Engineering Statement

1. Introduction

Intelsat License LLC, as debtor in possession ("Intelsat"), seeks authority in this Petition for Declaratory Ruling to provide service to the U.S. market (the "Petition") with its medium-Earth orbit ("MEO") non-geostationary orbit ("NGSO") satellite system ("Intelsat MEO Constellation"), which will operate under the authority of the Federal Republic of Germany in portions of Ku- and V-band.[1] The characteristics of the satellites, as well as their compliance with the various provisions of Part 25 of the Federal Communications Commission ("FCC" or "Commission") rules,[2] are provided in the remainder of this Engineering Statement.

The Intelsat MEO Constellation will complement Intelsat's geostationary orbit ("GSO") satellite fleet and will be a key component to our next-generation network. The satellite sector is undergoing a rapid and dynamic period of change, and Intelsat is excited to expand into the latest transformation of satellite communications with its multi-orbit, multi-band, software-defined 5G network. While we do not yet know what the real-world operations landscape for NGSO systems will look like or which of the currently proposed systems will deploy, Intelsat continues to be committed to both space flight safety and co-frequency coexistence and will coordinate with all potentially affected operators as necessary.

2. Technical Information for NGSO System

2.1. Description of System Facilities, Operations, and Services and Explanation of How Uplink Frequency Bands Will Be Connected to Downlink Frequency Bands

The Intelsat MEO Constellation will be deployed in phases in the following orbital parameters:

Altitude	8600 km		
Inclination Angle	47°	62.9°	89°
Number of Planes	6	6	6
Number of Satellites/Plane	12	12	12

Table 1. Intelsat MEO Constellation Orbital Parameters

Used in conjunction with the Intelsat GSO fleet, the combination of polar and inclined MEO orbits optimizes coverage of unserved or underserved geographies and significantly increases the capacity density of our next-generation network. The Intelsat MEO Constellation reduces round trip latency by almost 80%, from 500 ms for GSO satellites to 110 ms for Intelsat MEO Constellation satellites. The Intelsat MEO Constellation satellites will incorporate flexible use of

[1] The International Telecommunication Union ("ITU") filing for this system is ODYSSEY NGSO-2.

[2] Unless otherwise stated, all references to rule sections in this document refer to sections in Title 47 of the Code of Federal Regulations.

Ku- and V-band spectrum with beam-forming and beam-shaping antennas and digital switching capabilities in both uplink and downlink spectrum.

The coverage area of each satellite is defined by an area where earth stations communicating with the constellation have a minimum elevation angle of 35°. Each MEO satellite will employ phased array antennas and will be capable of activating transmit and receive beams within its coverage area to meet user demand. Overlapping coverage between adjacent satellites allows the Intelsat MEO Constellation to determine which satellite is best suited to provide service to an area on the ground; transmit and receive beams will be activated to optimize coverage and meet operational constraints. Optimization will be performed by ground software that is part of Intelsat's next-generation network.

The satellites will also be equipped with three parabolic gimbaled antennas for communication with gateways that provide connectivity between the satellite and the terrestrial networks. These gateway beams will also be used for telemetry, tracking, and command ("TT&C") operations.

The Intelsat MEO Constellation satellites will orbit the Earth every 5.1 hours, and the coverage areas will move with the satellites. During each orbit, each satellite will continuously reuse the Ku- and V-Band spectrum within its coverage areas. For illustrative purposes, Figure 1 below shows a snapshot of the proposed Intelsat MEO Constellation.

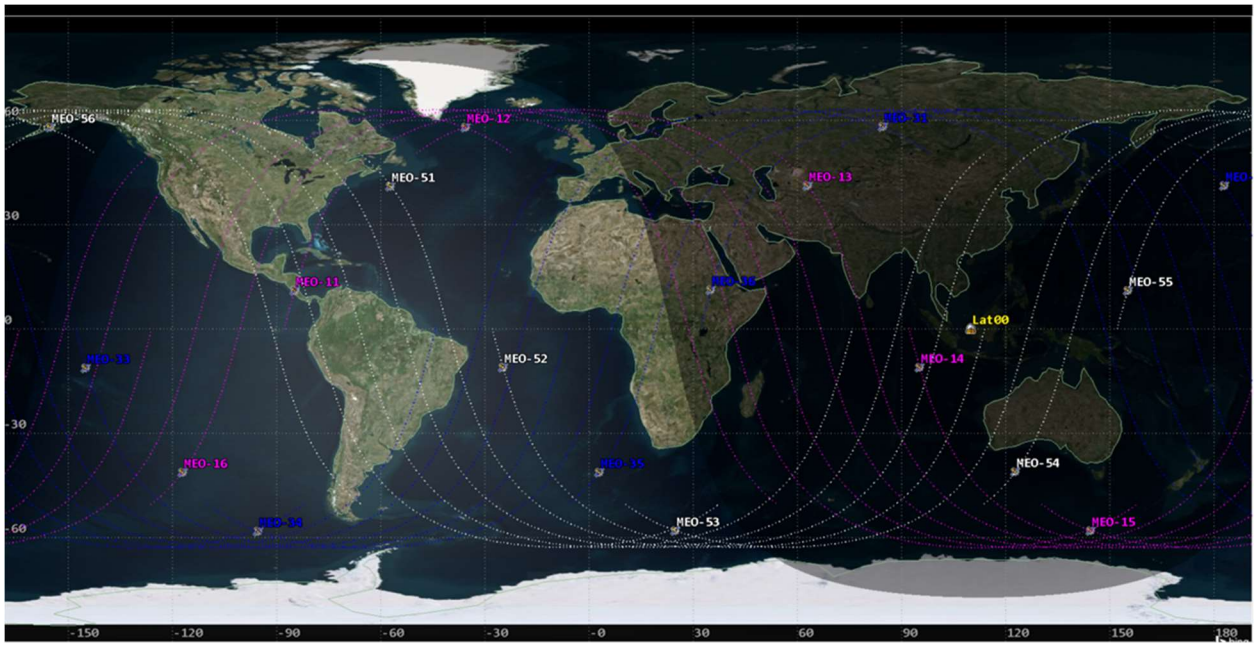

Figure 1. Snapshot of the Intelsat MEO Constellation

2.2. Predictions of Satellite Antenna Gain Contours

The satellite antenna gain contours for the user beams and gateway beams are provided in the GIMS database attached to the Form 312, Schedule S. For the transmit and receive user beams, in Ku- and V-band, the contours are shapeable and steerable, and representative GXT files are provided for a beam pointed at nadir and at the edge of the coverage area. All other beams will fall between these two extremes. The gateway transmit and receive beams are steerable, and

representative beams are provided in the GXT database. The satellites are capable of pointing the user beams and gateway beams anywhere in the coverage area of that satellite.

3. Compliance with Technical Standards

3.1. Frequency and Emission Requirements

3.1.1. Frequency Bands

The following table lists the frequencies of the Intelsat MEO Constellation.

User Terminals	12.5-12.75 GHz (Earth-to-space)[3]
	12.75-13.25 GHz (Earth-to-space)
	14.0-14.5 GHz (Earth-to-space)
	37.5-40.0 GHz (space-to-Earth)
	40.0-42.0 GHz (space-to-Earth)
	42.0-42.5 GHz (space-to-Earth)[4]
	48.2-50.2 GHz (Earth-to-space)
Gateways	37.5-40.0 GHz (space-to-Earth)
	40.0-42.0 GHz (space-to-Earth)
	47.2-48.2 GHz (Earth-to-space)
	48.2-50.2 GHz (Earth-to-space)
	50.4-51.4 GHz (Earth-to-space)

Table 2. Intelsat MEO Constellation Frequency Bands

The following sections address the use of each frequency band requested in the application and refer to the allocation and footnotes contained in the U.S. Table of Frequency Allocations. Intelsat will coordinate with and protect radio astronomy services from Intelsat's operations as required, such as taking all practicable steps to protect radio astronomy observations in the adjacent bands from harmful interference from its operations in the 40.5-42 GHz band (space-to-Earth). In addition to the sections below, Intelsat also understands that radio astronomy services frequently make use of observations (passive) in bands not allocated to the radio astronomy service because of "scientifically valuable signals being subject to the Doppler Effect and shifted in frequency outside radio astronomy-allocated bands."[5] As a result, Intelsat will coordinate with the National Science Foundation Spectrum Management Unit as needed.

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[3] Intelsat is not seeking market access in the 12.5-12.75 GHz frequency band and has omitted this band from the Schedule S.

[4] Intelsat is not seeking market access in the 42.0-42.5 GHz frequency band and has omitted this band from the Schedule S.

[5] *See, e.g.*, *ViaSat, Inc. Petition for Declaratory Ruling Granting Access for a Non-U.S.-Licensed Non-Geostationary Orbit Satellite Network*, Order and Declaratory Ruling, FCC 20-56, 35 FCC Rcd 4324 ¶ 42 (2020).

3.1.2. Use of Earth-to-Space Spectrum in the United States

The 12.75-13.25 GHz frequency band is allocated to the Fixed, Fixed-Satellite (Earth-to-space), and Mobile services on a primary basis. The operation of NGSO Fixed-Satellite Service ("FSS") systems is subject to footnote NG57, which requires NGSO FSS earth stations to be individually licensed. Intelsat is seeking a limited waiver to allow the Intelsat MEO Constellation to communicate with aeronautical terminals.[6] Footnote NG53 sets certain limits on NGSO FSS earth stations, and compliance with these provisions by earth stations communicating with the Intelsat MEO Constellation will be addressed in future earth station applications to the Commission as will coordination with space research (deep space) (space-to-Earth) service for reception at Goldstone, CA as required in footnote US251. Use of this band is also subject to meeting equivalent power-flux density ("EPFD") limits to protect GSO FSS operations. Annex 1 shows that Intelsat will meet the EPFD limits in this band in accordance with Section 25.289.

The 14.0-14.5 GHz band is allocated to the FSS (Earth-to-space) on a primary basis. The operation of NGSO FSS systems is subject to meeting EPFD limits to protect GSO operations. Annex 1 shows that Intelsat will meet the EPFD limits in this band. Intelsat acknowledges Federal use of portions of this band for radio astronomy observations and TDRSS operations and will address those services in future earth station applications.

The 47.2-48.2 GHz band is allocated to the Fixed, FSS (Earth-to-space), and Mobile services on a primary basis. In this band FSS earth stations are subject to Section 25.136 and Intelsat will address the relevant conditions of that rule in future earth station applications.

The 48.2-50.2 GHz band is allocated to the Fixed, FSS (Earth-to-space), and Mobile services on a primary basis. Footnote US156 sets unwanted emission levels for FSS earth stations operating in the 49.7-50.2 GHz band, and footnote US342 stipulates the need to protect radio astronomy observations in the 48.94-49.04 GHz band from transmitting FSS earth stations. Intelsat will address these requirements in future earth station applications. Intelsat will also coordinate with the National Telecommunications and Information Administration ("NTIA") and federal agencies to avoid interference to any of these and other federal government users operating consistent with the U.S. Table of Frequency Allocations.

The 50.4-51.4 GHz band is allocated to the Fixed, FSS (Earth-to-space), Mobile, and Mobile-Satellite (Earth-to-space) services on a primary basis. Footnote US156 sets unwanted emission levels for FSS earth stations operating in the 50.4-50.9 GHz band. Intelsat will address this requirement in future earth station applications. Intelsat will coordinate with NTIA and federal agencies to avoid interference to any federal government uses operating in accordance with the U.S. Table of Frequency Allocations. In this band FSS earth stations are subject to Section 25.136 and Intelsat will address the relevant conditions of that rule in future earth station applications to the Commission.

In the 47.2-50.2 GHz and 50.4-51.4 GHz bands, instead of adopting EPFD limits, which was done to protect GSO networks in the Ku- and Ka-bands, WRC-19 adopted ITU Radio Regulations ("RR") Nos. 22.5L and 22.5M. These provisions provide single entry and aggregate

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6 *See* Legal Narrative Section IV.A.1.

criteria for NGSO systems, as described in Section 3.1.9, to protect GSO networks respectively. Intelsat is committed to working with other NGSO operators to ensure that the aggregate criteria in 22.5M are met.

3.1.3. Use of Space-to-Earth Spectrum in the United States

The 37.5-40.0 GHz band is allocated to the Fixed, FSS (space-to-Earth), and Mobile services on a primary basis. Section 3.1.8 of this document addresses compliance with relevant power flux-density ("PFD") limits that protect terrestrial services. The Commission's V-band proceeding adopted Section 25.136 for individually licensed earth stations, and Intelsat will address the conditions of that rule in future related earth station applications. Additionally, Intelsat is seeking a limited waiver to allow the Intelsat MEO Constellation to serve individually licensed customer earth stations.[7]

This band is also allocated to federal users including Fixed, Mobile, Space Research (space-to-Earth), FSS, and Mobile-Satellite (space-to-Earth) services. Intelsat will coordinate with NTIA and federal agencies as needed to ensure the Intelsat MEO Constellation will operate in a manner that is compatible with these federal services.

The 40.0-42.0 GHz band is allocated to Broadcasting, Broadcasting-Satellite, Fixed, FSS (space-to-Earth), Mobile, and Mobile-Satellite (space-to-Earth) services in various segments on a primary basis. Section 3.1.8 of this document addresses compliance with relevant PFD limits that protect terrestrial services.

The band is also allocated to federal users including Earth-Exploration Satellite (Earth-to-space), FSS (space-to-Earth), Mobile-Satellite (space-to-Earth), and Space Research (Earth-to-space) services in various segments. Intelsat will coordinate with NTIA and federal agencies as needed to ensure the Intelsat MEO Constellation will operate in a manner that is compatible with these Federal services.

3.1.4. Frequency Tolerance for Space Stations

The Intelsat MEO Constellation satellites will maintain the carrier frequency within 0.002% of the reference frequency as required in Section 25.205(e).

3.1.5. Emission Limits

The emissions of the Intelsat MEO Constellation satellites will comply with Section 25.202(f). Additionally, Intelsat acknowledges that WRC-19 revised Resolution 750, which includes unwanted emissions from FSS operations in the 49.7-50.2 GHz and 50.4-50.9 GHz bands into the 50.2-50.4 GHz Earth-exploration satellite service (passive) frequency band, and Intelsat will meet these levels.

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7 *See* Legal Narrative Section IV.A.2.

3.1.6. Telemetry, Tracking, and Command

Consistent with Section 25.202(g), the Intelsat MEO Constellation will operate its TT&C signals in frequencies within the uplink and downlink V-band spectrum of its gateway links. These signals may not be at the band edge but will not cause greater interference or require more protection from harmful interference than the communications traffic on the satellite network.

At this stage, the Intelsat MEO Constellation TT&C facilities have not been identified; therefore, this application omits TT&C information in the Schedule S. If Intelsat identifies the need for TT&C facilities in the United States, Intelsat will submit appropriate applications for those to the Commission.

3.1.7. Cessation of Emissions

The space stations in the Intelsat MEO Constellation will be capable of ceasing radio emissions by commands transmitted from Intelsat ground facilities, thus complying with the Section 25.207 requirement.

3.1.8. PFD Limits

The PFD limits for NGSO space stations operating in the 37.5-42.00 GHz band are specified in Section 25.208 as shown in the Table below. The PFD limits in the 37.5-40.0 GHz band are 12 dB more stringent that those in Article 21 of the RR, while the PFD limits in the 40.0-40.5 GHz and 40.5-42.0 GHz are the same and consistent with Article 21 of the RR.

Band	**Applicable FCC Rule Section**
37.5-40.0 GHz	25.208(r)
40.0-40.5 GHz	25.208(s)
40.5-42.0 GHz	25.208(t)

Table 3. PFD Limits

As shown in the figures below and the Schedule S, the Intelsat MEO Constellation will comply with the PFD limits in Sections 25.208(r), 25.208(s), and 25.208(t).

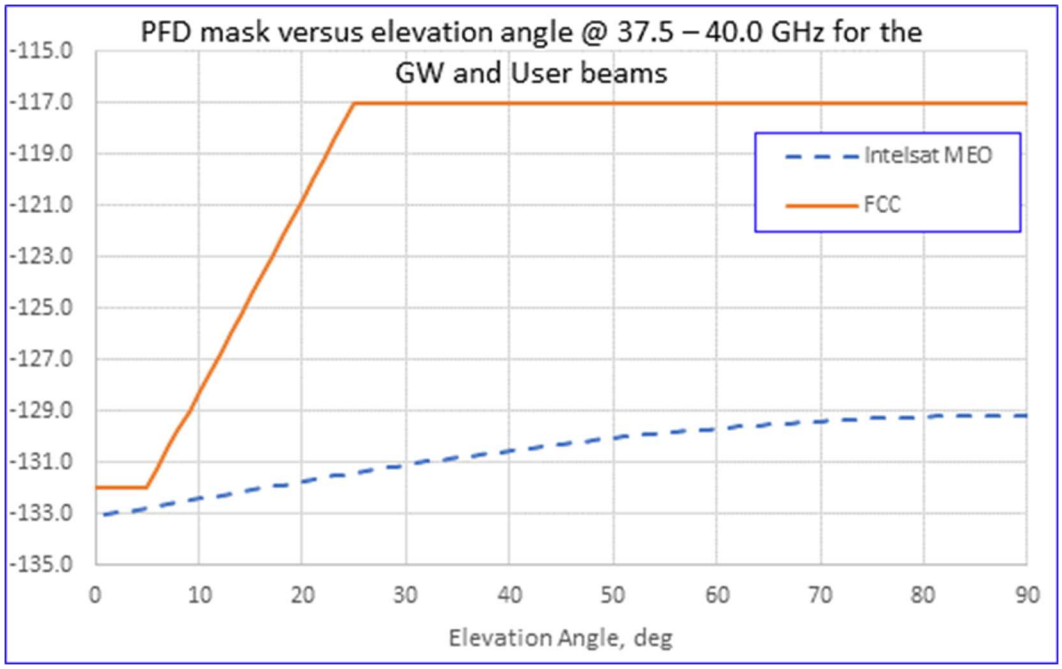

Figure 2. PFD Mask vs. Elevation Angle at 37.5-40.0 GHz for Gateway and User Beams

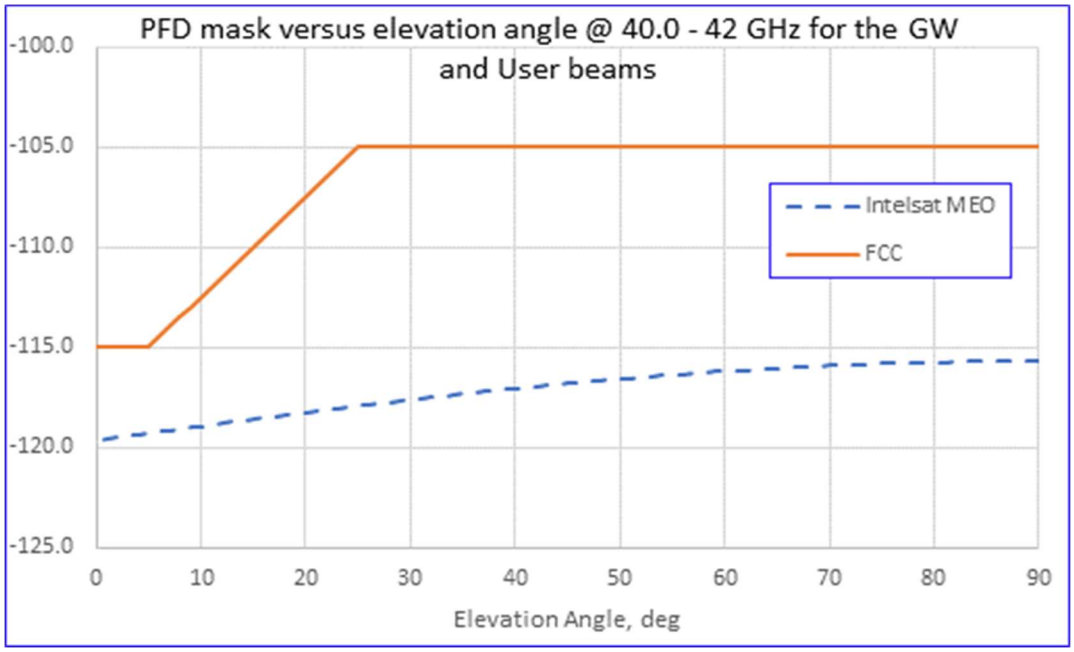

Figure 3. PFD Mask vs. Elevation Angle at 40.0-42.0 GHz for Gateway and User Beams

3.1.9. Protection of GSO Networks

To ensure protection of GSO networks in Ku-band, the ITU has adopted EPFD limits which are provided in ITU RR Article 22 and incorporated by reference into Part 25 of the FCC rules. The applicable single-entry EPFD limits for the proposed Ku-band uplink bands, 12.75-13.25 GHz

and 14.0-14.5 GHz, appear in ITU RR No. 22.5D. The Intelsat MEO Constellation meets the applicable EPFD levels.[8] Additionally, Intelsat commits to working with other NGSO systems operating in these frequency bands to meet the aggregate EPFD limits contained in Resolution 76 of the ITU RR. Intelsat will provide the Commission the results of the ITU finding for its ODYSSEY NGSO-2 filing confirming a favorable finding with respect to the EPFD limits when available.

For the 37.5-42.0 GHz, 47.2-50.2 GHz, and 50.4-51.5 GHz bands requested in this application, instead of EPFD limits, WRC-19 adopted ITU RR Nos. 22.5L and 22.5M that provide, respectively, single entry and aggregate interference criteria for NGSO systems to protect GSO networks.

Resolution 770 (WRC-19) of the ITU RR contains the methodology for determining conformity with the single-entry limits as well as the GSO characteristics to be used in the analysis. To date, the ITU has not created software tools to formally ascertain conformity of NGSO constellations with ITU RR No. 22.5L. Intelsat, therefore, used a beta version of a software developed by Transfinite that is based on the methodology described in Resolution 770 (WRC-19). The results appear in Annex 1 and show that the Intelsat MEO Constellation meets the criteria. Intelsat recognizes that the ITU has not fully validated the software and commits to meeting the limits specified in ITU RR No. 22.5L once the ITU releases validation software.

Resolution 769 (WRC-19) of the RR explains how co-frequency NGSO operations can meet the aggregate limits specified in ITU RR No. 22.5M. The resolution calls for regular consultation meetings among administrations operating or planning to operate NGSO systems in these bands to ensure the aggregate limits are met. Intelsat commits to actively participate in such meetings to ensure that the aggregate limits are met and GSO operations in these bands are protected.

3.2. Technical Requirements for FSS Space Stations

The Intelsat MEO Constellation space stations will employ full frequency reuse either through use of orthogonal polarization or spatially independent beams.

3.3. Procedures for Avoiding In-line Interference Events in NGSO FSS Bands

Intelsat will engage in good faith coordination with NGSO FSS operators authorized to operate in the frequency bands requested in this application consistent with Section 25.261 and the ITU RR. The Intelsat MEO Constellation is designed with flexibility to avoid in-line events with GSO satellite networks, and this flexibility and associated techniques can be applied to avoid in-line events with co-frequency operations of other NGSO FSS systems. Using frequency agility, dual polarization, beam-shaping and power allocation flexibility, geolocation interference detection, advanced monitoring, and multiple available satellites to serve a given location, the

[8] Intelsat also confirmed compliance with EPFD limits using the ITU Radiocommunication Bureau's EPFD software tool. The input data files used in the analysis are provided with this Petition.

Intelsat MEO Constellation provides multiple degrees of freedom to facilitate coexistence with other co-frequency NGSO systems.

Coordination between NGSO systems offers more flexibility compared to the need for NGSOs to protect GSO networks. For example, NGSO systems that operate in the same frequency bands can agree to operate in different frequency bands during in-line events. The specifics of when avoidance of another NGSO system will be required is a complex issue and is directly related to the orbital parameters, technical characteristics, and operational details of the other NGSO FSS systems. Consistent with Section 25.146(e), Intelsat will ensure that the ephemeris data for the Intelsat MEO Constellation will be available to all operators with authorized, in-orbit, co-frequency satellite systems. Intelsat acknowledges that if coordination cannot be achieved between NGSO FSS systems the Commission has adopted a default procedure, Section 25.261(c), that the Intelsat MEO Constellation will follow. Intelsat, however, believes that if NGSO FSS operators engage in good-faith coordination the default procedure will only be required in very limited situations.

4. Orbital Debris Mitigation Plan

The Intelsat MEO Constellation is subject to the direct and effective regulatory oversight of the Federal Republic of Germany. Additionally, in the spirit of transparency, Intelsat provides the following information on how it will mitigate orbital debris to keep a safe and sustainable orbital environment for all.

Intelsat has completed a preliminary assessment on the Intelsat MEO Constellation's orbital debris potential consistent with FCC rules.[9] Intelsat will work with the manufacturer to prioritize orbital debris assessment and mitigation in system design and operations and implement the latest technology to reduce the likelihood for collision, casualty, and explosion at any mission stage. Testing will include a failure mode verification analysis for the TT&C, propulsion, and energy systems, among other features, supporting orbital debris mitigation.

Intelsat is proactive in ensuring safe operation and disposal of all spacecraft under its control. The four elements of debris mitigation are addressed below.

4.1. Spacecraft Hardware Design

The Intelsat MEO Constellation will be designed to avoid the creation of debris during deployment and normal operation. The satellite design shall protect against Micro-Meteoroid flux and impact probability consistent with NASA guidelines and standards. Intelsat will assess and limit the amount of debris released in a planned manner during normal operations.

Intelsat will assess and limit the probability of a satellite in the proposed Intelsat MEO Constellation becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal.

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9 *See* 47 C.F.R. §§ 25.114(d)(14), 25.283.

4.2. Minimizing Accidental Explosions

Intelsat will assess and limit the probability of accidental explosions during and after completion of mission operations. Propellant tanks and thrusters will be designed consistent with standard industry practices. The satellites will be designed such that all energy sources, including chemical, pressure, and kinetic energy, can be removed at end of life by depleting the residual fuel, leaving all fuel line valves open, and venting all pressurized systems. The design will also enable Intelsat to leave all batteries in a permanently discharged state and remove all other remaining stored energy sources.

4.3. Safe Flight Profiles

The Intelsat MEO constellation will operate at an altitude of 8600 km, and Intelsat will continually assess and limit the probability of a satellite becoming a source of debris by collision with large debris or other space vehicles. The orbital parameters, including the apogee, perigee, inclination, and the right ascension of the ascending node of the constellation will be accurately maintained to allow sufficient spacing with other MEO constellations to minimize the risk of collision with other MEO satellites.

Below is the targeted minimum accuracy of each satellite's orbital parameters.

Parameter	**Accuracy**
Apogee	± 10 km
Perigee	± 10 km
Inclination	± 2 deg
Right Ascension of Ascending Node	± 3 deg

Table 3. Minimum Accuracy of Each Satellite's Orbital Parameters.

Intelsat has analyzed NGSO systems filed with the ITU, and the table below provides a list of the filings that are within +/- 100 km altitude of the Intelsat MEO Constellation, *i.e.*, 8500-8700 km.

ITU Filing Name	Administration	Operating Agency	Altitude (km)
THEME	G	OneWeb	8505, 8515, 8525, 8535, 8545, 8555, 8565, 8575
VANGUARD	G	OneWeb	8505, 8515, 8525, 8535, 8545, 8555, 8565, 8575
ZIP	F	OneWeb	8505, 8515, 8525, 8535, 8545, 8555, 8565, 8575
VALVE	F	OneWeb	8505, 8515, 8525, 8535, 8545, 8555, 8565, 8575

Table 4. ITU Filings between 8500 and 8700 km.

For the four filings within +/-100 km of the Intelsat MEO Constellation, the associated operator is OneWeb, and the filings indicate that one plane will be deployed for each of the filed altitudes. The closest altitude of these filings to the Intelsat MEO Constellation is 8575 km, which provides 25 km distance between our respective constellations. Intelsat believes that the 25 km distance between the constellations is sufficient to successfully coordinate with OneWeb. Intelsat will work with OneWeb and other NGSO operators of future ITU filings to coordinate flight safety operations as necessary.

4.3.1. Post-Mission Disposal

Intelsat will follow industry standards in determining the sufficient amount of fuel to reserve for the post-mission disposal maneuvers of Intelsat MEO Constellation satellites. Intelsat plans to maneuver the satellites to a near-circular disposal orbit at 8,900 km. This disposal orbit avoids crossing the GSO zone (20,182 +/- 300 km) and the LEO zone (2,000 km) for at least 100 years. This orbit also limits the risk to other operational and filed NGSO constellations as described below.[10]

Intelsat has analyzed NGSO systems filed with the ITU that are within +/- 100 km altitude of the Intelsat MEO Constellation's graveyard orbit of 8900 km, *i.e.*, 8800-9000 km.

ITU Filing Name	Administration	Operating Agency	Altitude (km)
O3B-C	G	O3b	9000
O3B-D	G	O3b	9000

Table 5. ITU Filings between 8800 and 8900 km.

As shown in the table for the two filings that are within +/-100 km of the Intelsat MEO Constellation graveyard orbit, the operator is O3b. The altitude of these filings is 9000 km, which provides 100 km distance between the O3b constellation and the planned Intelsat MEO Constellation satellite graveyard orbit. Intelsat believes that a 100 km distance is sufficient and that this distance will not cause any operational constraints to the O3b system once the Intelsat MEO Constellation satellites are placed in the graveyard orbit. However, Intelsat is prepared to enter into discussion and provide information on the status of the Intelsat MEO Constellation satellites in the graveyard orbit as needed. Intelsat will also coordinate with any operators with known deorbit altitudes +/- 100 km of 8900 km.

[10] This plan is consistent with U.S. orbital debris policy. *See* U.S. Government Orbital Debris Mitigation Standard Practices, November 2019 Update, at 5-6, *available at* https://orbitaldebris.jsc.nasa.gov/library/usg_orbital_debris_mitigation_standard_practices_november_2019.pdf.

Certification Statement

I hereby certify that I am a technically qualified person and am familiar with Part 25 of the Commission's rules. The contents of this engineering statement were prepared by me or under my direct supervision and to the best of my knowledge are complete and accurate.

/s/ Giselle Creeser
Giselle Creeser
Director, Spectrum Policy and
Engineering, Intelsat US LLC
On behalf of Intelsat License LLC

November 4, 2021
Date

ANNEX 1
PROTECTION OF GSO NETWORKS

This Annex demonstrates that Intelsat MEO Constellation operations will satisfy –

- single-entry EPFD limits in ITU RR No. 22.5D for Ku-band (Earth-to-space) spectrum.
- single-entry criteria in ITU RR No. 22.5L for V-band (Earth-to-space and space-to-Earth) spectrum.

The Intelsat MEO Constellation is designed with the flexibility to ensure protection of GSO operations. For example, the Intelsat MEO Constellation will employ an orbital arc avoidance of 5 degrees, which will require its earth stations to cease transmissions when the topocentric angle between an Intelsat MEO Constellation satellite and an associated earth station is less than or equal to 5 degrees from the GSO arc. Similarly, the angle between an Intelsat MEO Constellation satellite and the GSO arc, as seen from any point on the Earth, will be greater than or equal to 5 degrees.

1. Compliance with single-entry EPFD limits for Ku-band spectrum

ITU RR No. 22.5D provides for a Ku-band EPFD↑ limit of -160 dBW/m^2/40 kHz that NGSO systems need to meet 100% of the time to protect GSO space stations. The Ku-band limit applies to the 12.5-12.75 GHz, 12.75-13.25 GHz, and 14.0-14.5 GHz uplink frequency bands used in the Intelsat MEO constellation. Intelsat analyzed the Intelsat MEO Constellation's compliance with ITU RR No. 22.5D using the Visualyse EPFD software program, which is based on ITU-R Recommendation S.1503.

The characteristics of the GSO space station receive antenna used in the analysis are those contained in ITU RR Table 22-2. The Visualyse EPFD software selects the frequency and location of the GSO earth station that results in the worst-case interference, which is understood as giving the highest single entry EPFD or, if there is more than one location with equally high single entry EPFD, the location that has the highest EPFD for the longest period of time. For the Intelsat MEO Constellation, the highest single entry EPFD is the 12.5 GHz frequency because as the frequency increases the earth station antenna performance improves and the resultant EPFD reduces. Figure 1 shows the uplink EPFD results for the Intelsat MEO Constellation obtained with Visualyse EPFD software, and the limit called out in ITU RR No. 22.5D is shown by the red line.

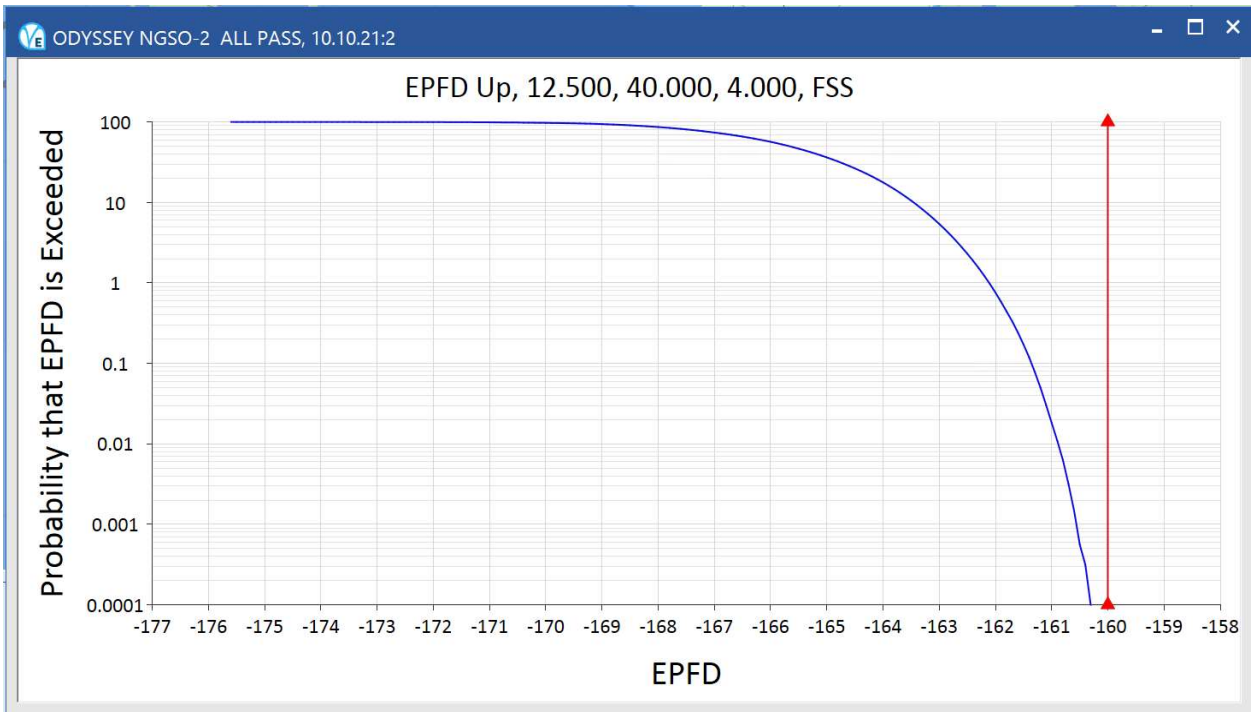

Figure 1. 12.5 GHz, 40 kHz Reference Bandwidth

The Intelsat MEO Constellation ITU filing submitted to the Radiocommunication Bureau passed using the ITU EPFD validation software, and Intelsat will provide the Commission the results confirming a favorable finding with respect to the EPFD limits when available.

2. Compliance with single-entry criteria for V-band spectrum

As described in the Engineering Statement, WRC-19 adopted technical and regulatory provisions for the protection of GSO networks from NGSO FSS systems. The criteria are based on the impact of the C/N and spectral efficiency of GSO network links using generic GSO reference links. The methodology for this assessment is contained in Resolution 770 (WRC-19). To date, no ITU software tools exist to formally ascertain conformity of NGSO constellations with ITU RR No. 22.5L. Intelsat, therefore, used a beta version of software developed by Transfinite that is based on the methodology described in Resolution 770 (WRC-19). The results show that the current design of the Intelsat MEO Constellation meets the relevant criteria. Intelsat expects the deployed system will meet the limits specified in ITU RR No. 22.5L once the ITU releases validation software.

2.1. V-band Uplink

As an exemplar, Intelsat evaluated the Intelsat MEO Constellation V-band uplink spectrum (47.2-50.2 and 50.4-51.4 GHz) using the 0.2° GSO satellite antenna beamwidth and ITU-R S.672 antenna pattern included in Resolution 770 (WRC-19).

Other inputs to the beta software included 1000 km as the average distance between cells, 0.000001/km^2 as the average earth station density, and two as the maximum number of NGSO

satellites receiving simultaneously with overlapping frequencies from an associated earth station within a given cell. As mentioned above, ITU RR No. 22.5L has two criteria for the GSO link: one allows a single-entry increase of the C/N, and the other allows a single-entry reduction in spectral efficiency. Figure 3 provides the results of the simulation using the beta software for the reference link budget in Resolution 770 (WRC-19) as a function of rain fade for the 0.2° beamwidth antenna. This figure demonstrates that the Intelsat MEO Constellation V-band uplink operations meet the 3% criteria level for the 0.2° beamwidth GSO space station antenna.

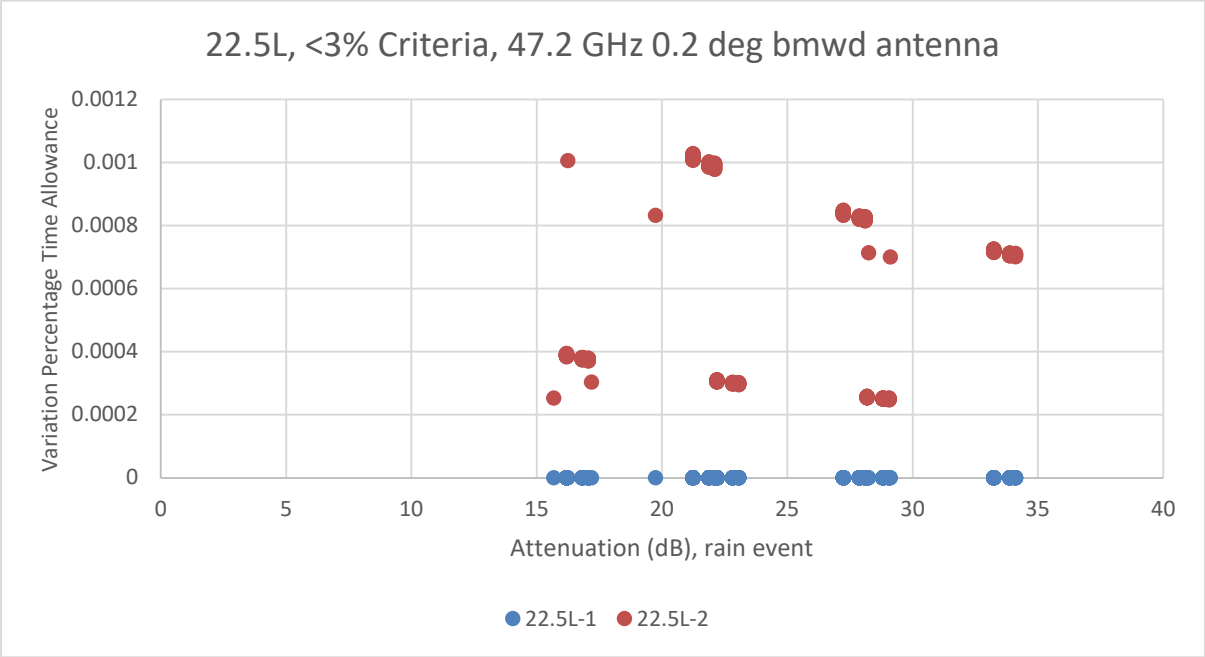

Figure 2. Variation in Percentage of Time Allowance for 22.5L-1 (C/N) Criteria and 22.5L-2 (spectral efficiency) Criteria for the 0.2° Beamwidth GSO Antenna

2.2. V-band Downlink

Intelsat analyzed the Intelsat MEO Constellation V-band downlink spectrum (37.5-42.5 GHz), using the GSO FSS 0.45m and 2.0m receive earth station antennas and the ITU-R S.1428 antenna gain pattern included in ITU-R Resolution 770 (WRC-19). A PFD mask in the alfa and delta longitude format consistent with PFD mask Option 1 of ITU-R Recommendation S.1503-2 was used.

Figures 3 and 4 provide the results of the simulation using the beta software for each of the reference link budgets defined in Resolution 770 (WRC-19) as a function of rain fade for the 0.45m and 2m antennas. These figures demonstrate that the Intelsat MEO Constellation downlink V-band operations meet the 3% criteria level for the 0.45m and 2m GSO earth station antennas.

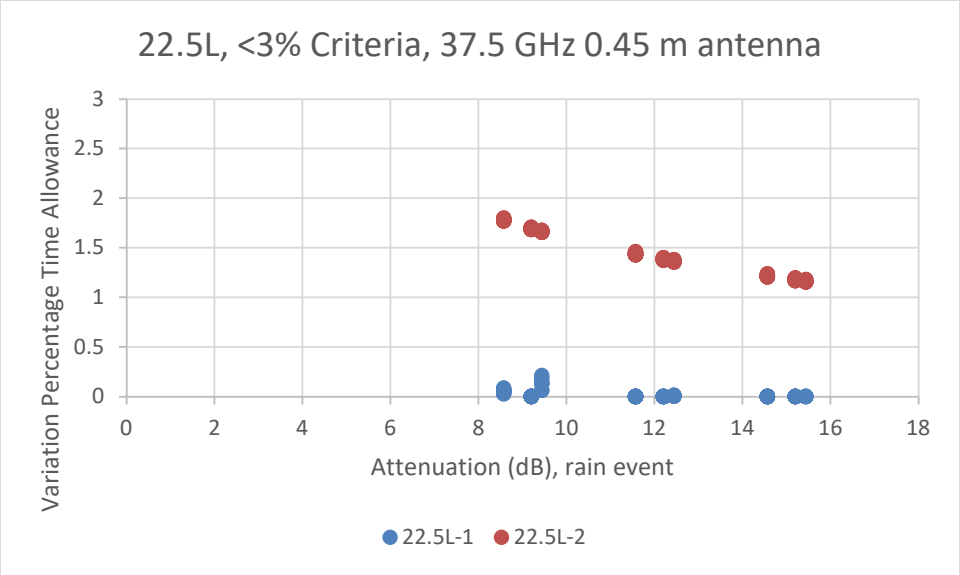

Figure 3. Variation in Percentage of Time Allowance for 22.5L-1 (C/N) Criteria and 22.5L-2 (spectral efficiency) Criteria for the .45m Antenna

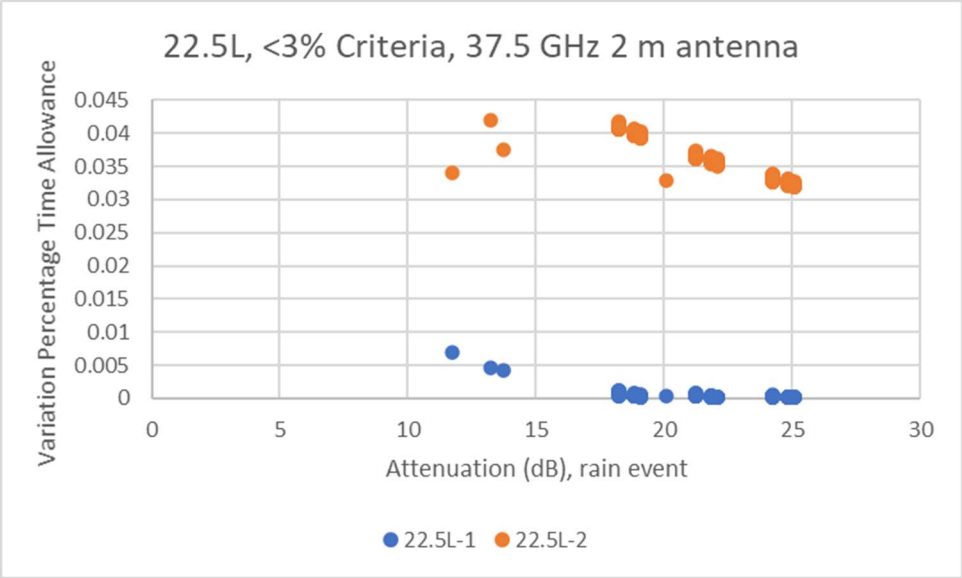

Figure 4. Variation in Percentage of Time Allowance for 22.5L-1 (C/N) Criteria and 22.5L-2 (spectral efficiency) Criteria for the 2m Antenna

3. Input Files for the Simulations

To allow interested parties to confirm these results, Intelsat is providing the following files in this application:

- PFD masks for uplink and downlink[1]
    - In xml format, named: mask ntc_id 1 mask_id XXX.xml
    -
    - In mdb format, named: 2021-10-10 Odyssey NGSO-2_masks.mdb
- SRS mdb file that contains the constellation parameters for the 8600 km altitude
    - In mdb format, named: 2021-10-10 Odyssey NGSO-2.mdb

[1] Please note that the attachment provided with this Petition contains all files.