admin.[5]	Orbital Location	Downlink Freq. (GHz)[6]	ITU Region Coverage Area	Serves U.S. [7]
Galaxy 3C	United States	95° W.L.	11.7 - 12.2	2	Yes
IS-14	United States	45° W.L.	11.45 – 11.7	1	No
IS-19	United States	166° E.L.	12.25 - 12.75	2,3	No
IS-22	United States	72.1° E.L.	11.45 -11.7 12.25 - 12.75	1,3	No
Telstar-11N	United States	37.5° W.L.	10.95 - 11.2 12.25 - 12.75	1	No
Telstar-14R	Brazil	63° W.L.	11.2 - 11.95	2	No
Telstar-12	United States	15° W.L.	11.45 - 12.2 12.5 - 12.75	2	No
E117WA (Satmex 8)	Mexico	116.8° W.L.	11.7 - 12.2	2	No
E172A	United States	172° E.L.	10.95 - 11.2 11.45 - 11.7 12.2 - 12.75	2,3	No
Apstar-7	China	76.5° E.L.	11.45 - 11.7	1,3	No

[5] Each licensing administration is a member of the World Trade Organization for services covered under the World Trade Organization Basic Telecommunications Agreement. *See* FCC Form 312 at Item 42; 47 CFR § 25.137(a). To the extent the Commission has not already granted authority to access any of the proposed satellite points of communication, there is a presumption in favor of such access under the Commission's *DISCO II* policies.

[6] ESAA uplinks will be operated in all or part of the 14.0-14.5 GHz band depending on available capacity and national/regional restrictions on Ku-band aeronautical uplink operations.

[7] "Yes" indicates that the relevant satellite will be used for ESAA operations in U.S. territory. "No" indicates that ESAA operations will be conducted outside U.S. territory, even if the satellite may have some coverage of the United States.

1. Galaxy 3C

Galaxy 3C (S2381) is a U.S.-licensed satellite positioned at the 95° W.L. orbital location.[8] Astronics AeroSat seeks authority to use Galaxy 3C capacity for ESAA operations in the 14.0-14.5 GHz band (Earth-to-space) and the 11.7-12.2 GHz band (space-to-Earth) in United States territory, including Alaska and Hawaii, as well as non-U.S. airspace.

The operator of Galaxy 3C, Intelsat, has reviewed the technical characteristics of Astronics AeroSat's proposed commercial ESAA operations and confirmed that such operations are consistent with its coordination agreements and will not result in unacceptable interference to other satellite operations within +/- 6 degrees of Galaxy 3C. Attached hereto in the Technical Appendix is a copy of a letter confirming that Astronics AeroSat's proposed operations with Galaxy 3C have been coordinated with operators of adjacent satellites.[9]

2. IS-14

IS-14 (S2785) is a U.S.-licensed satellite positioned at the 45° W.L. orbital location.[10] Astronics AeroSat seeks authority to use IS-14 capacity for ESAA operations in the 14.0-14.25 GHz band (Earth-to-space) and in the 11.45-11.7 GHz band (space-to-Earth) outside U.S. airspace, principally the Africa region.

The operator of IS-14, Intelsat, has reviewed the technical characteristics of Astronics AeroSat's proposed commercial ESAA operations and confirmed that such operations are

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[8] *See* Call Sign S2381, File No. SAT-LOA-19990812-00082.

[9] *See* Technical Appendix at Annex A.1. Although it is applying for authority to operate under Section 25.227(a)(2) of the FCC Rules, Astronics AeroSat intends to operate the HR6400 terminal at power levels that comply with the off-axis EIRP spectral density limits along the geostationary arc set forth in Section 25.227(a)(1) (i.e., consistent with the FCC's two-degree spacing policy) with the Galaxy 3C satellite.

[10] *See* Call Sign S2758, File No. SAT-RPL-20090123-00007.

consistent with its coordination agreements and will not result in unacceptable interference to other satellite operations within +/- 6 degrees of IS-14. Attached hereto in the Technical Appendix is a copy of a letter confirming that Astronics AeroSat's proposed operations with IS-14 have been coordinated with operators of adjacent satellites.[11]

3. IS-19

IS-19 (S2850) is a U.S.-licensed satellite positioned at the 166° E.L. orbital location.[12] Astronics AeroSat seeks authority to use IS-19 capacity for ESAA operations in the 14.0-14.5 GHz band (Earth-to-space) and in the 12.25-12.75 GHz band (space-to-Earth) outside U.S. airspace, principally the Pacific Ocean region.

The operator of IS-19, Intelsat, has reviewed the technical characteristics of Astronics AeroSat's proposed commercial ESAA operations and confirmed that such operations are consistent with its coordination agreements and will not result in unacceptable interference to other satellite operations within +/- 6 degrees of IS-19. Attached hereto in the Technical Appendix is a copy of a letter confirming that Astronics AeroSat's proposed operations with IS-19 have been coordinated with operators of adjacent satellites.[13]

4. IS-22

IS-22 (S2846) is a U.S.-licensed satellite positioned at the 72° E.L. orbital location.[14] Astronics AeroSat seeks authority to use IS-22 capacity for ESAA operations in the 14.0-14.5

[11] *See* Technical Appendix at Annex A.1.

[12] *See* Call Sign S2850, File No. SAT-RPL-20111222-00245.

[13] *See* Technical Appendix at Annex A.1.

[14] *See* Call Sign S2846, File No. SAT-LOA-20110929-00193.

GHz band (Earth-to-space) and the 11.7-12.2 GHz band (space-to-Earth) outside the United States, principally the Southeast Asia and Indian Ocean regions.

The operator of IS-22, Intelsat, has reviewed the technical characteristics of Astronics AeroSat's proposed commercial ESAA operations and confirmed that such operations are consistent with its coordination agreements and will not result in unacceptable interference to other satellite operations within +/- 6 degrees of IS-22. Attached hereto in the Technical Appendix is a copy of a letter confirming that Astronics AeroSat's proposed operations with IS-22 have been coordinated with operators of adjacent satellites.[15]

5. Telstar-11N

Telstar-11N (S2357) is a U.S.-licensed satellite positioned at the 37.5° W.L. orbital location.[16] Astronics AeroSat seeks authority to use Telstar-11N capacity for ESAA operations in the 14.0-14.5 GHz band (Earth-to-space) and in the 10.95-11.2 GHz and 12.25-12.75 GHz bands (space-to-Earth) outside the United States, principally the Europe and Africa regions.

The operator of Telstar-11N, Telesat, has reviewed the technical characteristics of Astronics AeroSat's proposed commercial ESAA operations and confirmed that such operations are consistent with its coordination agreements and will not result in unacceptable interference to other satellite operations within +/- 6 degrees of Telstar-11N. Attached hereto in the Technical Appendix is a copy of a letter confirming that Astronics AeroSat's proposed operations with Telstar-11N have been coordinated with operators of adjacent satellites.[17]

[15] *See* Technical Appendix at Annex A.1.

[16] *See* Call Sign S2357, File No. SAT-MOD-20060306-00024.

[17] *See* Technical Appendix at Annex A.2.

6. Telstar-14R

Telstar-14R (S2821), also known as Estrela Do Sul 2, is a non-U.S. licensed satellite positioned at the 63° W.L. orbital location that is licensed by Brazil and authorized to serve the U.S. market through the Commission's Permitted Space Station List.[18] Astronics AeroSat seeks authority to use Telstar-14R capacity for ESAA operations in the 14.0-14.5 GHz band (Earth-to-space), 11.2-11.7 GHz and 11.7-11.95 GHz bands (space-to-Earth) outside the United States, principally the North Atlantic Ocean region.

The operator of Telstar-14R, Telesat, has reviewed the technical characteristics of Astronics AeroSat's proposed commercial ESAA operations and confirmed that such operations are consistent with its coordination agreements and will not result in unacceptable interference to other satellite operations within +/- 6 degrees of Telstar-14R. Attached hereto in the Technical Appendix is a copy of a letter confirming that Astronics AeroSat's proposed operations with Telstar-14R have been coordinated with operators of adjacent satellites.[19]

7. Telstar-12

Telstar-12 (S2462) is a U.S.-licensed satellite positioned at the 15° W.L. orbital location.[20] Astronics AeroSat seeks authority to use Telstar-12 capacity for ESAA operations in the 14.0-14.5 GHz band (Earth-to-space) and the 11.7-12.2 GHz, 11.45-11.7 GHz and 12.5-12.75 GHz bands (space-to-Earth) outside the United States, principally in the Caribbean and South America.

The operator of Telstar-12, Telesat, has reviewed the technical characteristics of Astronics AeroSat's proposed commercial ESAA operations and confirmed that such operations are

[18] *See* Call Sign S2821, File No. SAT-PPL-20110112-00012.

[19] *See* Technical Appendix at Annex A.2.

[20] *See* Call Sign S2462, File No. SAT-ASG-20070130-00025.

consistent with its coordination agreements and will not result in unacceptable interference to other satellite operations within +/- 6 degrees of Telstar-12. Attached hereto in the Technical Appendix is a copy of a letter confirming that Astronics AeroSat's proposed operations with Telstar-12 have been coordinated with operators of adjacent satellites.[21]

8. E117WA (formerly Satmex 8)

E117WA (formerly Satmex 8) (S2873) is a non-U.S. satellite positioned at the 116.8° W.L. orbital location that is licensed by Mexico and authorized to serve the U.S. market through the Commission's Permitted Space Station List.[22] Astronics AeroSat seeks authority to use E117WA capacity for ESAA operations in the 14.0-14.5 GHz band (Earth-to-space) and the 11.7-12.2 GHz band (space-to-Earth) outside United States territory, principally in Mexico and South America.

The operator of E117WA, Eutelsat, has reviewed the technical characteristics of Astronics AeroSat's proposed commercial ESAA operations and confirmed that such operations are consistent with its coordination agreements and will not result in unacceptable interference to other satellite operations within +/- 6 degrees of E117WA. Attached hereto in the Technical Appendix is a copy of a letter confirming that Astronics AeroSat's proposed operations with E117WA have been coordinated with operators of adjacent satellites.[23]

[21] *See* Technical Appendix at Annex A.2.

[22] *See* Call Sign S2873, File No. SAT-PPL-20120823-00140.

[23] *See* Technical Appendix at Annex A.3.

9. E172A

E172A (S2610) is a U.S.-licensed satellite positioned at the 172° E.L. orbital location.[24] Astronics AeroSat seeks authority to use E172A capacity for ESAA operations in the 14.0-14.5 GHz band (Earth-to-space) and in the 10.95-11.2 GHz, 11.45-11.7 GHz, and 12.2-12.75 GHz bands (space-to-Earth) outside the United States, principally the Pacific Ocean region.

The operator of E172A, Eutelsat, has reviewed the technical characteristics of Astronics AeroSat's proposed commercial ESAA operations and confirmed that such operations are consistent with its coordination agreements and will not result in unacceptable interference to other satellite operations within +/- 6 degrees of E172A. Attached hereto in the Technical Appendix is a copy of a letter confirming that Astronics AeroSat's proposed operations with E172A have been coordinated with operators of adjacent satellites.[25]

10. Apstar-7

Apstar-7 is a non-U.S. licensed satellite positioned at the 76.5° E.L. orbital location that is licensed by China. Astronics AeroSat seeks authority to use Apstar-7 capacity for ESAA operations in the 14.0-14.5 GHz band (Earth-to-space) band and in the 11.45-11.7 GHz band (space-to-Earth) outside the United States, principally the Middle East, Europe, North Africa and Central Asia regions.

The operator of Apstar-7, APT, has reviewed the technical characteristics of Astronics AeroSat's proposed commercial ESAA operations and confirmed that such operations are consistent with its coordination agreements and will not result in unacceptable interference to other satellite operations within +/- 6 degrees of Apstar-7. Attached hereto in the Technical

[24] Call Sign S2610, File No. SAT-LOA-20031218-00358.

[25] *See* Technical Appendix at Annex A.3.

Appendix is a copy of a letter confirming that Astronics AeroSat's proposed operations with Apstar-7 have been coordinated with operators of adjacent satellites.[26]

Astronics AeroSat understands that the FCC is currently considering an application by Panasonic Avionics to access the Apstar-7 as an authorized satellite point of communication for Ku-band aeronautical terminals onboard U.S.-registered aircraft and that action in that proceeding is imminent.[27] Astronics AeroSat also understands that detailed information has been developed with respect to the Apstar-7 satellite's compliance with the FCC's orbital debris mitigation and satellite end-of-life policies.[28] Out of an abundance of caution and based on consultations with the International Bureau staff, Astronics AeroSat hereby incorporates by reference the publically available information regarding Apstar-7's compliance with FCC's orbital debris mitigation and satellite end-of-life policies.[29]

C. Ground Segment

Gateway earth stations for the proposed Astronics AeroSat ESAA network vary by satellite. The table below identifies each satellite and associated gateway earth station. Network control for Astronics AeroSat's proposed operations will be provided pursuant to an agreement

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[26] *See* Technical Appendix at Annex A.4.

[27] *See Modification Application of Panasonic Avionics Corporation*, Call Sign E100089, File No. SES-MFS-20130930-00845.

[28] *See* Section 1.65 Letter from Carlos M. Nalda to Marlene H. Dortch dated March 10, 2014, File No. SES-MFS-20130930-00845 (submitting information regarding Apstar-7 compliance with Section 47 C.F.R. § 25.114(d)(14)(i)-(iv) and §25.283 of the FCC Rules).

[29] This will permit the Commission to place the request to add Apstar-7 as an authorized point of communication on public notice even if it does not act on the Panasonic application before accepting the instant application for filing. Astronics AeroSat notes that a partial waiver of FCC orbital debris mitigation and satellite end-of-life rules may be necessary if the Commission has not otherwise permitted access to Apstar-7 before acting on this application. Astronics AeroSat hereby requests leave to supplement this application should any additional public interest information by necessary to support grant of authority to access the Apstar-7 satellite.

with Harris CapRock, subject to Astronics AeroSat's ultimate direction and control using linked Network Operations Centers ("NOCs") located at both companies' facilities.

Table 2 - Gateway Earth Stations

Satellite	Satellite Operator	Gateway Earth Station Location	Country	Gateway Operator	FCC Call Sign
Galaxy 3C	Intelsat	Hagerstown, MD	USA	Intelsat	E080006
IS-14	Intelsat	Aberdeen	UK	Harris CapRock	N/A
IS-22	Intelsat	Chungnam	S. Korea	Korea Telecom	N/A
IS-19	Intelsat	Napa, CA	USA	Intelsat	E980460
Telstar-12	Telesat	Aberdeen	UK	Harris CapRock	N/A
Telstar-14R	Telesat	Melbourne, FL	USA	Harris CapRock	E080151
Telstar-11N	Telesat	Melbourne, FL Aberdeen	USA UK	Harris CapRock Harris CapRock	E080145 N/A
E117WA	Eutelsat	Houston, TX	USA	Harris CapRock	E030279
E172A	Eutelsat	Brewster, WA	USA	USEI	E910548
Apstar-7	APT Satellite	Ortucchio	Italy	Telespazio	N/A

III. Other Technical Information

A. Operational Authority

Astronics AeroSat proposes to transmit under Section 25.227(a)(2) for operations with the specified satellite points of communication included in this application. Astronics AeroSat includes the technical demonstrations required by Section 25.227(b)(2) in this narrative and the attached Technical Appendix.[30] Astronics AeroSat also provides additional technical and operational information contemplated by Section 25.227 of the FCC Rules.

B. Geographic Area(s) of ESAA Operations

In the attached Technical Appendix, Astronics AeroSat includes an exhibit describing the geographic area in which the proposed ESAA network will operate, as well as the service area of individual satellite beams.[31] Astronics AeroSat again notes that it intends to use only the Galaxy

[30] *See* Regulatory Compliance Index, Technical Appendix at Annex D.

[31] *See* Technical Appendix at Annex A. *See also* 47 CFR § 25.227(b)(4).

3C satellite (and other Permitted List satellites) for ESAA operations within the United States consistent with Section 25.227(a).

C. Point of Contact

The facility is operated by remote control through NOCs run by Astronics AeroSat and its implementation partner, Harris CapRock Corporation. In the attached Technical Appendix, Astronics AeroSat includes the location and contact information of the primary and secondary control points for the proposed ESAA operations.

D. Certifications Required by Section 25.227

ESAA applicants filing for an ESAA terminal or system must include certifications in its application, in accordance with Sections 25.227(a)(15) and 25.227(b)(7).[32] In Annex E of the Technical Appendix, Astronics AeroSat certifies that it will comply with the record annotation and maintenance requirement of Section 25.227(a)(6), the automatic cessation of transmissions requirement of Section 25.227(a)(9), the monitoring and control requirement of Section 25.227(a)(10), the self-monitoring requirement of Section 25.227(a)(11), and in accordance with 25.227(a)(15) that it has confirmed with its target space station operators that its existing and proposed operations are within coordinated parameters for adjacent satellites up to six degrees away (+/- 6°).[33]

E. Other Operational and Technical Characteristics

1. Recordkeeping Requirements

Astronics AeroSat will establish and maintain records of ESAA operations, including terminal location (*i.e.*, latitude, longitude, and altitude), transmit frequency, channel bandwidth,

[32] 47 CFR §§ 25.227(a)(15), 25.227(b)(7).

[33] *See* Technical Appendix at Annex E.

and satellite used for communications and maintain such records for a period of not less than one year. Astronics AeroSat will record such information at time intervals no greater than one (1) minute while the ESAA is transmitting. Within 24 hours of receiving a request from the Commission, the National Telecommunications and Information Administration ("NTIA"), or a frequency coordinator for purposes of resolving harmful interference events, Astronics AeroSat will make this data available, in the form of a comma delimited electronic spreadsheet, and supply a description of the units (*i.e.*, degrees, minutes, MHz, etc.) in which records values are recorded.[34]

2. Automatic Cessation of Emissions

All emissions from the Astronics AeroSat ESAAs will automatically cease within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the ESAA antenna exceeds 0.5°, and transmission will not resume until such angle is less than or equal to 0.2°.[35] In addition, when the proposed ESAA operations are ongoing, each Astronics AeroSat ESAA terminal will cease transmitting automatically within 100 milliseconds upon loss of reception of the satellite downlink signal or when the ESAA terminal detects that unintended satellite tracking has happened or is about to happen.[36]

3. Monitoring and Control

Each Astronics AeroSat ESAA terminal will be subject to monitoring and control during operations by a NOC.[37] Each ESAA terminal will be able to receive "enable transmission" and

[34] 47 CFR §§ 25.227(a)(6).

[35] 47 CFR §§ 25.227(a)(1)(iii).

[36] 47 CFR §§ 25.227(a)(9).

[37] 47 CFR §§ 25.227(a)(10).

"disable transmission" commands from the NOC and will cease transmissions automatically on receiving any "parameter change command," which may cause harmful interference during the change, until the ESAA terminal receives an "enable transmission" command from the Astronics AeroSat NOC. In addition, the Astronics AeroSat NOC will be able to monitor the operation of each ESAA terminal to determine if it is malfunctioning.

4. Self-Monitoring

During operations, each Astronics AeroSat ESAA terminal will be self-monitoring.[38] Each ESAA terminal will cease transmissions automatically if a fault having the potential to cause harmful interference to FSS networks is detected.

5. Operations in Foreign Airspace

Prior to operations within the foreign nation's airspace, Astronics AeroSat will ascertain whether the relevant administration has operations that could be affected by ESAA operations and will determine whether that administration has adopted specific requirements concerning ESAA operations. Astronics AeroSat will comply with applicable requirements of foreign administrations. Astronics AeroSat's ESAA terminals will operate in foreign airspace under the Commission's rules, or those of the foreign administration, whichever are more constraining.[39]

5. Operations Near Primary Fixed Service Stations

Astronics AeroSat's ESAAs operating in the international airspace within line-of-sight of the territory of a foreign administration where fixed service networks have primary allocation I n

[38] 47 CFR §§ 25.227(a)(11).

[39] 47 CFR § 25.227(a)(16).

the ESAAs' transmit band will comply with applicable maximum power flux density (pfd) limitations at the surface of the Earth.[40]

F. Radio Frequency Hazard Analysis

The attached Technical Appendix includes a radio frequency hazard analysis as required by Section 25.227(b)(8) of the FCC Rules.[41]

IV. Coordination

The proposed Astronics AeroSat ESAA operations are subject to coordination with the National Aeronautics and Space Administration ("NASA") through the NTIA Interdepartment Radio Advisory Committee ("IRAC") and the National Science Foundation ("NSF"), in accordance with Sections 25.227(c) and (d) of the FCC Rules.[42] Astronics AeroSat is working with NASA and NSF to finalize the details of coordination.

Pending completion of coordination with NASA and NSF, Astronics AeroSat confirms that it will not operate ESAAs in the 14.0-14.2 GHz band the radio within line-of-site of NASA TDRSS facilities or in the 14.47-14.5 GHz band within the radio line-of-sight of radio astronomy observatories observing in the band. Accordingly, completion of coordination with NASA and NSF is not required to permit Commission processing and action on the instant application.

A. Coordination with Space Research Service in the 14.0 to 14.2 GHz Band

ESAA operations in the 14.0 to 14.2 GHz (Earth-to-space) frequency band in the radio line-of-sight of the NASA Space Research Service ("SRS") Tracking and Data Relay Satellite System ("TDRSS") facilities on Guam and at White Sands, New Mexico and Blossom Point,

[40] 47 CFR § 25.227(a)(13).

[41] 47 CFR § 25.227(b)(8).

[42] 47 CFR §§ 25.227(c), (d).

Maryland are subject to coordination with NASA.[43] Astronics AeroSat is in the process of coordinating its proposed ESAA operations within the radio line-of-sight of these locations with NASA. Astronics AeroSat will submit the executed coordination agreement to the Commission as soon as it becomes available. Astronics AeroSat will comply with the requirements for ESAA operations within the coordination zones and with respect to any new TDRSS sites.[44]

B. Coordination with Radioastronomy Service Stations in the 14.47 to 14.5 GHz Band

ESAA operations in the 14.47 to 14.5 GHz (Earth-to-space) frequency band within the radio line-of-sight of Radioastronomy Service ("RAS") are subject to coordination with NSF.[45] Astronics AeroSat has completed coordination with NSF and the final coordination agreement is in the process of internal NSF approval. Astronics AeroSat will submit the executed coordination agreement to the Commission as soon as it becomes available. Astronics AeroSat will comply with the requirements for ESAA operations within the coordination zones and with respect to any new RAS sites.[46]

V. Waiver Request

The FCC's Table of Allocations permits use of the 10.95-11.2 GHz and 11.45-11.7 GHz bands (on an unprotected basis) and the 11.7-12.2 GHz and 14.0-14.5 GHz bands (on a primary basis) for ESAA operations.[47] Astronics AeroSat also seeks to utilize FSS satellite capacity available in the 12.2-12.75 GHz for ESAA receive operations on an unprotected, non-harmful

[43] 47 CFR § 25.227(c)(1).

[44] 47 CFR § 25.227(c)(2).

[45] 47 CFR § 25.227(d)(1).

[46] 47 CFR § 25.227(d)(3).

[47] 47 CFR § 2.106 and n. NG52 and NG55.

interference basis outside the United States (principally in Regions 1 and 3).[48] The FCC may permit such operations for the same reasons it permits ESAA downlink operations in other extended Ku-band receive spectrum.

As the Commission noted in the ESAA Order, unprotected ESAA receive operations in identified Ku-band downlink spectrum are unlikely to interference with or restrict other co-frequency uses of the band.[49] This is also true for ESAA receive in other regions where additional spectrum is allocated for FSS downlink operations. Because Astronics AeroSat's proposed ESAA receive operations utilize FSS satellite capacity operating consistent with applicable space station licenses and allocations, the FCC may grant a waiver and include all or part of the 12.25-12.75 GHz receive band (depending on the satellite) in the requested ESAA blanket license.[50]

VI. Public Interest Demonstration

In adopting its existing ESAA rules, the Commission has recognized that expanding broadband connectivity to aircraft in flight and authorizing ESAA as an application of the FSS are in the public interest. The Commission decisions confirm that ESAA operations serve the public interest by "enhanc[ing] competition in an important sector of the mobile telecommunications market in the United States and promot[ing] the widespread availability of Internet access to aircraft passengers."[51]

Grant of the Astronics AeroSat ESAA license application will promote competition in the market for in-flight connectivity services, to the benefit of travelers in the United States and

[48] The 12.5-12.75 GHz band is allocated for FSS downlinks in Region 1 and the 12.2-12.75 is allocated for FSS downlinks in Region 3.

[49] *See* ESAA NPRM and R&O at ¶¶ 20-21.

[50] *See also supra* at 12-13 (discussing access to the Apstar-7 satellite).

[51] *See id.*, ¶ 1.

abroad. In particular, Astronics AeroSat is focusing on a relatively underserved segment of the aviation market – business jets and VVIP aircraft – that will enjoy increased productivity, operational efficiencies and other benefit from expanded access to broadband connectivity.

Astronics AeroSat has provided the technical and operational information necessary for the Commission to grant an ESAA blanket license pursuant to Section 25.227 of the FCC Rules. In particular, Astronics AeroSat has established that its ESAA terminals can operate with the specified satellite points of communication consistent with applicable coordination agreements and that its proposed operations are compatible with other co-frequency services.

Astronics AeroSat's ESAA network also conforms to the Commission's *DISCO II* policies.[52] All of the proposed satellite points of communication are licensed by the United States or World Trade Organization member countries, establishing a presumption in favor of granting market access. Of the three non-U.S. licensed satellites, E117WA and Telstar 14-R have been afforded U.S. market access through the Permitted Space Station List,[53] and action to grant access to Apstar-7 in the aeronautical context is imminent. Thus, granting access to the foreign satellites included in this application would be consistent with FCC policies and precedent.

Grant of the requested ESAA blanket license would be consistent with Commission rules, policies and precedent facilitating Ku-band aeronautical broadband operations, including multiple prior grants of blanket license authority for the HR6400 terminal which is the subject of the instant application. Accordingly, Astronics AeroSat submits that grant of this application would strongly serve the public interest.

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[52] *See Amendment of the Commission's Policies to Allow Non-U.S. Licensed Space Stations providing Domestic and International Service in the United States,* Report & Order, 12 FCC Rcd 24094 (1997) ("*DISCO II"); see also* 47 C.F.R. § 25.137.

[53] The policies that govern access to conventional Ku-band spectrum through the Permitted Space Station List also govern access to the extended bands requested herein. *See DISCO II.*

VII. Request for Permit-but-Disclose Status

Astronics AeroSat respectfully requests that the Commission designate this application proceeding as permit-but-disclose for purposes of the *ex parte* rules. Section 1.1200(a) of the FCC Rules permits the Commission to modify the *ex parte* status of a proceeding based on a finding that such modification is in the public interest.[54]

Grant of permit-but-disclose status for the Astronics AeroSat ESAA application will facilitate communication among the Commission staff, Astronics AeroSat and any other interested parties regarding issues raised in the application, which in turn will allow the Commission to develop a more complete record on which to evaluate the application. As a result, permit-but-disclose designation will enhance the Commission's ability to process and act on the Astronics AeroSat application.

VIII. Conclusion

Based on the foregoing information, Astronics AeroSat requests that the Commission grant its request for a blanket license to operate 1000 technically identical Ku-band transmit/receive ESAAs pursuant to Section 25.227 of the FCC Rules, consistent with the technical and operational parameters described herein.

Respectfully submitted,

ASTRONICS AEROSAT CORPORATION

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[54] 47 C.F.R. § 1.1200(a).

Attachment to Application

TECHNICAL ANNEX

Table of Contents

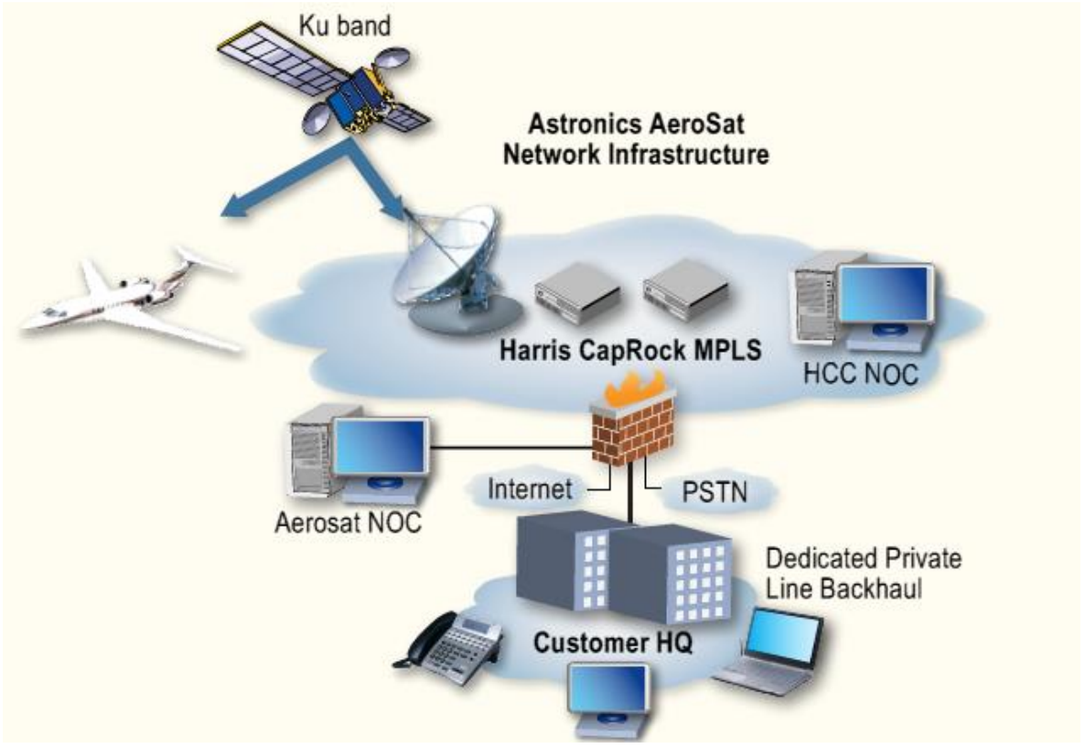
I. Detailed Description of the Proposed ESAA Network

A. System Description

1. Overview

Astronics AeroSat's FliteStream™ Ku-band earth stations onboard aircraft ("ESAA") system is shown in Figure 1. The system is comprised of aircraft earth station ("AES") equipment, leased capacity on commercial Ku-band fixed-satellite service ("FSS") satellites and an associated ground segment. The system is operated by Astronics AeroSat through its global implementation partner Harris CapRock Corporation.

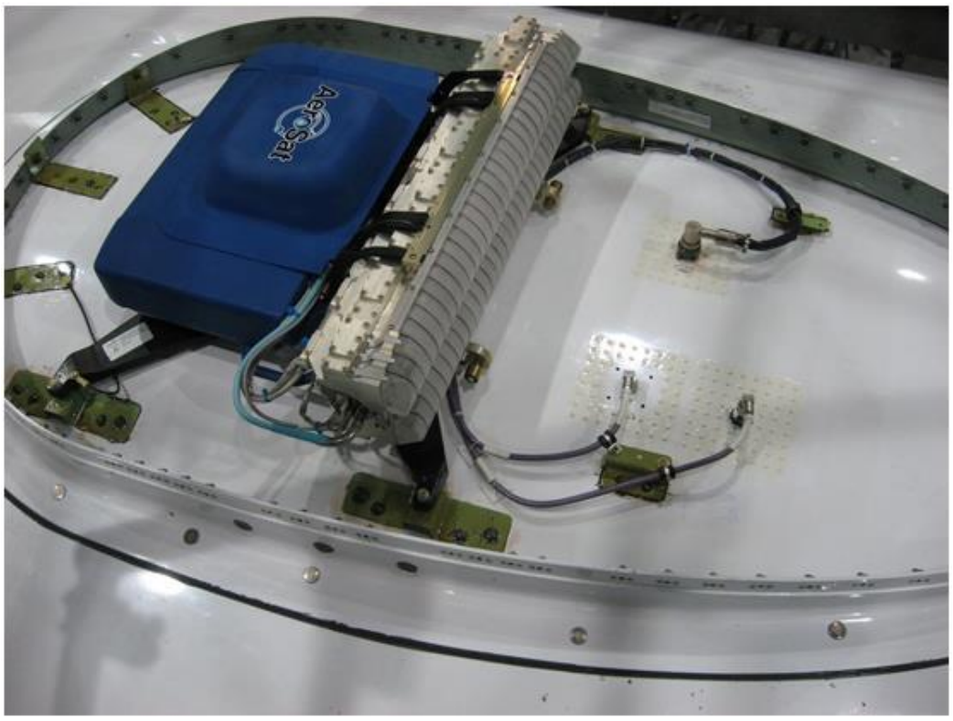
Figure 1: System Diagram



2. AES Equipment

Astronics AeroSat seeks to operate its HR6400 Ku-band terminal, which has been previously authorized by the Commission for experimental and commercial operations. In addition to the antenna subsystem mounted on the aircraft fuselage, an internally mounted Antenna Control Modem Unit ("ACMU") and a high power transceiver ("HPT") are mounted internally within the airframe of the aircraft, directly below the externally mounted equipment. Additional details related to the technical characteristics of the HR6400 terminal are set forth in Section C, Technical Characteristics of the Airborne Antenna Equipment.

Figure 2: HR6400 Terminal (installed on an aircraft)



3. Satellite Points of Communication

Astronics AeroSat will utilize commercial Ku-band Fixed Satellite Service ("FSS") capacity for its proposed commercial operations. Specifically, the HR6400 terminals will communicate with the satellites in the ITU regions indicated in the flowing table:

Table 1: Satellite Points of Communication

Satellite	Licensing Admin.[1]	Orbital Location	Downlink Freq. (GHz)[2]	ITU Region Coverage Area	Serves U.S. [3]
Galaxy 3C	United States	95° W.L.	11.7 - 12.2	2	Yes
IS-14	United States	45° W.L.	11.45 – 11.7	1	No
IS-19	United States	166° E.L.	12.25 - 12.75	2,3	No
IS-22	United States	72.1° E.L.	11.45 -11.7 12.25 - 12.75	1,3	No
Telstar-11N	United States	37.5° W.L.	10.95 - 11.2 12.25 - 12.75	1	No
Telstar-14R	Brazil	63° W.L.	11.2 - 11.95	2	No
Telstar-12	United States	15° W.L.	11.45 - 12.2 12.5 - 12.75	2	No
E117WA (Satmex 8)	Mexico	116.8° W.L.	11.7 - 12.2	2	No
E172A	United States	172° E.L.	10.95 - 11.2 11.45 - 11.7 12.2 - 12.75	2,3	No
Apstar-7	China	76.5° E.L.	11.45 - 11.7	1,3	No

The operational areas for the foregoing satellites are depicted in Annex 1. In addition, link budgets for each satellite are included in Annex 1.

Each satellite operator has reviewed and confirmed that Astronics AeroSat's proposed commercial operations are consistent with the satellite operator's coordination agreements and will not result in unacceptable interference to other satellite operations within +/- 6 degrees of each satellite. Letters from each satellite operator confirming these conclusions are included in Annex 1.

4. Gateway Earth Stations and Network Operations Center

As indicated in Table 2, the gateway earth stations for the Astronics AeroSat network are located in various countries around the world to provide global coverage. The earth stations include an iDirect hub (consisting of a DVB-S2 modulator and an iDirect D-TDMA demodulator) and are connected to Astronics AeroSat's network control facilities.

Table 2 - Gateway Earth Stations

Satellite	Satellite Operator	Gateway Earth Station Location	Country	Gateway Operator	FCC Call Sign
Galaxy 3C	Intelsat	Hagerstown, MD	USA	Intelsat	E080006
IS-14	Intelsat	Aberdeen	UK	Harris CapRock	N/A
IS-22	Intelsat	Chungnam	S. Korea	Korea Telecom	N/A
IS-19	Intelsat	Napa, CA	USA	Intelsat	E980460
Telstar-12	Telesat	Aberdeen	UK	Harris CapRock	N/A

[1] Each licensing administration is a member of the World Trade Organization for services covered under the World Trade Organization Basic Telecommunications Agreement. *See* FCC Form 312 at Item 42; 47 CFR § 25.137(a). To the extent the Commission has not already granted authority to access any of the proposed satellite points of communication, there is a presumption in favor of such access under the Commission's *DISCO II* policies.

[2] ESAA uplinks will be operated in part or all of the 14.0-14.5 GHz band depending on available capacity and national/regional restrictions on Ku-band aeronautical uplink operations.

[3] "Yes" indicates that the relevant satellite will be used for ESAA operations in U.S. territory. "No" indicates that ESAA operations will be conducted outside U.S. territory, even if the satellite may have some coverage of the United States.

Telstar-14R	Telesat	Melbourne, FL	USA	Harris CapRock	E080151
Telstar-11N	Telesat	Melbourne, FL Aberdeen	USA UK	Harris CapRock Harris CapRock	E080145 N/A
E117WA	Eutelsat	Houston, TX	USA	Harris CapRock	E030279
E172A	Eutelsat	Brewster, WA	USA	USEI	E910548
Apstar-7	APT Satellite	Ortucchio	Italy	Telespazio	N/A

Network control of Astronics AeroSat's proposed commercial operations will be provided pursuant to Astronics AeroSat's direction and control from a Network Operations Center ("NOC") in Amherst, New Hampshire, through its network control partner, Harris CapRock Corporation, who will provide managed network services to Astronics AeroSat. The NOC will be responsible for configuring, monitoring, controlling, and, if necessary, preventing transmissions from any HR6400 terminal. The NOC will be staffed at all times, providing continuous supervision and monitoring of such operations. In addition, Astronics AeroSat personnel will be accessible to address any operational issues.

Primary Point of Contact:

Networks Operations Center Coordinator
Office: +1 (603) 879-0205
Fax: +1 (603) 386-6488
Company Address:
Astronics AeroSat Corporation
Suite #2B 62 New Hampshire 101A
Amherst, NH 03031
Email Address: NOC@astronics.com

Secondary Point of Contact:

Harris CapRock Network Control Center
Managed Network Services 24x7 support
4400 S. Sam Houston Pkwy, E.
Houston, Texas 77046
Office: (832) 668-2775
Fax: (713) 987-2894
Email Address: hcc-hou-csc@harris.com

B. Network Technology

1. Satellite Access Techniques

Astronics AeroSat will lease capacity on a commercial Ku-band FSS satellite and utilize established waveforms – DVB-S2 and iDirect's Deterministic Time Division Multiple Access – for its proposed commercial operations. For the forward link, a hub earth station will broadcast a Time Division Multiplexed ("TDM") outbound channel from a central location shared by remote terminals within the airborne antenna equipment. For the return link, each remote terminal will transmit to the hub on a shared set of TDM access ("TDMA") inbound channels with dynamic timeslot assignments.

The forward link (hub-to-terminal) uses DVB-S2, and all of the traffic will be time division multiplexed on one carrier. DVB-S2 supports Adaptive Coding and Modulation ("ACM") with QPSK, 8PSK, and 16 APSK modulations and Low Density Parity Check Coding Rates between 0.25 and 0.9. Modulation and coding will be varied, and the airborne antenna equipment will determine which data are addressed to them by de-modulating all the frames they receive from the hub. The airborne antenna equipment then will transmit to the hub modems via the return link any information related to receive quality for the purpose of adapting future frame coding and modulation and ensuring acceptable performance.

The return link uses iDirect's Deterministic TDMA ("D-TDMA"), which supports multi-frequency ("MF") TDMA. The iDirect hub manages the frequency and timeslot assignments and ensures that no assignments are duplicated among the terminals. Timeslots and carriers are uniquely assigned, ensuring that only a single terminal can transmit in an assigned timeslot. Terminals will transmit a single carrier in each assigned time slots, and the hub will adjust the timeslot assignments as user demand varies with time on the return link.

The iDirect D-TDMA demodulator – which is located in the hub earth station – monitors the carrier-to-noise ratio ("*C/N*") of the signals transmitted from the airborne antenna to the hub. The iDirect demodulator issues power control corrections to terminals that are outside the target *C/N* range by adjusting the link power from the terminal to the target and maintaining the target level as return link characteristics change due to geographic position and operating environment. As detailed below in Section 3.3 - High Power Transceiver and Antenna Control Modem Unit, the HPT and ACMU in the airborne antenna equipment also help to control return link power.

2. Off-Axis EIRP Spectral Density

Off-axis EIRP spectral density emissions from the airborne antenna equipment will be controlled through the directivity of the antenna, limitations on the transmit power spectral density, control of pointing error, and control of skew angle relative to the orbital location of the serving satellite. Astronics AeroSat will limit the off-axis EIRP spectral density emissions to the values that the Commission applies to ESAAs in a two-degree spacing environment,[4] unless the satellite has been coordinated to a higher off-axis EIRP spectral density level.

Astronics AeroSat's HR6400 Ku-band Antenna System will limit off-axis EIRP spectral density to these values as follows:

- Limiting the transmit power spectral density by controlling the transmit power of the terminal and by selecting appropriate bandwidths for inbound channels

[4] *See* 47 C.F.R. § 25.227(a)(1)(i)(A)-(C).

- Controlling the off-axis gain of the antenna along the GSO arc by preventing transmissions when the skew angle exceeds a certain threshold
- Controlling pointing error of less than 0.2° and preventing transmissions when the pointing error exceeds 0.5°

C. Technical Characteristics of the Airborne Antenna Equipment

1. Radome and Radome Attachment Ring

The radome is transparent to the Ku-band radio waves and streamlines the HR6400 Ku-band antenna system by protecting the antenna from the outside environment and minimizing the impact of the system on the flight dynamics on the aircraft. The radome attachment ring provides structural support to the radome by distributing the structural load around the shell of the radome and securing the radome to the aircraft so the externally mounted equipment can withstand the forces applied to the radome and radome attachment ring during flight.

2. HR6400 Ku-band Antenna

The HR6400 FMU Ku-band antenna consists of the following components:

- A mechanically steered antenna array
- Low Noise Amplifier
- Polarization Converter Unit
- Antenna Driver
- Antenna Position Encoders

The antenna is mounted on a positioner with an elevation over azimuth gimbal. The positioner points the gimbaled antenna by controlling the antenna in azimuth, elevation and polarization and using received signal quality to assure that the positioner's reference system aligns with the aircraft inertial navigation system ("INS").

The antenna will not transmit until it receives the appropriate outbound signal from the satellite and it has validated antenna pointing within 0.2°. As noted in High Power Transceiver and Antenna Control Modem Unit, below, the antenna will cease transmission immediately in certain instances to avoid causing interference.

Table 3 – Summary of Technical Parameters - HR6400

Antenna diameter	24.375 in x 6.8 in
Type of Antenna	Horn antenna with lenses
Peak Power (SSPA)	35 watts
Transmit Bandwidth	160 kHz to 5.12 MHz
Transmit Gain	29 dBi
EIRP	44.4 dBW
Transmit Data Rate	Up to 4096 kbps
Transmit Polarization	Horizontal or Vertical
Transmit Max PSD	-16.3 dBW/4kHz
Transmit Beamwidth	1.5 degrees
Receive G/T	12.1 dB
Receive Bandwidth	2050 MHz
Receive Polarization	Vertical or Horizontal (orthogonal to Transmit Polarization)

Table 4 - Antenna Control Parameters

Azimuth	Continuous, 360º
Elevation	-10º to 90º
Position accuracy	0.2º (in-motion)
Dynamic Tracking capability	Heading, pitch, roll vel. 7º/sec Heading, pitch, roll accel. 7º/sec^2

3. High Power Transceiver and Antenna Control Modem Unit

The High Power Transceiver ("HPT") includes a power detector and a power amplifier, as well as an interconnection with the antenna and the ACMU. The ACMU consists of an iDirect modem and its associated interconnections (*i.e.*, D-TDMA modulator and DVB-S2 de-modulator), an interconnection with the on-board Inertial Navigation System, an interconnection with the HPT.

The on-board Inertial Navigation System ("INS") provides information on the aircraft's position, attitude and related factors to the ACMU, and, using the aircraft navigational data, the ACMU controls the antenna's position. Specifically, the ACMU obtains data regarding the latitude, longitude, altitude, roll angle, pitch angle, heading, roll rate, pitch rate, yaw rate, and ground speed from the INS via the ARINC 429 data bus. Then, the iDirect modem selects the serving satellite based on the location of the aircraft and pre-loaded maps, and the ACMU controls the antenna's positioner to the correct azimuth, elevation, and polarization orientation relative to the aircraft position and orientation and points the antenna toward the target satellite. The aircraft latitude and longitude is updated every 200 milliseconds or less, the heading data are updated every 50 milliseconds or less, and the pitch and roll data are updated every 20 milliseconds or less. The ACMU updates the positioner controls continuously to maintain accurate pointing toward the target satellite.

The ACMU controls the antenna pointing accuracy to a pointing error of less than 0.2° between the target satellite and the axis of the antenna's main lobe. The ACMU continuously monitors the pointing error and will mute the antenna transmitter if the pointing error exceeds 0.5°. All emissions automatically cease within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the antenna exceeds 0.5°, and transmission is not resumed until the pointing error is less than 0.2°.

The antenna transmitter also will cease transmissions automatically in the following instances:

- If the ACMU loses communication with the aircraft INS, or
- If the MODEM loses receive signal, or
- If there is a failure of the ACMU itself, or
- If the reference oscillator fails.

The HPT allows accurate power control, and the ACMU ensures compliance with the Power Spectral Density ("PSD") limits in the Commission's Rules. The power detector within the HPT is stable over frequency and temperature and reports the Ku-band transmit power from the Power Amplifier ("PA"). In this way, Astronics AeroSat can maintain accurate power control at the PA output regardless of variations in PA gain over temperature and frequency. The iDirect modem within the ACMU calculates PSD.

The HPT is phase locked to a frequency stability of 10 MHz reference at ±0.01 parts per million, which is how the return link frequency stability is determined. If there is a loss of lock to the reference by either the HPT or the modem, the terminal ceases transmission immediately.

II. Technical Demonstration

A. Operations Under 25.227(a)(2)

Astronics AeroSat is applying for ESAA operating authority under Section 25.227(a)(2) because it proposes to operate its ESAA terminals at off-axis EIRP spectral density levels in excess of those specified in Section 25.227(a)(1). Accordingly, Astronics AeroSat has included satellite operator certifications and other technical information required by Section 25.227(b)(2).

Nonetheless, as described in the following subsection, Astronics AeroSat intends to conduct operations in the United States with the Galaxy 3C satellite consistent with the off-axis EIRP spectral density levels along the geostationary arc specified in Section 25.227(a)(1) (*i.e.*, consistent with two-degree spacing levels).

B. Compliance with Two-Degree Spacing

The off-axis EIRP spectral density of the HR6400 Ku-band terminal will comply with the FCC's two-degree spacing policies when operating with the Galaxy 3C satellite (the only satellite Astronics AeroSat will access from U.S. territory) as set forth in Section 25.227(a)(1) of the FCC Rules at all operational skew angles from 0-55º. The maximum input power into the antenna has been selected to ensure compliance at the maximum skew angle of 55º. Astronics AeroSat provides select co-pol and cross pol antenna gains and spectral density plots from 0-10º and 0-180º off-axis for skew angles from 0º to 55º in Appendix B to this Technical Appendix, *infra*, as well as summary plots below showing compliance at all skew angles.

Figure 3: Co-Pol Off-Axis EIRP Spectral Density (14.25 GHz, 0º Skew)

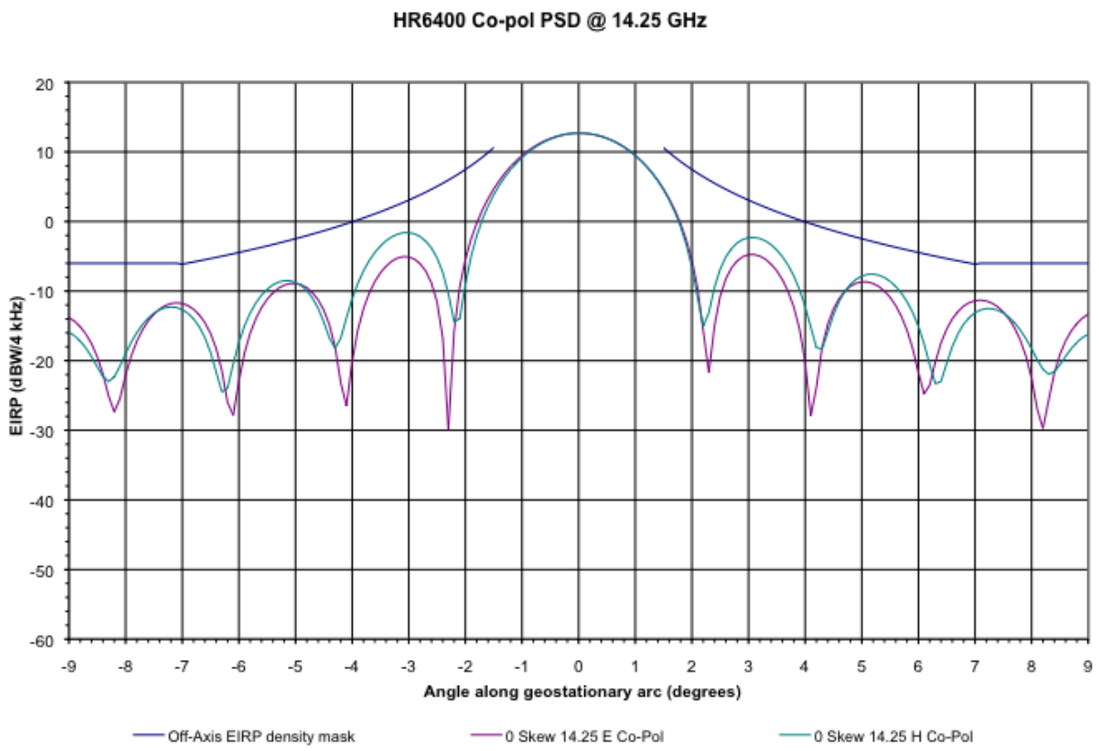


Figure 4: Co-Pol Off-Axis EIRP Spectral Density (14.25 GHz, 55º Skew)

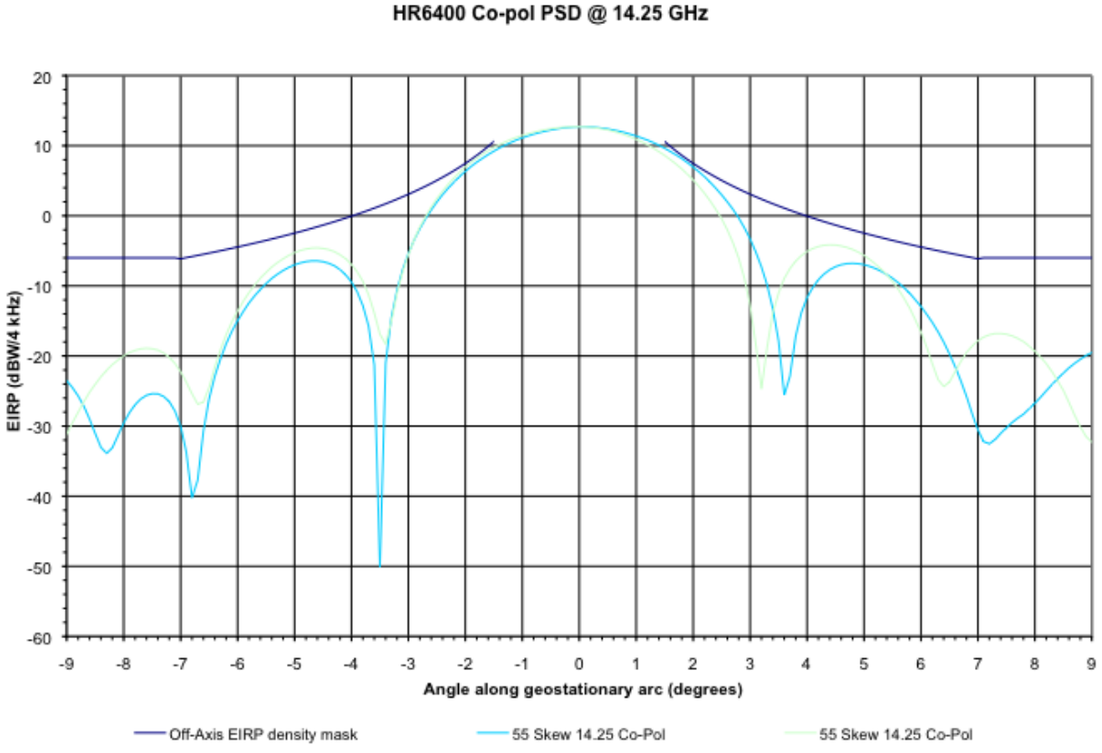


Figure 5: Co-Pol Off-Axis EIRP Spectral Density (14.25 GHz, 0º Skew)

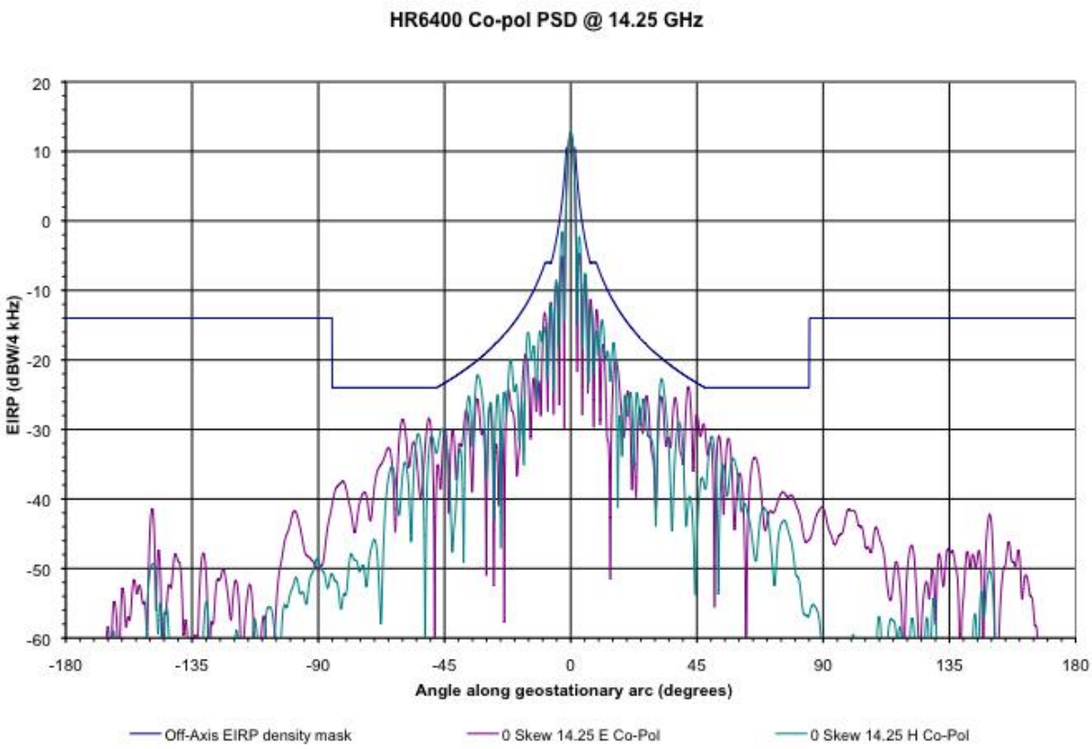


Figure 6: Co-Pol Off-Axis EIRP Spectral Density (14.25 GHz, 55º Skew)

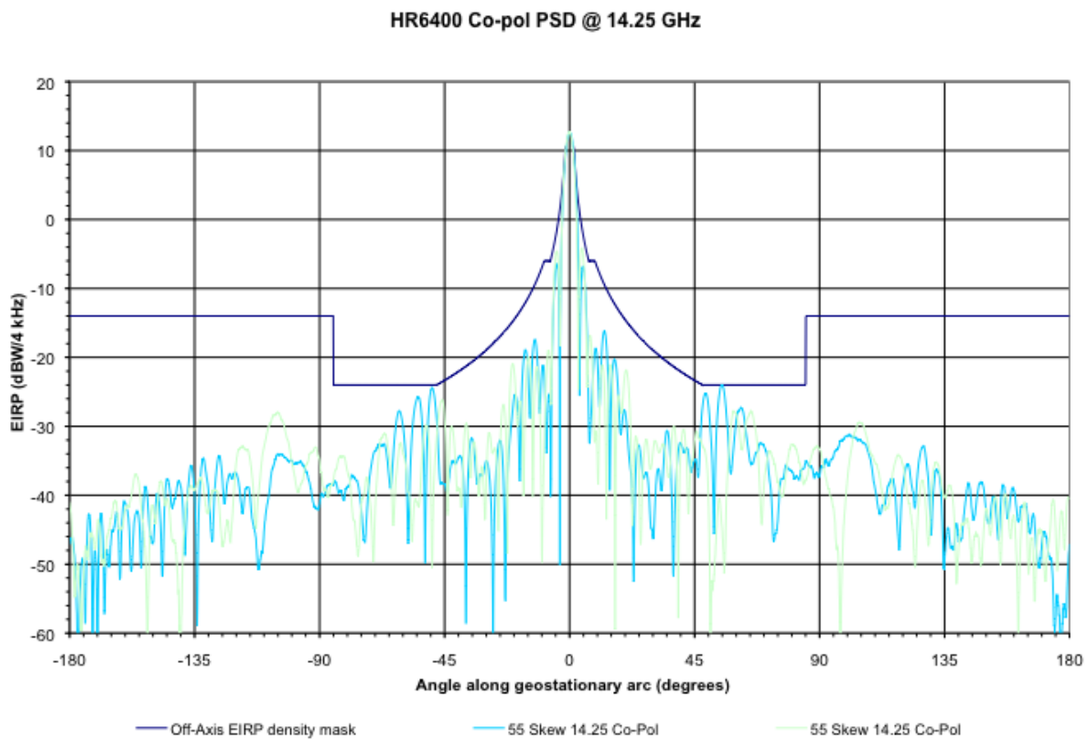


Figure 7: Co-Pol Off-Axis EIRP Spectral Density (14.25 GHz, All Skews)

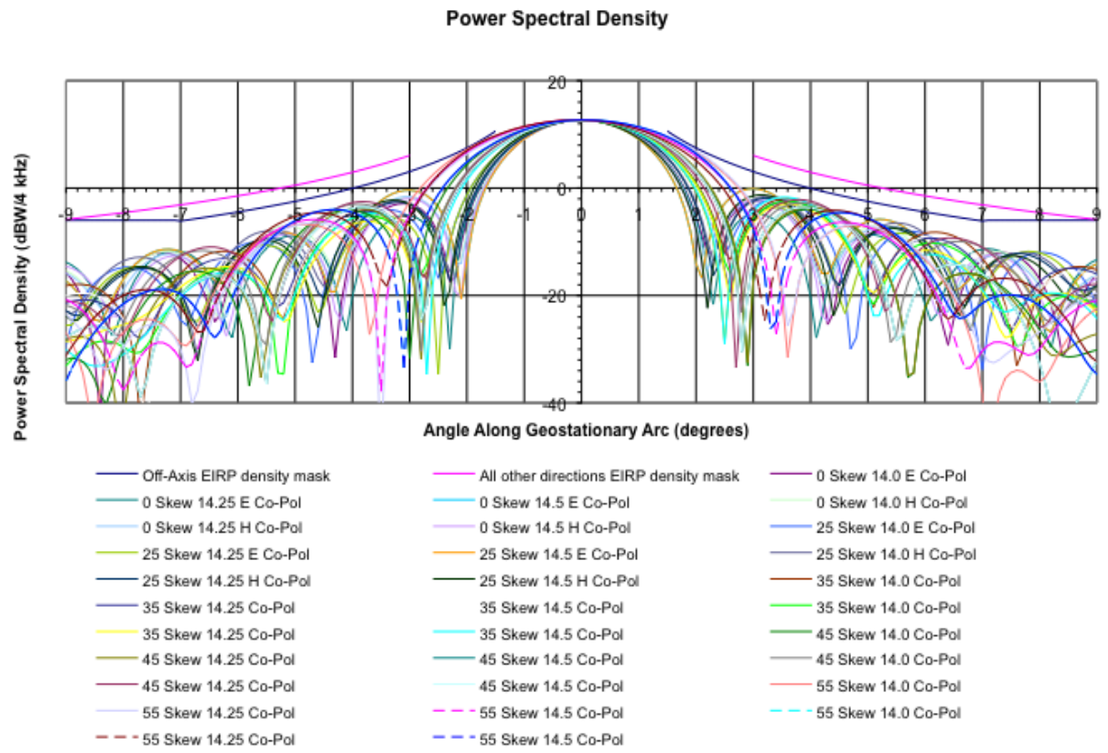


Figure 8: Co-Pol Off-Axis EIRP Spectral Density (14.25 GHz, All Skews)

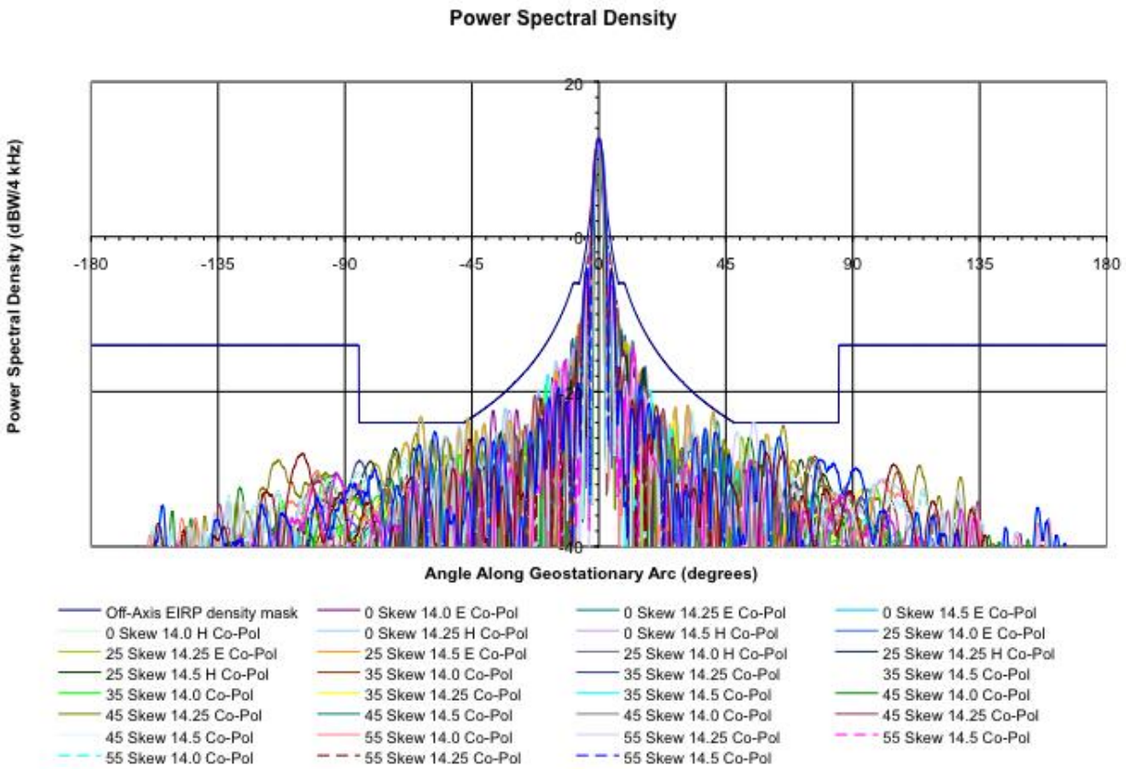


Figure 9: Cross-Pol Off-Axis EIRP Spectral Density (14.25 GHz, 0° Skew)

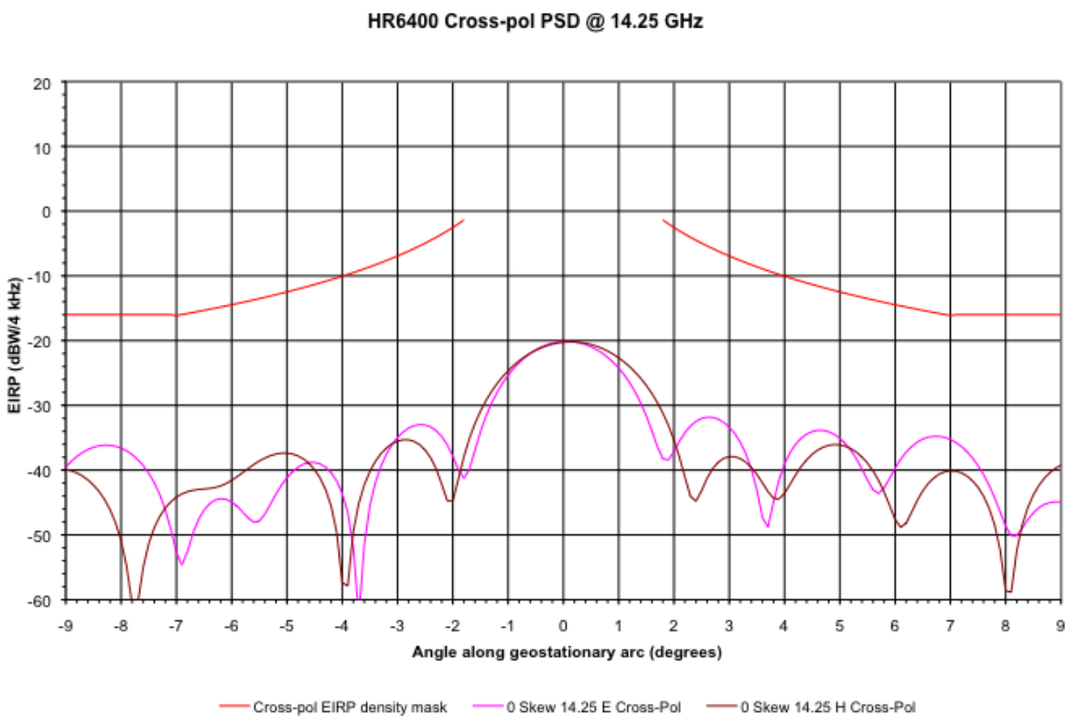


Figure 10: Cross-Pol Off-Axis EIRP Spectral Density (14.25 GHz, 55° Skew)

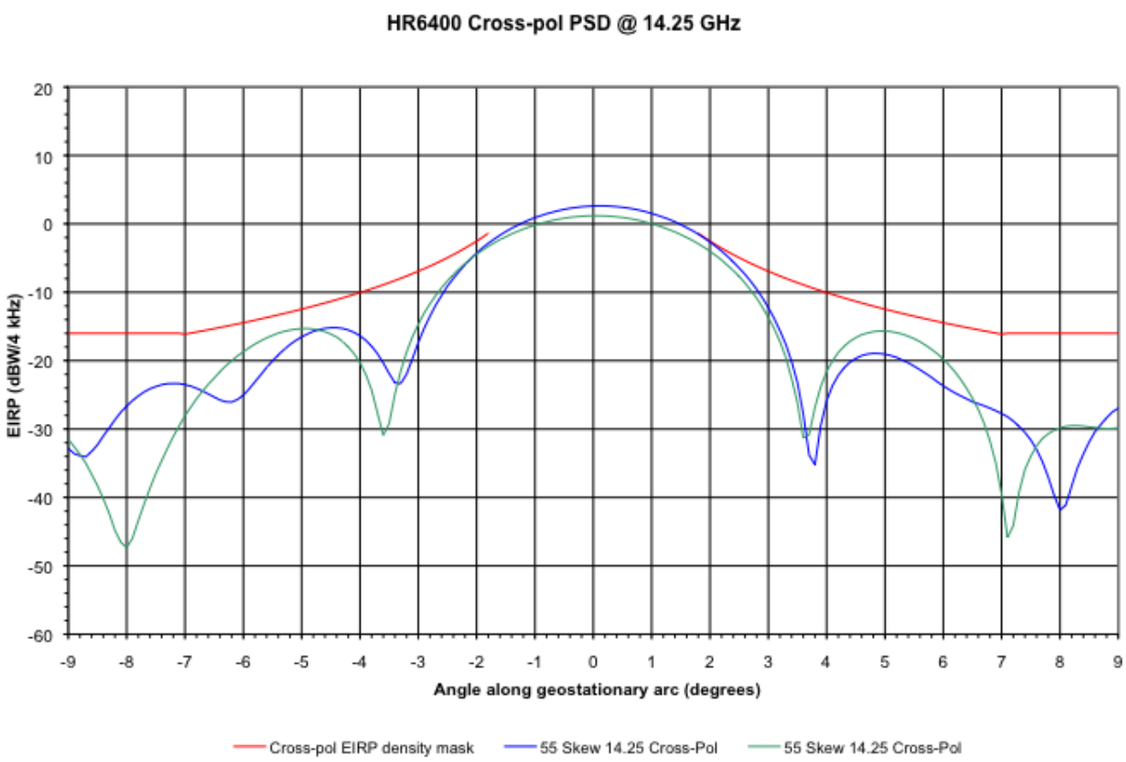
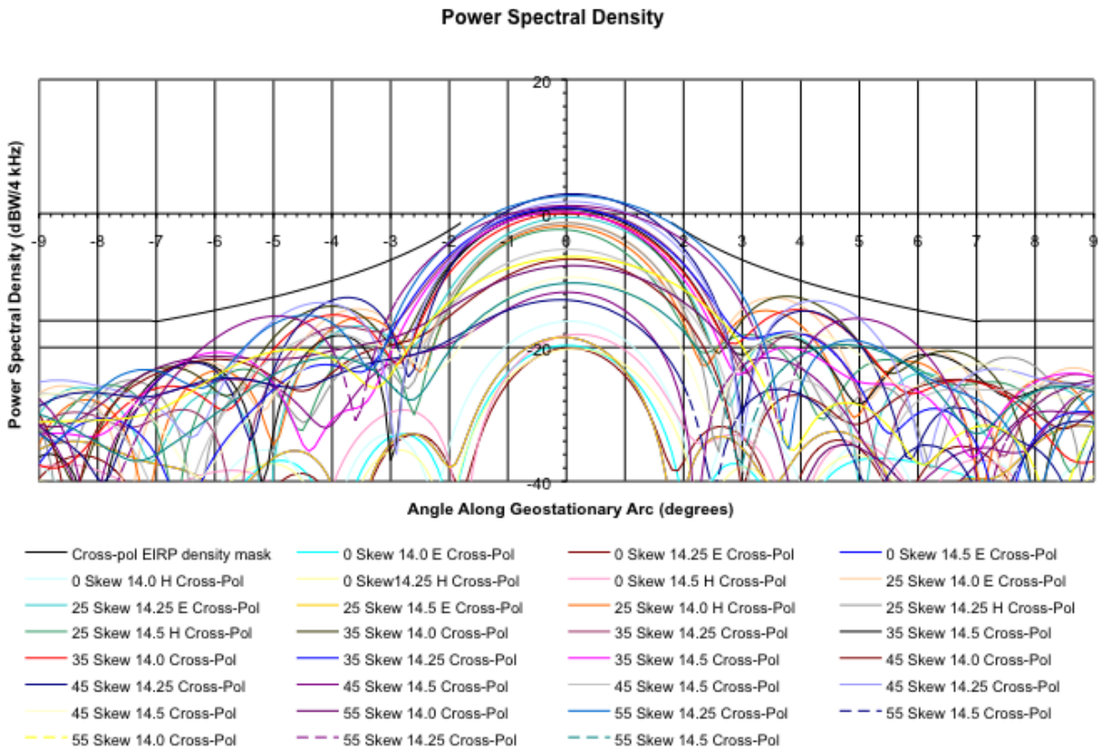


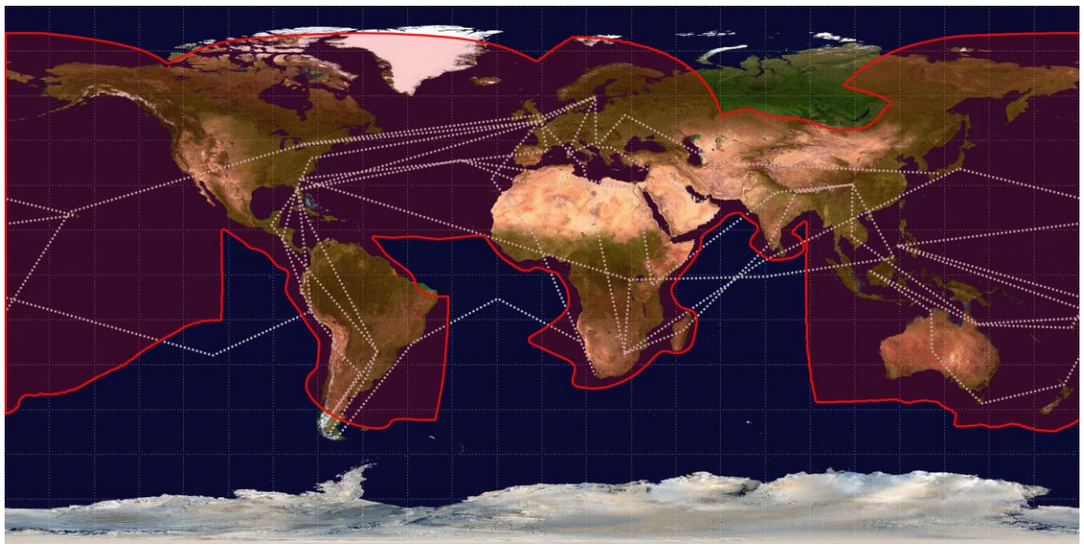
Figure 11: Cross-Pol Off-Axis EIRP Spectral Density (14.25 GHz, All Skews)



III. Geographic Area(s) of the Proposed ESAA Network

The Astronics AeroSat's FliteStream™ system will operate globally with in the service area of the satellites/beams identified herein. The figure below provides the notional coverage over the global network (with example flight city-pair routes). Annex 1 to the Technical Appendix provides detailed service areas for each serving satellite.

Figure 12: Planned Geographic Coverage of ESAA Network



ANNEX A

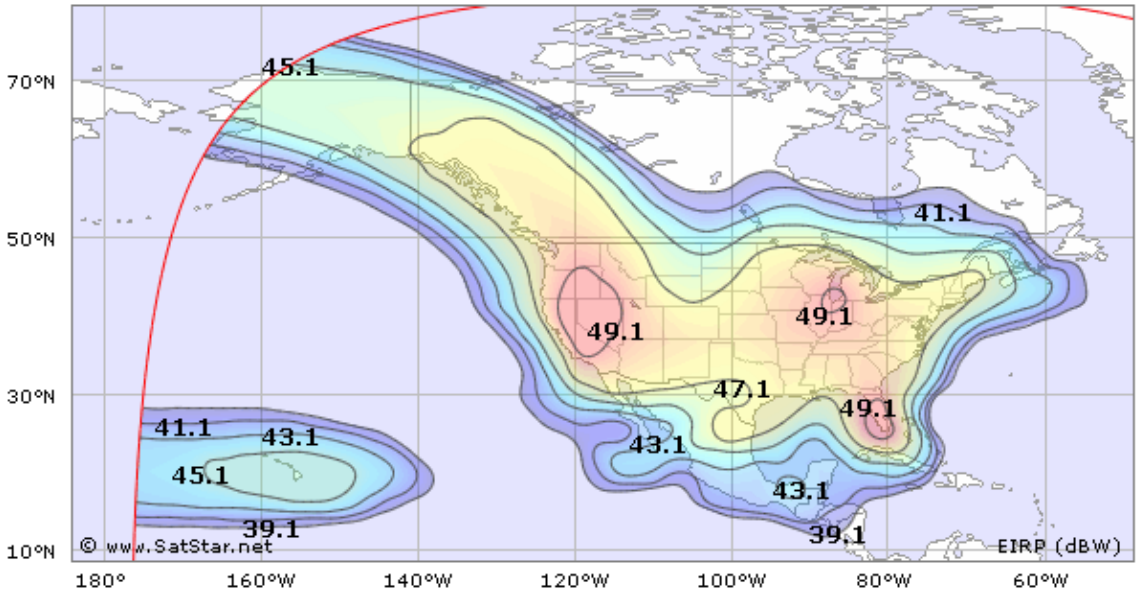
SATELLITE POINTS OF COMMUNICATIONS

TECHNICAL APPENDIX

ANNEX A-1.1: GALAXY 3C

A. Galaxy 3C Coverage Map

Figure 1: Galaxy 3C at North America Beam



B. Galaxy 3C Link Budget

G-3C Link Budget		
Forward Link Budget		
Receive Earth Station		
Site	Kent/U.S.A.	
Antenna Type	Aerosat HR6400	
Lat	47.4	deg
Lon	237.8	deg
G/T	12.2	dB/K
Satellite		
Name	G-3C	
Transponder	11K/11K	
Longitude	265.0	deg
Transmit Earth Station		
Site		
Lat	39.6	deg
Lon	282.3	deg
EIRP max	87.5	dBW
Signal		
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1.00	
Coding Rate	10/27	
Overhead Rate	1.00	
Channel Spacing	1.35	
Spectral Efficiency (Rate/Noise BW)	0.74	bps/Hz
Data Rate	4.22E+06	bps
Information Rate (Data + Overhead)	4.22E+06	bps
Symbol Rate	5.69E+06	Hz
Chip Rate (Noise Bandwidth)	5.69E+06	Hz
Occupied Bandwidth	7.68E+06	Hz
Power Equivelent Bandwidth	8.53E+06	Hz
C/N Threshold	0.2	dB
Uplink		
Frequency	14.230000	GHz
Power Control Mode	None	
Back off	5.0	dB
EIRP Spectral Density	29.4	dBW/4kHz
Slant Range	37710	km
Space Loss, Ls	207.0	dB
Pointing Loss, Lpnt	1.0	dB
Atmosphere / Weather Loss, La	1.0	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	4.3	dB/K
Thermal Noise, C/No	85.6	dBHz
Intra-System Interference, C/Io ISI	97.6	dBHz
Adj. Satellite Interference, C/Io ASI	85.4	dBHz
Cross-Pol Interference, C/Io XP	97.6	dBHz
C/(No+Io)	85.0	dBHz
Satellite		
Flux Density	-88.2	dBW/m2
SFD @ Hub	-102.8	dBW/m2
Small Signal Gain (IBO/OBO)	4.2	dB
OBO	12.0	dB
Downlink		
Frequency	11.930000	GHz
Transponder Sat. EIRP @ Beam Peak	50.1	dBW
Transponder Sat. EIRP @ Terminal	48.7	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	6.6	dBW/4kHz
Carrier EIRP @ Beam Peak	38.1	dBW
Carrier EIRP @ Terminal	36.7	dBW
Space Loss, Ls	205.7	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	85.6	dBHz
Intermod. Interference, C/IMo	87.6	dBHz
Intra-System Interference, C/Io ISI	97.6	dBHz
Adj. Satellite Interference, C/Io ASI	87.6	dBHz
Cross-Pol Interference, C/Io XP	97.6	dBHz
C/(No+Io)	81.8	dBHz
End to End		
End to End C/(No+Io)	80.1	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	3.4	dB
Link Margin	3.2	dB

G-3C Link Budget		
Return Link Budget		
Receive Earth Station		
Site		
Antenna Type	.US-Mountainside Teleport (MTN-K11-G3C)	
Lat	39.6	deg
Lon	282.3	deg
G/T	39.1	dB/K
Satellite		
Name	G-3C	
Transponder	11K/11K	
Longitude	265.0	deg
Transmit Earth Station		
Site	Kent/U.S.A.	
Lat	47.4	deg
Lon	237.8	deg
EIRP max	45.2	dBW
Signal		
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	2.00	
Coding Rate	1/2	
Overhead Rate	1.00	
Channel Spacing	1.35	
Spectral Efficiency (Rate/Noise BW)	0.25	bps/Hz
Data Rate	1.22E+06	bps
Information Rate (Data + Overhead)	1.22E+06	bps
Symbol Rate	2.43E+06	Hz
Chip Rate (Noise Bandwidth)	4.86E+06	Hz
Occupied Bandwidth	6.56E+06	Hz
Power Equivelent Bandwidth	1.14E+05	Hz
C/N Threshold	-1.8	dB
Uplink		
Frequency	14.230000	GHz
Power Control Mode	None	
Back off	1.0	dB
EIRP Spectral Density	15.0	dBW/4kHz
Slant Range	38650	km
Space Loss, Ls	207.3	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	3.4	dB/K
Thermal Noise, C/No	63.8	dBHz
Intra-System Interference, C/Io ISI	93.9	dBHz
Adj. Satellite Interference, C/Io ASI	85.4	dBHz
Cross-Pol Interference, C/Io XP	93.9	dBHz
C/(No+Io)	63.8	dBHz
Satellite		
Flux Density	-88.2	dBW/m2
SFD @ Hub	-120.6	dBW/m2
Small Signal Gain (IBO/OBO)	4.2	dB
OBO	30.8	dB
Downlink		
Frequency	11.930000	GHz
Transponder Sat. EIRP @ Beam Peak	50.1	dBW
Transponder Sat. EIRP @ Terminal	48.0	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-8.5	dBW/4kHz
Carrier EIRP @ Beam Peak	19.3	dBW
Carrier EIRP @ Terminal	17.2	dBW
Space Loss, Ls	205.5	dB
Pointing Loss, Lpnt	1.0	dB
Atmosphere / Weather Loss, La	0.2	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	63.8	dBHz
Intermod. Interference, C/IMo	83.9	dBHz
Intra-System Interference, C/Io ISI	93.9	dBHz
Adj. Satellite Interference, C/Io ASI	83.9	dBHz
Cross-Pol Interference, C/Io XP	93.9	dBHz
C/(No+Io)	63.7	dBHz
End to End		
End to End C/(No+Io)	60.7	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	-0.4	dB
Link Margin	1.4	dB

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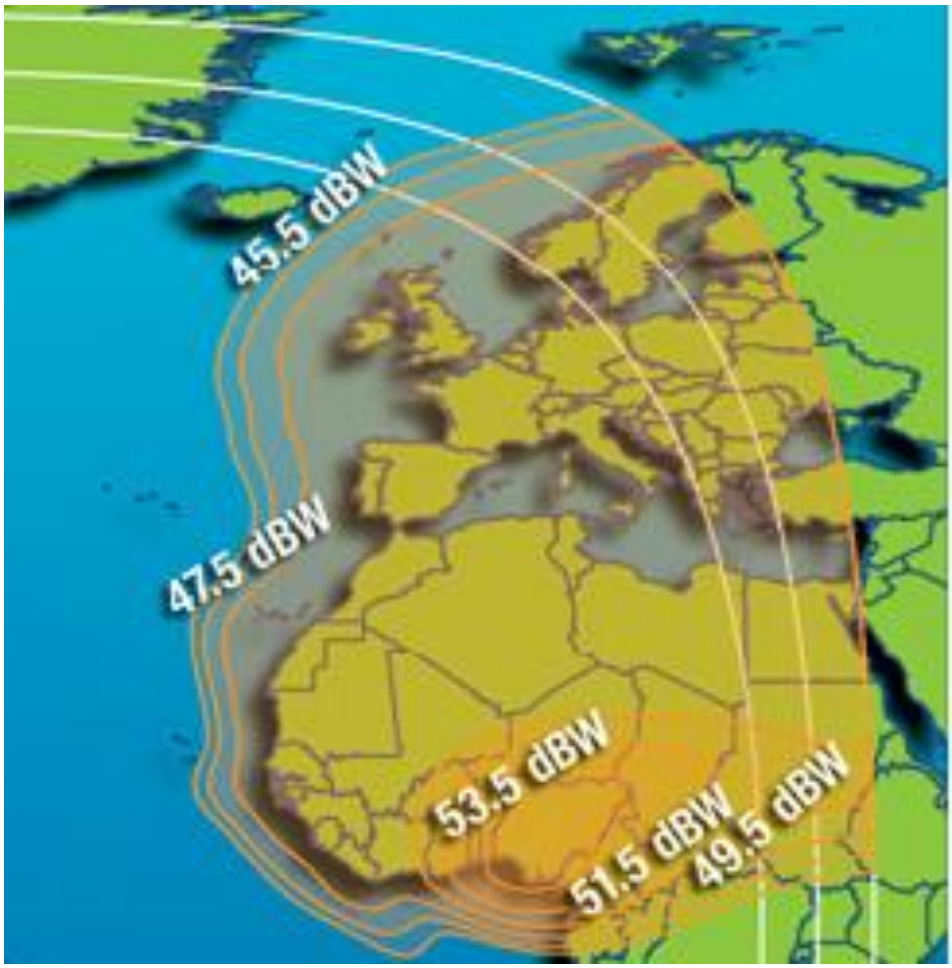
ANNEX A-1.2: IS-14

A. IS-14 Coverage Map



B. IS-14 Link Budget

IS-14 Link Budget		
Forward Link Budget		
Receive Earth Station		
Site	West Africa	
Antenna Type	Aerosat HR6400	
Lat	22.5	deg
Lon	-19.0	deg
G/T	11.9	dB/K
Satellite		
Name	IS-14	
Transponder	UF8K/UF8K	
Longitude	315.0	deg
Transmit Earth Station		
Site	Aberdeen/United Kingdom	
Lat	57.2	deg
Lon	-2.1	deg
EIRP max	70.5	dBW
Signal		
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1.00	
Coding Rate	31/75	
Overhead Rate	1.00	
Channel Spacing	1.35	
Spectral Efficiency (Rate/Noise BW)	0.83	bps/Hz
Data Rate	4.05E+06	bps
Information Rate (Data + Overhead)	4.05E+06	bps
Symbol Rate	4.90E+06	Hz
Chip Rate (Noise Bandwidth)	4.90E+06	Hz
Occupied Bandwidth	6.62E+06	Hz
Power Equivelent Bandwidth	6.72E+06	Hz
C/N Threshold	0.7	dB
Uplink		
Frequency	14.140000	GHz
Power Control Mode	None	
Back off	3.0	dB
EIRP Spectral Density	31.6	dBW/4kHz
Slant Range	40055	km
Space Loss, Ls	207.5	dB
Pointing Loss, Lpnt	0.2	dB
Atmosphere / Weather Loss, La	0.2	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	3.5	dB/K
Thermal Noise, C/No	86.1	dBHz
Intra-System Interference, C/Io ISI	93.9	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	93.9	dBHz
C/(No+Io)	84.9	dBHz
Satellite		
Flux Density	-94.0	dBW/m2
SFD @ Hub	-101.5	dBW/m2
Small Signal Gain (IBO/OBO)	2.1	dB
OBO	11.3	dB
Downlink		
Frequency	11.590000	GHz
Transponder Sat. EIRP @ Beam Peak	54.3	dBW
Transponder Sat. EIRP @ Terminal	47.3	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	12.1	dBW/4kHz
Carrier EIRP @ Beam Peak	43.0	dBW
Carrier EIRP @ Terminal	36.1	dBW
Space Loss, Ls	205.1	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.2	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	86.1	dBHz
Intermod. Interference, C/IMo	96.9	dBHz
Intra-System Interference, C/Io ISI	93.9	dBHz
Adj. Satellite Interference, C/Io ASI	91.9	dBHz
Cross-Pol Interference, C/Io XP	93.9	dBHz
C/(No+Io)	83.9	dBHz
End to End		
End to End C/(No+Io)	81.3	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	3.9	dB
Link Margin	3.2	dB

IS-14 Link Budget		
Return Link Budget		
Receive Earth Station		
Site	Aberdeen/United Kingdom	
Antenna Type	,GB-ABD10H (ABZ-J-3.8-IS-14)	
Lat	57.2	deg
Lon	-2.1	deg
G/T	29.6	dB/K
Satellite		
Name	IS-14	
Transponder	UF8K/UF8K	
Longitude	315.0	deg
Transmit Earth Station		
Site	West Africa	
Lat	22.5	deg
Lon	-19.0	deg
EIRP max	45.1	dBW
Signal		
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	1.00	
Coding Rate	1/2	
Overhead Rate	1.00	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.50	bps/Hz
Data Rate	6.18E+05	bps
Information Rate (Data + Overhead)	6.18E+05	bps
Symbol Rate	1.24E+06	Hz
Chip Rate (Noise Bandwidth)	1.24E+06	Hz
Occupied Bandwidth	1.48E+06	Hz
Power Equivelent Bandwidth	6.58E+04	Hz
C/N Threshold	1.2	dB
Uplink		
Frequency	14.140000	GHz
Power Control Mode	None	
Back off	1.0	dB
EIRP Spectral Density	19.1	dBW/4kHz
Slant Range	37033	km
Space Loss, Ls	206.8	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	0.8	dB/K
Thermal Noise, C/No	66.1	dBHz
Intra-System Interference, C/Io ISI	87.9	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	87.9	dBHz
C/(No+Io)	66.0	dBHz
Satellite		
Flux Density	-94.0	dBW/m2
SFD @ Hub	-118.9	dBW/m2
Small Signal Gain (IBO/OBO)	2.1	dB
OBO	31.4	dB
Downlink		
Frequency	11.590000	GHz
Transponder Sat. EIRP @ Beam Peak	54.3	dBW
Transponder Sat. EIRP @ Terminal	48.7	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-2.0	dBW/4kHz
Carrier EIRP @ Beam Peak	22.9	dBW
Carrier EIRP @ Terminal	17.4	dBW
Space Loss, Ls	205.8	dB
Pointing Loss, Lpnt	0.2	dB
Atmosphere / Weather Loss, La	0.6	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	66.1	dBHz
Intermod. Interference, C/IMo	90.9	dBHz
Intra-System Interference, C/Io ISI	87.9	dBHz
Adj. Satellite Interference, C/Io ASI	85.9	dBHz
Cross-Pol Interference, C/Io XP	87.9	dBHz
C/(No+Io)	65.9	dBHz
End to End		
End to End C/(No+Io)	63.0	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	3.4	dB
Link Margin	2.2	dB

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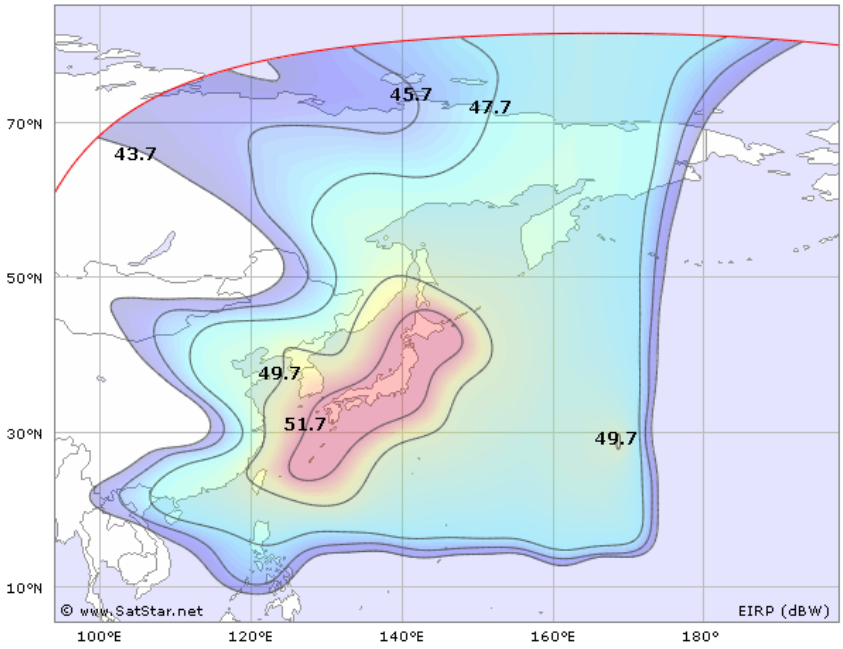
ANNEX A-1.3: IS-19

A. IS-19 Coverage Maps

Figure 1: IS-19 at North West Pacific Beam



B. IS-19 Link Budget

IS-19 Link Budget		
Forward Link Budget		
Receive Earth Station		
Site	Japan	
Antenna Type	Aerosat HR6400	
Lat	53.4	deg
Lon	142.4	deg
G/T	12.5	dB/K
Satellite		
Name	IS-19	
Transponder	NWPK26	
Longitude	166.0	deg
Transmit Earth Station		
Site	Napa/U.S.A.	
Lat	38.3	deg
Lon	-122.3	deg
EIRP max	96.4	dBW
Signal		
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1.00	
Coding Rate	10/27	
Overhead Rate	1.00	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.74	bps/Hz
Data Rate	2.89E+06	bps
Information Rate (Data + Overhead)	2.89E+06	bps
Symbol Rate	3.90E+06	Hz
Chip Rate (Noise Bandwidth)	3.90E+06	Hz
Occupied Bandwidth	4.68E+06	Hz
Power Equivelent Bandwidth	9.31E+06	Hz
C/N Threshold	0.2	dB
Uplink		
Frequency	14.154000	GHz
Power Control Mode	None	
Back off	4.0	dB
EIRP Spectral Density	36.2	dBW/4kHz
Slant Range	41057	km
Space Loss, Ls	207.7	dB
Pointing Loss, Lpnt	0.5	dB
Atmosphere / Weather Loss, La	0.5	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	-2.0	dB/K
Thermal Noise, C/No	83.5	dBHz
Intra-System Interference, C/Io ISI	92.9	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	92.9	dBHz
C/(No+Io)	82.6	dBHz
Satellite		
Flux Density	-91.7	dBW/m2
SFD @ Hub	-98.6	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	9.7	dB
Downlink		
Frequency	12.406000	GHz
Transponder Sat. EIRP @ Beam Peak	52.7	dBW
Transponder Sat. EIRP @ Terminal	49.0	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	13.1	dBW/4kHz
Carrier EIRP @ Beam Peak	43.0	dBW
Carrier EIRP @ Terminal	39.3	dBW
Space Loss, Ls	206.1	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.4	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	83.5	dBHz
Intermod. Interference, C/IMo	95.9	dBHz
Intra-System Interference, C/Io ISI	92.9	dBHz
Adj. Satellite Interference, C/Io ASI	90.9	dBHz
Cross-Pol Interference, C/Io XP	92.9	dBHz
C/(No+Io)	81.8	dBHz
End to End		
End to End C/(No+Io)	79.2	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	7.2	dB
Link Margin	7.0	dB

IS-19 Link Budget		
Return Link Budget		
Receive Earth Station		
Site	Napa/U.S.A.	
Antenna Type	,US-Napa IntelsatTeleport IS-19 Ku	
Lat	38.3	deg
Lon	-122.3	deg
G/T	41.0	dB/K
Satellite		
Name	IS-19	
Transponder	NWPK26	
Longitude	166.0	deg
Transmit Earth Station		
Site	Japan	
Lat	53.4	deg
Lon	142.4	deg
EIRP max	45.1	dBW
Signal		
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	4.00	
Coding Rate	1/2	
Overhead Rate	1.00	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.13	bps/Hz
Data Rate	6.18E+05	bps
Information Rate (Data + Overhead)	6.18E+05	bps
Symbol Rate	1.24E+06	Hz
Chip Rate (Noise Bandwidth)	4.94E+06	Hz
Occupied Bandwidth	5.93E+06	Hz
Power Equivelent Bandwidth	8.50E+04	Hz
C/N Threshold	-4.8	dB
Uplink		
Frequency	14.154000	GHz
Power Control Mode	None	
Back off	1.0	dB
EIRP Spectral Density	18.0	dBW/4kHz
Slant Range	39035	km
Space Loss, Ls	207.3	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	-0.4	dB/K
Thermal Noise, C/No	57.0	dBHz
Intra-System Interference, C/Io ISI	87.9	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	87.9	dBHz
C/(No+Io)	57.0	dBHz
Satellite		
Flux Density	-91.7	dBW/m2
SFD @ Hub	-120.7	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	30.1	dB
Downlink		
Frequency	12.406000	GHz
Transponder Sat. EIRP @ Beam Peak	52.7	dBW
Transponder Sat. EIRP @ Terminal	47.6	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-2.3	dBW/4kHz
Carrier EIRP @ Beam Peak	22.6	dBW
Carrier EIRP @ Terminal	17.6	dBW
Space Loss, Ls	206.6	dB
Pointing Loss, Lpnt	0.5	dB
Atmosphere / Weather Loss, La	0.8	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	57.0	dBHz
Intermod. Interference, C/IMo	90.9	dBHz
Intra-System Interference, C/Io ISI	87.9	dBHz
Adj. Satellite Interference, C/Io ASI	85.9	dBHz
Cross-Pol Interference, C/Io XP	87.9	dBHz
C/(No+Io)	57.0	dBHz
End to End		
End to End C/(No+Io)	54.0	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	-4.0	dB
Link Margin	0.8	dB

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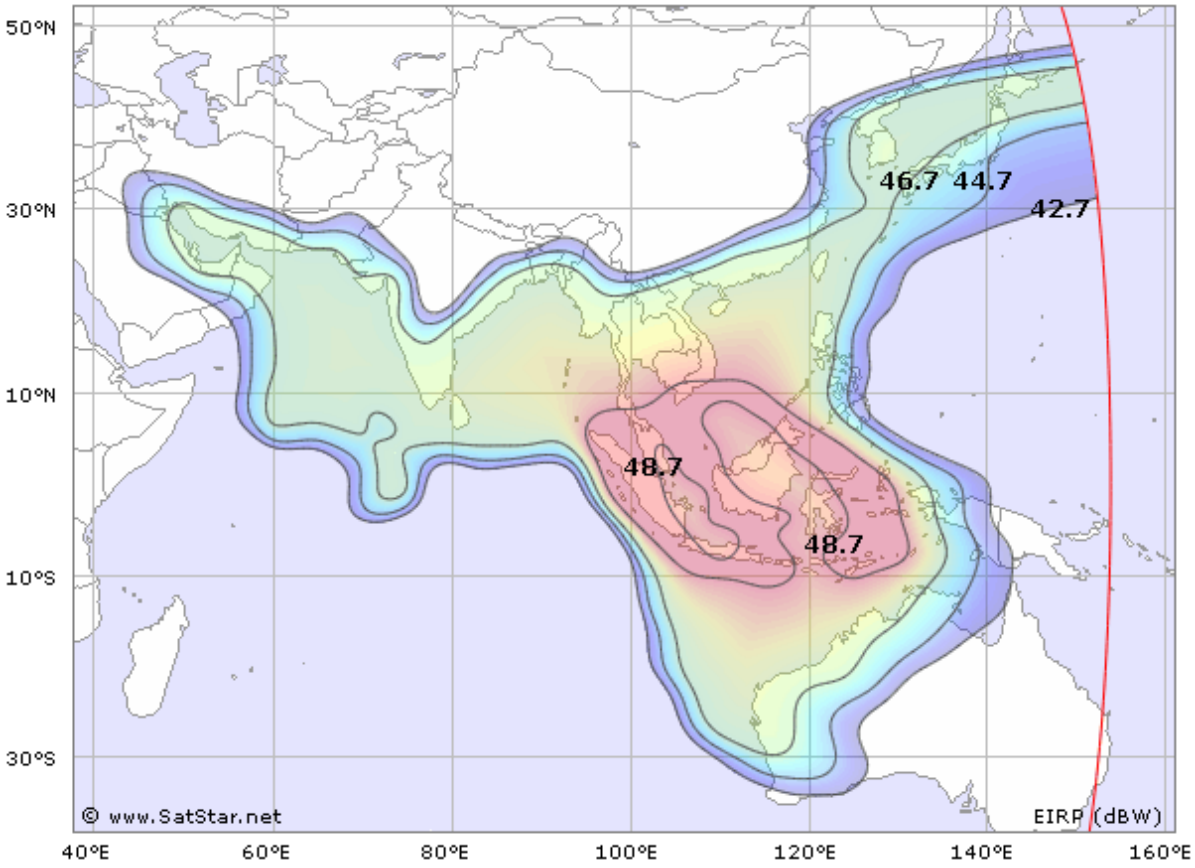
ANNEX A-1.3: IS-22

A. IS-22 Coverage Maps

Figure 1: IS-22 at Mobility Beam



B. IS-22 Link Budget

IS-22 Link Budget		
Forward Link Budget		
Receive Earth Station		
Site	Malaysia	
Antenna Type	Aerosat HR6400	
Lat	-1.0	deg
Lon	104.0	deg
G/T	12.4	dB/K
Satellite		
Name	IS-22	
Transponder	31K	
Longitude	72.0	deg
Transmit Earth Station		
Site	Korea	
Lat	37.8	deg
Lon	127.8	deg
EIRP max	83.8	dBW
Signal		
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1.00	
Coding Rate	10/27	
Overhead Rate	1.00	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.74	bps/Hz
Data Rate	2.83E+06	bps
Information Rate (Data + Overhead)	2.83E+06	bps
Symbol Rate	3.82E+06	Hz
Chip Rate (Noise Bandwidth)	3.82E+06	Hz
Occupied Bandwidth	4.59E+06	Hz
Power Equivelent Bandwidth	7.34E+06	Hz
C/N Threshold	0.2	dB
Uplink		
Frequency	14.295000	GHz
Power Control Mode	None	
Back off	4.0	dB
EIRP Spectral Density	32.0	dBW/4kHz
Slant Range	39739	km
Space Loss, Ls	207.5	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	0.4	dB/K
Thermal Noise, C/No	82.3	dBHz
Intra-System Interference, C/Io ISI	92.8	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	92.8	dBHz
C/(No+Io)	81.6	dBHz
Satellite		
Flux Density	-90.7	dBW/m2
SFD @ Hub	-102.1	dBW/m2
Small Signal Gain (IBO/OBO)	1.7	dB
OBO	13.7	dB
Downlink		
Frequency	12.295000	GHz
Transponder Sat. EIRP @ Beam Peak	49.6	dBW
Transponder Sat. EIRP @ Terminal	48.5	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	6.1	dBW/4kHz
Carrier EIRP @ Beam Peak	35.9	dBW
Carrier EIRP @ Terminal	34.8	dBW
Space Loss, Ls	205.6	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.2	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	82.3	dBHz
Intermod. Interference, C/IMo	95.8	dBHz
Intra-System Interference, C/Io ISI	92.8	dBHz
Adj. Satellite Interference, C/Io ASI	90.8	dBHz
Cross-Pol Interference, C/Io XP	92.8	dBHz
C/(No+Io)	81.0	dBHz
End to End		
End to End C/(No+Io)	78.3	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	3.6	dB
Link Margin	3.4	dB

IS-22 Link Budget		
Return Link Budget		
Receive Earth Station		
Site	Korea	
Antenna Type	Intelsat Korea Teleport	
Lat	37.8	deg
Lon	127.8	deg
G/T	38.6	dB/K
Satellite		
Name	IS-22	
Transponder	31K	
Longitude	72.0	deg
Transmit Earth Station		
Site	Malaysia	
Lat	-1.0	deg
Lon	104.0	deg
EIRP max	45.2	dBW
Signal		
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	4.00	
Coding Rate	1/2	
Overhead Rate	1.00	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.13	bps/Hz
Data Rate	1.22E+06	bps
Information Rate (Data + Overhead)	1.22E+06	bps
Symbol Rate	2.43E+06	Hz
Chip Rate (Noise Bandwidth)	9.72E+06	Hz
Occupied Bandwidth	1.17E+07	Hz
Power Equivelent Bandwidth	3.40E+05	Hz
C/N Threshold	-4.8	dB
Uplink		
Frequency	14.295000	GHz
Power Control Mode	None	
Back off	1.0	dB
EIRP Spectral Density	16.0	dBW/4kHz
Slant Range	36909	km
Space Loss, Ls	206.9	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	3.9	dB/K
Thermal Noise, C/No	63.0	dBHz
Intra-System Interference, C/Io ISI	90.9	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	90.9	dBHz
C/(No+Io)	62.9	dBHz
Satellite		
Flux Density	-90.7	dBW/m2
SFD @ Hub	-119.0	dBW/m2
Small Signal Gain (IBO/OBO)	1.7	dB
OBO	27.1	dB
Downlink		
Frequency	12.295000	GHz
Transponder Sat. EIRP @ Beam Peak	49.6	dBW
Transponder Sat. EIRP @ Terminal	47.9	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-5.3	dBW/4kHz
Carrier EIRP @ Beam Peak	22.5	dBW
Carrier EIRP @ Terminal	20.8	dBW
Space Loss, Ls	206.2	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.5	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	63.0	dBHz
Intermod. Interference, C/IMo	93.9	dBHz
Intra-System Interference, C/Io ISI	90.9	dBHz
Adj. Satellite Interference, C/Io ASI	88.9	dBHz
Cross-Pol Interference, C/Io XP	90.9	dBHz
C/(No+Io)	62.9	dBHz
End to End		
End to End C/(No+Io)	59.9	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	-1.2	dB
Link Margin	3.7	dB

INTELSAT
Envision. Connect. Transform.

28 August 2014

Federal Communications Commission
International Bureau
445 12th Street, S.W.
Washington, D.C. 20554

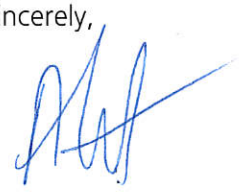
Re: Engineering Certification of Intelsat

To Whom It May Concern:

This letter certifies that Intelsat is aware that Astronics AeroSat Corporation ("Astronics AeroSat") is planning to seek authorization from the Federal Communications Commission ("FCC") to operate Ku-band transmit/receive earth stations aboard aircraft ("ESAA") terminals with the IS-19 at 166°E, G3C at 95°W, IS-14 at 45°W and IS-22 at 72°E. Specifically, we understand that Astronics AeroSat seeks to operate the HR6400 Ku-band antenna system for development and demonstration purposes consistent with the FCC's experimental licensing rules, and for commercial purposes consistent with the FCC's ESAA rules including Section 25.227.

Based on the information provided by Astronics AeroSat, Intelsat understands the technical characteristics of the HR6400 terminal, and Intelsat (i) recognizes that operation of the HR6400 terminals at the power density levels provided to Intelsat is consistent with existing coordination agreements with all adjacent satellite operators within +/- 6 degrees of orbital separation from IS-19 at 166°E, G3C at 95°W, IS-14 at 45°W and IS-22 at 72°E; (ii) acknowledges that the proposed operation of the HR6400 terminal has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable; and (iii) if the FCC authorizes the operations proposed by Astronics AeroSat, Intelsat will take into consideration the power density levels associated such operations in all future satellite network coordinations with adjacent satellite operators.

Sincerely,



Alan Yates,
Senior Technical Advisor,
Spectrum Strategy.

Intelsat Corporation
7900 Tysons One Place, McLean, VA 22102-5972 USA **www.intelsat.com** T +1 703-559-6800

TECHNICAL APPENDIX

ANNEX A-2.1: TELSTAR 11N

A. Telstar 11N Coverage Maps

Figure 1: Telstar 11N at Europe Beam

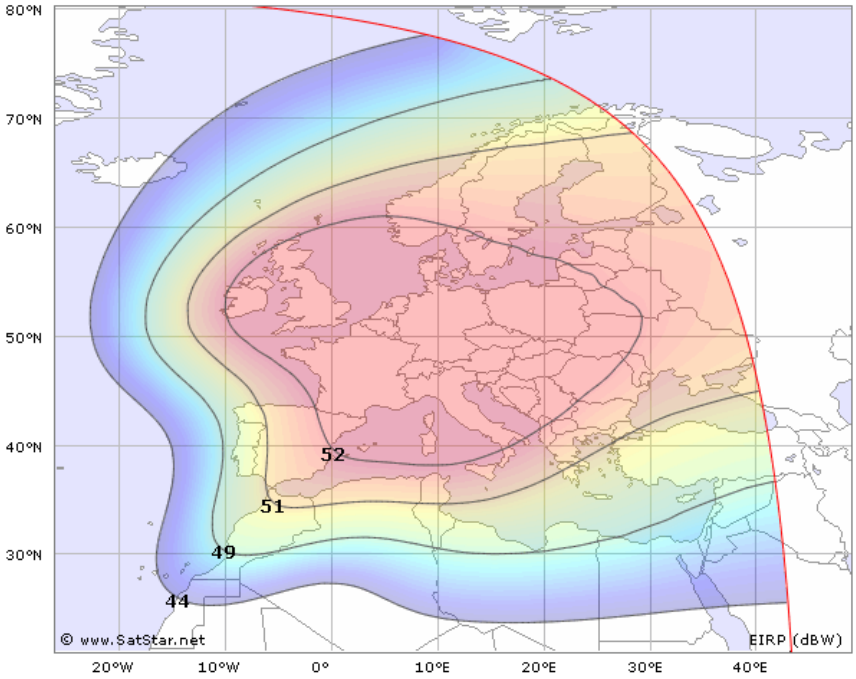
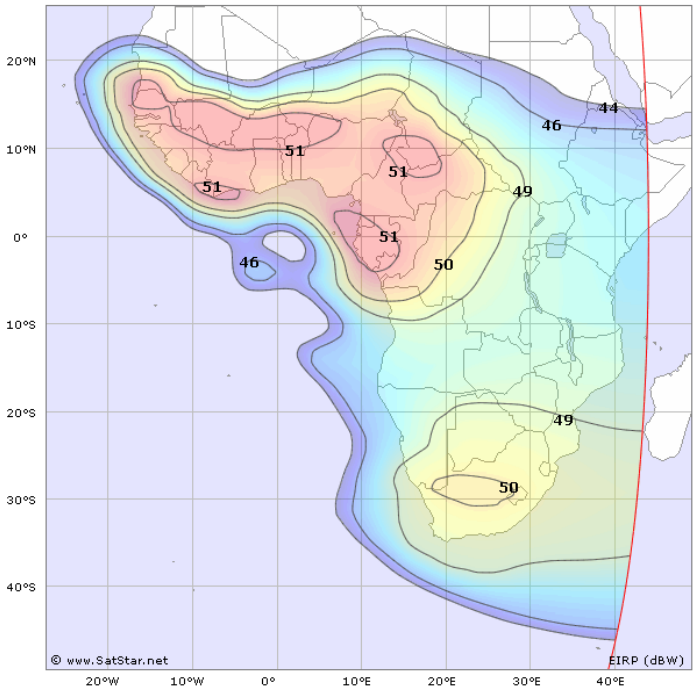


Figure 2: Telstar 11-N at Sub-Saharan Africa Beam



B. Telstar 11N Link Budgets

Telstar 11N Link Budget		
Forward Link Budget		
Receive Earth Station		
Site	South Africa	
Antenna Type	Aerosat HR6400	
Lat	-16.0	deg
Lon	27.0	deg
G/T	11.5	dB/K
Satellite		
Name	Telstar 11N	
Transponder	K05-EUV/AFH	
Longitude	322.5	deg
Transmit Earth Station		
Site	Aberdeen/UK	
Lat	57.0	deg
Lon	-2.0	deg
EIRP max	85.6	dBW
Signal		
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1.00	
Coding Rate	31/75	
Overhead Rate	1.00	
Channel Spacing	1.35	
Spectral Efficiency (Rate/Noise BW)	0.83	bps/Hz
Data Rate	4.05E+06	bps
Information Rate (Data + Overhead)	4.05E+06	bps
Symbol Rate	4.90E+06	Hz
Chip Rate (Noise Bandwidth)	4.90E+06	Hz
Occupied Bandwidth	6.62E+06	Hz
Power Equivelent Bandwidth	1.23E+07	Hz
C/N Threshold	0.7	dB
Uplink		
Frequency	14.401000	GHz
Power Control Mode	None	
Back off	4.0	dB
EIRP Spectral Density	29.4	dBW/4kHz
Slant Range	39740	km
Space Loss, Ls	207.6	dB
Pointing Loss, Lpnt	0.5	dB
Atmosphere / Weather Loss, La	0.5	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	8.0	dB/K
Thermal Noise, C/No	88.2	dBHz
Intra-System Interference, C/Io ISI	93.9	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	93.9	dBHz
C/(No+Io)	86.3	dBHz
Satellite		
Flux Density	-93.5	dBW/m2
SFD @ Hub	-103.9	dBW/m2
Small Signal Gain (IBO/OBO)	1.8	dB
OBO	9.6	dB
Downlink		
Frequency	11.101000	GHz
Transponder Sat. EIRP @ Beam Peak	51.9	dBW
Transponder Sat. EIRP @ Terminal	48.8	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	11.4	dBW/4kHz
Carrier EIRP @ Beam Peak	42.3	dBW
Carrier EIRP @ Terminal	39.2	dBW
Space Loss, Ls	205.4	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.5	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	88.2	dBHz
Intermod. Interference, C/IMo	96.9	dBHz
Intra-System Interference, C/Io ISI	93.9	dBHz
Adj. Satellite Interference, C/Io ASI	91.9	dBHz
Cross-Pol Interference, C/Io XP	93.9	dBHz
C/(No+Io)	85.0	dBHz
End to End		
End to End C/(No+Io)	82.6	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	6.0	dB
Link Margin	5.4	dB

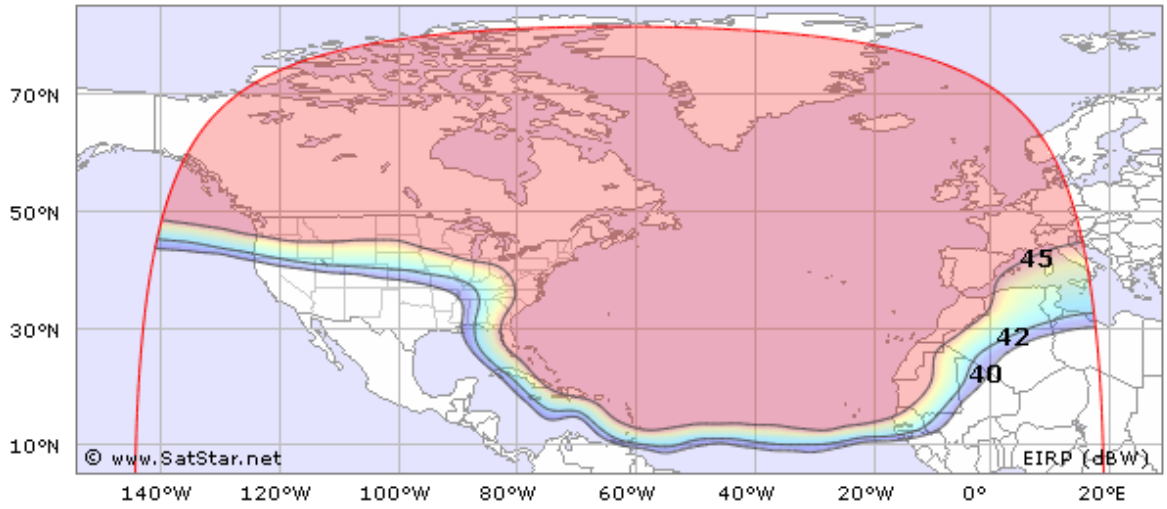
Telstar 11N Link Budget		
Return Link Budget		
Receive Earth Station		
Site	Aberdeen/UK	
Antenna Type	,GB-ABSV (T-11N KU)	
Lat	57.0	deg
Lon	-2.0	deg
G/T	34.3	dB/K
Satellite		
Name	Telstar 11N	
Transponder	K03-AFV/EUH	
Longitude	322.5	deg
Transmit Earth Station		
Site	South Africa	
Lat	-16.0	deg
Lon	27.0	deg
EIRP max	45.2	dBW
Signal		
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	4.00	
Coding Rate	1/2	
Overhead Rate	1.00	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.13	bps/Hz
Data Rate	6.18E+05	bps
Information Rate (Data + Overhead)	6.18E+05	bps
Symbol Rate	1.24E+06	Hz
Chip Rate (Noise Bandwidth)	4.94E+06	Hz
Occupied Bandwidth	5.93E+06	Hz
Power Equivelent Bandwidth	1.15E+05	Hz
C/N Threshold	-4.8	dB
Uplink		
Frequency	14.340000	GHz
Power Control Mode	None	
Back off	1.0	dB
EIRP Spectral Density	19.1	dBW/4kHz
Slant Range	39947	km
Space Loss, Ls	207.6	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	2.1	dB/K
Thermal Noise, C/No	60.0	dBHz
Intra-System Interference, C/Io ISI	87.9	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	87.9	dBHz
C/(No+Io)	60.0	dBHz
Satellite		
Flux Density	-93.0	dBW/m2
SFD @ Hub	-120.1	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	29.7	dB
Downlink		
Frequency	11.040000	GHz
Transponder Sat. EIRP @ Beam Peak	52.6	dBW
Transponder Sat. EIRP @ Terminal	52.2	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-2.0	dBW/4kHz
Carrier EIRP @ Beam Peak	22.9	dBW
Carrier EIRP @ Terminal	22.5	dBW
Space Loss, Ls	205.3	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	0.5	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	60.0	dBHz
Intermod. Interference, C/IMo	90.9	dBHz
Intra-System Interference, C/Io ISI	87.9	dBHz
Adj. Satellite Interference, C/Io ASI	85.9	dBHz
Cross-Pol Interference, C/Io XP	87.9	dBHz
C/(No+Io)	60.0	dBHz
End to End		
End to End C/(No+Io)	57.0	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	-1.1	dB
Link Margin	3.8	dB

TECHNICAL APPENDIX

ANNEX A-2.2: TELSTAR-14R

A. Telstar-14R Coverage Map

Figure 1: Telstar-14R at North Atlantic Ocean Region Beam



B. Telstar-14R Link Budget

Telstar 14R	Link Budget	
Forward Link Budget		
Receive Earth Station		
Site	Atlantic Ocean	
Antenna Type	Aerosat HR6400	
Lat	55.0	deg
Lon	-60.0	deg
G/T	12.0	dB/K
Satellite		
Name	Telstar 14R	
Transponder	K46-USV/AOH	
Longitude	297.0	deg
Transmit Earth Station		
Site	Melbourne Beach/U.S.A.	
Lat	28.1	deg
Lon	279.4	deg
EIRP max	75.5	dBW
Signal		
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1.00	
Coding Rate	10/27	
Overhead Rate	1.00	
Channel Spacing	1.30	
Spectral Efficiency (Rate/Noise BW)	0.74	bps/Hz
Data Rate	3.70E+06	bps
Information Rate (Data + Overhead)	3.70E+06	bps
Symbol Rate	5.00E+06	Hz
Chip Rate (Noise Bandwidth)	5.00E+06	Hz
Occupied Bandwidth	6.50E+06	Hz
Power Equivelent Bandwidth	9.24E+06	Hz
C/N Threshold	0.2	dB
Uplink		
Frequency	13.974000	GHz
Power Control Mode	AUPC	
Back off	0.0	dB
EIRP Spectral Density	28.3	dBW/4kHz
Slant Range	36957	km
Space Loss, Ls	206.7	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	2.3	dB/K
Thermal Noise, C/No	83.2	dBHz
Intra-System Interference, C/Io ISI	94.0	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	94.0	dBHz
C/(No+Io)	82.6	dBHz
Satellite		
Flux Density	-95.0	dBW/m2
SFD @ Hub	-103.3	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	8.9	dB
Downlink		
Frequency	11.674000	GHz
Transponder Sat. EIRP @ Beam Peak	48.4	dBW
Transponder Sat. EIRP @ Terminal	44.5	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	8.5	dBW/4kHz
Carrier EIRP @ Beam Peak	39.5	dBW
Carrier EIRP @ Terminal	35.6	dBW
Space Loss, Ls	205.6	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	83.2	dBHz
Intermod. Interference, C/IMo	97.0	dBHz
Intra-System Interference, C/Io ISI	94.0	dBHz
Adj. Satellite Interference, C/Io ASI	92.0	dBHz
Cross-Pol Interference, C/Io XP	94.0	dBHz
C/(No+Io)	81.9	dBHz
End to End		
End to End C/(No+Io)	79.2	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	2.8	dB
Link Margin	2.6	dB

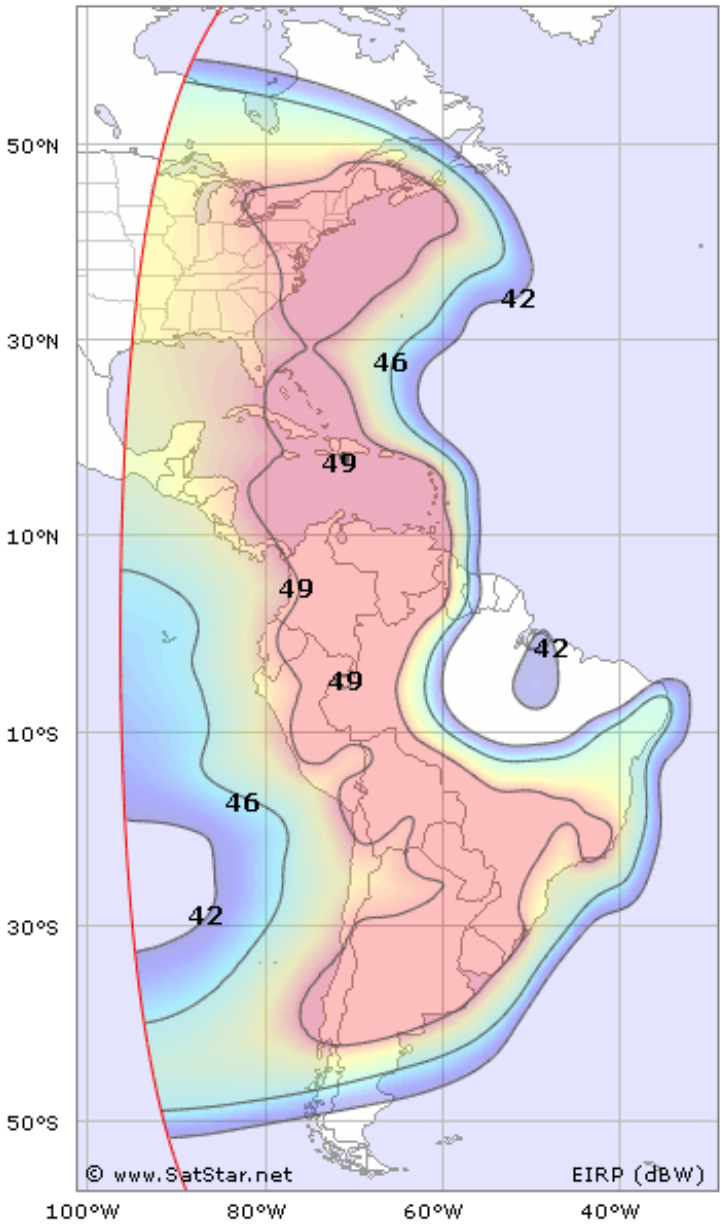
Telstar 14R	Link Budget	
Return Link Budget		
Receive Earth Station		
Site	Melbourne Beach/U.S.A.	
Antenna Type	,US-Melbourne Teleport SES1/G-25	
Lat	28.1	deg
Lon	279.4	deg
G/T	34.8	dB/K
Satellite		
Name	Telstar 14R	
Transponder	K31L-AOV/USH	
Longitude	297.0	deg
Transmit Earth Station		
Site	Atlantic Ocean	
Lat	55.0	deg
Lon	-60.0	deg
EIRP max	45.0	dBW
Signal		
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	1.00	
Coding Rate	1/2	
Overhead Rate	1.00	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.50	bps/Hz
Data Rate	4.65E+05	bps
Information Rate (Data + Overhead)	4.65E+05	bps
Symbol Rate	9.30E+05	Hz
Chip Rate (Noise Bandwidth)	9.30E+05	Hz
Occupied Bandwidth	1.12E+06	Hz
Power Equivelent Bandwidth	2.37E+05	Hz
C/N Threshold	1.2	dB
Uplink		
Frequency	14.020000	GHz
Power Control Mode	None	
Back off	1.0	dB
EIRP Spectral Density	19.0	dBW/4kHz
Slant Range	38851	km
Space Loss, Ls	207.2	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	-0.9	dB/K
Thermal Noise, C/No	62.5	dBHz
Intra-System Interference, C/Io ISI	86.7	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	86.7	dBHz
C/(No+Io)	62.5	dBHz
Satellite		
Flux Density	-92.5	dBW/m2
SFD @ Hub	-120.8	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	28.5	dB
Downlink		
Frequency	11.720000	GHz
Transponder Sat. EIRP @ Beam Peak	51.3	dBW
Transponder Sat. EIRP @ Terminal	49.9	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-0.9	dBW/4kHz
Carrier EIRP @ Beam Peak	22.8	dBW
Carrier EIRP @ Terminal	21.4	dBW
Space Loss, Ls	205.2	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	0.2	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	62.5	dBHz
Intermod. Interference, C/IMo	89.7	dBHz
Intra-System Interference, C/Io ISI	86.7	dBHz
Adj. Satellite Interference, C/Io ASI	84.7	dBHz
Cross-Pol Interference, C/Io XP	86.7	dBHz
C/(No+Io)	62.4	dBHz
End to End		
End to End C/(No+Io)	59.4	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	2.7	dB
Link Margin	1.5	dB

TECHNICAL APPENDIX

ANNEX A-2.3: TELSTAR-12

A. Telstar-12 Coverage Map

Figure 1: Telstar-12 at Americas Beam



B. Telstar-12 Link Budget

Telstar 12 Link Budget		
Forward Link Budget		
Receive Earth Station		
Site	Chile	
Antenna Type	Aerosat HR6400	
Lat	-41.0	deg
Lon	-72.0	deg
G/T	12.2	dB/K
Satellite		
Name	Telstar 12	
Transponder	K35-ESV/PAV	
Longitude	345.0	deg
Transmit Earth Station		
Site	Aberdeen/United Kingdom	
Lat	57.2	deg
Lon	-2.1	deg
EIRP max	79.0	dBW
Signal		
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1.00	
Coding Rate	10/27	
Overhead Rate	1.00	
Channel Spacing	1.30	
Spectral Efficiency (Rate/Noise BW)	0.74	bps/Hz
Data Rate	4.05E+06	bps
Information Rate (Data + Overhead)	4.05E+06	bps
Symbol Rate	5.47E+06	Hz
Chip Rate (Noise Bandwidth)	5.47E+06	Hz
Occupied Bandwidth	7.12E+06	Hz
Power Equivelent Bandwidth	7.74E+06	Hz
C/N Threshold	0.2	dB
Uplink		
Frequency	14.281000	GHz
Power Control Mode	None	
Back off	3.0	dB
EIRP Spectral Density	34.0	dBW/4kHz
Slant Range	39162	km
Space Loss, Ls	207.4	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	1.9	dB/K
Thermal Noise, C/No	87.6	dBHz
Intra-System Interference, C/Io ISI	94.4	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	94.4	dBHz
C/(No+Io)	86.1	dBHz
Satellite		
Flux Density	-86.2	dBW/m2
SFD @ Hub	-98.3	dBW/m2
Small Signal Gain (IBO/OBO)	1.8	dB
OBO	11.6	dB
Downlink		
Frequency	11.981000	GHz
Transponder Sat. EIRP @ Beam Peak	50.4	dBW
Transponder Sat. EIRP @ Terminal	49.2	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	7.4	dBW/4kHz
Carrier EIRP @ Beam Peak	38.8	dBW
Carrier EIRP @ Terminal	37.6	dBW
Space Loss, Ls	206.1	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.6	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	87.6	dBHz
Intermod. Interference, C/IMo	97.4	dBHz
Intra-System Interference, C/Io ISI	94.4	dBHz
Adj. Satellite Interference, C/Io ASI	92.4	dBHz
Cross-Pol Interference, C/Io XP	94.4	dBHz
C/(No+Io)	84.9	dBHz
End to End		
End to End C/(No+Io)	82.5	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	3.9	dB
Link Margin	3.7	dB

Telstar 12 Link Budget		
Return Link Budget		
Receive Earth Station		
Site	Aberdeen/United Kingdom	
Antenna Type	,GB-ABD14V (ABZ-N-5.6-T12)	
Lat	57.2	deg
Lon	-2.1	deg
G/T	32.9	dB/K
Satellite		
Name	Telstar 12	
Transponder	K15-PAH/ESH	
Longitude	345.0	deg
Transmit Earth Station		
Site	Chile	
Lat	-41.0	deg
Lon	-72.0	deg
EIRP max	45.3	dBW
Signal		
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	4.00	
Coding Rate	1/2	
Overhead Rate	1.00	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.13	bps/Hz
Data Rate	6.18E+05	bps
Information Rate (Data + Overhead)	6.18E+05	bps
Symbol Rate	1.24E+06	Hz
Chip Rate (Noise Bandwidth)	4.94E+06	Hz
Occupied Bandwidth	5.93E+06	Hz
Power Equivelent Bandwidth	2.91E+04	Hz
C/N Threshold	-4.8	dB
Uplink		
Frequency	14.405000	GHz
Power Control Mode	None	
Back off	1.0	dB
EIRP Spectral Density	18.5	dBW/4kHz
Slant Range	39961	km
Space Loss, Ls	207.7	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	2.1	dB/K
Thermal Noise, C/No	59.4	dBHz
Intra-System Interference, C/Io ISI	87.9	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	87.9	dBHz
C/(No+Io)	59.4	dBHz
Satellite		
Flux Density	-85.3	dBW/m2
SFD @ Hub	-120.6	dBW/m2
Small Signal Gain (IBO/OBO)	1.8	dB
OBO	35.9	dB
Downlink		
Frequency	11.605000	GHz
Transponder Sat. EIRP @ Beam Peak	52.2	dBW
Transponder Sat. EIRP @ Terminal	49.7	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-8.6	dBW/4kHz
Carrier EIRP @ Beam Peak	16.3	dBW
Carrier EIRP @ Terminal	13.8	dBW
Space Loss, Ls	205.6	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.4	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	59.4	dBHz
Intermod. Interference, C/IMo	90.9	dBHz
Intra-System Interference, C/Io ISI	87.9	dBHz
Adj. Satellite Interference, C/Io ASI	85.9	dBHz
Cross-Pol Interference, C/Io XP	87.9	dBHz
C/(No+Io)	59.4	dBHz
End to End		
End to End C/(No+Io)	56.4	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	-1.9	dB
Link Margin	2.9	dB

TELESAT
1601 Telesat Court
Ottawa, ON, Canada K1B 5P4

EN2014-007
11 June 2014

Federal Communications Commission
International Bureau
445 12th Street, S.W.
Washington, D.C. 20554

Re: Astronics AeroSat Application for earth stations aboard aircraft ("ESAA") terminals

To Whom It May Concern:

This letter certifies Telesat is aware that Astronics AeroSat Corporation ("Astronics AeroSat") is planning to seek authorization from the Federal Communications Commission ("FCC") to operate Ku-band transmit/receive earth stations aboard aircraft ("ESAA") terminals with the T14R, T11N, T12 and T18 satellites at orbital positions 63W, 37.5W, 15W and 138E, respectively. Specifically, Telesat understands that Astronics AeroSat seeks to operate the HR6400 Ku-band antenna system for development and demonstration purposes consistent with the FCC's experimental licensing rules, and for commercial purposes consistent with the FCC's Part 25 rules, including Section 25.227.

Based on the information provided by Astronics AeroSat, Telesat (i) recognizes that the operation of the HR6400 terminals in compliance with the FCC Part 25 rules, Section 25.227, will insure compliance with existing coordination agreements with adjacent satellite operators within +/- 6 degrees of the orbital locations identified above; (ii) acknowledges that the proposed operation of the HR6400 terminal has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable; and (iii) if the FCC authorizes the operations proposed by Astronics AeroSat, Telesat will take into consideration the power density levels associated with such operations in future satellite network coordination with adjacent satellite operators.

Sincerely,

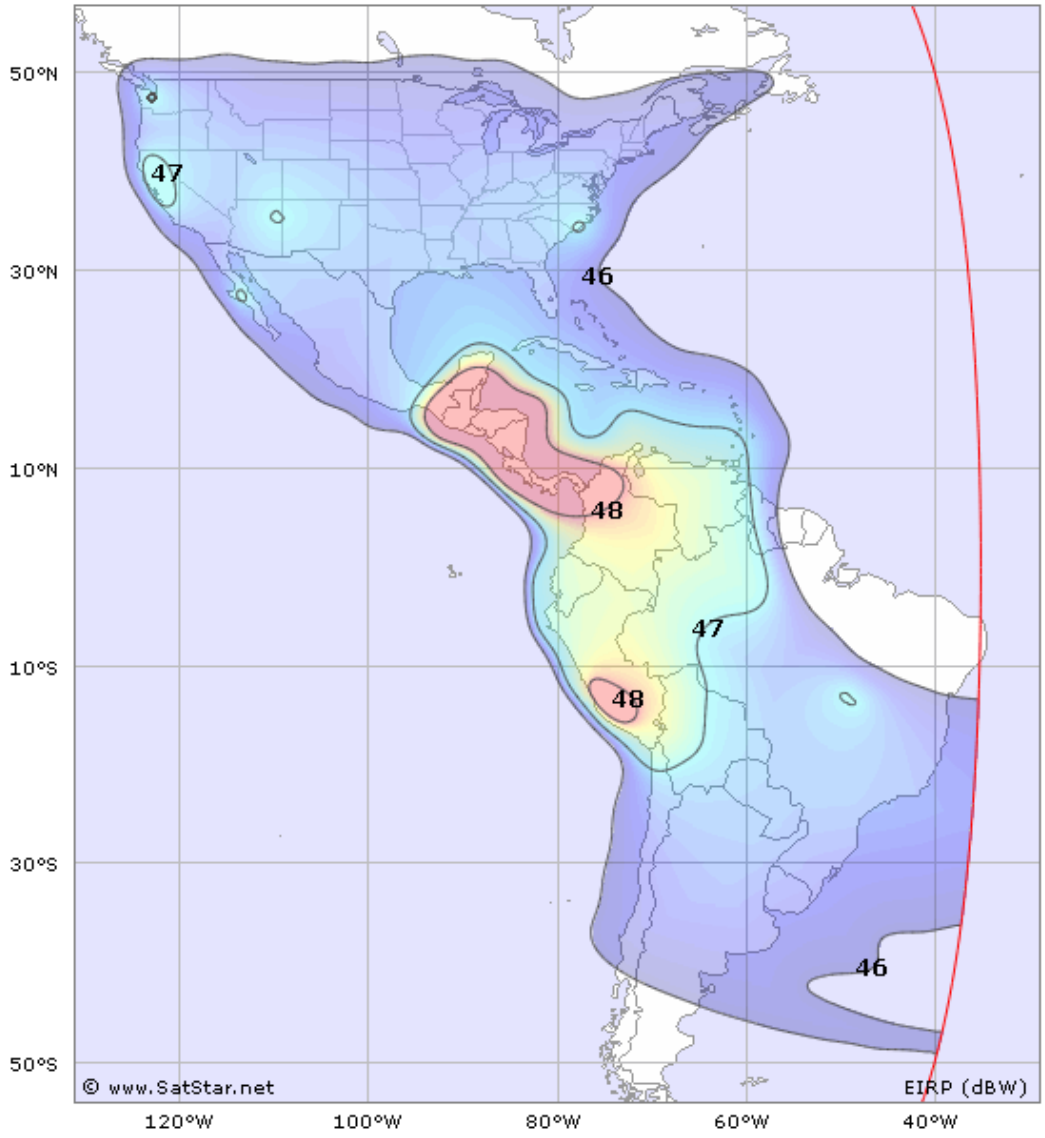
Elisabeth Neasmith, P. Eng
Manager, International Coordination
Department of CTO
TELESAT

TECHNICAL APPENDIX

ANNEX A-3.1: E117WA (Satmex 8)

A. E117WA Coverage Map

Figure 1: E117WA (Satmex 8) at Hemi Beam



B. E117WA Link Budget

E117WA Link Budget		
Forward Link Budget		
Receive Earth Station		
Site	Argentina	
Antenna Type	Aerosat HR6400	
Lat	-41.0	deg
Lon	-69.0	deg
G/T	12.3	dB/K
Satellite		
Name	E117WA	
Transponder	21K(Ku2/Ku2)	
Longitude	243.2	deg
Transmit Earth Station		
Site	Houston/USA	
Lat	29.6	deg
Lon	-95.4	deg
EIRP max	73.2	dBW
Signal		
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1.00	
Coding Rate	10/27	
Overhead Rate	1.00	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.74	bps/Hz
Data Rate	4.22E+06	bps
Information Rate (Data + Overhead)	4.22E+06	bps
Symbol Rate	5.69E+06	Hz
Chip Rate (Noise Bandwidth)	5.69E+06	Hz
Occupied Bandwidth	6.83E+06	Hz
Power Equivelent Bandwidth	8.46E+06	Hz
C/N Threshold	0.2	dB
Uplink		
Frequency	14.420000	GHz
Power Control Mode	AUPC	
Back off	6.0	dB
EIRP Spectral Density	29.8	dBW/4kHz
Slant Range	37184	km
Space Loss, Ls	207.0	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	2.5	dB/K
Thermal Noise, C/No	84.9	dBHz
Intra-System Interference, C/Io ISI	94.6	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	94.6	dBHz
C/(No+Io)	84.0	dBHz
Satellite		
Flux Density	-92.9	dBW/m2
SFD @ Hub	-101.6	dBW/m2
Small Signal Gain (IBO/OBO)	1.5	dB
OBO	9.6	dB
Downlink		
Frequency	12.120000	GHz
Transponder Sat. EIRP @ Beam Peak	49.7	dBW
Transponder Sat. EIRP @ Terminal	45.0	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	8.5	dBW/4kHz
Carrier EIRP @ Beam Peak	40.1	dBW
Carrier EIRP @ Terminal	35.4	dBW
Space Loss, Ls	206.0	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.4	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	84.9	dBHz
Intermod. Interference, C/IMo	97.6	dBHz
Intra-System Interference, C/Io ISI	94.6	dBHz
Adj. Satellite Interference, C/Io ASI	92.6	dBHz
Cross-Pol Interference, C/Io XP	94.6	dBHz
C/(No+Io)	83.3	dBHz
End to End		
End to End C/(No+Io)	80.6	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	1.9	dB
Link Margin	1.7	dB

E117WA Link Budget		
Return Link Budget		
Receive Earth Station		
Site	Houston/USA	
Antenna Type	,US-HOU02V (HOU-G-6.1-KU-SM6)	
Lat	29.6	deg
Lon	-95.4	deg
G/T	33.9	dB/K
Satellite		
Name	E117WA	
Transponder	21K(Ku2/Ku2)	
Longitude	243.2	deg
Transmit Earth Station		
Site	Argentina	
Lat	-41.0	deg
Lon	-69.0	deg
EIRP max	45.3	dBW
Signal		
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	4.00	
Coding Rate	1/2	
Overhead Rate	1.00	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.13	bps/Hz
Data Rate	6.12E+05	bps
Information Rate (Data + Overhead)	6.12E+05	bps
Symbol Rate	1.22E+06	Hz
Chip Rate (Noise Bandwidth)	4.89E+06	Hz
Occupied Bandwidth	5.87E+06	Hz
Power Equivelent Bandwidth	7.18E+04	Hz
C/N Threshold	-4.8	dB
Uplink		
Frequency	14.420000	GHz
Power Control Mode	None	
Back off	1.0	dB
EIRP Spectral Density	18.8	dBW/4kHz
Slant Range	39309	km
Space Loss, Ls	207.5	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	0.2	dB/K
Thermal Noise, C/No	58.2	dBHz
Intra-System Interference, C/Io ISI	87.9	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	87.9	dBHz
C/(No+Io)	58.1	dBHz
Satellite		
Flux Density	-92.9	dBW/m2
SFD @ Hub	-120.0	dBW/m2
Small Signal Gain (IBO/OBO)	1.5	dB
OBO	30.3	dB
Downlink		
Frequency	12.120000	GHz
Transponder Sat. EIRP @ Beam Peak	49.7	dBW
Transponder Sat. EIRP @ Terminal	47.3	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-5.5	dBW/4kHz
Carrier EIRP @ Beam Peak	19.4	dBW
Carrier EIRP @ Terminal	17.0	dBW
Space Loss, Ls	205.5	dB
Pointing Loss, Lpnt	0.7	dB
Atmosphere / Weather Loss, La	0.2	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	58.2	dBHz
Intermod. Interference, C/IMo	90.9	dBHz
Intra-System Interference, C/Io ISI	87.9	dBHz
Adj. Satellite Interference, C/Io ASI	85.9	dBHz
Cross-Pol Interference, C/Io XP	87.9	dBHz
C/(No+Io)	58.1	dBHz
End to End		
End to End C/(No+Io)	55.1	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	-3.3	dB
Link Margin	1.6	dB

eutelsat

June 17, 2014

Federal Communications Commission
International Bureau
445 12th Street, S.W.
Washington, D.C. 20554

Re: Engineering Certification of Eutelsat Americas

To Whom It May Concern:

This letter certifies that Eutelsat Americas ("EAS") is aware that Astronics AeroSat Corporation ("Astronics AeroSat") is planning to seek authorization from the Federal Communications Commission ("FCC") to operate Ku-band transmit/receive earth stations aboard aircraft ("ESAA") terminals with the Eutelsat 117WA (E117WA) satellite located at 116.8° W.L. Specifically, we understand that Astronics AeroSat seeks to operate the previously authorized HR6400 Ku-band antenna system with E117WA for development and demonstration purposes consistent with the FCC's experimental licensing rules, and for commercial purposes consistent with the FCC's ESAA rules including Section 25.227.

Based on the information provided by Astronics AeroSat, EAS understands the technical characteristics of the HR6400 terminal, and EAS (i) recognizes that operation of the HR6400 terminals at the power density levels provided to EAS is consistent with existing coordination agreements with all adjacent satellite operators within +/- 6 degrees of orbital separation from E117WA; (ii) acknowledges that the proposed operation of the HR6400 terminal has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable; and (iii) if the FCC authorizes the operations proposed by Astronics AeroSat, EAS will take into consideration the power density levels associated such operations in all future satellite network coordinations with adjacent satellite operators.

Sincerely,

Hector Fortis
Eutelsat Americas
International and Regulatory Affairs

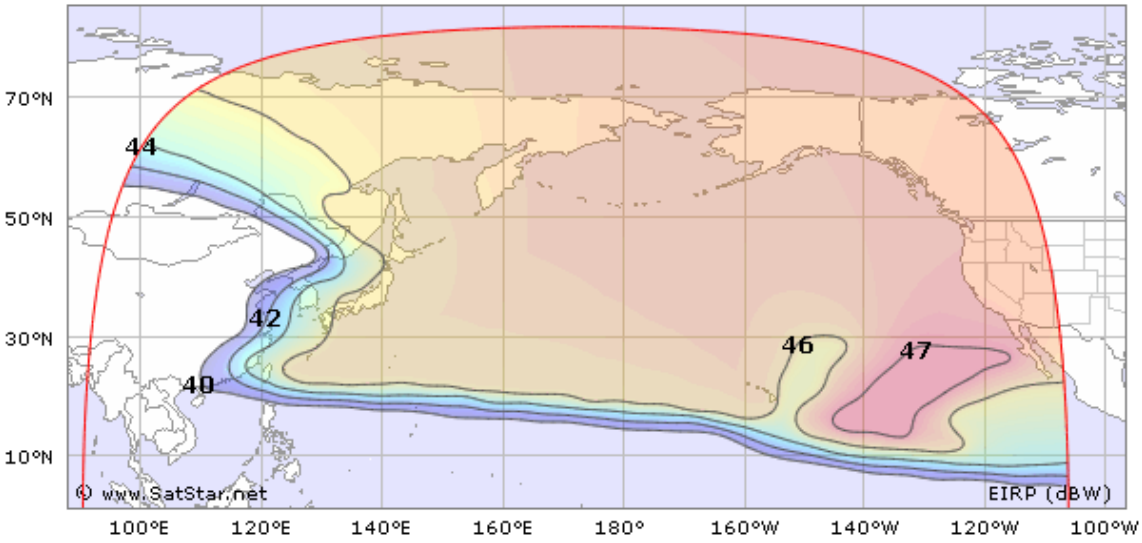
JR

TECHNICAL APPENDIX

ANNEX A-3.2: E172A

A. E172A Coverage Map

Figure 1: E172A at North Pacific Beam



B. E172A Link Budget

172A Link Budget		
Forward Link Budget		
Receive Earth Station		
Site	North Pacific	
Antenna Type	Aerosat HR6400	
Lat	19.4	deg
Lon	-155.6	deg
G/T	11.5	dB/K
Satellite		
Name	172A	
Transponder	NPH3W/NPV3W	
Longitude	172.0	deg
Transmit Earth Station		
Site	Brewster/Washington	
Lat	48.2	deg
Lon	240.3	deg
EIRP max	85.4	dBW
Signal		
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1.00	
Coding Rate	10/27	
Overhead Rate	1.00	
Channel Spacing	1.35	
Spectral Efficiency (Rate/Noise BW)	0.74	bps/Hz
Data Rate	4.22E+06	bps
Information Rate (Data + Overhead)	4.22E+06	bps
Symbol Rate	5.69E+06	Hz
Chip Rate (Noise Bandwidth)	5.69E+06	Hz
Occupied Bandwidth	7.68E+06	Hz
Power Equivelent Bandwidth	1.26E+07	Hz
C/N Threshold	0.2	dB
Uplink		
Frequency	14.119000	GHz
Power Control Mode	AUPC	
Back off	0.0	dB
EIRP Spectral Density	35.7	dBW/4kHz
Slant Range	41054	km
Space Loss, Ls	207.7	dB
Pointing Loss, Lpnt	0.5	dB
Atmosphere / Weather Loss, La	0.5	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	0.9	dB/K
Thermal Noise, C/No	87.6	dBHz
Intra-System Interference, C/Io ISI	94.6	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	94.6	dBHz
C/(No+Io)	86.1	dBHz
Satellite		
Flux Density	-86.2	dBW/m2
SFD @ Hub	-97.4	dBW/m2
Small Signal Gain (IBO/OBO)	1.9	dB
OBO	11.7	dB
Downlink		
Frequency	11.069000	GHz
Transponder Sat. EIRP @ Beam Peak	47.7	dBW
Transponder Sat. EIRP @ Terminal	46.7	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	4.5	dBW/4kHz
Carrier EIRP @ Beam Peak	36.0	dBW
Carrier EIRP @ Terminal	35.0	dBW
Space Loss, Ls	204.8	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.2	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	87.6	dBHz
Intermod. Interference, C/IMo	97.6	dBHz
Intra-System Interference, C/Io ISI	94.6	dBHz
Adj. Satellite Interference, C/Io ASI	92.6	dBHz
Cross-Pol Interference, C/Io XP	94.6	dBHz
C/(No+Io)	85.0	dBHz
End to End		
End to End C/(No+Io)	82.5	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	2.2	dB
Link Margin	2.0	dB

172A Link Budget		
Return Link Budget		
Receive Earth Station		
Site	Brewster/Washington	
Antenna Type	,US-BRWH(BRW_9.0-GE-23)	
Lat	48.2	deg
Lon	240.3	deg
G/T	35.6	dB/K
Satellite		
Name	172A	
Transponder	NPH3W/NPV3W	
Longitude	172.0	deg
Transmit Earth Station		
Site	North Pacific	
Lat	19.4	deg
Lon	-155.6	deg
EIRP max	45.1	dBW
Signal		
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	1.00	
Coding Rate	1/2	
Overhead Rate	1.00	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.50	bps/Hz
Data Rate	6.12E+05	bps
Information Rate (Data + Overhead)	6.12E+05	bps
Symbol Rate	1.22E+06	Hz
Chip Rate (Noise Bandwidth)	1.22E+06	Hz
Occupied Bandwidth	1.47E+06	Hz
Power Equivelent Bandwidth	1.13E+05	Hz
C/N Threshold	1.2	dB
Uplink		
Frequency	14.119000	GHz
Power Control Mode	None	
Back off	1.0	dB
EIRP Spectral Density	18.9	dBW/4kHz
Slant Range	37280	km
Space Loss, Ls	206.9	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	2.2	dB/K
Thermal Noise, C/No	67.1	dBHz
Intra-System Interference, C/Io ISI	87.9	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	87.9	dBHz
C/(No+Io)	67.0	dBHz
Satellite		
Flux Density	-86.2	dBW/m2
SFD @ Hub	-119.3	dBW/m2
Small Signal Gain (IBO/OBO)	1.9	dB
OBO	32.1	dB
Downlink		
Frequency	11.069000	GHz
Transponder Sat. EIRP @ Beam Peak	47.7	dBW
Transponder Sat. EIRP @ Terminal	46.1	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-9.3	dBW/4kHz
Carrier EIRP @ Beam Peak	15.6	dBW
Carrier EIRP @ Terminal	14.0	dBW
Space Loss, Ls	205.6	dB
Pointing Loss, Lpnt	0.5	dB
Atmosphere / Weather Loss, La	0.7	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	67.1	dBHz
Intermod. Interference, C/IMo	90.9	dBHz
Intra-System Interference, C/Io ISI	87.9	dBHz
Adj. Satellite Interference, C/Io ASI	85.9	dBHz
Cross-Pol Interference, C/Io XP	87.9	dBHz
C/(No+Io)	67.0	dBHz
End to End		
End to End C/(No+Io)	64.0	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	4.9	dB
Link Margin	3.7	dB

31 July, 2014

Federal Communications Commission
International Bureau 445
12th Street, S.W.
Washington, D.C. 20554

Re: Engineering Certification of Eutelsat

To Whom It May Concern:

This letter confirms that Eutelsat is aware that Astronics AeroSat Corporation ("Astronics AeroSat") is planning to seek a blanket authorization from the Federal Communications Commission ("FCC") to operate technically identical Ku-band transmit/receive earth stations aboard aircraft ("ESAAs") manufactured by Astronics AeroSat -- the HR6400 terminal. Astronics AeroSat seeks authority for these aeronautical terminals to utilize E172A at 172° E.L. and E36B at 36° E.L. under the current ESAA rules, including Section 25.227. The HR6400 terminal has already been authorized by the FCC to communicate with a wide range of satellites around the world, including E172A. *See* Gogo, LLC, Radio Station Authorization, Call Sign E120106, File No. SES-MFS-20131114-01015.

Based upon the representations made to Eutelsat by Astronics AeroSat concerning the contents of its FCC application:

- Eutelsat certifies that the proposed use of the ESAA transmit/receive terminals at the power density levels that Astronics AeroSat provided to Eutelsat is consistent with existing coordination agreements to which Eutelsat is a party with all adjacent satellite operators within +/- 6 degrees of orbital separation from E172A and E36B.
- Eutelsat also acknowledges that the proposed operation of the Astronics AeroSat ESAA terminal has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable.
- If the FCC authorizes the operations proposed by Astronics AeroSat, Eutelsat will include the power density levels specified by Astronics AeroSat in all future satellite network coordination with other adjacent satellite operators.

Sincerely,

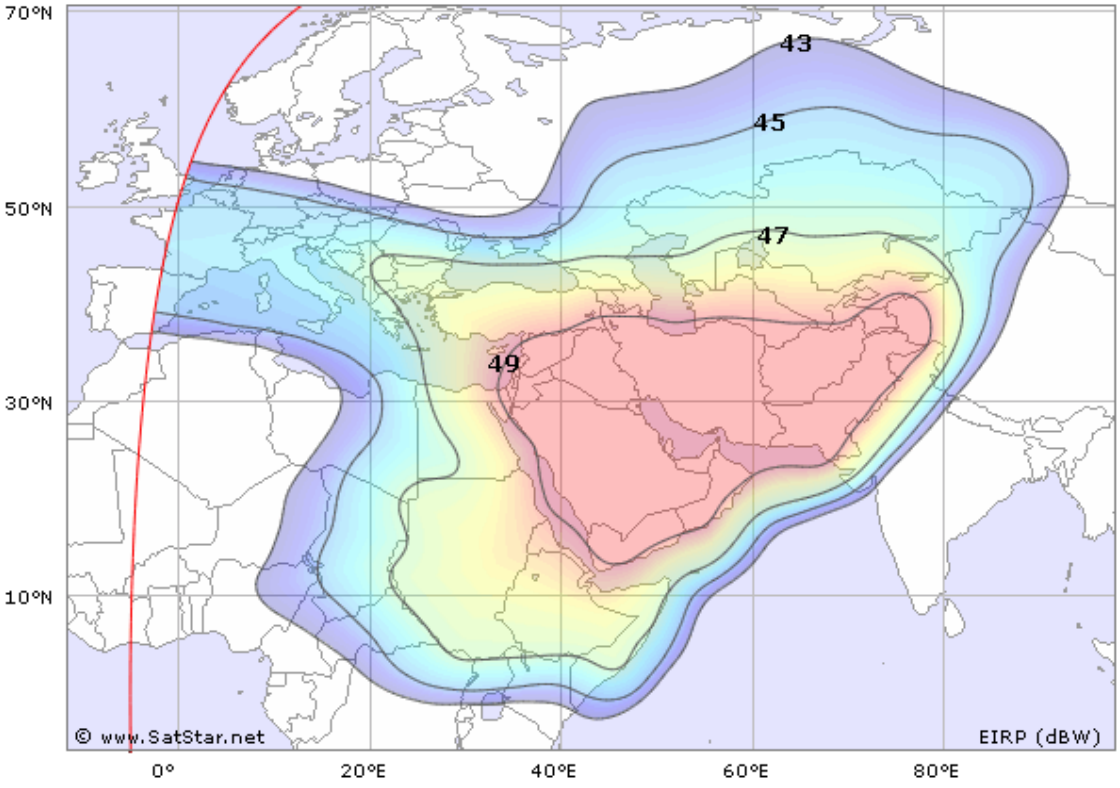
Ethan Lavan
Director of Orbital Resources
Eutelsat S.A.

TECHNICAL APPENDIX

ANNEX A-4.1: APSTAR-7

A. Apstar-7 Coverage Map

Figure 1: Apstar-7 at Middle Eastern North Africa Beam



B. Apstar-7 Link Budget

APSTAR 7	Link Budget	
Forward Link Budget		
Receive Earth Station		
Site	Turkey	
Antenna Type	Aerosat HR6400	
Lat	38.0	deg
Lon	37.0	deg
G/T	12.0	dB/K
Satellite		
Name	APSTAR 7	
Transponder	KM13	
Longitude	76.0	deg
Transmit Earth Station		
Site		
Lat	41.6	deg
Lon	13.4	deg
EIRP max	90.7	dBW
Signal		
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1.00	
Coding Rate	10/27	
Overhead Rate	1.00	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.74	bps/Hz
Data Rate	1.85E+07	bps
Information Rate (Data + Overhead)	1.85E+07	bps
Symbol Rate	2.50E+07	Hz
Chip Rate (Noise Bandwidth)	2.50E+07	Hz
Occupied Bandwidth	3.00E+07	Hz
Power Equivelent Bandwidth	4.18E+07	Hz
C/N Threshold	0.2	dB
Uplink		
Frequency	14.219500	GHz
Power Control Mode	None	
Back off	0.0	dB
EIRP Spectral Density	34.5	dBW/4kHz
Slant Range	40414	km
Space Loss, Ls	207.6	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	0.3	dB/K
Thermal Noise, C/No	92.8	dBHz
Intra-System Interference, C/Io ISI	101.0	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	101.0	dBHz
C/(No+Io)	91.6	dBHz
Satellite		
Flux Density	-89.5	dBW/m2
SFD @ Hub	-91.6	dBW/m2
Small Signal Gain (IBO/OBO)	1.5	dB
OBO	4.6	dB
Downlink		
Frequency	11.669500	GHz
Transponder Sat. EIRP @ Beam Peak	49.7	dBW
Transponder Sat. EIRP @ Terminal	49.0	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	7.1	dBW/4kHz
Carrier EIRP @ Beam Peak	45.0	dBW
Carrier EIRP @ Terminal	44.4	dBW
Space Loss, Ls	205.5	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	92.8	dBHz
Intermod. Interference, C/IMo	104.0	dBHz
Intra-System Interference, C/Io ISI	101.0	dBHz
Adj. Satellite Interference, C/Io ASI	99.0	dBHz
Cross-Pol Interference, C/Io XP	101.0	dBHz
C/(No+Io)	90.7	dBHz
End to End		
End to End C/(No+Io)	88.1	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	4.7	dB
Link Margin	4.5	dB

APSTAR 7	Link Budget	
Return Link Budget		
Receive Earth Station		
Site		
Antenna Type	,IT-FUC01H (FUC-11.0-Apstar7)	
Lat	41.6	deg
Lon	13.4	deg
G/T	37.0	dB/K
Satellite		
Name	APSTAR 7	
Transponder	KM11	
Longitude	76.0	deg
Transmit Earth Station		
Site	Turkey	
Lat	38.0	deg
Lon	37.0	deg
EIRP max	45.1	dBW
Signal		
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	1.00	
Coding Rate	1/2	
Overhead Rate	1.00	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.50	bps/Hz
Data Rate	1.22E+06	bps
Information Rate (Data + Overhead)	1.22E+06	bps
Symbol Rate	2.43E+06	Hz
Chip Rate (Noise Bandwidth)	2.43E+06	Hz
Occupied Bandwidth	2.92E+06	Hz
Power Equivelent Bandwidth	2.77E+05	Hz
C/N Threshold	1.2	dB
Uplink		
Frequency	14.094500	GHz
Power Control Mode	None	
Back off	1.0	dB
EIRP Spectral Density	16.1	dBW/4kHz
Slant Range	38581	km
Space Loss, Ls	207.2	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.3	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	2.1	dB/K
Thermal Noise, C/No	66.8	dBHz
Intra-System Interference, C/Io ISI	90.9	dBHz
Adj. Satellite Interference, C/Io ASI	80.0	dBHz
Cross-Pol Interference, C/Io XP	90.9	dBHz
C/(No+Io)	66.7	dBHz
Satellite		
Flux Density	-93.8	dBW/m2
SFD @ Hub	-119.5	dBW/m2
Small Signal Gain (IBO/OBO)	1.5	dB
OBO	26.4	dB
Downlink		
Frequency	11.544500	GHz
Transponder Sat. EIRP @ Beam Peak	49.7	dBW
Transponder Sat. EIRP @ Terminal	46.8	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-4.5	dBW/4kHz
Carrier EIRP @ Beam Peak	23.3	dBW
Carrier EIRP @ Terminal	20.4	dBW
Space Loss, Ls	205.8	dB
Pointing Loss, Lpnt	0.5	dB
Atmosphere / Weather Loss, La	0.8	dB
Radome, Lr	0.0	dB
Thermal Noise, C/No	66.8	dBHz
Intermod. Interference, C/IMo	93.9	dBHz
Intra-System Interference, C/Io ISI	90.9	dBHz
Adj. Satellite Interference, C/Io ASI	88.9	dBHz
Cross-Pol Interference, C/Io XP	90.9	dBHz
C/(No+Io)	66.7	dBHz
End to End		
End to End C/(No+Io)	63.7	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	2.6	dB
Link Margin	1.5	dB

亞太通信衛星有限公司
APT SATELLITE COMPANY LIMITED
香港新界大埔工業邨六號街22號
22 Dai Kwai St., Ta Po Ind. Est., N.T., Hong Kong
電話Tel: (852) 2600 2100 傳真Fax: (852) 2666 7838
網址Web-site: www.apstar.com

Federal Communications Commission
International Bureau
445 12th Street, S.W.
Washington, D.C. 20554

Re: Engineering Certification of APT Satellite Company Limited

To Whom It May Concern:

This letter certifies that APT Satellite Company Limited ("APT") is aware that Astronics AeroSat Corporation ("Astronics AeroSat") is planning to seek authorization from the Federal Communications Commission ("FCC") to operate Ku-band transmit/receive earth stations aboard aircraft ("ESAA") terminals with the Apstar 7 satellite located at 76.5° E.L. Specifically, we understand that Astronics AeroSat seeks to operate the previously authorized HR6400 Ku-band antenna system with Apstar 7 for development and demonstration purposes consistent with the FCC's experimental licensing rules, and for commercial purposes consistent with the FCC's ESAA rules including Section 25.227.

Based on the information provided by Astronics AeroSat, APT understands the technical characteristics of the HR6400 terminal, and APT (i) recognizes that operation of the HR6400 terminals at the power density levels provided to APT is consistent with existing coordination agreements with all adjacent satellite operators within +/- 6 degrees of orbital separation from Apstar 7; (ii) acknowledges that the proposed operation of the HR6400 terminal has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable; and (iii) if the FCC authorizes the operations proposed by Astronics AeroSat, APT will take into consideration the power density levels associated such operations in all future satellite network coordinations with adjacent satellite operators.

Sincerely,

Zhang Shilin,
Vice President
APT Satellite Company Limited

9 . May, 2014
Date

ANNEX B:

Antenna Patterns / Antenna Gain and

Off-Axis EIRP Compliance Tables

I. Antenna Patterns

A. Co-Pol Gain Azimuth

Figure 1 - Co-Pol Gain ± 10 deg., Skew 0 deg.

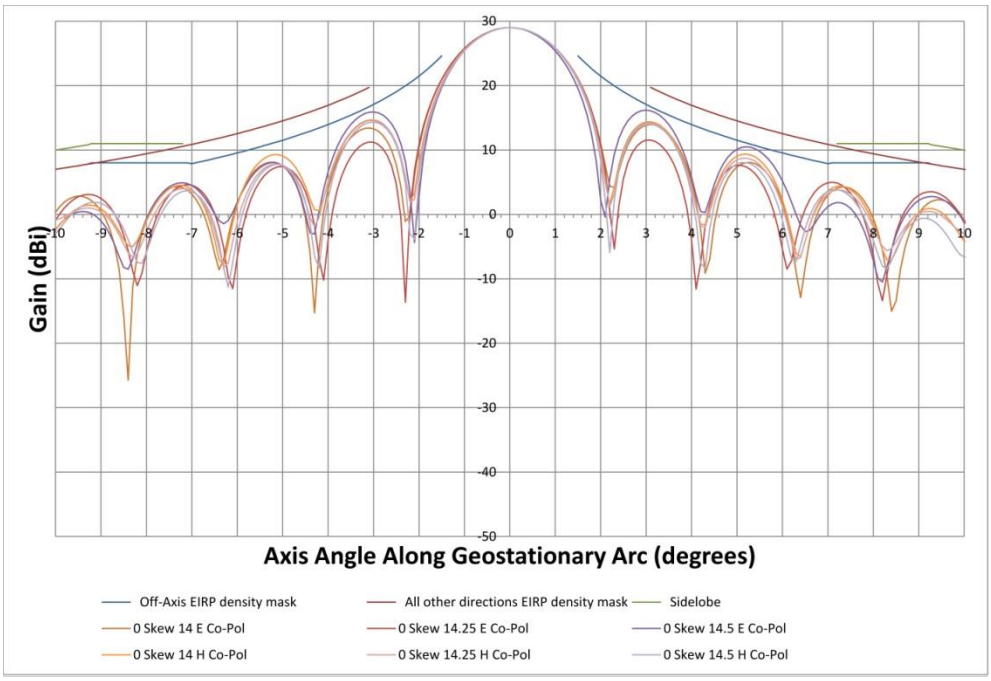


Figure 2 - Co-Pol Gain ± 10 deg., Skew 25 deg.

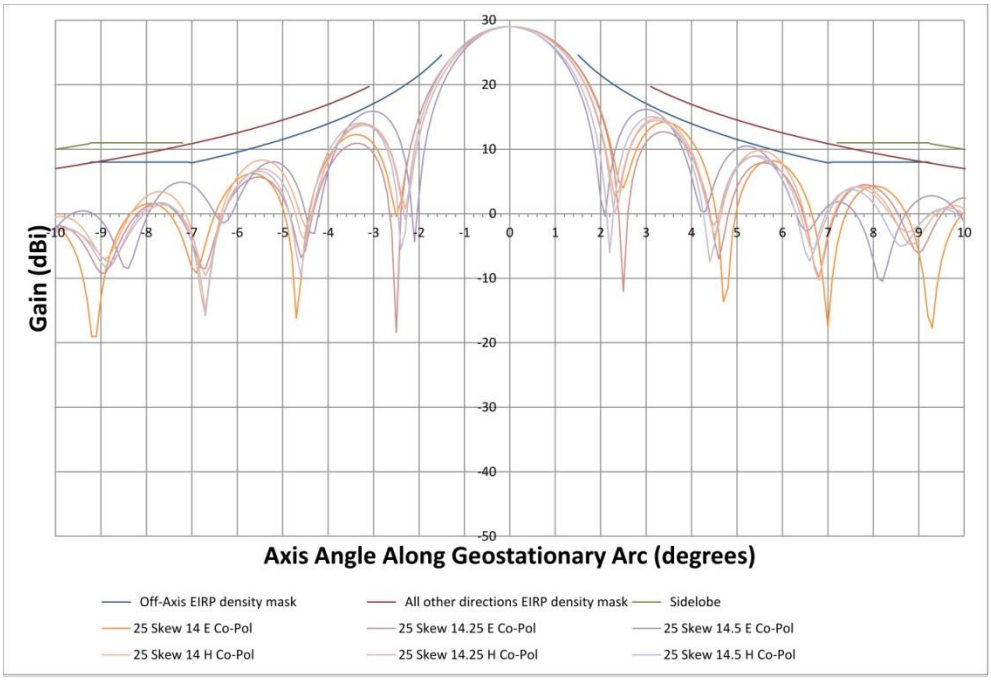


Figure 3 - Co-Pol Gain ± 10 deg., Skew 35 deg.

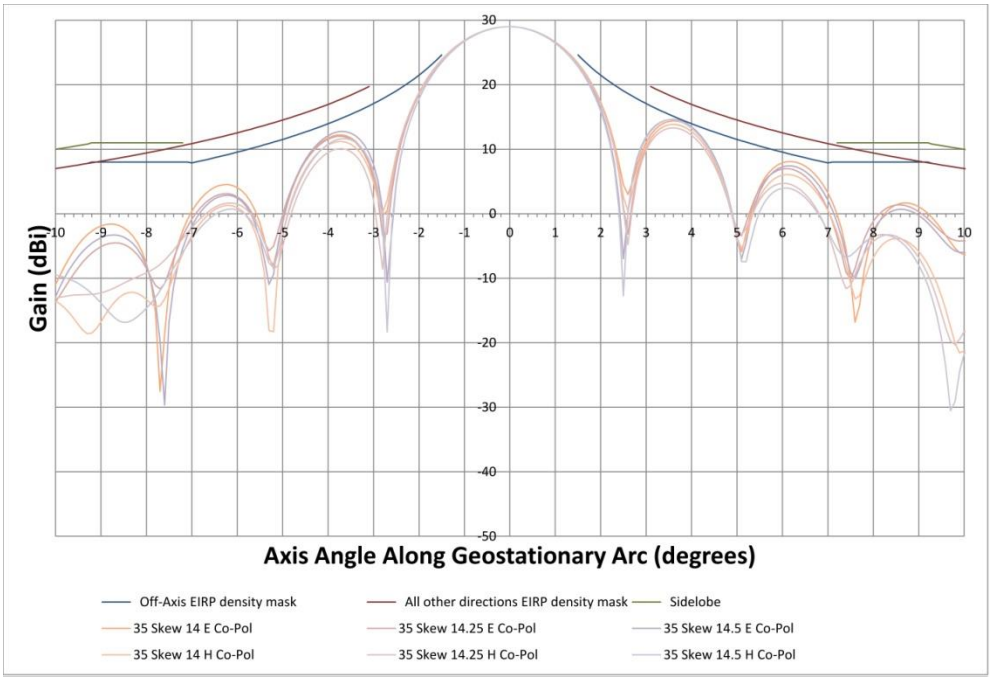


Figure 4 - Co-Pol Gain ± 10 deg., Skew 45 deg.

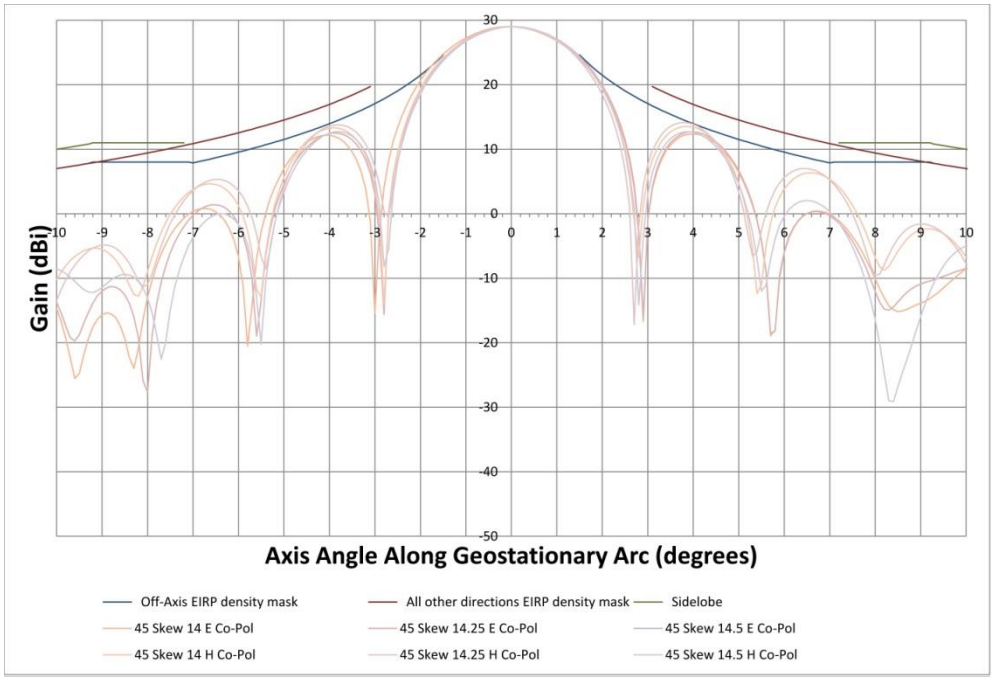


Figure 5 - Co-Pol Gain ± 10 deg., Skew 55 deg.

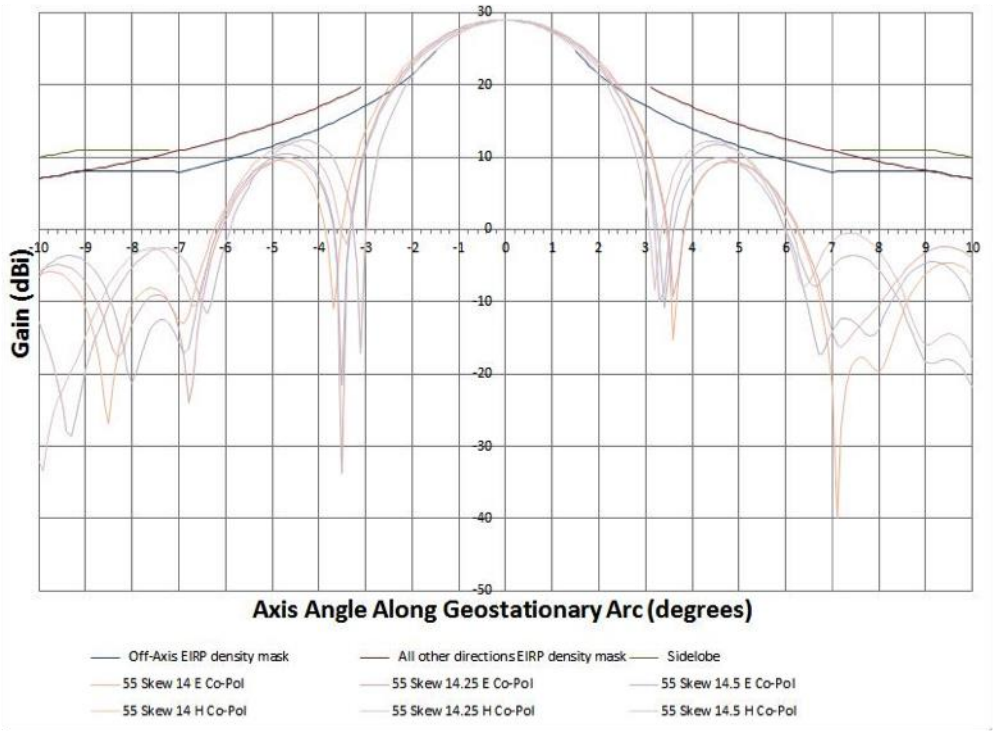


Figure 6 - Co-Pol Gain ± 180 deg., Skew 0 deg.

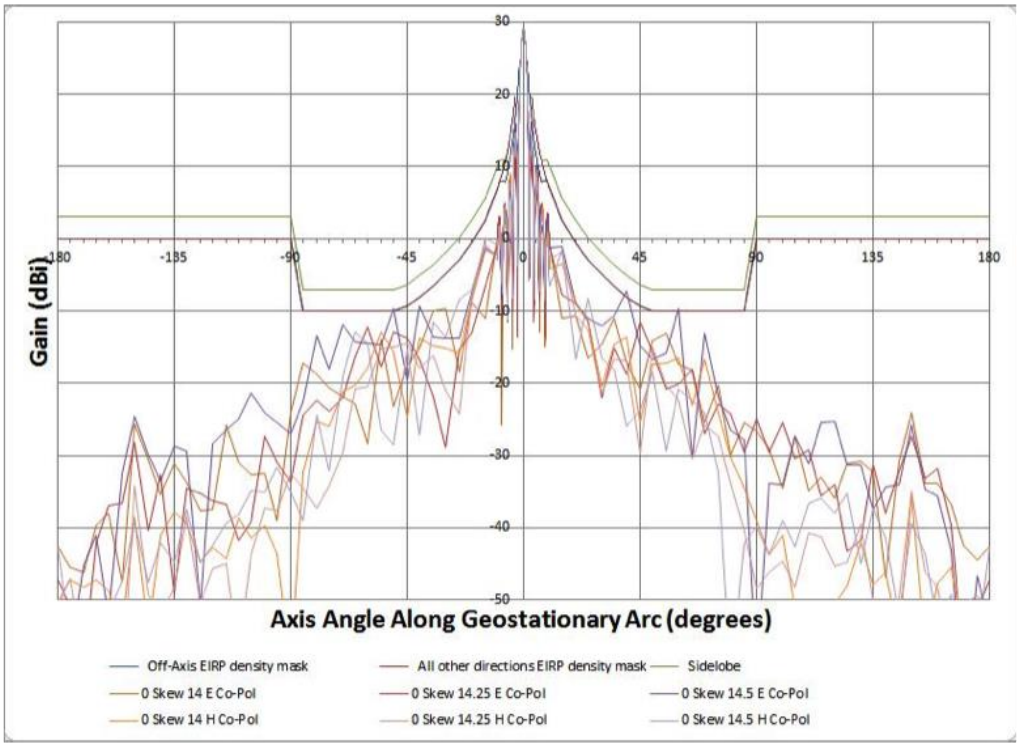


Figure 7 - Co-Pol Gain ± 180 deg., Skew 25 deg.

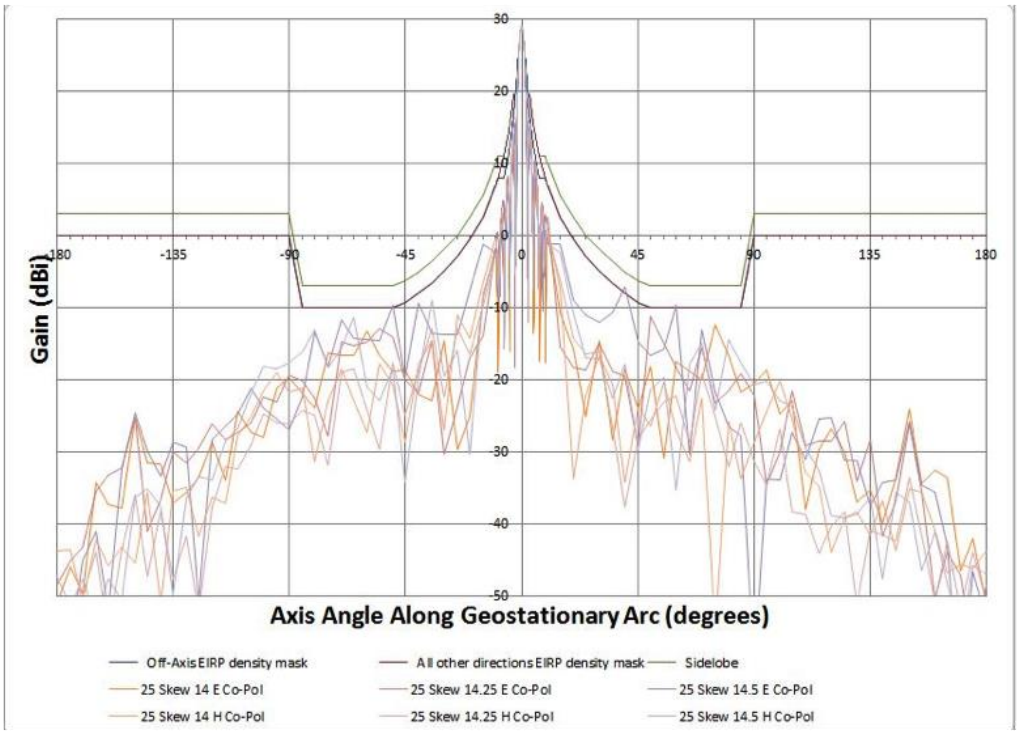


Figure 8 - Co-Pol Gain ± 180 deg., Skew 35 deg.

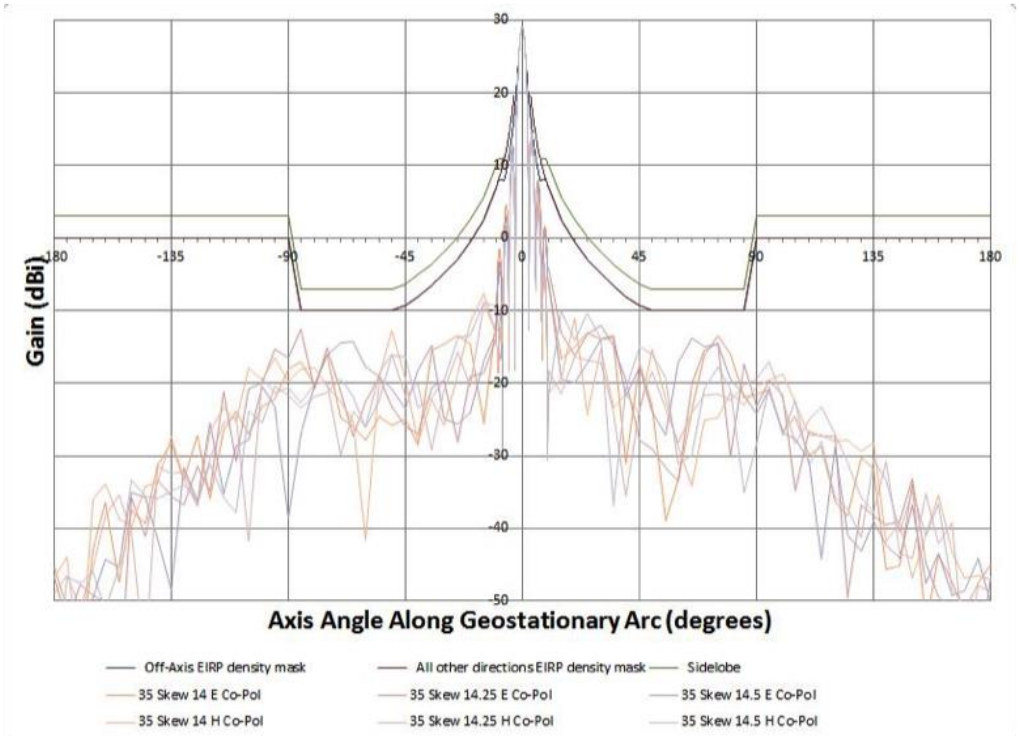


Figure 9 - Co-Pol Gain ± 180 deg., Skew 45 deg.

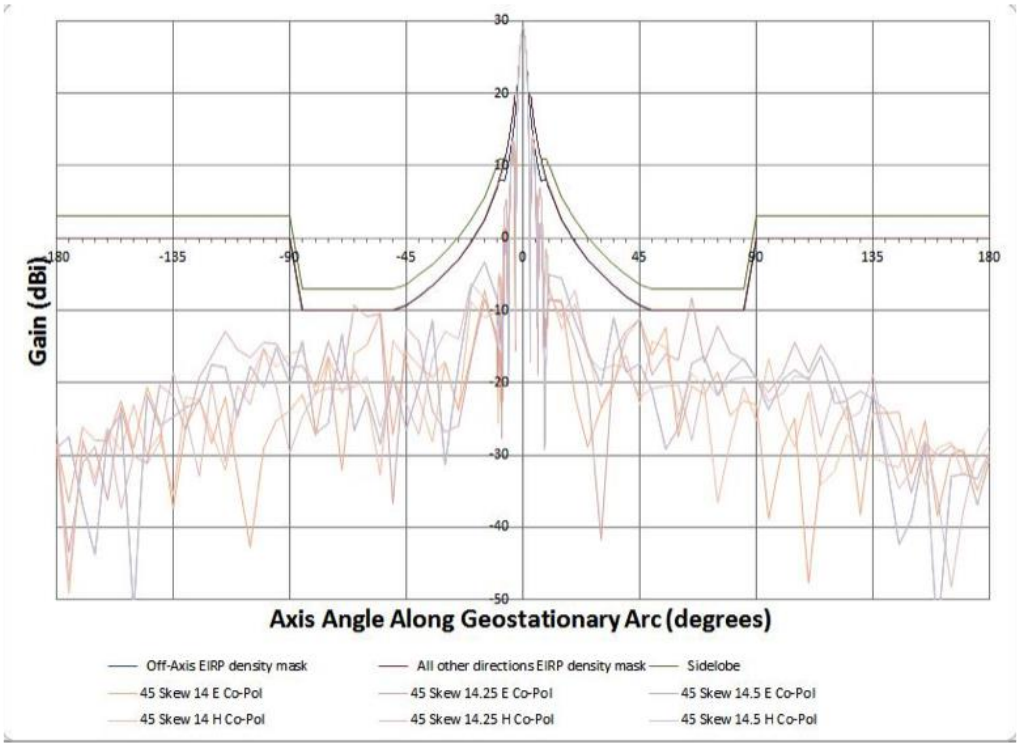


Figure 10 - Co-Pol Gain ± 180 deg., Skew 55 deg.

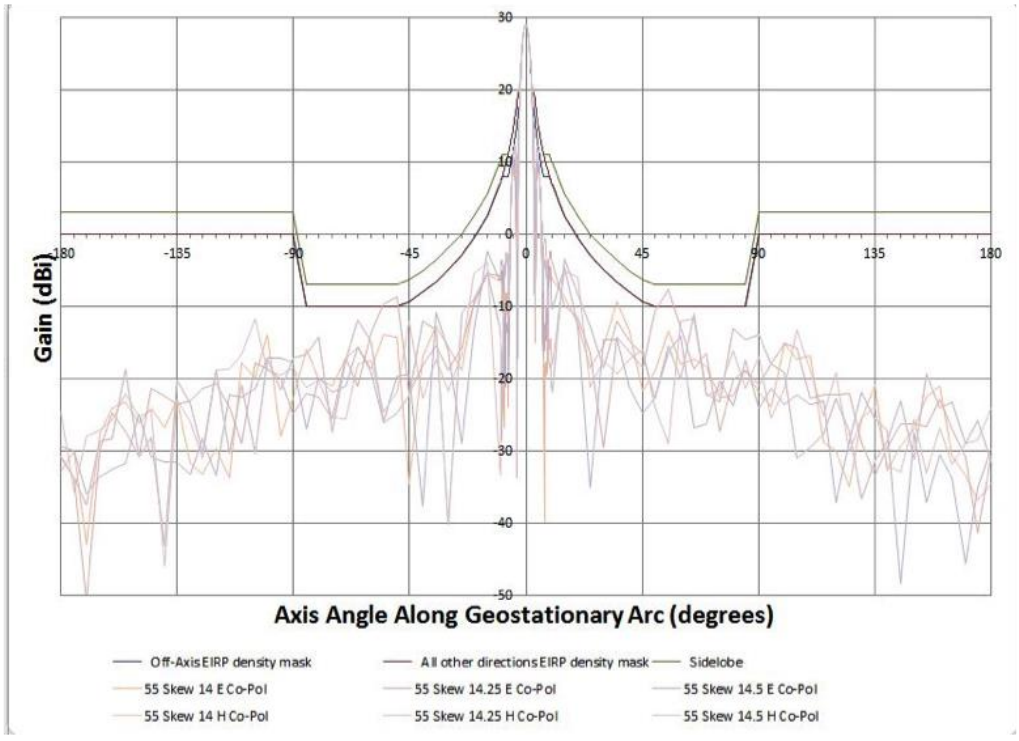
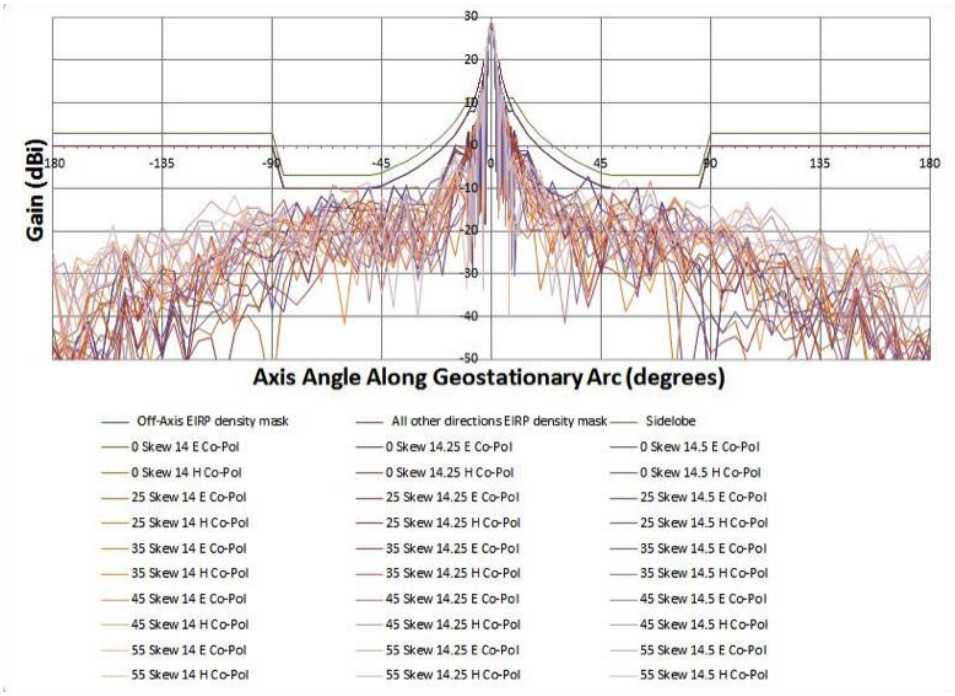


Figure 2 - Co-Pol Gain ± 180 deg., Composite



B. Cross-Pol Gain Azimuth

Figure 12 - Cross-Pol Gain ± 10 deg., Skew 0 deg.

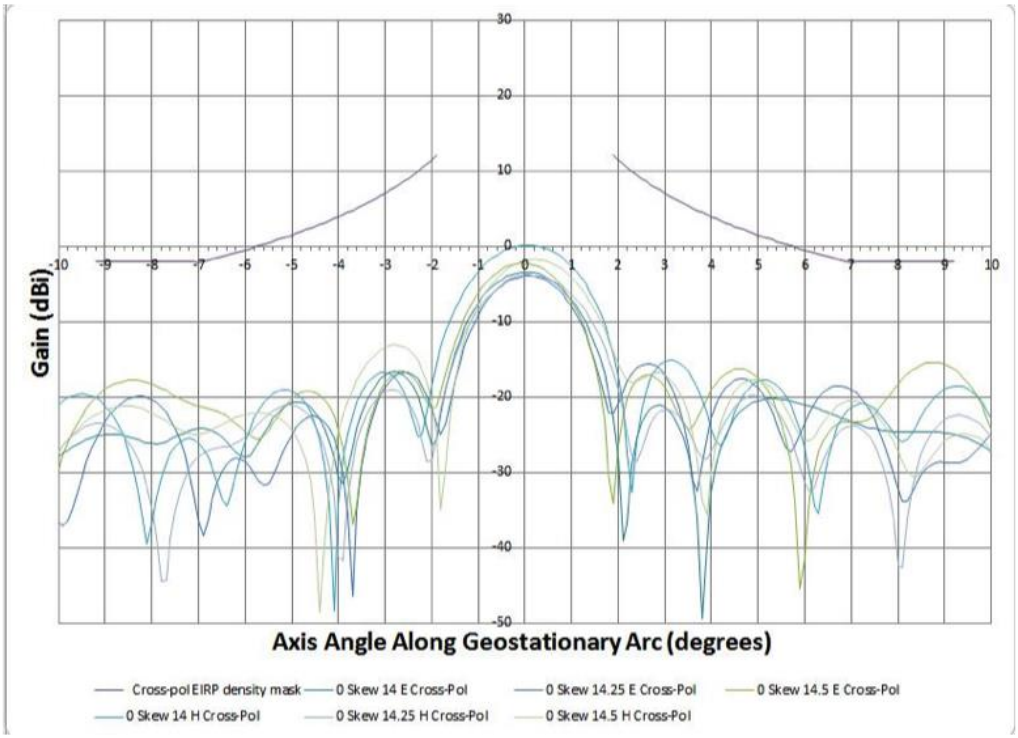


Figure 13 - Cross-Pol Gain ± 10 deg., Skew 25 deg.

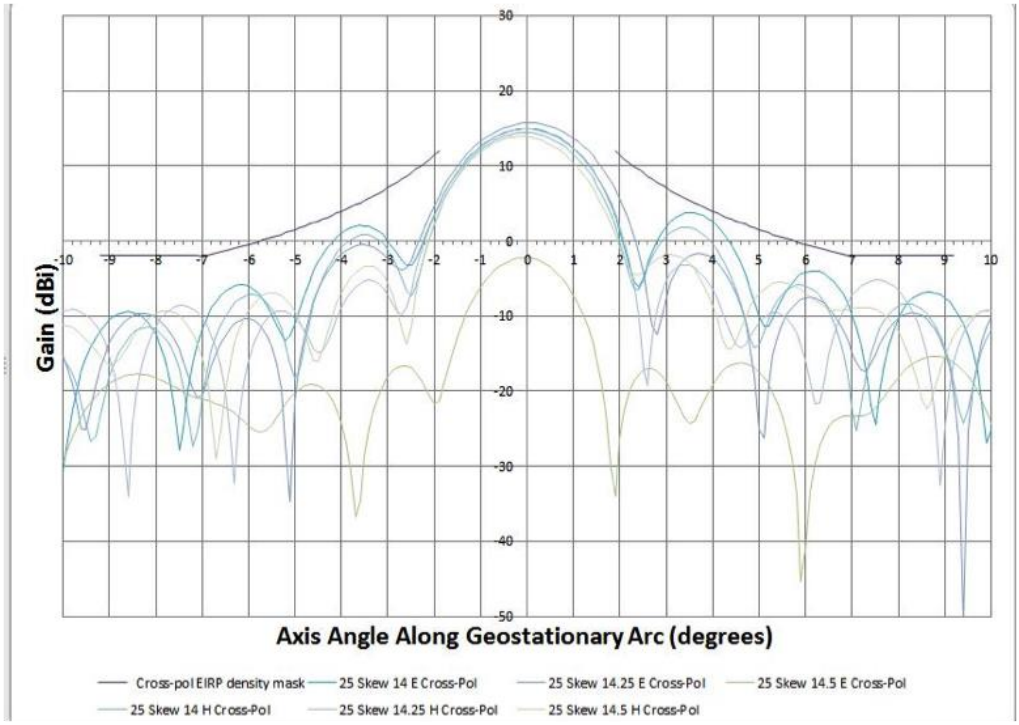


Figure 14 - Cross-Pol Gain ± 10 deg., Skew 35 deg.

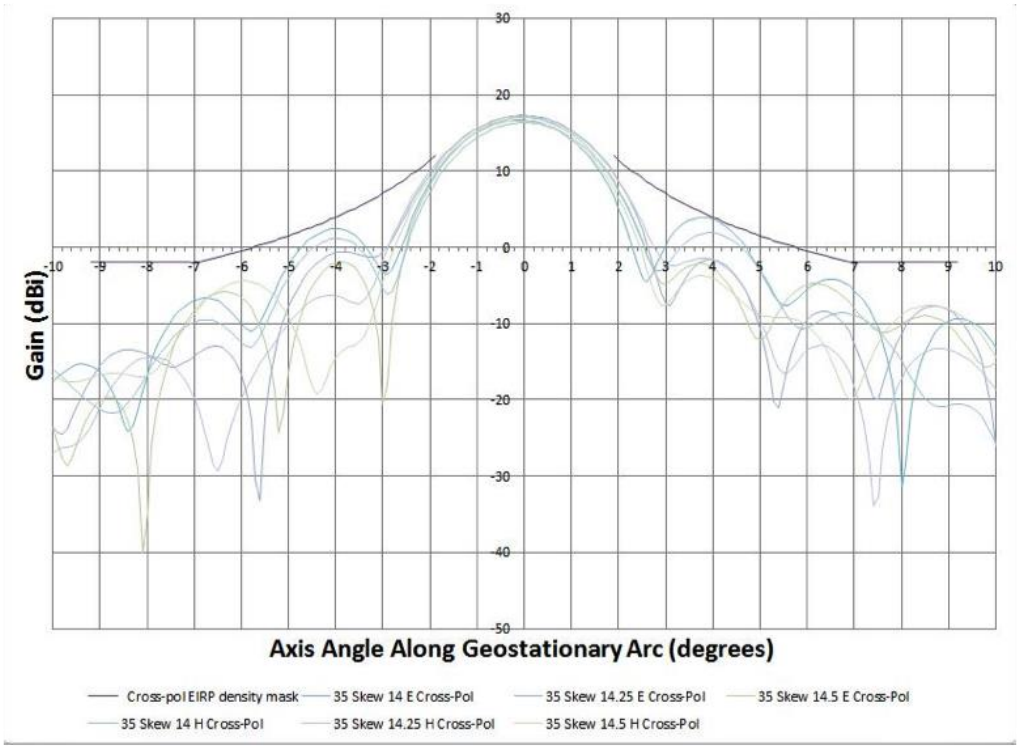


Figure 15 - Cross-Pol Gain ± 10 deg., Skew 45 deg.

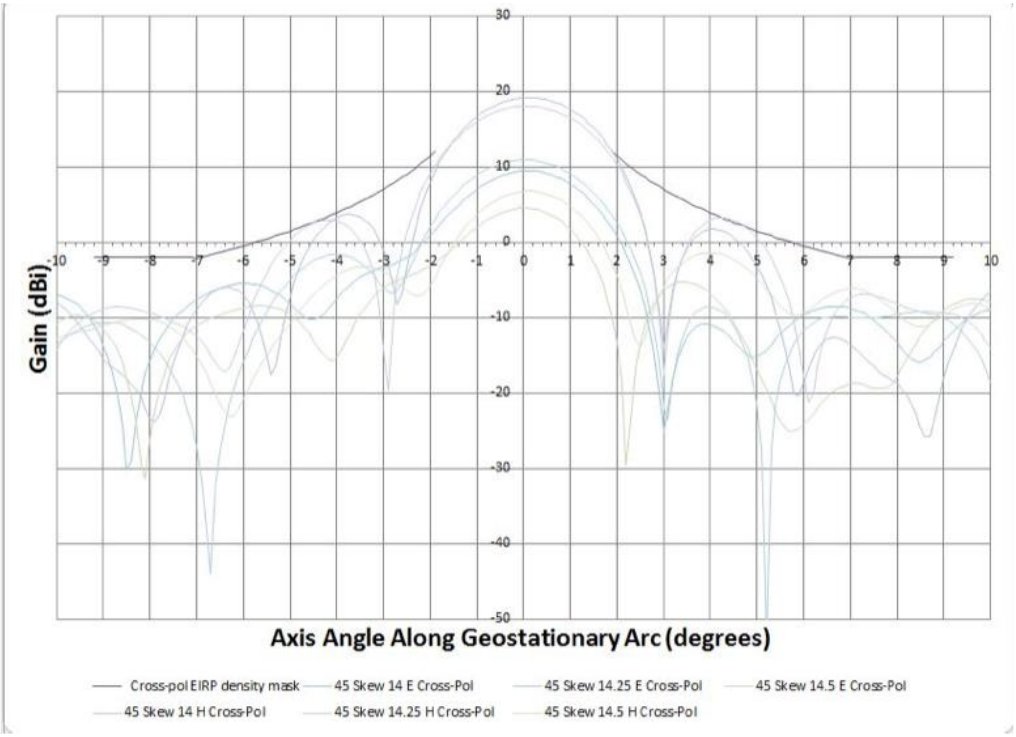


Figure 16 - Cross-Pol Gain ± 10 deg., Skew 55 deg.

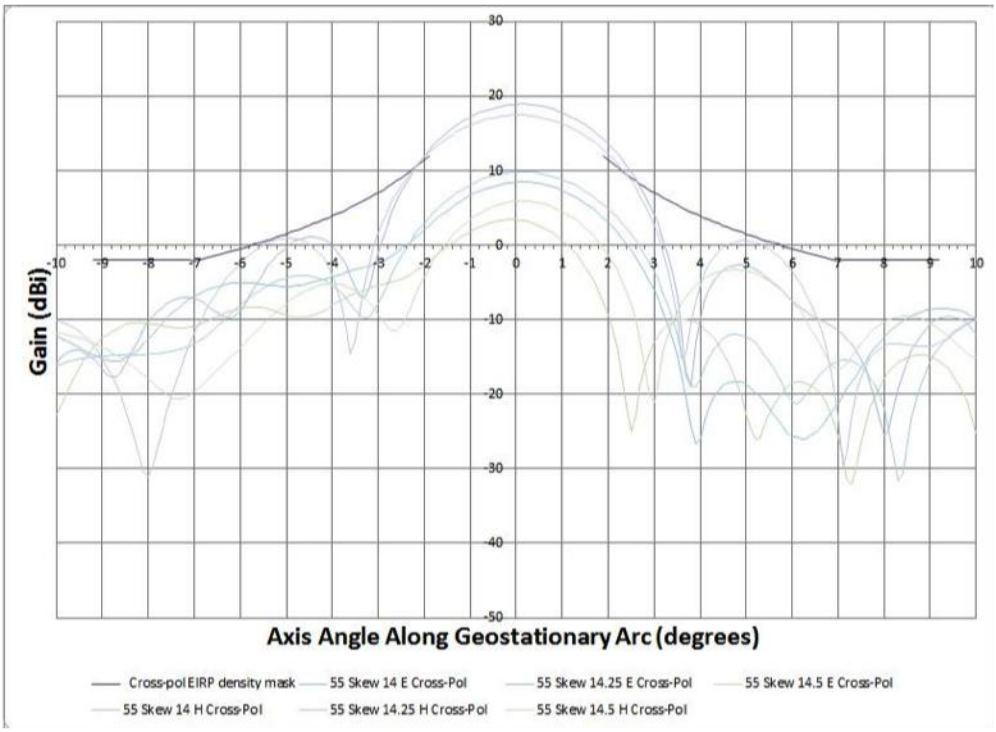
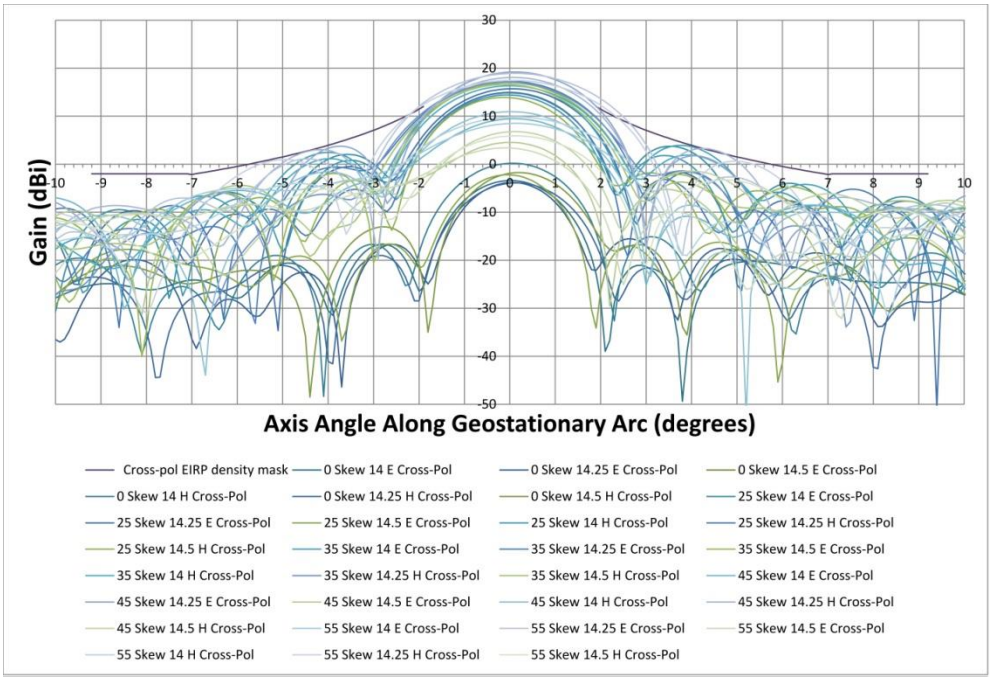


Figure 17 - Cross-Pol Gain ± 10 deg., Composite



C. Co-Pol Elevation Gain

Figure 18 - Co-Pol Elevation Gain, 0-180 deg.

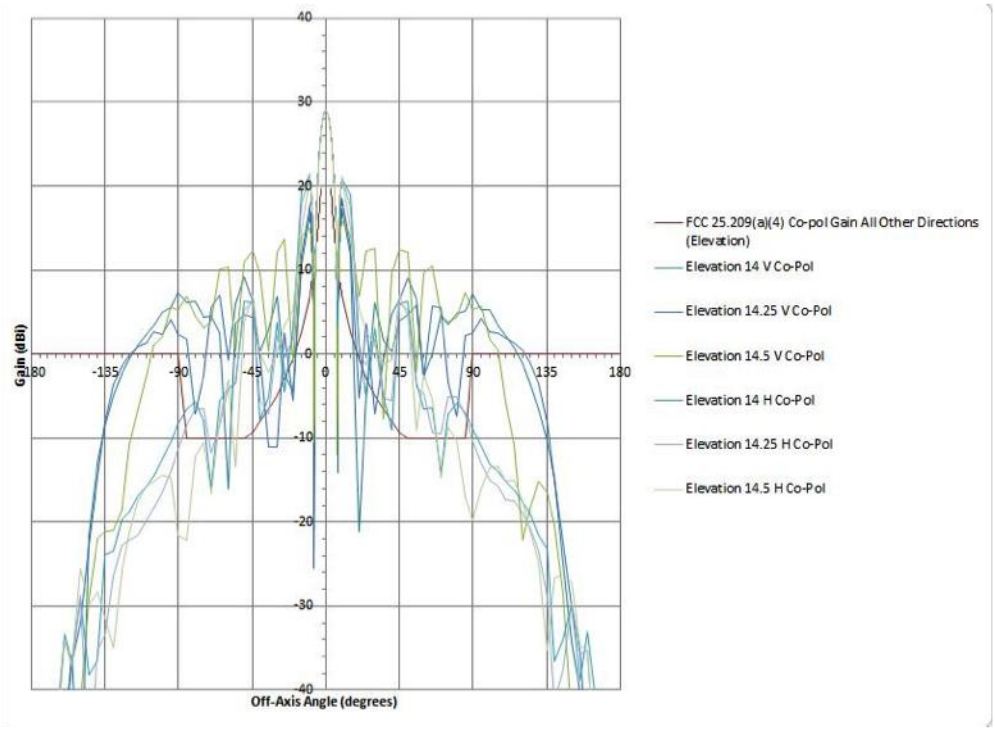
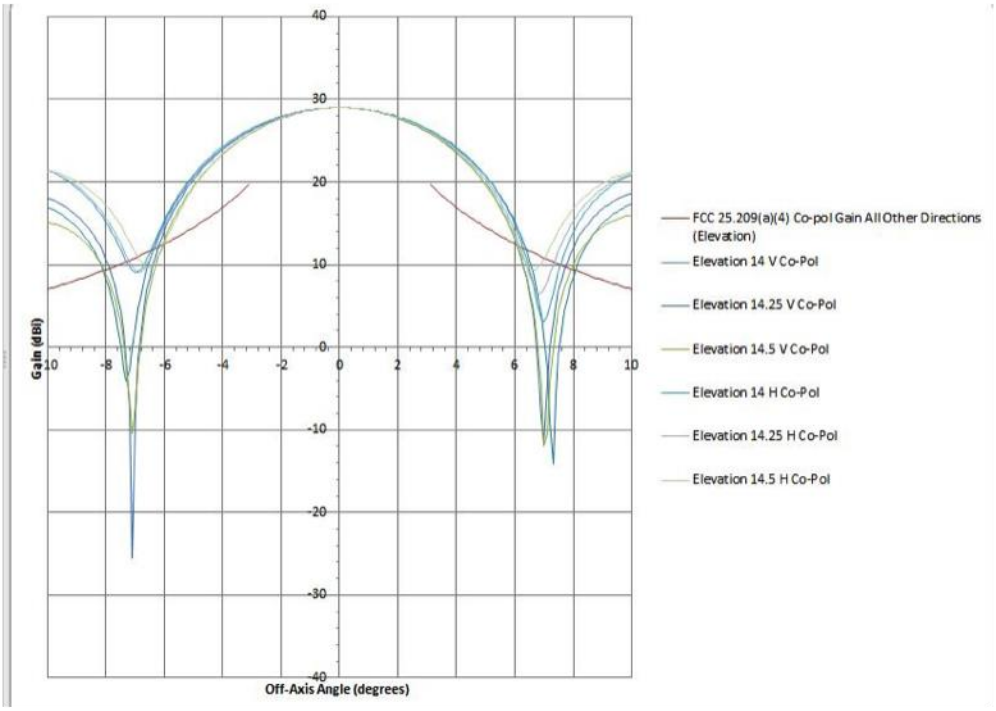


Figure 19 - Co-Pol Elevation Gain, 0-10 deg.



D. Cross-Pol Elevation Gain

Figure 20 - Cross-Pol Elevation Gain, 0-180 deg.

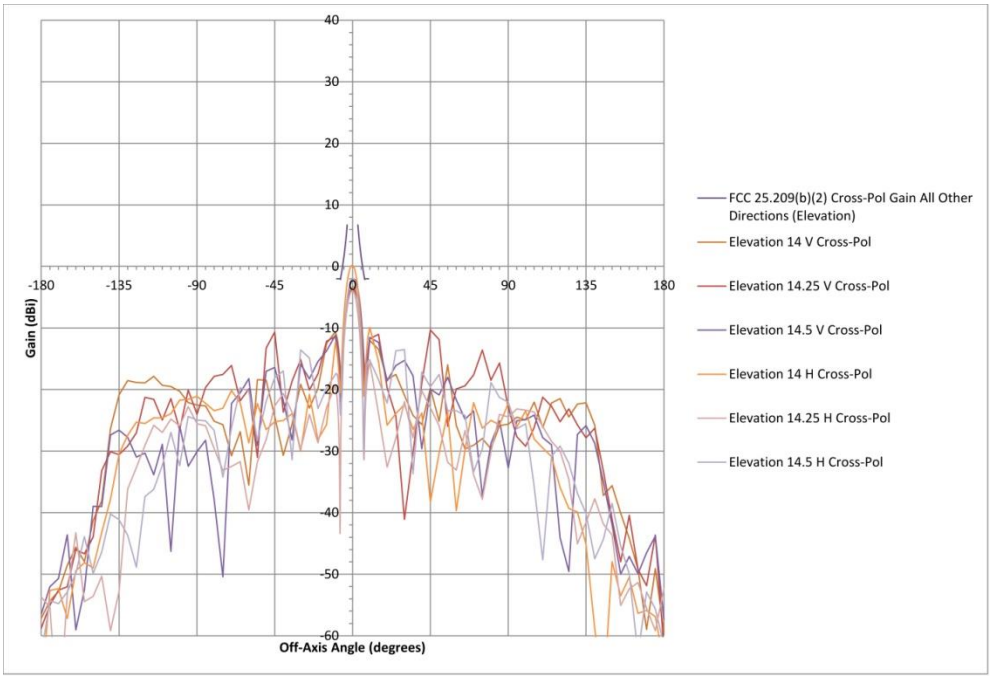
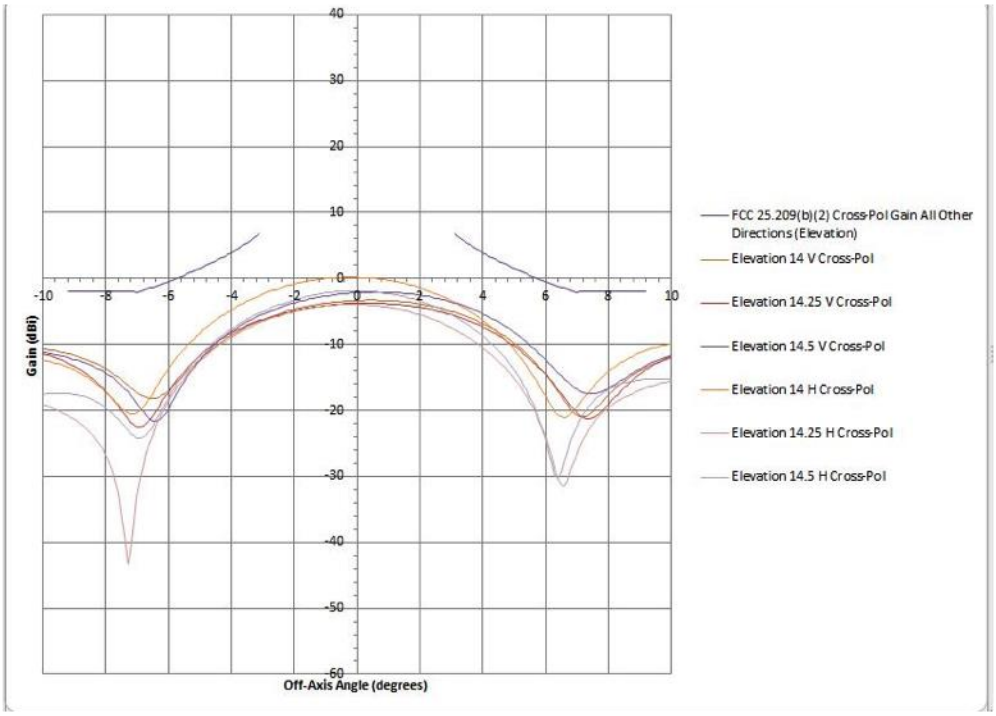


Figure 21 - Cross-Pol Elevation Gain, 0-10 deg.



E. Gain Elevation

Figure 22 – Co-Pol and Cross-Pol Elevation Gain, 0-180 deg.

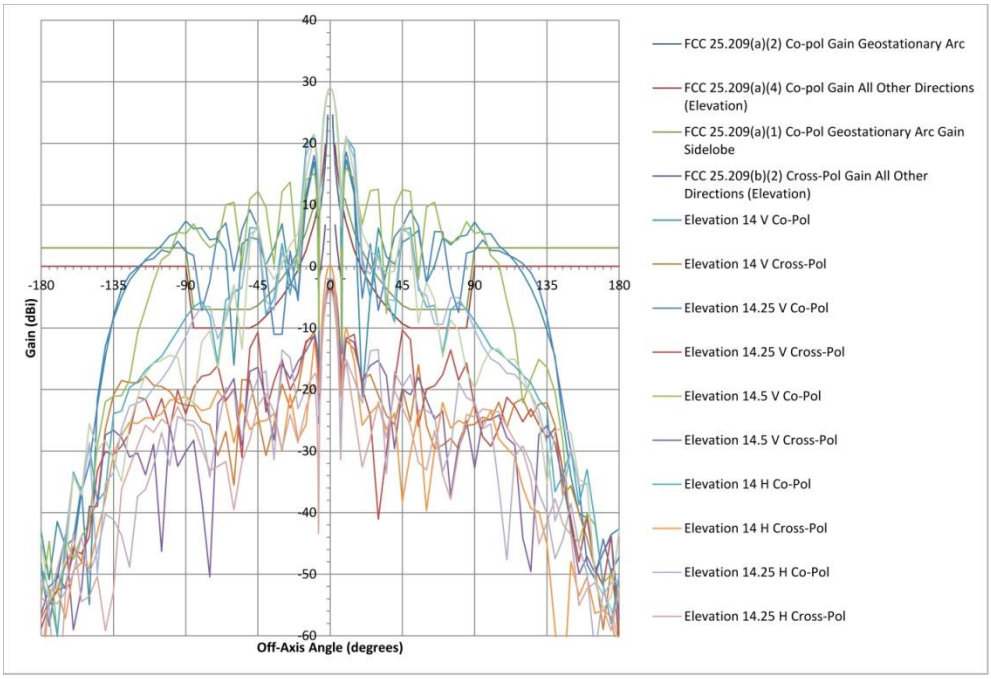
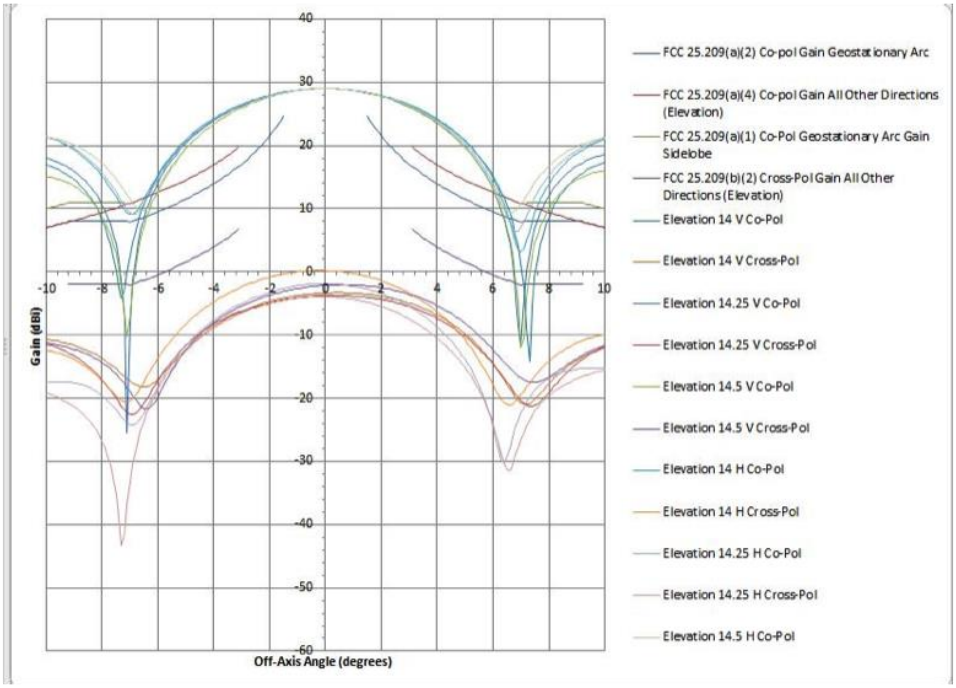


Figure 23 – Co-Pol and Cross-Pol Elevation Gain, 0-10 deg.



F. EIRP Spectral Density Plots

1. Co-Pol Elevation EIRP

Figure 24 - Co-Pol Off-Axis EIRP ± 10 deg., Skew 0 deg.

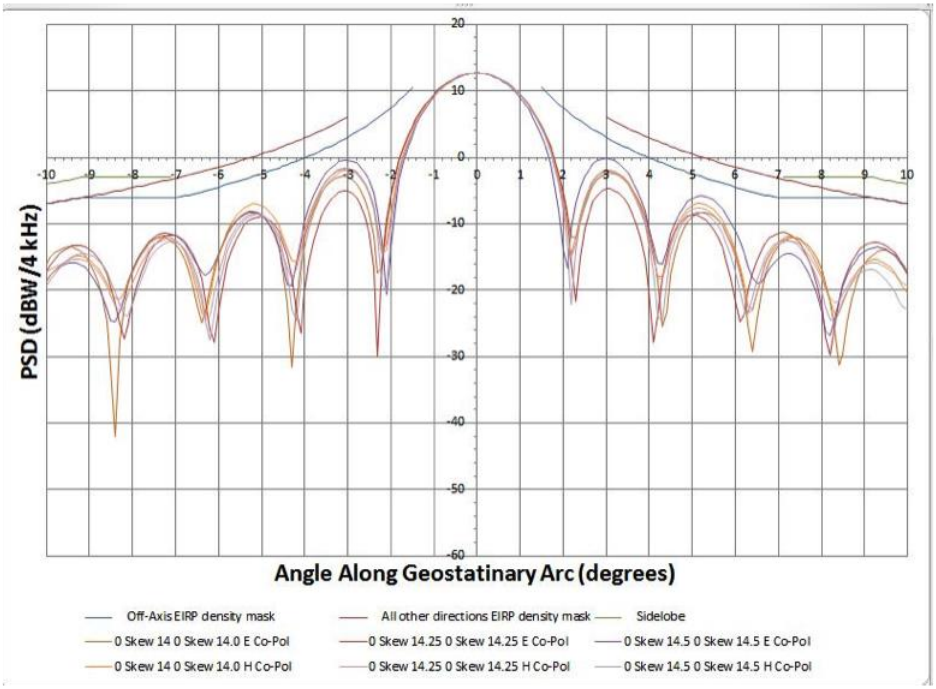


Figure 25 - Co-Pol Off-Axis EIRP ± 10 deg., Skew 25 deg.

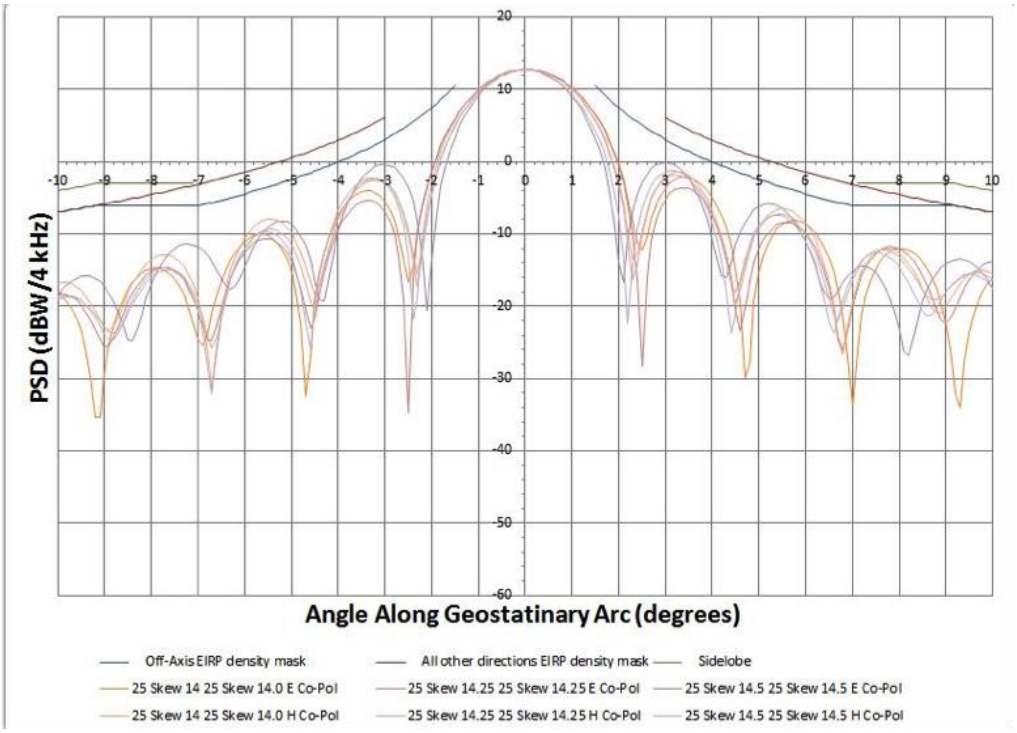


Figure 26 - Co-Pol Off-Axis EIRP ± 10 deg., Skew 35 deg.

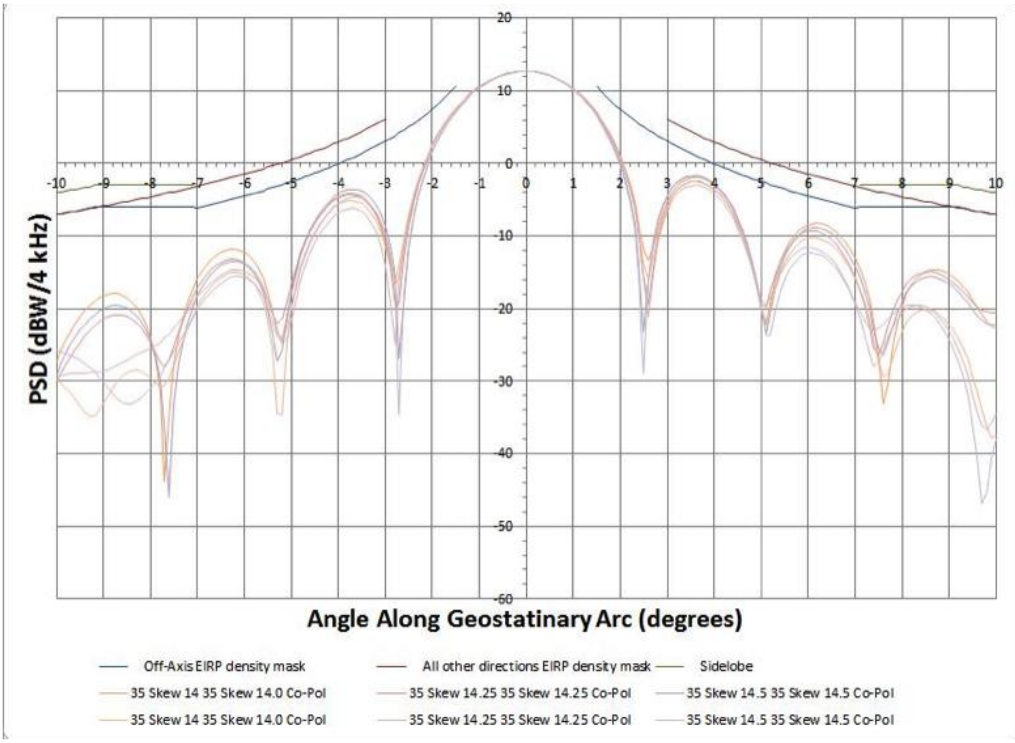


Figure 27 - Co-Pol Off-Axis EIRP ± 10 deg., Skew 45 deg.

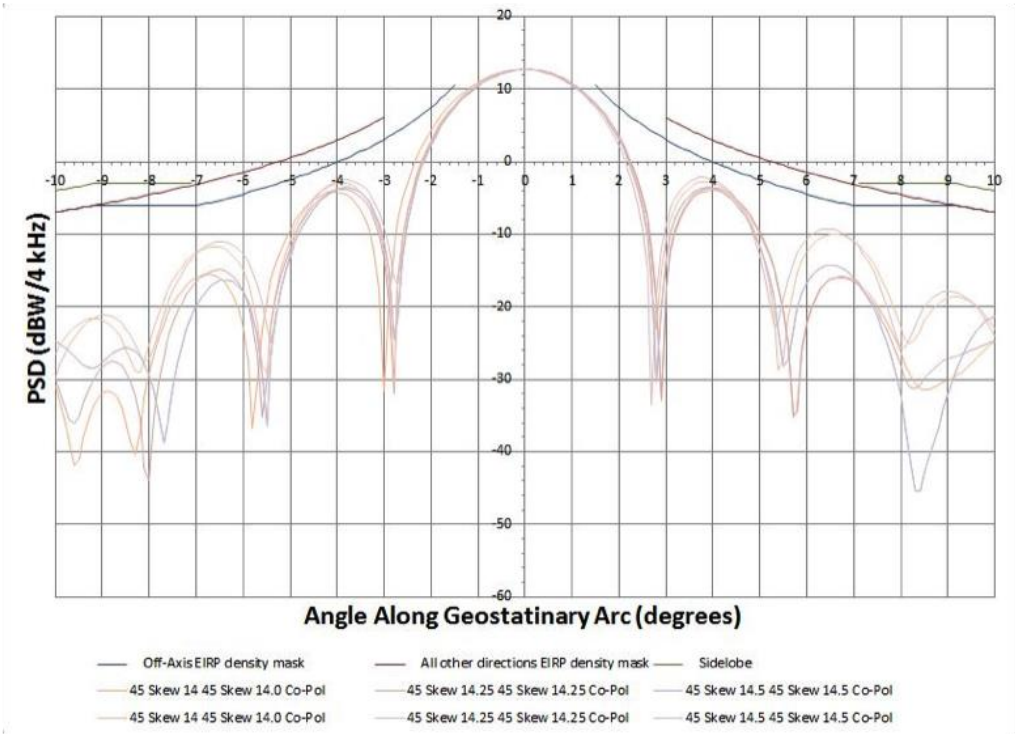


Figure 28 - Co-Pol Off-Axis EIRP ± 10 deg., Skew 55 deg.

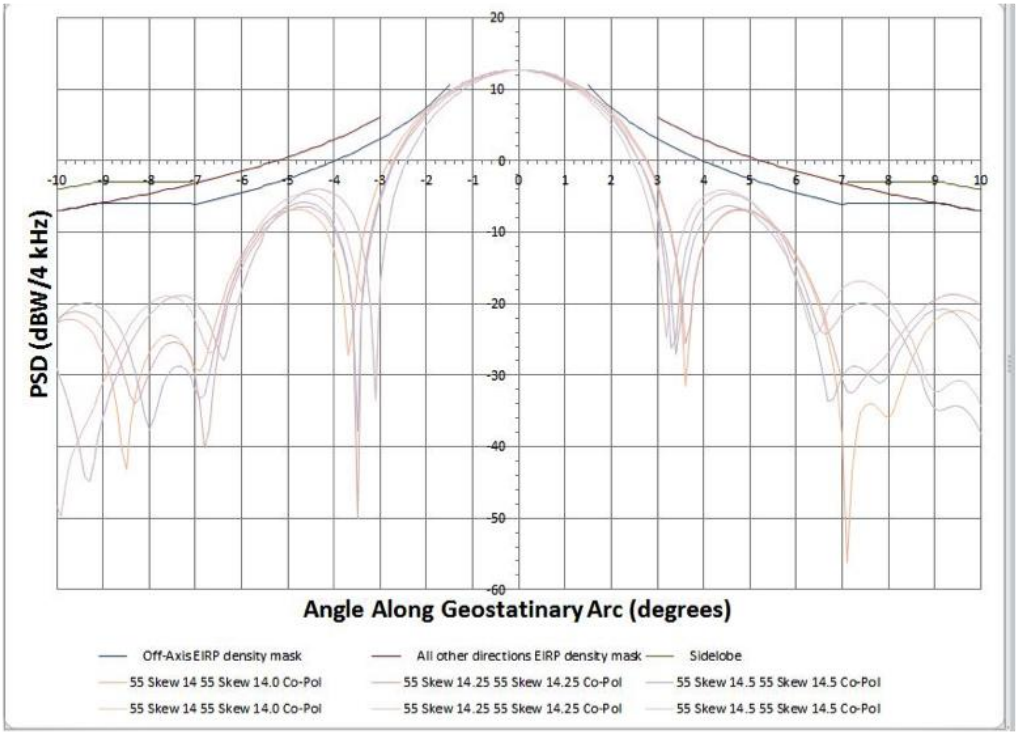


Figure 29 - Co-Pol Off-Axis EIRP ± 10 deg., Composite

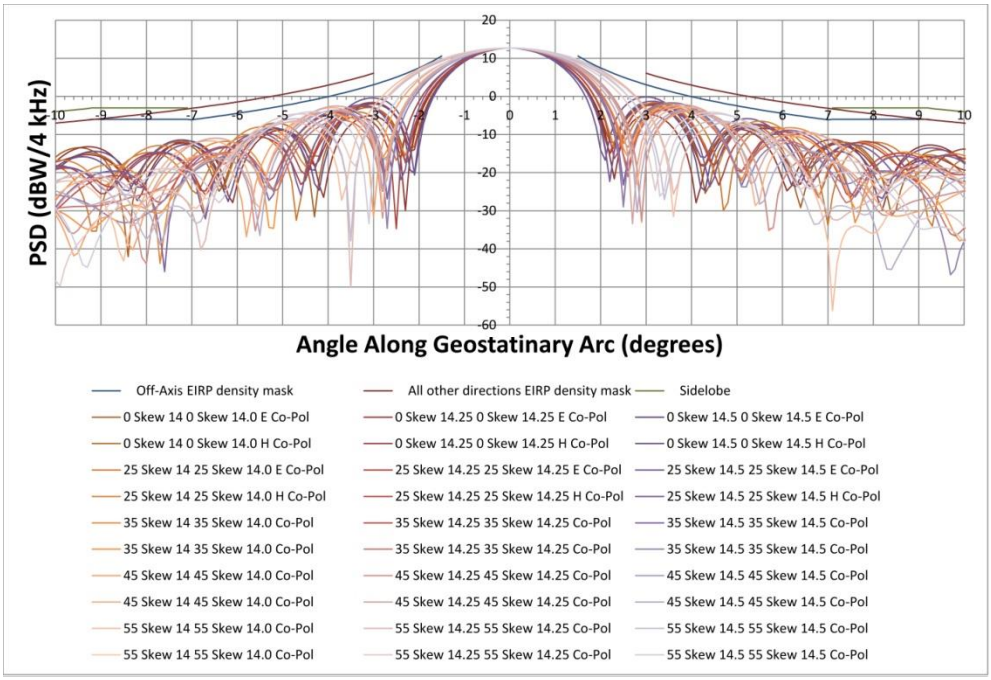


Figure 30 - Co-Pol Off-Axis EIRP ± 180 deg., Skew 0 deg.

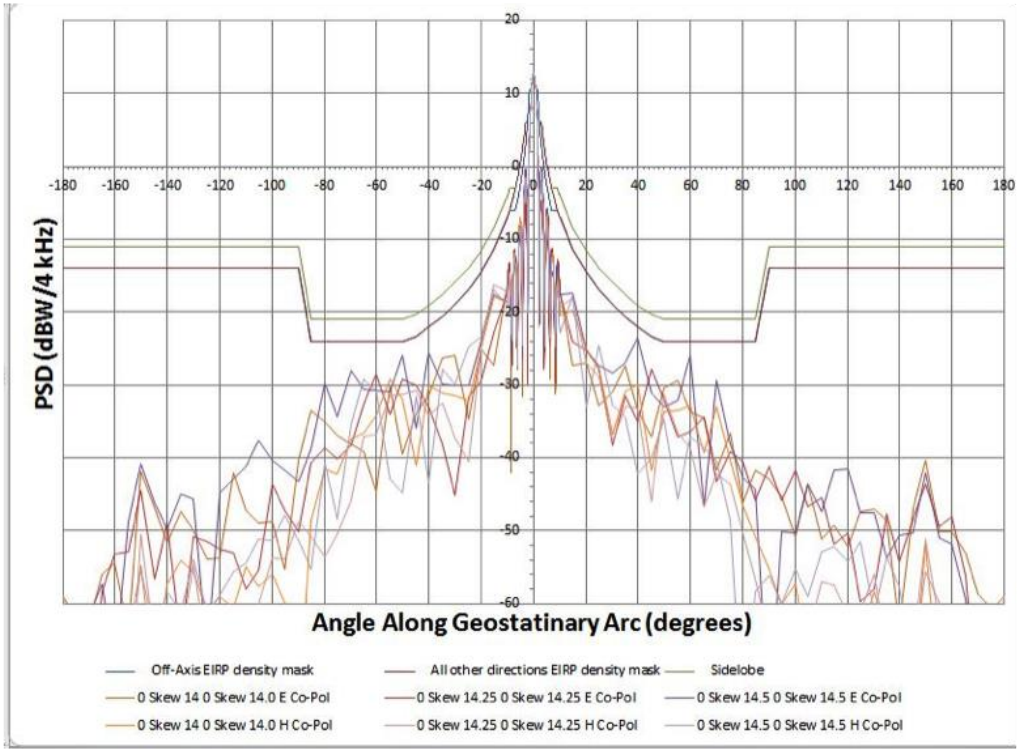


Figure 31 - Co-Pol Off-Axis EIRP ± 180 deg., Skew 25 deg.

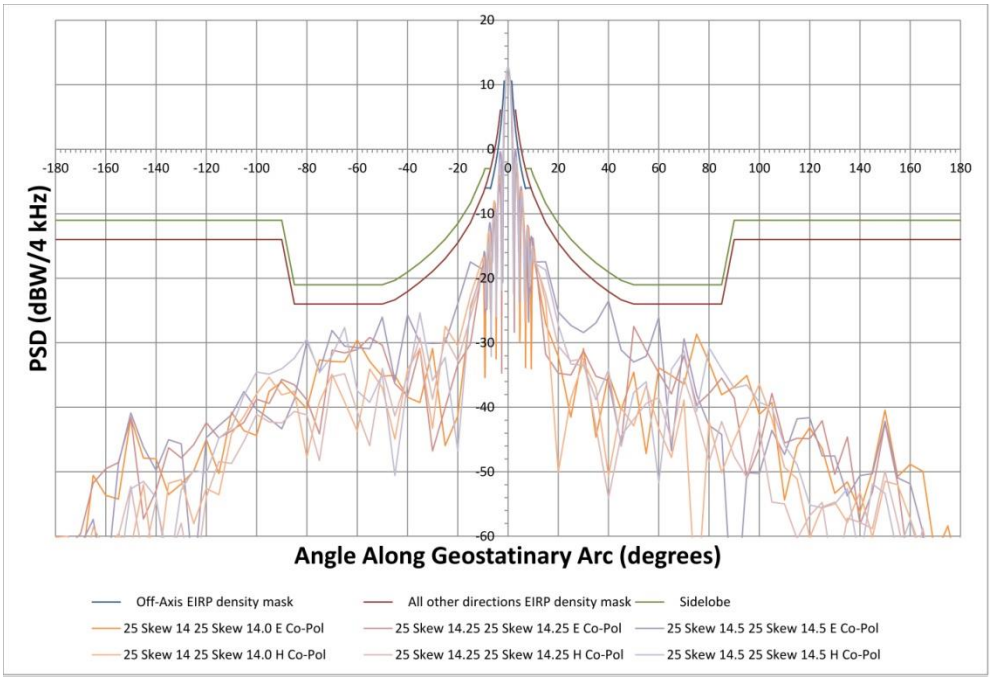


Figure 32 - Co-Pol Off-Axis EIRP ± 180 deg., Skew 35 deg.

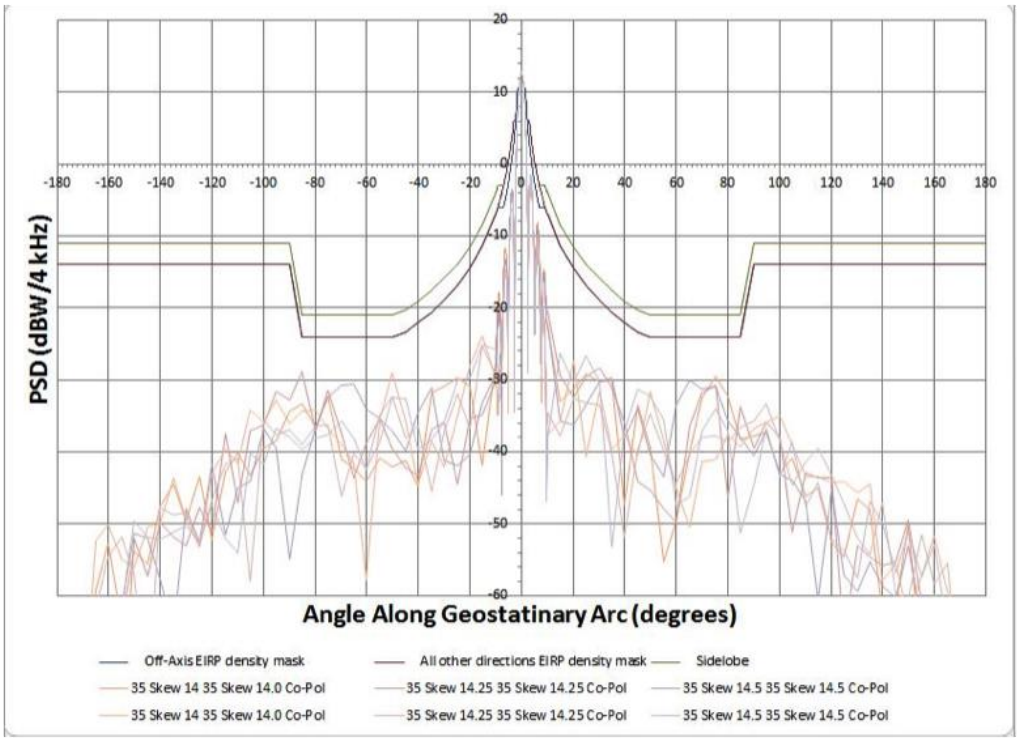


Figure 33 - Co-Pol Off-Axis EIRP ± 180 deg., Skew 45 deg.

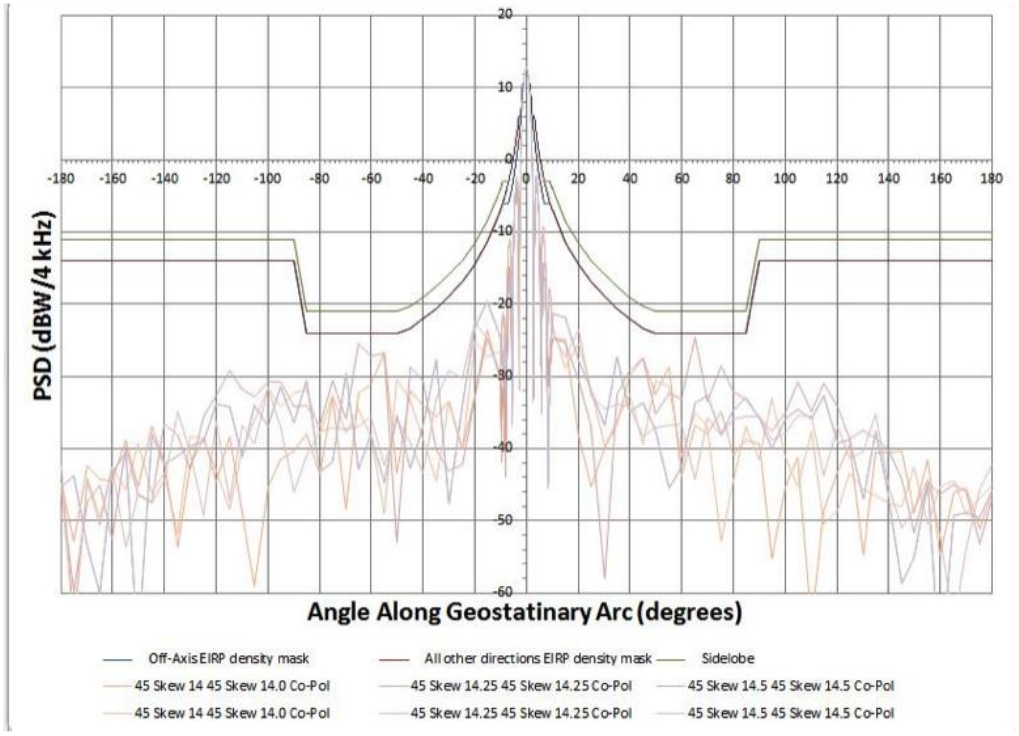


Figure 34 - Co-Pol Off-Axis EIRP ± 180 deg., Skew 55 deg.

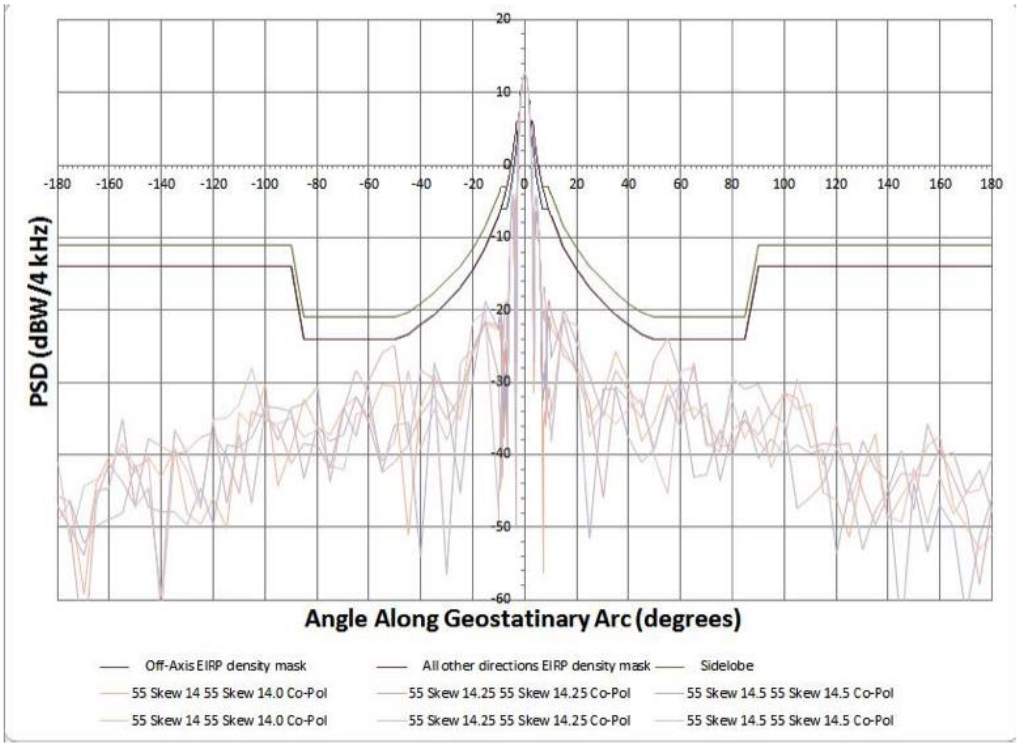
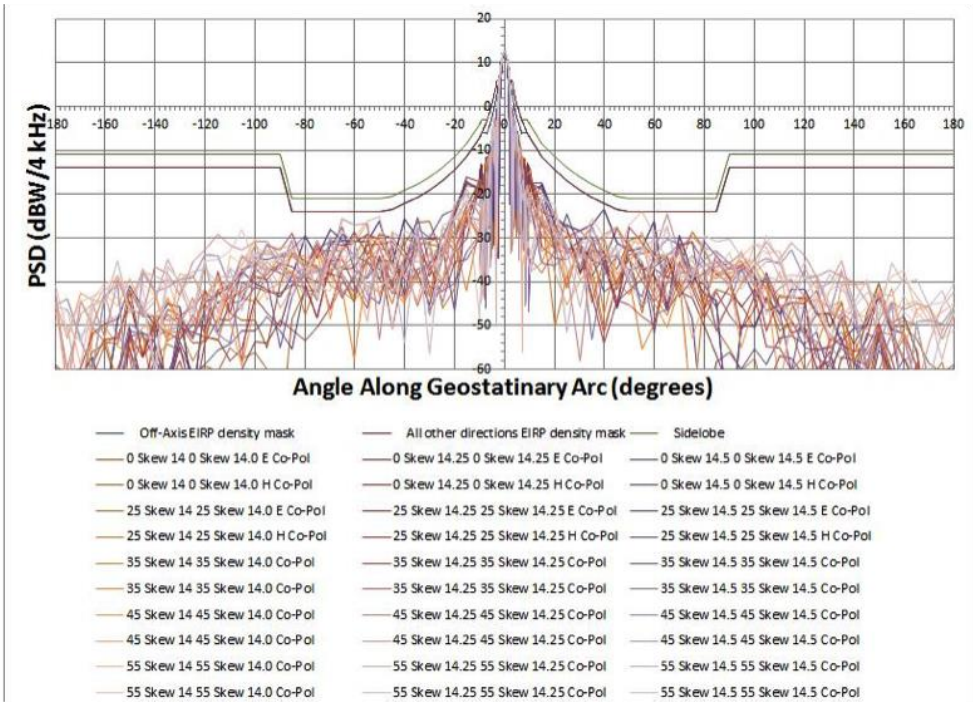


Figure 37 - Co-Pol Off-Axis EIRP ± 180 deg., Composite



2. Cross-Pol Azimuth EIRP

Figure 38 - Cross-Pol Off-Axis EIRP ± 10 deg., Skew 0 deg.

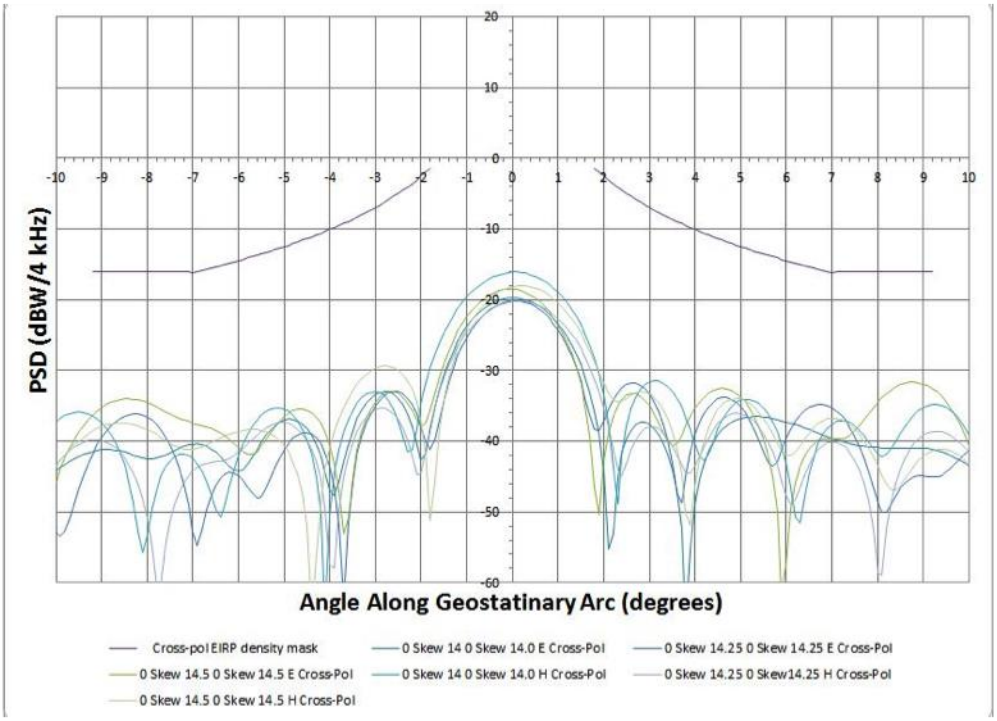


Figure 39 - Cross-Pol Off-Axis EIRP ± 10 deg., Skew 25 deg.

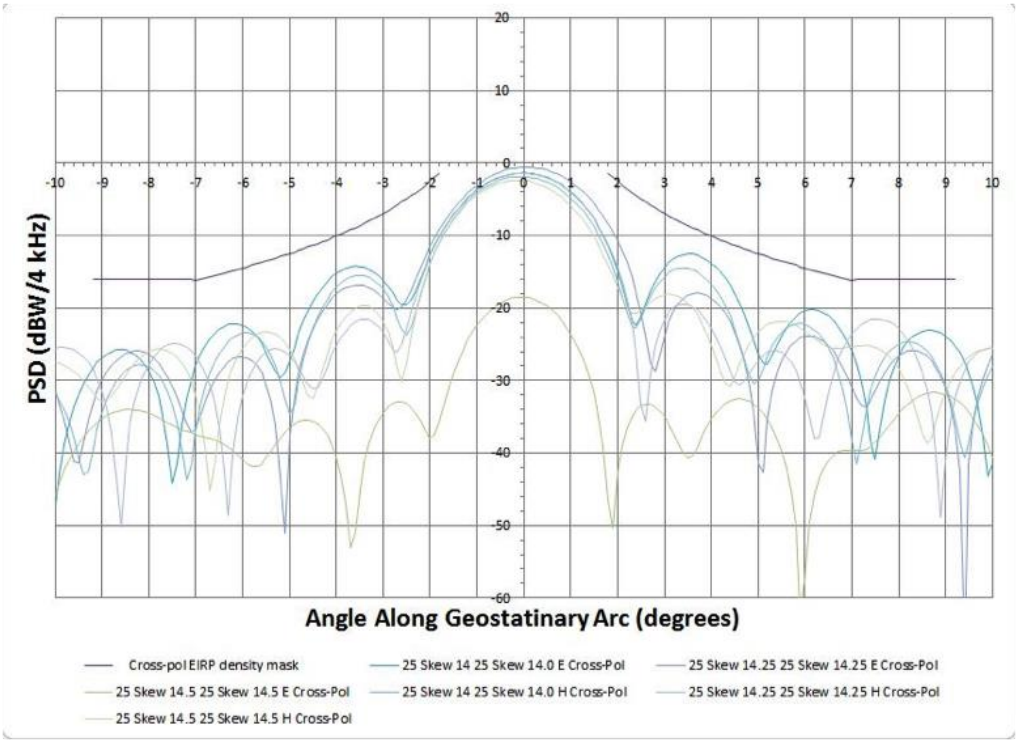


Figure 40 - Cross-Pol Off-Axis EIRP ± 10 deg., Skew 35 deg.

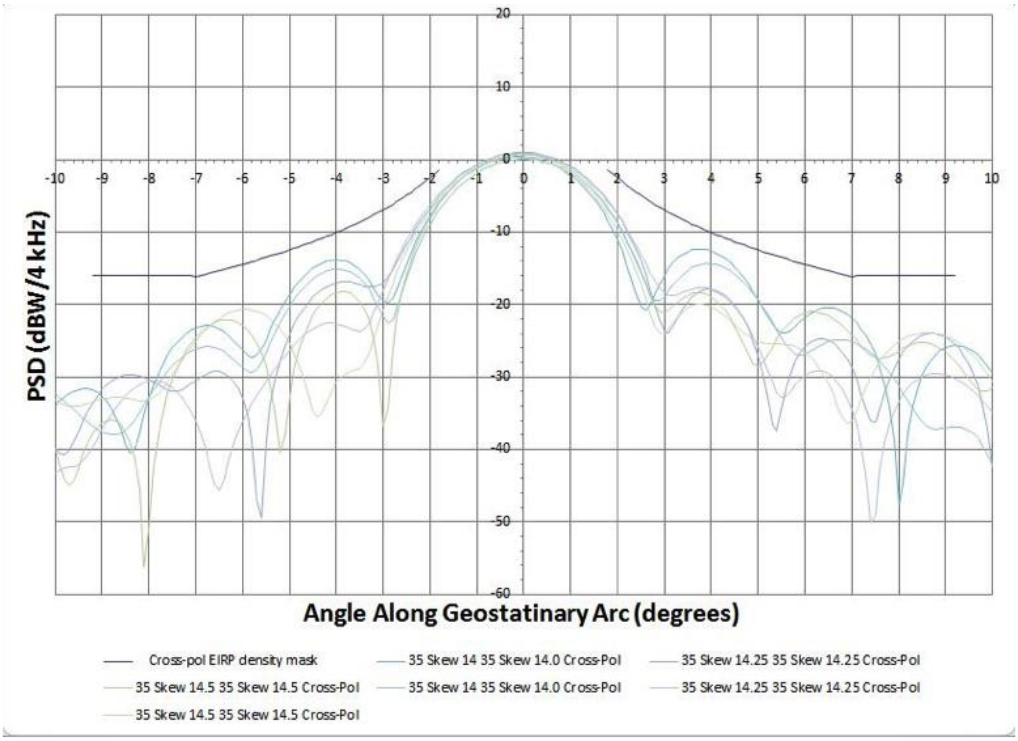


Figure 41 - Cross-Pol Off-Axis EIRP ± 10 deg., Skew 45 deg.

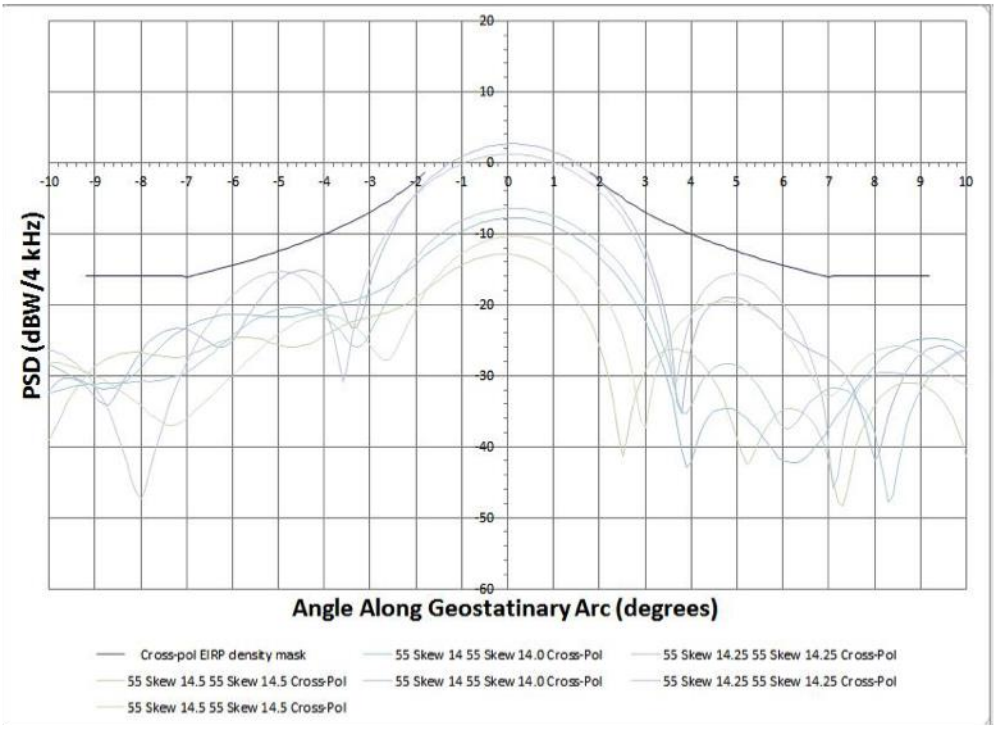


Figure 42 - Cross-Pol Off-Axis EIRP ± 10 deg., Skew 55 deg.

Figure 43 - Cross-Pol Off-Axis EIRP ± 10 deg., Composite

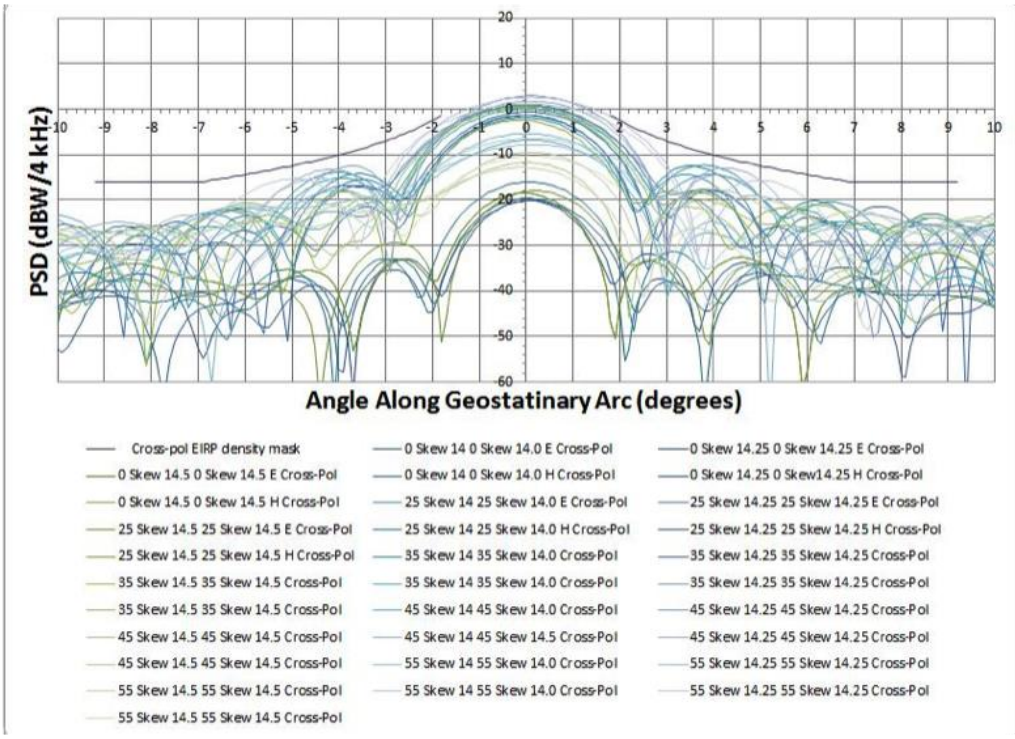
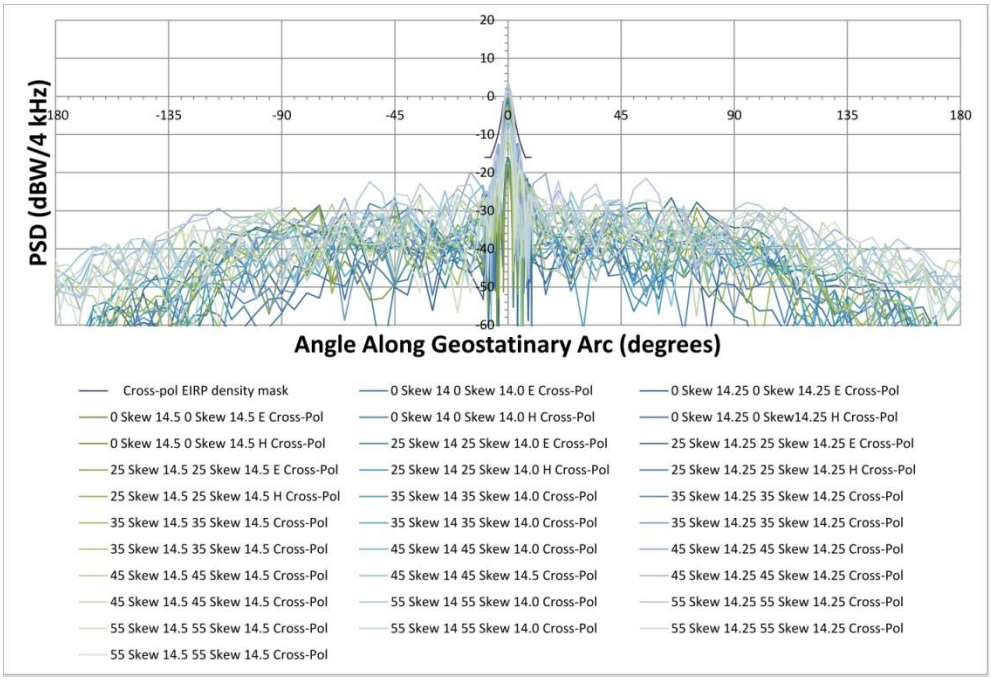


Figure 44 - Cross-Pol Off-Axis EIRP ± 180 deg., Composite



II. Antenna Gain and Off-Axis EIRP Compliance Table

	Antenna Gain						FCC Masks			EIRP (dBW/4 kHz)					
Off-Axis Angle Deg.	0 Skew 14 GHz E Co-Pol	0 Skew 14.25 GHz E Co-Pol	0 Skew 14.5 GHz E Co-Pol	0 Skew 14 GHz H Co-Pol	0 Skew 14.25 GHz H Co-Pol	0 Skew 14.5 GHz H Co-Pol	W/n 3° of GSO Arc	All Other Dir.	0 Skew 14 GHz E Co-Pol	0 Skew 14.25 GHz E Co-Pol	0 Skew 14.5 GHz E Co-Pol	0 Skew 14 GHz H Co-Pol	0 Skew 14.25 GHz H Co-Pol	0 Skew 14.5 GHz H Co-Pol	Complies with Mask
-180	-42.661	-47.209	-53.358	-50.243	-50.8	-42.747	-14	-14	-58.961	-63.509	-69.658	-66.543	-67.1	-59.047	Y
-175	-45.568	-50.858	-57.023	-47.166	-46.964	-55.013	-14	-14	-61.868	-67.158	-73.323	-63.466	-63.264	-71.313	Y
-170	-46.24	-58.938	-45.125	-48.29	-58.017	-49.923	-14	-14	-62.54	-75.238	-61.425	-64.59	-74.317	-66.223	Y
-165	-39.661	-42.045	-41.089	-47.161	-56.179	-55.357	-14	-14	-55.961	-58.345	-57.389	-63.461	-72.479	-71.657	Y
-160	-38.03	-36.98	-52.32	-48.758	-50.494	-51.809	-14	-14	-54.33	-53.28	-68.62	-65.058	-66.794	-68.109	Y
-155	-47.53	-36.647	-32.507	-53.351	-62.886	-47.404	-14	-14	-63.83	-52.947	-48.807	-69.651	-79.186	-63.704	Y
-150	-25.682	-28.2	-24.583	-38.388	-34.122	-39.215	-14	-14	-41.982	-44.5	-40.883	-54.688	-50.422	-55.515	Y
-145	-30.533	-40.289	-29.87	-54.162	-49.338	-47.518	-14	-14	-46.833	-56.589	-46.17	-70.462	-65.638	-63.818	Y
-140	-35.38	-32.605	-33.479	-41.042	-51.609	-42.071	-14	-14	-51.68	-48.905	-49.779	-57.342	-67.909	-58.371	Y
-135	-31.017	-49.121	-28.723	-37.847	-48.332	-44.816	-14	-14	-47.317	-65.421	-45.023	-54.147	-64.632	-61.116	Y
-130	-33.696	-34.446	-29.383	-39.358	-38.502	-37.52	-14	-14	-49.996	-50.746	-45.683	-55.658	-54.802	-53.82	Y
-125	-37.657	-35.257	-50.898	-44.807	-50.497	-44.891	-14	-14	-53.957	-51.557	-67.198	-61.107	-66.797	-61.191	Y
-120	-37.507	-36.304	-28.432	-42.77	-45.736	-42.494	-14	-14	-53.807	-52.604	-44.732	-59.07	-62.036	-58.794	Y
-115	-25.74	-36.735	-26.541	-44.249	-45.032	-39.296	-14	-14	-42.04	-53.035	-42.841	-60.549	-61.332	-55.596	Y

-110	-30.925	-41.712	-24.863	-38.698	-57.419	-38.072	-14	-14	-47.225	-58.012	-41.163	-54.998	-73.719	-54.372	Y
-105	-32.628	-39.169	-21.265	-41.353	-43.773	-34.848	-14	-14	-48.928	-55.469	-37.565	-57.653	-60.073	-51.148	Y
-100	-32.525	-27.253	-24.022	-39.734	-37.337	-35.053	-14	-14	-48.825	-43.553	-40.322	-56.034	-53.637	-51.353	Y
-95	-38.897	-30.992	-25.447	-43.612	-37.677	-31.562	-14	-14	-55.197	-47.292	-41.747	-59.912	-53.977	-47.862	Y
-90	-24.128	-33.739	-27.041	-59.189	-32.492	-35.058	-14	-14	-40.428	-50.039	-43.341	-75.489	-48.792	-51.358	Y
-85	-17.284	-24.37	-22.448	-32.27	-34.557	-38.999	-24	-24	-33.584	-40.67	-38.748	-48.57	-50.857	-55.299	Y
-80	-18.759	-22.404	-13.462	-25.315	-37.209	-24.408	-24	-24	-35.059	-38.704	-29.762	-41.615	-53.509	-40.708	Y
-75	-20.65	-23.865	-18.128	-25.988	-34.113	-32.089	-24	-24	-36.95	-40.165	-34.428	-42.288	-50.413	-48.389	Y
-70	-21.758	-22.004	-11.797	-21.121	-29.572	-19.104	-24	-24	-38.058	-38.304	-28.097	-37.421	-45.872	-35.404	Y
-65	-22.774	-16.349	-14.211	-20.291	-20.768	-12.956	-24	-24	-39.074	-32.649	-30.511	-36.591	-37.068	-29.256	Y
-60	-28.289	-12.291	-14.454	-17.819	-20.411	-14.523	-24	-24	-44.589	-28.591	-30.754	-34.119	-36.711	-30.823	Y
-55	-13.875	-17.63	-14.631	-12.979	-15.184	-26.543	-24	-24	-30.175	-33.93	-30.931	-29.279	-31.484	-42.843	Y
-50	-23.161	-12.877	-9.723	-15.575	-15.034	-28.566	-24	-24	-39.461	-29.177	-26.023	-31.875	-31.334	-44.866	Y
-45	-17.547	-13.715	-19.638	-24.689	-14.49	-15.301	-23.33	-23.33	-33.847	-30.015	-35.938	-40.989	-30.79	-31.601	Y
-40	-15.119	-16.653	-9.355	-13.729	-17.936	-27.144	-22.05	-22.05	-31.419	-32.953	-25.655	-30.029	-34.236	-43.444	Y
-35	-10.067	-21.797	-13.662	-14.74	-16.22	-11.557	-20.60	-20.60	-26.367	-38.097	-29.962	-31.04	-32.52	-27.857	Y
-30	-9.737	-28.839	-13.818	-15.084	-20.895	-13.585	-18.93	-18.93	-26.037	-45.139	-30.118	-31.384	-37.195	-29.885	Y
-25	-18.341	-15.299	-13.728	-15.847	-24.156	-8.467	-16.95	-16.95	-34.641	-31.599	-30.028	-32.147	-40.456	-24.767	Y

-20	-8.745	-13.149	-7.637	-8.609	-8.213	-7.147	-14.53	-14.53	-25.045	-29.449	-23.937	-24.909	-24.513	-23.447	Y
-15	-11.091	-6.608	-1.185	-1.648	0.12	-0.654	-11.40	-11.40	-27.391	-22.908	-17.485	-17.948	-16.18	-16.954	Y
-10	0.361	-0.901	-2.328	-2.256	-0.881	-2.964	-7.00	-7.00	-15.939	-17.201	-18.628	-18.556	-17.181	-19.264	Y
-9.9	1.266	0.168	-1.469	-1.512	-0.621	-2.117	-6.89	-6.89	-15.034	-16.132	-17.769	-17.812	-16.921	-18.417	Y
-9.8	1.944	1.051	-0.774	-0.75	-0.282	-1.238	-6.78	-6.78	-14.356	-15.249	-17.074	-17.05	-16.582	-17.538	Y
-9.7	2.423	1.765	-0.235	-0.051	0.085	-0.411	-6.67	-6.67	-13.877	-14.535	-16.535	-16.351	-16.215	-16.711	Y
-9.6	2.72	2.321	0.151	0.537	0.431	0.316	-6.56	-6.56	-13.58	-13.979	-16.149	-15.763	-15.869	-15.984	Y
-9.5	2.842	2.728	0.387	0.991	0.719	0.919	-6.44	-6.44	-13.458	-13.572	-15.913	-15.309	-15.581	-15.381	Y
-9.4	2.79	2.989	0.468	1.297	0.917	1.385	-6.33	-6.33	-13.51	-13.311	-15.832	-15.003	-15.383	-14.915	Y
-9.3	2.557	3.104	0.386	1.448	1.004	1.706	-6.21	-6.21	-13.743	-13.196	-15.914	-14.852	-15.296	-14.594	Y
-9.2	2.129	3.068	0.131	1.435	0.96	1.876	-6	-6.09	-14.171	-13.232	-16.169	-14.865	-15.34	-14.424	Y
-9.1	1.48	2.874	-0.317	1.25	0.767	1.888	-6	-5.98	-14.82	-13.426	-16.617	-15.05	-15.533	-14.412	Y
-9	0.568	2.509	-0.984	0.881	0.407	1.734	-6	-5.86	-15.732	-13.791	-17.284	-15.419	-15.893	-14.566	Y
-8.9	-0.678	1.95	-1.906	0.315	-0.142	1.4	-6	-5.73	-16.978	-14.35	-18.206	-15.985	-16.442	-14.9	Y
-8.8	-2.38	1.167	-3.126	-0.463	-0.903	0.865	-6	-5.61	-18.68	-15.133	-19.426	-16.763	-17.203	-15.435	Y
-8.7	-4.78	0.111	-4.685	-1.459	-1.902	0.104	-6	-5.49	-21.08	-16.189	-20.985	-17.759	-18.202	-16.196	Y
-8.6	-8.459	-1.291	-6.53	-2.646	-3.15	-0.921	-6	-5.36	-24.759	-17.591	-22.83	-18.946	-19.45	-17.221	Y
-8.5	-15.562	-3.153	-8.21	-3.894	-4.594	-2.252	-6	-5.24	-31.862	-19.453	-24.51	-20.194	-20.894	-18.552	Y
-8.4	-25.705	-5.636	-8.502	-4.847	-5.978	-3.92	-6	-5.11	-42.005	-21.936	-24.802	-21.147	-22.278	-20.22	Y
-8.3	-11.27	-8.784	-6.901	-4.964	-6.661	-5.84	-6	-4.98	-27.57	-25.084	-23.201	-21.264	-22.961	-22.14	Y
-8.2	-6.144	-11.062	-4.612	-4.062	-6.044	-7.468	-6	-4.85	-22.444	-27.362	-20.912	-20.362	-22.344	-23.768	Y
-8.1	-3.023	-9.151	-2.475	-2.583	-4.472	-7.58	-6	-4.71	-19.323	-25.451	-18.775	-18.883	-20.772	-23.88	Y
-8	-0.839	-5.77	-0.674	-1.017	-2.674	-5.956	-6	-4.58	-17.139	-22.07	-16.974	-17.317	-18.974	-22.256	Y
-7.9	0.778	-2.992	0.803	0.404	-1.026	-3.813	-6	-4.44	-15.522	-19.292	-15.497	-15.896	-17.326	-20.113	Y
-7.8	1.999	-0.869	2.001	1.61	0.372	-1.865	-6	-4.30	-14.301	-17.169	-14.299	-14.69	-15.928	-18.165	Y
-7.7	2.916	0.764	2.96	2.594	1.517	-0.26	-6	-4.16	-13.384	-15.536	-13.34	-13.706	-14.783	-16.56	Y
-7.6	3.583	2.026	3.71	3.366	2.427	1.02	-6	-4.02	-12.717	-14.274	-12.59	-12.934	-13.873	-15.28	Y
-7.5	4.03	2.993	4.27	3.938	3.121	2.015	-6	-3.88	-12.27	-13.307	-12.03	-12.362	-13.179	-14.285	Y

-7.4	4.272	3.712	4.654	4.316	3.614	2.759	-6	-3.73	-12.028	-12.588	-11.646	-11.984	-12.686	-13.541	Y
-7.3	4.316	4.212	4.868	4.505	3.915	3.274	-6	-3.58	-11.984	-12.088	-11.432	-11.795	-12.385	-13.026	Y
-7.2	4.159	4.511	4.915	4.5	4.025	3.574	-6	-3.43	-12.141	-11.789	-11.385	-11.8	-12.275	-12.726	Y
-7.1	3.788	4.615	4.792	4.292	3.939	3.663	-6	-3.28	-12.512	-11.685	-11.508	-12.008	-12.361	-12.637	Y
-7	3.176	4.523	4.493	3.858	3.643	3.534	-6.13	-3.13	-13.124	-11.777	-11.807	-12.442	-12.657	-12.766	Y
-6.9	2.283	4.223	4.006	3.167	3.115	3.172	-5.97	-2.97	-14.017	-12.077	-12.294	-13.133	-13.185	-13.128	Y
-6.8	1.041	3.693	3.32	2.163	2.316	2.545	-5.81	-2.81	-15.259	-12.607	-12.98	-14.137	-13.984	-13.755	Y
-6.7	-0.659	2.897	2.424	0.761	1.184	1.601	-5.65	-2.65	-16.959	-13.403	-13.876	-15.539	-15.116	-14.699	Y
-6.6	-2.978	1.773	1.331	-1.177	-0.377	0.251	-5.49	-2.49	-19.278	-14.527	-14.969	-17.477	-16.677	-16.049	Y
-6.5	-6.018	0.215	0.119	-3.83	-2.513	-1.661	-5.32	-2.32	-22.318	-16.085	-16.181	-20.13	-18.813	-17.961	Y
-6.4	-8.582	-1.966	-0.967	-7.015	-5.357	-4.415	-5.15	-2.15	-24.882	-18.266	-17.267	-23.315	-21.657	-20.715	Y
-6.3	-6.993	-5.125	-1.451	-7.859	-8.205	-8.371	-4.98	-1.98	-23.293	-21.425	-17.751	-24.159	-24.505	-24.671	Y
-6.2	-3.456	-9.686	-0.949	-4.644	-7.589	-11.276	-4.81	-1.81	-19.756	-25.986	-17.249	-20.944	-23.889	-27.576	Y
-6.1	-0.486	-11.531	0.33	-1.218	-4.183	-7.461	-4.63	-1.63	-16.786	-27.831	-15.97	-17.518	-20.483	-23.761	Y
-6	1.798	-6.647	1.873	1.457	-1.087	-3.225	-4.45	-1.45	-14.502	-22.947	-14.427	-14.843	-17.387	-19.525	Y
-5.9	3.568	-2.591	3.353	3.52	1.31	-0.169	-4.27	-1.27	-12.732	-18.891	-12.947	-12.78	-14.99	-16.469	Y
-5.8	4.954	0.254	4.646	5.135	3.161	2.083	-4.09	-1.09	-11.346	-16.046	-11.654	-11.165	-13.139	-14.217	Y
-5.7	6.036	2.342	5.723	6.408	4.601	3.796	-3.90	-0.90	-10.264	-13.958	-10.577	-9.892	-11.699	-12.504	Y
-5.6	6.867	3.923	6.587	7.407	5.72	5.115	-3.70	-0.70	-9.433	-12.377	-9.713	-8.893	-10.58	-11.185	Y
-5.5	7.477	5.132	7.247	8.172	6.572	6.124	-3.51	-0.51	-8.823	-11.168	-9.053	-8.128	-9.728	-10.176	Y
-5.4	7.887	6.045	7.712	8.73	7.19	6.874	-3.31	-0.31	-8.413	-10.255	-8.588	-7.57	-9.11	-9.426	Y
-5.3	8.104	6.71	7.983	9.097	7.595	7.392	-3.11	-0.11	-8.196	-9.59	-8.317	-7.203	-8.705	-8.908	Y
-5.2	8.128	7.151	8.059	9.28	7.794	7.694	-2.90	0.10	-8.172	-9.149	-8.241	-7.02	-8.506	-8.606	Y
-5.1	7.95	7.381	7.928	9.277	7.787	7.782	-2.69	0.31	-8.35	-8.919	-8.372	-7.023	-8.513	-8.518	Y
-5	7.55	7.404	7.569	9.081	7.562	7.649	-2.47	0.53	-8.75	-8.896	-8.731	-7.219	-8.738	-8.651	Y
-4.9	6.893	7.211	6.948	8.677	7.099	7.274	-2.25	0.75	-9.407	-9.089	-9.352	-7.623	-9.201	-9.026	Y
-4.8	5.92	6.782	6.009	8.04	6.361	6.619	-2.03	0.97	-10.38	-9.518	-10.291	-8.26	-9.939	-9.681	Y
-4.7	4.53	6.08	4.661	7.133	5.293	5.62	-1.80	1.20	-11.77	-10.22	-11.639	-9.167	-11.007	-10.68	Y
-4.6	2.527	5.044	2.762	5.909	3.816	4.16	-1.57	1.43	-13.773	-11.256	-13.538	-10.391	-12.484	-12.14	Y
-4.5	-0.512	3.565	0.138	4.323	1.852	2.023	-1.33	1.67	-16.812	-12.735	-16.162	-11.977	-14.448	-14.277	Y

-4.4	-5.804	1.442	-2.88	2.428	-0.472	-1.251	-1.09	1.91	-22.104	-14.858	-19.18	-13.872	-16.772	-17.551	Y
-4.3	-15.269	-1.746	-3.054	0.736	-1.909	-6.541	-0.84	2.16	-31.569	-18.046	-19.354	-15.564	-18.209	-22.841	Y
-4.2	-5.418	-6.875	0.455	0.618	-0.455	-8.325	-0.58	2.42	-21.718	-23.175	-15.845	-15.682	-16.755	-24.625	Y
-4.1	0.417	-10.19	3.922	2.461	2.466	-1.937	-0.32	2.68	-15.883	-26.49	-12.378	-13.839	-13.834	-18.237	Y
-4	3.97	-3.904	6.649	4.883	5.176	2.501	-0.05	2.95	-12.33	-20.204	-9.651	-11.417	-11.124	-13.799	Y
-3.9	6.477	0.684	8.795	7.083	7.398	5.553	0.22	3.22	-9.823	-15.616	-7.505	-9.217	-8.902	-10.747	Y
-3.8	8.37	3.756	10.515	8.921	9.195	7.816	0.51	3.51	-7.93	-12.544	-5.785	-7.379	-7.105	-8.484	Y
-3.7	9.843	5.978	11.911	10.426	10.654	9.569	0.79	3.79	-6.457	-10.322	-4.389	-5.874	-5.646	-6.731	Y
-3.6	11.001	7.652	13.048	11.649	11.837	10.954	1.09	4.09	-5.299	-8.648	-3.252	-4.651	-4.463	-5.346	Y
-3.5	11.902	8.93	13.968	12.63	12.788	12.051	1.40	4.40	-4.398	-7.37	-2.332	-3.67	-3.512	-4.249	Y
-3.4	12.582	9.894	14.695	13.399	13.534	12.91	1.71	4.71	-3.718	-6.406	-1.605	-2.901	-2.766	-3.39	Y
-3.3	13.059	10.588	15.248	13.973	14.093	13.557	2.04	5.04	-3.241	-5.712	-1.052	-2.327	-2.207	-2.743	Y
-3.2	13.342	11.037	15.634	14.363	14.474	14.009	2.37	5.37	-2.958	-5.263	-0.666	-1.937	-1.826	-2.291	Y
-3.1	13.429	11.247	15.855	14.572	14.679	14.272	2.72	5.72	-2.871	-5.053	-0.445	-1.728	-1.621	-2.028	Y
-3	13.308	11.208	15.907	14.593	14.702	14.342	3.07	6.07	-2.992	-5.092	-0.393	-1.707	-1.598	-1.958	Y
-2.9	12.956	10.893	15.779	14.414	14.53	14.206	3.44		-3.344	-5.407	-0.521	-1.886	-1.77	-2.094	Y
-2.8	12.33	10.249	15.45	14.009	14.137	13.84	3.82		-3.97	-6.051	-0.85	-2.291	-2.163	-2.46	Y
-2.7	11.357	9.177	14.885	13.335	13.482	13.2	4.22		-4.943	-7.123	-1.415	-2.965	-2.818	-3.1	Y
-2.6	9.909	7.483	14.029	12.324	12.498	12.21	4.63		-6.391	-8.817	-2.271	-3.976	-3.802	-4.09	Y
-2.5	7.738	4.731	12.785	10.859	11.071	10.733	5.05		-8.562	-11.569	-3.515	-5.441	-5.229	-5.567	Y
-2.4	4.318	-0.422	10.977	8.737	8.998	8.492	5.49		-11.982	-16.722	-5.323	-7.563	-7.302	-7.808	Y
-2.3	-1.101	-13.631	8.229	5.642	5.928	4.794	5.96		-17.401	-29.931	-8.071	-10.658	-10.372	-11.506	Y
-2.2	-0.289	0.441	3.566	2.005	1.881	-3.018	6.44		-16.589	-15.859	-12.734	-14.295	-14.419	-19.318	Y
-2.1	6.023	6.888	-4.352	3.288	2.337	-3.867	6.94		-10.277	-9.412	-20.652	-13.012	-13.963	-20.167	Y
-2	10.334	10.857	2.907	7.938	7.281	5.661	7.47		-5.966	-5.443	-13.393	-8.362	-9.019	-10.639	Y
-1.9	13.446	13.763	9.049	11.686	11.253	10.505	8.03		-2.854	-2.537	-7.251	-4.614	-5.047	-5.795	Y
-1.8	15.869	16.063	12.908	14.55	14.237	13.787	8.62		-0.431	-0.237	-3.392	-1.75	-2.063	-2.513	Y
-1.7	17.846	17.966	15.711	16.829	16.589	16.279	9.24		1.546	1.666	-0.589	0.529	0.289	-0.021	Y
-1.6	19.509	19.581	17.907	18.708	18.515	18.286	9.90		3.209	3.281	1.607	2.408	2.215	1.986	Y
-1.5	20.933	20.976	19.703	20.293	20.135	19.958	10.60		4.633	4.676	3.403	3.993	3.835	3.658	Y

-1.4	22.17	22.194	21.213	21.654	21.521	21.381			5.87	5.894	4.913	5.354	5.221	5.081	Y
-1.3	23.252	23.265	22.502	22.833	22.721	22.609			6.952	6.965	6.202	6.533	6.421	6.309	Y
-1.2	24.203	24.21	23.616	23.862	23.767	23.677			7.903	7.91	7.316	7.562	7.467	7.377	Y
-1.1	25.04	25.043	24.582	24.764	24.682	24.61			8.74	8.743	8.282	8.464	8.382	8.31	Y
-1	25.776	25.778	25.422	25.553	25.484	25.426			9.476	9.478	9.122	9.253	9.184	9.126	Y
-0.9	26.422	26.424	26.152	26.242	26.184	26.138			10.122	10.124	9.852	9.942	9.884	9.838	Y
-0.8	26.984	26.987	26.784	26.842	26.792	26.757			10.684	10.687	10.484	10.542	10.492	10.457	Y
-0.7	27.469	27.473	27.325	27.358	27.317	27.29			11.169	11.173	11.025	11.058	11.017	10.99	Y
-0.6	27.882	27.887	27.782	27.797	27.764	27.744			11.582	11.587	11.482	11.497	11.464	11.444	Y
-0.5	28.226	28.231	28.162	28.163	28.137	28.123			11.926	11.931	11.862	11.863	11.837	11.823	Y
-0.4	28.505	28.51	28.468	28.46	28.44	28.431			12.205	12.21	12.168	12.16	12.14	12.131	Y
-0.3	28.72	28.725	28.703	28.691	28.676	28.671			12.42	12.425	12.403	12.391	12.376	12.371	Y
-0.2	28.874	28.878	28.869	28.857	28.847	28.845			12.574	12.578	12.569	12.557	12.547	12.545	Y
-0.1	28.967	28.969	28.967	28.959	28.955	28.954			12.667	12.669	12.667	12.659	12.655	12.654	Y
0	29	29	29	29	29	29			12.7	12.7	12.7	12.7	12.7	12.7	Y
0.1	28.974	28.97	28.966	28.978	28.982	28.982			12.674	12.67	12.666	12.678	12.682	12.682	Y
0.2	28.888	28.88	28.865	28.894	28.903	28.902			12.588	12.58	12.565	12.594	12.603	12.602	Y
0.3	28.742	28.728	28.697	28.747	28.76	28.757			12.442	12.428	12.397	12.447	12.46	12.457	Y
0.4	28.534	28.514	28.459	28.536	28.553	28.547			12.234	12.214	12.159	12.236	12.253	12.247	Y
0.5	28.262	28.235	28.15	28.26	28.28	28.27			11.962	11.935	11.85	11.96	11.98	11.97	Y
0.6	27.926	27.891	27.766	27.915	27.94	27.923			11.626	11.591	11.466	11.615	11.64	11.623	Y
0.7	27.521	27.477	27.303	27.498	27.527	27.504			11.221	11.177	11.003	11.198	11.227	11.204	Y
0.8	27.043	26.991	26.756	27.006	27.04	27.008			10.743	10.691	10.456	10.706	10.74	10.708	Y
0.9	26.49	26.427	26.116	26.434	26.473	26.429			10.19	10.127	9.816	10.134	10.173	10.129	Y
1	25.853	25.78	25.376	25.773	25.819	25.761			9.553	9.48	9.076	9.473	9.519	9.461	Y
1.1	25.126	25.043	24.522	25.017	25.069	24.994			8.826	8.743	8.222	8.717	8.769	8.694	Y
1.2	24.3	24.207	23.538	24.153	24.215	24.118			8	7.907	7.238	7.853	7.915	7.818	Y
1.3	23.361	23.258	22.403	23.167	23.24	23.117			7.061	6.958	6.103	6.867	6.94	6.817	Y
1.4	22.294	22.182	21.083	22.04	22.127	21.969			5.994	5.882	4.783	5.74	5.827	5.669	Y
1.5	21.077	20.956	19.533	20.745	20.85	20.645	10.60		4.777	4.656	3.233	4.445	4.55	4.345	Y

1.6	19.679	19.551	17.68	19.242	19.372	19.102	9.90		3.379	3.251	1.38	2.942	3.072	2.802	Y
1.7	18.057	17.922	15.402	17.475	17.638	17.275	9.24		1.757	1.622	-0.898	1.175	1.338	0.975	Y
1.8	16.149	16.001	12.474	15.352	15.565	15.053	8.62		-0.151	-0.299	-3.826	-0.948	-0.735	-1.247	Y
1.9	13.862	13.676	8.418	12.726	13.012	12.232	8.03		-2.438	-2.624	-7.882	-3.574	-3.288	-4.068	Y
2	11.063	10.738	2.253	9.348	9.737	8.377	7.47		-5.237	-5.562	-14.047	-6.952	-6.563	-7.923	Y
2.1	7.664	6.748	-0.413	4.963	5.408	2.281	6.94		-8.636	-9.552	-16.713	-11.337	-10.892	-14.019	Y
2.2	4.373	0.603	5.55	1.638	1.248	-5.91	6.44		-11.927	-15.697	-10.75	-14.662	-15.052	-22.21	Y
2.3	4.201	-5.36	9.374	4.253	3.205	2.173	5.96		-12.099	-21.66	-6.926	-12.047	-13.095	-14.127	Y
2.4	6.703	1.325	11.79	7.67	6.869	6.953	5.49		-9.597	-14.975	-4.51	-8.63	-9.431	-9.347	Y
2.5	9.078	5.571	13.422	10.073	9.451	9.7	5.05		-7.222	-10.729	-2.878	-6.227	-6.849	-6.6	Y
2.6	10.84	8.058	14.555	11.725	11.207	11.47	4.63		-5.46	-8.242	-1.745	-4.575	-5.093	-4.83	Y
2.7	12.097	9.632	15.331	12.865	12.411	12.654	4.22		-4.203	-6.668	-0.969	-3.435	-3.889	-3.646	Y
2.8	12.969	10.639	15.832	13.632	13.219	13.436	3.82		-3.331	-5.661	-0.468	-2.668	-3.081	-2.864	Y
2.9	13.541	11.242	16.106	14.11	13.724	13.913	3.44		-2.759	-5.058	-0.194	-2.19	-2.576	-2.387	Y
3	13.864	11.531	16.183	14.346	13.979	14.139	3.07	6.07	-2.436	-4.769	-0.117	-1.954	-2.321	-2.161	Y
3.1	13.973	11.551	16.08	14.371	14.017	14.148	2.72	5.72	-2.327	-4.749	-0.22	-1.929	-2.283	-2.152	Y
3.2	13.886	11.329	15.805	14.2	13.856	13.957	2.37	5.37	-2.414	-4.971	-0.495	-2.1	-2.444	-2.343	Y
3.3	13.615	10.871	15.36	13.841	13.503	13.571	2.04	5.04	-2.685	-5.429	-0.94	-2.459	-2.797	-2.729	Y
3.4	13.159	10.169	14.739	13.291	12.958	12.989	1.71	4.71	-3.141	-6.131	-1.561	-3.009	-3.342	-3.311	Y
3.5	12.512	9.201	13.93	12.539	12.21	12.198	1.40	4.40	-3.788	-7.099	-2.37	-3.761	-4.09	-4.102	Y
3.6	11.658	7.918	12.91	11.565	11.238	11.171	1.09	4.09	-4.642	-8.382	-3.39	-4.735	-5.062	-5.129	Y
3.7	10.567	6.237	11.648	10.332	10.01	9.867	0.79	3.79	-5.733	-10.063	-4.652	-5.968	-6.29	-6.433	Y
3.8	9.19	4.002	10.093	8.787	8.472	8.211	0.51	3.51	-7.11	-12.298	-6.207	-7.513	-7.828	-8.089	Y
3.9	7.446	0.888	8.173	6.846	6.542	6.076	0.22	3.22	-8.854	-15.412	-8.127	-9.454	-9.758	-10.224	Y
4	5.188	-3.89	5.804	4.394	4.109	3.211	-0.05	2.95	-11.112	-20.19	-10.496	-11.906	-12.191	-13.089	Y
4.1	2.128	-11.588	2.997	1.372	1.113	-0.936	-0.32	2.68	-14.172	-27.888	-13.303	-14.928	-15.187	-17.236	Y
4.2	-2.374	-7.519	0.46	-1.523	-1.802	-7.526	-0.58	2.42	-18.674	-23.819	-15.84	-17.823	-18.102	-23.826	Y
4.3	-9.1	-1.798	0.309	-1.579	-2.018	-8.403	-0.84	2.16	-25.4	-18.098	-15.991	-17.879	-18.318	-24.703	Y
4.4	-6.947	1.534	2.407	0.944	0.417	-2.181	-1.09	1.91	-23.247	-14.766	-13.893	-15.356	-15.883	-18.481	Y
4.5	-1.438	3.714	4.678	3.447	2.904	1.544	-1.33	1.67	-17.738	-12.586	-11.622	-12.853	-13.396	-14.756	Y

4.6	1.904	5.221	6.499	5.374	4.826	3.916	-1.57	1.43	-14.396	-11.079	-9.801	-10.926	-11.474	-12.384	Y
4.7	4.094	6.275	7.877	6.801	6.247	5.526	-1.80	1.20	-12.206	-10.025	-8.423	-9.499	-10.053	-10.774	Y
4.8	5.607	6.99	8.895	7.84	7.277	6.637	-2.03	0.97	-10.693	-9.31	-7.405	-8.46	-9.023	-9.663	Y
4.9	6.665	7.428	9.626	8.573	7.997	7.385	-2.25	0.75	-9.635	-8.872	-6.674	-7.727	-8.303	-8.915	Y
5	7.384	7.63	10.116	9.051	8.461	7.843	-2.47	0.53	-8.916	-8.67	-6.184	-7.249	-7.839	-8.457	Y
5.1	7.832	7.615	10.4	9.31	8.701	8.057	-2.69	0.31	-8.468	-8.685	-5.9	-6.99	-7.599	-8.243	Y
5.2	8.049	7.391	10.499	9.37	8.739	8.05	-2.90	0.10	-8.251	-8.909	-5.801	-6.93	-7.561	-8.25	Y
5.3	8.055	6.958	10.429	9.241	8.586	7.836	-3.11	-0.11	-8.245	-9.342	-5.871	-7.059	-7.714	-8.464	Y
5.4	7.863	6.304	10.195	8.929	8.245	7.415	-3.31	-0.31	-8.437	-9.996	-6.105	-7.371	-8.055	-8.885	Y
5.5	7.473	5.404	9.802	8.429	7.711	6.78	-3.51	-0.51	-8.827	-10.896	-6.498	-7.871	-8.589	-9.52	Y
5.6	6.877	4.217	9.246	7.729	6.972	5.912	-3.70	-0.70	-9.423	-12.083	-7.054	-8.571	-9.328	-10.388	Y
5.7	6.055	2.675	8.523	6.809	6.003	4.778	-3.90	-0.90	-10.245	-13.625	-7.777	-9.491	-10.297	-11.522	Y
5.8	4.974	0.667	7.62	5.634	4.769	3.326	-4.09	-1.09	-11.326	-15.633	-8.68	-10.666	-11.531	-12.974	Y
5.9	3.575	-1.977	6.522	4.153	3.212	1.473	-4.27	-1.27	-12.725	-18.277	-9.778	-12.147	-13.088	-14.827	Y
6	1.761	-5.399	5.211	2.284	1.245	-0.898	-4.45	-1.45	-14.539	-21.699	-11.089	-14.016	-15.055	-17.198	Y
6.1	-0.649	-8.466	3.671	-0.084	-1.247	-3.878	-4.63	-1.63	-16.949	-24.766	-12.629	-16.384	-17.547	-20.178	Y
6.2	-4.003	-7.195	1.907	-3.032	-4.293	-6.926	-4.81	-1.81	-20.303	-23.495	-14.393	-19.332	-20.593	-23.226	Y
6.3	-8.936	-3.856	0.009	-6.039	-7.008	-7.314	-4.98	-1.98	-25.236	-20.156	-16.291	-22.339	-23.308	-23.614	Y
6.4	-12.908	-1.143	-1.719	-6.54	-6.663	-4.779	-5.15	-2.15	-29.208	-17.443	-18.019	-22.84	-22.963	-21.079	Y
6.5	-8.183	0.85	-2.672	-4.146	-4.081	-2.168	-5.32	-2.32	-24.483	-15.45	-18.972	-20.446	-20.381	-18.468	Y
6.6	-3.979	2.312	-2.47	-1.588	-1.655	-0.163	-5.49	-2.49	-20.279	-13.988	-18.77	-17.888	-17.955	-16.463	Y
6.7	-1.218	3.381	-1.52	0.398	0.193	1.312	-5.65	-2.65	-17.518	-12.919	-17.82	-15.902	-16.107	-14.988	Y
6.8	0.689	4.142	-0.423	1.863	1.55	2.377	-5.81	-2.81	-15.611	-12.158	-16.723	-14.437	-14.75	-13.923	Y
6.9	2.047	4.646	0.519	2.924	2.525	3.119	-5.97	-2.97	-14.253	-11.654	-15.781	-13.376	-13.775	-13.181	Y
7	3.013	4.926	1.216	3.663	3.193	3.592	-6.13	-3.13	-13.287	-11.374	-15.084	-12.637	-13.107	-12.708	Y
7.1	3.674	5.002	1.656	4.135	3.605	3.832	-6	-3.28	-12.626	-11.298	-14.644	-12.165	-12.695	-12.468	Y
7.2	4.083	4.882	1.846	4.375	3.791	3.859	-6	-3.43	-12.217	-11.418	-14.454	-11.925	-12.509	-12.441	Y
7.3	4.27	4.566	1.794	4.404	3.771	3.684	-6	-3.58	-12.03	-11.734	-14.506	-11.896	-12.529	-12.616	Y
7.4	4.251	4.045	1.499	4.231	3.555	3.311	-6	-3.73	-12.049	-12.255	-14.801	-12.069	-12.745	-12.989	Y
7.5	4.033	3.299	0.95	3.86	3.146	2.732	-6	-3.88	-12.267	-13.001	-15.35	-12.44	-13.154	-13.568	Y

7.6	3.611	2.295	0.123	3.285	2.541	1.936	-6	-4.02	-12.689	-14.005	-16.177	-13.015	-13.759	-14.364	Y
7.7	2.973	0.975	-1.025	2.493	1.73	0.899	-6	-4.16	-13.327	-15.325	-17.325	-13.807	-14.57	-15.401	Y
7.8	2.091	-0.756	-2.562	1.46	0.704	-0.411	-6	-4.30	-14.209	-17.056	-18.862	-14.84	-15.596	-16.711	Y
7.9	0.92	-3.067	-4.583	0.157	-0.544	-2.032	-6	-4.44	-15.38	-19.367	-20.883	-16.143	-16.844	-18.332	Y
8	-0.616	-6.261	-7.158	-1.45	-1.996	-3.986	-6	-4.58	-16.916	-22.561	-23.458	-17.75	-18.296	-20.286	Y
8.1	-2.654	-10.701	-9.861	-3.364	-3.554	-6.173	-6	-4.71	-18.954	-27.001	-26.161	-19.664	-19.854	-22.473	Y
8.2	-5.451	-13.404	-10.48	-5.435	-4.934	-8.041	-6	-4.85	-21.751	-29.704	-26.78	-21.735	-21.234	-24.341	Y
8.3	-9.52	-9.391	-8.164	-7.026	-5.625	-8.429	-6	-4.98	-25.82	-25.691	-24.464	-23.326	-21.925	-24.729	Y
8.4	-15.013	-5.508	-5.428	-7.092	-5.306	-7.172	-6	-5.11	-31.313	-21.808	-21.728	-23.392	-21.606	-23.472	Y
8.5	-13.463	-2.798	-3.195	-5.733	-4.284	-5.419	-6	-5.24	-29.763	-19.098	-19.495	-22.033	-20.584	-21.719	Y
8.6	-8.394	-0.853	-1.467	-4.009	-3.073	-3.852	-6	-5.36	-24.694	-17.153	-17.767	-20.309	-19.373	-20.152	Y
8.7	-5.002	0.583	-0.138	-2.477	-1.963	-2.618	-6	-5.49	-21.302	-15.717	-16.438	-18.777	-18.263	-18.918	Y
8.8	-2.681	1.651	0.879	-1.258	-1.055	-1.708	-6	-5.61	-18.981	-14.649	-15.421	-17.558	-17.355	-18.008	Y
8.9	-1.017	2.435	1.642	-0.341	-0.365	-1.082	-6	-5.73	-17.317	-13.865	-14.658	-16.641	-16.665	-17.382	Y
9	0.199	2.987	2.191	0.308	0.114	-0.71	-6	-5.86	-16.101	-13.313	-14.109	-15.992	-16.186	-17.01	Y
9.1	1.082	3.339	2.553	0.719	0.396	-0.569	-6	-5.98	-15.218	-12.961	-13.747	-15.581	-15.904	-16.869	Y
9.2	1.698	3.512	2.748	0.912	0.495	-0.644	-6	-6.09	-14.602	-12.788	-13.552	-15.388	-15.805	-16.944	Y
9.3	2.086	3.518	2.788	0.902	0.42	-0.928	-6.21	-6.21	-14.214	-12.782	-13.512	-15.398	-15.88	-17.228	Y
9.4	2.269	3.365	2.679	0.696	0.183	-1.419	-6.33	-6.33	-14.031	-12.935	-13.621	-15.604	-16.117	-17.719	Y
9.5	2.261	3.051	2.424	0.295	-0.204	-2.116	-6.44	-6.44	-14.039	-13.249	-13.876	-16.005	-16.504	-18.416	Y
9.6	2.063	2.574	2.025	-0.299	-0.724	-3.013	-6.56	-6.56	-14.237	-13.726	-14.275	-16.599	-17.024	-19.313	Y
9.7	1.671	1.923	1.475	-1.085	-1.344	-4.077	-6.67	-6.67	-14.629	-14.377	-14.825	-17.385	-17.644	-20.377	Y
9.8	1.07	1.08	0.768	-2.045	-2.005	-5.209	-6.78	-6.78	-15.23	-15.22	-15.532	-18.345	-18.305	-21.509	Y
9.9	0.231	0.018	-0.112	-3.122	-2.61	-6.179	-6.89	-6.89	-16.069	-16.282	-16.412	-19.422	-18.91	-22.479	Y
10	-0.893	-1.304	-1.183	-4.166	-3.024	-6.623	-7.00	-7.00	-17.193	-17.604	-17.483	-20.466	-19.324	-22.923	Y
15	-11.1	-7.737	-1.138	-3.427	-1.741	-1.513	-11.40	-11.40	-27.4	-24.037	-17.438	-19.727	-18.041	-17.813	Y
20	-10.695	-8.998	-8.939	-8.774	-10.764	-16.763	-14.53	-14.53	-26.995	-25.298	-25.239	-25.074	-27.064	-33.063	Y
25	-16.51	-11.424	-11.009	-11.499	-12.65	-8.206	-16.95	-16.95	-32.81	-27.724	-27.309	-27.799	-28.95	-24.506	Y

30	-14.586	-21.966	-12.124	-20.389	-21.409	-16.525	-18.93	-18.93	-30.886	-38.266	-28.424	-36.689	-37.709	-32.825	Y
35	-11.087	-15.064	-10.638	-14.6	-16.645	-18.088	-20.60	-20.60	-27.387	-31.364	-26.938	-30.9	-32.945	-34.388	Y
40	-17.126	-18.698	-7.216	-13.565	-16.819	-25.983	-22.05	-22.05	-33.426	-34.998	-23.516	-29.865	-33.119	-42.283	Y
45	-20.882	-11.61	-14.816	-25.372	-29.746	-23.659	-23.33	-23.33	-37.182	-27.91	-31.116	-41.672	-46.046	-39.959	Y
50	-14.13	-15.717	-16.684	-17.429	-14.951	-18.353	-24	-24	-30.43	-32.017	-32.984	-33.729	-31.251	-34.653	Y
55	-13.049	-20.848	-15.793	-17.185	-20.275	-29.449	-24	-24	-29.349	-37.148	-32.093	-33.485	-36.575	-45.749	Y
60	-17.453	-20.172	-9.731	-16.549	-22.274	-20.758	-24	-24	-33.753	-36.472	-26.031	-32.849	-38.574	-37.058	Y
65	-18.154	-18.084	-30.401	-22.958	-30.342	-22.409	-24	-24	-34.454	-34.384	-46.701	-39.258	-46.642	-38.709	Y
70	-25.412	-27.028	-13.094	-16.674	-25.858	-24.055	-24	-24	-41.712	-43.328	-29.394	-32.974	-42.158	-40.355	Y
75	-20.269	-22.914	-21.76	-23.994	-27.371	-32.249	-24	-24	-36.569	-39.214	-38.06	-40.294	-43.671	-48.549	Y
80	-29.846	-24.205	-26.503	-30.287	-33.915	-60.718	-24	-24	-46.146	-40.505	-42.803	-46.587	-50.215	-77.018	Y
85	-25.372	-29.563	-27.917	-34.459	-40.389	-41.995	-24	-24	-41.672	-45.863	-44.217	-50.759	-56.689	-58.295	Y
90	-26.634	-24.979	-60.348	-39.042	-48.349	-39.775	-14	-14	-42.934	-41.279	-76.648	-55.342	-64.649	-56.075	Y
95	-29.036	-29.608	-33.823	-43.835	-46.11	-43.699	-14	-14	-45.336	-45.908	-50.123	-60.135	-62.41	-59.999	Y
100	-34.452	-25.379	-33.952	-41.1	-44.683	-38.94	-14	-14	-50.752	-41.679	-50.252	-57.4	-60.983	-55.24	Y
105	-27.236	-30.379	-27.278	-51.307	-48.197	-42.654	-14	-14	-43.536	-46.679	-43.578	-67.607	-64.497	-58.954	Y
110	-34.935	-29.174	-31.021	-55.893	-40.66	-36.515	-14	-14	-51.235	-45.474	-47.321	-72.193	-56.96	-52.815	Y
115	-32.902	-35.57	-25.499	-53.399	-41.17	-35.96	-14	-14	-49.202	-51.87	-41.799	-69.699	-57.47	-52.26	Y

120	-35.902	-34.023	-25.31	-50.609	-45.384	-37.884	-14	-14	-52.202	-50.323	-41.61	-66.909	-61.684	-54.184	Y
125	-31.034	-43.352	-31.243	-48.063	-44.778	-35.134	-14	-14	-47.334	-59.652	-47.543	-64.363	-61.078	-51.434	Y
130	-30.813	-41.723	-31.252	-42.055	-39.58	-44.931	-14	-14	-47.113	-58.023	-47.552	-58.355	-55.88	-61.231	Y
135	-32.269	-31.348	-37.449	-47.971	-50.081	-37.3	-14	-14	-48.569	-47.648	-53.749	-64.271	-66.381	-53.6	Y
140	-46.81	-37.897	-34.277	-46.252	-53.332	-41.326	-14	-14	-63.11	-54.197	-50.577	-62.552	-69.632	-57.626	Y
145	-30.795	-32.167	-33.994	-54.988	-49.777	-52.179	-14	-14	-47.095	-48.467	-50.294	-71.288	-66.077	-68.479	Y
150	-24.136	-27.264	-25.85	-35.579	-34.831	-39.392	-14	-14	-40.436	-43.564	-42.15	-51.879	-51.131	-55.692	Y
155	-33.862	-33.083	-34.647	-56.227	-46.155	-43.631	-14	-14	-50.162	-49.383	-50.947	-72.527	-62.455	-59.931	Y
160	-33.895	-31.769	-35.576	-47.715	-48.298	-53.555	-14	-14	-50.195	-48.069	-51.876	-64.015	-64.598	-69.855	Y
165	-36.735	-39.736	-43.033	-45.45	-57.869	-49.196	-14	-14	-53.035	-56.036	-59.333	-61.75	-74.169	-65.496	Y
170	-42.345	-58.856	-65.684	-54.379	-50.537	-56.82	-14	-14	-58.645	-75.156	-81.984	-70.679	-66.837	-73.12	Y
175	-44.506	-51.473	-46.713	-53.66	-49.401	-55.78	-14	-14	-60.806	-67.773	-63.013	-69.96	-65.701	-72.08	Y
180	-42.66	-47.209	-53.358	-50.244	-50.8	-42.747	-14	-14	-58.96	-63.509	-69.658	-66.544	-67.1	-59.047	Y

ANNEX C:

Radio-Frequency Hazard Analysis

Radio-Frequency Hazard Analysis

A. Radio-Frequency Hazard Report

This report analyzes the non-ionizing radiation levels for the HR6400 Antenna System. This report is developed in accordance with the prediction methods contained in OET Bulletin No. 65, Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, Edition 97-01.

Bulletin No. 65 specifies that there are two separate tiers of exposure limits that are dependent on the situation in which the exposure takes place and/or the status of the individuals who are subject to the exposure -- the General Population/ Uncontrolled Environment and the Controlled Environment, where the general population does not have access.

The maximum level of non-ionizing radiation to which individuals may be exposed is limited to a power density level of 5 milliwatts per square centimeter (5 mW/cm^2) averaged over any 6 minute period in a controlled environment, and the maximum level of non-ionizing radiation to which the general public is exposed is limited to a power density level of 1 milliwatt per square centimeter (1 mW/cm^2) averaged over any 30 minute period in a uncontrolled environment.

In the normal range of transmit powers for satellite antennas, the power densities at or around the antenna radiating surface is expected to exceed safe levels. This area will not be accessible to the general public. Operators and technicians will receive training specifying this area as a high exposure area. Procedures will be established to ensure that all transmitters are turned off before this area may be accessed by operators, maintenance or other authorized personnel.

B. Near Field Exposure

The HR6400 Antenna potentially exceeds MPE limits in the near field within the rectangular volume directly in front of the panels (14.8 mW/cm^2). For this calculation, it was assumed that all 35 watts from the SSPA are uniformly distributed across the surface area of the panel. This is a reasonable assumption for a waveguide fed horn with lens array with minimal sidelobe tapering.

In normal operation, this antenna is mounted on the top of an aircraft fuselage, with restricted access, with the main beam pointed toward the sky at a typical elevation angle of 25 degrees such that human exposure in the near field is not possible. Furthermore, normal TDMA operation uses a duty cycle of 10% or less, reducing maximum near field exposure by an order of magnitude to 1.5 mW/cm^2. Additionally, in normal operation, any blockage in the near field (human or otherwise) will cause the transmitter to be disabled within milliseconds seconds as the system does not transmit unless it can receive the downlink carrier from the satellite. Therefore, prolonged exposure in the near field is not possible in normal operation.

C. Transition Region Exposure

At a distance of 6.65 m from the antenna, maximum exposure is 5 mW/cm^2. This assumes that PFD decreases linearly from 33.2 mW/cm^2 to 1.8 mW/cm^2 in this region between the near field and far field.

D. Far Field Exposure

At a distance of 14.87 meters, the power density of the HR6400 is 1 mW/cm^2, which is within the limits of General Population/Uncontrolled Exposure (MPE) even in the direction of the main beam of the antenna. As noted previously, the antenna will be mounted on an aircraft fuselage, with the main beam pointed to the sky at a typical elevation angle of 25 degrees. In this case, maximum far field exposure to humans would be due to a sidelobe which is at least 7 dB below the main beam. At a distance of 14.87 meters, the exposure to humans would be less than 0.2 mW/cm^2.

Table 1: Parameters Used for Determining PFD (HR6400)

Antenna Width	34 in	0.8636	m
Antenna Height	6.5 in	0.1651	m
Antenna Surface Area		0.14258	m^2
Frequency		14250	MHz
Wavelength		0.021	m
Transmit Power		10	W
Antenna Gain		38	dBi
Antenna Gain		6309.573	
EIRP		48	dBW
Far Field Boundary (Azimuth)		22.0	m
Power Density at far field boundary (Azimuth)		1.0	mW/cm^2
Near Field Distance (Azimuth)		8.9	m
Near Field Power Density (Azimuth)		7.0	mW/cm^2
Elevation sidelobe level		-15.0	dB
Far Field Boundary (Elevation)		0.8	m
Power Density at far field boundary (Elevation)		26.3	mW/cm^2
Safe Far Field Distance (Elevation)		1.8	m
Power Density		4.9	mW/cm^2
Safe Far Field Distance (Elevation)		4.0	m
Power Density		1.0	mW/cm^2

E. Conclusions

The worse-case radiation hazards exist along the beam axis. In the case of the proposed commercial operations, it is highly unlikely that the antenna axis will be aligned with any uncontrolled area since commercial operations will be conducted primarily in flight and

on the ground away from occupied areas, the antenna will be mounted on the top of the aircraft fuselage and pointed upwards towards the GSO arc, and transmit operations will only be conducted with a clear field of view towards the serving satellites.

That said, commissioning and testing of the HR6400 antenna will only be conducted by trained personnel in a controlled environment. By maintaining a safety radius of 14.87 meters during transmit operations, it can be guaranteed that the General Population/Uncontrolled Exposure limits will not be exceeded under any test conditions.

Technically sidelobes are only observed in the far field. For the HR6400 antenna the far field distance in the elevation plane is approximately 0.9 meters. The 5 mW/cm^2 threshold is reached at a distance of 3.0 meters and the 1 mW/cm^2 threshold is reached at a distance of 6.5 meters. Observing the safe radius distance noted above during transmit operations will ensure that the threshold will not be exceeded.

ANNEX D

SECTION 25.227 COMPLIANCE MATRIX

ANNEX D: SECTION 25.227
REGULATORY COMPLIANCE MATRIX

Section 25.227 Requirement	**Citation to Information Provided**
25.227(a)(1), (2) or (3) and (b)(1), (2) or (3)	Technical information included in Narrative and Technical Appendix. (Note: application filed under 25.227(a)(2); demonstration of compliance with 25.227(a)(1) values along geostationary included to confirm compliance with two-degree spacing policies; 25.225(a)(3) and (b)(3) not applicable because applicant does not use variable power-density control for individual simultaneously transmitting co-frequency ESAAs)
25.227(a)(4) & 25.227(b)(5)	Not applicable because applicant does not use a contention protocol.
25.227(a)(5) & 25.227(b)(6)	Point of contact is provided in the Technical Appendix.
25.227(a)(6)	Complies with record annotation and maintenance. *See* Narrative.
25.227(a)(7), (8), (14)	Applicable regulatory status, licensing and protection provisions.
25.227(a)(9)-(13)	ESAA system complies with operational requirements. *See* Narrative and Technical Appendix.
25.227(a)(12)	Applicant does not seek Permitted List authority at this time.
25.227(a)(15)	Certification related to operation in international airspace. *See* Technical Appendix at Annex E (Section 25.227 Certifications).
25.227(b)(4)	Geographic areas of ESAA operations include in the Technical Appendix at Annex A.
25.227(b)(7)	Certification of compliance with Sections 25.227(a)(6), (a)(9), (a)(10), and (a)(11). *See* Technical Appendix at Annex E (Section 25.227 Certifications).
25.227(b)(8)	Radio frequency hazard analysis is included in the Technical Appendix at Annex C.
25.227(c)	Coordination with NASA TDRSS operations is in progress. *See* Narrative.
25.227(d)	Coordination with NSF to protect radio astronomy sites is complete and awaiting final signature. *See* Narrative.

ANNEX E

SECTION 25.227 CERTIFICATIONS

SECTION 25.227 CERTIFICATIONS

Astronics AeroSat Corporation ("Astronics AeroSat"), pursuant to Section 25.227 of the FCC's Rules, hereby certifies the following:

1. In accordance with Section 25.227(a)(15), as the operator of an ESAA system operating over international waters, Astronics AeroSat has confirmed with its target space station operators that its existing and proposed operations are within coordinated parameters for adjacent satellites up to six degrees away (+/- 6°) on the geostationary arc.

2. In accordance with Section 25.227(b)(7), Astronics AeroSat certifies that its existing and proposed operations comply with the following requirements of Section 25.227:
   - Per Section 25.227(a)(6), for each ESAA transmitter, Astronics AeroSat will time annotate and maintain a record for a period of not less than one year of the vehicle location (i.e., latitude/longitude/altitude), transmit frequency, channel bandwidth and satellite used. Records will be recorded at time intervals no greater than one (1) minute while the ESAA is transmitting. Astronics AeroSat will make this data available in the requisite format within 24 hours of a request from the Commission, NTIA, or a frequency coordinator for purposes of resolving harmful interference events.
   - Per Section 25.227(a)(9), each ESAA terminal will automatically cease transmitting within 100 milliseconds upon loss of reception of the satellite downlink signal or when it detects that unintended satellite tracking has happened or is about to happen.
   - Per Section 25.227(a)(10), each ESAA terminal will be subject to the monitoring and control by an NCMC. Each terminal will be able to receive "enable transmission" and "disable transmission" commands from the NCMC and must automatically cease transmissions immediately on receiving any "parameter change command", which may cause harmful interference during the change, until it receives an "enable transmission" command from its NCMC. In addition, the NCMC will be able to monitor the operation of an ESAA terminal to determine if it is malfunctioning.
   - Per Section 25.227(a)(11), each ESAA terminal shall be self-monitoring and, should a fault which can cause harmful interference to FSS networks be detected, the terminal will automatically cease transmissions.

By: s/ Frank Blanda

Frank Blanda
Astronics AeroSat Corporation
Chief Technical Officer

September 2, 2014

ANNEX F

TECHNICAL CERTIFICATION

Technical Certification

I, Frank Blanda, hereby certify that I am the technically qualified person responsible for the preparation of the technical information contained in the Astronics AeroSat blanket license application for ESAA operating authority and the accompanying Technical Appendix, that I am familiar with Part 25 of the Commission's Rules (47 C.F.R. Part 25), and that I have either prepared or reviewed the technical information submitted in this application and found it to be complete and accurate to the best of my knowledge and belief.

By: s/ Frank Blanda

Frank Blanda
Astronics AeroSat Corporation
Chief Technical Officer

September 2, 2014