Engineering Statement

1 Introduction

Intelsat License LLC ("Intelsat") seeks authority in this application to operate the satellite designated as Intelsat 1R from 50.1° W.L.

The characteristics of the Intelsat 1R spacecraft, as well as its compliance with the various provisions of Part 25 of the Federal Communication Commission's ("FCC or "Commission") rules, are provided in the remainder of this Engineering Statement, which updates the beam gain contours. In all other respects, the characteristics of Intelsat 1R are the same as those described in SAT-MOD-20090720-00073.

2 Spacecraft Overview

Intelsat 1R is a Boeing 702MP spacecraft that is capable of operating in C-band and Ku-band frequencies listed below.

Direction	Frequency
Uplink	5925 – 6425 MHz
	13750 – 14500 MHz
Downlink	3700 – 4200 MHz
	10950 – 11200 MHz
	11450 – 11700 MHz
	11700 – 11950 MHz

The spacecraft provides the following coverage:

Beam	Coverage
US/Latin America	United States, Central America, South America
Europe/Africa	Europe, Africa
US/Mexico	United States, Mexico, Caribbean, Central America
South America	South America
Combined Uplink	United States, Mexico, Caribbean, Central America, Europe, Africa
Global	Global

2.1 Spacecraft Characteristics

Intelsat 1R is a three-axis stabilized type spacecraft that has a rectangular outer body structure. Intelsat 1R utilizes two deployable solar array wings and a number of deployable and non-deployable antennas.

The Intelsat 1R 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 1R 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 spacecraft.

2.2 Communication Subsystem

Intelsat 1R provides active communication channels at C-band and Ku-band frequencies each having a bandwidth of 36 MHz. The Intelsat 1R frequencies, polarization, and channel plan are provided in the Schedule S.

The coverage contours and performance characteristics of all Intelsat 1R beams are provided in the Schedule S. Exhibits 1 and 2 provide the beam parameters for the Intelsat 1R 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.

The Intelsat 1R command and telemetry channel frequencies are shown in Exhibit 3. The coverage patterns of the on-station command and telemetry beams are provided in the Schedule S. The coverage patterns of the bi-conical 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 1R command and telemetry subsystem performance is summarized in Exhibit 3.

2.4 Uplink Power Control Subsystem

Intelsat 1R utilizes two Ku-band channels for uplink power control ("ULPC"), antenna tracking, and ranging. The coverage patterns of the ULPC beams are provided in the Schedule S. The Intelsat 1R ULPC frequencies and subsystem performance are summarized in Exhibit 3.

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 1R 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 1R 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 3700 – 4200 MHz, 10950 – 11200 MHz, and 11450 -11700 MHz bands are contained in Section 25.208 of the Commission's rules. Neither the Commission's rules nor the ITU Radio Regulations specify any PFD limits for the 11700 – 11950 MHz band applicable to geostationary satellites operating in the fixed satellite service.

The maximum PFD levels for the Intelsat 1R transmissions were calculated for the 3700 – 4200 MHz, 10950 – 11200 MHz, and 11450 -11700 MHz bands. The results are provided in Schedule S and show that the downlink power flux density levels of the Intelsat 1R carriers do not exceed the limits specified in Sections 25.208 of the Commission's rules.

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 1R 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 1R emissions.

6 Orbital Location

Intelsat requests that it be assigned the 50.1° W.L. orbital location for Intelsat 1R. The 50.1° W.L. location satisfies Intelsat 1R 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 with Co-frequency Space Stations

The Intelsat 1R transmissions will comply with the levels contained in Sections 25.212(c) and (d) and Section 25.140(a)(3)(i) and (ii) of the Commission's rules, as recently amended,[1] unless higher levels are coordinated with affected adjacent satellite operators within ±6°.

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

[1] Intelsat understands that the FCC will apply the new rules and procedures to pending applications as soon as these rules become effective. *See Comprehensive Review of Licensing and Operating Rules for Satellite Services*, Second Report and Order, IB Docket No. 12-267, FCC 15-167 at ¶ 333 (rel. Dec. 17, 2015).

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 that all active units are turned off. However, due to the design of Intelsat 1R, Intelsat will not be able to vent all pressurized systems. Intelsat previously received waiver of Section 25.283(c) of the Commission's rules, 47 C.F.R. § 25.283.[2]

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. Once relocated to 50.1° W.L., Intelsat 1R will not be located at an orbital location that has an overlapping station-keeping volume with another satellite.

During the relocation of Intelsat 1R, Intelsat will take all the necessary steps to coordinate the move internally to minimize the risk of collision or interference between Intelsat 1R and Intelsat 29e. Intelsat is not aware of any other FCC licensed system, or any other system applied for and under consideration by the FCC, that will have an overlapping station-keeping volume with Intelsat 1R. Intelsat is also not aware of any system with an overlapping station-keeping volume with Intelsat 1R 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 expects to dispose of the spacecraft by moving it to a planned minimum altitude of 300 kilometers above the geostationary arc. This altitude exceeds the minimum altitude established by the Inter-Agency Space Debris Coordination Committee

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[2] *See PanAmSat Licensee Corp. Application to Modify License for Intelsat 1R*, File No. SAT-MOD-20090720-00073 at ¶ 8 (stamp grant issued by Steve Duall on Aug. 5, 2010)

("IADC") formula. Intelsat has reserved 30.035 kilograms of xenon for this purpose. The reserved xenon figure was determined by the spacecraft manufacturer and is 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.[3] For reference, the effective area to mass ratio (Cr*A/M) of the Intelsat 1R spacecraft is 0.0625 m^2/kg, resulting in a minimum perigee disposal altitude under the IADC formula of at most 297.4 kilometers above the geostationary arc. Accordingly, the Intelsat 1R planned disposal orbit complies with the FCC's rules.

9 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 1R from its facilities in McLean, VA.

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

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/ Candice DeVane	February 19, 2016
Candice DeVane Intelsat Manager, Spectrum Policy	Date

EXHIBIT 1

COMMUNICATION SUBSYSTEM UPLINK BEAM PARAMETERS

Beam Name	C-Band Linear	C-Band Linear	C-Band Linear	C-Band Linear
Schedule S Beam ID	ACHU	ACVU	ECVU	GCHU
Frequency Band (MHz)	**5925 – 6425**	**5925 – 6425**	**5925 – 6425**	**5925 – 6425**
Polarization	Horizontal	Vertical	Vertical	Horizontal
Beam Peak Gain (dBi)	29.1	28.4	28.8	19.6
G/T (dB/K)	1.4	1.3	1.2	-8.2
Minimum SFD-- (dBW/m^2)	-99.3	-98.4	-94.9	-88.8

Beam Name	KU-Band Linear	KU-Band Linear	KU-Band Linear	KU-Band Linear
Schedule S Beam ID	NKHU	NKVU	SKVU	SKHU
Frequency Band (MHz)	**13750 - 14500**	**13750 - 14500**	**13750 - 14500**	**13750 - 14500**
Polarization	Horizontal	Vertical	Vertical	Horizontal
Beam Peak Gain (dBi)	33.9	33.3	33.1	32.6
G/T (dB/K)	6.8	6.8	6.5	6.1
Minimum SFD-- (dBW/m^2)	-104.8	-104.2	-104.6	-104.1

Beam Name	KU-Band Linear	KU-Band Linear	KU-Band Linear
Schedule S Beam ID	EKHU	EKVU	CKVU
Frequency Band (MHz)	**13750 - 14500**	**13750 - 14500**	**13750 - 14500**
Polarization	Horizontal	Vertical	Vertical
Beam Peak Gain (dBi)	33.8	31.6	33.3
G/T (dB/K)	6.6	4.8	6.5
Minimum SFD-- (dBW/m^2)	-104.9	-102.9	-104.3

EXHIBIT 2

COMMUNICATION SUBSYSTEM DOWNLINK BEAM PARAMETERS

Beam Name	C-Band Linear	C-Band Linear	C-Band Linear	C-Band Linear
Schedule S Beam ID	ACHD	ACVD	ECHD	GCVD
Frequency Band (MHz)	3700 - 4200	3700 - 4200	3700 - 4200	3700 - 4200
Polarization	Horizontal	Vertical	Horizontal	Vertical
Peak Antenna Gain (dBi)	28.0	27.8	28.5	19.3
EIRP (dBW)	43.7	43.4	41.9	34.6

Beam Name	Ku-Band Linear	Ku-Band Linear	Ku-Band Linear	Ku-Band Linear
Schedule S Beam ID	NKHD	NKVD	SKHD	S1KV
Frequency Band (MHz)	10950 – 11200 & 11450 – 11700	10950 – 11200	11700 - 11950	11700 - 11950
Polarization	Horizontal	Vertical	Horizontal	Vertical
Peak Antenna Gain (dBi)	31.9	31.6	33.1	33.1
EIRP (dBW)	50.9	50.3	52.9	53.0

Beam Name	Ku-Band Linear	Ku-Band Linear	Ku-Band Linear
Schedule S Beam ID	S2KV	EKHD	EKVD
Frequency Band (MHz)	11450 - 11700	11450 - 11700	10950 – 11200 & 11450 – 11700
Polarization	Vertical	Horizontal	Vertical
Peak Antenna Gain (dBi)	33.1	32.8	31.3
EIRP (dBW)	52.1	52.3	50.3

EXHIBIT 3

TC&R SUBSYSTEM CHARACTERISTICS

Beam Name	Command US/Mexico	Command Bicone	Command Pipe
Schedule S Beam ID	CMDC	CMDB	CMDP
Frequencies (MHz)	13995.0	13995.0	14498.5
Polarization	Horizontal	Vertical	LHCP
Peak Antenna Gain (dBi)	33.9	3.5	4.7

Beam Name	Telemetry US/Mexico	Telemetry Bicone	Telemetry Pipe	ULPC	ULPC
Schedule S Beam ID	TLMC	TLMB	TLMP	UPCR	UPCL
Frequencies (MHz)	11696.0 & 11697.0	11696.0 & 11697.0	11696.0 & 11697.0	11699.0	11699.0
Polarization	Vertical	Horizontal	LHCP	RHCP	LHCP
Peak Antenna Gain (dBi)	31.6	3.7	4.5	19.0	19.0
Maximum Channel EIRP (dBW)	15.0	11.8	10.7	11.2	11.2

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