THALES

Thales Avionics
700 S. Babcock Street
Melbourne, FL 32901 USA

February 16, 2017

<u>FILED ELECTRONICALLY VIA IBFS</u>

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

Re: Thales Avionics Authorization for ESAA Blanket Authorization

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 for authorization for blanket license to operate network of Earth Station Aboard Aircraft (ESAA) terminals at Ka-band.

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 Authorization Submission

Technical Narrative

February 16, 2017

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1 Introduction

Thales Avionics, Inc. ("Thales"), with operations in Melbourne and Orlando, FL and Irvine, CA employing 3000 professionals, is a global leader in providing leading-edge inflight entertainment (IFE) and high-speed Internet connectivity (IFC) services to commercial airlines, their passengers, and crews. Thales seeks a FCC blanket license to operate technically identical Ka-band transmit/receive Earth Stations Aboard Aircraft (ESAA) consistent with the Commission's current operational framework for Ka band earth stations. Thales's ESAA will operate over SES's Ka-band satellite capacity on the AMC-15 and AMC-16 spacecraft to provide IFC services on commercial airliners flying in the North American region. This new service will provide airlines a new opportunity to meet passengers' increasing demands for reliable robust, high-speed IFC while also providing airlines with access to critical, real-time data streams from inflight aircraft to help improve operational efficiencies.

Thales's blanket license request has 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, and FCC precedents set by previous Ka-band ESAA blanket license grants[1].

The Ka terminals proposed in this request are technically identical to those covered under Thales's active Ka experimental license (File Number 0542-EX-PL-2016; Call Sign WI2XNE), granted October 20, 2016.

2 System Description

2.1 Overview

Thales's IFC service will operate over SES satellites AMC-15 (orbital location of 105.05° WL) and AMC-16 (orbital location of 85° WL) in the Ka bands 28.438 – 28.563 GHz and 29.5 – 30.0 GHz (uplink); and 18.638 – 18.763 GHz and 19.7 – 20.2 GHz (downlink). In the future, Thales's 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.

Use of multiple transponders and dynamic spot beam cross-strappings on AMC-15 and AMC-16 will ensure consistent service and optimum spectral efficiencies as aircraft move within and between spot beams and coverage areas of both satellites.

The connected aircraft will have both an in-cabin Wi-Fi LAN (for personal electronic devices) and a wired LAN (for seatback screens). Passengers will be offered IFC at various service levels, and will initiate a billing transaction that occurs between the aircraft and the ground via the satellite links. Once the purchase has been confirmed, connectivity sessions to/from the public internet will commence via the aircraft LAN, satellite WAN, and terrestrial WAN segments. IFC services for airline and crew use will also be provided.

[1] See ViaSat Ka-band filing Call Sign E120075

2.1.1 Network Architecture

Thales's IFC network will use SES Ka space segment and gateway earth stations, and the Hughes Jupiter satellite platform of baseband hubs and aero modems. Figure 1 below the network architecture.

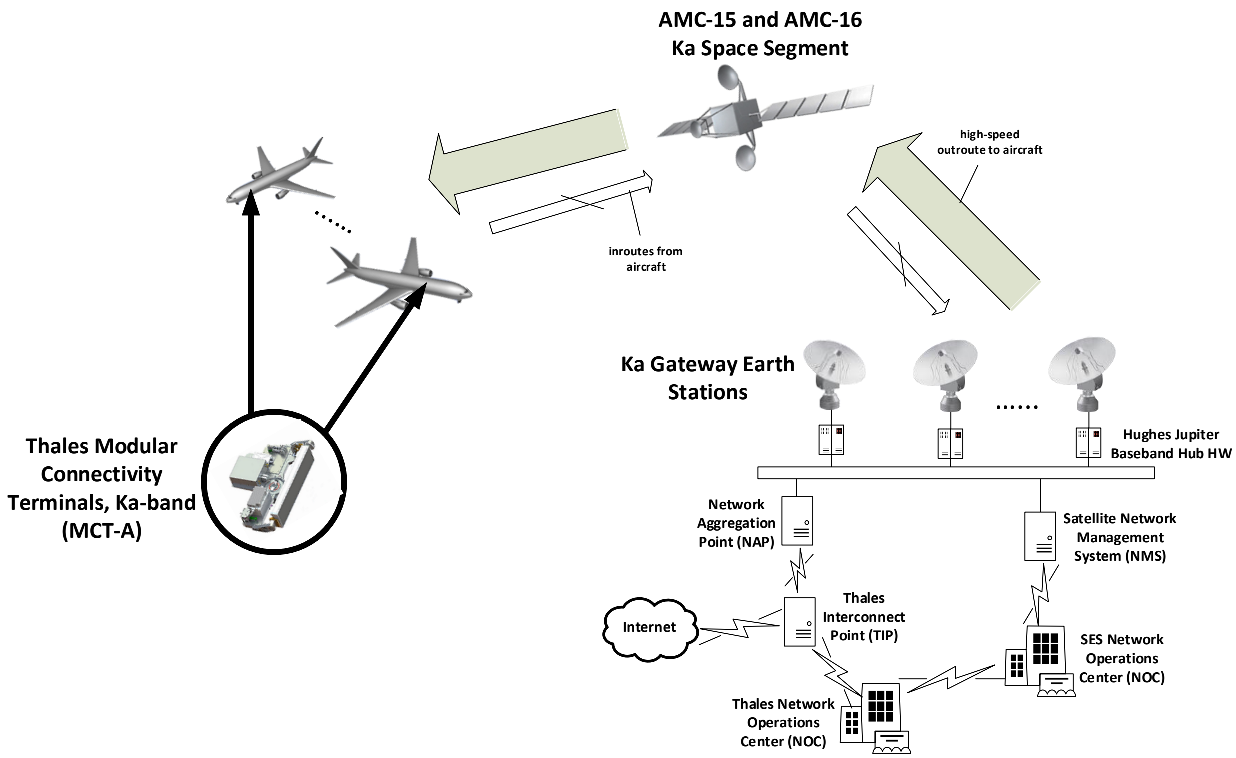

Figure 1 – Thales Aero Connectivity Network Architecture

The network is comprised of:

- a terrestrial IP backhaul network interconnecting multiple controlling Ka earth station gateways, with radio frequency terminals (RFTs) and Hughes Jupiter hub baseband equipment co-located at each gateway
- Ka space segment on AMC-15 and AMC-16 (FCC Call Signs S2180 and S2181, respectively)
- Thales Ka ESAA, known as Modular Connectivity Terminals, Ka-band (MCT-A) and including the Hughes Jupiter aero modem, installed on commercial aircraft

The Hughes Jupiter platform supports the two-way, Internet Protocol (IP) satellite links. This is an aeronautical-enabled version of the same platform used in the HughesNet service that provides satellite-based internet connectivity to over 1 million homes and businesses.

Multiple Ka gateway earth stations transmit and receive outbound (ground-to-aircraft) and inbound (aircraft-to-ground) transmissions to/from aircraft. All inbound IP traffic is routed from the receiving gateway(s) via the backhaul network to a single Network Aggregation Point (NAP). The use of a single NAP ensures that consistent IP connections are maintained.

The interface between Thales and the NAP is the Thales Interconnect Point (TIP). The TIP acts as the gateway to the Internet Service Provider (ISP), and also hosts networking, data computing and storage, and server equipment for IP traffic routing, network security, payment processing, and provision of add-on services.

The outbound channels are based on the DVB-S2X standard and use adaptive coding and modulation (ACM) over a wide range of modulation/coding schemes (modcods) and symbol rates to maintain high spectral efficiency. Inbound transmissions from aircraft use a multi-frequency time division multiple access (MF-TDMA) scheme, efficient low density parity check (LDPC) coding, constant offset QPSK (OQPSK) modulation and adaptive coding, spreading, and closed-loop power control to maintain link closure with approximately 1 dB of margin, while conforming to the EIRP spectral density limits of FCC 47 CFR §25.138.

The SES Network Operations Center (NOC) in Bristow, VA is the primary NOC for the network. In addition to managing the Ka space segment, 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 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

2.2.1 Antenna and Controller

The MCT-A consists of the following major systems and subsystems:

- Thales Modular Antenna System, Ka-band (MAS-A), consisting of:
    - Antenna System Interface (ASI)
    - Thales Modular Dorsal Antenna, Ka-band (MDA-A), consisting of:
        - Ka-band aperture (KAA)
        - RF up/down converter subsystems
        - Antenna control subsystem
        - Antenna positioning subsystem
- Thales Modular Modem (TMM; or modem manager, “modman”), including Hughes Jupiter aero modem

The MCT-A architecture is depicted in Figure 2 below.

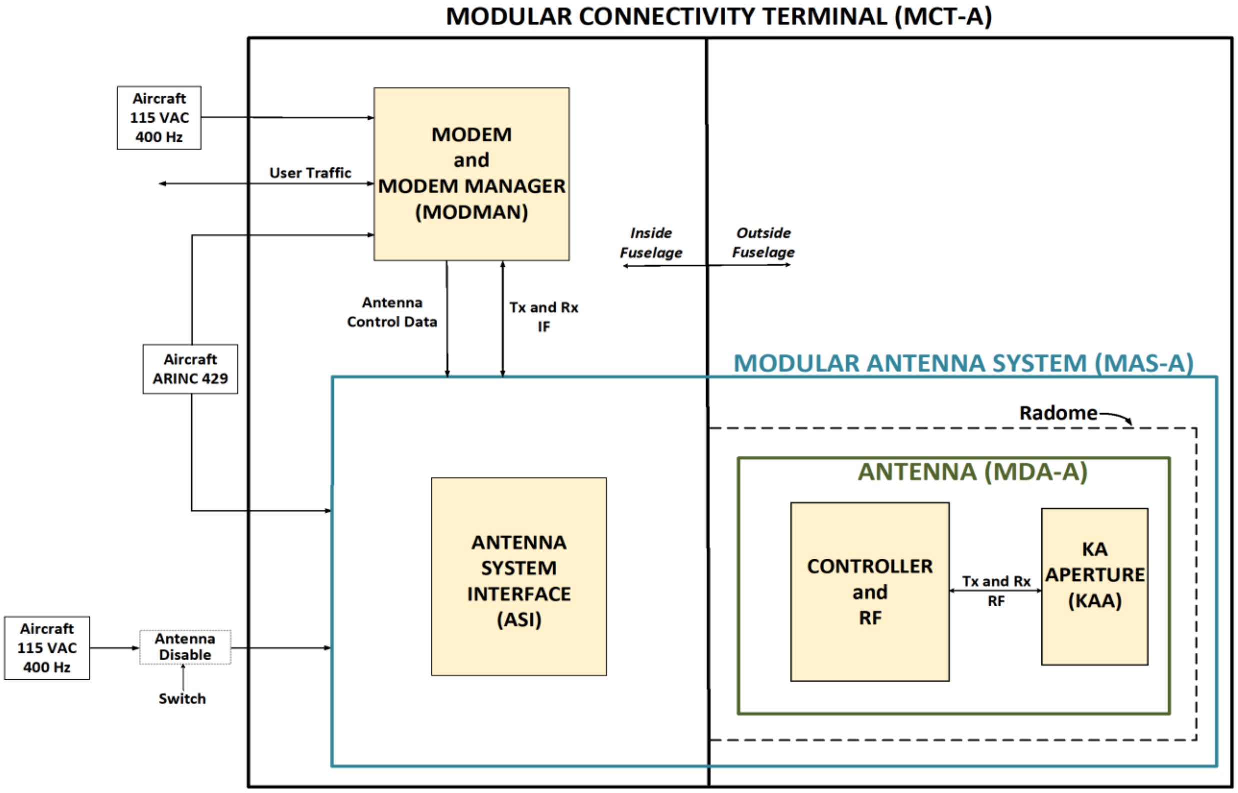

Figure 2: Thales Modular Connectivity Terminal, Ka-band (MCT-A) Architecture

The MDA-A is the Ka-band aeronautical subsystem installed on the aircraft fuselage exterior that generates and steers the antenna beam, and transmits and receives full-duplex RF signals over that beam, to and from geosynchronous orbit (GSO) satellites. Both the ASI and the TMM are installed inside the fuselage – the ASI resides directly below the radome, and the TMM is a single, 4 MCU enclosure mounted in the aircraft electronics equipment bay.

A rendering of the MDA-A is shown below in Figure 3.

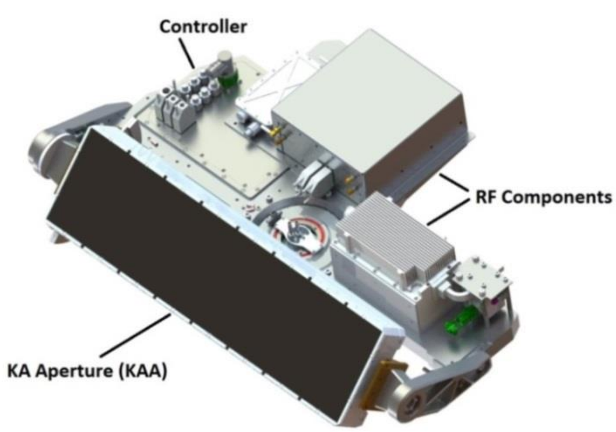

Figure 3: Modular Dorsal Antenna, Ka-band (MDA-A)

MDA-A specifications are provided in Table 1 below.

Ka Aperture (KAA) Physical	rectangular, planar 64 x 16 micro-horn array; each horn individually waveguide-fed
KAA Dimensions	62.3 cm width; 16.8 cm height; 5.1 cm depth
Frequency Range	28.3 – 31.0 GHz (transmit) 18.2 – 21.2 GHz (receive)
Polarization	LHCP and RHCP (transmit) LHCP and RHCP (receive)
Gain	38.9 dBi @ 29.5 GHz (transmit) 38.2 dBi @ 28.5 GHz (transmit) 35.6 dBi @ 19.7 GHz (receive)
EIRP (including 1 dB radome loss)	45.5 dBW @ 29.5 GHz 45.4 dBW @ 28.5 GHz
G/T (at normal flight level; including radome)	13.1 dB/K @ 20.2 GHz 12.0 dB/K @ 18.7 GHz
SSPA	16 watts (12.0 dBW) linear; 20 watts (13.0 dBW) total
Post-SSPA Losses (not including radome)	4.4 dB @ 29.5 GHz 3.8 dB @ 28.5 GHz
3 dB Beamwidths (@ 29.5 GHz, 35° Skew)	1.16° azimuth 1.6° elevation

Table 1: Modular Dorsal Antenna, Ka-band (MDA-A) Specifications

The RF up/down converter subsystem performs frequency conversions between IF and RF, and RF signal amplification.

The ASI converts single-phase 115 VAC/400 Hz power from the aircraft into DC power used by MDA-A components. The ASI also receives, isolates, and passes through antenna control data to the controller to steer the antenna beam.

The TMM hosts the Jupiter aero modem and terminal management functions of the MCT-A. In the forward link direction (ground to aircraft), the modman demodulates the received IF signal, and forwards baseband IP datagrams via an Ethernet LAN port to the on-board IFC system. In the return link direction (aircraft to ground), user IP data from the aircraft LAN is encapsulated by software and proprietary firmware, then coded, modulated, upconverted, and transmitted via the MDA-A.

The TMM manager subsystem is a processor module with a solid state hard drive for non-volatile storage. The manager also provides a receiver that connects to the aircraft inertial reference unit (IRU) bus for navigation and position information.

2.2.2 Antenna Pointing

Ka Aperture (KAA) pointing is done via an azimuth/elevation gimbal with motors on each axis to physically steer the KAA.

KAA pointing is based on data from the aircraft's IRU, obtained via the ARINC 429 data bus. Pointing accuracy is further enhanced by a tracking process that allows additional offsets to be calculated by the pointing algorithm. When tracking, the KAA goes through a scan pattern and monitors the target satellite's received signal strength indicator (RSSI) to determine its location. The controller automatically switches between using IRU data and tracking.

Use of IRU data only is sensitive to alignment errors as a result of "twist" in the aircraft between the IRU and antenna mount. (During MCT-A installation, any initial alignment offsets between the aircraft IRU and the antenna's location on the fuselage are "zeroed-out".) Tracking is a fully closed-loop pointing method that is not affected by any misalignments.

Feedback control loops using motor currents and data from a gyroscope system are used in all modes of operation to inertially stabilize the KAA. While the scale factors of the gyroscopes do drift over long periods of time, this is a non-issue for stabilization because the system nulls the gyro outputs to zero.

2.2.3 Antenna Pointing Performance and Transmit Muting

The MCT-A's pointing performance has been evaluated through a combination of simulation and ground-based mobile testing conducted under Thales's active experimental license for the MCT-A.

The mean pointing error is zero through use of RSSI closed-loop tracking. As shown below in Table 2, in the azimuth (GSO) plane the three-sigma (3σ) pointing error is 0.18°, and 0.2° in the elevation (NGSO) plane.

3σ Pointing Error	
Azimuth (GSO)	Elevation (NGSO)
0.18°	0.2°

Table 2: MCT-A 3σ Pointing Error

Per §25.227(a)(1)(ii)(A), the MCT-A will maintain a pointing error of ≤ 0.2 between the orbital location of the target satellite and the axis of the main lobe of the MCT-A. Transmit muting will occur within 100 msec if the pointing error exceeds 0.5°, and the transmitter will remain muted until pointing error is ≤ 0.2°. Design and experimental testing show that transmit muting occurs well within 100 msec.

The system is designed to maintain the 3-sigma pointing accuracy of ≤ 0.18° in the GSO plane and ≤ 0.2° in the NGSO plane in the range of aircraft dynamic conditions detailed in Table 3 below.

	Roll	Pitch	Yaw
Angular Range	± 30º	± 15º	0 – 360º
Angular Rate	± 5º/Sec	± 3º/Sec	± 3º/Sec
Angular Acceleration	± 5º/Sec/Sec	± 5º/Sec/Sec	± 5º/Sec/Sec

Table 3: Defined Flight Dynamic Conditions

At certain latitudes and longitudes the aircraft's attitude in pitch and/or roll may result in an elevation angle to the satellite that exceeds the mechanical range of the antenna system. Transmit muting will occur within 100 msec if this limit is reached. The MAS-A will continue calculating the elevation angle to the target satellite during these excursions, and resume pointing and transmission within 1 second of the elevation angle returning to within the mechanical limits.

Transmit muting will occur within 100 msec in other scenarios, including:

- the modem's loss of receive lock on the outbound carrier
- a fault condition such as a bad navigation or gyroscope reading
- a deviation beyond a threshold established for gyroscope output (angular "bumps") that can be caused by an unexpected turbulence event
- an intentional conical scan tracking period that results in pointing error greater than 0.2°
- when specific pointing angles with respect to the airframe are commanded, to prevent signal scattering by airframe (blockages)

2.3 Space System

2.3.1 Satellite System List

Thales's proposed ESAA will operate over Ka-band capacity on AMC-15 orbital location of 105.05° WL (FCC Call Sign S2180) and AMC-16 orbital location of 85° WL (FCC Call Sign S2181). The service will operate in the following frequency ranges on both satellites: 28.438 – 28.563 GHz and 29.5 – 30.0 GHz (uplink); and 18.638 – 18.763 GHz and 19.7 – 20.2 GHz (downlink). Thales's service using these satellites will not use Ka spectrum in the LMDS band 29.1 – 29.25 GHz.

The satellite coverage areas are shown below in Figure 4.

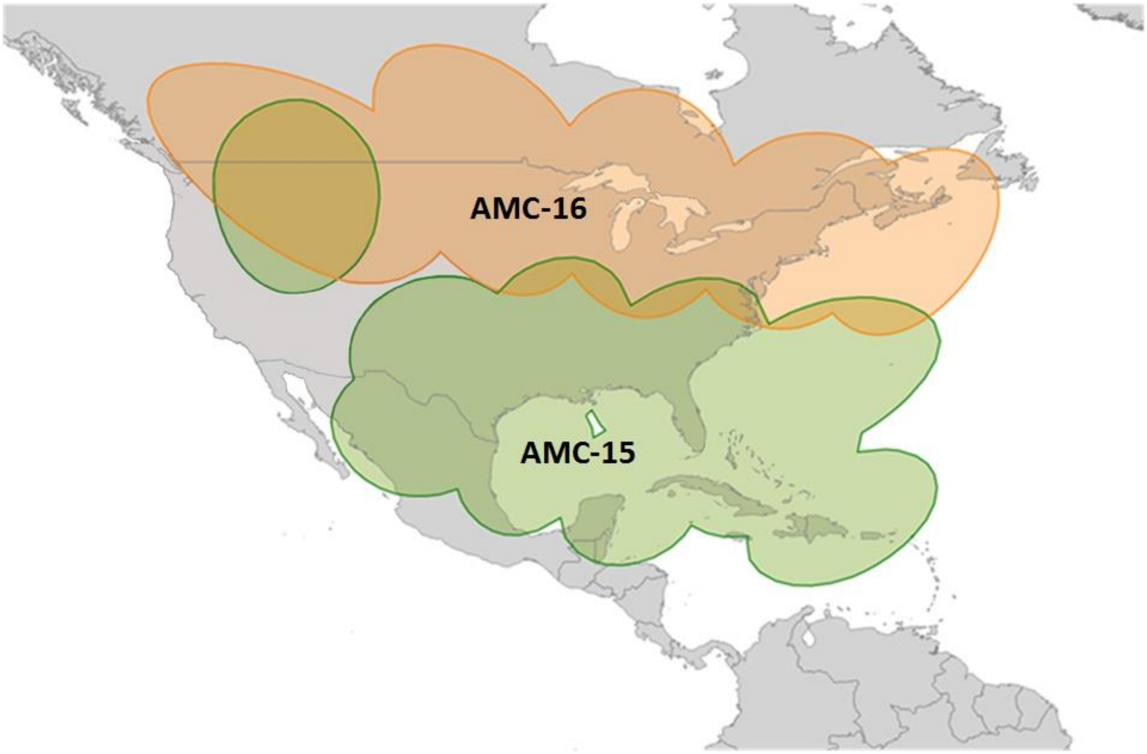

Figure 4: AMC-15 and AMC-16 Anticipated Coverage Areas

It should be noted that the AMC-15 coverage area shown in Figure 4 above is the anticipated coverage area subsequent to AMC-15 beam pointing modifications that are expected to occur during Q2 or Q3 of 2017. All link analyses assumed the coverages shown in Figure 4.

2.4 Ground Segment

2.4.1 Remote Control Network Operations Centers (NOCs)

The primary network operations center (NOC) for the network is the SES NOC:

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

The SES NOC 24/7 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:

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

The Thales NOC 24/7 phone number is 949-754-6985

2.4.2 Network Gateway Earth Stations

Thales's service will use FCC-licensed hub antennas at the gateway earth stations to communicate with AMC-15 and AMC-16. As of the time of this filing, several hub antennas to be used in this service are not yet completed and/or have not yet been granted FCC licenses, and therefore do not yet have FCC callsigns. Full remote control of the ESAA terminals and the network will be possible from the Thales NOC.

<u>AMC-15 and AMC-16 Earth Station</u>:

9815 West Hallett Road
Spokane, WA 99224
FCC callsign E050372

<u>AMC-15 Earth Station</u>

AMV Westar
777 Westar Lane
Cedar Hill, TX 75104
FCC callsign TBD

<u>AMC-16 Earth Station:</u>

SES Woodbine
2323 Grimville Road
Mount Airy, MD 21771
FCC callsign TBD

2.5 Waveforms

2.5.1 Inbound Description

The inbound (aircraft to ground) waveform is based on Multi-Frequency, Time Division Multiple Access (MF-TDMA), an Aloha-based access scheme. The capabilities of the inbound channels are provided in Table 4 below.

Channel Type	Adaptive Inroute Selection (AIS), adaptive FEC coding rates are burst-to-burst on same carrier, symbol rate, and spectral spreading
Symbol Rates	256, 512, 1024, 2048, 4096, and 6144 and 8192 ksps
Modulation	OQPSK
Forward Error Correction (FEC)	LDPC Rates ½, 2/3, 4/5 and 9/10
Spectral Spreading	2x and 4x, Direct Sequence Spreading
Carrier Roll-off	25% (typical channel spacing of 1.25 x symbol rate)
Power Control	Closed loop power control using Gateway SNR feedback and Power Spectral Density (PSD) management using configured RF gain, antenna skew angle performance, and gain calibration tables for temperature and frequency
Power Control Range	> 20 dB

Table 4: Inbound Channel Capabilities

2.5.2 Outbound Description

The outbound (ground to aircraft) waveform is based on the DVB-S2X standard. The capabilities of the outbound channels are provided in Table 5 below.

Channel Type	Adaptive Coding and Modulation (ACM)
ACM Dynamic Range	Full modcod range
Symbol Rates	1 to 235 Msps
Modulation	QPSK, 8PSK, 16APSK, and 32APSK
Carrier Roll-off	5% (channel spacing of 1.05 x symbol rate)
Packet Encapsulation	DVB-S2 Generic Stream Encapsulation (GSE)

Table 5: Outbound Channel Capabilities

2.5.3 Satellite Access Techniques

The MF-TDMA access scheme employs an Aloha-based contention channel by which the aero modems request inbound bandwidth. A contention algorithm assigns random backoff times to modems that contend for the same inbound channel. MF-TDMA is and has been used extensively in VSAT, ESV, and VMES networks for many years, and Thales considers its use reasonable in this network, per 47 CFR §25.227(a)(4).

2.5.4 Out-of-Band Emissions

The MCT-A's out-of-band emission limits shown below in Table 6 will comply with §25.202(f).

Frequency Band (GHz)	Out-of-Band Emission Limit (dBpW/100 kHz)
3.4 – 10.7	55
10.7 – 11.7	61
11.7 – 21.2	78
21.2 – 25.5	67

Table 6: Out-of-Band Emission Limits

2.6 Network Management

2.6.1 How Terminals Connect to Network

When first installed in the aircraft, the aero modem has a default configuration stored in the modman that allows it to receive and lock onto outbound carriers from the hub. In operation, anytime the MCT-A is powered up or goes through a restart, the MDA-A goes through an outbound carrier acquisition and pointing refinement process in receive-only mode. Transmission operation begins only after the controller indicates the antenna has found the satellite, is functional, and pointed. An initial information exchange between the hub and modman allows configuration files or required updates to be uploaded to the modman, including beam maps, skew tables, and power control algorithms.

2.6.2 Automatic Beam Selection

Data provided by the modman to the antenna controller allows the controller to prepare for and perform beam switches as the aero modem moves between spot beams and between satellites. Active TCP sessions are preserved during the switching process.

2.6.3 Return Link Power Control

The modman is responsible for return link power control. It runs a power control algorithm that uses feedback from messages containing the current skew angle, the current output power from the SSPA, and the current maximum allowable PSD. The modman calculates the required transmit power using this information in conjunction with the skew table, and also adjusts the carrier spread factor, symbol rate, and FEC code rate as necessary to operate the return link efficiently while not exceeding PSD limits.

2.6.4 Return Link Frequency Control

The system allocates a set of inbound channels that are defined by a unique symbol rate/spreading combination. Within each of these inbound carriers, MCT-A's can transmit with the appropriate modcod determined by the AIS algorithm. Different modcods can be mixed in the same inroute channel. AIS operates dynamically to select the correct inbound channel, and the correct modcod within the channel, based on the MCT-A's current link conditions as it moves during flight.

2.6.5 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, including the ability to remotely disable terminals in the event of interference. The SES NOC will monitor and control the AMC-15 and AMC-16 satellites and Ka capacity used in the service, as well as the gateway earth stations and terrestrial backhaul network.

Per §25.227(a)(6) the NOC will have records of each transmitting ESAA's location (i.e., latitude, longitude, altitude), transmit frequency, channel bandwidth, and satellite used. This data will be recorded at time intervals no greater than one minute while the ESAA is transmitting. The records will be time annotated and maintained for a period of not less than one year.

3 Protection of Other Services

3.1 Protection of Other Ka-band Services

3.1.1 GSO

Thales intends to operate their ESAA network over AMC-15 at orbital location 105.05° WL and AMC-16 at orbital location 85° WL. Operation on both satellites will be compliant with 25.138(a)(1). Thales has worked with SES to ensure that the off-axis emissions will comply with their AMC-15 and AMC-16 coordination agreements (see Exhibit C).

3.1.1.1 AMC-15 Off-Axis EIRP Spectral Density

On AMC-15, Thales will limit their ESAA operation for the worst case skew angle of 65° for off-axis EIRP emission in the GSO plane, as shown below in Figure 5. Exhibit B attached contains AMC-15 link budgets including operation for three operational scenarios:

- Location at the center of the beam (peak G/T) and 0° skew angle
- Location at mid-beam (average G/T) and 35° skew angle
- Location at the edge of the beam (worst case G/T) and 65° skew angle

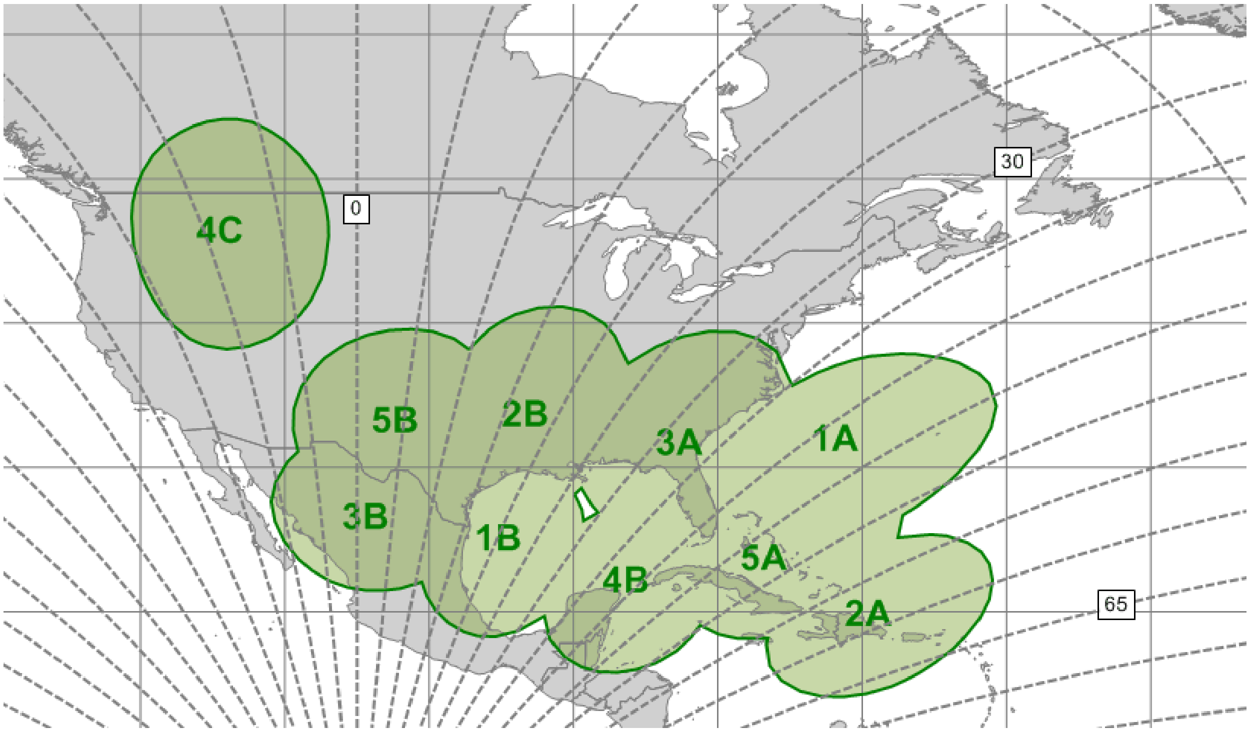

Figure 5: Thales ESAA Operating on AMC-15 - Worst Case Skew Angle of 65°

The plots below show compliance with 25.138(a)(1) and consider up to 0.2° antenna mispointing. The EIRP density plots for additional frequencies, off-axis angles, and planes are included in Exhibit G.

Shown below are the plots for:
0° skew angle at 29.5 GHz Co-Pol and Cross-Pol LHCP GSO Plane +/- 10°, see Figure 6
0° skew angle at 29.5 GHz Co-Pol and Cross-Pol LHCP NGSO Plane +/- 10°, see Figure 7
35° skew angle at 29.5 GHz Co-Pol and Cross-Pol LHCP GSO Plane +/- 10°, see Figure 8
35° skew angle at 29.5 GHz Co-Pol and Cross-Pol LHCP NGSO Plane +/- 10°, see Figure 9
65° skew angle at 29.5 GHz Co-Pol and Cross-Pol LHCP GSO Plane +/- 10°, see Figure 10
65° skew angle at 29.5 GHz Co-Pol and Cross-Pol LHCP NGSO Plane +/- 10°, see Figure 11

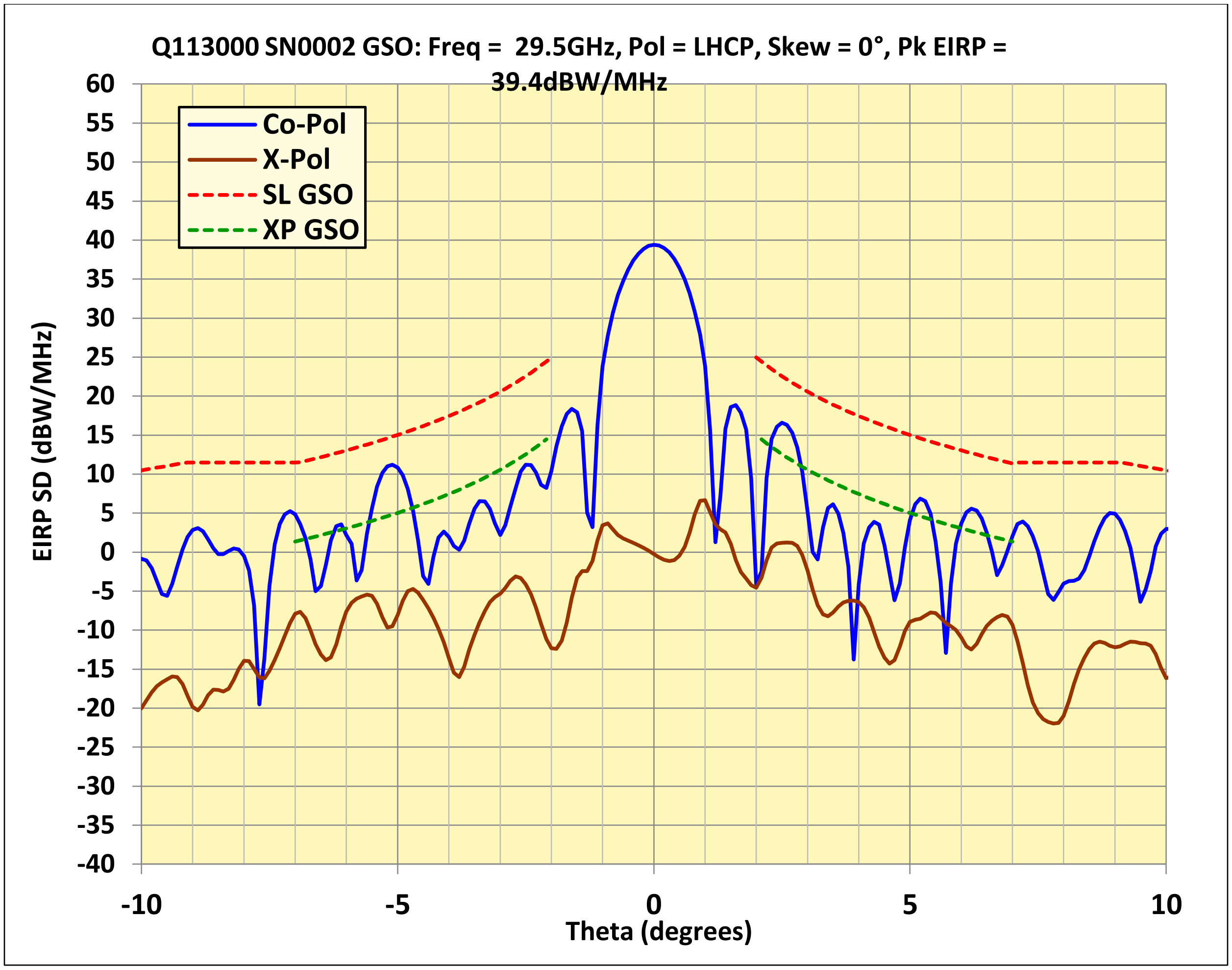

Figure 6: AMC-15 0° skew in the GSO plane, the maximum EIRP density is 39.1 dBW/MHz. Note, the maximum co-polarized EIRP density in the plane perpendicular to the GSO arc at off-axis angles +/- 10° is shown in blue and the +/- 10° Cross-Pol EIRP Density in brown.

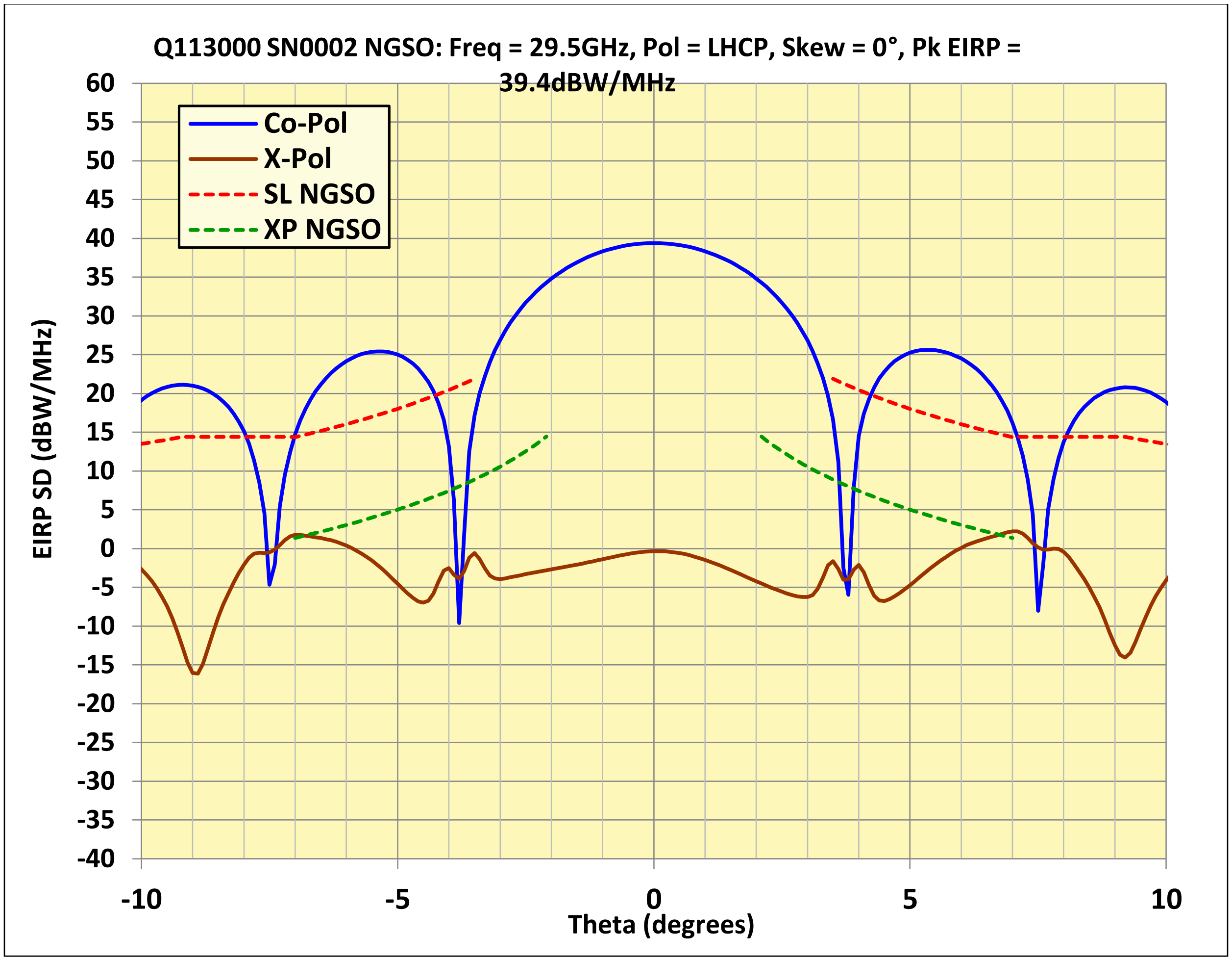

Figure 7: AMC-15 0° skew in the NGSO plane, the EIRP density of 43.0 dBW/MHz, which is 8.7 dB above the 25.138(a)(2). Link Analyses are included in Exhibit B and a waiver request for operation in excess of the 25.138(a)(3) in the NGSO plane for 0°, 5°, and 10° skew angles is included in Exhibit A. Note, the maximum co-polarized EIRP density in the plane perpendicular to the GSO arc at off-axis angles +/- 10°, is shown in blue and the +/- 10° Cross-Pol EIRP Density in brown.

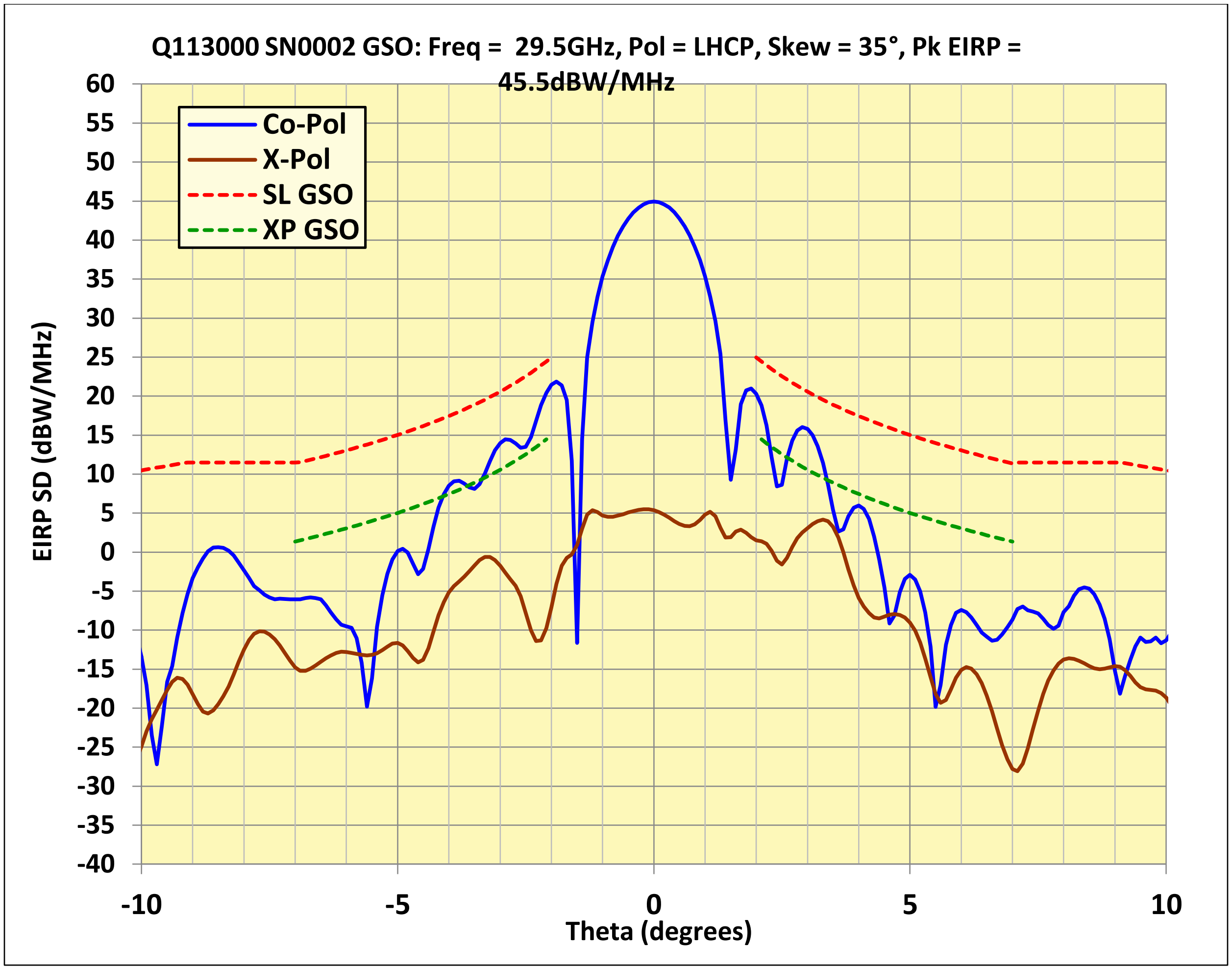

Figure 8: AMC-15 35° skew in the GSO plane, maximum EIRP density of 45.5 dBW/MHz. Note, the maximum co-polarized EIRP density in the plane perpendicular to the GSO arc at off-axis angles +/- 10° is shown in blue and the +/- 10° Cross-Pol EIRP Density in brown.

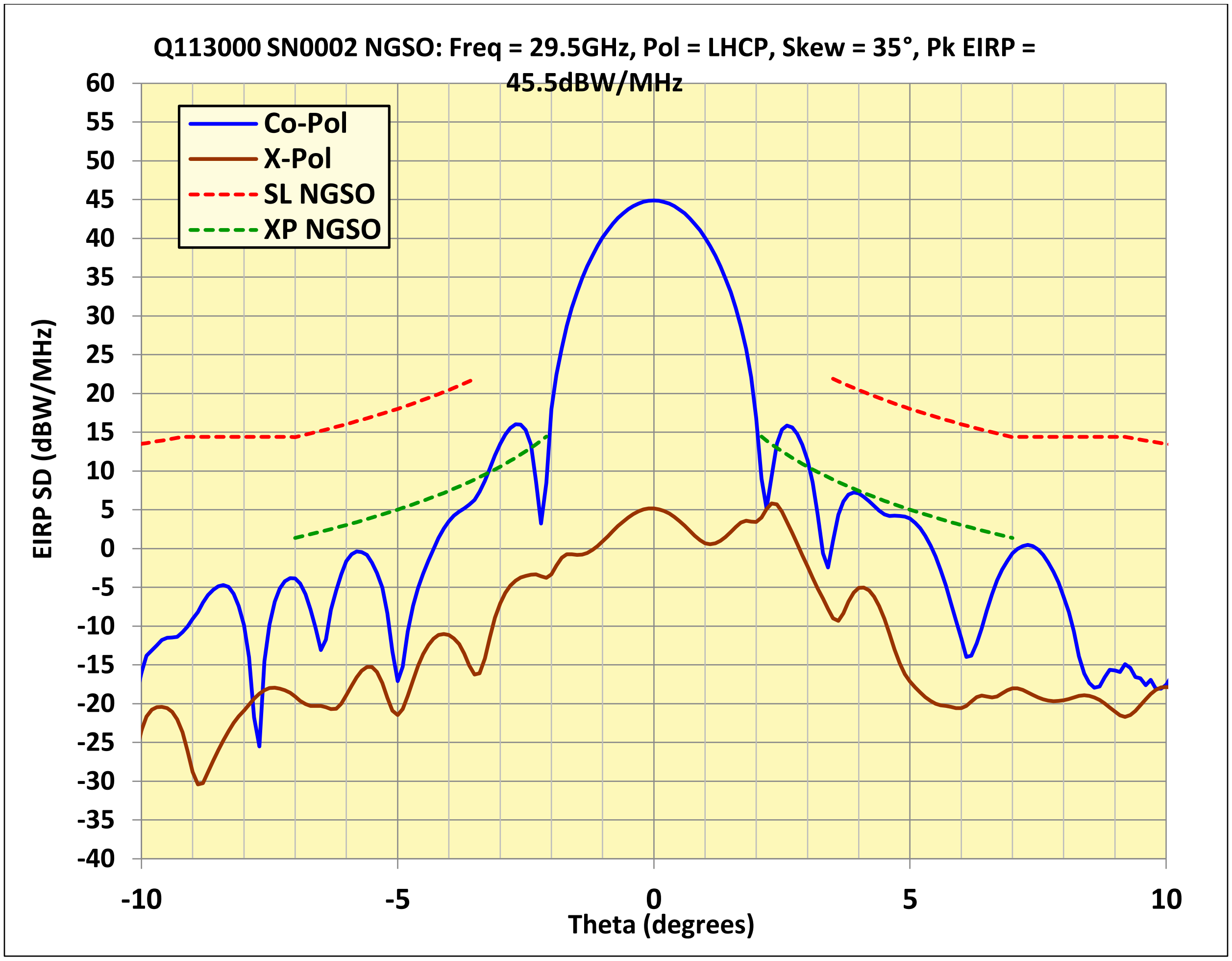

Figure 9: AMC-15 35° skew in the NGSO plane, the EIRP density of 45.5 dBW/MHz. Note, the maximum co-polarized EIRP density in the plane perpendicular to the GSO arc at off-axis angles +/- 10°, is shown in blue and the. +/- 10° Cross-Pol EIRP Density in brown.

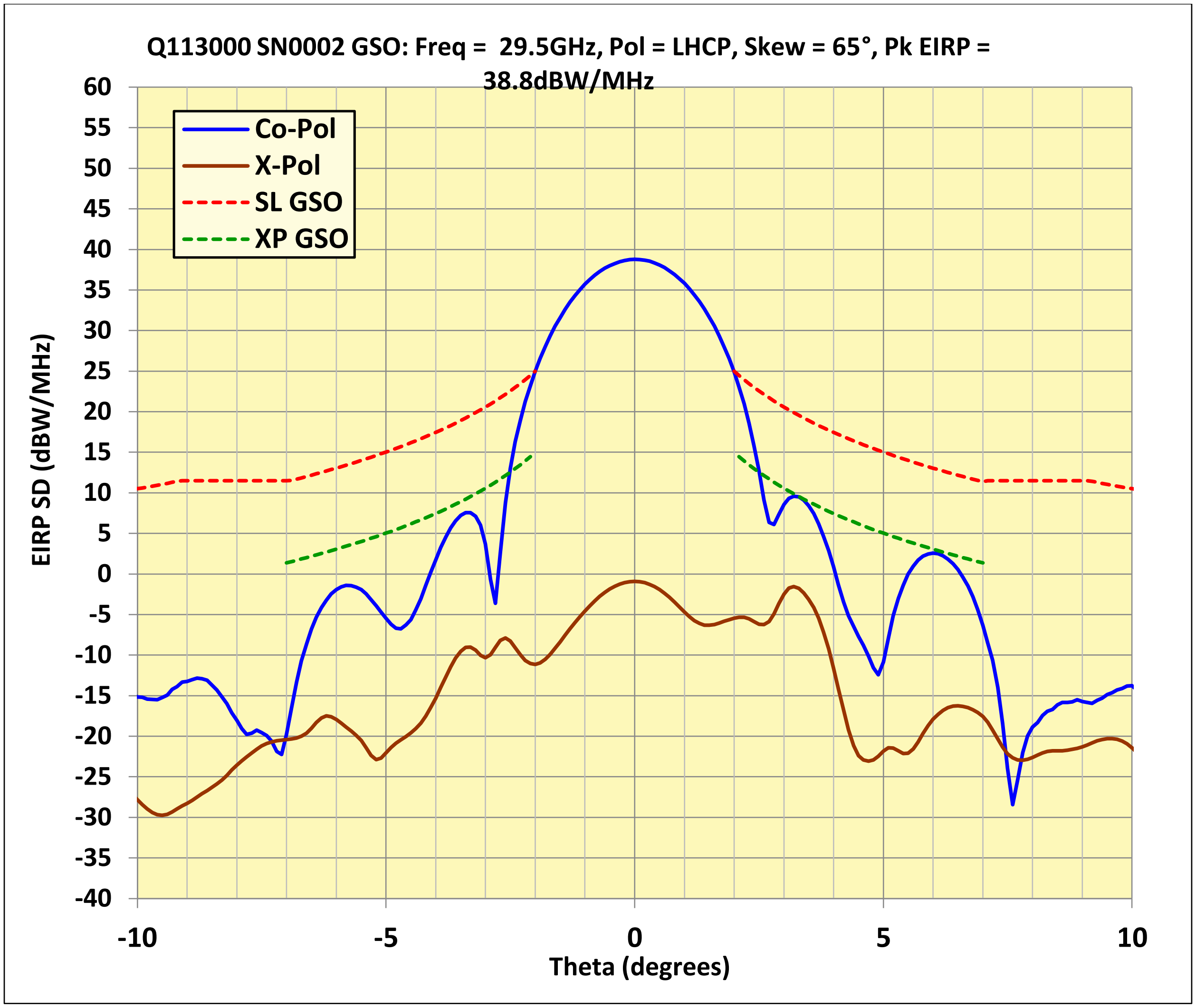

Figure 10: AMC-15 65° skew in the GSO plane, maximum allowed EIRP density is 38.8 dBW/MHz. Note, the maximum co-polarized EIRP density in the plane perpendicular to the GSO arc at off-axis angles +/- 10° is shown in blue and the +/- 10° Cross-Pol EIRP Density in brown.

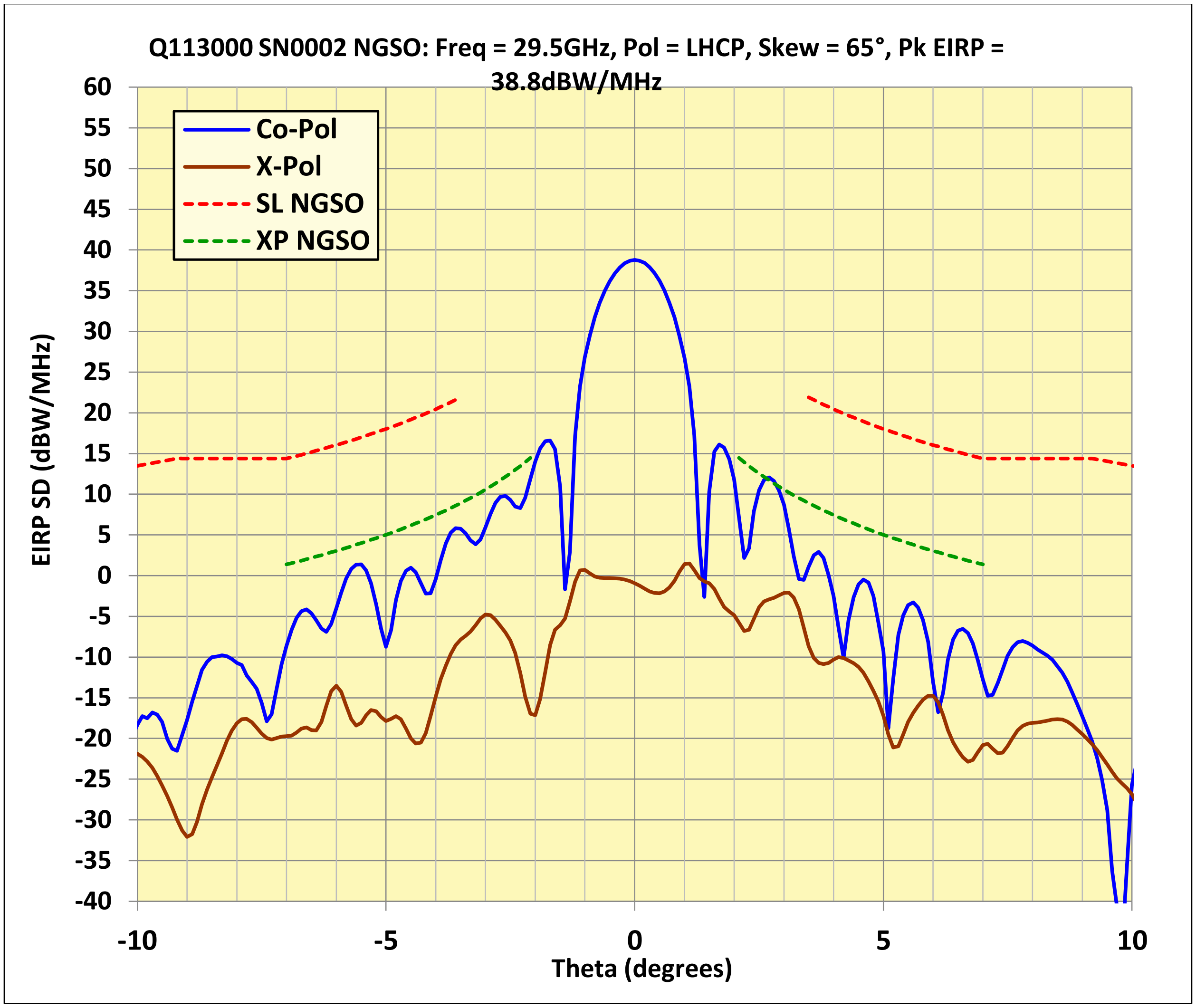

Figure 11: AMC-15 65° skew in the NGSO plane, the max allowed EIRP density is 38.8 dBW/MHz. Note, the maximum co-polarized EIRP density in the plane perpendicular to the GSO arc at off-axis angles +/- 10°, is shown in blue and the. +/- 10° Cross-Pol EIRP Density in brown.

3.1.1.2 AMC-16 Off-Axis EIRP Spectral Density

Thales ESAA operation on AMC-16 at orbital location 85° W.L. will utilize spot beams covering northern USA and southern Canada. As shown in Figure 12 below the worst case skew angles will be around 30°. Thales will maintain their uplink EIRP densities to never exceed the limits set in §25.138(a)(1). Exhibit B attached contains AMC-16 link budgets including operation scenarios at 0° and 30° skew angles.

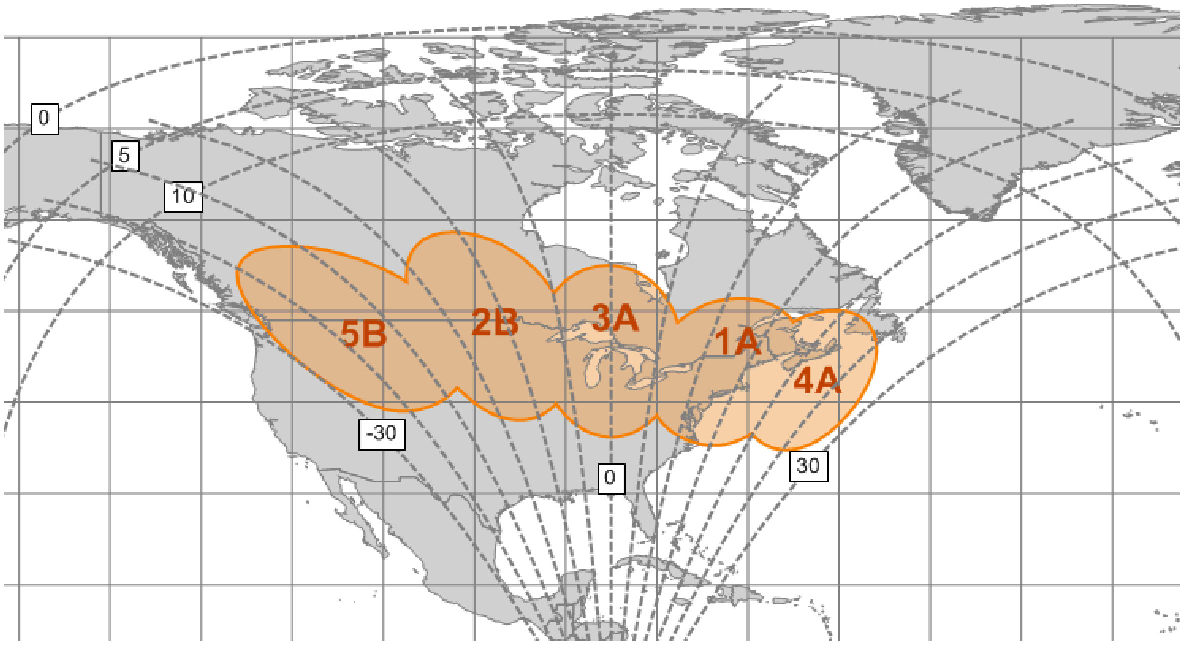

Figure 12: Thales ESAA Operating on AMC-16 - Worst Case Skew Angle of 30°

3.1.2 Protection of NGSO Systems

For operation on AMC-15 and AMC-16 Thales does not intend to operate in spectrum allocated to NGSO systems. The NGSO transmit band is 28.6 – 29.1 GHz[2]. Thales will only operate between 28.438 – 28.563 GHz in the lower band and 29.5 – 30.0 GHz in the upper portion of the band. Thales agrees to coordinate with any authorized NGSO users in the GSO band which may be impacted by their operation. At the time of this filing there appears to be one such NGSO system authorized to use the 28.35 – 28.4 GHz portion of the band which will not overlap with the Thales operational spectrum[3].

3.1.3 Protection of LMDS Systems

The nearest allocation for LMDS service is 27.5 – 28.35 GHz[4] and, as noted in Section 3.1.2 above, Thales will not operate within this band.

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[2] 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)

[3] O3b is currently authorized to operate in the 28.35-28.4 GHz band, see FCC File No.1 SES-LIC-20100723-00952. This upper band edge is below the Thales lower band edge of 28.438 GHz.

[4] 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

Thales' operation will not operate within the MSS gateway operations allocated to the 29.1 – 29.5 GHz band[5]. Thales will work with the MSS gateway service providers and respond to any requests for coordination as necessary.

3.1.5 Radiation Hazard Study

Exhibit D attached contains the radiation hazard study for the Thales ESAA terminal. As shown by the study the maximum permissible exposure (MPE) limits are met for both the general population (uncontrolled environment) and the occupational (controlled environment) limits. The automatic shut-down features of the terminal, along with the training which Thales provides their technicians will ensure that no harmful levels of electromagnetic radiation will occur for all persons in proximity to the ESAA terminal.

3.2 List of Exhibits

The following five exhibits are provided in this document:

- Exhibit A contains the waiver request.
- Exhibit B contains the link budgets for AMC-15 and AMC-16.
- Exhibit C contains the SES certification letters for Thales's operations on AMC-15 and AMC-16.
- Exhibit D contains the radiation hazard study.
- Exhibit E contains the compliance tables for §25.227 and §25.138.

The following two exhibits are provided separately:

- Exhibit F contains the receive and transmit antenna gain plots and tables.
- Exhibit G contains the transmit EIRP density plots and tables for all the skew angles mentioned above.

4 Conclusion

As demonstrated herein, the grant of this application will serve the public interest by enabling Thales to offer a new innovative and competitive IFC service to airline passengers in a manner fully consistent with the FCC rules. As such, Thales respectfully requests grant of this application.

[5] See, FN1

5 Exhibit A – Waiver Request

Waiver of 25.138(a)(2) for Certain Skew Angles

The non-symmetrical shape of the terminal will cause the off-axis EIRP density levels to exceed the FCC limits set forth in rule part 25.138(a)(2) in the plane perpendicular to the GSO arc (the NGSO plane). At a skew angle of 0° the off-axis EIRP may exceed the limits by as much as 8.7 dB, the levels may also be exceeded for skew angles of 5° and 10°[6]. Because of this, Thales requests any necessary waiver of this rule part. The intention of this rule is prevent interference into NGSO systems. As detailed in our application and further explained in Section 3.1.2 above, Thales will only operate in the GSO primary allocations, 28.438 – 28.563 GHz and 29.5-30.0 GHz, and will not operate in the NGSO primary allocation of the Ka-band, 28.6-29.1 GHz, see band Ka-band plan in Figure 13 below. If necessary, Thales agrees to coordinate with any authorized NGSO operator(s) in the GSO portion of the band[7]. At the time of this filing there is one authorized NGSO users in the GSO band[8] but there is no spectrum overlap between the Thales system and the authorized NGSO system. Also, as noted in 3.1.1 above, SES, the satellite operator for AMC-15 and AMC-16, has certified that the Thales ESAA operation will comply with their coordination agreements, see Exhibit C for certification letters. Given the above, Thales respectfully requests that the FCC grant this waiver request.

UPLINK BAND (28GHz)

LMDS	GSO/FSS	NGSO/FSS	MSS/FL and LMDS	MSS/FL and GSO/ FSS	GSO/FSS
fss	ngso/fss	gso/fss			ngso/fss
850 MHz	250 MHz	500 MHz	150 MHz	250 MHz	500 MHz

27.5 28.35 28.6 29.1 29.25 29.5 30.0 GHz

Figure 13: FCC Ka-Band Frequency Band Plan, 27.5 GHz – 30.0 GHz[9]

[6] At 5 degree skew the NGSO mask, 25.138(a)(2), exceedance may be up 6 dB, at 10° the exceedance is up to 3.5 dB. All other skew angles will meet the NGSO mask.

[7] See FCC Rules 25.140(a)(3)(iii) re Ka-band rules on coordinating with authorized users.

[8] O3b is currently authorized to operate in the 28.35-28.4 GHz band, see FCC File No.1 SES-LIC-20100723-00952. This upper band edge is below the Thales lower band edge of 28.438 GHz.

[9] See FCC IB Docket No. 98-172, *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-Service Use*, R&O Adopted: June 8, 2000, p10.

6 Exhibit B – Link Budgets

<u>AMC-15 Link Budgets</u>

Inbound link budgets on AMC-15 covering ESAA operation scenarios at 0°, 35°, and 65° skew angles are attached below. A representative outbound link is also provided.

		AMC-15 Inbound Link Budget		
		0° Skew	**35° Skew**	**65° Skew**
General Parameters				
Orbital location	°E.L.	254.95	254.95	254.95
Uplink Frequency	MHz	29625	29625	29500
Downlink Frequency	MHz	19950	19950	19950
Transmit Earth Station				
Antenna width x height	cm	62.3 x 16.8	62.3 x 16.8	62.3 x 16.8
Antenna elevation angle	degrees	59.3	47.5	42.1
Antenna Gain	dBi	39.0	39.0	38.9
Earth station transmit EIRP/carrier	dBW	45.5	45.5	44.0
Pointing loss	dB	0.50	0.50	0.50
Receive Earth Station				
Antenna diameter	m	9.10	9.10	9.10
Antenna elevation angle	degrees	34.0	34.0	34.0
Rx E/S G/T clear sky	dB/K	38.9	38.9	38.9
Receive pointing loss	dB	0.25	0.25	0.25
Carrier				
Information rate	Mbps	5.460	2.730	1.024
FEC Coding		2/3	2/3	1/2
Modulation		OQPSK	OQPSK	OQPSK-SF4
Symbol rate	Msps	4.095	2.048	4.096
Allocated bandwidth	MHz	5.119	2.559	5.120
Uplink				
Uplink path loss	dB	213.1	213.3	213.4
Uplink atmospheric loss	dB	0.50	0.50	0.50
C/N uplink	dB-Hz	8.9	7.5	-0.8
C/I uplink (prior to ASI)	dB-Hz	29.3	29.3	21.0
On-axis EIRP spectral density	dBW/MHz	39.4	42.4	37.9
Downlink				
Downlink atmospheric loss	dB	0.50	0.50	0.50
Downlink path loss	dB	210.1	210.1	210.1
Carrier downlink EIRP at BC	dBW	42.0	37.8	30.9
PFD at earth's surface	dBW/m^2/MHz	-126.8	-128.0	-137.8
C/N downlink	dB-Hz	29.9	28.7	18.9
C/I downlink (prior to ASI)	dB-Hz	16.7	16.7	16.7
End-to-End				
C/I adjacent spacecraft interference	dB-Hz	13.6	14.6	7.6
C/(N+I) total	dB-Hz	7.1	6.3	-1.5
Link margin	dB	2.5	1.7	1.6

AMC-15 Outbound Link Budget		
General Parameters		
Orbital location	°E.L.	254.95
Uplink Frequency	MHz	29750
Downlink Frequency	MHz	19825
Transmit Earth Station		
Antenna diameter	m	9.10
Antenna elevation angle	degrees	34.0
Antenna Gain	dBi	66.6
Earth station transmit EIRP/carrier	dBW	72.4
Pointing loss	dB	0.25
Receive Earth Station		
Antenna width x height	cm	62.3 x 16.8
Antenna elevation angle	degrees	47.5
Rx E/S G/T clear sky	dB/K	12.5
Receive pointing loss	dB	0.50
Carrier		
Information rate	Mbps	47.759
FEC Coding		2/3
R-S Coding		0.996
Modulation		DVB-S2 QPSK
Symbol rate	Msps	37.000
Allocated bandwidth	MHz	39.000
Uplink		
Uplink path loss	dB	213.6
Uplink atmospheric loss	dB	0.50
C/N uplink	dB-Hz	23.3
C/I uplink (prior to ASI)	dB-Hz	30.0
On-axis EIRP spectral density	dBW/MHz	56.7
Downlink		
Downlink atmospheric loss	dB	0.50
Downlink path loss	dB	209.8
Carrier downlink EIRP at BC	dBW	54.7
PFD at earth's surface	dBW/m^2/MHz	-123.4
C/N downlink	dB-Hz	5.3
C/I downlink (prior to ASI)	dB-Hz	18.7
End-to-End		
C/I adjacent spacecraft interference	dB-Hz	13.3
C/(N+I) total	dB-Hz	4.4
Link margin	dB	1.0

AMC-16 Link Budgets

Inbound link budgets on AMC-16 covering ESAA operation scenarios at 0° and 30° skew angles are attached below. A representative outbound link is also provided.

		AMC-16 Inbound Link Budgets		
		0° Skew	**30° Skew Mid-Beam**	**30° Skew Beam Edge**
General Parameters				
Orbital location	°E.L.	275	275	275
Uplink Frequency	MHz	29625	29875	29875
Downlink Frequency	MHz	19700	19700	19700
Transmit Earth Station				
Antenna width x height	cm	62.3 x 16.8	62.3 x 16.8	62.3 x 16.8
Antenna elevation angle	degrees	38.5	35.2	26.4
Antenna Gain	dBi	39.0	39.0	39.0
Earth station transmit EIRP/carrier	dBW	45.5	45.5	45.5
Pointing loss	dB	0.50	0.50	0.50
Receive Earth Station				
Antenna diameter	m	4.50	4.50	4.50
Antenna elevation angle	degrees	35.7	35.7	35.7
Rx E/S G/T clear sky	dB/K	32.6	32.6	32.6
Receive pointing loss	dB	0.25	0.25	0.25
Carrier				
Information rate	Mbps	5.460	2.730	1.024
FEC Coding		2/3	2/3	1/2
Modulation		OQPSK	OQPSK	OQPSK-SF2
Symbol rate	Msps	4.095	2.048	2.048
Allocated bandwidth	MHz	5.119	2.559	2.559
Uplink				
Uplink path loss	dB	213.5	213.6	213.8
Uplink atmospheric loss	dB	0.50	0.50	0.50
C/N uplink	dB-Hz	8.3	7.2	2.3
C/I uplink (prior to ASI)	dB-Hz	29.3	29.3	29.3
On-axis EIRP spectral density	dBW/MHz	39.4	42.4	42.4
Downlink				
Downlink atmospheric loss	dB	0.50	0.50	0.50
Downlink path loss	dB	210.0	210.0	210.0
Carrier downlink EIRP at BC	dBW	42.3	37.0	32.1
PFD at earth's surface	dBW/m^2/MHz	-126.4	-128.7	-133.6
C/N downlink	dB-Hz	22.7	20.4	15.5
C/I downlink (prior to ASI)	dB-Hz	16.8	16.8	16.8
End-to-End				
C/I adjacent spacecraft interference	dB-Hz	18.5	16.5	12.0
C/(N+I) total	dB-Hz	7.3	6.1	1.5
Link margin	dB	2.7	1.5	1.6

AMC-16 Outbound Link Budget		
General Parameters		
Orbital location	°E.L.	275
Uplink Frequency	MHz	29500
Downlink Frequency	MHz	20075
Transmit Earth Station		
Antenna diameter	m	4.50
Antenna elevation angle	degrees	35.7
Antenna Gain	dBi	60.8
Earth station transmit EIRP/carrier	dBW	73.4
Pointing loss	dB	0.25
Receive Earth Station		
Antenna width x height	cm	62.3 x 16.8
Antenna elevation angle	degrees	35.7
Rx E/S G/T clear sky	dB/K	12.5
Receive pointing loss	dB	0.50
Carrier		
Information rate	Mbps	47.759
FEC Coding		2/3
R-S Coding		0.996
Modulation		DVB-S2 QPSK
Symbol rate	Msps	37.000
Allocated bandwidth	MHz	39.000
Uplink		
Uplink path loss	dB	213.5
Uplink atmospheric loss	dB	0.50
C/N uplink	dB-Hz	21.7
C/I uplink (prior to ASI)	dB-Hz	30.0
On-axis EIRP spectral density	dBW/MHz	57.7
Downlink		
Downlink atmospheric loss	dB	0.50
Downlink path loss	dB	210.1
Carrier downlink EIRP at BC	dBW	54.3
PFD at earth's surface	dBW/m^2/MHz	-124.0
C/N downlink	dB-Hz	5.0
C/I downlink (prior to ASI)	dB-Hz	18.7
End-to-End		
C/I adjacent spacecraft interference	dB-Hz	14.3
C/(N+I) total	dB-Hz	4.3
Link margin	dB	0.9

7 Exhibit C – Satellite Certification Letters

SES

Kimberly M. Baum
Vice President Spectrum Management & Development, Americas

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

15 February 2017

Subject: Engineering Certification of SES Americom, Inc. for the AMC-15 Satellite

To whom it may concern,

This letter confirms that SES is aware that Thales Avionics, Inc., licensed by the Federal Communications Commission ("FCC") as Thales Avionics, Inc. ("Thales"), is seeking FCC a blanket authorization to operate technically identical conventional Ka-band transmit/receive remote terminals pursuant to ITU RR 5.526 and the Commission's current framework for the Ka band. Thales seeks authority for Thales Avionics, Inc.'s new remote terminals to communicate with the AMC-15 satellite at 105° W.L., according to the Commission's precedent for Ka band aeronautical applications.

Based upon the contents of the application (we understand that Thales will seek a new blanket authorization) and the representations made to SES by Thales concerning how it will operate on AMC-15 according to its letter dated February 10, 2017:

- SES certifies that it has completed coordination as required under the FCC's rules and that the power density levels specified by Thales are consistent with any existing coordination agreements to which SES is a party with adjacent satellite operators within +/- 6 degrees of orbital separation from AMC-15.
- If the FCC authorizes the operations proposed by Thales, SES will include the power density levels specified by Thales in all future satellite network coordination with other operators of satellites adjacent to AMC-15.

SES has also reviewed the discussion in the applications regarding the off-axis EIRP density of Thales antennas communicating with AMC-15 in directions other than along the GSO plane. SES is of the view that the non-compliant emissions would not create interference to Ka-band geostationary satellites.

Yours Sincerely,

Kimberly M. Baum

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Kimberly M. Baum
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Washington, D.C. 20554

15 February 2017

Subject: Engineering Certification of SES Americom, Inc. for the AMC-16 Satellite

To whom it may concern,

This letter confirms that SES is aware that Thales Avionics, Inc., licensed by the Federal Communications Commission ("FCC") as Thales Avionics, Inc. ("Thales"), is seeking FCC a blanket authorization to operate technically identical conventional Ka-band transmit/receive remote terminals pursuant to ITU RR 5.526 and the Commission's current framework for the Ka band. Thales seeks authority for Thales Avionics, Inc.'s new remote terminals to communicate with the AMC-16 satellite at 85° W.L., according to the Commission's precedent for Ka band aeronautical applications.

Based upon the contents of the application (we understand that Thales will seek a new blanket authorization) and the representations made to SES by Thales concerning how it will operate on AMC-16 according to its letter dated February 10, 2017:

- SES certifies that it has completed coordination as required under the FCC's rules and that the power density levels specified by Thales are consistent with any existing coordination agreements to which SES is a party with adjacent satellite operators within +/- 6 degrees of orbital separation from AMC-16.
- If the FCC authorizes the operations proposed by Thales, SES will include the power density levels specified by Thales in all future satellite network coordination with other operators of satellites adjacent to AMC-16.

SES has also reviewed the discussion in the applications regarding the off-axis EIRP density of Thales antennas communicating with AMC-16 in directions other than along the GSO plane. SES is of the view that the non-compliant emissions would not create interference to Ka-band geostationary satellites.

Yours Sincerely,

Kimberly M. Baum

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8 Exhibit D – Radiation Hazard Study

Analysis of Non-Ionizing Radiation for Thales ESAA Antenna

This report analyzes the non-ionizing radiation levels for a 0.365m effective aperture earth station antenna (0.623m x 0.168m aperture). The analysis and calculations performed in this report are in compliance with the methods described in the FCC Office of Engineering and Technology Bulletin No. 65. Bulletin No. 65 specifies that there are two separate tiers of exposure limits that are dependent upon the situation in which the exposure takes place and/or the status of the individuals who are subject to the exposure. The two tiers are General Population /Uncontrolled environment, and an Occupational /Controlled environment.

The applicable exposure limit for the General Population /Uncontrolled environment at this frequency of operation is 1 mW/cm². The applicable exposure limit for the Occupational / Controlled environment at this frequency of operation is 5 mW/cm².

<u>Definition of terms</u>

The terms are used in the formulas here are defined as follows:

$S_{surface}$ = maximum power density at the antenna surface

S_{nf} = maximum near-field power density

S_t = power density in the transition region

S_{ff} = power density (on axis)

R_{nf} = extent of near-field

R_{ff} = distance to the beginning of the far-field

R = distance to point of interest

Pa = 16 W	power amplifier maximum output in Watts
Lfs = 5.4 dB	losses between amplifier and antenna input in dB (Includes 1 dB radome loss)
P = 4.57 W	power input to the antenna in Watts (16 W / 10^(5.44 dB / 10))
A = 0.1046 m^2	physical area of the aperture antenna (0.623x0.168 m²)
G = 7762 (38.9 dBi)	power gain relative to an isotropic radiator
Dmaj = 0.623 m	Aperture antenna major axis
Dmin = 0.168 m	Aperture antenna minor axis
F = 29,500	frequency in MHz
λ = 0.0102 m	wavelength in meters (300/F_{MHz})
η = 0.61	aperture efficiency

Antenna Surface. The maximum power density directly in front of an antenna (e.g., at the antenna surface) can be approximated by the following equation:

Ssurface = (4 * P) / A, Note, P is 1 dB higher under the radome

$= (4 * 5.76)/0.104\ m^2$

$= 220.19\ W/m^2$

$= 22.019\ mW/cm^2$

Near Field Region. In the near-field or Fresnel region, of the main beam, the power density can reach a maximum before it begins to decrease with distance. The extent of the near field can be described by the following equation (**D** and λ in same units):

Rnf $= Dmaj^2 / (4 * \lambda)$

$= 0.623^2 / (4 * 0.0102)$

$= 9.54\ m$

The magnitude of the on-axis (main beam) power density varies according to location in the near field. However, the maximum value of the near-field, on-axis, power density can be expressed by the following equation:

Snf $= (16 * \eta * P) / (\pi * Dmaj^2)$

$= (16 * 0.61 * 4.57) / (\pi * 0.623^2)$

$= 36.61\ W/m^2$

$= 3.66\ mW/cm^2$

Far-Field Region. The power density in the far-field or Fraunhofer region of the antenna pattern decreases inversely as the square of the distance. The distance to the start of the far field can be calculated by the following equation:

Rff $= (0.6 * Dmaj^2) / \lambda$

$= (0.6 * 0.623^2) / 0.0102$

$= 22.9$ m

The power density at the start of the far-field region of the radiation pattern can be estimated by the equation:

Sff $= (P * G) / (4 * \pi * Rff^2)$

$= (4.57 * 7762) / (4 * \pi * 22.9^2)$

$= 5.38$ W/m^2

$= 0.538$ mW/cm^2

Transition Region. Power density in the transition region decreases inversely with distance from the antenna, while power density in the far field (Fraunhofer region) of the antenna decreases inversely with the square of the distance. The transition region will then be the region extending from Rnf to Rff. If the location of interest falls within this transition region, the on-axis power density can be determined from the following equation:

$S_t = (S_{nf} * R_{nf}) / R$

$= (3.66$ mW/cm^2 $* 9.54$ m$) / R$

$= 3.66$ mW/cm^2 where R is the start of the transition region (9.54m)

Summary of expected radiation levels for an Uncontrolled environment

Region	Maximum Power Density	Hazard Assessment
Far field (R_{ff}) = 22.9 m	0.538 mW/cm^2	Satisfies FCC MPE
Near field (R_{nf}) = 9.54 m	3.66 mW/cm^2	Potential Hazard
Transition region (R_t) (R_t) = $R_{nf} < R_t < R_{ff}$	3.66 mW/cm^2	Potential Hazard
Main Reflector Surface (Ssurface)	22.02 mW/cm^2	Potential Hazard

Note, power density level in the area between the feed and the reflector surface is greater than the reflector surface and is assumed to be a potential hazard.

Summary of expected radiation levels for a Controlled environment

Region	Maximum Power Density	Hazard Assessment
Far field (Rff) = 22.9 m	0.538 mW/cm2	Satisfies FCC MPE
Near field (Rnf) = 9.54 m	3.66 mW/cm2	Satisfies FCC MPE
Transition region (Rt)	3.66 mW/cm2	Satisfies FCC MPE
(Rt) = Rnf < Rt < Rff		
Main Reflector Surface (Ssurface)	22.02 mW/cm2	Potential Hazard

Conclusions

The proposed earth station system will be located on top of an airplane fuselage with controlled access and will be serviced by trained personnel. The radio and amplifier system will be turned off when servicing the antenna system. Based on the above analysis it is concluded that harmful radiation levels will not exist in regions normally occupied by the public. The applicant agrees to abide by the conditions specified in Condition 5208 provided below:

Condition 5208 - The licensee shall take all necessary measures to ensure that the antenna does not create potential exposure of humans to radiofrequency radiation in excess of the FCC exposure limits defined in 47 CFR 1.1307(b) and 1.1310 wherever such exposures might occur. Measures must be taken to ensure compliance with limits for both occupational/controlled exposure and for general population/uncontrolled exposure, as defined in these rule sections. Compliance can be accomplished in most cases by appropriate restrictions such as fencing. Requirements for restrictions can be determined by predictions based on calculations, modeling or by field measurements. The FCC's OET Bulletin 65 (available on-line at www.fcc.gov/oet/rfsafety) provides information on predicting exposure levels and on methods for ensuring compliance, including the use of warning and alerting signs and protective equipment for workers.

9 Exhibit E - §25.227 and §25.138 Rules Compliance Tables

FCC Rules 25.227 Compliance Table		
FCC Rule Part	**Description**	**Comments**
§25.227	§25.227 Blanket licensing provisions for ESAAs operating with GSO FSS space stations in the 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz, and 14.0-14.5 GHz bands.	In support of their filing Thales agrees to comply with applicable §25.227 ESAA Rules
§25.227(a)	(a) The following ongoing requirements govern all ESAA licensees and operations in the 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), 11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space) frequency bands receiving from and transmitting to geostationary orbit satellites in the Fixed-Satellite Service. ESAA licensees shall comply with the requirements in either paragraph (a)(1), (a)(2) or (a)(3) of this section and all of the requirements set forth in paragraphs (a)(4) through (a)(16) and paragraphs (c), (d), and (e) of this section. Paragraph (b) of this section identifies items that shall be included in the application for ESAA operations to demonstrate that these ongoing requirements will be met.	Thales will comply with §25.138 EIRP Density limits and §25.227 rules regarding pointing, logging, and protection of others
§25.227(a)(1)	(1) The following requirements shall apply to an ESAA that uses transmitters with off-axis EIRP spectral-densities lower than or equal to the levels in paragraph (a)(1)(i) of this section. ESAA licensees operating under this section shall provide a detailed demonstration as described in paragraph (b)(1) of this section. The ESAA transmitter also shall comply with the antenna pointing and cessation of emission requirements in paragraphs (a)(1)(ii) and (iii) of this section.	Thales will exceed the levels specfied in (a)(1)(i)(B) for skew angle between 0° and 10°. A Waiver to operate is provided in Exhibit A.
§25.227(a)(1)(i)(A)	(i)(A) EIRP spectral density emitted in the plane tangent to the GSO arc, as defined in §25.103, must not exceed the following values: 15-25 log10 θ dBW/4 kHz for 1.5° ≤ θ ≤ 7°. −6 dBW/4 kHz for 7° < θ ≤ 9.2°. 18-25 log10 θ dBW/4 kHz for 9.2° < θ ≤ 19.1°. −14 dBW/4 kHz for 19.1° < θ ≤ 180°.	Thales will comply for skew angles 0° to 65°. Will limit operation to 65 degree skew angle worst case. See Section 3.1
	Where theta (θ) is the angle in degrees from a line from the earth station antenna to the assigned orbital location of the target satellite. The EIRP density levels specified for θ > 7° may be exceeded by up to 3 dB in up to 10% of the range of theta (θ) angles from ±7-180°, and by up to 6 dB in the region of main reflector spillover energy.	

§25.227(a)(1)(i)(B)	(B) The EIRP spectral density of co-polarized signals must not exceed the following values in the plane perpendicular to the GSO arc, as defined in §25.103: 18-25 log θ dBW/4 kHz for 3.0° ≤ θ ≤ 19.1°. −14 dBW/4 kHz for 19.1° < θ ≤ 180°.	Thales will limit skew angles to 0° to 65°. Thales will not comply at skew angles of 0°, 5°, 10°. Thales is seeking a waiver at those angles, see Exhibit A
	Where θ is as defined in paragraph (a)(1)(i)(A) of this section. These EIRP density levels may be exceeded by up to 6 dB in the region of main reflector spillover energy and in up to 10% of the range of θ angles not included in that region, on each side of the line from the earth station to the target satellite.	
§25.227(a)(1)(i)(C)	(C) The off-axis EIRP spectral-density of cross-polarized signals must not exceed the following values in the plane tangent to the GSO arc or in the plane perpendicular to the GSO arc:	Thales complies at skew angles of 0° to 65°. Thales will not operate with skew angles greater than 65°
	5-25 log10 θ; dBW/4 kHz for 1.8° ≤ θ ≤ 7.0°.	
	Where θ is as defined in paragraph (a)(1)(i)(A) of this section.	
§25.227(a)(1)(ii)	(ii) Each ESAA transmitter shall meet one of the following antenna pointing requirements:	
§25.227(a)(1)(ii)(A)	(A) Each ESAA transmitter shall maintain a pointing error of less than or equal to 0.2° between the orbital location of the target satellite and the axis of the main lobe of the ESAA antenna; or	Thales will comply, see Section 2.2.3
§25.227(a)(1)(ii)(B)	(B) Each ESAA transmitter shall declare a maximum antenna pointing error that may be greater than 0.2° provided that the ESAA does not exceed the off-axis EIRP spectral-density limits in paragraph (a)(1)(i) of this section, taking into account the antenna pointing error.	N/A
§25.227(a)(1)(iii)	(iii) Each ESAA transmitter shall meet one of the following cessation of emission requirements:	
§25.227(a)(1)(iii)(A)	(A) For ESAAs operating under paragraph (a)(1)(ii)(A) of this section, all emissions from the ESAA shall 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 shall not resume until such angle is less than or equal to 0.2°, or	Thales will comply , see Section 2.2.3

§25.227(a)(1)(iii)(B)	(B) For ESAA transmitters operating under paragraph (a)(1)(ii)(B) of this section, all emissions from the ESAA shall 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 the declared maximum antenna pointing error and shall not resume transmissions until such angle is less than or equal to the declared maximum antenna pointing error.	Not applicable to this filing
§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.	Thales will not comply in the NGSO plane for skew angles between 0° and 10°, see Exhibit A
§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 Exhibits B and C
§25.227(a)(2)(ii)	(ii) Any ESAA transmitter operating under a license granted based on certifications filed pursuant to paragraph (b)(2) of this section must be self-monitoring and capable of shutting itself off and must cease or reduce emissions within 100 milliseconds after generating off-axis EIRP-density in excess of the specifications supplied to the target satellite operator.	Thales will comply, see Section 2.1.1
§25.227(a)(2)(iii)	(iii) A system with variable power control of individual ESAA transmitters must monitor the aggregate off-axis EIRP density from simultaneously transmitting ESAA transmitters at the system's network control and monitoring center. If simultaneous operation of two or more ESAA transmitters causes aggregate off-axis EIRP density to exceed the off-axis EIRP density specifications supplied to the target satellite operator, the network control and monitoring center must command those transmitters to cease emissions or reduce the aggregate EIRP density to a level at or below those specifications, and the transmitters must comply within 100 milliseconds of receiving the command.	Thales will comply, see Section 2.1.1
§25.227(a)(3)	(3) The following requirements apply to an ESAA system that uses variable power-density control of individual ESAA earth stations transmitting simultaneously in the same frequencies to the same target satellite, unless the system operates pursuant to	Not Applicable to this filing

	paragraph (a)(2) of this section.	
§25.227(a)(3)(i)	(i) Aggregate EIRP density from co-frequency earth stations in each target satellite receiving beam, not resulting from colliding data bursts transmitted pursuant to a contention protocol, will not exceed the limits specified in paragraph (a)(1)(i) of this section.	Not Applicable to this filing
§25.227(a)(3)(ii)	(ii) Each ESAA transmitter must be self-monitoring and capable of shutting itself off and must cease or reduce emissions within 100 milliseconds after generating off-axis EIRP density in excess of the limit in paragraph (a)(3)(i) of this section.	Not Applicable to this filing
§25.227(a)(3)(iii)	(iii) A system with variable power control of individual ESAA transmitters must monitor aggregate power density from simultaneously transmitting ESAA transmitters at the network control and monitoring center. If simultaneous operation of two or more transmitters causes aggregate off-axis EIRP density to exceed the off-axis EIRP density limit in paragraph (a)(3)(i) of this section, the network control and monitoring center must command those transmitters to cease emissions or reduce the aggregate EIRP density to a level at or below that limit, and those transmitters must comply within 100 milliseconds of receiving the command.	Not Applicable to this filing
§25.227(a)(4)	(4) An applicant filing to operate an ESAA terminal or system and planning to use a contention protocol shall certify that its contention protocol use will be reasonable.	The access scheme is MF-TDMA with ALOHA. This TDMA access technique has been used in many VSATs world-wide and is reasonable, see Section 2.5.3
§25.227(a)(5)	(5) There shall be a point of contact in the United States, with phone number and address, available 24 hours a day, seven days a week, with authority and ability to cease all emissions from the ESAA.	See Section 2.4.1
§25.227(a)(6)	(6) For each ESAA transmitter, a record of the vehicle location (i.e., latitude/longitude/altitude), transmit frequency, channel bandwidth and satellite used shall be time annotated and maintained for a period of not less than one year. Records shall be recorded at time intervals no greater than one (1) minute while the ESAA is transmitting. The ESAA operator shall make this data available, in the form of a comma delimited electronic spreadsheet, within 24 hours of a request from the	Thales will comply, see certification in Section 2.6.5

	Commission, NTIA, or a frequency coordinator for purposes of resolving harmful interference events. A description of the units (i.e., degrees, minutes, MHz) in which the records values are recorded will be supplied along with the records.	
§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 18.6-18.8 GHz band and does not 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 using Ka-band spectrum.
§25.227(a)(9)	(9) Each ESAA terminal shall 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.	Thales will comply, see certification in Section 2.2.3
§25.227(a)(10)	(10) Each ESAA terminal should be subject to the monitoring and control by an NCMC or equivalent facility. Each terminal must be able to receive at least “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 must be able to monitor the operation of an ESAA terminal to determine if it is malfunctioning.	Thales will comply, see section 2.6.5
§25.227(a)(11)	(11) Each ESAA terminal shall be self-monitoring and,	Thales will comply, see

	should a fault which can cause harmful interference to FSS networks be detected, the terminal must automatically cease transmissions.	Section 2.2.3
§25.227(a)(12)	(12) Unless otherwise stated all ESAA system that comply with the off-axis EIRP spectral-density limits in paragraph (a)(1)(i) of this section may request Permitted List authority.	Understood
§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 3.1.2 and Link Budgets in Exhibit B.
	$-132 + 0.5 \cdot \theta$ dB(W/(m2 · MHz)) For $\theta \leq 40°$	
	-112 dB(W/(m2 · MHz)) For $40° < \theta \leq 90°$	
§25.227(a)(14)	(14) All ESAA terminals operated in U.S. airspace, whether on U.S.-registered civil aircraft or non-U.S.-registered civil aircraft, must be licensed by the Commission. All ESAA terminals on U.S.-registered civil aircraft operating outside of U.S. airspace must be licensed by the Commission, except as provided by section 303(t) of the Communications Act.	Thales understands and will comply
§25.227(a)(15)	(15) For ESAA systems operating over international waters, ESAA operators will certify that their target space station operators have confirmed that proposed ESAA operations are within coordinated parameters for adjacent satellites up to 6 ° away on the geostationary arc.	Thales understands and will comply, see Exhibit C
§25.227(a)(16)	(16) Prior to operations within the foreign nation's airspace, the ESAA operator will ascertain whether the relevant administration has operations that could be affected by ESAA terminals, and will determine whether that administration has adopted specific requirements concerning ESAA operations. When the aircraft enters foreign airspace, the ESAA terminal would be required to operate under the Commission's rules, or those of the foreign administration, whichever is more constraining. To the extent that all relevant administrations have identified geographic areas from which ESAA operations would not affect their radio operations, ESAA operators would be free to operate within those identified areas without further action. To	Thales understands and will comply

	the extent that the foreign administration has not adopted requirements regarding ESAA operations, ESAA operators would be required to coordinate their operations with any potentially affected operations.	
§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 F and G
§25.227(b)(1)	(1) An ESAA applicant proposing to implement a transmitter under paragraph (a)(1) of this section must provide the information required by §25.115(g)(1). An applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(A) of this section must also provide the certifications identified in paragraph (b)(1)(iii) of this section. An applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(B) of this section must also provide the demonstrations identified in paragraph (b)(1)(iv) of this section.	Thales is proposing to apply under §25.227(a)(2) so this section does not apply
§25.227(b)(1)(i)-(ii)	(i)-(ii) [Reserved]	N/A
§25.227(b)(1)(iii)	(iii) An ESAA applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(A) of this section shall:	
§25.227(b)(1)(iii)(A)	(A) Demonstrate that the total tracking error budget of their antenna is within 0.2° or less between the orbital location of the target satellite and the axis of the main lobe of the ESAA antenna. As part of the engineering analysis, the ESAA applicant must show that the antenna pointing error is within three sigma () from the mean value, i.e., that there is a 0.997 probability the antenna maintains a pointing error within 0.2°; and	Thales is proposing to apply under §25.227(a)(2) so this section does not apply
§25.227(b)(1)(iii)(B)	(B) Demonstrate that the antenna tracking system is capable of ceasing emissions 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°.	Thales is proposing to apply under §25.227(a)(2) so this section does not apply
§25.227(b)(1)(iv)	(iv) An ESAA applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(B) of this section shall:	

§25.227(b)(1)(iv)(A)	(A) Declare, in its application, a maximum antenna pointing error and demonstrate that the maximum antenna pointing error can be achieved without exceeding the off-axis EIRP spectral-density limits in paragraph (a)(1)(i) of this section; and	Thales is proposing to apply under §25.227(a)(2) so this section does not apply
§25.227(b)(1)(iv)(B)	(B) Demonstrate that the ESAA transmitter can detect if the transmitter exceeds the declared maximum antenna pointing error and can cease transmission 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 the declared maximum antenna pointing error, and will not resume transmissions until the angle between the orbital location of the target satellite and the axis of the main lobe of the ESAA antenna is less than or equal to the declared maximum antenna pointing error.	Thales is proposing to apply under §25.227(a)(2) so this section does not apply
§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:	
§25.227(b)(2)(i)	(i) Off-axis EIRP density data pursuant to §25.115(g)(1);	See Section 3.1.1 and Exhibit G
§25.227(b)(2)(ii)	(ii) The certifications required by §25.220(d); and	See Exhibit C
§25.227(b)(2)(iii)	(iii) A detailed showing that each ESAA transmitter in the system will automatically cease or reduce emissions within 100 milliseconds after generating EIRP density exceeding specifications provided to the target satellite operator; and	See Section 2.1.1
§25.227(b)(2)(iv)	(iv) A detailed showing that the aggregate power density from simultaneously transmitting ESAA transmitters will be monitored at the system's network control and monitoring center; that if simultaneous operation of two or more ESAA transmitters causes the aggregate off-axis EIRP density to exceed the off-axis EIRP density specifications supplied to the target satellite operator, the network control and monitoring center will command those transmitters to cease emissions or reduce the aggregate EIRP density to a level at or below those specifications; and that those transmitters will comply within 100 milliseconds of receiving the command.	See Section 2.2.3
§25.227(b)(3)	(3) An applicant proposing to implement an ESAA system subject to paragraph (a)(3) of this section must provide the following information in exhibits to its earth station application:	Not Applicable to this filing

§25.227(b)(3)(i)	(i) Off-axis EIRP density data pursuant to §25.115(g)(1);	Not Applicable to this filing
§25.227(b)(3)(ii)	(ii) A detailed showing of the measures that will be employed to maintain aggregate EIRP density at or below the limit in paragraph (a)(3)(i) of this section;	Not Applicable to this filing
§25.227(b)(3)(iii)	(iii) A detailed showing that each ESAA terminal will automatically cease or reduce emissions within 100 milliseconds after generating off-axis EIRP density exceeding the limit in paragraph (a)(3)(i) of this section; and	Not Applicable to this filing
§25.227(b)(3)(iv)	(iv) A detailed showing that the aggregate power density from simultaneously transmitting ESAA transmitters will be monitored at the system's network control and monitoring center; that if simultaneous operation of two or more transmitters in the ESAA network causes aggregate off-axis EIRP density to exceed the off-axis density limit in paragraph (a)(3)(i) of this section, the network control and monitoring center will command those transmitters to cease emissions or reduce the aggregate EIRP density to a level at or below that limit; and that those transmitters will comply within 100 milliseconds of receiving the command.	Not Applicable to this filing
§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
§25.227(b)(5)	(5) Any ESAA applicant filing for an ESAA terminal or system and planning to use a contention protocol shall include in its application a certification that will comply with the requirements of paragraph (a)(4) of this section.	See Section 2.5.3
§25.227(b)(6)	(6) The point of contact referred to in paragraph (a)(5) of this section shall be included in the application.	See Section 2.4.1
§25.227(b)(7)	(7) Any ESAA applicant filing for an ESAA terminal or system shall include in its application a certification that will comply with the requirements of paragraphs (a)(6), (a)(9), (a)(10), and (a)(11) of this section.	See Section 2.6.5 and 2.2.3
§25.227(b)(8)	(8) All ESAA applicants shall submit a radio frequency hazard analysis determining via calculation, simulation, or field measurement whether ESAA terminals, or classes of terminals, will produce power densities that will exceed the Commission's radio frequency exposure criteria. ESAA applicants with ESAA terminals that will exceed the guidelines in §1.1310 of this chapter for radio frequency radiation exposure shall provide, with their environmental assessment, a plan for mitigation	Thales will comply, See Radiation Hazard Study in Exhibit D

	of radiation exposure to the extent required to meet those guidelines. All ESAA licensees shall ensure installation of ESAA terminals on aircraft by qualified installers who have an understanding of the antenna's radiation environment and the measures best suited to maximize protection of the general public and persons operating the vehicle and equipment. An ESAA terminal exhibiting radiation exposure levels exceeding 1.0 mW/cm2 in accessible areas, such as at the exterior surface of the radome, shall have a label attached to the surface of the terminal warning about the radiation hazard and shall include thereon a diagram showing the regions around the terminal where the radiation levels could exceed 1.0 mW/cm2.	
§25.227(c)(1)	(c)(1) Operations of ESAAs in the 14.0-14.2 GHz (Earth-to-space) frequency band in the radio line-of-sight of the NASA TDRSS facilities on Guam (latitude 13°36’55” N, longitude 144°51’22” E) or White Sands, New Mexico (latitude 32°20’59” N, longitude 106°36’31” W and latitude 32°32’40” N, longitude 106°36’48” W) are subject to coordination with the National Aeronautics and Space Administration (NASA) through the National Telecommunications and Information Administration (NTIA) Interdepartment Radio Advisory Committee (IRAC). Licensees shall notify the International Bureau once they have completed coordination. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations.	Not Applicable to Ka-Band
§25.227(c)(2)	(2) When NTIA seeks to provide similar protection to future TDRSS sites that have been coordinated through the IRAC Frequency Assignment Subcommittee process, NTIA will notify the Commission's International Bureau that the site is nearing operational status. Upon public notice from the International Bureau, all Ku-band ESAA licensees shall cease operations in the 14.0-14.2 GHz band within radio line-of-sight of the new TDRSS site until the licensees complete coordination with NTIA/IRAC for the new TDRSS facility. Licensees shall notify the International Bureau once they have completed coordination for the new TDRSS site. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the	Not Applicable to Ka-Band

	coordination zone in 30 days if no party has opposed the operations. The ESAA licensee then will be permitted to commence operations in the 14.0-14.2 GHz band within radio line-of-sight of the new TDRSS site, subject to any operational constraints developed in the coordination process.	
§25.227(d)(1)	(d)(1) Operations of ESAA in the 14.47-14.5 GHz (Earth-to-space) frequency band in the radio line-of-sight of radio astronomy service (RAS) observatories observing in the 14.47-14.5 GHz band are subject to coordination with the National Science Foundation (NSF). The appropriate NSF contact point to initiate coordination is Electromagnetic Spectrum Manager, NSF, 4201 Wilson Blvd., Suite 1045, Arlington VA 22203, fax 703-292-9034, email esm@nsf.gov. Licensees shall notify the International Bureau once they have completed coordination. Upon receipt of the coordination agreement from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations.	Not Applicable to Ka-Band
§25.227(d)(2)	(2) A list of applicable RAS sites and their locations can be found in §25.227(d)(2) Table 1.	Not Applicable to Ka-Band
§25.227(d)(3)	(3) When NTIA seeks to provide similar protection to future RAS sites that have been coordinated through the IRAC Frequency Assignment Subcommittee process, NTIA will notify the Commission's International Bureau that the site is nearing operational status. Upon public notice from the International Bureau, all Ku-band ESAA licensees shall cease operations in the 14.47-14.5 GHz band within the relevant geographic zone of the new RAS site until the licensees complete coordination for the new RAS facility. Licensees shall notify the International Bureau once they have completed coordination for the new RAS site and shall submit the coordination agreement to the Commission. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations. The ESAA licensee then will be permitted to commence operations in the 14.47-14.5 GHz band within the relevant coordination distance around the new RAS site, subject to any operational constraints developed in the coordination process.	Not Applicable to Ka-Band

§25.138 Licensing requirements for GSO FSS earth stations in the conventional Ka-band		
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 G
	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:	Thales may exceed for certain skew angles, see Section 3.1, Exhibit A, and Exhibit G
	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 G
	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 (a)(5)	(5) A license application for earth station operation in a network using variable power density control of earth stations transmitting simultaneously in shared frequencies to the same target satellite receiving beam may be routinely processed if the applicant certifies	Thales will be using an MF-TDMA access scheme, see Section 2.5.3

	that the aggregate off-axis EIRP density from all co-frequency earth stations transmitting simultaneously to the same target satellite receiving beam, not resulting from colliding data bursts transmitted pursuant to a contention protocol, will not exceed the off-axis EIRP density limits permissible for a single earth station, as specified in paragraphs (a)(1) through (a)(4) of this section.	
§25.138(a)(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 understands and will comply, see Link Budgets in Exhibit B
§25.138(a)(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 understands and will comply, see Exhibit C
§25.138(a)(6)(c)-(e)	(c)-(e) [Reserved]	
§25.138(a)(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