

Engineering Statement

1 Introduction

Intelsat License LLC (“Intelsat”) hereby seeks to modify the authorization for Intelsat 35e (Call Sign S2959) at the 34.5° W.L. orbital location. Specifically, this modification application seeks authority to operate Intelsat 35e’s command channels with center frequencies in the ranges 5850.5 - 5853.0 MHz and 6422 - 6424.5 MHz, selectable via ground command in 100 kHz steps. The characteristics of the Intelsat 35e spacecraft, 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 the remainder of this Engineering Statement, which updates command channel frequencies. In all other respects, the characteristics of Intelsat 35e are the same as those described in SAT-LOA-20160408-00034.

2 Spacecraft Overview

Intelsat 35e is a Boeing 702MP spacecraft that is capable of operating in C-band and Ku-band frequencies listed below.

Direction	Frequency
Uplink	5850 – 6425 MHz
	13750 – 14500 MHz
Downlink	3625 – 4200 MHz
	10950 – 11200 MHz
	11450 – 11700 MHz

The spacecraft provides the following coverage:

Beam	Coverage
Caribbean	Caribbean
Europe/Mediterranean	Europe and Mediterranean Area
Europe/Africa	Europe and West Africa
C-Band Spot Beams	South America, Caribbean, Greenland, Europe, and West Africa
Global	Global

2.1 Spacecraft Characteristics

Intelsat 35e is a three-axis stabilized type spacecraft that has a rectangular outer body structure. Intelsat 35e utilizes two deployable solar array wings and a number of deployable and non-deployable antennas.

The Intelsat 35e spacecraft is composed of the following subsystems:

- Thermal
- Power
- Attitude Control
- Propulsion
- Telemetry, Command and Ranging
- Uplink Power Control
- Communications

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

The structural design of Intelsat 35e 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 spacecraft.

2.2 Communication Subsystem

Intelsat 35e provides active communication channels at C-band and Ku-band frequencies. The C-band payload employs channels having bandwidths of 36 MHz, 108 MHz, and 216 MHz. The Ku-band payload employs channels having bandwidths of 36 MHz and 54 MHz. The Intelsat 35e frequency and polarization plan are provided in the Schedule S as is the Ku-band transponder plan. Due to the extensive number of C-band channel and beam combinations, the uplink channels and downlink channels have been listed separately in the Schedule S S10 “Space Station Transponders” table. Customer requirements will dictate the final C-band interconnections. Some typical configurations will use uplink and downlink channels within one spot beam, and others will have uplink and downlink channels in separate spot beams to provide communications links between regions. Channels in the global C-band beam can be connected to global or spot beam channels as required.

The Ku-band and C-band communication subsystems are separate and therefore there are no interconnections between C-band and Ku-band beams.

Intelsat 35e utilizes a multiple spot-beam architecture in C-band in which each spot beam has an identical design. Therefore, the coverage contours and performance characteristics for only a single representative spot beam are provided in the Schedule S. The latitude and longitude of each C-band spot beam's maximum gain point on the Earth is provided in Exhibit 1 in conformance with Section 25.114(c)(4)(vii)(B) of the Commission's rules. Additionally, Intelsat has included the Schedule S beam designation for all beams in Exhibit 5.

The performance characteristics of all Intelsat 35e beams are provided with Schedule S. The coverage contours of all Intelsat 35e beams except for those with their -8.0 dB contour extending beyond the edge of the Earth are provided with Schedule S. Exhibits 2 and 3 provide the beam parameters for the Intelsat 35e uplink and downlink beams, respectively.

2.3 Telemetry, Command and Ranging Subsystem

The telemetry, command and ranging ("TC&R") subsystem provides the following functions:

- 1) Acquisition, processing and transmission of spacecraft telemetry data;
- 2) Reception and retransmission of ground station generated ranging signals; and
- 3) Reception, processing and distribution of telecommands.

Intelsat 35e can be commanded through the use of two tunable command channels with center frequencies in the ranges 5850.5-5853.0 MHz and 6422.0-6424.5 MHz, selectable via ground command in 100 kHz steps. The spacecraft telemetry is received through telemetry channels centered at the frequencies 4197.75 MHz, 4198.25 MHz, 4198.75 MHz, and 4199.25 MHz.

- Selectable center frequencies for channels CMD1 may be calculated as:
Frequency (MHz) = $6422.0 + 0.1 * n$, where n is an integer from 0 to 25, inclusive; and
- Selectable center frequencies for channel CMD2 may be calculated as:
Frequency (MHz) = $5850.5 + 0.1 * n$, where n is an integer from 0 to 25, inclusive.

The Intelsat 35e command and telemetry channel frequencies are shown in Exhibit 4. The coverage patterns of the on-station command and telemetry beams as well as the pipe and hemi emergency 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 Intelsat 35e command and telemetry subsystem performance is summarized in Exhibit 4.

2.4 Uplink Power Control Subsystem

Intelsat 35e utilizes one C-band and 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 this beam are not required to be provided and the associated GXT file has not been included in Schedule S. The Intelsat 35e ULPC frequencies and subsystem performance are summarized in Exhibit 4.

2.5 Satellite Station-Keeping

The spacecraft will be maintained within 0.05° of its nominal longitudinal position in the east-west direction. Accordingly, it will be in compliance with Section 25.210(j) of the Commission’s rules.

The attitude of the spacecraft 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

Intelsat 35e 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 Intelsat 35e can accommodate television, radio, voice, and data communications. 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 3650 – 4200 MHz, 10950 – 11200 MHz, and 11450 -11700 MHz bands are specified in Section 25.208 of the Commission’s rules. The power flux density (“PFD”) limits for space stations operating in the 3625 – 3650 MHz are specified in No. 21.16 of the ITU Radio Regulations.

The maximum PFD levels for the Intelsat 35e transmissions were calculated for the 3625 – 4200 MHz, 10950 – 11200 MHz, and 11450 -11700 MHz bands. The results are provided in Schedule

S and show that the downlink PFD levels of the Intelsat 35e carriers do not exceed the limits specified in Sections 25.208 of the Commission's rules or the limits specified 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. Intelsat 35e 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 Intelsat 35e emissions.

6 Orbital Location

Intelsat requests that it be assigned the 34.5° W.L. orbital location for Intelsat 35e. The 34.5° W.L. location satisfies Intelsat 35e 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 Coordination Statement and Certifications

The downlink EIRP density of Intelsat 35e's transmissions in the conventional and extended C-band will not exceed 3 dBW/4kHz for digital transmissions or 8 dBW/4kHz for analog transmissions, and associated uplink transmissions will not exceed applicable EIRP density envelopes in Sections 25.218 or 25.221(a)(1) 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 Intelsat 35e at 34.5° W.L.

The downlink EIRP density of Intelsat 35e's transmissions in the conventional and extended Ku-band 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 Sections 25.218, 25.222(a)(1), 25.226(a)(1), or 25.227(a)(1) 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 Intelsat 35e at 34.5° W.L.

8 Orbital Debris Mitigation Plan

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

8.1 Spacecraft Hardware Design

The spacecraft is designed such that no debris will be released during normal operations. Intelsat has assessed the probability of collision with meteoroids and other small debris (<1 cm diameter)

and has taken the following steps to limit the effects of such collisions: (1) critical spacecraft components are located inside the protective body of the spacecraft and properly shielded; and (2) all spacecraft subsystems have redundant components to ensure no single-point failures. The spacecraft does not use any subsystems for end-of-life disposal that are not used for normal operations.

8.2 Minimizing Accidental Explosions

Intelsat has assessed the probability of accidental explosions during and after completion of mission operations. The spacecraft 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 spacecraft, Intelsat will ensure the removal of all stored energy on the spacecraft by depleting all propellant tanks, venting all pressurized systems and by leaving the batteries in a permanent discharge state.

8.3 Safe Flight Profiles

Intelsat has assessed and limited the probability of the space station becoming a source of debris as a result of collisions with large debris or other operational space stations. Intelsat 35e is not located at the same orbital location as another satellite or at an orbital location that has an overlapping station-keeping volume with another satellite.

Intelsat is not aware of any other FCC licensed system, or any other system applied for and under consideration by the FCC, that has an overlapping station-keeping volume with Intelsat 35e. Intelsat is also not aware of any system with an overlapping station-keeping volume with Intelsat 35e that is the subject of an ITU filing and that is either in orbit or progressing towards launch.

8.4 Post Mission Disposal

At the end of the mission, Intelsat intends to dispose of the spacecraft by moving it to an altitude of 300 kilometers above the geostationary arc. Intelsat has reserved 3.3 kilograms of hydrazine for this purpose. The reserved fuel figure was determined by the spacecraft 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.

In calculating the disposal orbit, Intelsat has used simplifying assumptions as permitted under the Commission's Orbital Debris Report and Order.¹ For reference, the effective area to mass ratio ($Cr \cdot A/M$) of the Intelsat 35e spacecraft is 0.032 m²/kg, resulting in a minimum perigee disposal altitude under the Inter-Agency Space Debris Coordination Committee formula of at most 271.8

¹ *Mitigation of Orbital Debris*, Second Report and Order, IB Docket No. 02-54, FCC 04-130 (rel. June 21, 2004).

kilometers above the geostationary arc. Accordingly, the Intelsat 35e planned disposal orbit complies with the FCC's rules.

9 ITU Filing

Intelsat 35e's operations in all bands have been coordinated under Administration of the United States International Telecommunication Union ("ITU") filings. Therefore, no new ITU filings are required.

10 TC&R Control Earth Stations

Intelsat will conduct TC&R operations through one or more of the following earth stations: Castle Rock, Colorado and Fillmore, California. Additionally, Intelsat is capable of remotely controlling Intelsat 35e from its facilities in McLean, VA.

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/ Alexander Gerdenitsch

March 20, 2018

Alexander Gerdenitsch

Date

Intelsat

Manager, Spectrum Policy,
Americas

EXHIBIT 1
Coordinates of C-Band Spot Beams Maximum Gain Points

Beam Designation	Latitude (°N)	Longitude (°E)
C1	47.4	1.3
C2	11.5	-9.3
C3	11.9	8.6
C4	0.6	2.2
C5	-0.5	19.5
C6	-13.0	17.2
C7	-26.0	17.4
C8	41.3	-79.1
C9	21.8	-77.1
C10	3.3	-77.6
C11	7.8	-62.9
C12	-8.7	-70.0
C13	-18.0	-60.2
C14	-23.0	-47.3
C15	-3.4	-52.0
C16	-9.8	-40.4
C17	59.5	-40.6

EXHIBIT 2

COMMUNICATION SUBSYSTEM UPLINK BEAM PARAMETERS

Beam Name	C-band Spot	C-band Spot	C-band Global	C-band Global
Schedule S Beam ID	CSLU	CSRU	CGLU	CGRU
Frequency Band (MHz)	5850-6340	5850-6340	6330-6425	6330-6425
Polarization	LHCP	RHCP	LHCP	RHCP
Beam Peak G/T (dB/K)	11.0	11.0	-5.1	-5.1
Minimum SFD-- (dBW/m ²)	-108.0	-108.0	-102.9	-102.9
Maximum SFD-- (dBW/m ²)	-83.0	-83.0	-77.9	-77.9

Beam Name	Ku-band Caribbean	Ku-band Caribbean	Ku-band Europe/Med	Ku-band Europe/Med	Ku-band Africa/EU
Schedule S Beam ID	KCHU	KCVU	KMHU	KMVU	KAHU
Frequency Band (MHz)	14000 - 14500	14000 - 14500	13750 - 14500	13750 - 14500	14000 – 14500
Polarization	Horizontal	Vertical	Horizontal	Vertical	Horizontal
Beam Peak G/T (dB/K)	10.4	10.4	10.8	10.8	5.7
Minimum SFD-- (dBW/m ²)	-110.4	-110.4	-110.8	-110.8	-106.7
Maximum SFD-- (dBW/m ²)	-82.4	-82.4	-82.8	-82.8	-78.7

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

EXHIBIT 3

COMMUNICATION SUBSYSTEM DOWNLINK BEAM PARAMETERS

Beam Name	C-band Spot	C-band Spot	C-band Global	C-band Global
Schedule S Beam ID	CSLD	CSRD	CGLD	CGRD
Frequency Band (MHz)	3625-4115	3625-4115	4105-4200	4105-4200
Polarization	LHCP	RHCP	LHCP	RHCP
Maximum Beam Peak EIRP (dBW)	51.0	51.0	37.3	37.3
Maximum Beam Peak EIRP Density (dBW/Hz)	-27.3	-27.3	-33.2	-33.2
Maximum Beam Peak EIRP Density (dBW/4kHz)	8.7	8.7	2.8	2.8

Beam Name	Ku-band Caribbean	Ku-band Caribbean	Ku-band Europe/Med	Ku-band Europe/Med	Ku-band Africa/EU
Schedule S Beam ID	KCHD	KCVD	KMHD	KMVD	KAVD
Frequency Band (MHz)	10950-11200	10950-11200	10950-11200	10950-11200	10950-11200
Polarization	Horizontal	Vertical	Horizontal	Vertical	Vertical
Maximum Beam Peak EIRP (dBW)	53.7	56	55.3	55.7	49.5
Maximum Beam Peak EIRP Density (dBW/Hz)	-23.6	-21.3	-22	-21.6	-27.8
Maximum Beam Peak EIRP Density (dBW/4kHz)	12.4	14.7	14	14.4	8.2

Beam Name	Ku-band Caribbean	Ku-band Caribbean	Ku-band Europe/Med	Ku-band Europe/Med	Ku-band Africa/EU
Schedule S Beam ID	KCHE	KCVE	KMHE	KMVE	KAVE
Frequency Band (MHz)	11450-11700	11450-11700	11450-11700	11450-11700	11450-11700
Polarization	Horizontal	Vertical	Horizontal	Vertical	Vertical
Maximum Beam Peak EIRP (dBW)	53.7	56	55.3	55.7	49.5
Maximum Beam Peak EIRP Density (dBW/Hz)	-23.6	-21.3	-22	-21.6	-27.8
Maximum Beam Peak EIRP Density (dBW/4kHz)	12.4	14.7	14	14.4	8.2

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

EXHIBIT 4

TC&R SUBSYSTEM CHARACTERISTICS

Beam Name	Command Global Horn	Command Hemi	Command Pipe
Schedule S Beam ID	CGVU	CHLU	CPLU
Center Frequencies (MHz)	6422.0-6424.5*	6422.0-6424.5*	5850.5-5853.0*
Occupied Band (MHz)	6421.5-6425.0	6421.5-6425.0	5850.0-5853.5
Command Carrier Bandwidth (MHz)	1.0	1.0	1.0
Polarization	Vertical	LHCP	LHCP
Peak Flux Density at Command Threshold (dBW/m ² -Hz)	-90	-80	-80

* Tunable in 100 kHz steps

Beam Name	Telemetry Global Horn	Telemetry Hemi	Telemetry Pipe
Schedule S Beam ID	TGHD	THLD	TPLD
Frequencies (MHz)	4197.75, 4198.75, 4198.25, 4199.25		
Polarization	Horizontal	LHCP	LHCP
Maximum Channel EIRP (dBW)	10.1	11.5	15.4
Maximum Beam Peak EIRP Density (dBW/Hz)	-39.9	-38.5	-34.6
Maximum Beam Peak EIRP Density (dBW/4kHz)	-3.9	-2.5	1.4

Beam Name	ULPC	ULPC	ULPC
Schedule S Beam ID	CLVD	KLRD	KLRE
Frequencies (MHz)	4199.75	11198.0	11451.5
Polarization	Vertical	RHCP	RHCP
Maximum Channel EIRP (dBW)	13.0	15.6	15.6
Maximum Beam Peak EIRP Density (dBW/Hz)	-31	-28.4	-28.4
Maximum Beam Peak EIRP Density (dBW/4kHz)	5.0	7.6	7.6

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

EXHIBIT 5

Beam Polarizations and GXT File Names

Beam Designation	Schedule S Beam Names							
	Linear Polarization				Circular Polarization			
	Uplink (H-Pol.)	Uplink (V-Pol.)	Downlink (H-Pol.)	Downlink (V-Pol.)	Uplink (LHCP)	Uplink (RHCP)	Downlink (LHCP)	Downlink (RHCP)
C-Band Beams								
Spot Beams	----			----	CSLU	CSRU	CSLD	CSRD
Global Beam	----	----	----	----	CGLU*	CGRU*	CGLD*	CGRD*
C-band ULPC	----	----	----	CLVD*	----	----	----	----
Telemetry Global	----	----	TGHD*	----	----	----	----	----
Command Global	----	CGVU*	----	----	----	----	----	----
Telemetry Pipe	----	----	----	----	----	----	TPLD*	----
Telemetry Hemi	----	----	----	----	----	----	THLD*	----
Command Pipe	----	----	----	----	CPLU*	----	----	----
Command Hemi	----	----	----	----	CHLU*	----	----	----
Ku-Band Beams¹								
Caribbean Beam	KCHU	KCVU	KCHD KCHE	KCVD KCVE	----	----	----	----
Europe/ Mediterranean	KMHU	KMVU	KMHD KMHE	KMVD KMVE	----	----	----	----
Africa/EU Beam	KAHU	----	----	KAVD KAVE	----	----	----	----
Ku-band ULPC	----	----	----	----	----	----	----	KLRD* KLRE*

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

¹Two beam designators within a cell indicate that the beam includes two disjoint frequency ranges.