# Engineering Statement

## 1 Introduction

Intelsat License LLC ("Intelsat") seeks authority in this application to redeploy the satellite designated as Intelsat 901 (Call Sign S2405) to, and operate at, 27.5° W.L. (332.5°E.). As described in the Legal Narrative, prior to deployment to the 27.5° W.L. orbital location, the Intelsat 901 satellite will be raised to 300 km above the geostationary arc and dock with the MEV-1 (S2990) spacecraft. Intelsat 901 will then be reinserted to 27.5° W.L as a combined vehicle stack ("CVS") with MEV-1. The characteristics of the Intelsat 901 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 this Engineering Statement, which updates the beam gain contours. In all other respects, the characteristics of Intelsat 901 are the same as those described in SAT-MOD-20170831-00126.

## 2 Spacecraft Overview

Intelsat 901 is capable of operating in the C-band and Ku-band frequencies listed below.

| Direction | Frequency |
|---|---|
| Uplink | 5850-5925 MHz |
| | 5925-6425 MHz |
| | 14000-14500 MHz |
| Downlink | 3625-3700 MHz |
| | 3700-4200 MHz |
| | 10950-11200 MHz |
| | 11450-11700 MHz |

The spacecraft provides the following coverage:

| Beam | Coverage |
|---|---|
| West Hemi | North and South America |
| East Hemi | Africa and Europe |
| Northwest | Northern United States and Eastern Canada |
| Southwest | South America and Caribbean |
| Southeast | Africa and Middle East |
| Northeast | Europe and Greenland |
| Global | Global |
| Steerable Spot Beams | May be pointed toward any visible location on the Earth |

## 2.1 Spacecraft Characteristics

Intelsat 901 is a Space Systems Loral FS-1300HL three-axis stabilized spacecraft with a rectangular outer body structure. Intelsat 901 utilizes two deployable solar array wings and a number of deployable and non-deployable antennas.

The Intelsat 901 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 subsystems in order to avoid single-point failures.

The structural design of Intelsat 901 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 901 provides active communication channels in C-band and Ku-band. In C-band, active communication channels have a bandwidth of either 36 MHz, 41 MHz, or 72 MHz. In Ku-band, active communication channels have a bandwidth of either 36 MHz, 72 MHz, or 77 MHz. The Intelsat 901 frequencies, polarization, and channel plan are provided in the Schedule S.

The coverage contours and performance characteristics of all Intelsat 901 beams, except for the global beams, are provided in the Schedule S. The global 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. Exhibits 1 and 2 provide the beam parameters for the Intelsat 901 uplink and downlink beams, respectively.

Intelsat 901 is equipped with two steerable Ku-band spot beams. Gain contours for both beams are provided in Schedule S. Each steerable beam may be pointed toward any location on the earth that is visible from 27.5° 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's rules and International Telecommunications Union ("ITU") Radio Regulations.

## 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 901 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 are not included in Schedule S. The Intelsat 901 command and telemetry subsystem performance is summarized in Exhibit 3.

## 2.4 Uplink Power Control Subsystem

Intelsat 901 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 have not been included in Schedule S. The Intelsat 901 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 spacecraft will be maintained within 0.05° of its nominal longitudinal position in the east-west direction.

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 901 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 901 can accommodate digital and analog 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 3625-4200 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 901 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 power flux density levels of the Intelsat 901 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 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 901 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 901 emissions.

## 6 Orbital Location

Intelsat requests that it be assigned the 27.5° W.L. orbital location for Intelsat 901. The 27.5° W.L. location satisfies Intelsat 901 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. Although 27.5° W.L. was entered into Schedule S, the Schedule S software rounded it to 28.0°W.L.

## 7 ITU Filling

Intelsat 901 operations in the 3625-3700 MHz, 3700-4200 MHz, 5850-5925 MHz, 5925-6425 MHz, 10950-11200 MHz, 11450-11700 MHz, and 14000-14500 MHz frequency bands have been notified and coordinated under the Administration of the United States' ITU filings INTELSAT6 332.5E, INTELSAT7 332.5E, INTELSAT8 332.5E, and INTELSAT9 332.5E.

## 8 Coordination with Co-frequency Space Stations

Intelsat 901 will operate under existing ITU filings of the United States Administration. The downlink EIRP density of Intelsat 901 transmissions in the conventional 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 901 at 27.5° W.L.

The downlink EIRP density of Intelsat 901 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 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 901 at 27.5° W.L.

Given the above, the uplink frequency bands 5850-5925 MHz, 5925-6425 MHz, and 14000-14500 MHz; and the downlink frequency bands 3625-3700 MHz, 3700-4200 MHz, 10950-11200

MHz, and 11450-11700 MHz do not require any interference analysis or 2-degree analysis under 47 C.F.R. § 25.140 of the Commission's rules.

In all cases, Intelsat will comply with all executed operator-to-operator agreements for 27.5° W.L.

# 9 Orbital Debris Mitigation Plan

## 9.1 Spacecraft Hardware Design

Intelsat 901 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 spacecraft components are located inside the protective body of the spacecraft and are properly shielded. The spacecraft 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 a catastrophic failure including 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.

## 9.3 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, including during the orbit raising maneuver to 300 km and docking with the MEV spacecraft. Subject to receipt of FCC approval, Intelsat will raise Intelsat 901 to 300 km above the geostationary arc; to dock with MEV-1; and to redeploy Intelsat 901—as a CVS with MEV-1—to, and operate at, 27.5° W.L. on the geostationary arc.

During the relocation of Intelsat 901, Intelsat will take all the necessary steps to coordinate with any effected satellite to minimize the risk of collision or interference between Intelsat 901 and any other satellite. 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 901. Intelsat is also not aware of any system with an overlapping station-keeping volume with Intelsat 901 at 27.5° W.L. that is the subject of an ITU filing and that is either in orbit or progressing towards launch.

### 9.4 Post Mission Disposal

At the end of the mission, Intelsat intends to dispose of the spacecraft by moving it to an altitude of at least 150 km above the geostationary arc. Intelsat has reserved 54.7 kilograms of fuel for this purpose. In its *Second Report and Order* in IB Docket 02-54, Mitigation of Orbital Debris,[1] the FCC declared that satellites launched prior to March 18, 2002, such as the Intelsat 901 satellite, would be designated as grandfathered satellites not subject to a specific disposal altitude. Therefore, the planned disposal orbit for Intelsat 901 complies with the FCC's rules.

The reserved fuel figure was determined by the spacecraft manufacturer and provided for in the propellant budget. This figure 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.

## 10 TC&R Control Earth Stations

Intelsat will conduct TC&R operations through one or more of the following earth stations: Fuchsstadt, Germany; Mountainside, Maryland; Hartebeeshoek, South Africa; Castle Rock, Colorado; Atlanta Georgia; Riverside, Fillmore, California; or Fucino, Italy. Additionally, Intelsat is capable of remotely controlling Intelsat 901 from its facilities in McLean, Virginia or in Long Beach, California.

[1] Mitigation of Orbital Debris, *Second Report and Order*, 19 FCC Rcd 11567 (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/ Giselle Creeser* | February 7, 2019 |
| Giselle Creeser<br>Intelsat<br>Director, Spectrum Policy and Engineering | Date |

# EXHIBIT 1

# COMMUNICATION SUBSYSTEM UPLINK BEAM PARAMETERS

| **Beam Name** | C-Band Global | C-Band Global | West Hemi | East Hemi |
|---|---|---|---|---|
| **Schedule S Beam ID** | CGRU | CGLU | CWLU | CELU |
| **Frequency Band (MHz)** | 6300 - 6425 | 6300 – 6425 | 5850 - 6300 | 5850 - 6300 |
| **Polarization** | RHCP | LHCP | LHCP | LHCP |
| **G/T (dB/K)** | -6.7 | -6.7 | -2.2 | -2.5 |
| **Minimum SFD-- ($dBW/m^2$)** | -91.2 | -92.6 | -89.5 | -89.7 |
| **Maximum SFD-- ($dBW/m^2$)** | -69.2 | -70.6 | -67.5 | -67.7 |

| **Beam Name** | Southwest | Northwest | Southeast | Northeast |
|---|---|---|---|---|
| **Schedule S Beam ID** | SWRU | NWRU | SERU | NERU |
| **Frequency Band (MHz)** | 5850 - 6300 | 5850 – 6300 | 5850 - 6300 | 5850 - 6300 |
| **Polarization** | RHCP | RHCP | RHCP | RHCP |
| **G/T (dB/K)** | 1.5 | 5.8 | 0.0 | 4.5 |
| **Minimum SFD-- ($dBW/m^2$)** | -89.9 | -90.2 | -91.2 | -92.0 |
| **Maximum SFD-- ($dBW/m^2$)** | -67.9 | -68.2 | -69.2 | -70.0 |

| **Beam Name** | Ku-Band Spot1 | Ku-Band Spot2 |
|---|---|---|
| **Schedule S Beam ID** | KSVU | KSHU |
| **Frequency Band (MHz)** | 14000 – 14500 | 14000 - 14500 |
| **Polarization** | Vertical | Horizontal |
| **G/T (dB/K)** | 8.7 | 8.9 |
| **Minimum SFD-- ($dBW/m^2$)** | -92.3 | -91.8 |
| **Maximum SFD-- (dBW/m2)** | -74.3 | -73.8 |

# EXHIBIT 2

# COMMUNICATION SUBSYSTEM DOWNLINK BEAM PARAMETERS

| **Beam Name** | C-Band Global | C-Band Global | West Hemi | East Hemi |
|---|---|---|---|---|
| **Schedule S Beam ID** | CGLD | CGRD | CWRD | CERD |
| **Frequency Band (MHz)** | 4075 - 4200 | 4075 – 4200 | 3625 - 4075 | 3625 - 4075 |
| **Polarization** | LHCP | RHCP | RHCP | RHCP |
| **Maximum Beam Peak EIRP Density (dBW/Hz)** | -40.1 | -39.8 | -34.6 | -34.6 |
| **Maximum Beam Peak EIRP (dBW)** | 35.5 | 35.8 | 41.0 | 41.0 |
| **Maximum Beam Peak EIRP Density (dBW/4kHz)** | -4.0 | -3.7 | 1.5 | 1.5 |

| **Beam Name** | Southwest | Southeast | Northeast | Northwest |
|---|---|---|---|---|
| **Schedule S Beam ID** | SWLD | SELD | NELD | NWLD |
| **Frequency Band (MHz)** | 3625 - 4075 | 3625 – 4075 | 3625 - 4075 | 3625 - 4075 |
| **Polarization** | LHCP | LHCP | LHCP | LHCP |
| **Maximum Beam Peak EIRP Density (dBW/Hz)** | -31.6 | -34.1 | -32.1 | -34.6 |
| **Maximum Beam Peak EIRP (dBW)** | 44.0 | 41.5 | 43.5 | 42 |
| **Maximum Beam Peak EIRP Density (dBW/4kHz)** | 4.4 | 2 | 4.0 | 2.5 |

| **Beam Name** | Ku-Band Spot1 | Ku-Band Spot1 | Ku-Band Spot2 | Ku-Band Spot2 |
|---|---|---|---|---|
| **Schedule S Beam ID** | KSHD | KSHE | KSVD | KSVE |
| **Frequency Band (MHz)** | 10950 – 11200 | 11450 - 11700 | 10950 – 11200 | 11450 - 11700 |
| **Polarization** | Horizontal | Horizontal | Vertical | Vertical |
| **Maximum Beam Peak EIRP Density (dBW/Hz)** | -22.6 | -22.6 | -22.6 | -22.6 |
| **Maximum Beam Peak EIRP (dBW)** | 53.0 | 53.0 | 53.0 | 53.0 |
| **Maximum Beam Peak EIRP Density (dBW/4kHz)** | 13.5 | 13.5 | 13.5 | 13.5 |

# EXHIBIT 3

# TC&R SUBSYSTEM CHARACTERISTICS

| **Beam Name** | Command Global | Command Bicone |
|---|---|---|
| **Schedule S Beam ID** | CMDG | CMDB |
| **Frequencies (MHz)** | 6173.7 | 6176.3 |
| **Polarization** | LHCP | LHCP |
| **Peak Flux Density at Command Threshold (dBW/m$^2$)** | -90 | -90 |

| **Beam Name** | Telemetry Global | Telemetry Bicone | ULPC | ULPC | ULPC |
|---|---|---|---|---|---|
| **Schedule S Beam ID** | TLMG | TLMB | UPKC | UPKD | UPCV |
| **Frequencies (MHz)** | 3947.5, 3948, 3952.0, & 3952.5 | 3947.5, 3948, 3952.0, & 3952.5 | 11198.0 | 11452.0 | 3950.0 |
| **Polarization** | RHCP | RHCP | RHCP | RHCP | Vertical |
| **Maximum Channel EIRP (dBW)** | 8.0 | 8.0 | 11.0 | 11.0 | 8.0 |
| **Maximum Beam Peak EIRP Density (dBW/4kHz)** | -6.0 | -6.0 | -3.0 | -3.0 | 0.0 |
| **Maximum Beam Peak EIRP Density (dBW/Hz)** | -42 | -42 | -39 | -39 | -36 |

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

# EXHIBIT 4
## 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)** |
| **C-Band Beams** | | | | | | | | |
| Global Beam | ---- | ---- | ---- | ---- | CGLU* | CGRU* | CGLD* | CGRD* |
| West Hemi | ---- | ---- | ---- | ---- | CWLU | ---- | ---- | CWRD |
| East Hemi | ---- | ---- | ---- | ---- | CELU | ---- | ---- | CERD |
| Northwest | ---- | ---- | ---- | ---- | ---- | NWRU | NWLD | ---- |
| Southwest | ---- | ---- | ---- | ---- | ---- | SWRU | SWLD | ---- |
| Southeast | ---- | ---- | ---- | ---- | ---- | SERU | SELD | ---- |
| Northeast | ---- | ---- | ---- | ---- | ---- | NERU | NELD | ---- |
| Telemetry Global | ---- | ---- | ---- | ---- | ---- | ---- | ---- | TLMG* |
| Telemetry Bicone | ---- | ---- | ---- | ---- | ---- | ---- | ---- | TLMB* |
| Command Global | ---- | ---- | ---- | ---- | CMDG* | ---- | ---- | ---- |
| Command Bicone | ---- | ---- | ---- | ---- | CMDB* | ---- | ---- | ---- |
| C-band ULPC | ---- | ---- | ---- | UPCV* | ---- | ---- | ---- | ---- |
| | | | | | | | | |
| **Ku-Band Beams** | | | | | | | | |
| Central America and Caribbean | ---- | KSVU | KSHD KSHE | ---- | ---- | ---- | ---- | ---- |
| Europe and Greenland | KSHU | ---- | ---- | KSVD KSVE | ---- | ---- | ---- | ---- |
| 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.*