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May 5, 2016

By Electronic Filing

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: Gogo LLC Section 1.65 Letter
File No. SES-MFS-20151022-00735, Call Sign E120106

Dear Ms. Dortch:

Gogo LLC ("Gogo"), by its attorney and pursuant to Section 1.65 of the Commission's rules, 47 C.F.R. § 1.65, hereby updates the above-referenced application to modify Gogo's license for Earth Stations Aboard Aircraft ("ESAA"), which sought to add a number of satellites to the Gogo ESAA network (the "Gogo Modification"). Specifically, Gogo supplements the record relating to its pending request for use of the AMC-1 satellite by providing additional analysis and data relating to Gogo's request for waiver of Section 25.227(a)(1)(i)(B) of the Commission's rules.

Gogo had previously requested that the Commission defer action on the AMC-1 portion of the Gogo Modification. However, with the submission of this additional information, Gogo asks that the Commission proceed to address Gogo's request to use AMC-1.

Please let me know if you have any questions regarding this matter.

Respectfully submitted,

/s/ Karis A. Hastings

Karis A. Hastings
Counsel for Gogo LLC
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Attachments

cc: Jose Albuquerque
Paul Blais
Stephen Duall
Chip Fleming
Karl Kensinger
Kathyrn Medley
Trang Nguyen
Cindy Spiers

Date:	**May 4, 2016**
To:	**Paul Blais, Branch Chief, Satellite Division, International Bureau, FCC**
From :	**Ken Ryan, Skjei Telecom**
Subject:	**Gogo FCC Modification Application, File No. SES-MFS-20151022-00735**
	Additional Support for 25.227(a)(1)(i)(B) Waiver Request for AMC-1

Summary

Following up on our recent telephone conversation, this memorandum supplements Gogo's showing with respect to its proposed use of the AeroSat HR6400 earth stations aboard aircraft (ESAA) terminal with the AMC-1 spacecraft and Gogo's associated request for waiver of Section 25.227(a)(1)(i)(B).

When communicating with AMC-1, Gogo will operate the AeroSat HR6400 antenna within the 14.0-14.5 GHz FSS uplink band and the 11.7-12.2 GHz band FSS downlink band. The AeroSat HR6400 antenna consists of two rows of 32 element array with each lensed-horn element being 3.4 X 0.75 inches. The antenna operates under gimbaled motor control to orient the antenna in azimuth, elevation and polarization and Gogo has previously demonstrated that it achieves better than a ± 0.2 degree rms pointing accuracy during active tracking of the intended satellite. All emissions automatically cease within 100 ms if the pointing error exceeds 0.5°, and transmission is not resumed until the angle is verified to be less than 0.2°.

When communicating with AMC-1, the operating parameters for Gogo's AeroSat HR6400 ESAA aircraft remote terminals are as follows: the maximum input power flux density, at the antenna flange, is -15.45 dBW/4kHz, with a worst case skew angle of -52 degrees and elevation angle of 5 degrees. Transmissions will not exceed the PFD mask in Section 25.227 (a)(1)(i)(A). Due to the asymmetric geometry of the antenna, the transmission will exceed the mask in 25.227(a)(1)(i)(B), and so a waiver of this rule section is required.

AeroSat HR6400 EIRP Density Patterns

The following charts show the off-axis EIRP density for the AeroSat HR6400 terminal for the worst case skew angles. As can be seen, the RF power density has been limited to keep the off-axis emission levels toward the GSO arc within the FCC mask as specified in 25.227 (a)(1)(i)(A). The off-axis EIRP emissions will vary with respect to skew angle but not with respect to elevation angle for the AeroSat HR6400 terminal.

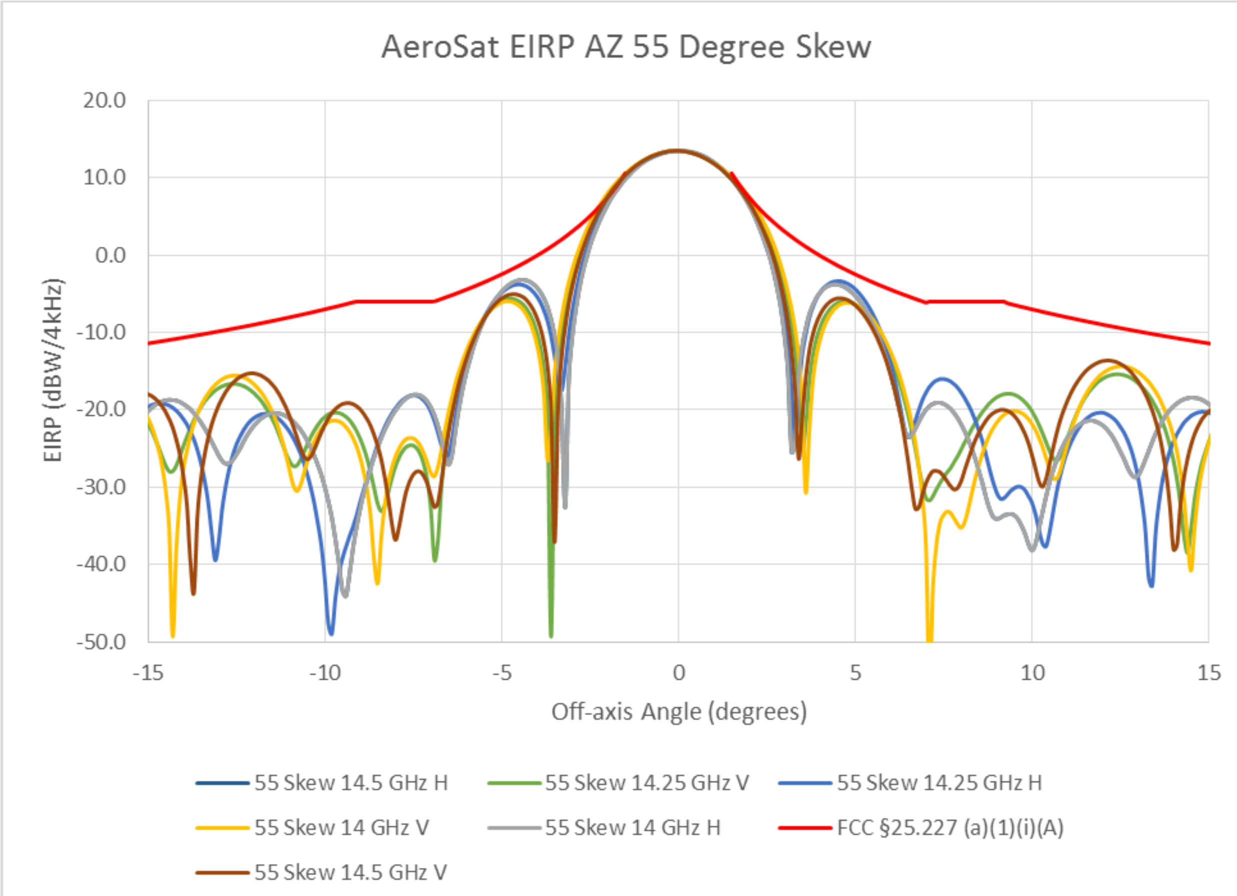

Figure 1 – Close-in image of AeroSat HR6400 Off-Axis EIRP pattern. As can be seen, the system's RF power has been limited to keep operation under the 25.227(a)(1)(i)(A) envelope.

Impact of Skew Angle on Radiation Pattern

It should be noted that without skewing the reflector, as the Gogo aircraft flies within the satellite beam using the AeroSat antenna, performance to AMC-1 is unaffected. The peak antenna performance is at the antenna's boresite, and the boresite is kept accurately pointing to AMC-1 throughout the flight. Consequently, the EIRP transmitted by the AeroSat antenna towards AMC-1 does not change during the flight.

What does change is the amount of energy transmitted towards adjacent satellites (ASI). The antenna reflector remains aligned to the local horizon - we are assuming level flight for this example – while the plane of adjacent satellites skews. As skew increases, the low-profile antenna presents less and less effective area (in this case radiating elements in the phased array antenna) in the direction of adjacent satellites. With less effective area, there is less focusing of the RF signal and, consequently, an increase in transmitted ASI.

However, the values of these performance changes are precisely measured and known. During end-to-end network design and FCC licensing, the AMC-1 operation was engineered to account for these variations. The coverage areas of the Gogo ESAA network are set to ensure that ASI limits are not exceeded. In addition to coverage limits, an airplane terminal constantly knows its instantaneous skew value and will automatically cease transmission if the limit is exceeded due to, for example, airplane banking.

Since the HR6400 has an effective elliptical shape with a large dimension of 24.4 inches and an orthogonal short dimension of 6.8 inches, the effective gain pattern with 0 degree skew considering the major axis of the antenna (also called the azimuth pattern) is the most focused, and operation at 90 degree skew (also termed elevation pattern) is the least focused. Figure 2 below shows the azimuth pattern at mid-band for 0 degrees skew compared to 90 degrees skew.

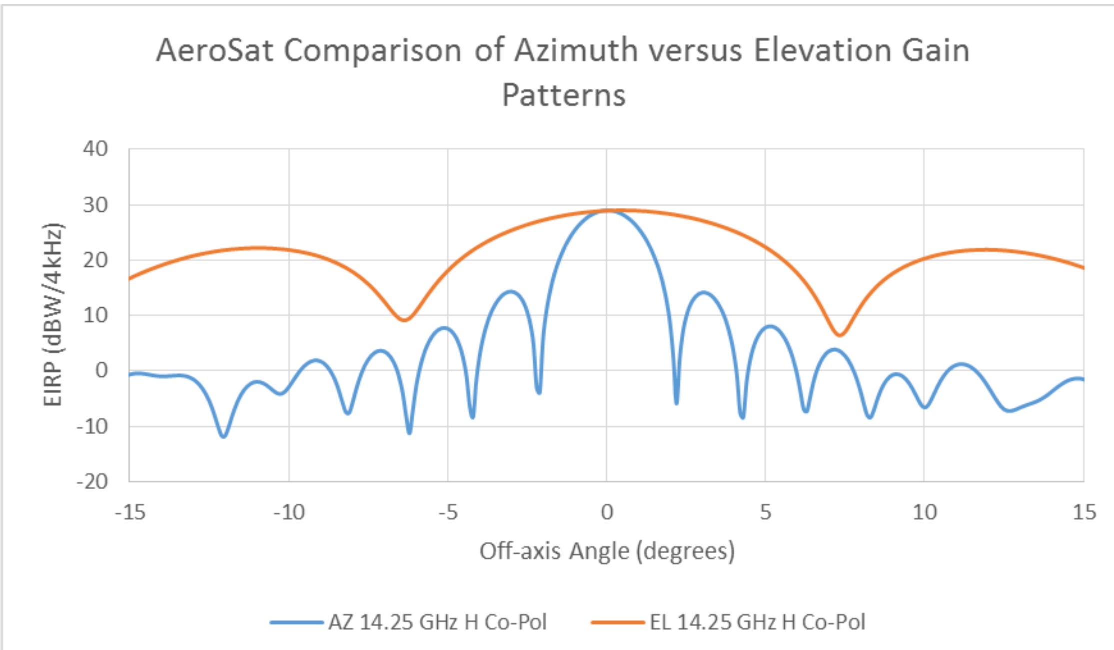

Figure 2 – Comparison of HR6400 antenna gain patterns. Blue line represents the azimuth pattern at 0 degrees skew, and orange line represents the elevation pattern (90 degree skew).

In the case of AMC-1, the worst case position of the aircraft will be when the elevation is 5 degrees and the skew is 52 degrees. Because Gogo does not have pattern data for 52 degrees skew, we are using the 55 degree skew pattern data, as seen in Figure 3 below. As the aircraft nears the edge of these operation limits the network is designed to switch the aircraft to another coordinated and licensed satellite beam.

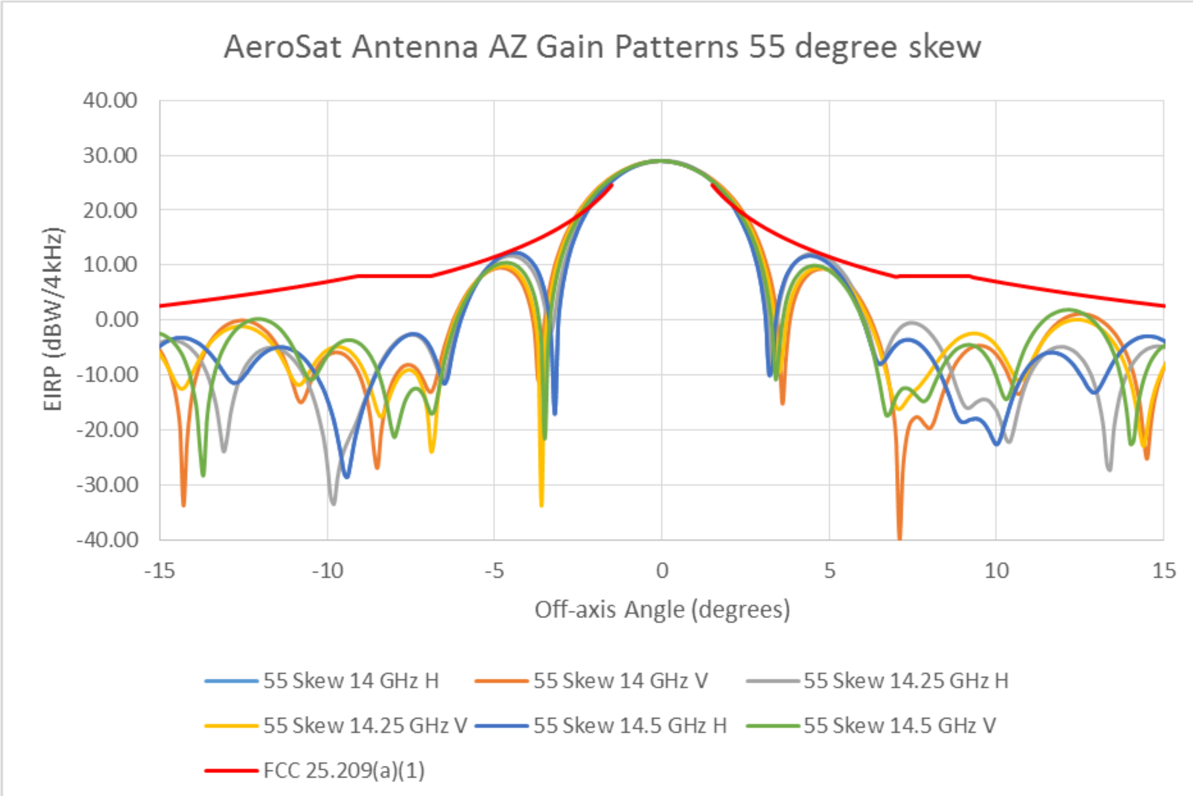

Figure 3 – Worst case azimuth gain pattern at 55 degrees skew. The pattern exceeds the mask slightly requiring a small reduction in RF transmit power density.

The pattern exceeds the mask slightly. Attached to this memo is an excel spreadsheet which contains the tabularized pattern data. That data shows that the worst case exceedances are between 1-3 degrees and are around 1.5 dB. The RF power density has been reduced by 1.5 dB to account for this. Figure 4 below shows that the worst case EIRP density at 55 degrees skew will meet the FCC mask in 25.227(a)(1)(i)(A).

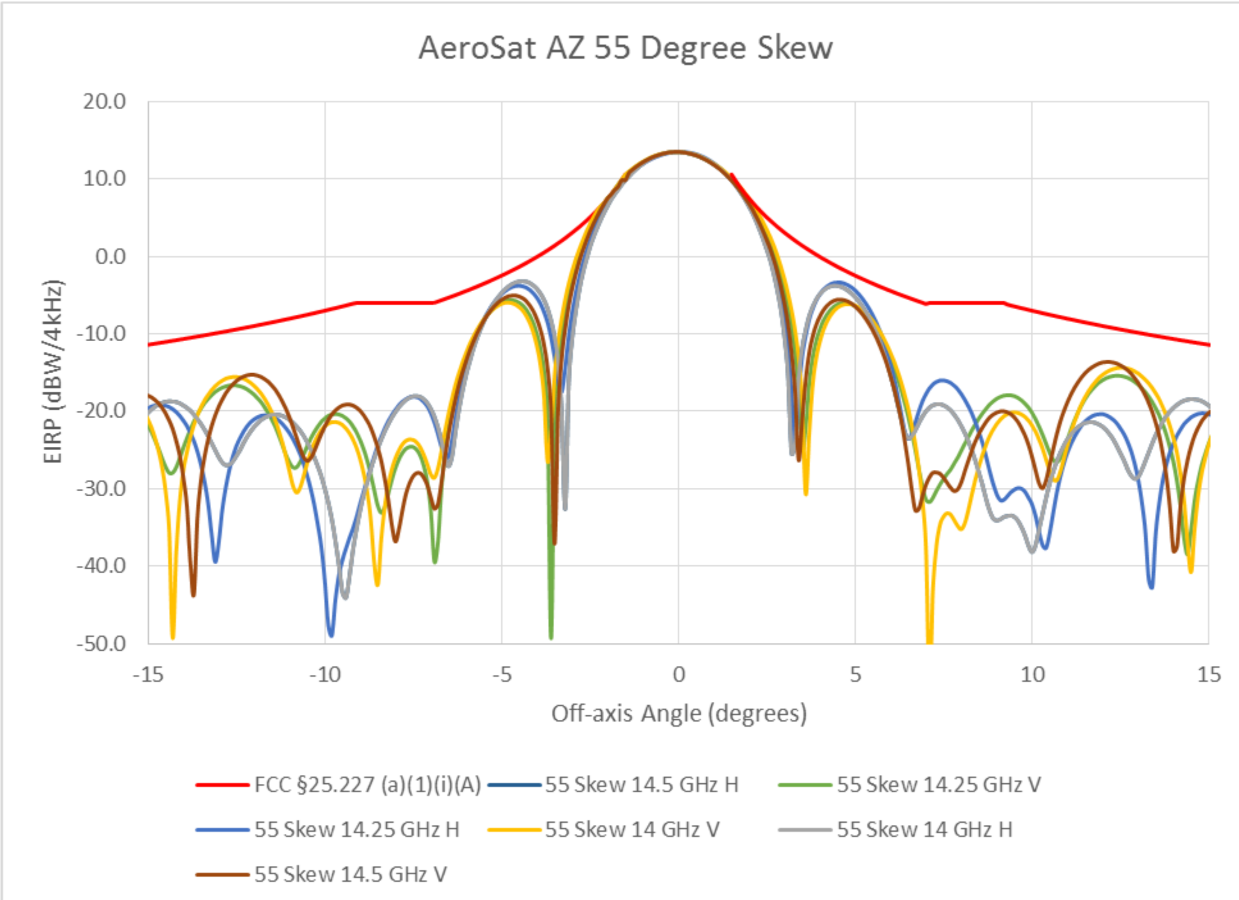

Figure 4 – Aerosat worst case operation off-axis EIRP performance, 55 degrees skew. Slight reduction in RF power ensures non-interference into GSO systems.

Figure 5 below compares the EIRP off-axis performance in two cases: when the aircraft is operating at a best case scenario of 0 degrees skew and when it is operating with the worst case performance at 55 degrees skew. At zero degrees skew, the antenna is operating without impact from the elevation pattern. As the aircraft approaches areas where the skew increases up to 55 degrees, the main beam widens, as shown in Figure 5. Gogo will limit its RF power density and spread its uplink signal enough to keep the off-axis EIRP density toward the GSO arc under the 25.227(a)(1)(i)(A) mask.

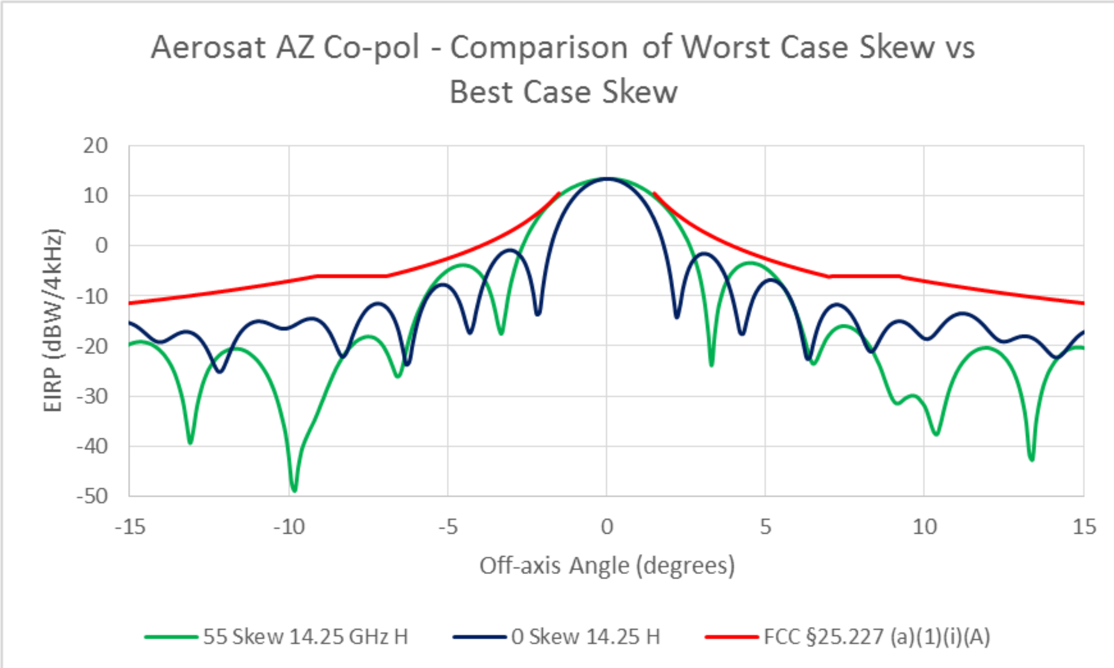

Figure 5 – Comparison of azimuth plane best case skew, 0 degrees, with worst case skew, 55 degrees. As skew increases, the main beam is less focused and spreads.

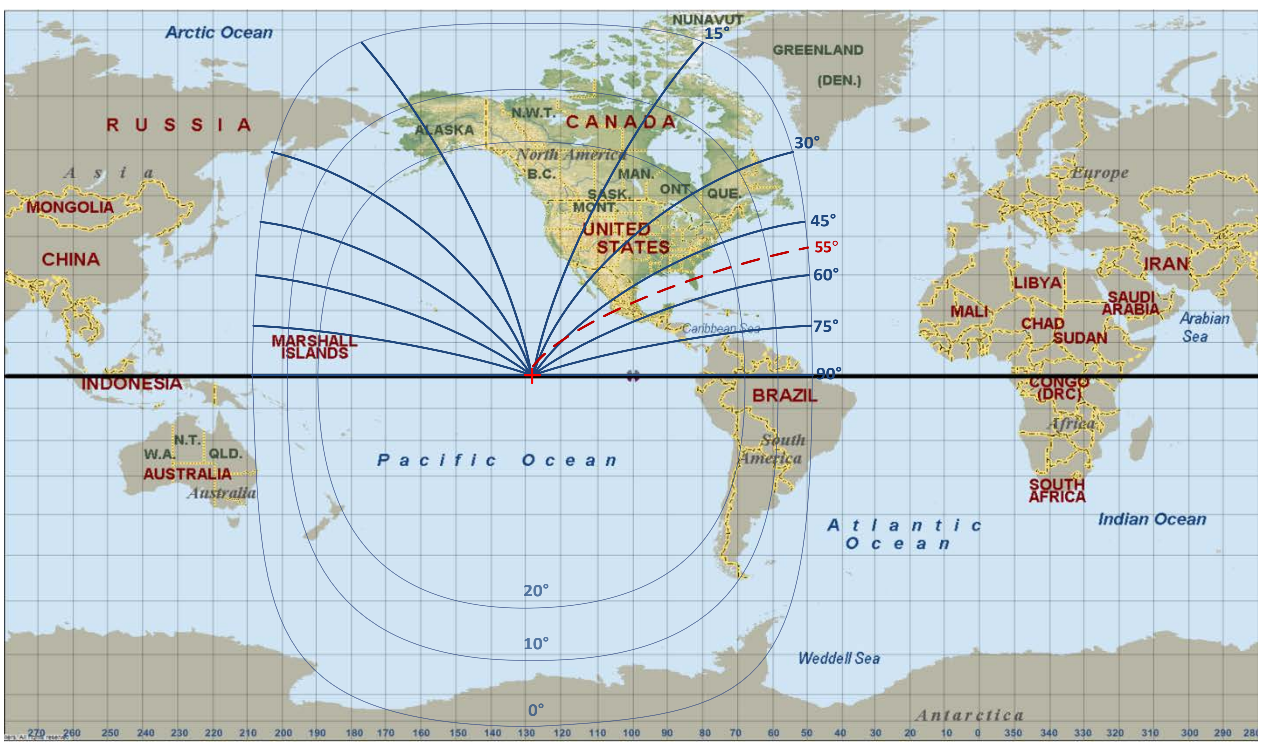

Figure 6 - Example of changing skew angles (in degrees) for locations in North America for an ESAA communicating with a GSO Satellite at 129.15° W.L.

Elevation Plane

As noted above, the elliptical shape of the antenna will result in poorer sidelobe performance in the elevation plane. Since this plane is orthogonal to the azimuth plane, the all elevation sidelobe power will not be directed toward the GSO arc. The simulated EIRP density plot below shows the relative power level along the GSO and non-GSO axes.

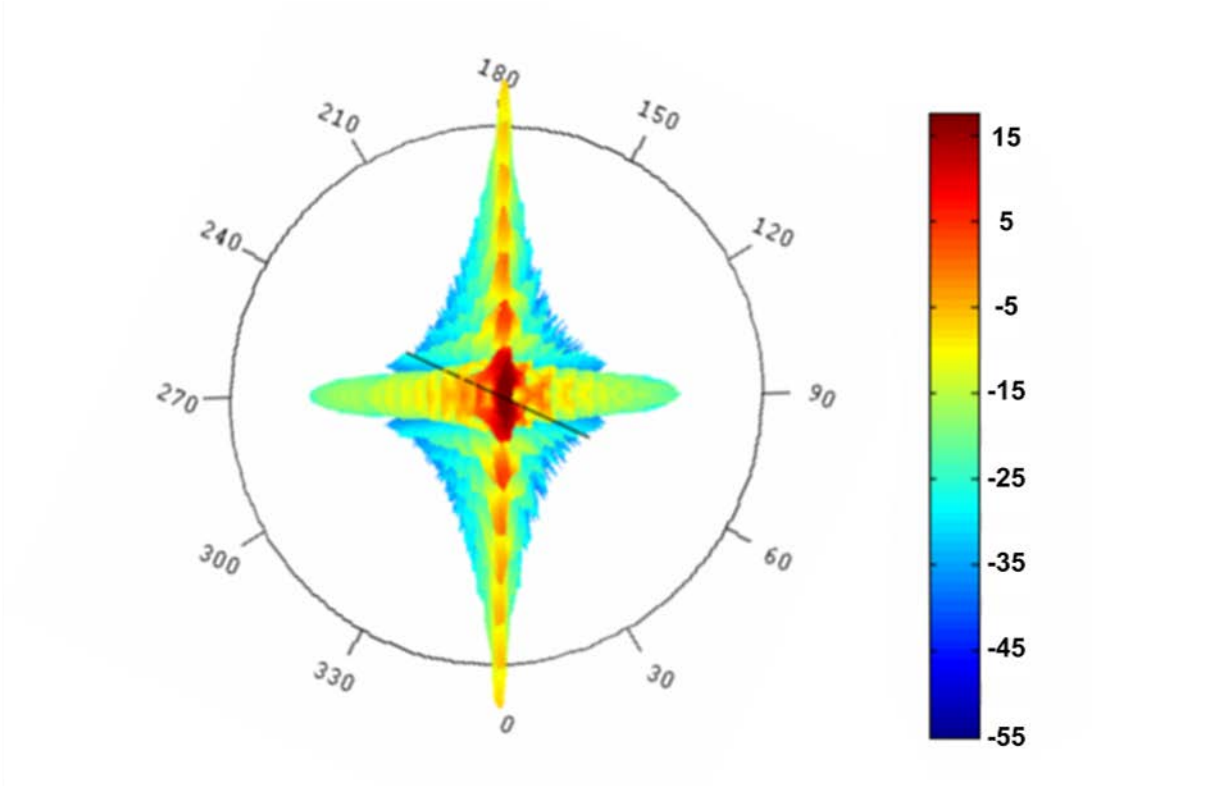

Figure 7 – EIRP Density (dBW/4kHz) along the azimuth and elevation planes (0 degrees skew) 3D pattern. The levels along the GSO arc are below the FCC ESAA mask.

The transmissions in the elevation plane will not impact any existing systems operating in the GSO arc. As noted above, the ESAA system will maintain very tight pointing accuracy and the impact of the elevation pattern on the azimuth pattern considering the worst case skew has been included in our calculations, see Figure 4 above. All non FCC compliant transmission levels are directed to areas where no current systems exist.

Tables containing all of the data used in the figures in the memo are included in the attached spreadsheet *AeroSat HR6400 Gain and EIRP Information 04282016.xlsx*