Engineering Statement

1 Introduction

Intelsat License LLC ("Intelsat") seeks authority in this application to redeploy Horizons 2 (Call Sign S2423) to 73.8° W.L. (286.2° E.L).

The characteristics of the Horizons 2 satellite, as well as its compliance with the various provisions of Part 25 of the Federal Communications Commission's ("FCC" or "Commission") rules, are provided in this Engineering Statement, which also provides the beam gain contours at the 73.8° W.L. orbital location. In all other respects, the characteristics of Horizons 2 are the same as those described in SAT-MOD-20110928-00190.

2 Satellite Overview

Horizons 2 is a Northrop Grumman Innovation System GeoStar-2.3 satellite capable of operating in the Ku-band frequencies listed below:

Direction	Frequency
Uplink	14000-14500 MHz
Downlink	11700-12200 MHz

At the 73.8° W.L. orbital location the satellite will provide the following coverage:

Beam	Coverage
Boomerang Beam	Western part of the Contiguous United States ("CONUS"), Canada, Mexico, and western parts of Caribbean
CONUS Beam	CONUS, Canada, Mexico, and the Caribbean

2.1 Satellite Characteristics

Horizons 2 is a three-axis stabilized type satellite that has a rectangular outer body structure. The satellite utilizes two deployable solar array wings and two Ku band antennas.

The satellite is composed of the following subsystems:

- Thermal;
- Power;
- Attitude Control;
- Propulsion;
- Telemetry, Command, and Ranging (TC&R);
- Uplink Power Control; and
- Communications.

These subsystems maintain the correct position and attitude of the satellite; ensure that all internal units are maintained within the required temperature range; and ensure that the satellite can be commanded and controlled with a high level of reliability from launch to the end of its useful life. The satellite design incorporates redundancy in all of the various subsystems in order to avoid single-point failures.

The structural design of Horizons 2 provides mechanical support for all subsystems. The structure supports the communication antennas, solar arrays, and thrusters. It also provides a stable platform for preserving the alignment of critical elements of the satellite.

2.2 Communication Subsystem

Horizons 2 provides active communication channels with channel bandwidths of 36 MHz and/or 72 MHz. The Horizons 2 frequencies, polarization, and channel plan are provided in the Schedule S.

The coverage contours and performance characteristics of the Horizons 2 beams are provided in the Schedule S.

Exhibits 1 and 2 provide the beam parameters for the Horizons 2 uplink and downlink beams, respectively.

Horizons 2 is equipped with one steerable Ku-band beam. Gain contours for this beam is provided in Schedule S. This steerable beam may be pointed toward any location on the earth that is visible from 73.8° W.L. Regardless of pointing, the coverage contours remain identical in gain and roll-off. Intelsat will ensure that transmissions in these beams are consistent with the relevant Commission rules and International Telecommunication Union ("ITU") Radio Regulations.

2.3 TC&R Subsystem

The TC&R subsystem provides the following functions:

1) Acquisition, processing, and transmission of satellite telemetry data;

2) Reception and retransmission of ground station generated ranging signals; and

3) Reception, processing, and distribution of telecommands.

The satellite's command and telemetry channel frequencies are shown in Exhibit 3. The coverage patterns of the command and telemetry beams have gain contours that vary by less than 8 dB across the surface of the Earth, and accordingly the gain at 8 dB below the peak falls beyond the edge of the Earth. Therefore, pursuant to Section 25.114(c)(4)(vi)(A) of the FCC's rules, contours for these beams are not required to be provided and the associated GXT files have not been included in Schedule S. The Horizons 2 command and telemetry subsystem performance is summarized in Exhibit 3.

2.4 Uplink Power Control Subsystem

Horizons 2 utilizes two Ku-band channels for uplink power control ("ULPC"), antenna tracking, and ranging. The coverage patterns of the ULPC beams have gain contours that vary by less than 8 dB across the surface of the Earth, and accordingly the gain at 8 dB below the peak falls beyond the edge of the Earth. Therefore, pursuant to Section 25.114(c)(4)(vi)(A) of the FCC's rules, contours for these beams are not required to be provided and the associated GXT files are not included in Schedule S. The Horizons 2 ULPC frequencies and subsystem performance are summarized in Exhibit 3.

2.5 Satellite Station-Keeping

In compliance with Section 25.210(j) of the Commission's rules, the satellite will be maintained within 0.05° of its nominal longitudinal position in the east-west direction.

The attitude of the satellite will be maintained with accuracy consistent with the achievement of the specified communications performance, after taking into account all error sources (i.e., attitude perturbations, thermal distortions, misalignments, orbital tolerances and thruster perturbations, etc.).

3 Services

Horizons 2 is a general-purpose communications satellite and has been designed to support various services offered within the Intelsat satellite system. Depending upon the needs of the users, the transponders on Horizons 2 can accommodate television, radio, voice, and data communications. Typical communication services include:

a) Compressed digital video;

b) High speed digital data; and

c) Digital single channel per carrier data channels.

Bandwidths for representative communication carriers are provided in Schedule S.

4 Power Flux Density

The power flux density ("PFD") limit for Horizons 2 is compliant with Section 25.208 of the Commission's rules and in No. 21.16 of the ITU Radio Regulations.

5 Emission Compliance

Section 25.202(e) of the Commission's rules requires that the carrier frequency of each space station transmitter be maintained within 0.002% of the reference frequency. Horizons 2 is designed to be compliant with the provisions of this rule.

Intelsat will comply with the provisions of Section 25.202(f) of the Commission's rules with regard to Horizons 2 emissions.

6 Orbital Location

Intelsat requests that it be assigned the 286.2° E.L./73.8° W.L. orbital location for the Horizons 2 satellite. The 73.8° W.L. location satisfies Horizons 2 requirements for optimizing coverage, elevation angles, and service availability. Additionally, the location also ensures that the maximum operational, economic, and public interest benefits will be derived from the operation of Horizons 2.

The Schedule S software automatically rounded the requested 73.8° W.L. location to 74.0°W.L

7 ITU Filling

Horizons 2 operations in the 11700-12200 MHz and 14000-14500 MHz frequency bands will operate under the United States Administration's ITU filing USASAT-55E-2 at 74W.

8 Coordination with Co-frequency Space Stations

The downlink equivalent isotropically radiated power ("EIRP") density of Horizons 2 transmissions in the conventional or extended Ku-bands will not exceed 14 dBW/4kHz for digital transmissions or 17 dBW/4kHz for analog transmissions, and associated uplink transmissions will not exceed applicable EIRP density envelopes in Section 25.218 unless the non-routine uplink and/or downlink operation is coordinated with operators of authorized co-frequency space stations at assigned locations within six degrees of Horizons 2 at 73.8° W.L.

Given the above, the uplink frequency band 14000-14500 MHz; and the downlink frequency band 11700-12200 MHz do not require an interference analysis or 2-degree spacing analysis under Section 25.140 of the Commission's rules.

In all cases, Intelsat will comply with all executed operator-to-operator agreements for the 73.8° W.L. orbital location.

9 Orbital Debris Mitigation Plan

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

9.1 Satellite Hardware Design

Horizons 2 is designed such that no debris will be released during normal operations. Intelsat has assessed the probability of collision with meteoroids and other debris. In order to limit the effects of such unlikely collisions critical satellite components are located inside the protective body of the satellite and are properly shielded. The satellite does not use any subsystems for end-of-life disposal that are not used for normal operations.

9.2 Minimizing Accidental Explosions

The manufacturer has assessed the probability of accidental explosions during and after completion of mission operations. The satellite is designed in a manner to minimize the potential for such explosions. Propellant tanks and thrusters are isolated using redundant valves and electrical power systems are shielded in accordance with standard industry practices. At the completion of the mission and upon disposal of the satellite, Intelsat will ensure the removal of all stored energy on the satellite by depleting all propellant tanks, venting all pressurized systems and by leaving the batteries in a permanent discharge state.

9.3 Safe Flight Profiles

Intelsat has assessed and limited the probability of the satellite becoming a source of debris as a result of collisions with large debris or other operational satellites.

During the relocation of Horizons 2, Intelsat will take all the necessary steps to coordinate the move to minimize the risk of collision or interference between Horizons 2 and any other satellites. Intelsat is not aware of any FCC licensed satellites, or any other satellites applied for and under consideration by the FCC, that will have an overlapping station-keeping volume with Horizons 2. Intelsat is also not aware of any ITU filed satellite with an overlapping station-keeping volume with Horizons 2 that is either in orbit or progressing towards launch.

9.4 Post Mission Disposal

At the end of the mission, Intelsat will dispose of the spacecraft by moving it to an altitude of at least 280 kilometers above the geostationary arc. Intelsat has reserved 34.9 kilograms of fuel for that purpose.

In calculating the disposal orbit, Intelsat has used simplifying assumptions as permitted under the Commission's Orbital Debris Report and Order.[1] The effective area to mass ratio (Cr*A/M) of Horizons 2 spacecraft is 0.038 m^2/kg, resulting in a minimum perigee disposal altitude under the Inter-Agency Space Debris Coordination Committee formula of 280 kilometers above the geostationary arc. Accordingly, the Horizons 2 planned disposal orbit complies with the FCC's rules.

The reserved fuel figure in the propellant budget was determined by Intelsat based on manufacturer document and flight data. This calculation takes into account the expected mass of the satellite at the end of life and the required delta-velocity to achieve the desired orbit. The fuel gauging uncertainty has been taken into account in these calculations.

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[1] *Mitigation of Orbital Debris*, Second Report and Order, 19 FCC Rcd 11567 (2004).

The reserved fuel figure was determined by the satellite manufacturer and provided for in the propellant budget. This figure was calculated taking into account the expected mass of the satellite at the end of life and the required delta-velocity to achieve the desired orbit. The fuel gauging uncertainty has been taken into account in these calculations.

10 TC&R Control Earth Stations

Intelsat will conduct TC&R operations through one or more of the following earth stations: Napa, Riverside, California; Castle Rock, Colorado; Mountainside, Maryland; and Atlanta, Georgia. Additionally, Intelsat is capable of remotely controlling Horizons 2 from its facilities in McLean, VA or in Long Beach, CA.

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

Intelsat
Director Spectrum Policy,
Engineering

January 14, 2020

Date

EXHIBIT 1

COMMUNICATION SUBSYSTEM UPLINK BEAM PARAMETERS

Beam Name	**Ku CONUS**	**Ku CONUS**	**Boomerang**
Schedule S Beam ID	NAVU	NAHU	BMHU
Frequency Band (MHz)	14000 - 14500	14000 - 14500	14000 - 14500
Polarization	Vertical	Horizontal	Horizontal
G/T (dB/K)	8.2	8.3	8.5
Minimum SFD-- (dBW/m^2)	-105.1	-105.1	-105.1
Maximum SFD-- (dBW/m^2)	-80.1	-80.1	-80.1

EXHIBIT 2

COMMUNICATION SUBSYSTEM DOWNLINK BEAM PARAMETERS

Beam Name	Ku CONUS	Ku CONUS	Boomerang
Schedule S Beam ID	NAVD	NAHD	BMVD
Frequency Band (MHz)	11700 - 12200	11700 - 12200	11700 - 12200
Polarization	Vertical	Horizontal	Vertical
Maximum Beam Peak EIRP (dBW)	53.6	50.9	54.9
Maximum Beam Peak EIRP Density (dBW/4kHz)	14.1	11.4	15.4
Maximum Beam Peak EIRP Density (dBW/Hz)	-22.0	-24.7	-20.7

EXHIBIT 3

TC&R SUBSYSTEM CHARACTERISTICS

Beam Name	Command Dish	Command Omni	Command Dish	Command Omni
Schedule S Beam ID	CMDH	CMDV	CMDL	CMLD
Frequencies (MHz)	14000.5	14499.5	14000.5	14499.5
Polarization	Horizontal	Vertical	LHCP	LHCP
Peak Flux Density at Command Threshold (dBW/m^2-Hz)	-90	-90	-90	-90

Beam Name	Telemetry Dish	Telemetry Dish	Telemetry Omni	Telemetry Omni	ULPC	ULPC
Schedule S Beam ID	TLMD	TLMH	TLMF	TLMG	ULC1	ULC2
Frequencies (MHz)	12196.00	12198.63	12196.00	12198.63	11701.5	12198
Polarization	Horizontal	Horizontal	RHCP	RHCP	Vertical	Horizontal
Maximum Channel EIRP (dBW)	14.0	11.4	14.0	11.4	17.1	15.5
Maximum Beam Peak EIRP Density (dBW/4kHz)	-7.0	-9.6	-7.0	-9.6	9.1	7.5
Maximum Beam Peak EIRP Density (dBW/Hz)	-43.0	-45.6	-43.0	-45.6	-26.9	-28.5

Note: *RHCP: Right Hand Circular Polarization, LHCP: Left Hand Circular Polarization*

Beam Polarizations and GXT File Names

	Schedule S Beam Names							
	Linear Polarization				Circular Polarization			
Beam Designation	**Uplink (H-Pol.)**	**Uplink (V-Pol.)**	**Downlink (H-Pol.)**	**Downlink (V-Pol.)**	**Uplink (LHCP)**	**Uplink (RHCP)**	**Downlink (LHCP)**	**Downlink (RHCP)**
Ku-Band Beams								
Ku CONUS	NAHU	NAVU	NAHD	NAVD	----	----	----	----
Boomerang	BMHU	----	----	BMVD	----	----	----	----
Command Dish	CMDH	----	----	----	CMDL	----	----	----
Command Omni	----	CMDV	----	----	CMLD	----	----	----
Telemetry Dish	----	----	TLMD & TLMH	----	----	----	----	----
Telemetry Omni	----	----	----	----	----	----	----	TLMF & TLMG
Ku-band ULPC	----	----	ULC2*	ULC1*	----	----	----	----

** GXT files are not provided for the indicated beams because their -8 dB gain contours extend beyond the edge of the Earth*