Engineering Statement

1 Introduction

Intelsat License LLC ("Intelsat") seeks Federal Communications Commission's ("FCC or "Commission") authorization for the Spanish-licensed HISPASAT 143W-1 spacecraft (Call Sign S2476) to serve the United States from the 143º W.L. (217° E.L.) orbital location. The satellite is registered in the United Nations Register of Objects Launched into Outer Space under the administration of Spain.[1]

The characteristics of the HISPASAT 143W-1 satellite, as well as its compliance with the various provisions of Part 25 of the Commission's rules, are provided in the remainder of this Engineering Statement. In all other respects, the characteristics of HISPASAT 143W-1 are the same as those described in a previous grant of market access.[2]

2 Satellite Overview

HISPASAT 143W-1 is an Alcatel Space model SPACEBUS-3000B satellite that is capable of operating in the Ku-band and broadcast-satellite service ("BSS") Feeder Link band frequencies listed below:

Direction	Frequency
Uplink	13750-14000 MHz
	14000-14500 MHz
	17300-17800 MHz
Downlink	11450-11700 MHz
	11700-12200 MHz
	12200-12750 MHz

[1] *See* Note Verbale from the Permanent Mission of Spain to the United Nations (Vienna) addressed to the Secretary-General (Jul. 28, 2008), *available at* https://www.unoosa.org/documents/pdf/ser531Ea.pdf.

[2] *Petition for Declaratory Ruling to Add HISPASAT-1D Satellite at 30º W.L to the Permitted Space Station List*, File No. SAT-PDR-20030430-00090 (Apr. 30, 2003).

Telemetry commanding and ranging ("TC&R") will be performed in the following center frequencies: 2072.7958 MHz (back-up) and 14498.7 MHz at (Earth-to-space); and 12749.75 MHz (back-up), 2251 MHz, and 11700 MHz (space-to-Earth).

At the 143° W.L. orbital location the satellite will provide coverage of the continental United States ("CONUS"), western parts of Mexico and Canada, as well large parts of the Pacific Ocean, including Alaska and Hawaii.

2.1 Satellite Characteristics

HISPASAT 143W-1 is a three-axis stabilized type satellite that has a rectangular outer body structure and utilizes two deployable solar array wings and a number of deployable and non-deployable antennas.

The HISPASAT 143W-1 satellite is composed of the following subsystems:

- Thermal
- Power
- Attitude Control
- Propulsion
- Telemetry, Commanding and Ranging
- Uplink Power Control
- 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 various subsystems in order to avoid single-point failures.

The structural design of HISPASAT 143W-1 provides mechanical support for all subsystems. The structure supports the communication antennas, solar arrays, and the thrusters. It also provides a stable platform for preserving the alignment of critical elements of the satellite.

2.2 Communication Subsystem

HISPASAT 143W-1 provides active communication channels in Ku-band frequencies. The active communication channels have bandwidths of 33 MHz, 36 MHz, 42 MHz, 46 MHz, 50 MHz, 54 MHz, and 72 MHz. The HISPASAT 143W-1 frequencies, polarization, and channel plan are provided in the Schedule S.

The coverage contours and performance characteristics of all HISPASAT 143W-1 beams are provided in the Schedule S. Exhibits 1 and 2 provide the beam parameters for the HISPASAT 143W-1 uplink and downlink beams, respectively.

2.3 Telemetry, Command and Ranging 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 HISPASAT 143W-1 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 contour at 8 dB below peak falls entirely beyond the edge of the visible 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 the GIMS container file. The HISPASAT 143W-1 command and telemetry subsystem performance is summarized in Exhibit 3.

2.4 Tracking and Beacon Subsystem

HISPASAT 143W-1 utilizes one Ku-band channel for antenna tracking and ranging. The coverage patterns of the UPKC and UPKD beacons 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 HISPASAT 143W-1 beacon frequencies and subsystem performance are summarized in Exhibit 3.

2.5 Satellite Station-Keeping

The satellite will be maintained within 0.1° 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

HISPASAT 143W-1 is a general-purpose communications satellite and has been designed to support various services. Depending upon the needs of the users, the transponders on HISPASAT 143W-1 can accommodate data communications, including mobility services. Typical communication services include:

a) Compressed digital video

b) High speed digital data

c) Digital single channel per carrier ("SCPC") data channels

Emission designators and allocated bandwidths for representative communication carriers are provided in Schedule S.

4 Power Flux Density

The power flux density ("PFD") limits for space stations operating in the 11450-11700 MHz and 12200-12750 MHz bands are specified in Section 25.208 of the Commission's rules.

The PFD levels for the HISPASAT 143W-1 transmissions were calculated for the 11450-11700 MHz and 12200-12750 MHz bands. The results are provided in Schedule S and demonstrate that the downlink power flux density levels of the HISPASAT 143W-1 carriers do not exceed the limits specified in Section 25.208 of the Commission's rules or those specified in No. 21.16 of the International Telecommunication Union ("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. HISPASAT 143W-1 is compliant with the provisions of this rule.

HISPASAT 143W-1 emissions will comply with the provisions of Section 25.202(f) of the Commission's rules with respect to emission limitations.

6 Orbital Location

HISPASAT 143W-1 will operate at the 143° W.L. orbital location. This orbital location satisfies Intelsat's 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.

7 ITU Filings

HISPASAT 143W-1 operations in the 2072.3958-2073.1958 MHz, 2250.7-2251.3 MHz, 11450-11700 MHz, 11700-12200 MHz, 13750-14000 MHz, and 14000-14500 MHz frequency bands will be pursuant to the UKNETSAT-143W satellite network filing of the administration of the United Kingdom.

HISPASAT 143W-1 operations in the 17300-17800 MHz band and the planned BSS band 12200-12700 MHz (Region 2) will be pursuant to the INTELSAT KUEXT 143W satellite network filings of the administration of the United Kingdom.

Both satellite network filings listed above are currently under review by Ofcom and will be submitted to the Radio Bureau in December 2019.

8 Coordination with Co-frequency Space Stations

The downlink EIRP density of the satellite's transmissions in the conventional or extended Ku-bands will not exceed 14 dBW/4kHz for digital transmissions and 17 dBW/4kHz for analog transmissions Associated uplink transmissions will not exceed applicable EIRP density envelopes in Sections 25.218, 25.222(a)(1), 25.226(a)(1), or 25.227(a)(1) of the Commission's rules 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 HISPASAT 143W-1 at 143° W.L.

Given the above, the 14000-14500 MHz uplink frequency band and the 11450-11700 MHz and 11700-12200 MHz downlink frequency bands do not require any interference analysis under the Commission's rules. In all cases, Intelsat will comply with the applicable coordination agreements for 143° W.L.

As for the 12200-12700 MHz BSS frequency band and the associated 17300-17800 MHz feeder link band, there is no potential for harmful interference from HISPASAT 143W-1 into any BSS satellite networks. The closest operational U.S. BSS satellite network is 24º away and the closest operational non-U.S. BSS satellite network (Canadian) is 14º away. In both cases, the orbital

separation is greater than the typical 9º orbital separation prescribed in the ITU Radio Regulations. Additionally, there are no active Mexican BSS satellite networks within +/- 9º of the 143º W.L. orbital position.

9 Orbital Debris Mitigation Plan

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

9.1 Satellite Hardware Design

The satellite is designed such that no debris will be released during normal operations. The HISPASAT 143W-1 design incorporates the following elements to limit the effects of collision with small debris: (1) critical satellite components are located inside the protective body of the satellite; and (2) satellite subsystems have redundant components to minimize single-point failures. 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 probability of accidental explosions during and after completion of mission operations has been assessed. HISPASAT 143W-1 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.

9.3 Safe Flight Profiles

Intelsat has assessed and limited the probability of the HISPASAT 143W-1 space station becoming a source of debris as a result of collision with large debris or other operational space stations at 143° W.L.

Further, Intelsat is not aware of any other FCC-licensed system, or any other system applied for and under consideration by the FCC, having an overlapping station-keeping volume with HISPASAT 143W-1 at 143.0° W.L. Additionally, Intelsat is not aware of any system with an

overlapping station-keeping volume with HISPASAT 143W-1 at 143.0° W.L. that is the subject of an ITU filing and that is either in orbit or progressing toward launch.

9.4 Post Mission Disposal

The deorbit of HISPASAT 143W-1 will follow the ITU guidelines for post-mission disposal maneuvers. At the end of the mission, HISPASAT 143W-1 will be disposed by moving it to an altitude of 290 kilometers above the geostationary arc.[3] For that purpose, 6.6 kilograms of hydrazine have been reserved. 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

Hispasat will conduct TC&R operations for the satellite via VPN connection to Intelsat earth stations located in Mountainside, Maryland; Castle Rock, Colorado; Paumalu, Hawaii; or Riverside, California. Intelsat retains the ability to terminate the antennas' command and ranging uplinks at any time, without the consent of Hispasat.

[3] In calculating the disposal orbit, simplifying assumptions have been used as permitted under the Commission's Orbital Debris Report and Order. *Mitigation of Orbital Debris*, Second Report and Order, IB Docket No. 02-54, FCC 04-130 (rel. June 21, 2004). For reference, the effective area to mass ratio (Cr*A/M) of the HISPASAT 143W-1 satellite is 0.055 m^2/kg, resulting in a minimum perigee disposal altitude under the Inter-Agency Space Debris Coordination Committee formula of at most 290 kilometers above the geostationary arc.

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	December 4, 2019
	Date

Intelsat
Director, Spectrum Policy &
Engineering

EXHIBIT 1

COMMUNICATION SUBSYSTEM UPLINK BEAM PARAMETERS

Beam Name	Europe Ku Beam	Europe Ku Beam	Europe BSS Feeder Link Beam	Americas Uplink Beam	Americas Uplink Beam
Schedule S Beam ID	EUHU	EUVU	EKHU	AMHU	AMVU
Frequency Band (MHz)	14000-14500	13750-14500	17300-17800	14000-14250	13750-14000 14250-14500
Polarization	Horizontal	Vertical	Horizontal	Horizontal	Vertical
Beam Peak G/T (dB/K)	12.17	12.17	12.17	4.63	4.63
Minimum SFD at Beam Peak (dBW/m^2)	-102	-102	-102	-97	-97
Maximum SFD at Beam Peak (dBW/m^2)	-84	-84	-84	-79	-79

EXHIBIT 2

COMMUNICATION SUBSYSTEM DOWNLINK BEAM PARAMETERS

Beam Name	Europe Ku Beam H	Europe Ku Beam V	Americas Downlink H	Americas Downlink V
Schedule S Beam ID	EUHD EBHD	EUVD EBVD	AMHD	AMVD
Frequency Band (MHz)	11450-11700 12500-12750	11450-11700 12200-12750	11950-12200	11700-11950
Polarization	Horizontal	Vertical	Horizontal	Vertical
Maximum Beam Peak EIRP (dBW)	52.9	52.9	48.43	48.43
Maximum Beam Peak EIRP Density (dBW/4kHz)	13.4	13.4	8.9	8.9

EXHIBIT 3
TC&R SUBSYSTEM CHARACTERISTICS
Telecommand Carriers

Beam Name	Ku Beam	S Beam	S Beam
Schedule S Beam ID	CMGJ	CMDO	CMDG
Frequencies (MHz)	14498.7	2072.796	2072.796
Polarization	Vertical	RHCP	LHCP
Peak Flux Density at Command Threshold (dBW/m^2)	-92	-90	-90

Telemetry Carriers

Beam Name	S Beam	S Beam	Ku Beam
Schedule S Beam ID	TLMJ	TLMO	TLMG
Frequencies (MHz)	2251	2251	12749.758
Polarization	RHCP	LHCP	Vertical
Maximum Channel EIRP (dBW)	5.76	5.76	19
Maximum Beam Peak EIRP Density (dBW/4kHz)	-12.2	-12.2	1
Maximum Beam Peak EIRP Density (dBW/Hz)	-48.2	-48.2	-35

Tracking Beacons

Beam Name	Ku Beam	Ku Beam
Schedule S Beam ID	UPKC	UPKD
Frequencies (MHz)	11700	11700
Polarization	Horizontal	Vertical
Maximum Channel EIRP (dBW)	25	25
Maximum Beam Peak EIRP Density (dBW/4kHz)	13.2	13.2
Maximum Beam Peak EIRP Density (dBW/Hz)	-22.8	-22.8

EXHIBIT 4
Beam Polarizations and GXT File Names

	Schedule S Beam Names							
	Linear Polarization				Circular Polarization			
Beam Designation	**Uplink**	**Uplink**	**Downlink**	**Downlink**	**Uplink**	**Uplink**	**Downlink**	**Downlink**
	(H-Pol.)	**(V-Pol.)**	**(H-Pol.)**	**(V-Pol.)**	**(LHCP)**	**(RHCP)**	**(LHCP)**	**(RHCP)**
BSS Feeder Link-Band Beams								
Europe BSS Feeder Link Beam	EKHU	----	----	----	----	----	----	----
Ku-Band Beams								
Europe Ku Uplink Beam	EUHU	EUVU	----	----	----	----	----	----
Europe Ku Downlink Beam	----	----	EUHD EBHD	EUVD EBVD	----	----	----	----
Americas Uplink Beam	AMHU	AMVU	----	----	----	----	----	----
Americas Downlink Beam	----	----	AMHD	AMVD	----	----	----	----
Telemetry S-band	----	----	----	----	----	----	TLMO*	TLMJ*
Telemetry Ku	----	----	----	TLMG*	----	----	----	----
Command Horn	----	CMDJ*	----	----	----	----	----	----
Command S	----	----	----	----	CMDG*	CMDO*	----	----
Ku-band ULPC	----	----	UPKC*	UPKD*	----	----	----	----

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