Thales Avionics
1110 W. Hibiscus Blvd.
Melbourne, FL 32901 USA

April 24, 2019

FILED ELECTRONICALLY VIA IBFS

Ms. Marlene H. Dortch,
Secretary Federal
Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Thales Avionics, Inc. Ka-band ESAA Blanket License Modification Request

Dear Ms. Dortch:

Thales Avionics, Inc. (Thales) files this letter pursuant to Section 1.65 of the Federal Communications Commission's ("FCC" or "Commission") rules, seeking authorization to operate its network of Earth Station Aboard Aircraft (ESAA) terminals at Ka-band using the Thor-7 space station operated by Telenor Satellite (Norway).

Thales has designed this filing under the requirements of §25.138 for operation of GSO FSS at Ka-band, the existing FCC Rules governing ESAA, §25.227, and previously granted licenses for ESAAs using GSO FSS at Ka-band.

Please direct any questions regarding this matter to the undersigned.

Sincerely,

/s/ Pat Amodio

Pat Amodio
Senior Director - Regulatory Compliance

Thales Avionics, Inc.

Ka-band Earth Station Aboard Aircraft (ESAA)

FCC License Modification Request

IBFS File No. SES-LIC-20170217-00183

Technical Narrative

April 24, 2019

Table of Contents

1 Introduction

Thales Avionics, Inc. seeks to modify its active Ka-band ESAA blanket license[1] authorizing ESAA operation over GSO FSS Ka-band capacity as follows:

1) Adding Thor-7 as a Point of Communication, and;
2) Adding new carriers and emission designators.

Thales's ESAA will operate over Ka-band capacity on the Telenor Satellite (Telenor) Thor-7 space station to allow provision of in-flight connectivity (IFC) services on commercial airliners traversing intercontinental flight routes in the North Atlantic Ocean. These flight routes are mainly between destinations in North America and the United Kingdom, Ireland, and several other European nations.

Thales's initial blanket license requests[2] and this modification request have been designed to the requirements set forth in 47 CFR §25.138 rules for GSO FSS Ka-band Earth Stations, §25.227 rules for ESAAs operating with GSO FSS Ku-band blanket licensing provisions[3], and FCC precedents set by previous Ka-band ESAA blanket license grants[4].

2 System Description

2.1 Overview

Thales's Modular Connectivity Terminals, Ka-band (MCT-A) ESAA will operate over the Telenor satellite Thor-7 at orbital location 0.65° W.L. in the Ka band 29.5 – 30.0 GHz (uplink), and 19.7 – 20.2 GHz (downlink). In the future, Thales's IFC service may use Ka space segment on other satellites to increase coverage areas in the North American region and beyond. If so, Thales will seek appropriate FCC approvals to utilize other space segments for this service.

2.1.1 Network Architecture

Thales's IFC network operations over Thor-7 will use Telenor satellite earth stations and the Hughes Jupiter platform baseband hub equipment located in Norway, which will communicate with Hughes Jupiter aero modems on the aircraft. A high-level network architecture diagram is shown below in Figure 1. This architecture is very similar to that provided in Thales's initial filings; the main differences are:

- a trans-Atlantic backhaul to provide connectivity between the Jupiter baseband hubs in Norway and the Network Aggregation Point (NAP) and Thales Interconnect Point (TIP) in northern Virginia

[1] *See* IBFS File No. SES-LIC-20170217, Call Sign E170068, granted July 7, 2017
[2] *See* Initial request IBFS File No. SES-LIC-20170217, Call Sign E170068, filed February 17, 2017; amendment filing IBFS File No. SES-AMD-20170414-00381, Call Sign E170068, filed April 13, 2017
[3] Per Thales's meeting with the International Bureau (IB) on December 15, 2016: while §25.227 ESAA rules currently only apply to Ku-band ESAA operations, IB staff has expressed its intentions to develop parallel Ka-band rules in the future. Thales's technical showings in its initial filings (see Footnote 2) and this modification request demonstrate the extent to which the proposed operations are consistent with those Ku-band ESAA requirements that may be adopted for Ka-band ESAA in the future.
[4] *See* ViaSat Ka-band filing Call Sign E120075

- the Telenor Network Operations Center (NOC) for management and control of the Thor-7 satellite.

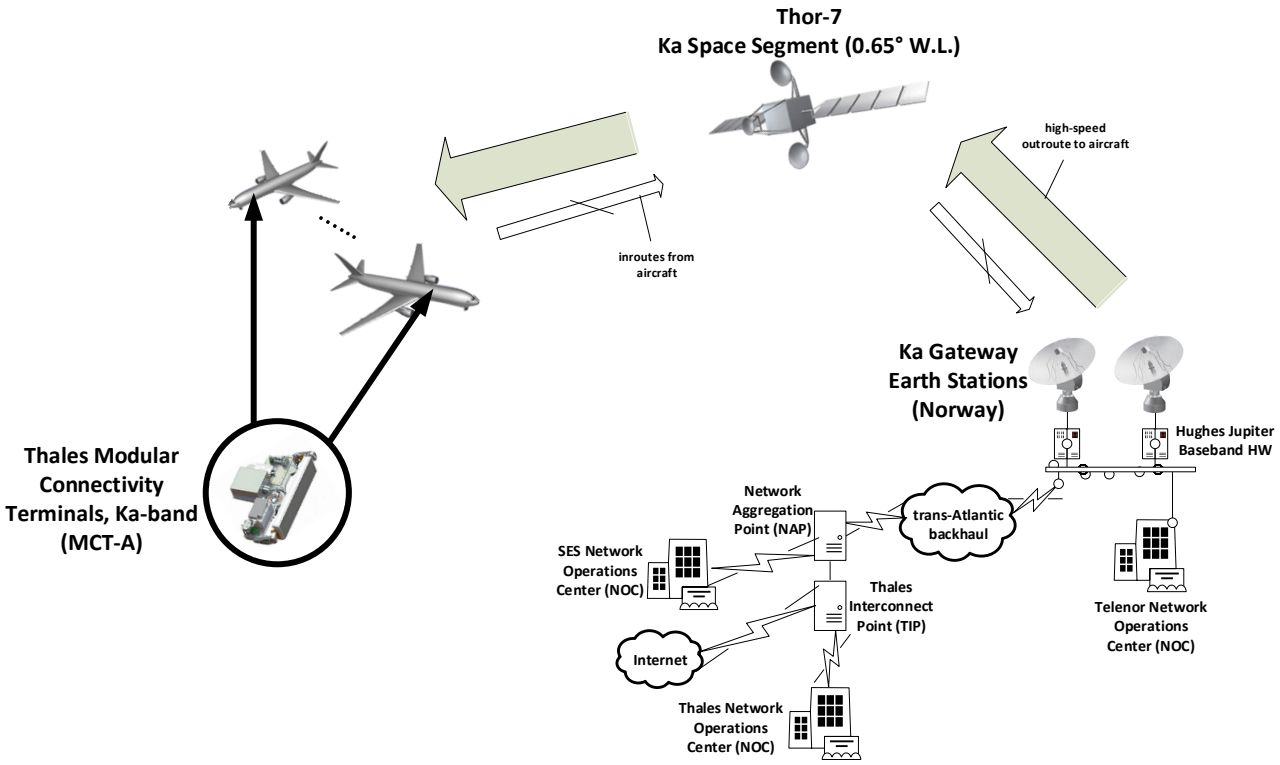

Figure 1: Thales Aero Connectivity Network Architecture Using Thor-7

The network is comprised of:

- a terrestrial IP backhaul network interconnecting the controlling Ka earth station gateways (detailed later in Section 2.4.2), and connecting the baseband hubs to the Virginia-based Network Aggregation Point (NAP) and Thales Interconnect Point (TIP)
- Ka space segment on Thor-7
- Thales Ka ESAAs, known as Modular Connectivity Terminals, Ka-band (MCT-A) including the Hughes Jupiter aero modem, installed on commercial aircraft

The SES Network Operations Center (NOC) in Bristow, VA remains as the primary NOC for the network. The SES NOC has real-time visibility into the Hughes Jupiter Network Management System (NMS) in Germantown, MD for management and control of every aero modem in the network (on aircraft) and the hub baseband instances (at gateways). The SES NOC also provides the Thales NOC in Orlando, FL with data that Thales requires to deliver and manage the overall service.

2.2 ESAA Segment Details

The operational details and specifications of the Thales MCT-A (ESAA) as provided in Thales's initial filings, and indicated in its active authorization, remain the same.[5]

2.3 Space System

2.3.1 Satellite System List

Table 1 below provides the complete list of satellites to be used for Thales's ESAA operations. This list includes the Thor-7 satellite being requested as a new Point of Communication, and the four satellites already authorized in Thales's current ESAA blanket license[6]. Thales's ESAA services using these satellites will not use Ka spectrum in the LMDS band 29.1 – 29.25 GHz.

Satellite (Call Sign)	Satellite Operator	GSO Orbital Location (W.L.)	Transmit Spectrum (MHz)	Receive Spectrum (MHz)
Thor-7*	Telenor	0.65°	27500 – 30000	18300 – 20200
Echostar XVII (Jupiter-1) (S2753)**	Hughes	107.1°	28350 – 29100 29250 – 30000	18300 – 19300 19700 – 20200
Jupiter-2 (S2968)**	Hughes	97.1°	27850 – 29100 29250 – 30000	18300 – 19300 19700 – 20200
AMC-15 (S2180)**	SES	105.05°	28438 – 28563 29500 – 30000	18638 – 18763 19700 – 20200
AMC-16 (S2181)**	SES	85.0°	28438 – 28563 29500 – 30000	18638 – 18763 19700 – 20200

Notes: *being requested as a new Point of Communication in this modification request
**already authorized in Thales's current ESAA blanket license[7]

Table 1: Satellite List and Spectrum Details for Thales's ESAA Operations

2.3.2 Thor-7 Coverage Area for Thales ESAA Operation

The beam coverage areas and skew angle contours for Thor-7 are shown below in Figure 2.

[5] *See* Section 2.2, ESAA Segment Details (pp. 5-9) of Thales's FCC Authorization Submission for Ka-band Earth Station Aboard Aircraft (ESAA), dated February 16, 2017.
[6] *See* IBFS File No. SES-LIC-20170217, Call Sign E170068, granted July 7, 2017
[7] *Ibid.*

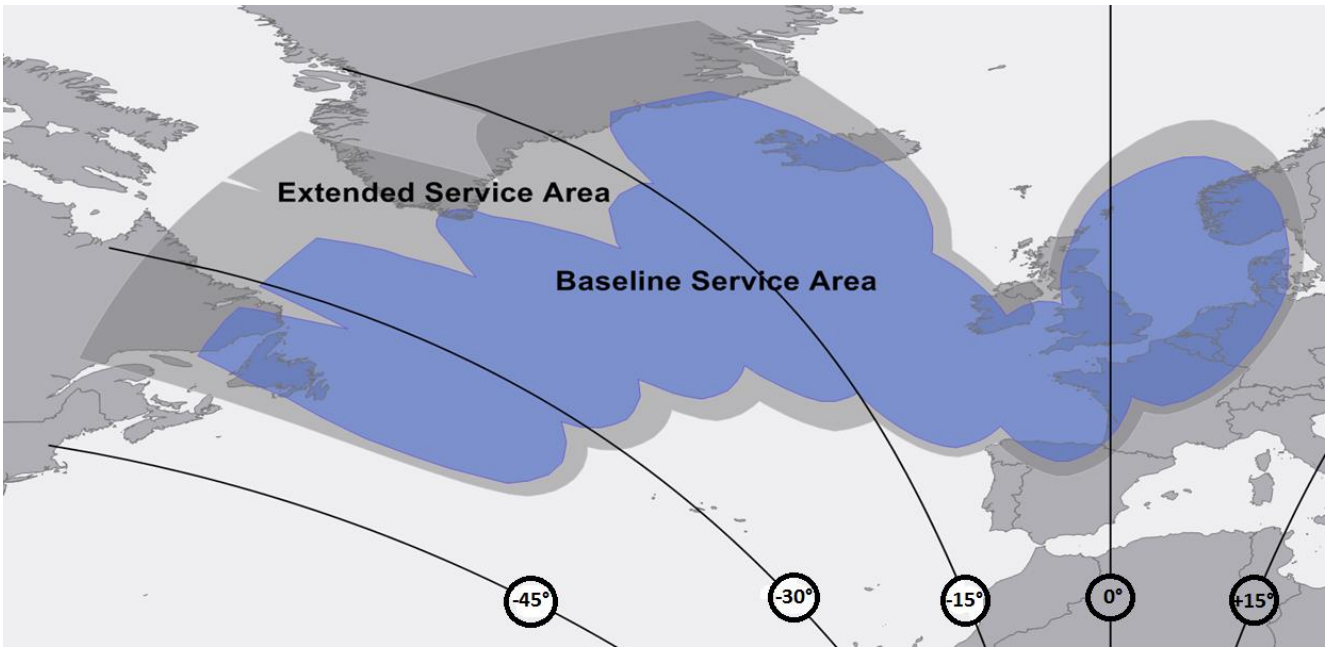

Figure 2: Thor-7 Coverage Area and Skew Angles for Thales ESAA Operation (Worst-Case Skew Angle of ~40°)

2.4 Ground Segment

2.4.1 Remote Control Network Operations Centers (NOCs)

The network operations centers (NOCs) as described in Thales's current authorization are not affected by this amendment request. The SES NOC remains as the primary NOC for this network:

SES Network Operations Center - Manassas
8000 Gainsford Court
Bristow, VA 20136

The SES NOC 24/7/365 phone number is +1 703-330-3305, Option 1

The Thales NOC is also responsible for overall management of the service and can be reached 24/7/365:

Thales Network Operations Center
7415 Emerald Dunes Drive, Suite 2000
Orlando, FL 32822

The Thales NOC phone number is 407-812-2538, and the email address is: MOC@us.thalesgroup.com

2.4.2 Network Gateway Earth Stations

Thales's service over Thor-7 will use Telenor's authorized gateway earth station antennas for Earth-to-space uplinks and space-to-Earth downlinks between the gateways and the satellite. Full remote control of the ESAA terminals and the network is possible from the Thales NOC.

2.5 Additional Carriers, Emission Designators

The waveforms and capabilities of the return link (inbound) channels and the forward link (outbound) channels as detailed in Thales's current authorization are not changing as a result of this modification request. However, Thales's ESAA operations on Thor-7 will require one new carrier type/emission designator for the return channel (from ESAA), and two new carrier types/emission designators for the forward channel (from gateway). These additions are detailed in Table 2 below and in the Form 312 submitted with this modification request.

Link	Emission Designator	Carrier Symbol Rate (Msps)	Carrier EIRP Density		Thor-7 Spectrum (MHz)	
			(dBW/ MHz)	(dBW/4 kHz)	Earth-to-Space	Space-to-Earth
ESAA Return (Inbound)	1M00G7D	1.0	42.4	18.4	29500 – 30000	18900.5 – 19337.5
Gateway Forward (Outbound)	11M4G7D	11.4	55.3	31.3	28483 – 28975	19700 – 20200
Gateway Forward (Outbound)	22M8G7D	22.8	58.3	34.3	28483 – 28975	19700 – 20200

Table 2: New Carrier Types, Emission Designators, and EIRP Density Levels for Thales ESAA Operation on Thor-7

Link budgets provided in Exhibit A of this narrative confirm that the power density level of the new return carrier is equal to highest level in Thales's current authorization. Therefore, Thales is not seeking an increase in power density levels in this request.

2.5.1 NOC Monitoring and Control

At all times the SES NOC and the Thales NOC will monitor and have control of the transmission parameters of all Thales ESAA operating in the network on Thor-7, including the ability to remotely disable terminals in the event of harmful interference.

3 Protection of Other Services

3.1 Protection of Other Ka-band Services

3.1.1 GSO

Thales intends to operate its ESAA network with Thor-7 at orbital location 0.65° W.L. ESAA operation with Thor-7 will be compliant with 25.138(a)(1)[8]. Thales has worked with Telenor to ensure that the off-axis emissions will comply with applicable Thor-7 coordination agreements (see Exhibit B).

3.1.1.1 Thor-7 Off-Axis EIRP Spectral Density

On Thor-7, Thales will limit their ESAA operation to the worst-case skew angle of 40° for off-axis EIRP emission in the GSO plane, as shown earlier in Figure 2. Exhibit A attached contains Thor-7 return link budgets including ESAA operation in three scenarios:

- Case 1: Best satellite G/T; 20° skew angle

- Case 2: Average satellite G/T; 40° skew angle

- Case 3: Worst satellite G/T; 0° skew angle

As shown in the return channel link budgets in Exhibit A, the peak on-axis power density at skew angles of 0°, 20°, and maximum 40° is 42.4 dBW/MHz. This density is equal to and does not exceed the peak densities that Thales's ESAA operations are currently authorized for.

The plots below in Figures 3 and 4 show compliance with §25.138(a)(1) and (a)(2), respectively, at a worst-case 40° skew angle and consider up to 0.2° antenna mispointing.

[8] The existing Thales License contains a provision granting a waiver of 25.138(a)(2). See Provision 90421 *Waiver of Section 25.138(a)(2) of the Commission Rules is granted. The antenna performance specifications do not comply with Section 25.138(a)(2). The operation of these antennas will not be protected from harmful interference caused by other geostationary satellite networks to the extent that harmful interference would not be expected to be caused to an antenna that is compliant with the antenna performance standards of Section 25.209.*

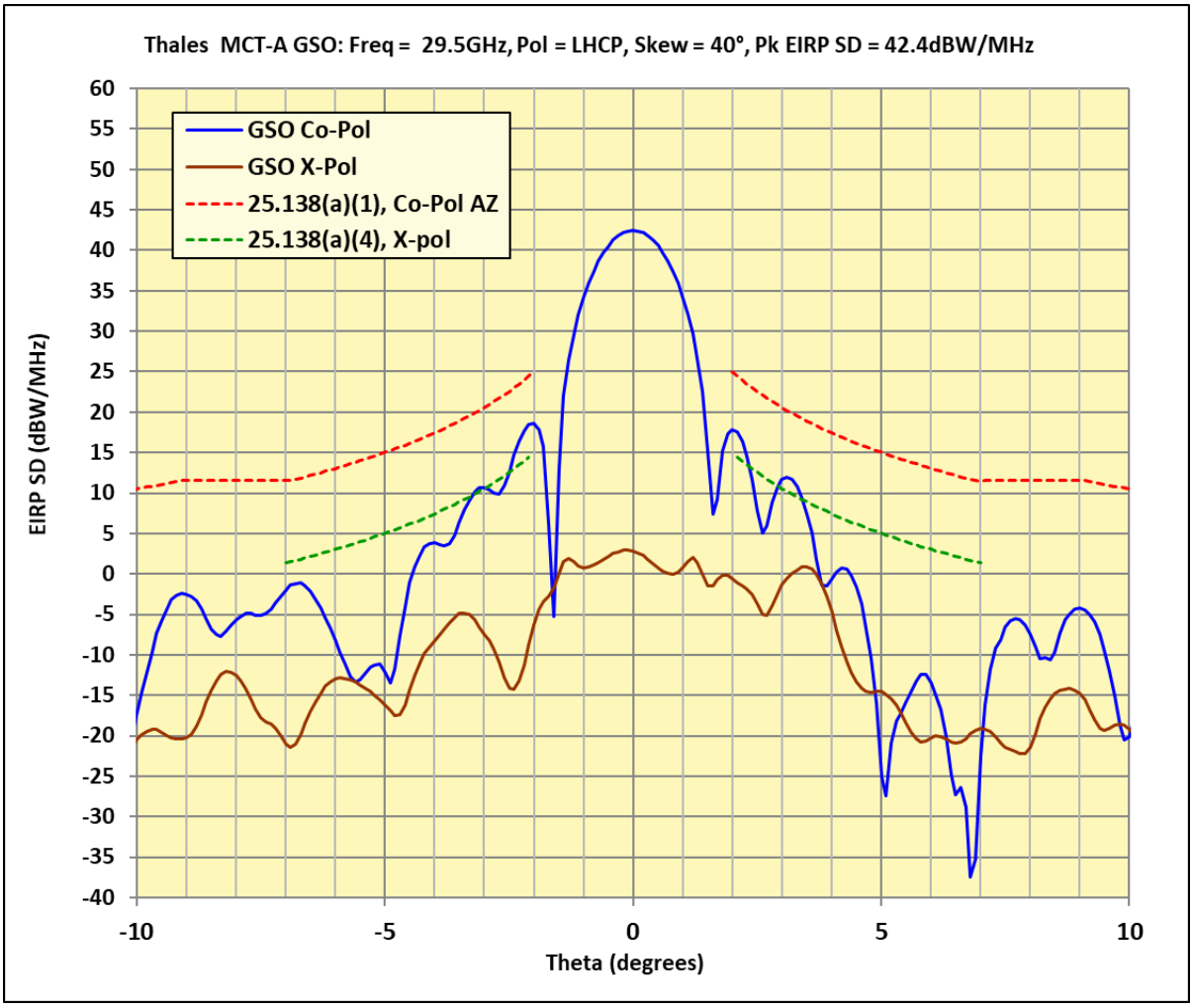

Figure 3: MCT-A EIRP SD Pattern 40° skew angle at 29.5 GHz; Co-Pol and Cross-Pol LHCP; GSO Plane +/- 10°

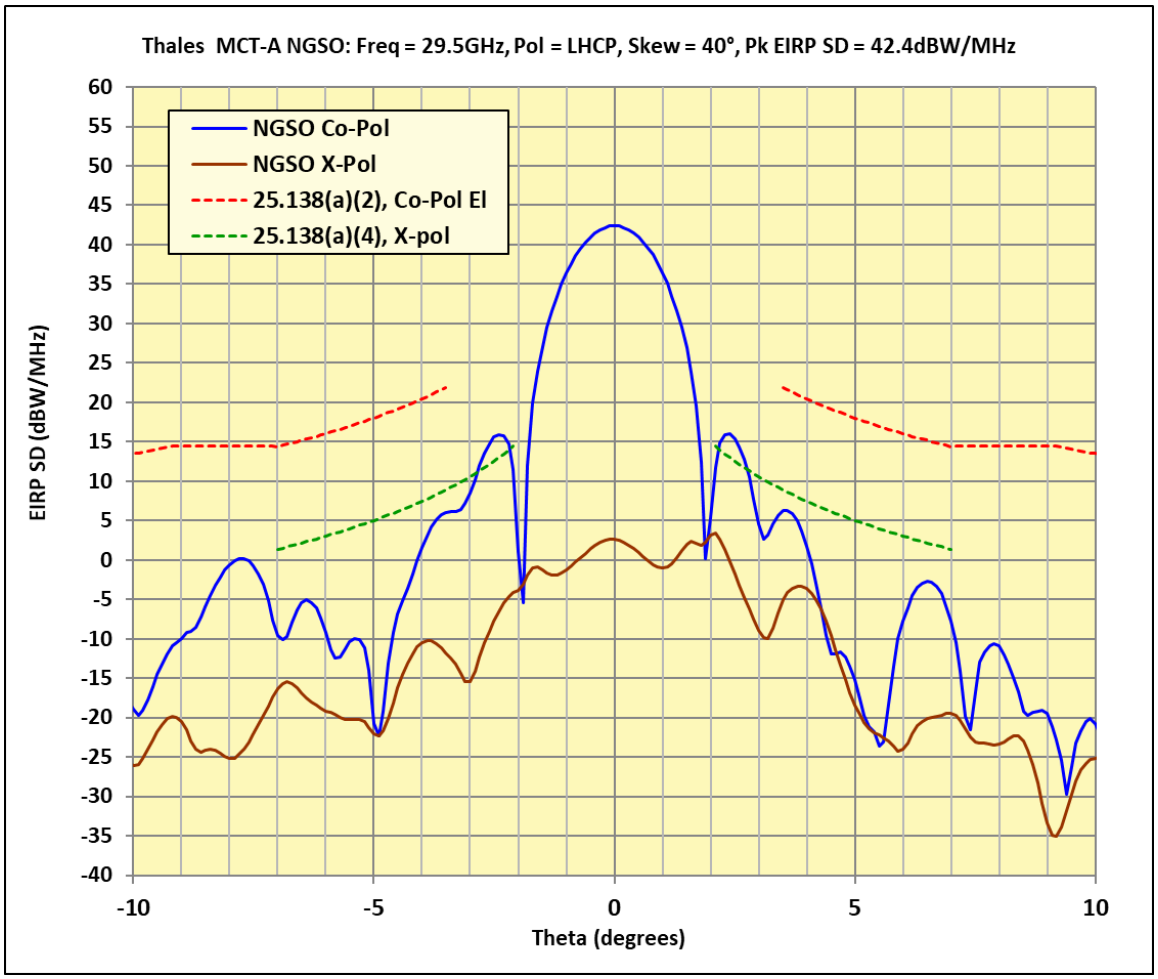

Figure 4: MCT-A EIRP SD Pattern 40° skew angle at 29.5 GHz; Co-Pol and Cross-Pol LHCP; NGSO Plane +/- 10°

3.1.2 Protection of NGSO Systems

For ESAA operations on Thor-7, Thales does not intend to operate in spectrum allocated to NGSO systems. The NGSO transmit band is 28.6 – 29.1 GHz[9]. Thales will only operate between 29.5 and 30.0 GHz.

3.1.3 Protection of LMDS Systems

The nearest allocation for LMDS service is 27.5 – 28.35 GHz[10] and, as noted in Section 3.1.2 above, Thales will not operate within this band.

[9] *See*, e.g., Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for Broadcast Satellite-Serv. Use, 16 FCC Rcd 19808, at ¶ 23 (2001)

[10] Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services, First Report and Order, 11 FCC Rcd 19005 ¶ 85 (1996).

3.1.4 Protection of Mobile Satellite Systems at Ka-band

For ESAA operations on Thor-7, Thales does not intend to operate in the 29.25 – 29.5 GHz band, which is allocated to GSO FSS and NGSO MSS feeder links on a co-primary basis.

3.1.5 Radiation Hazard Study

Since the Thales MCT-A (ESAA) characteristics and specifications are not changing as part of this amendment, the radiation hazard study provided in Thales's initial filing[11] still applies and is not repeated in this narrative.

3.2 List of Exhibits

The following six exhibits are provided in this document:

- Exhibit A contains the link budgets for Thor-7.
- Exhibit B contains the Telenor Satellite certification letter for Thales's operations on Thor-7.
- Exhibit C contains the compliance tables for §25.227 and §25.138.
- Exhibit D contains transmit antenna gain plots for the skew angle of 40°.
- Exhibit E contains the transmit EIRP density plots for the skew angle of 40°.
- Exhibit F contains the Telenor Satellite orbital debris mitigation letter for Thor-7.

4 Conclusion

The grant of this license modification will serve the public interest by enabling Thales to expand the geographic areas in which its IFC services can be utilized by commercial airlines, their passengers, and crew, in a manner fully consistent with the FCC rules. As such, Thales respectfully requests grant of this license modification.

[11] See Exhibit D – Radiation Hazard Study (p. 30) of Thales's FCC Authorization Submission for Ka-band Earth Station Aboard Aircraft (ESAA), dated February 16, 2017.

5 Exhibit A - Thor-7 Link Budgets

As referenced earlier in Section 3.1.1.1, return channel link budgets over Thor-7 for ESAA operation at best, average, and worst satellite G/T (20°, 40°, and 0° skew angles respectively) are provided below. A representative forward link budget is also provided.

		Thor-7 Return Channel Link Budgets		
		Case 1: Best Satellite G/T; 20° Skew Angle	**Case 2: Average Satellite G/T; 40° Skew Angle**	**Case 3: Worst Satellite G/T; 0° Skew Angle**
General Parameters				
Orbital location	°W.L.	0.65	0.65	0.65
Uplink Frequency	MHz	29942	29810	29750
Downlink Frequency	MHz	19017	19335	19275
Transmit Earth Station				
Antenna width x height	cm	62.3 x 15.8	62.3 x 15.8	62.3 x 15.8
Antenna elevation angle	degrees	21.8	5.7	18.5
Antenna Gain	dBi	39.0	39.0	39.0
Earth station transmit EIRP/carrier	dBW	45.5	42.5	45.5
Pointing loss	dB	0.00	0.00	0.50
Receive Earth Station				
Antenna diameter	m	13.00	13.00	13.00
Antenna elevation angle	degrees	21.3	21.3	21.3
Receive E/S G/T clear sky	dB/K	39.3	39.3	39.3
Receive pointing loss	dB	0.00	0.00	0.00
Carrier				
Information rate	Mbps	3.200	1.330	0.512
FEC Coding		4/5	2/3	1/2
Modulation		OQPSK	OQPSK	OQPSK-SF4
Symbol rate	Msps	2.048	1.024	0.512
Allocated bandwidth	MHz	2.500	1.250	2.500
Uplink				
Satellite G/T toward ESAA	dB/K	12.1	9.6	5.2
Uplink path loss	dB	214.0	213.9	213.9
Uplink atmospheric loss	dB	0.10	0.10	0.10
C/N uplink	dB	9.1	6.3	2.4
C/(N+I) uplink	dB	8.7	6.1	2.3
On-axis EIRP spectral density	dBW/MHz	42.4	42.4	42.4
Downlink				
Downlink atmospheric loss	dB	0.40	0.40	0.40
Downlink path loss	dB	209.9	209.9	209.9
Carrier downlink EIRP	dBW	62.2	62.0	62.2
PSD at earth's surface	dBW/m^2/MHz	-92.9	-97.7	-96.9
C/N downlink	dB	20.4	17.2	13.5
C/(N+I) downlink	dB	17.9	15.9	12.8
End-to-End				
C/I adjacent spacecraft interference	dB	32.0	32.0	32.0
C/(N+I) total	dB	8.1	5.7	1.9
Link margin	dB	0.9	0.1	0.9

Thor-7 Forward Channel Link Budget		
General Parameters		
Orbital location	°W.L.	0.65
Uplink Frequency	MHz	28510
Downlink Frequency	MHz	20032.5
Transmit Earth Station		
Antenna diameter	m	13.00
Antenna elevation angle	degrees	21.3
Antenna Gain	dBi	54.3
Earth station transmit EIRP/carrier	dBW	66.1
Pointing loss	dB	0.00
Receive Earth Station		
Antenna width x height	cm	62.3 x 16.8
Antenna elevation angle	degrees	21.5
Rx E/S G/T clear sky	dB/K	11.3
Receive pointing loss	dB	0.00
Carrier		
Information rate	Mbps	18.100
FEC Coding		3/4
R-S Coding		0.996
Modulation		DVB-S2 QPSK
Symbol rate	Msps	11.900
Allocated bandwidth	MHz	12.500
Uplink		
Uplink path loss	dB	213.5
Uplink atmospheric loss	dB	0.60
C/N uplink	dB-Hz	27.6
C/(N+I) uplink	dB-Hz	18.5
On-axis EIRP spectral density	dBW/MHz	55.3
Downlink		
Downlink atmospheric loss	dB	0.04
Downlink path loss	dB	210.4
Carrier downlink EIRP	dBW	61.2
PFD at earth's surface	dBW/m^2/MHz	-86.5
C/N downlink	dB-Hz	7.2
C/(N+I) downlink	dB-Hz	7.0
End-to-End		
C/I adjacent spacecraft interference	dB-Hz	32.0
C/(N+I) total	dB-Hz	6.7
Link margin	dB	1.3

6 Exhibit B - Satellite Operator Certification Letter

telenor | satellite

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

Our date: 2019.24.04
Our reference: 2019/01
Your date:
Your reference:

Our contact:
Kjersti Thomassen Hamborgstrøm

Engineering Certification of Telenor Satellite for the Thor-7 Satellite

This letter confirms that Telenor Satellite ("Telenor") is aware that Thales Avionics, Inc. ("Thales"), licensed by the Federal Communications Commission ("FCC"), is seeking authorization from the FCC to operate technically identical Ka-band transmit/receive remote terminals, consistent with ITU RR 5.528 and the Commission's current framework for the Ka band. Thales seeks authority for Thales Avionics, Inc.'s remote terminals to communicate with the Thor-7 satellite at 0.65° W.L. according to the Commission's precedent for Ka-band aeronautical applications.

Based upon the representations made to Telenor by Thales concerning how it will operate on Thor-7:

- Telenor certifies that the power density levels are consistent with off-axis EIRP density levels specified in the FCC's rules in 47 CFR, Part 25, §25.138(a)(1). Telenor is aware that Thales holds an FCC waiver of §25.138(a)(2) rules due to the antenna's non-compliance in the NGSO plane when operating at low skew angles.
- Telenor certifies that the power flux density (PFD) levels are consistent with PFD levels specified in §25.138(a)(6)(a).
- Telenor certifies that the power density levels specified comply with any existing coordination agreements to which Telenor is a party, with adjacent satellite operators within +/-6°of orbital separation from Thor-7.
- Telenor certifies that Thales's operations are consistent with the following §25.227 rules that apply to Ka-band operation:
  - (a)(1), (a)(2), (a)(4) through (a)(16); (b)(1), (b)(2), (b)(4) through (b)(8)
- If the FCC authorizes the operations proposed by Thales, Telenor will, as long as Thales is using Thor-7 capacity, incooperate the power density levels specified in this letter in future satellite network coordination agreements with other operators of satellites adjacent to Thor-7 .

Yours Sincerely,

Kjersti Thomassen Hamborgstrøm
Director Spectrum Management
Telenor Satellite

Telenor Satellite
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N-1331 Fornebu, Norway
Org no 974 329 068 MVA

Tel: +47 67 89 00 00
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Web: www.telenorsat.com

7 Exhibit C - §25.227 and §25.138 Rules Compliance Tables

FCC Rules §25.227 Compliance Table		
FCC Rule Part	**Description**	**Comments**
§25.227(a)(2)	(2) The following requirements apply to ESAA systems that operate with off-axis EIRP spectral-densities in excess of the levels in paragraph (a)(1)(i) or (a)(3)(i) of this section under licenses granted based on certifications filed pursuant to paragraph (b)(2) of this section.	See Existing License Provision 90421
§25.227(a)(2)(i)	(i) An ESAA or ESAA system licensed based on certifications filed pursuant to paragraph (b)(2) of this section must operate in accordance with the off-axis EIRP density specifications provided to the target satellite operator in order to obtain the certifications.	Thales will comply, see Section 3.1 and Exhibit B
§25.227(a)(7)	(7) In the 10.95-11.2 GHz (space-to-Earth) and 11.45-11.7 GHz (space-to-Earth) frequency bands ESAAs shall not claim protection from interference from any authorized terrestrial stations to which frequencies are either already assigned, or may be assigned in the future.	Thales understands that the Ka-band spectrum sought could be used by terrestrial microwave in the 18.3-18.8 GHz band and does expect to receive protection from interference. The possibility for interference while in operation is very remote
§25.227(a)(8)	(8) An ESAA terminal receiving in the 11.7-12.2 GHz (space-to-Earth) bands shall receive protection from interference caused by space stations other than the target space station only to the degree to which harmful interference would not be expected to be caused to an earth station employing an antenna conforming to the referenced patterns defined in paragraphs (a) and (b) of section 25.209 and stationary at the location at which any interference occurred.	Thales understands and expects similar protection from Ka-band satellites
§25.227(a)(13)	(13) ESAA providers operating in the international airspace within line-of-sight of the territory of a foreign administration where fixed service networks have primary allocation in this band, the maximum power flux density (pfd) produced at the surface of the Earth by emissions from a single aircraft carrying an ESAA terminal should not exceed the following values unless the foreign Administration has imposed other conditions for protecting its fixed service stations:	Thales will comply with 25.138 downlink PFD limits, see Section 3.1 and Link Budgets in Exhibit A

	-132 + 0.5 · θ dB(W/(m2 · MHz)) For θ ≤40°	
	-112 dB(W/(m2 · MHz)) For 40° <θ ≤90°	
§25.227(b)	(b) Applications for ESAA operation in the 14.0-14.5 GHz (Earth-to-space) band to GSO satellites in the FSS shall include, in addition to the particulars of operation identified on FCC Form 312, and associated Schedule B, the applicable technical demonstrations in paragraphs (b)(1), (b)(2), or (b)(3), and the documentation identified in paragraphs (b)(4) through (b)(8) of this section.	Thales will comply, see Sections 3.1 and Exhibits D and E
§25.227(b)(2)	(2) An ESAA applicant proposing to operate with off-axis EIRP density in excess of the levels in paragraph (a)(1)(i) or (a)(3)(i) of this section must provide the following in exhibits to its earth station application:	Thales will comply, see Sections 3.1 and Exhibits D and E
§25.227(b)(2)(i)	(i) Off-axis EIRP density data pursuant to §25.115(g)(1);	See Section 3.1.1 and Exhibit E
§25.227(b)(2)(ii)	(ii) The certifications required by §25.220(d); and	See Exhibit B
§25.227(b)(4)	(4) There shall be an exhibit included with the application describing the geographic area(s) in which the ESAA will operate.	See Section 2.3.1

FCC Rules §25.138 Compliance Table		
FCC Rule Part	**Description**	**Comments**
25.138(a)	Applications for earth station licenses in the GSO FSS in the conventional Ka-band that indicate that the following requirements will be met and include the information required by relevant provisions in §§25.115 and 25.130 may be routinely processed:	
25.138(a)(1)	The EIRP density of co-polarized signals in the plane tangent to the GSO arc, as defined in §25.103, will not exceed the following values under clear sky conditions:	Thales will comply, see Section 3.1 and Exhibit E
	32.5-25log(θ) dBW/MHz for 2.0° ≤ θ ≤ 7°.	
	11.5 dBW/MHz for 7° ≤ θ ≤ 9.2°	
	35.5-25log(θ) dBW/MHz for 9.2° ≤ θ ≤ 19.1°	
	3.5 dBW/MHz for 19.1° < θ ≤ 180°	
	Where:	
	θ is the angle in degrees from a line from the earth station antenna to the assigned orbital location of the target satellite.	

25.138(a)(2)	In the plane perpendicular to the GSO arc, as defined in §25.103, the EIRP density of co-polarized signals will not exceed the following values under clear sky conditions:	See existing license provision 90421
	35.5-25log(θ) dBW/MHz for 3.5° ≤ θ ≤ 7°	
	14.4 dBW/MHz for 7° < θ ≤ 9.2°	
	38.5-25log(θ) dBW/MHz for 9.2° < θ ≤ 19.1°	
	6.5 dBW/MHz for 19.1° < θ ≤ 180°	
	Where θ is as defined in paragraph (a)(1) of this section.	
25.138(a)(3)	The EIRP density levels specified in paragraphs (a)(1) and (2) of this section may be exceeded by up to 3 dB, for values of θ > 7°, over 10% of the range of theta (θ) angles from 7-180° on each side of the line from the earth station to the target satellite.	Thales understands
25.138(a)(4)	The EIRP density of cross-polarized signals will not exceed the following values in the plane tangent to the GSO arc or in the plane perpendicular to the GSO arc under clear sky conditions:	Thales will comply, see Section 3.1 and Exhibit E
	22.5-25log(θ) dBW/MHz for 2.0° < θ ≤ 7.0°	
	Where θ is as defined in paragraph (a)(1) of this section.	
25.138(6)(a)	(6) Power flux-density (PFD) at the Earth's surface produced by emissions from a space station for all conditions, including clear sky, and for all methods of modulation shall not exceed a level of −118 dBW/m2/MHz, in addition to the limits specified in §25.208 (d).	Thales understand and will not exceed, See outbound LBAs in Exhibit A
25.138(6)(b)	(b) Operation with off-axis EIRP density exceeding a relevant envelope specified in paragraph (a) of this section and applications proposing such operation are subject to coordination requirements in §25.220.	Thales understand and will comply
25.138(6)(c)-(e)	(c)-(e) [Reserved]	
25.138(6)(f)	(f) The holder of a blanket license pursuant to this section will be responsible for operation of any transceiver to receive service provided by that licensee or provided by another party with the blanket licensee's consent. Space station operators may not transmit communications to or from user transceivers in the United States in the 18.3-18.8 GHz, 19.7-20.2 GHz, 28.35-28.6 GHz, or 29.25-30.0 GHz band unless such communications are authorized under an FCC earth station license.	Thales understands and will comply

8 Exhibit D - Antenna Gain Plots

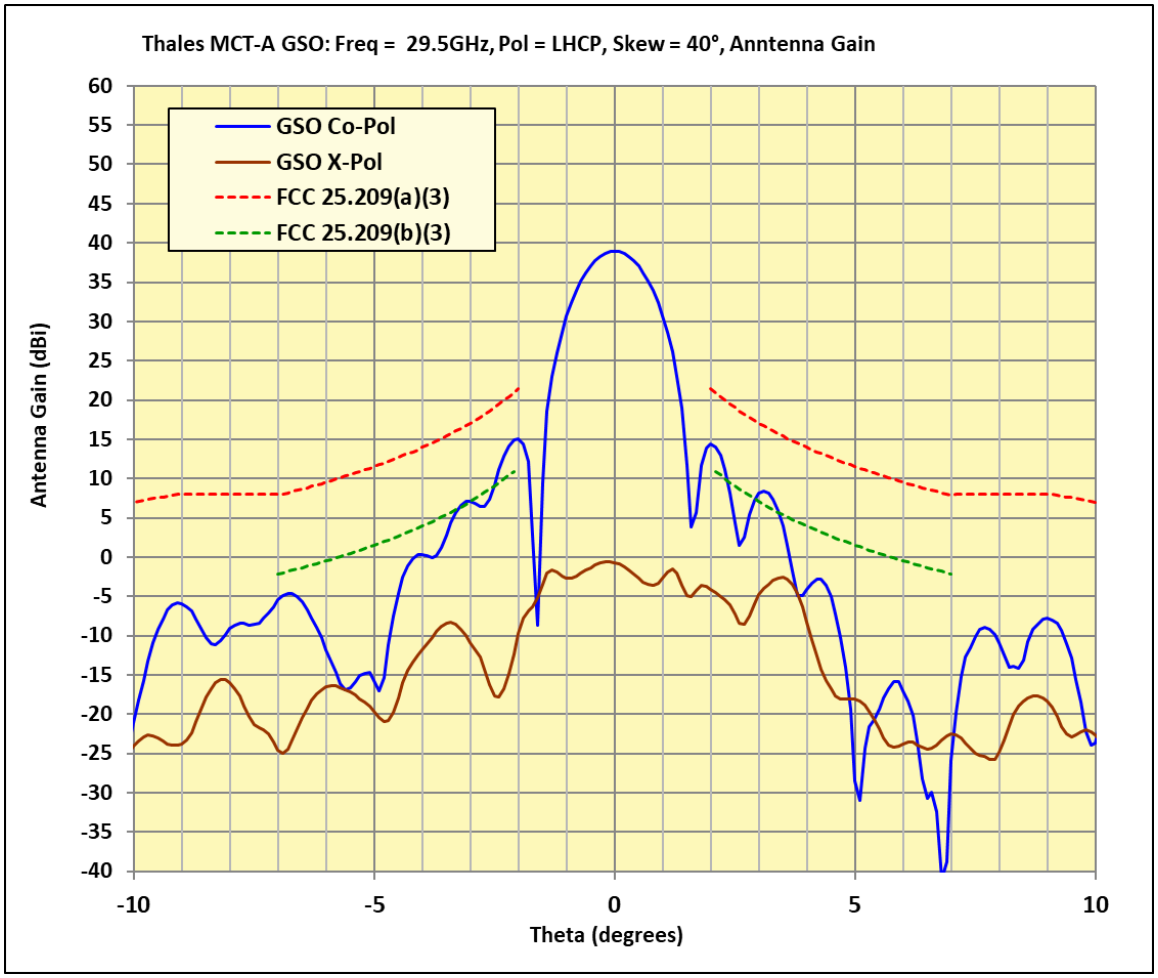

Figure 8-1: MCT-A Transmit Gain Pattern; 40° skew angle; 29.5 GHz; Co-Pol and Cross-Pol LHCP; GSO Plane +/- 10°

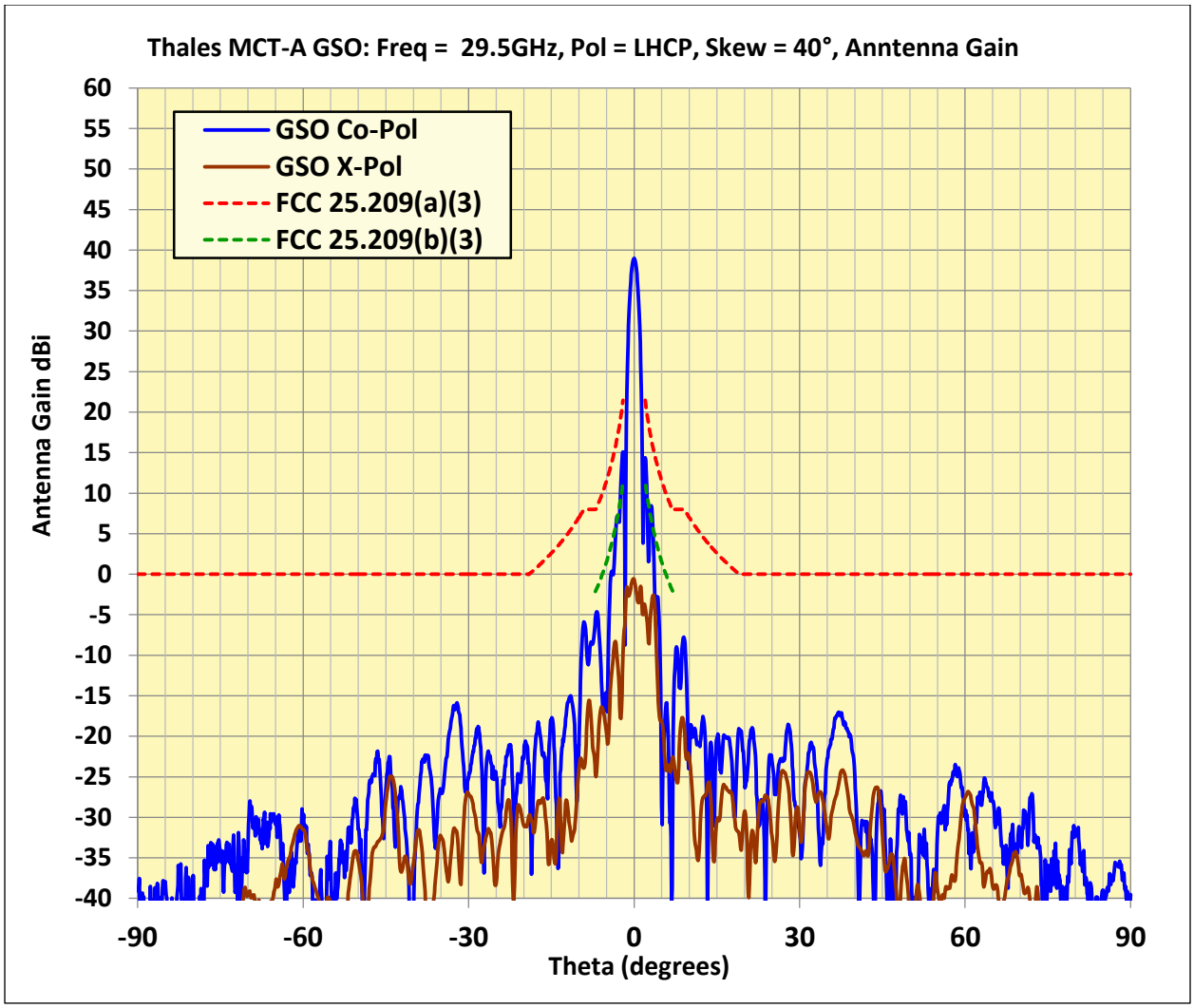

Figure 8-2: MCT-A Transmit Gain Pattern; 40° skew angle; 29.5 GHz; Co-Pol and Cross-Pol LHCP; GSO Plane +/- 90°

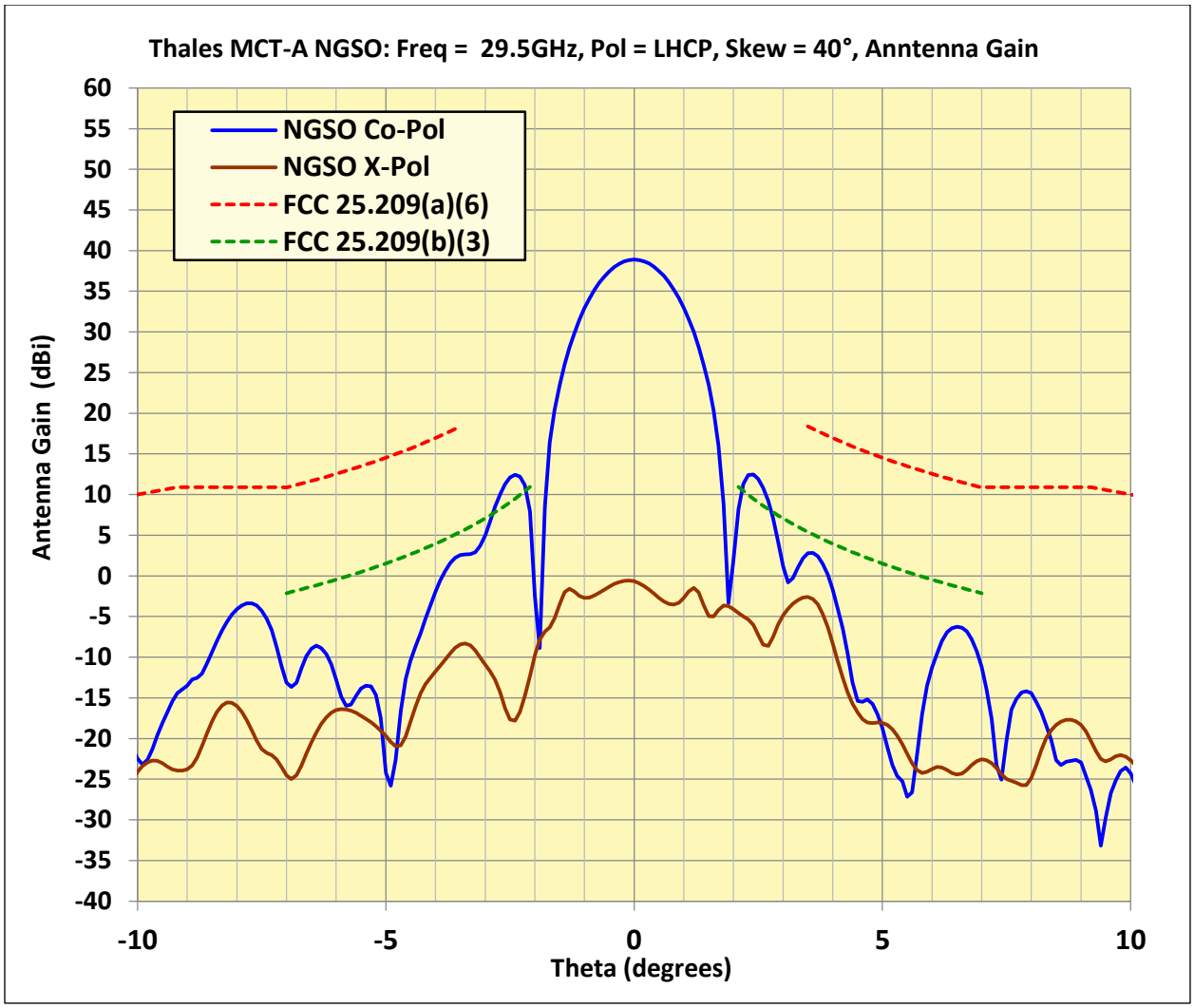

Figure 8-3: MCT-A Transmit Gain Pattern 40° skew angle, 29.5 GHz; Co-Pol and Cross-Pol LHCP; NGSO Plane +/- 10°

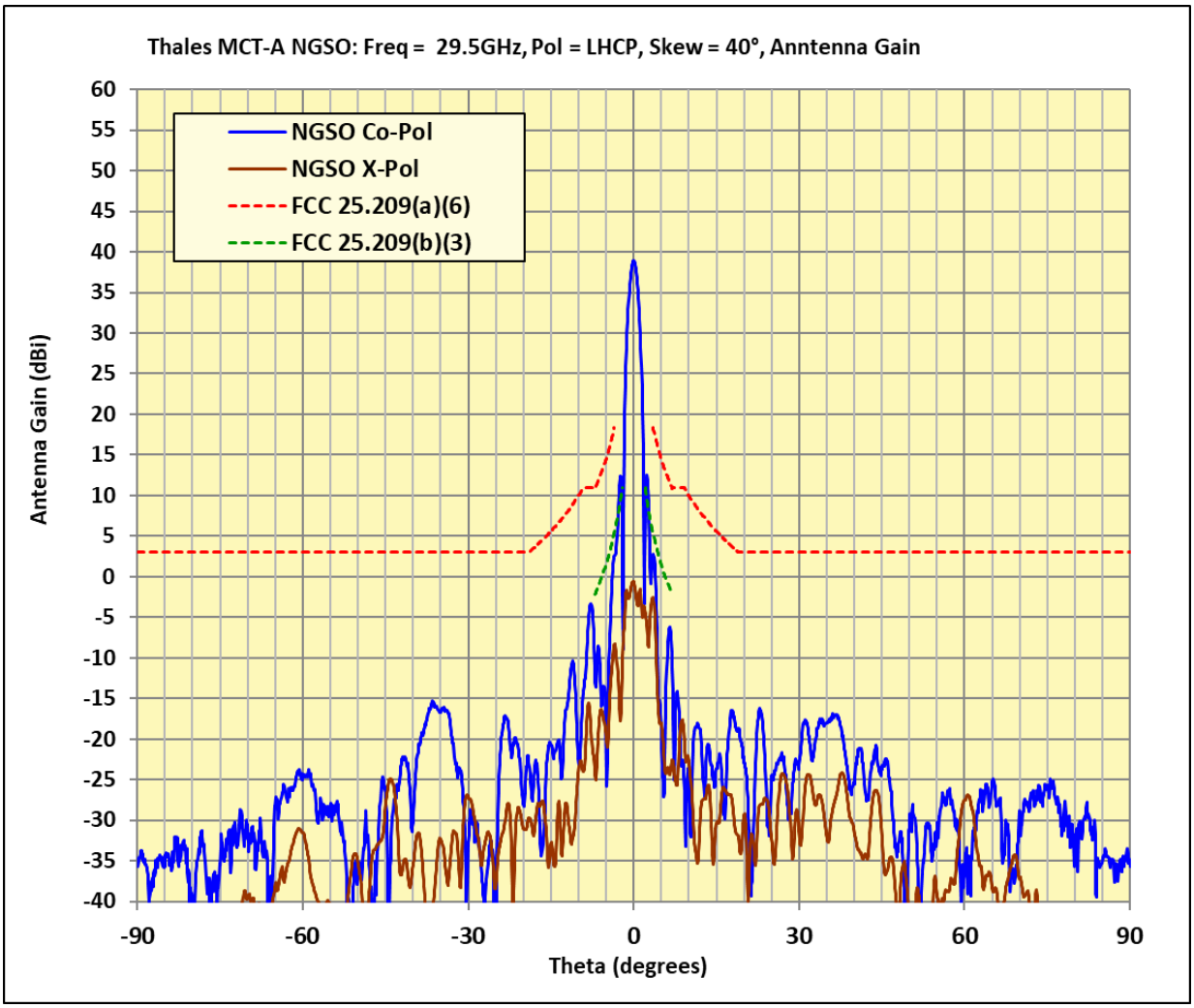

Figure 8-4: MCT-A Transmit Gain Pattern 40° skew angle, 29.5 GHz; Co-Pol and Cross-Pol LHCP; NGSO Plane +/- 90°

9 Exhibit E - EIRP Density Plots

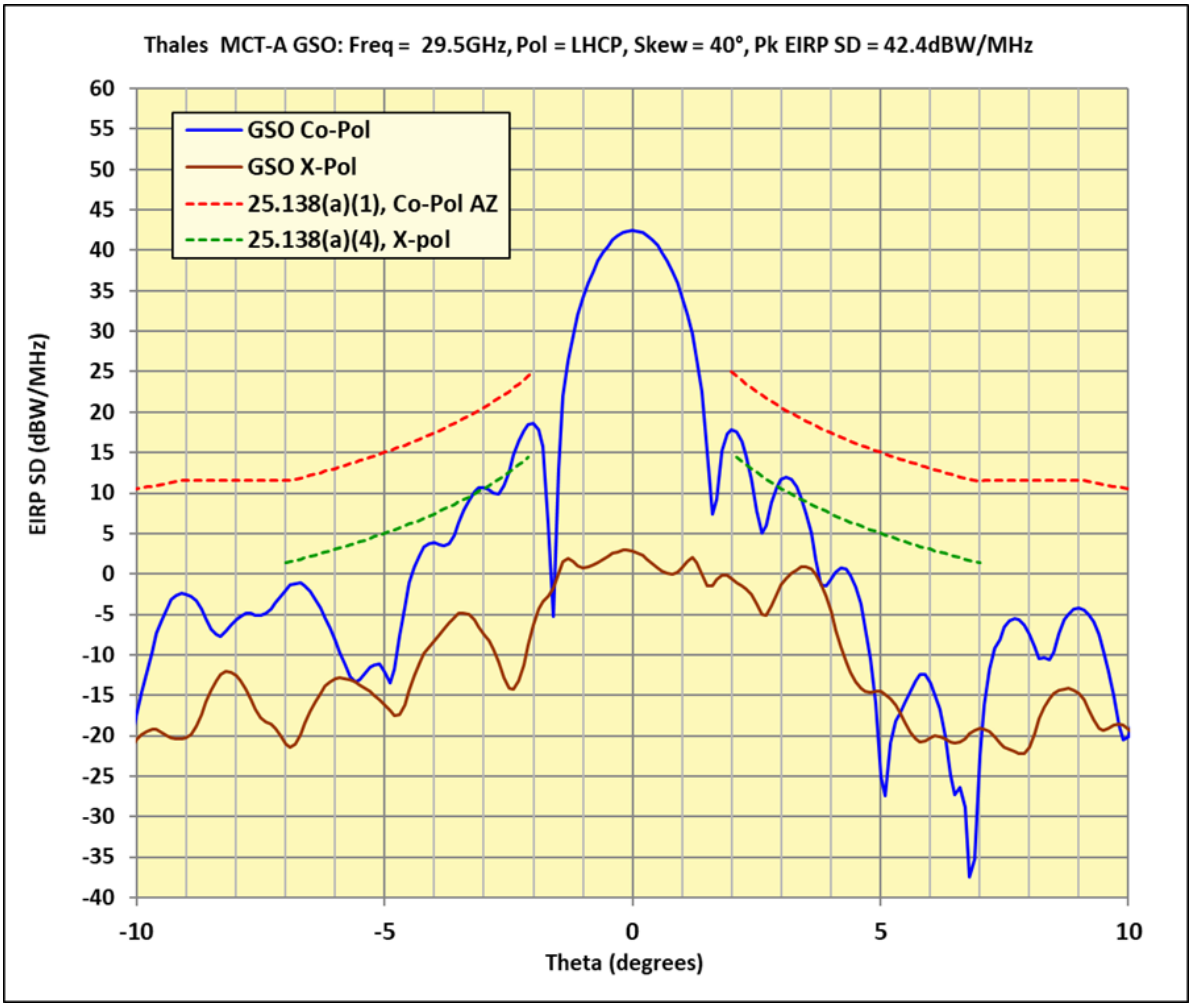

Figure 9-1: MCT-A EIRP SD Pattern 40° skew angle, 29.5 GHz; Co-Pol and Cross-Pol LHCP; GSO Plane +/- 10°

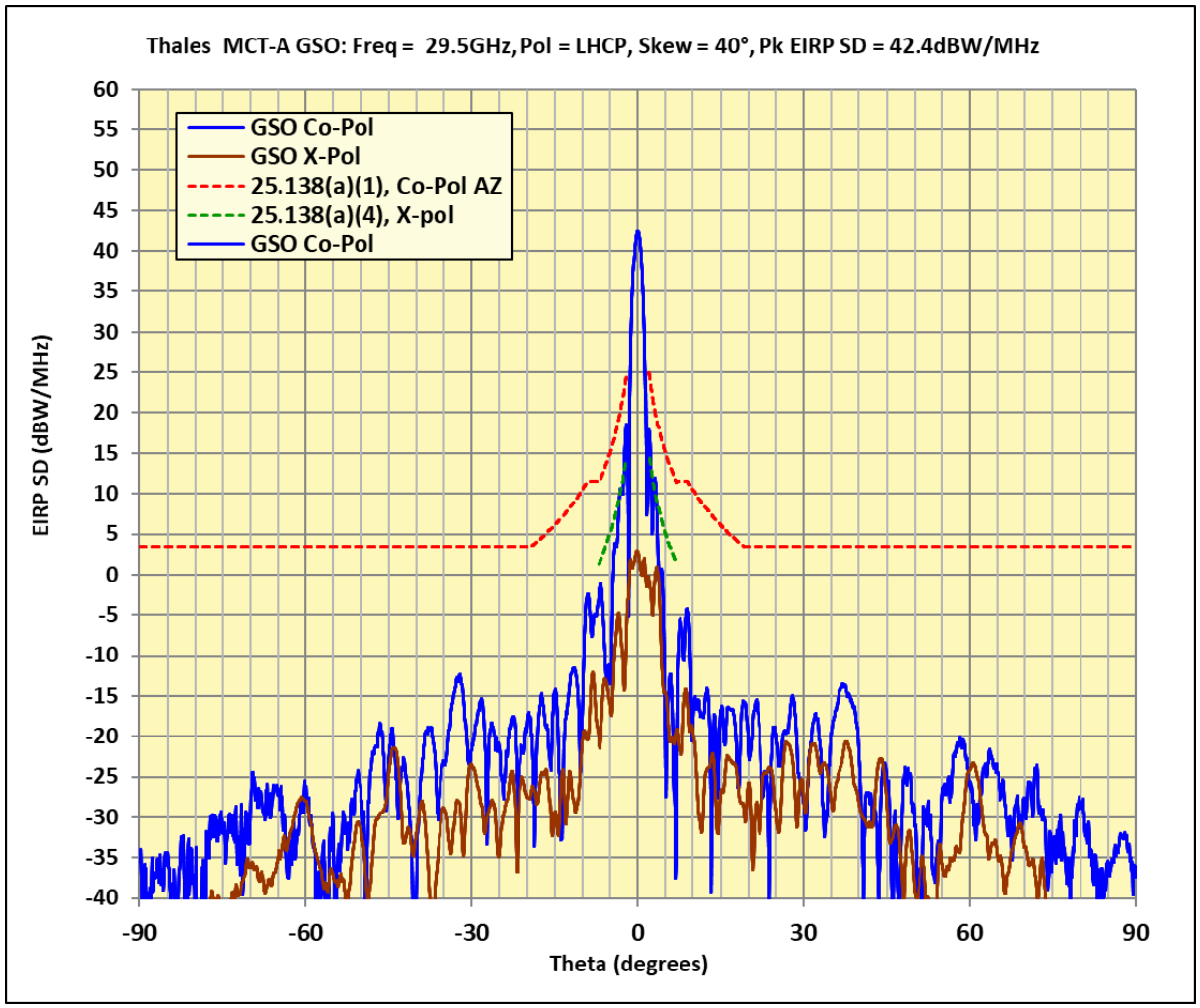

Figure 9-2: MCT-A EIRP SD Pattern 40° skew angle, 29.5 GHz; Co-Pol and Cross-Pol LHCP; GSO Plane +/- 90°

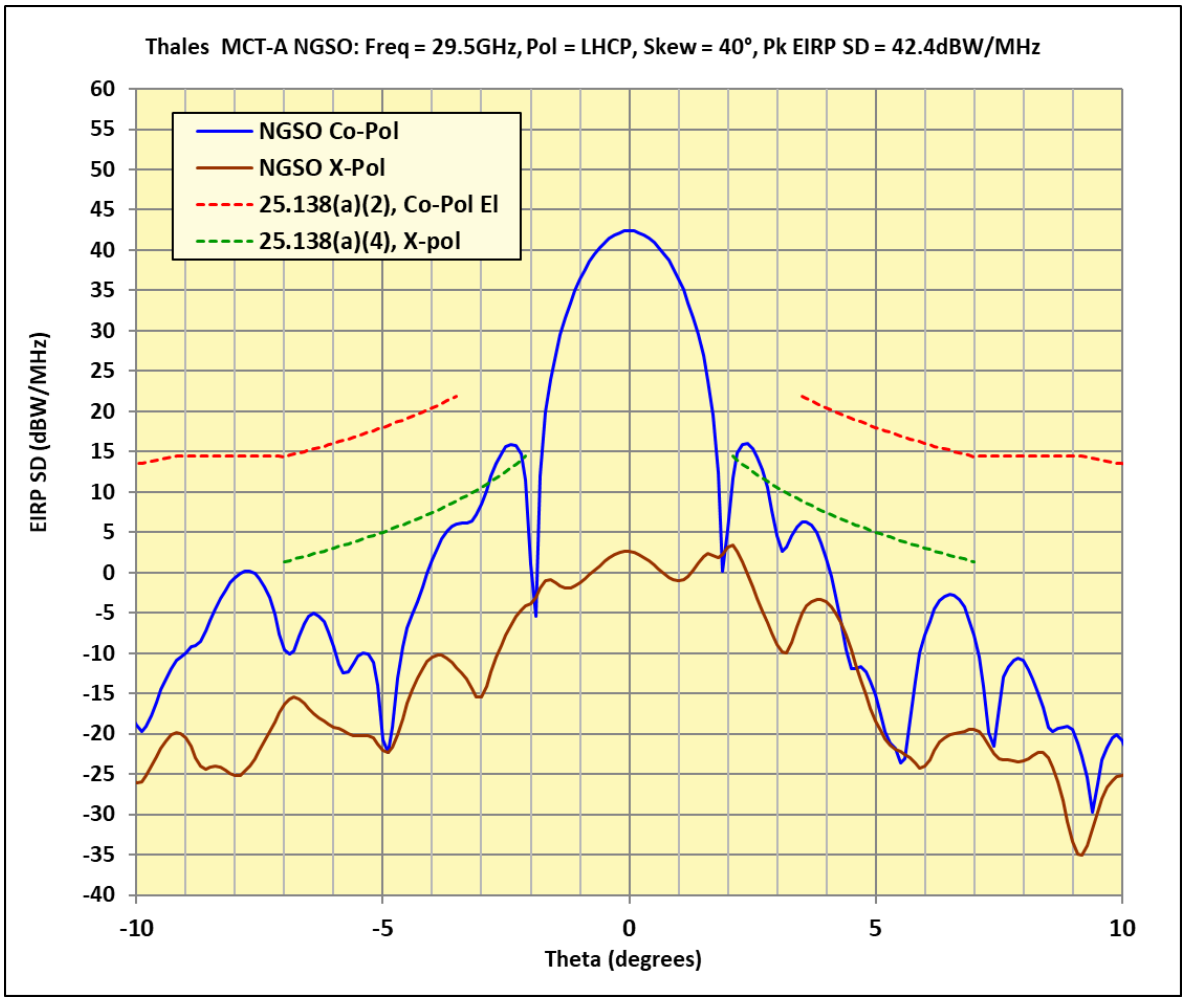

Figure 9-3: MCT-A EIRP SD Pattern 40° skew angle, 29.5 GHz; Co-Pol and Cross-Pol LHCP; NGSO Plane +/- 10°

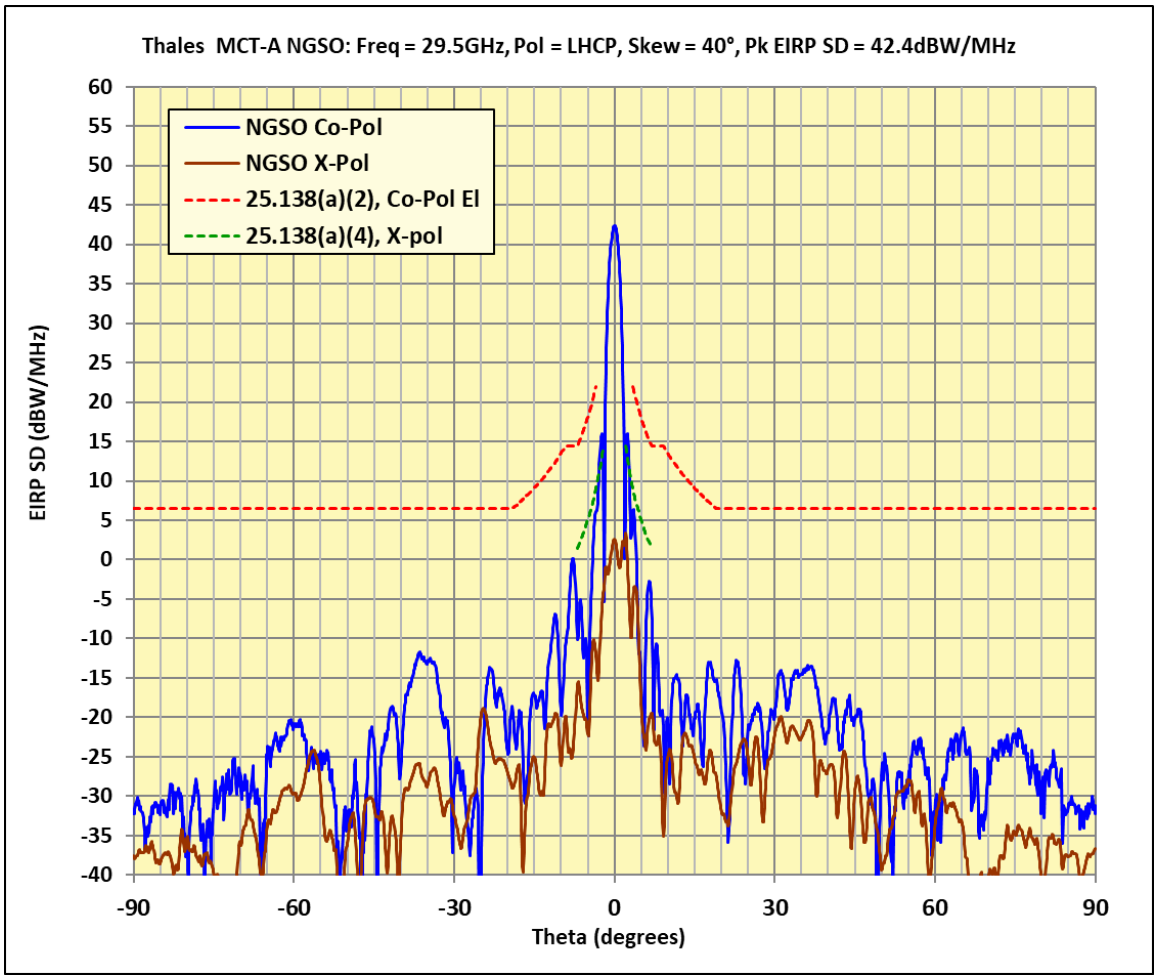

Figure 9-4: MCT-A EIRP SD Pattern 40° skew angle, 29.5 GHz; Co-Pol and Cross-Pol LHCP; NGSO Plane +/- 90°

10 Exhibit F - Satellite Operator Orbital Debris Mitigation Letter

telenor | satellite

Date: 24 April 2019

Mitigation of Orbital Debris

Spacecraft Hardware Design
Telenor Satellite AS, which was responsible for the design, manufacture and operation of the THOR7 satellite, has assessed and limited the amount of debris released in a planned manner during normal operations.

No debris is generated during normal on-station operations, and the spacecraft is in a stable configuration.

Telenor has also assessed and limited the probability of the orbital location becoming a source of orbital debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal. The design of the THOR7 satellite locates all sources of stored energy within the body of the structure, which provides protection from small orbital debris.

Telenor requires that spacecraft manufacturers assess the probability of micrometeorite damage that can cause any loss of functionality. This probability is then factored into the ultimate spacecraft probability of success. Telenor has taken steps to limit the effects of any collisions through shielding, the placement of components, and the use of redundant systems.

Minimizing Accidental Explosions:
The LS1300 satellite was designed and manufactured by Space Systems/Loral. Telenor has assessed and limited the probability of accidental explosions during and after completion of mission operations.

The design of the LS1300 spacecraft is such that the risk of explosion is minimized both during and after mission operations. In designing and building the spacecraft, the manufacturer took steps to ensure that debris generation will not result from the conversion of energy sources on board the satellite into energy that fragments the satellite. All propulsion subsystem pressure vessels, which have high margins of safety at launch, have even higher margins in orbit, since use of propellants and pressurants during launch decreases the propulsion system pressure. Burst tests are performed on all pressure vessels during qualification testing to demonstrate a margin of safety against burst. Bipropellant mixing is prevented by the use of valves that prevent backwards flow in propellant and pressurization lines. All pressures, including those of the batteries, are monitored by telemetry.

At the end of operational life, after the satellite has reached its final disposal orbit, onboard sources of stored energy will be depleted or secured, and the batteries will be discharged.

Safe Flight Profiles
Telenor has assessed and limited the probability of THOR7 becoming a source of debris by collision with large debris or other operational spacecraft.
Specifically, Telenor has assessed the possibility of collision with satellites located at, or reasonably expected to be located in the vicinity of THOR7.

	IS 10-02	THOR6	THOR5	THOR7
Location	1.0°W	0.85°W	0.75°W	0.65°W
Variation ±	± 0.05°	± 0.05°	± 0.05°	± 0.05°

Telenor uses longitudinal separation for co-location. On-station operations are kept within +/- 0.05 degrees for N-S station-keeping and +/- 0.05 degrees for E-W station-keeping, thereby ensuring adequate collision avoidance distance from other satellites.

Telenor uses Jspoc to monitor the risk of close approach of its satellites with other objects. If required, avoidance maneuvers are performed to eliminate the possibility of collisions.

Post Mission Disposal Plan
Post-mission disposal of the satellite from operational orbit will be accomplished by carrying out maneuvers to raise the satellite to a higher orbit. The fuel budget for elevating the satellite to a disposal orbit is included in the satellite design. Telenor has assessed fuel-gauging uncertainty and has provided an adequate margin of fuel reserve to address the assessed uncertainty.

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