Engineering Statement

1) Introduction

Intelsat North America LLC ("Intelsat") proposes to launch and operate a new satellite designated as Galaxy KA at the orbital location of 89.1° W.L. Galaxy KA will provide service to the continental United States ("CONUS"), Hawaii, Puerto Rico and portions of Alaska from this orbital location in the frequency bands 29500 – 30000 MHz and 19700 to 20200 MHz. Additionally, Galaxy KA will use portions of the 5925 – 6425 MHz and 3700 – 4200 MHz frequency bands for telemetry, command and ranging.

Intelsat currently has pending before the Commission an application for authorization to launch and operate Galaxy KA from 89.1º W.L. (see FCC File No.: SAT-LOA-20090227-00029). In that application, Intelsat proposed service to North America as well as South America in the frequency bands 28350 – 28600 MHz, 29250 – 30000 MHz, 18300 – 18800 MHz and 19700 – 20200 MHz. Intelsat now proposes to modify the design of Galaxy KA so as to provide service only to North America on the frequency bands 29500 – 30000 MHz and 19700 – 20200 MHz and thus files this amendment to its pending application.

The characteristics of the Galaxy KA spacecraft 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.

2) Spacecraft Overview

Galaxy KA will be a 3-axis stabilized type spacecraft, with a rectangular cube main body that will support the antennas and electronics for the various subsystems. It will utilize two deployable reflector antennas, two deployable solar array wings and a bi-propellant propulsion system. A summary of the basic spacecraft characteristics is provided in Exhibit 1.

2.1) Structure

The structural design of Galaxy KA will provide mechanical support for all subsystems. It will also provide a stable platform for preserving the alignment of critical elements of the spacecraft.

The spacecraft will be comprised of a number of panels that will form a cubical structure. A number of internally placed auxiliary panels will be employed in order to enhance the rigidity of the spacecraft structure and in order to provide additional surface area upon which various electronic and/or non-electronic units may be mounted and/or housed.

The structure externally will support the communication antennas, command and telemetry antennas, the solar wings, Earth and sun sensors, and the spacecraft thrusters. Internally, the structure will house all of the spacecraft's electronic units, batteries, momentum/reaction wheels and the propellant tanks.

Galaxy KA will utilize two deployable reflector antennas to be located on the east and west sides of the spacecraft. It will also employ four wide coverage antennas ("WCAs") and an omni-directional bicone antenna for Telemetry, Command and Ranging ("TC&R"). The wide coverage antennas will be grouped into two transmit/receive pairs, with one pair located on the nadir (Earth facing) section of the spacecraft and the other pair located in the aft section. The bicone antenna will be mounted on the nadir side of the spacecraft. The spacecraft will also utilize one global horn antenna for Uplink Power Control ("ULPC"). The ULPC antenna will be mounted on the nadir side of the spacecraft.

The spacecraft will utilize two deployable solar wings, which will be extended when the spacecraft reaches its on-station orbital location. One solar wing will be located on the north side of the spacecraft and the other on the south side of the spacecraft. The solar wings will provide the mounting surfaces for the solar cells. Each solar wing will be connected to the main spacecraft structure through a dedicated Solar Array Drive Assembly ("SADA").

The main Liquid Apogee Engine ("LAE") will be located at the aft end of the spacecraft.

The Galaxy KA mass budget is provided in Exhibit 2.

2.2) <u>Thermal Subsystem</u>

Thermal control will be accomplished through the use of Optical Solar Reflectors ("OSRs"), heat pipes, Multilayer Insulation ("MLI") blankets and electrical heaters. The outer surface of the north and south panels will be covered with OSRs to maximize the heat rejection to space while minimizing the absorbed solar energy. The heat generated by high power units, e.g., TWTAs, OMUXs, etc., will be spread over the panels on which they will be mounted by means of heat pipes that will be embedded in the panels. MLI blankets will cover all external areas, except radiative areas. Heaters will be used to limit the lower temperature extremes of the electronics as well as the propulsion thrusters and propellant lines.

2.3) Power Subsystem

The Electrical Power Subsystem ("EPS") will generate, store, condition and protect the satellite's electrical power. It will provide the energy required to operate the satellite during all modes of operation. The EPS will consist of the solar arrays, batteries, associated power electronics, and power harnesses that will integrate and regulate the systems.

Galaxy KA will utilize two deployable solar array wings, with one wing located on the north side of the spacecraft and the other located on the south side of the spacecraft. Each solar wing will be composed of multiple solar panels. Each panel will support an array of solar cells. During launch, the solar array wings will be in the stowed position. However, once on station, the solar wings are deployed, with each wing extending out on the north and south sides of the spacecraft. The solar array is designed to provide power to the spacecraft for at least 15 years.

Power from the solar arrays is transferred to the spacecraft through the use of two Solar Array Drive Assemblies ("SADAs") – one for each solar wing. The SADAs also control the rotation of the solar wings.

During eclipse periods, rechargeable multiple cell batteries are the primary source of power to the spacecraft. The battery packs will be located near the aft section of the spacecraft and will be mounted on the north and south sides of the spacecraft.

The Galaxy KA EPS will be designed so that no single failure in the subsystem will cause a spacecraft failure. The EPS will provide sufficient power to the spacecraft throughout its design life to support all active communication channels as well as all necessary housekeeping loads. The beginning of life ("BOL") and end of life ("EOL") power budgets for Galaxy KA are provided in Exhibit 3.

2.4) <u>Attitude Control Subsystem</u>

The Attitude Control Subsystem ("ACS") will maintain the spacecraft attitude during the transfer orbit, initial acquisition period, and on-station geostationary operations. Additionally, the ACS will be responsible for re-acquisition of the spacecraft in case of emergency and its placement into a safe configuration.

The ACS will employ primary and redundant sun and earth sensors and inertial reference units to perform all attitude determination functions. Control of spacecraft attitude will be accomplished through the use of four-for-three redundant fixed momentum wheels and pulsed or continuous firing of selected thrusters by the ACS.

2.5) <u>Propulsion Subsystem</u>

The propulsion subsystem will provide impulse for the spacecraft maneuvering during all phases of the mission beginning with launch vehicle separation and through the operational lifetime of the satellite. The spacecraft will employ a dual mode propulsion system utilizing both bi-propellant and mono-propellant subsystems. The major features of the propulsion system are: 1) fuel tanks 2) oxidizer tanks, 3) Helium pressurant tanks, 4) the LAE, 5) auxiliary thrusters, 6) stationkeeping thrusters and 7) propellant management system utilizing Helium as pressurant.

Prior to the start of the transfer orbit, the propellant tanks will be pressurized by the activation of the pressure blow-down system, whereby pressurized Helium will be injected into the fuel and oxidizer tanks. The system will then be operated in bi-propellant mode using the LAE. In case of an anomaly with the main thruster, the auxiliary thrusters in conjunction with a number of the station-keeping thrusters will be utilized as back-up to complete the transfer orbit maneuvers.

Upon completion of transfer orbit operations, the bipropellant LAE will be isolated from the on-orbit operation system. This leaves the propulsion system in a blow-down configuration. On-orbit operation is performed through the use of the stationkeeping thrusters that will be mounted at various locations on the spacecraft.

The architecture of the propulsion systems is based on a low risk approach and is patterned after successful designs used throughout the industry utilizing space-proven or space-qualified components. The system will incorporate full redundancy for all critical components. All thrusters will have been flight qualified to more than 1.25 times the required throughput to complete the mission life.

2.6) Communication Subsystem

2.6.1) Overview

Galaxy KA will provide 8 active communication channels at Ka-band frequencies with each channel having a bandwidth of 110 MHz. The spacecraft provides coverage of CONUS, Hawaii, Puerto Rico and portions of Alaska. The Galaxy KA frequency and polarization plans are provided in Exhibit 4.

Galaxy KA will employ full frequency reuse through the use of orthogonal circular polarization. Accordingly, Galaxy KA is compliant with sections 25.210(b) and (d) of the Commission's rules.

2.6.2) Antennas and Beam Coverage

Galaxy KA will utilize a 2.5 meter Ka-band transmit/receive antenna deployed off the east side of the spacecraft; and a 2.5 meter Ka-band transmit/receive antenna deployed off the west side of the spacecraft. The coverage beams of the Galaxy KA communication antennas are shown in Exhibits 5A through 5D, in the format prescribed in section 25.114(d)(3) of the Commission's rules.

The peak Equivalent Isotropic Radiated Power ("EIRP") of the Ka-band CONUS transmit beams is 61.2 dBW. The peak G/T of the Ka-band CONUS receive beams is 6.5 dB/K. The minimum saturation flux density ("SFD") corresponding to the peak G/T point of the Ka-band CONUS receive beams is -98.2 dBW/m^2. The SFD at any G/T contour may be determined using the following formula:

$SFD_D = SFD_P + [(G/T)_P - (G/T)_D] + A$

where

SFD_D: SFD at desired G/T level (dBW/m^2)
SFD_P: Minimum SFD at peak G/T (dBW/m^2)
$(G/T)_D$: Desired G/T level (dB/K)
$(G/T)_P$: Peak G/T (dB/K)
A = Transponder attenuator setting (dB), ranging from 0 to 25 dB in 1 dB steps.

Exhibit 6 provides a detailed calculation of the EIRP, G/T and SFD of the Galaxy KA uplink and downlink beams.

The Galaxy KA uplink and downlink beams are designed to have a minimum cross-polarization of 30 dB or greater within the primary coverage area and are compliant with section 25.210(i)(1) of the Commission's rules.

2.6.3) Ka-band Transponder Description

Signals in the 29500 – 30000 MHz frequency bands are received by the appropriate receive antenna horn. The output of the receive antenna is routed through a diplexer, a test coupler, a band-pass filter and then to a set of Low Noise Amplifiers ("LNAs").

The LNAs will be arranged in a 4-for-2 redundancy ring. Each uplink can access one of four LNAs by ground command. From the LNAs, the signal is routed to two sets of hybrid units. Each hybrid unit splits the incoming signal into two. The outputs from the hybrids are connected to a 4-for-2 redundant set of frequency down-converters, which translates the Ka-band signal to the appropriate Ka-band transmission frequencies. Each Galaxy KA downconverter is able to maintain over the life of the spacecraft the frequency of the transmitted (downconverted) signal to within 0.002% of the desired value. Accordingly, Galaxy KA is compliant with the provisions of section 25.202(e) of the Commission's rules.

From the down-converters, the signal is routed to a set of IMUXs via multiple banks of hybrids and switches. The output of each selected IMUX is split into four (output signals) through a network of hybrids. The output of each hybrid is connected to a dedicated Linearized Channel Traveling Wave

Tube Amplifier ("LCTWTA") through a bank of redundancy switches. The redundancy switching permits the outputs of each IMUX (hybrid) to be routed to a redundant LCTWTA should the primary units fail or malfunction.

Each LCTWTA may operate in the fixed gain mode or in the automatic level control ("ALC") mode. When operating in the fixed gain mode, the gain of each channel (and its associated transponder saturation flux density) may be independently adjusted by changing the attenuation of its designated LCTWTA by ground command. Consequently, the output of each LCTWTA may be varied by ground command over a range of 25 dB in 1 dB increments. Accordingly, Galaxy KA is compliant with the provisions of section 25.210(c) of the Commission's rules. When operating in the ALC mode, the input power into the TWTA may be maintained at a specific level chosen within a range of 25 dB, in 1 dB increments.

Each Galaxy KA LCTWTA will utilize a Traveling Wave Tube Amplifier ("TWTA") which produces a nominal output power of 130 Watts. Galaxy KA will employ 40-for-32 redundancy with the Ka-band LCTWTAs. For each channel, the outputs from four LCTWTAs are combined to produce an aggregate output power of 520 Watts.

The (aggregate) output from each set four LCTWTA amplifiers is routed through a bank of switches to the appropriate Output Multiplexer ("OMUX") bank. The switching network allows the output of a redundant set of LCTWTAs to be forwarded to the appropriate OMUX should the primary units fail or malfunction. The output of each OMUX is connected to the transmit antenna (feed) via a bandpass filter, test coupler and a diplexer.

2.7) <u>Telemetry, Command and Ranging Subsystem</u>

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

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

The TC&R subsystem will consist of the following elements: 1) two circularly polarized Wide Coverage Antennas (“WCAs”) for commanding – one on the nadir side of the spacecraft and the other on the aft side; 2) two circularly polarized telemetry WCAs – one on the nadir side of the spacecraft and the other on the aft side; 3) one horizontally polarized, toroidal, omni-directional Bicone transmit/receive antenna; 4) one circularly polarized transmit/receive communication antenna; 5) two Ka-band command receivers; 6) two C-band command receivers 7) two Ka-band telemetry transmitters; 8) two C-band telemetry transmitters 9) data handling electronics including data encoders and decoders; 10) two 10 Watt C-band TWTAs and 11) two 30 Watt Ka-band TWTAs and 12) microwave components including filters, switches, couplers, isolators, cables and waveguide.

As shown in Exhibits 4A and 4B, Galaxy KA would utilize both C-band and Ka-band frequencies for telemetry, command and ranging. With respect to the use of C-band command and telemetry frequencies, Intelsat requests a waiver of Section 25.202(g) of the FCC’s rules. Intelsat intends to utilize the C-band TC&R channels only during orbit raising maneuvers and during emergency conditions. It is noted that Galaxy 28 is currently authorized to operate in the frequency bands 5925-6425 MHz and 3700-4200 MHz at 89º W.L. The proposed C-band TC&R frequencies for Galaxy KA, however, were chosen in a way that minimizes interference to and from Galaxy 28. In any case, during emergency conditions Intelsat willl internally coordinate the C-band TC&R transmission of Galaxy KA with the C-band transmissions of Galaxy 28.

With the exception of Galaxy 28, the nearest satellites that utilize C-band frequencies are Galaxy 17, operating from the nominal orbital location of 91° W.L., and AMC 3, operating from 87° W.L. Galaxy 17 is licensed to Intelsat and AMC 3 is licensed to SES World Skies. Given that 1) TC&R ground stations typically employ large transmit and receive antennas, 2) the maximum EIRP level (and EIRP density level) of the Galaxy KA telemetry carrier is low, as compared to typical communication carriers, and 3) that the off-axis power density level of the command carrier would be quite low, no significant interference to or from the TC&R and communication carriers of the adjacent satellites is expected. Accordingly, based on the aforementioned reasons, Intelsat believes that a waiver of section 25.202(g) of the FCC’s rules is justified.

2.7.1) Antennas

When on-station, command and telemetry signals are received and transmitted through Galaxy KA's right hand circularly polarized, CONUS coverage, communication antenna. The gain contours of the on-station command and telemetry beams are provided in Exhibits 5E and 5H, respectively.

During emergencies and transfer orbit operations, command and telemetry signals are received and transmitted through the WCAs and the Bicone antenna. For command, one WCA will be located on the front (or nadir) section of the spacecraft and one will be located on the aft section. Similarly, for telemetry, one WCA will be located on the nadir section of the spacecraft and one will be located on the aft section. The Bicone antenna will be located on the nadir side of the spacecraft. Representative gain graphs for the command and telemetry WCAs are provided in Exhibits 5F and 5I, respectively. Representative gain graphs for the command and telemetry Bicone antenna are provided in Exhibits 5G and 5J, respectively.

With respect to the command and telemetry Bicone antenna, Exhibit 5G and 5J each contains two antenna gain graphs. Diagram "a" shows the variation in the gain of the antenna at three elevation angles (-20º, 0º and +20º) referenced to the antenna axis with the azimuth varying from –160º and +160º. Diagram "b" shows the variation in the gain of the antenna at a representative azimuth of 0° referenced to the antenna axis with the elevation angle varying from -160º and +160º.

During emergency conditions, the Bicone antenna would be used, in conjunction with the WCAs, since its field of view is +/- 20º and the Earth disk is only +/- 8.7º. From Exhibits 5G and 5J, it is evident that the coverage of the Bicone antenna is relatively flat over the entire Earth. Specifically, as shown in Exhibits 5G(a) and 5J(a), the gain of the Bicone antenna varies by less than 3 dB at any given elevation angle (within ±20°) as the azimuth angle varies from -160° to +160°. Similarly as shown in Exhibit 5G(b) and 5J(b) at a given azimuth, the gain of the Bicone antenna changes by less than 3 dB as the elevation angle varies by ±20° about the antenna's peak gain points.

With regard to the wide coverage antennas, the graphs in Exhibits 5F and 5I show the variation in the gain of the antenna at 0° elevation angle, referenced to the (horizontal) plane on the center axis of the antenna aperture, with the azimuth varying from -120º and +120º. Given that the antennas are horn antennas having symmetrical gain performance about the center axis of the antenna aperture, the gain variation shown in Exhibits 5F and 5I is also representative of the case where the azimuth angle of the antenna is 0°, referenced to the (vertical) plane located at the center axis of the antenna aperture, with the elevation varying from -120° and +120°.

The field of view of the wide coverage antennas (±30º) envelopes the Earth disk (±8.7º). From Exhibits 5F and 5I it is evident that the coverage of the wide coverage antennas is relatively flat over the entire Earth and that the variation in gain will be typically less than 7 dB within the antennas' field of view.

The antenna gain diagrams associated with the TC&R Bicone and wide coverage antennas, shown in Exhibits 5F, 5G, 5I and 5J were not prepared in accordance with the parameters specified in Section 25.114(d)(3) of the Commission's rules due to the fact that typically satellite manufacturers do not provide the patterns in the required form. Given the specificity of the situation, it is our understanding that Exhibits 5F, 5G, 5I and 5J together with the descriptive characterization given in the previous paragraphs, fulfill the requirements of Section 25.114(d)(3). However, in case the Commission has a different understanding in this respect, a waiver of the requirements of Section 25.114(d)(3) of the FCC's rules with respect to the presentation of these antenna patterns is respectfully requested.

2.7.2) <u>Command</u>

The Galaxy KA command subsystem performance summary is provided in Exhibit 7. Detailed calculation of the G/T and SFD for each command beam is provided in Exhibit 8.

During on-station operations, commands are transmitted to the spacecraft by transmission of circularly polarized, FM signals on the frequency of 29996 and/or 29998 MHz. The 29996 MHz command signal is received by the spacecraft through the CONUS beam communication antenna and the 29998 MHz command signal is received through the two WCAs. The command signals are then multiplexed/combined and then routed to the two command receivers. The receivers amplify and demodulate the signal, and convert the command signal into a digital stream. The output of the command receivers are decoded and sent to the appropriate unit.

During transfer orbit or emergency operations, the operation of the command subsystem is similar to that for on-station operations, except that the transmitted command signals are received by the two WCAs and the Bicone antenna on the frequencies of 29998 MHz and 6422 MHz, respectively. Exhibit 4 provides the frequency and polarization plan for the Galaxy KA command channels.

2.7.3) Telemetry

The Galaxy KA telemetry subsystem performance summary is provided in Exhibit 7. Detailed calculation of the EIRP for each telemetry beam is provided in Exhibit 8.

During on-station operations, telemetry is transmitted by the spacecraft on two independent, circularly polarized, PM signals on the frequencies of 20195.5 MHz and 20196.5 MHz. The telemetry baseband data from the various spacecraft units are collected, processed, multiplexed, formatted and encoded onto subcarriers. The encoded baseband signal is then routed to two telemetry transmitters where the signal is modulated onto the main carrier frequencies of 20195.5 MHz and 20196.5 MHz. The output of the telemetry transmitters is then routed to the CONUS beam communication antenna for transmission to Earth.

During transfer orbit or emergency operations, the operation of the telemetry subsystem is similar to that for on-station operations, except that the output of each Ka-band telemetry transmitter is routed to a dedicated amplifier that generates up to 30 Watts of power and then to the WCAs. Additionally, spacecraft telemetry may be transmitted via two C-band telemetry transmitters. The output of each of the C-band telemetry transmitters is routed to a dedicated amplifier that produces up to 10 Watts of power. The amplified C-band telemetry signal is transmitted to Earth through the Bicone antenna. Exhibit 4 provides the frequency and polarization plan for the Galaxy KA telemetry channels.

2.7.4) Ranging

During all phases of the mission, the slant range of the spacecraft will be determined to a relatively high level of accuracy through the use of a multiple tone ranging system. The ranging tones selected are combined with the normal command data and modulated onto the command carrier and transmitted to the spacecraft. Once received by the spacecraft through the appropriate receiving antenna, the signal is routed to the command receiver where it is separated from the normal command data and routed directly to the spacecraft's telemetry transmitter. At the telemetry transmitter, the ranging signal is combined with other telemetry data and modulated onto the main telemetry carrier and transmitted to Earth through the appropriate spacecraft transmitting antenna. On the ground, the ranging tones are separated from the telemetry data, demodulated and their phase compared with that of the transmitted signal to determine the range of the satellite.

Because the ranging subsystem uses the command and telemetry subsystems, the descriptions of the operation of these two latter systems during on-station, transfer orbit and emergency conditions are applicable to the ranging subsystem as well. The performance summary of the Galaxy KA command, telemetry and ranging subsystems are provided in Exhibit 7.

2.8) Uplink Power Control Subsystem

Galaxy KA provides one Ka-band beacon which can be used for uplink power control ("ULPC"). The ULPC beacon is linearly polarized and operates on the frequency of 20199.5 MHz.

The characteristics of the ULPC beacon are provided in Exhibit 1. Detailed calculation of the EIRP for each ULPC beam is provided in Exhibit 6.

The ULPC frequency is generated by a 2-for-1 redundant transmitter. The output of the transmitter is transmitted to Earth through separate Ka-band global horn transmit antenna. The coverage pattern of the UPLC antenna is provided in Exhibit 5K.

2.9) Satellite Station-Keeping

The spacecraft will be maintained within 0.05° of its nominal position in the east-west direction as well as in the north-south direction. Accordingly, it is in compliance with the provisions of 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).

2.10) <u>Satellite Useful Lifetime</u>

The design lifetime of the satellite in orbit is 15 years. This has been determined by a conservative evaluation of the effect of the synchronous orbit environment on the solar array, the amount of fuel aboard the spacecraft, the effect of the charge-discharge cycling on the life of the battery, and the wear out of the amplifiers and other active units. The mass allocation of propellant for spacecraft station-keeping is at least 15 years. To enhance the probability of survival, equipment/unit redundancy is incorporated into the spacecraft design where possible. Materials and processes will be selected so that aging or wearing effects will not adversely affect spacecraft performance over the estimated life.

2.11) <u>Spacecraft Reliability</u>

Galaxy KA will be designed for an operational and mission life of at least 15 years. Life and reliability are maximized by incorporating flight proven or flight qualified units and designs to the greatest extent possible. All subsystems and units will have a minimum design life of 15 years. Redundancy concepts will be applied to all critical components. All avoidable single-point failure modes will have been eliminated.

The projected reliability of the payload is 88.2%. The projected reliability of the bus system is 85.8%. The overall reliability of the Galaxy KA spacecraft is projected to be 75.7%. The subsystem reliability assessments were based upon the use of failure rates, modeling assumptions from previous spacecraft programs and those specific to Galaxy KA.

3.0) <u>Emission Limitations</u>

The Galaxy KA receiver and transmitter channel filter response characteristics are provided in Exhibit 9, as required under section 25.114(c)(4)(vii) of the Commission's rules.

Intelsat will comply with the provisions of 25.202(f) of the Commission's rules with regard to Galaxy KA emissions.

4.0) <u>Service Area</u>

The primary service area of Galaxy KA is the continental United States Hawaii, Puerto Rico and portions of Alaska.

5.0) <u>Orbital Location</u>

Intelsat requests that it be assigned the 89.1° W.L. orbital location for Galaxy KA. The 89.1° W.L. location satisfies Galaxy KA requirements for optimizing coverage, elevation angles and service availability and ensures that maximum operational, economic and public interest benefits will be derived.

6.0) <u>Orbital Arc Limitations</u>

Galaxy KA is intended to provide video, audio and data services within the service area described above. The 89.1° W.L. position affords reasonable earth station angles in this service area. The attractiveness of Galaxy KA to this market would be severely diminished if service to this area is not possible.

7.0) <u>Services and Emission Designators</u>

Galaxy KA is to be a general purpose communications satellite and has been designed to support a wide variety of services. Depending upon the needs of the users, the transponders on Galaxy KA can accommodate television, radio, voice or data communications. Typical types of communication services to be offered include:

a) Compressed digital video
b) High speed digital data

c) Digital single channel per carrier ("SCPC") data channels
d) Digital SCPC with 64 kbps data rates

Emission designators and allocated bandwidths for representative communication carriers, telemetry and command signals are provided in Exhibit 10.

Intelsat does not contemplate transmitting any analog TV/FM carriers via Galaxy KA. However, should Intelsat require to place analog video carriers, it shall coordinate the operation of these carriers with all the affected adjacent satellite operators prior to initiating such transmissions.

8.0) Power Flux Density ("PFD")

The power flux density limits for space stations are specified in section 25.138(a)(6) of the Commission's rules for the 19700 – 20200 MHz frequency band. For the 3700 – 4200 MHz frequency band, the power flux density limits for space stations are specified in section 25.208(a).

For these frequency bands, the power flux density ("PFD") level at the Earth's surface produced by Galaxy KA was calculated for each of the emissions specified in Exhibit 10. The PFD level at the Earth's surface was also calculated for the Galaxy KA telemetry and ULPC carrier. As shown in Exhibit 11, the downlink PFD levels of Galaxy KA carriers do not exceed the limits specified in Sections 25.208(a) and 25.138(a)(6) of the FCC's rules. Intelsat does not intend to transmit any TV/FM carriers through Galaxy KA.

9.0) Galaxy KA Carrier Link Analysis

At Ka-band frequencies, link analysis for Galaxy KA was conducted for a number of representative carriers. For the analyses, it was assumed that the nearest satellites to Galaxy KA was a hypothetical satellite operating from 87.1° W.L. and a hypothetical satellite operating from 91.1° W.L. The hypothetical satellites were assumed to have the same operational parameters as Galaxy KA.

Other assumptions made for the link budget analysis were as follows:

a) In the plane of the geostationary satellite orbit, all transmitting and receiving earth station antennas have off-axis co-polar gains that are compliant with the limits specified in section 25.209(a)(2) of the FCC's rules.

b) All transmitting and receiving earth stations have a cross-polarization isolation value of at least 30 dB within their main beam lobe.
c) At Ka-band frequencies rain attenuation predictions are derived using Recommendation ITU-R P.618-8.
d) At Ka-band frequencies, increase in noise temperature of the receiving earth station due to rain is taken into account.
e) At Ka-band frequencies, attenuation due to oxygen absorption was taken into account.
f) For the cases where the transponder operates in a multi-carrier mode, the effects due to intermodulation interference are taken into account.

The results of the Ka-band analysis are shown in Exhibit 12 and demonstrate that operation of the Galaxy KA satellite from 89.1º W.L., within a two-degree environment, would permit the intended services to achieve their respective performance objectives while maintaining sufficient link margin. Additionally, the EIRP density levels of the carriers listed in Exhibit 12 comply with the limits contained in section 25.138(a) of the Commission's rules.

Intelsat is currently authorized to operate Galaxy 28 at 89º W.L. and this satellite includes the frequency bands 29500-30000 MHz and 19700-20200 MHz. As Galaxy KA is meant to replace the Ka-band payload on Galaxy 28, Intelsat does not anticipate operating the Ka-band payload on Galaxy 28 once Galaxy KA is operational at 89.1º W.L.

10.0) Adjacent Satellite Link Analysis

The impact of the Galaxy KA emissions on the transmissions of adjacent satellites was not analyzed. This is due to Intelsat's intent to limit the power level of Galaxy KA transmissions to those levels contained in sections 25.138(a) of the FCC's rules. In those cases where Intelsat may require to transmit carriers with power levels in excess of those in 25.138(a), it will coordinate its emissions with other adjacent operators so as to limit the level of interference that is caused and received by Galaxy Ka and any future satellites that may occupy the 87.1° W.L. and/or 91.1° W.L. orbital locations.

11.0) Schedule S Submission

Intelsat is providing with its application a Schedule S for the operations of Galaxy KA at 89.1º W.L. It is noted that the antenna gain patterns for the Galaxy KA command and telemetry Bicone and WCA antennas were included in column "e" (instead of column "f") of section S8 of the Schedule S, since they are not in GXT format (see section 2.7.1).

In column "g" of section S13 of the Schedule S, a link budget file has been included for the first link (i.e. the first row of data) contained in that section. This link budget file is applicable to all of the links listed in section S13 and should have been included with each row of data in that section of the Schedule S. However, given that the link budget file is rather large and its inclusion with each link (or data row) would lead to the Schedule S file having an unmanageable size, all other links (or rows of data) contain a small ASCII file that references the link budget file that is attached to the first link (i.e. the link budget file attached to the first row of data).

12.0) 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:

12.1) 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 will be located inside the protective body of the spacecraft and properly shielded; and (2) all spacecraft subsystems will have redundant components to ensure no single-point failures. The spacecraft will not use any subsystems for end-of-life disposal that are not used for normal operations.

12.2) 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 will be isolated using redundant valves and electrical power systems will be 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, isolating the batteries from the spacecraft bus, and turning off all active units.

12.3) 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. Galaxy KA will not be located at the same orbital location as another satellite or at an orbital location that has an overlapping station-keeping volume with another satellite.

The proposed orbital location for Galaxy KA is 89.1° W.L. Intelsat notes that ViaSat, Inc. has recently filed with the FCC seeking authorization to operate a Ka-band satellite at 89.1º W.L. (see FCC File No.: SAT-LOA-20100217-00029). Intelsat will work with ViaSat, Inc. to ensure that both satellites can be safely operated. 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 Galaxy KA. Intelsat is also not aware of any system with an overlapping station-keeping volume with Galaxy KA that is the subject of an ITU filing and that is either in orbit or progressing towards launch.

12.4) Post Mission Disposal

At the end of the mission, Intelsat will dispose of the spacecraft by moving it to a minimum altitude of 300 kilometers above the geostationary arc. This exceeds the minimum altitude established by the IADC formula. The Galaxy KA design currently contemplates that 14.8 kilograms of fuel will be reserved for this purpose. The reserved fuel figure will be provided for in the propellant budget. To calculate this figure, the "rocket equation" was used, 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. For reference, the effective area to mass ratios (Cr*A/M) of the Galaxy KA spacecraft is expected to be 0.04 m^2/kg, resulting in a minimum perigee disposal altitude under the IADC formula of at most 279.8 kilometers above the geostationary arc, which is lower than the 300 kilometer above geostationary disposal altitude specified by Intelsat in this filing. Accordingly, the Galaxy KA planned disposal orbit complies with the FCC's rules.

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/ Jose Albuquerque
Jose Albuquerque
Intelsat Corporation
Senior Director, Spectrum Engineering

March 1, 2010
Date

EXHIBIT 1: SUMMARY OF SPACECRAFT CHARACTERISTICS

GENERAL	
Orbital Location	89.1° WL
Spacecraft Type	3-axis stabilized
Spacecraft Dimensions	
Length	24.8 meters
Width	6.4 meters
Depth	6.4meters
Spacecraft Mass	
Mass w/o fuel	2181 kg
Mass w/ fuel	4580 kg
Spacecraft Expected Lifetime	> 15 years
Eclipse Capability	100%
Station-keeping	
North-South	±0.05°
East-West	±0.05°
Antenna Pointing Accuracy	
North-South	0.11°
East-West	0.11°
Rotational	0.11°
Spacecraft Reliability	75.7%
Payload Reliability	88.2%
Bus Reliability	85.8%
Propulsion Type	Bi-propellant
Maximum Solar Array Power	
Beginning of Life	12149Watts
End of Life	11045Watts
Deployed Area of Solar Array	74.5 m^2

EXHIBIT 1: SUMMARY OF SPACECRAFT CHARACTERISTICS (continued)

COMMUNICATION	
Frequency Bands	
Uplink	29500 – 30000 MHz
Downlink	19700 – 20200 MHz
Polarization	
Uplink	Right Hand Circular / Left Hand Circular
Downlink	Right Hand Circular / Left Hand Circular
Coverage Area	
Uplink	Continental United States ("CONUS"), Alaska, Hawaii, Puerto Rico
Downlink	Continental United States ("CONUS"), Alaska, Hawaii, Puerto Rico
Beam Cross-Polarization Isolation	
Uplink	≥ 30 dB
Downlink	≥ 30 dB
Number of Channels	16
Channel Bandwidth	110 MHz
Maximum Downlink EIRP	
CONUS Beam	61.2 dBW
Maximum Uplink G/T	
CONUS Beam	6.5 dB/K
Uplink SFD Range @ Maximum G/T	
CONUS Beam	-98.2 to -73.2 dBW/m^2
Transponder Range	
Fixed Gain Mode	25 dB in 1 dB increments
Automatic Level Control Mode	25 dB
Transponder Gain	
CONUS Uplink-to-CONUS Downlink	139.8 dB – 114.8 dB

EXHIBIT 1: SUMMARY OF SPACECRAFT CHARACTERISTICS (continued)

COMMUNICATION	
Unit Redundancy	
Low Noise Amplifiers (“LNAs”)	4-for-2
Frequency Downconverters (per frequency set)	4-for-2
Amplifiers	40-for-32
Maximum Power of Last Amplifier Stage	130 Watts
Transmit Frequency Stability	< 0.002%
TELEMETRY, COMMAND & RANGING	
Command Frequency	
Bicone Antenna	6422 MHz
Wide Coverage Antenna (“WCA”)	29998 MHz
CONUS Communication Receive Antenna	29996 MHz
Command Polarization	
Bicone Antenna	Linear Horizontal
Wide Coverage Antenna (“WCA”)	Left Hand Circular
CONUS Communication Receive Antenna	Right Hand Circular
Command Carrier Modulation	FM
Command Carrier Bandwidth	
Occupied Bandwidth	860 kHz
Allocated Bandwidth	1000 kHz
Command Antennas	
Transfer Orbit / Emergency	2 WCAs and/ or Bicone Antenna
On-Station	CONUS Communication Antenna or 2 WCAs
Command Threshold at Beam Peak	
Bicone Antenna	-91.8 dBW/m^2
Wide Coverage Antenna (“WCA”)	-100.2 dBW/m^2
CONUS Communication Receive Antenna	-115.0 dBW/m^2
Command G/T at Beam Peak	
Bicone Antenna	-30.8 dB/K
Wide Coverage Antenna (“WCA”)	-16.4 dB/K
CONUS Communication Receive Antenna	-1.6 dB/K

EXHIBIT 1: SUMMARY OF SPACECRAFT CHARACTERISTICS
(continued)

TELEMETRY, COMMAND & RANGING	
Telemetry Frequency	
Bicone Antenna	4198.75 / 4199.25 MHz
Wide Coverage Antenna ("WCA")	20195.5 / 20196.5 MHz
CONUS Communication Transmit Antenna	20195.5 / 20196.5 MHz
Telemetry Polarization	
Bicone Antenna	Linear Horizontal
Wide Coverage Antenna ("WCA")	Left Hand Circular
CONUS Communication Transmit Antenna	Right Hand Circular
Telemetry Modulation	PM
Telemetry Carrier Bandwidth	
Occupied Bandwidth	250 kHz
Allocated Bandwidth	500 kHz
Telemetry Antenna	
Transfer Orbit / Emergency	2 WCAs and/or Bicone Antenna
On-Station	CONUS Communication Transmit Antenna
Telemetry EIRP at Beam Peak	
Bicone Antenna	11.6 dBW
Wide Coverage Antenna ("WCA")	26.5 dBW
CONUS Communication Transmit Antenna	29.5 dBW
Ranging Accuracy	≤ 10 meters
Uplink Power Control ("ULPC")	
Frequency	20199.5 MHz
Polarization	Linear Vertical
Coverage Area	Global
Number of channels	1
Channel Bandwidth	25 kHz
Maximum Downlink EIRP	15.2 dBW

EXHIBIT 2: SPACECRAFT MASS BUDGET

Mass of Spacecraft without Fuel (kg)	2181
Mass of Fuel and Disposables (kg)	2399
Launch Mass (kg)	4580
Mass of Fuel, in orbit, at Beginning of Life (kg)	633

EXHIBIT 3: SPACECRAFT POWER BUDGET

	BEGINNING OF LIFE		END OF LIFE	
	AUTUMN EQUINOX	SUMMER SOLSTICE	AUTUMN EQUINOX	SUMMER SOLSTICE
PAYLOAD (WATTS)	7538	7538	7538	7538
BUS (WATTS)	1508	1508	1508	1508
TOTAL POWER (WATTS)	9046	9046	9046	9046
SOLAR ARRAY POWER (WATTS)	12149	10945	11045	9950
DEPTH OF BATTERY DISCHARGE (%)	73.2%	N/A	76.3%	N/A

EXHIBIT 4A: FREQUENCY PLAN

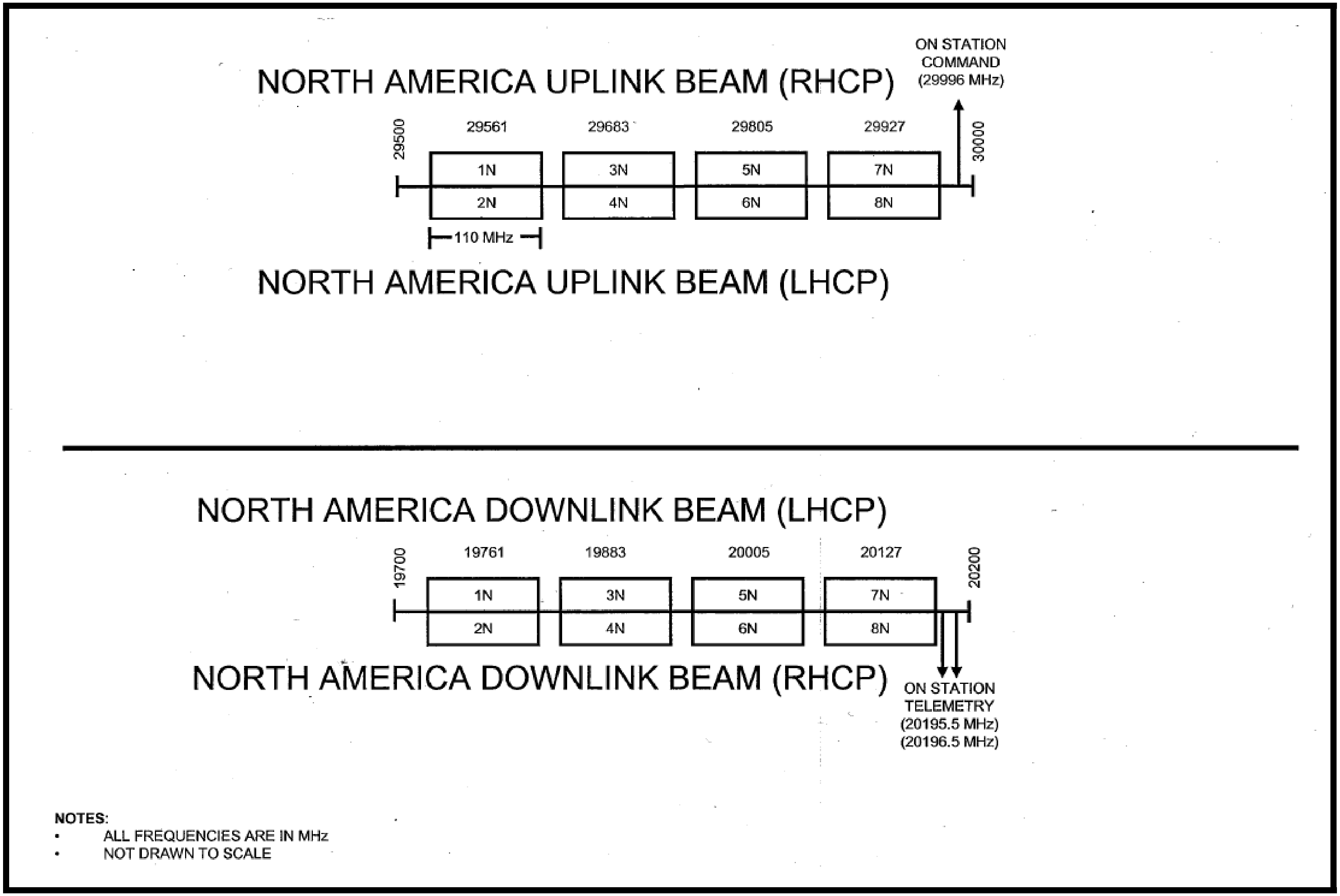


EXHIBIT 4A: FREQUENCY PLAN (continued)

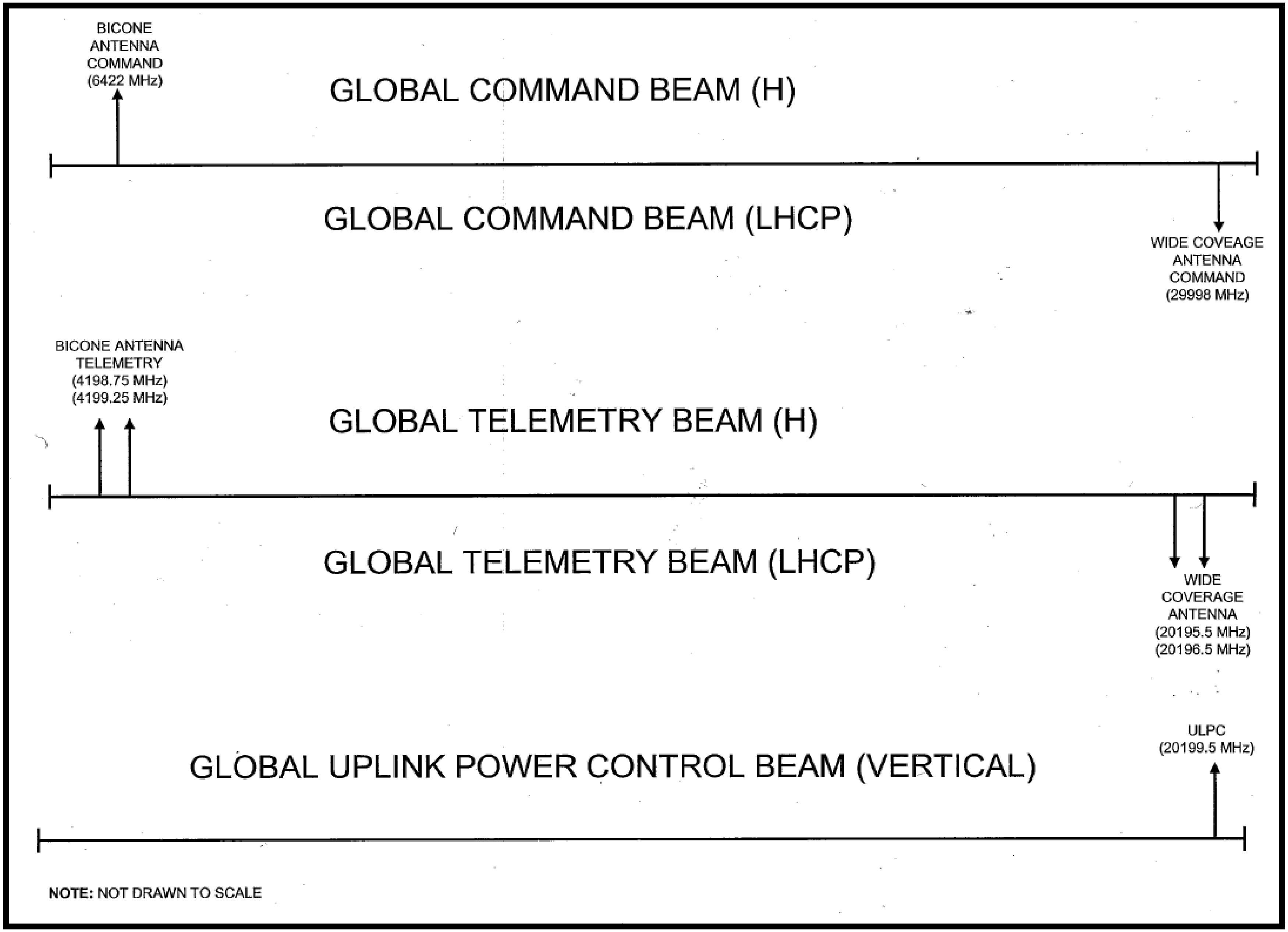


EXHIBIT 4B: FREQUENCY ASSIGNMENTS

Uplink Transponder Designation	Uplink Beam Name	Uplink Polarization	Uplink Center Frequency (MHz)	Downlink Transponder Designation	Downlink Beam Name	Downlink Polarization	Downlink Center Frequency (MHz)	Channel Bandwidth (MHz)	Maximum Channel Gain (dB)
1N	North America	RHCP	29561	1N	North America	LHCP	19761	110	139.8
3N	North America	RHCP	29683	3N	North America	LHCP	19883	110	139.8
5N	North America	RHCP	29805	5N	North America	LHCP	20005	110	139.8
7N	North America	RHCP	29927	7N	North America	LHCP	20127	110	139.8
2N	North America	LHCP	29561	2N	North America	RHCP	19761	110	139.8
4N	North America	LHCP	29683	4N	North America	RHCP	19883	110	139.8
6N	North America	LHCP	29805	6N	North America	RHCP	20005	110	139.8
8N	North America	LHCP	29927	8N	North America	RHCP	20127	110	139.8
CMD1	North America	RHCP	29996					1.0	
CMD2	Global	LHCP	29998					1.0	
CMD 3	Global	H	6422					1.0	
				TLM1	North America	RHCP	20195.5	0.5	
				TLM2	North America	RHCP	20196.5	0.5	
				TLM3	Global	LHCP	20195.5	0.5	
				TLM4	Global	LHCP	20196.5	0.5	
				TLM5	Global	H	4198.75	0.5	
				TLM6	Global	H	4199.25	0.5	
				UPC1	Global	V	20199.5	0.025	

Notes:
RHCP: Right Hand Circular Polarization
LHCP: Left Hand Circular Polarization
H: Linear Horizontal Polarization
V: Linear Vertical Polarization

EXHIBIT 5A: NORTH AMERICA RECEIVE BEAM

Beam Polarization: Right Hand Circular
Peak Antenna Gain: 35.5 dBi
Peak G/T: 6.5 dB/K
Saturated Flux Density at Peak G/T: -98.2 to -73.2 dBW/m^2
(Schedule S Beam Designation: NRFR)

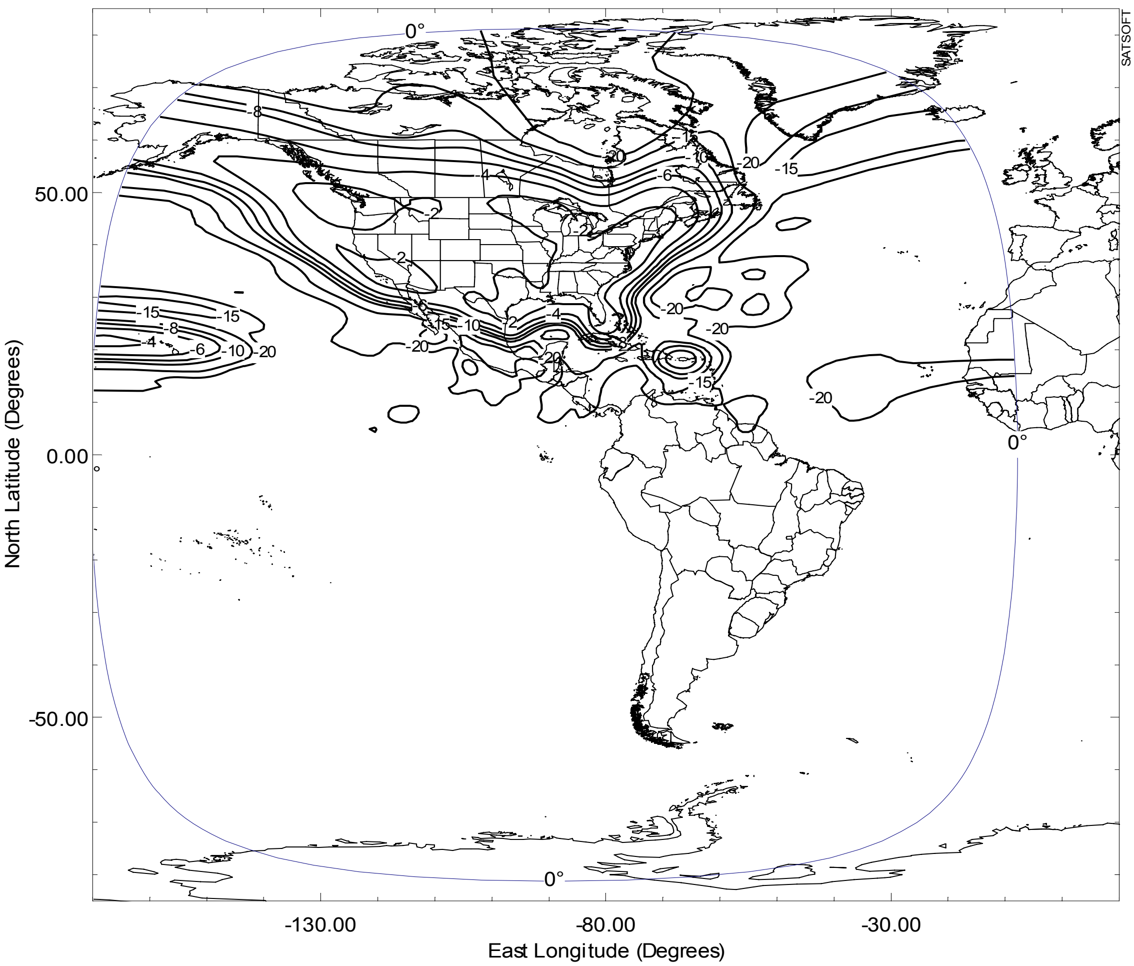


EXHIBIT 5B: NORTH AMERICA RECEIVE BEAM

Beam Polarization: Left Hand Circular
Peak Antenna Gain: 35.5 dBi
Peak G/T: 6.5 dB/K
Saturated Flux Density at Peak G/T: -98.2 to -73.2 dBW/m^2
(Schedule S Beam Designation: NRFL)

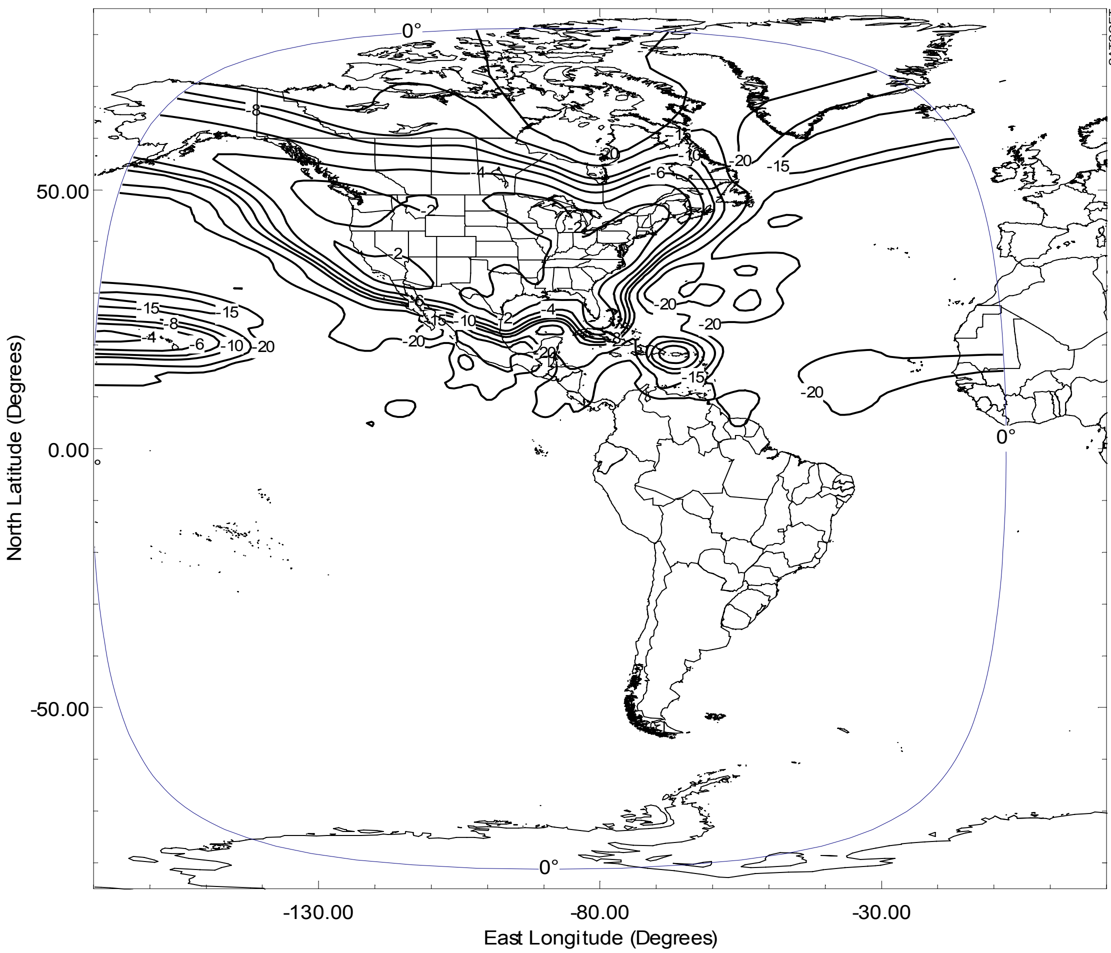


EXHIBIT 5C: NORTH AMERICA TRANSMIT BEAM

Beam Polarization: Right Hand Circular
Peak Antenna Gain: 35.0 dBi
Peak EIRP: 61.2 dBW
(Schedule S Beam Designation: NTFR)

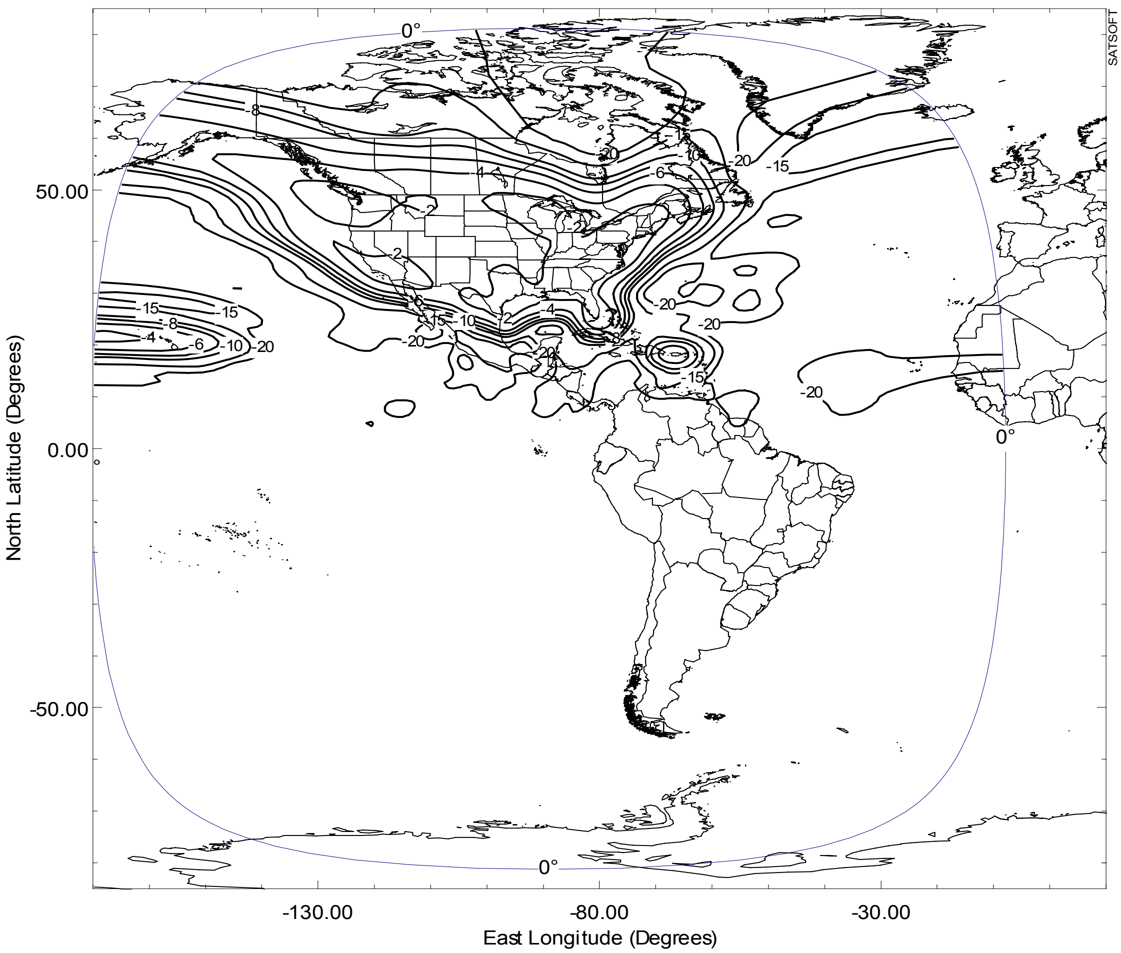


EXHIBIT 5D: NORTH AMERICA TRANSMIT BEAM

Beam Polarization: Left Hand Circular
Peak Antenna Gain: 35.0 dBi
Peak EIRP: 61.2 dBW
(Schedule S Beam Designation: NTFL)

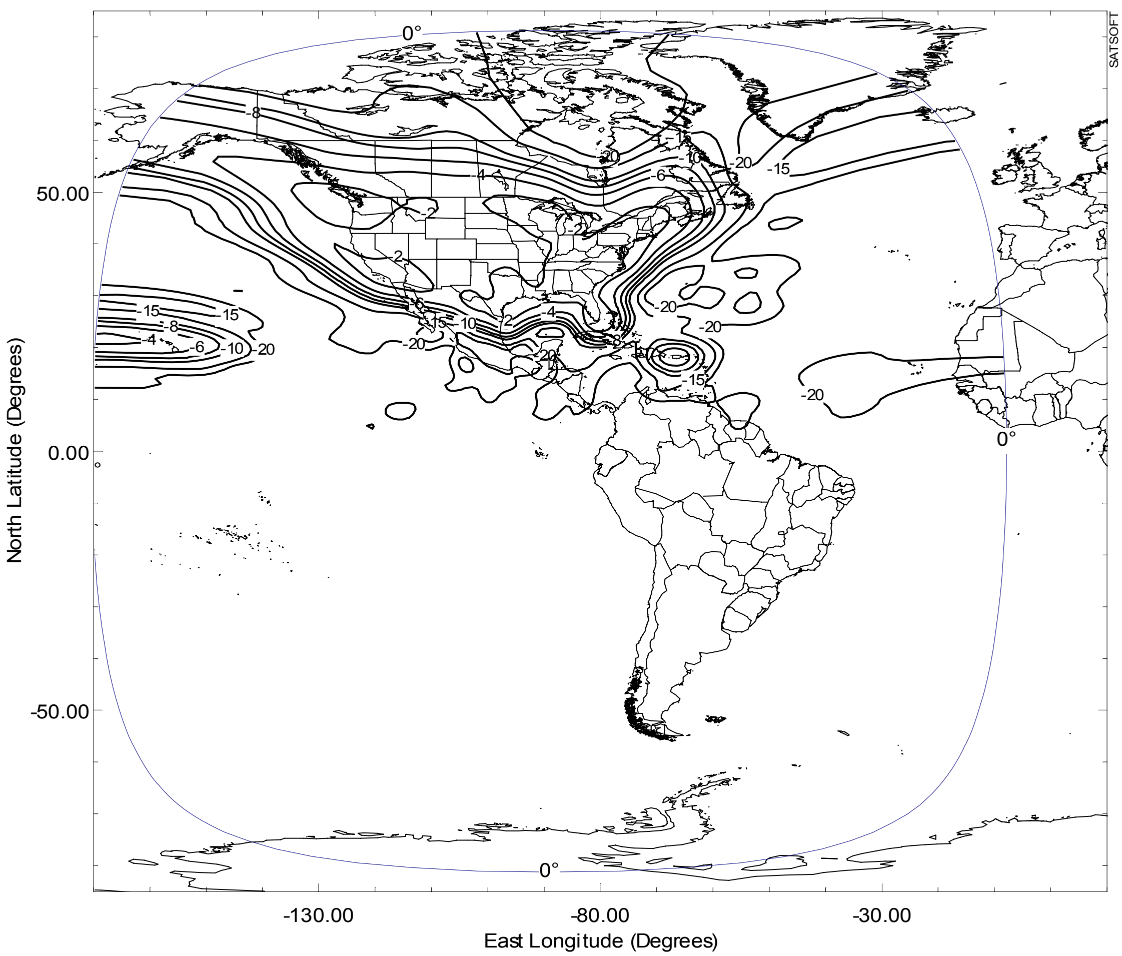


EXHIBIT 5E: ON-STATION COMMAND BEAM

Beam Polarization: Right Hand Circular
Peak Antenna Gain: 35.5 dBi
Peak G/T: -1.6 dB/K
Command Threshold Flux Density at Peak G/T: -115 dBW/m^2
(Schedule S Beam Designation: CMDC)

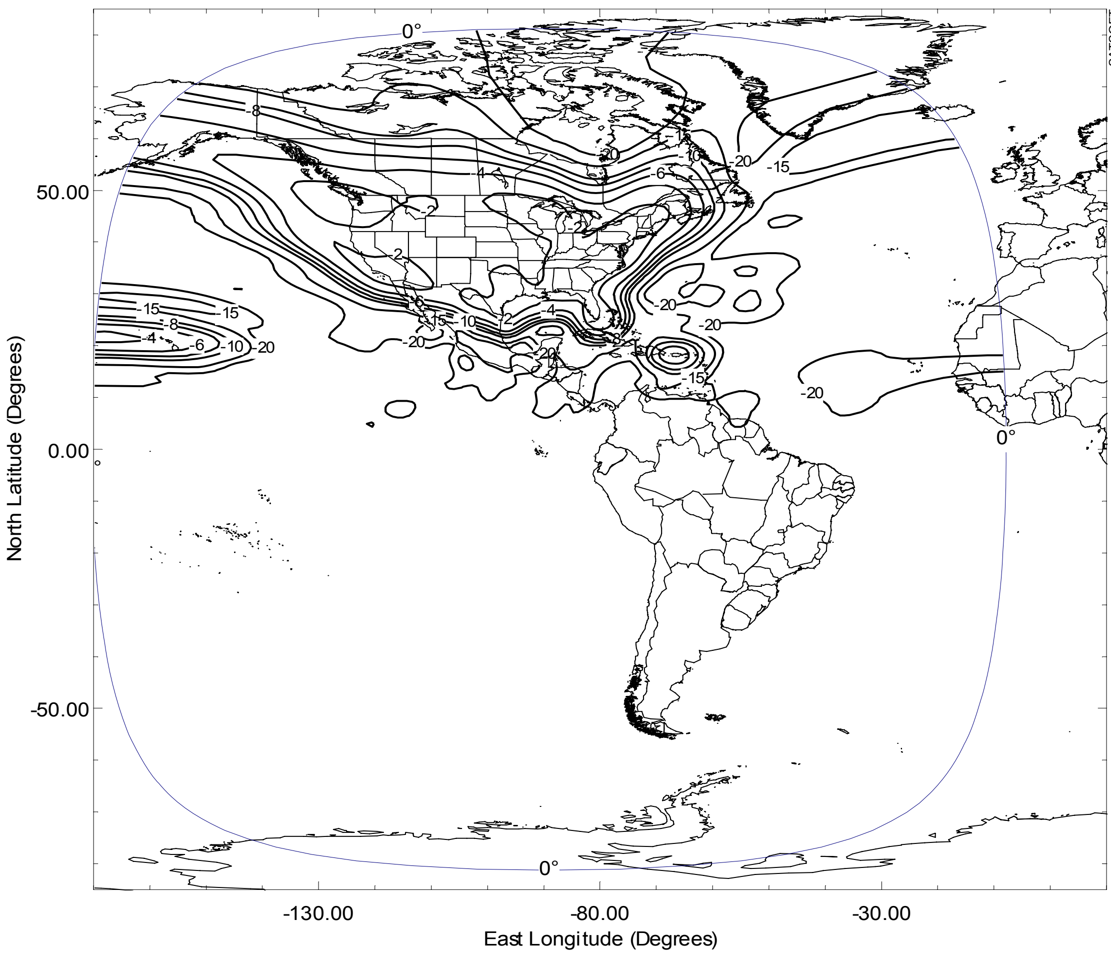


EXHIBIT 5F: BACK-UP COMMAND BEAM

Beam Polarization: Left Hand Circular
Peak Antenna Gain: 13.2 dBi
Peak G/T: -16.4 dB/K
Command Threshold Flux Density at Peak G/T: -100.2 dBW/m^2
(Schedule S Beam Designation: CMDW)

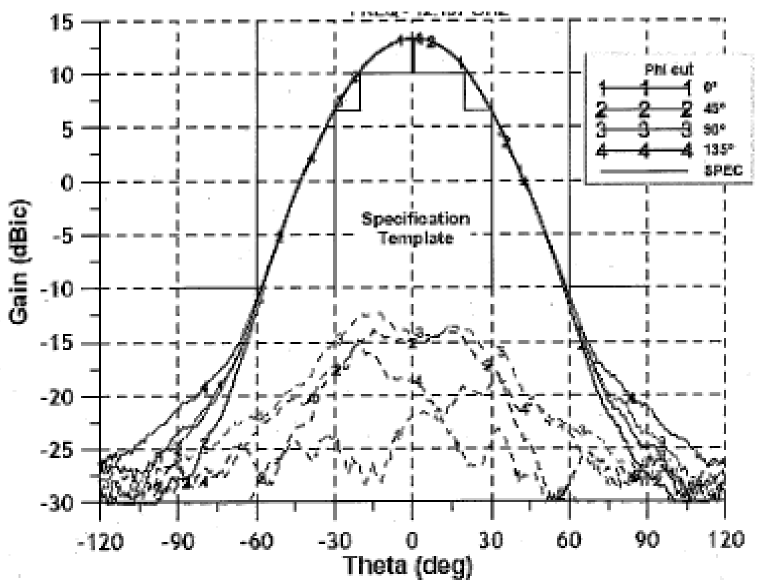
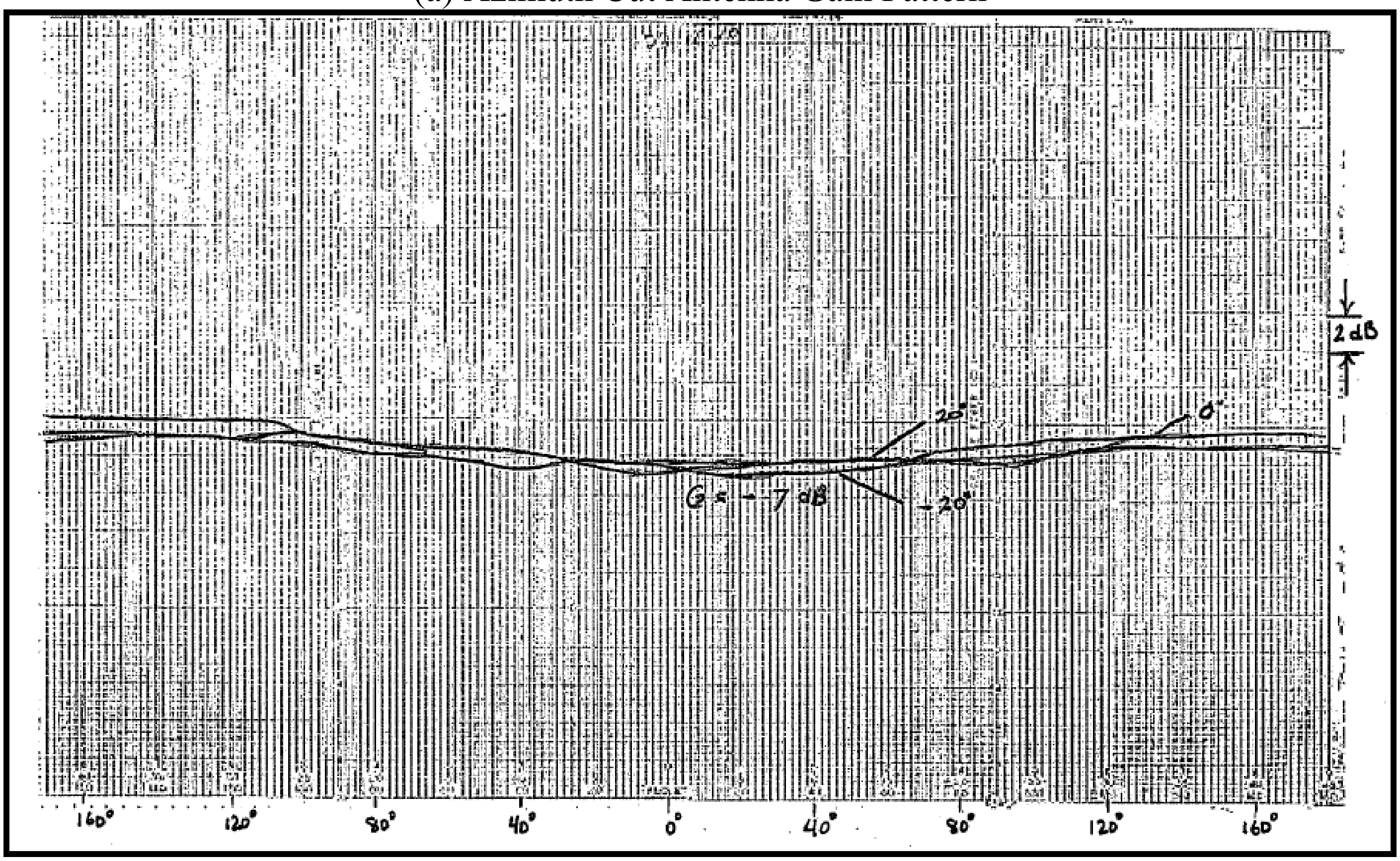


EXHIBIT 5G: BACK-UP COMMAND BEAM

Beam Polarization: Linear Horizontal
Peak Antenna Gain: 2.2 dBi
Peak G/T: -30.8 dB/K
Command Threshold Flux Density at Peak G/T: -91.8 dBW/m^2
(Schedule S Beam Designation: CMDB)

(a) Azimuth Cut Antenna Gain Pattern

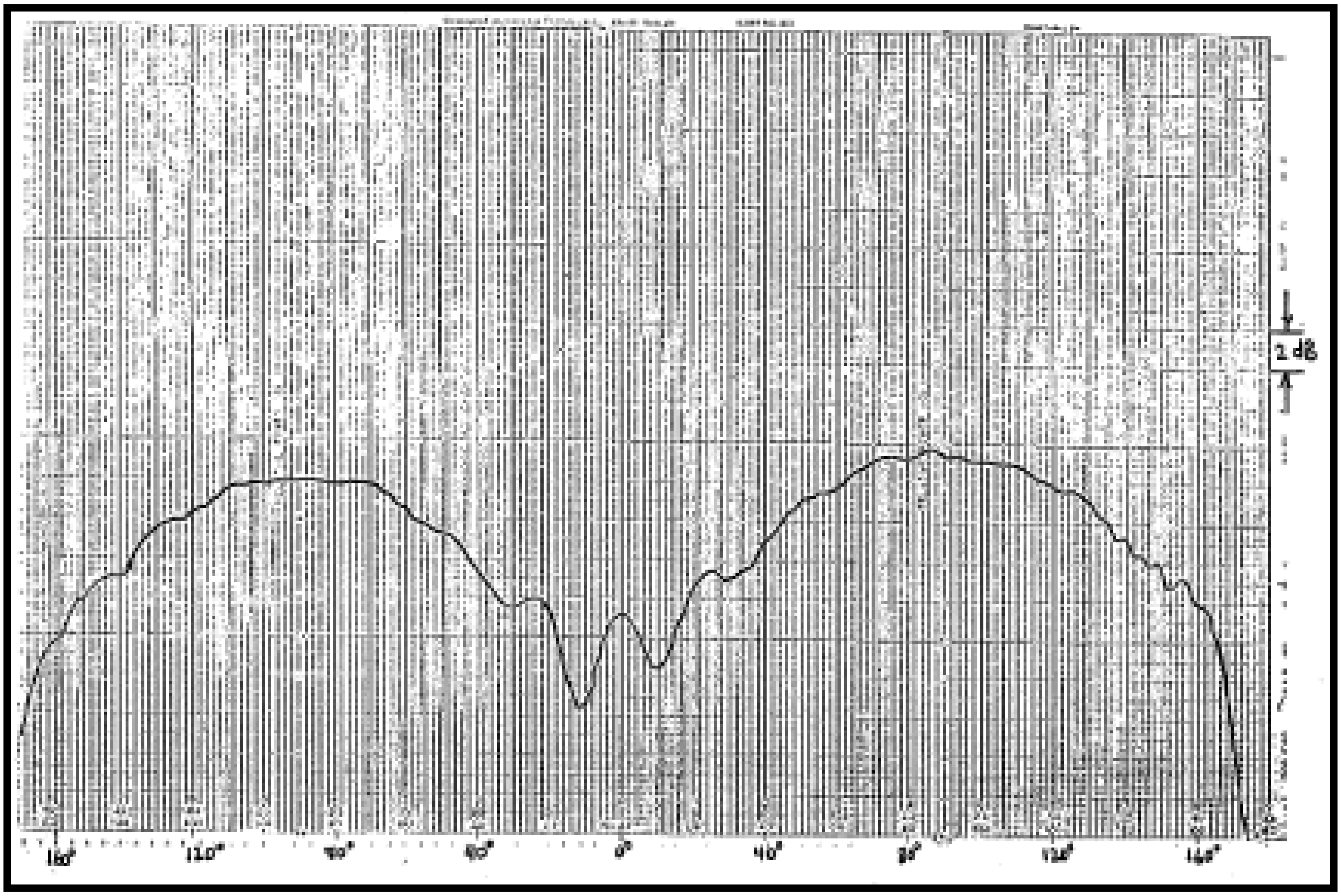


Notes:
1) Gain variation in azimuth shown for elevation angles of 0° and ±20°.
2) The x-axis represents the azimuth angle and spans from -160° to +160°.
3) The y-axis represents the antenna gain.

EXHIBIT 5G: BACK-UP COMMAND BEAM (continued)

Beam Polarization: Linear Horizontal
Peak Antenna Gain: 2.2 dBi
Peak G/T: -30.8 dB/K
Command Threshold Flux Density at Peak G/T: -91.8 dBW/m^2
(Schedule S Beam Designation: CMDB)

(b) Elevation Cut Antenna Gain Pattern



Notes:
1) Gain variation in elevation shown for the azimuth angle of 0°.
2) The x-axis represents the elevation angle and spans from -160° to +160°.
3) The y-axis represents the antenna gain.

EXHIBIT 5H: ON-STATION TELEMETRY BEAM

Beam Polarization: Right Hand Circular
Peak Antenna Gain: 35.0 dBi
Peak EIRP: 29.5 dBW
(Schedule S Beam Designation: TLMC)

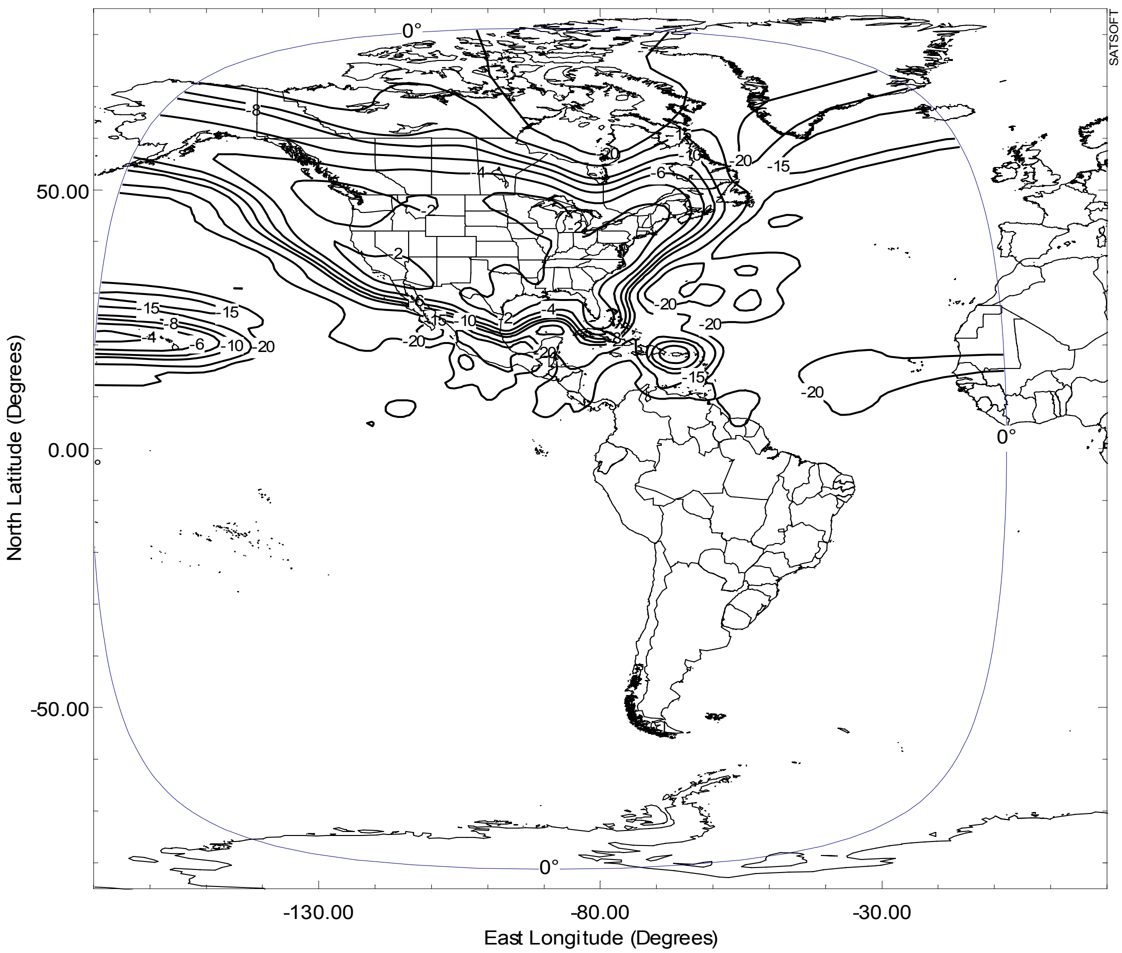


EXHIBIT 5I: BACK-UP TELEMETRY BEAM

Beam Polarization: Left Hand Circular
Peak Antenna Gain: 13.2 dBi
Peak EIRP: 26.5 dBW
(Schedule S Beam Designation: TLMW)

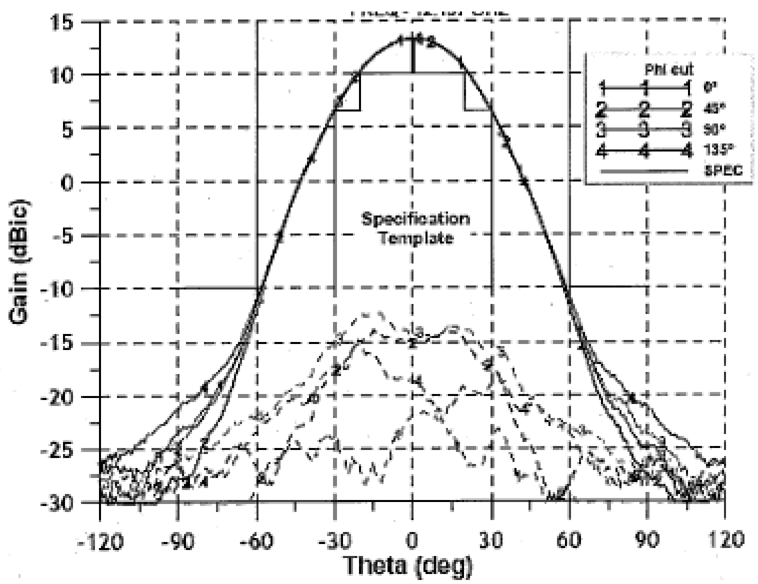


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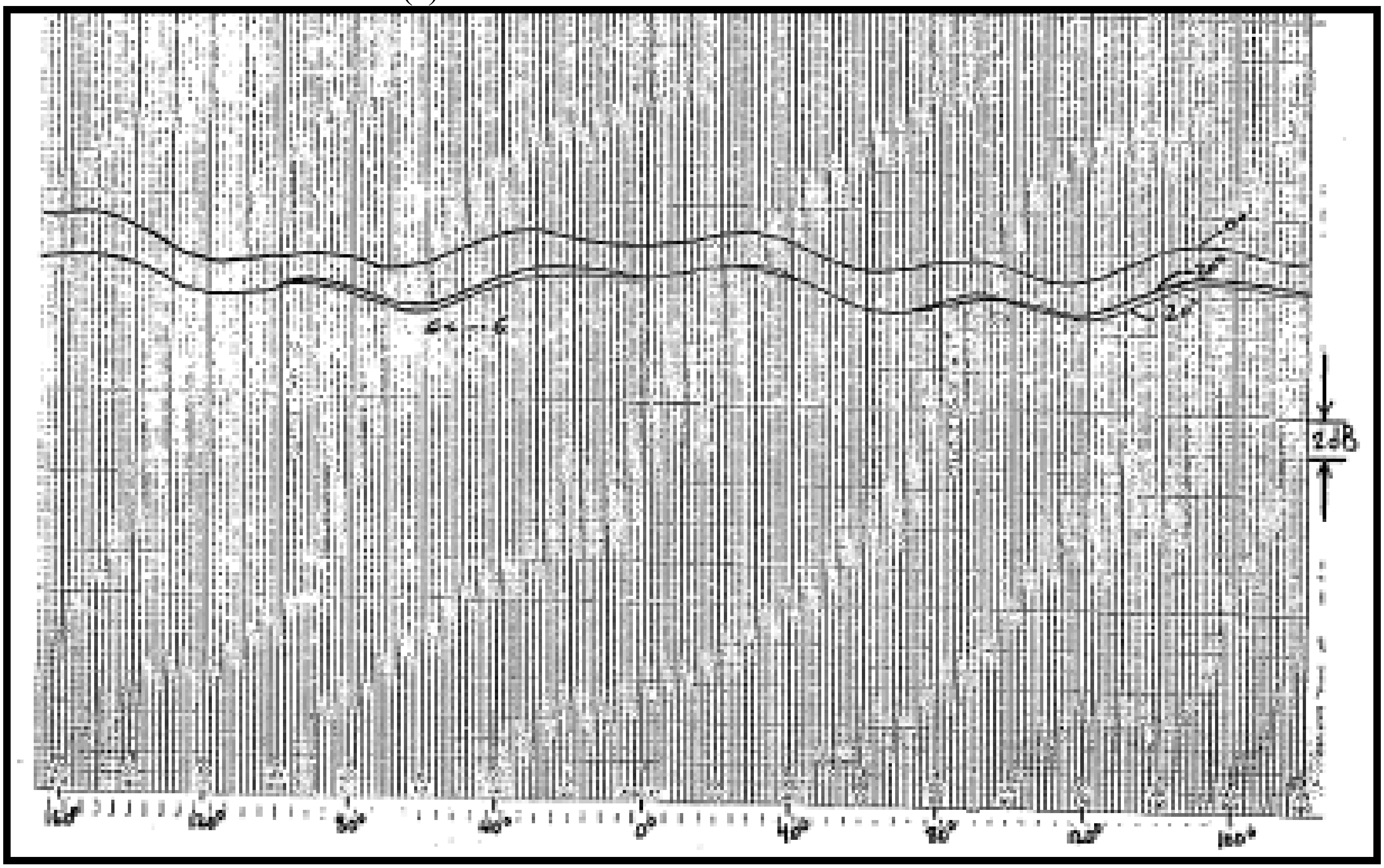
EXHIBIT 5J: BACK-UP TELEMETRY BEAM

Beam Polarization: Linear Horizontal
Peak Antenna Gain: 2.7 dBi
Peak EIRP: 11.6 dBW
(Schedule S Beam Designation: TLMB)

(a) Azimuth Cut Antenna Gain Pattern

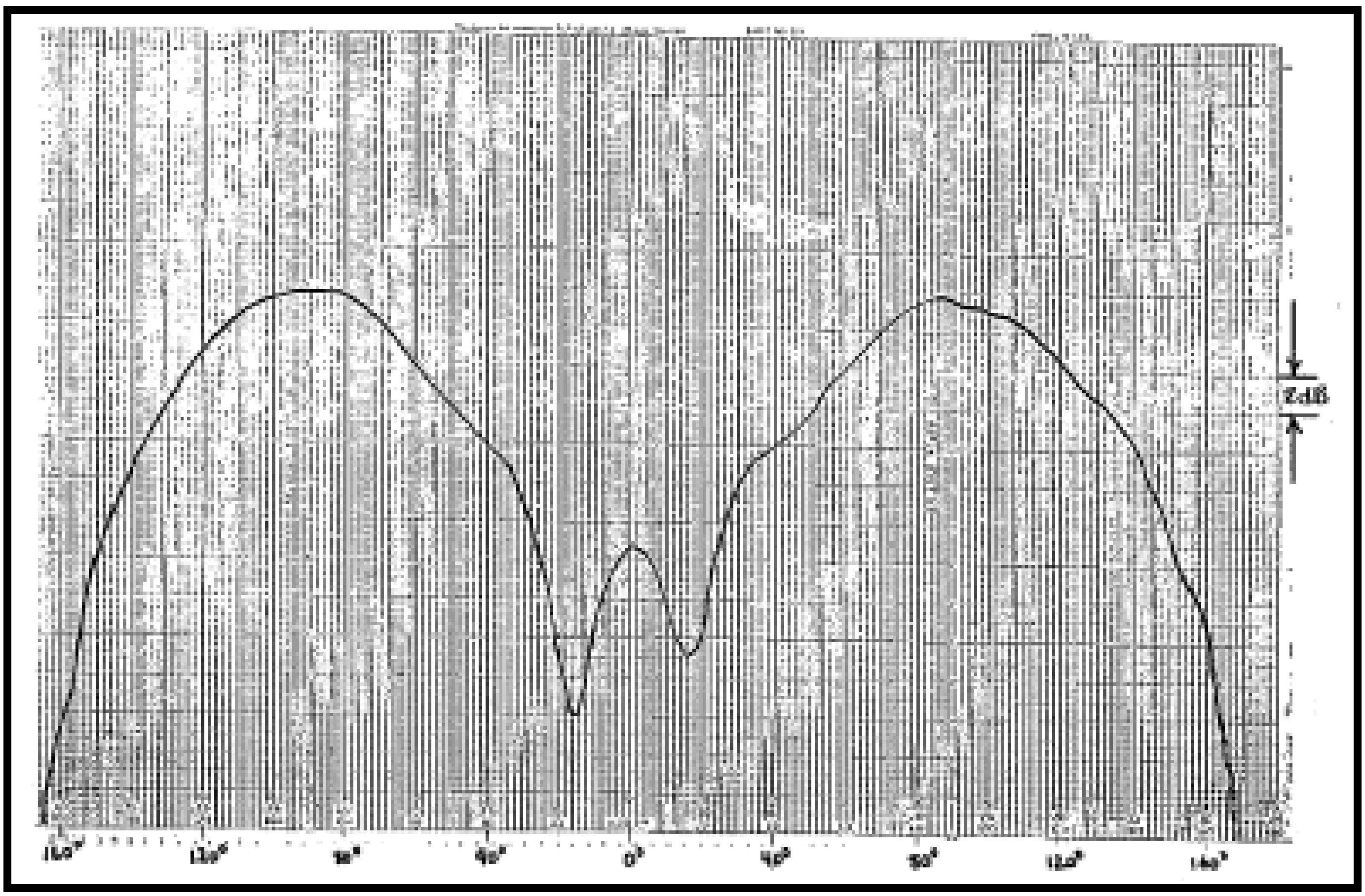


Notes:
1) Gain variation in azimuth shown for elevation angles of 0° and ±20°.
2) The x-axis represents the azimuth angle and spans from -160° to +160°.
3) The y-axis represents the antenna gain.

<u>**EXHIBIT 5J: BACK-UP TELEMETRY BEAM (continued)**</u>

Beam Polarization: Linear Horizontal
Peak Antenna Gain: 2.7 dBi
Peak EIRP: 11.6 dBW
(Schedule S Beam Designation: TLMB)

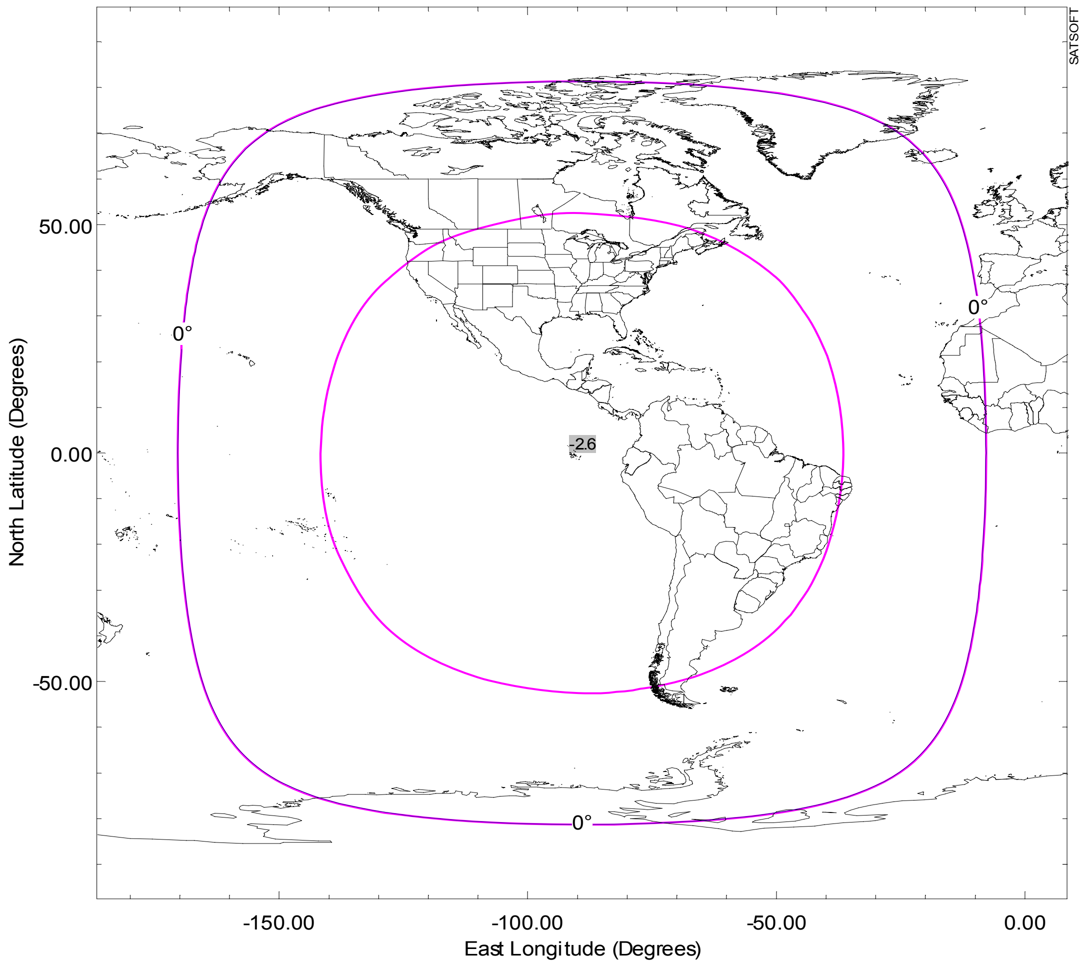
(b) Elevation Cut Antenna Gain Pattern



Notes:
1) Gain variation in elevation shown for the azimuth angle of 0°.
2) The x-axis represents the elevation angle and spans from -160° to +160°.
3) The y-axis represents the antenna gain.

EXHIBIT 5K: GLOBAL ULPC BEAM

Beam Polarization: Linear Vertical
Peak Antenna Gain: 20.2 dBi
Peak EIRP: 15.2 dBW
(Schedule S Beam Designation: ULPC)



Relative Gain Contours Shown: -2 dB, -2.6 dB. The -2.6 dB contour coincides with the 0º elevation contour shown above. The -2.6 dB number in the middle of the figure is to be ignored.

EXHIBIT 6: COMMUNICATION SUBSYSTEM EIRP AND G/T BUDGETS

Beam Name	North America	
Frequency Band (MHz)	–29500 - 30000	
Channel Bandwidth (MHz)	110	
Polarization	RHCP / LHCP	
Antenna Noise Temperature (°Kelvin)	290	
Receiver Noise Temperature (°Kelvin)	505	
Total System Noise Temperature (°Kelvin)	795	
Total System Noise Temperature (dBK)	29.0	
Peak Gain of Satellite Receive Antenna (dBi)	35.5	
Peak G/T (dB/K)	6.5	
Minimum SFD [G/T: Peak, Attn: 0 dB] -- (dBW/m^2)	-98.2	
Beam Name	North America	ULPC
Frequency Band (MHz)	19700 - 20200	20199.5
Channel Bandwidth (MHz)	110	0.025
Polarization	RHCP / LHCP	V
Maximum Power At The Output of Last Stage Amplifier (dBW)	27.2	-4.0
Loss From Last Stage Amplifier To Transmit Antenna Interface (dB)	1.0	1.0
Power Into Transmit Antenna (dBW)	26.2	-5.0
Peak Gain of Satellite Transmit Antenna (dBi)	35.0	20.2
Maximum Downlink EIRP (dBW)	61.2	15.2

Notes:
V : Linear Vertical Polarization
RHCP: Right Hand Circular Polarization
LHCP: Left Hand Circular Polarization

EXHIBIT 7: TC&R SUBSYSTEM CHARACTERISTICS

	Spacecraft Antenna		
	North America (Comm. Antenna)	**Global (WCA Antennas)**	**Global (Bicone Antenna)**
Command Frequency (MHz) / Polarization (see note)			
Transfer Orbit / Emergency	n/a	29998 (LHCP)	6422 (H)
On-Station	29996 (RHCP)	n/a	n/a
Command Modulation	FM	FM	FM
Bandwidth of Command Carrier (kHz)			
Occupied Bandwidth	860	860	860
Allocated Bandwidth	1000	1000	1000
Command Threshold (dBW/m^2)			
Beam Peak	-115.0	-100.2	-91.8
Edge of Coverage	-105.0	-97.2	-88.8
Command G/T (dB/K)			
Beam Peak	-1.6	-16.4	-30.8
Edge of Coverage	-11.6	-19.4	-27.8
Telemetry Frequency (MHz) / Polarization (see note)			
Transfer Orbit / Emergency	n/a	20195.5 (LHCP) 20196.5 (LHCP)	4198.75 (H) 4199.25 (H)
On-Station	20195.5 (RHCP) 20196.5 (RHCP)	n/a	n/a
Telemetry Modulation	PM	PM	PM
Bandwidth of Telemetry Carrier (kHz)			
Occupied	250	250	250
Allocated	500	500	500
Telemetry EIRP			
Beam Peak	29.5	26.5	11.6
Edge of Coverage	19.5	23.5	8.6
On-Station Ranging Accuracy (meters)	≤10	≤10	≤10

Note:
H : Linear Horizontal Polarization
RHCP: Right Hand Circular Polarization
LHCP: Left Hand Circular Polarization

EXHIBIT 8: TC&R SUBSYSTEM EIRP and G/T BUDGETS

Beam Name	North America	Global	Global
Antenna Type	Communication	WCA	Bicone
Frequency Band (MHz)	29996	29998	6422
Polarization (see Note)	RHCP	LHCP	H
Antenna Noise Temperature (°Kelvin)	290	290	290
Receiver Noise Temperature (°Kelvin)	4867	627	1721
Total System Noise Temperature (°Kelvin)	5157	917	2011
Total System Noise Temperature (dBK)	37.1	29.6	33.0
Peak Gain of Satellite Receive Antenna (dBi)	35.5	13.2	2.2
Peak G/T (dB/K)	-1.6	-16.4	-30.8
SFD Threshold at Peak G/T (dBW/m^2)	-115.0	-100.2	-91.8
Beam Name	North America	Global	Global
Antenna Type	Communication	WCA	Bicone
Frequency Band (MHz)	20195.5 / 20196.5	20195.5 / 20196.5	4198.75 / 4199.25
Polarization (see note)	RHCP	LHCP	H
Maximum Power At The Output of Last Stage Amplifier (dBW)	-4.0	14.8	10.0
Loss From Last Stage Amplifier To Transmit Antenna Interface (dB)	1.5	1.5	1.1
Power into Transmit Antenna (dBW)	-5.5	13.3	8.9
Peak Gain of Satellite Transmit Antenna (dBi)	35.0	13.2	2.7
Maximum Downlink EIRP (dBW)	29.5	26.5	11.6

Notes:
RHCP: Right Hand Circular Polarization
LHCP: Left Hand Circular Polarization

EXHIBIT 9: CHANNEL FREQUENCY RESPONSE CHARACTERISTIC

	Attenuation Relative To Peak Level (dB)		
Frequency Offset Relative to Channel Center Frequency (MHz)	Receive Section	Transmit Section	Total
±18	0.10	0.12	0.22
±28	0.15	0.29	0.44
±38	0.20	0.59	0.79
±49	0.30	0.96	1.26
±55	0.80	2.54	3.34
±67	15.3	10.2	25.5
±78	30.3	25.2	55.5
±92	35.3	25.2	60.5

EXHIBIT 10: EMISSION DESIGNATORS

Signal Type	Emission Designator	Allocated Bandwidth (kHz)
Digital MCPC	110M7G7W	110000
SCPC	10M3G7W	10300
64 kbps carrier	100KG7W	100
Digital (out-route) carrier	1M45G7W	1450
Digital (in-route) carrier	400KG7W	400

EXHIBIT 11: POWER FLUX DENSITY CALCULATIONS

110MG7W							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP	61.2	61.2	61.2	61.2	61.2	61.2	61.2
Carrier Occupied Bandwidth (kHz)	93616	93616	93616	93616	93616	93616	93616
Spreading Loss (dB/m^2)	163.4	163.3	163.2	163.0	162.9	162.8	162.1
Maximum EIRP Spectral Density (dBW/m^2/MHz)	-121.9	-121.8	-121.7	-121.6	-121.4	-121.3	-120.6
FCC Limit (dBW/m^2/MHz)	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0
Margin (dB)	3.9	3.8	3.7	3.6	3.4	3.3	2.6
10M3G7W							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP	52.4	52.4	52.4	52.4	52.4	52.4	52.4
Carrier Occupied Bandwidth (kHz)	6771	6771	6771	6771	6771	6771	6771
Spreading Loss (dB/m^2)	163.4	163.3	163.2	163.0	162.9	162.8	162.1
Maximum EIRP Spectral Density (dBW/m^2/MHz)	-119.3	-119.2	-119.1	-119.0	-118.8	-118.7	-118.0
FCC Limit (dBW/m^2/MHz)	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0
Margin (dB)	1.3	1.2	1.1	1.0	0.8	0.7	0.0

<u>**EXHIBIT 11: POWER FLUX DENSITY CALCULATIONS (continued)**</u>

100KG7W							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP	32.8	32.8	32.8	32.8	32.8	32.8	32.8
Carrier Occupied Bandwidth (kHz)	75	75	75	75	75	75	75
Spreading Loss (dB/m^2)	163.4	163.3	163.2	163.0	162.9	162.8	162.1
Maximum EIRP Spectral Density (dBW/m^2/MHz)	-119.3	-119.2	-119.1	-119.0	-118.9	-118.8	-118.0
FCC Limit (dBW/m^2/MHz)	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0
Margin (dB)	1.3	1.2	1.1	1.0	0.9	0.8	0.0
1M45G7W							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP	42.5	42.5	42.5	42.5	42.5	42.5	42.5
Carrier Occupied Bandwidth (kHz)	1229	1229	1229	1229	1229	1229	1229
Spreading Loss (dB/m^2)	163.4	163.3	163.2	163.0	162.9	162.8	162.1
Maximum EIRP Spectral Density (dBW/m^2/MHz)	-121.8	-121.7	-121.6	-121.4	-121.3	-121.2	-120.5
FCC Limit (dBW/m^2/MHz)	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0
Margin (dB)	3.8	3.7	3.6	3.4	3.3	3.2	2.5

EXHIBIT 11: POWER FLUX DENSITY CALCULATIONS (continued)

400KG7W							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP	25.7	25.7	25.7	25.7	25.7	25.7	25.7
Carrier Occupied Bandwidth (kHz)	307	307	307	307	307	307	307
Spreading Loss (dB/m^2)	163.4	163.3	163.2	163.0	162.9	162.8	162.1
Maximum EIRP Spectral Density (dBW/m^2/MHz)	-132.6	-132.4	-132.3	-132.2	-132.1	-132.0	-131.2
FCC Limit (dBW/m^2/MHz)	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0
Margin (dB)	14.6	14.4	14.3	14.2	14.1	14.0	13.2
TELEMETRY (Ka-Band)							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP	29.5	29.5	29.5	29.5	29.5	29.5	29.5
Carrier Occupied Bandwidth (kHz)	250	250	250	250	250	250	250
Spreading Loss (dB/m^2)	163.4	163.3	163.2	163.0	162.9	162.8	162.1
Maximum EIRP Spectral Density (dBW/m^2/MHz)	-127.9	-127.8	-127.6	-127.5	-127.4	-127.3	-126.5
FCC Limit (dBW/m^2/MHz)	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0
Margin (dB)	9.9	9.8	9.6	9.5	9.4	9.3	8.5

EXHIBIT 11: POWER FLUX DENSITY CALCULATIONS (continued)

TELEMETRY (C-BAND)							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP	11.6	11.6	11.6	11.6	11.6	11.6	11.6
Carrier Occupied Bandwidth (kHz)	250	250	250	250	250	250	250
Spreading Loss (dB/m^2)	163.4	163.3	163.2	163.0	162.9	162.8	162.1
Maximum EIRP Spectral Density (dBW/m^2/4kHz)	-169.7	-169.6	-169.5	-169.4	-169.3	-169.2	-168.4
FCC Limit (dBW/m^2/4kHz)	-152.0	-152.0	-149.5	-147.0	-144.5	-142.0	-142.0
Margin (dB)	17.7	17.6	20.0	22.4	24.8	27.2	26.4
ULPC							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP	15.2	15.2	15.2	15.2	15.2	15.2	15.2
Carrier Occupied Bandwidth (kHz)	25	25	25	25	25	25	25
Spreading Loss (dB/m^2)	163.4	163.3	163.2	163.0	162.9	162.8	162.1
Maximum EIRP Spectral Density (dBW/m^2/MHz)	-132.2	-132.1	-131.9	-131.8	-131.7	-131.6	-130.8
FCC Limit (dBW/m^2/MHz)	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0	-118.0
Margin (dB)	14.2	14.1	13.9	13.8	13.7	13.6	12.8

EXHIBIT 12: GALAXY KA LINK BUDGETS

Satellite Information	Clear Sky	Up Fade	Dn Fade
Satellite Longitude (degrees)	-89.1	-89.1	-89.1
G/T (EOC, dB/K)	2.5	2.5	2.5
Attenuation setting (dB)	17.0	17.0	17.0
SFD (EOC, dBW/m2)	-77.2	-77.2	-77.2
Downlink EIRP (Beam Peak, dBW)	61.2	61.2	61.2
Carrier Information			
Emission Designation	110MG7W	110MG7W	110MG7W
Bits/Symbol	2	2	2
Info Rate + Overhead (Mbit/s)	86.27	86.27	86.27
Codec:	0.50	0.50	0.50
RS:	0.92	0.92	0.92
Noise Bandwidth (MHz)	93.616	93.616	93.616
C/N required (dB)	3.1	3.1	3.1
Transmit Earth Station			
Antenna Diameter (m)	6.0	6.0	6.0
Rain Rate (mm/hr)	41.9	41.9	41.9
Peak Antenna Gain (dBi)	63.6	63.6	63.6
S/C Relative Gain from Peak towards E/S (dB)	-4.0	-4.0	-4.0
Receive Earth Station			
Antenna Diameter (m)	0.66	0.66	0.66
Rain Rate (mm/hr)	41.9	41.9	41.9
Peak Antenna Gain (dBi)	40.9	40.9	40.9
D/Lamda	43.9	43.9	43.9
S/C Relative Gain from Peak towards E/S (dB)	-4.0	-4.0	-4.0
System (LNA_Sky) Noise Temp	150.0	150.0	150.0
Temperature due to rain fade and gases	20.7	20.7	151.6
G/T of ES (dB/K)	18.6	18.6	16.1
C/N Uplink Per Carrier			
Uplink EIRP per carrier (EOC, dBW)	85.3	91.5	85.3
Pathloss at uplink frequency (dB)	213.4	213.4	213.4
Uplink gazeous atttenuation (dB)	0.3	0.3	0.3
Uplink rain attenuation (dB)	0.0	6.3	0.0
Uplink control correction (dB)	0.0	6.2	0.0
Gain of 1 m2 antenna (dB)	50.9	50.9	50.9
Per carrier input back-off (dB)	0.0	0.0	0.0
C/N uplink, thermal (EOC, dB)	22.9	22.9	22.9
C/N Downlink Per Carrier			
Transponder BP saturation EIRP (dBW)	61.2	61.2	61.2
Per carrier output back-off (dB)	0.0	0.0	0.0
Per carrier EIRP (EOC, dBW)	57.2	57.2	57.2
Pointing Error (dB)	-0.5	-0.5	-0.5
Pathloss at downlink frequency (dB)	210.0	210.0	210.0
Downlink gazeous attenuation (dB)	0.3	0.3	0.3
Downlink rain attenuation (dB)	0.0	0.0	2.9
ES G/T (dB/K)	18.6	18.6	16.1
C/N downlink, thermal (EOC, dB)	13.9	13.9	8.5
C/I Other links (re-use, IM)	30.0	30.0	30.0
INTERFERING SATELLITE #1			
Orbital Separation (degrees)	1.77	1.77	1.77
G (AP-7) (dBi)	25.9	25.9	25.9
Interfering Uplink power density (dBW/Hz)	-56.5	-56.5	-56.5
Interfering D/L eirp density (dBW/Hz)	-15.9	-15.9	-15.9
C/I ASI uplink (dB)	40.6	46.8	40.6
C/I ASI downlink (dB)	8.5	8.5	8.5
INTERFERING SATELLITE #2			
Orbital Separation (degrees)	1.88	1.88	1.88
G (AP-7) (dBi)	23.9	23.9	23.9
Interfering Uplink power density (dBW/Hz)	-56.5	-56.5	-56.5
Interfering D/L eirp density (dBW/Hz)	-15.9	-15.9	-15.9
C/I ASI uplink (dB)	40.6	46.8	40.6
C/I ASI downlink (dB)	10.4	10.4	10.4
Total C/N			
C/N available per carrier (dB)	5.5	5.5	4.2
Margin for other losses (dB)	1.1	1.1	1.1
C/N total (clear-sky, dB)	4.4	4.4	3.1
PSD (EOC, dBW/Hz)	-58.0	-51.8	-58.0
ESD at beam peak (dBW/Hz)	-18.5	-18.5	-18.5
# of carriers	1	1	1

Notes:

1) Carrier modulation is QPSK
2) The orbital location listed for each adjacent satellite corresponds to the topocentric location corresponding to a 2 degree geocentric separation with respect to Galaxy Ka and incorporating 0.05 degrees of stationkeeping accuracy as well as 0.05 degrees of receive antenna mispointing towards one of the adjacent satellites (and 0.05 degree of mispointing away from the other adjacent satellite).

EXHIBIT 12: GALAXY KA LINK BUDGETS (continued)

Satellite Information	Clear Sky	Up Fade	Dn Fade
Satellite Longitude (degrees)	-89.1	-89.1	-89.1
G/T (EOC, dB/K)	2.5	2.5	2.5
Attenuation setting (dB)	15.0	15.0	15.0
SFD (EOC, dBW/m2)	-79.2	-79.2	-79.2
Downlink EIRP (Beam Peak, dBW)	61.2	61.2	61.2
Carrier Information			
Emission Designation	10M3G7W	10M3G7W	10M3G7W
Bits/Symbol	2	2	2
Info Rate + Overhead (Mbit/s)	6.24	6.24	6.24
Codec:	0.50	0.50	0.50
RS:	0.92	0.92	0.92
Noise Bandwidth (MHz)	6.771	6.771	6.771
C/N required (dB)	3.9	3.6	3.6
Transmit Earth Station			
Antenna Diameter (m)	6.0	6.0	6.0
Rain Rate (mm/hr)	41.9	41.9	41.9
Peak Antenna Gain (dBi)	63.6	63.6	63.6
S/C Relative Gain from Peak towards E/S (dB)	-4.0	-4.0	-4.0
Receive Earth Station			
Antenna Diameter (m)	0.62	0.62	0.62
Rain Rate (mm/hr)	41.9	41.9	41.9
Peak Antenna Gain (dBi)	40.4	40.4	40.4
D/Lamda	41.2	41.2	41.2
S/C Relative Gain from Peak towards E/S (dB)	-4.0	-4.0	-4.0
System (LNA_Sky) Noise Temp	150.0	150.0	150.0
Temperature due to rain fade and gases	20.7	20.7	151.6
G/T of ES (dB/K)	18.1	18.1	15.6
C/N Uplink Per Carrier			
Uplink EIRP per carrier (EOC, dBW)	69.4	75.6	69.4
Pathloss at uplink frequency (dB)	213.4	213.4	213.4
Uplink gazeous atttenuation (dB)	0.3	0.3	0.3
Uplink rain attenuation (dB)	0.0	6.3	0.0
Uplink control correction (dB)	0.0	6.2	0.0
Gain of 1 m2 antenna (dB)	50.9	50.9	50.9
Per carrier input back-off (dB)	-13.9	-13.9	-13.9
C/N uplink, thermal (EOC, dB)	18.4	18.4	18.4
C/N Downlink Per Carrier			
Transponder BP saturation EIRP (dBW)	61.2	61.2	61.2
Per carrier output back-off (dB)	-8.8	-8.8	-8.8
Per carrier EIRP (EOC, dBW)	48.4	48.4	48.4
Pointing Error (dB)	-0.5	-0.5	-0.5
Pathloss at downlink frequency (dB)	210.0	210.0	210.0
Downlink gazeous attenuation (dB)	0.3	0.3	0.3
Downlink rain attenuation (dB)	0.0	0.0	2.9
ES G/T (dB/K)	18.1	18.1	15.6
C/N downlink, thermal (EOC, dB)	16.0	16.0	10.6
C/I Other links (re-use, IM)	16.0	16.0	16.0
INTERFERING SATELLITE #1			
Orbital Separation (degrees)	1.75	1.75	1.75
G (AP-7) (dBi)	27.4	27.4	27.4
Interfering Uplink power density (dBW/Hz)	-56.5	-56.5	-56.5
Interfering D/L eirp density (dBW/Hz)	-15.9	-15.9	-15.9
C/I ASI uplink (dB)	36.1	42.3	36.1
C/I ASI downlink (dB)	9.0	9.0	9.0
INTERFERING SATELLITE #2			
Orbital Separation (degrees)	1.86	1.86	1.86
G (AP-7) (dBi)	25.7	25.7	25.7
Interfering Uplink power density (dBW/Hz)	-56.5	-56.5	-56.5
Interfering D/L eirp density (dBW/Hz)	-15.9	-15.9	-15.9
C/I ASI uplink (dB)	36.1	42.3	36.1
C/I ASI downlink (dB)	10.7	10.7	10.7
Total C/N			
C/N available per carrier (dB)	5.6	5.6	4.7
Margin for other losses (dB)	1.1	1.1	1.1
C/N total (clear-sky, dB)	4.5	4.5	3.6
PSD (EOC, dBW/Hz)	-62.5	-56.3	-62.5
ESD at beam peak (dBW/Hz)	-15.9	-15.9	-15.9
# of carriers	7	7	7

Notes:

1) Carrier modulation is QPSK
2) The orbital location listed for each adjacent satellite corresponds to the topocentric location corresponding to a 2 degree geocentric separation with respect to Galaxy Ka and incorporating 0.05 degrees of stationkeeping accuracy as well as 0.05 degrees of receive antenna mispointing towards one of the adjacent satellites (and 0.05 degree of mispointing away from the other adjacent satellite).

EXHIBIT 12: GALAXY KA LINK BUDGETS (continued)

Satellite Information	Clear Sky	Up Fade	Dn Fade
Satellite Longitude (degrees)	-89.1	-89.1	-89.1
G/T (EOC, dB/K)	2.5	2.5	2.5
Attenuation setting (dB)	15.0	15.0	15.0
SFD (EOC, dBW/m2)	-79.2	-79.2	-79.2
Downlink EIRP (Beam Peak, dBW)	61.2	61.2	61.2
Carrier Information			
Emission Designation	100KG7W	100KG7W	100KG7W
Bits/Symbol	2	2	2
Info Rate + Overhead (Mbit/s)	0.07	0.07	0.07
Codec:	0.50	0.50	0.50
RS:	0.93	0.93	0.93
Noise Bandwidth (MHz)	0.075	0.075	0.075
C/N required (dB)	3.0	2.8	2.8
Transmit Earth Station			
Antenna Diameter (m)	6.0	6.0	6.0
Rain Rate (mm/hr)	41.9	41.9	41.9
Peak Antenna Gain (dBi)	63.6	63.6	63.6
S/C Relative Gain from Peak towards E/S (dB)	-4.0	-4.0	-4.0
Receive Earth Station			
Antenna Diameter (m)	0.60	0.60	0.60
Rain Rate (mm/hr)	41.9	41.9	41.9
Peak Antenna Gain (dBi)	40.1	40.1	40.1
D/Lamda	39.9	39.9	39.9
S/C Relative Gain from Peak towards E/S (dB)	-4.0	-4.0	-4.0
System (LNA_Sky) Noise Temp	150.0	150.0	150.0
Temperature due to rain fade and gases	20.7	20.7	151.6
G/T of ES (dB/K)	17.8	17.8	15.3
C/N Uplink Per Carrier			
Uplink EIRP per carrier (EOC, dBW)	49.8	56.0	49.8
Pathloss at uplink frequency (dB)	213.4	213.4	213.4
Uplink gazeous atttenuation (dB)	0.3	0.3	0.3
Uplink rain attenuation (dB)	0.0	6.3	0.0
Uplink control correction (dB)	0.0	6.2	0.0
Gain of 1 m2 antenna (dB)	50.9	50.9	50.9
Per carrier input back-off (dB)	-33.5	-33.5	-33.5
C/N uplink, thermal (EOC, dB)	18.4	18.3	18.4
C/N Downlink Per Carrier			
Transponder BP saturation EIRP (dBW)	61.2	61.2	61.2
Per carrier output back-off (dB)	-28.4	-28.4	-28.4
Per carrier EIRP (EOC, dBW)	28.8	28.8	28.8
Pointing Error (dB)	-0.5	-0.5	-0.5
Pathloss at downlink frequency (dB)	210.0	210.0	210.0
Downlink gazeous attenuation (dB)	0.3	0.3	0.3
Downlink rain attenuation (dB)	0.0	0.0	2.9
ES G/T (dB/K)	17.8	17.8	15.3
C/N downlink, thermal (EOC, dB)	15.6	15.6	10.3
C/I Other links (re-use, IM)	16.0	16.0	16.0
INTERFERING SATELLITE #1			
Orbital Separation (degrees)	1.74	1.74	1.74
G (AP-7) (dBi)	28.1	28.1	28.1
Interfering Uplink power density (dBW/Hz)	-56.5	-56.5	-56.5
Interfering D/L eirp density (dBW/Hz)	-15.9	-15.9	-15.9
C/I ASI uplink (dB)	36.1	42.3	36.1
C/I ASI downlink (dB)	7.9	7.9	7.9
INTERFERING SATELLITE #2			
Orbital Separation (degrees)	1.85	1.85	1.85
G (AP-7) (dBi)	26.5	26.5	26.5
Interfering Uplink power density (dBW/Hz)	-56.5	-56.5	-56.5
Interfering D/L eirp density (dBW/Hz)	-15.9	-15.9	-15.9
C/I ASI uplink (dB)	36.1	42.3	36.1
C/I ASI downlink (dB)	9.5	9.5	9.5
Total C/N			
C/N available per carrier (dB)	4.7	4.7	3.9
Margin for other losses (dB)	1.1	1.1	1.1
C/N total (clear-sky, dB)	3.6	3.6	2.8
PSD (EOC, dBW/Hz)	-62.5	-56.3	-62.5
ESD at beam peak (dBW/Hz)	-16.0	-16.0	-16.0
# of carriers	689	689	689

Notes:

1) Carrier modulation is QPSK
2) The orbital location listed for each adjacent satellite corresponds to the topocentric location corresponding to a 2 degree geocentric separation with respect to Galaxy Ka and incorporating 0.05 degrees of stationkeeping accuracy as well as 0.05 degrees of receive antenna mispointing towards one of the adjacent satellites (and 0.05 degree of mispointing away from the other adjacent satellite).

EXHIBIT 12: GALAXY KA LINK BUDGETS (continued)

Satellite Information	Clear Sky	Up Fade	Dn Fade
Satellite Longitude (degrees)	-89.1	-89.1	-89.1
G/T (EOC, dB/K)	2.5	2.5	2.5
Attenuation setting (dB)	15.0	15.0	15.0
SFD (EOC, dBW/m2)	-79.2	-79.2	-79.2
Downlink EIRP (Beam Peak, dBW)	61.2	61.2	61.2
Carrier Information			
Emission Designation	1M45G7W	1M45G7W	1M45G7W
Bits/Symbol	1	1	1
Info Rate + Overhead (Mbit/s)	0.61	0.61	0.61
Codec:	0.50	0.50	0.50
RS:	1.00	1.00	1.00
Noise Bandwidth (MHz)	1.229	1.229	1.229
C/N required (dB)	3.4	2.7	2.7
Transmit Earth Station			
Antenna Diameter (m)	6.0	6.0	6.0
Rain Rate (mm/hr)	41.9	41.9	41.9
Peak Antenna Gain (dBi)	63.6	63.6	63.6
S/C Relative Gain from Peak towards E/S (dB)	-4.0	-4.0	-4.0
Receive Earth Station			
Antenna Diameter (m)	0.66	0.66	0.66
Rain Rate (mm/hr)	41.9	41.9	41.9
Peak Antenna Gain (dBi)	40.9	40.9	40.9
D/Lamda	43.9	43.9	43.9
S/C Relative Gain from Peak towards E/S (dB)	-4.0	-4.0	-4.0
System (LNA_Sky) Noise Temp	150.0	150.0	150.0
Temperature due to rain fade and gases	20.7	20.7	151.6
G/T of ES (dB/K)	18.6	18.6	16.1
C/N Uplink Per Carrier			
Uplink EIRP per carrier (EOC, dBW)	59.5	65.7	59.5
Pathloss at uplink frequency (dB)	213.4	213.4	213.4
Uplink gazeous attenuation (dB)	0.3	0.3	0.3
Uplink rain attenuation (dB)	0.0	6.3	0.0
Uplink control correction (dB)	0.0	6.2	0.0
Gain of 1 m2 antenna (dB)	50.9	50.9	50.9
Per carrier input back-off (dB)	-23.8	-23.8	-23.8
C/N uplink, thermal (EOC, dB)	15.9	15.9	15.9
C/N Downlink Per Carrier			
Transponder BP saturation EIRP (dBW)	61.2	61.2	61.2
Per carrier output back-off (dB)	-18.7	-18.7	-18.7
Per carrier EIRP (EOC, dBW)	38.5	38.5	38.5
Pointing Error (dB)	-0.5	-0.5	-0.5
Pathloss at downlink frequency (dB)	210.0	210.0	210.0
Downlink gazeous attenuation (dB)	0.3	0.3	0.3
Downlink rain attenuation (dB)	0.0	0.0	2.9
ES G/T (dB/K)	18.6	18.6	16.1
C/N downlink, thermal (EOC, dB)	14.0	14.0	8.7
C/I Other links (re-use, IM)	16.0	16.0	16.0
INTERFERING SATELLITE #1			
Orbital Separation (degrees)	1.77	1.77	1.77
G (AP-7) (dBi)	25.9	25.9	25.9
Interfering Uplink power density (dBW/Hz)	-56.5	-56.5	-56.5
Interfering D/L eirp density (dBW/Hz)	-15.9	-15.9	-15.9
C/I ASI uplink (dB)	33.6	39.8	33.6
C/I ASI downlink (dB)	8.6	8.6	8.6
INTERFERING SATELLITE #2			
Orbital Separation (degrees)	1.88	1.88	1.88
G (AP-7) (dBi)	23.9	23.9	23.9
Interfering Uplink power density (dBW/Hz)	-56.5	-56.5	-56.5
Interfering D/L eirp density (dBW/Hz)	-15.9	-15.9	-15.9
C/I ASI uplink (dB)	33.6	39.8	33.6
C/I ASI downlink (dB)	10.5	10.5	10.5
Total C/N			
C/N available per carrier (dB)	4.9	4.9	3.8
Margin for other losses (dB)	1.1	1.1	1.1
C/N total (clear-sky, dB)	3.8	3.8	2.7
PSD (EOC, dBW/Hz)	-65.0	-58.8	-65.0
ESD at beam peak (dBW/Hz)	-18.4	-18.4	-18.4
# of carriers	74	74	74

Notes:

1) Carrier modulation is BPSK
2) The orbital location listed for each adjacent satellite corresponds to the topocentric location corresponding to a 2 degree geocentric separation with respect to Galaxy Ka and incorporating 0.05 degrees of stationkeeping accuracy as well as 0.05 degrees of receive antenna mispointing towards one of the adjacent satellites (and 0.05 degree of mispointing away from the other adjacent satellite).

EXHIBIT 12: GALAXY KA LINK BUDGETS (continued)

Satellite Information	Clear Sky	Up Fade	Dn Fade
Satellite Longitude (degrees)	-89.1	-89.1	-89.1
G/T (EOC, dB/K)	2.5	2.5	2.5
Attenuation setting (dB)	15.0	15.0	15.0
SFD (EOC, dBW/m2)	-79.2	-79.2	-79.2
Downlink EIRP (Beam Peak, dBW)	61.2	61.2	61.2
Carrier Information			
Emission Designation	400KG7W	400KG7W	400KG7W
Bits/Symbol	1	1	1
Info Rate + Overhead (Mbit/s)	0.15	0.15	0.15
Codec:	0.50	0.50	0.50
RS:	1.00	1.00	1.00
Noise Bandwidth (MHz)	0.307	0.307	0.307
C/N required (dB)	3.4	2.7	2.7
Transmit Earth Station			
Antenna Diameter (m)	0.7	0.7	0.7
Rain Rate (mm/hr)	41.9	41.9	41.9
Peak Antenna Gain (dBi)	44.4	44.4	44.4
S/C Relative Gain from Peak towards E/S (dB)	-4.0	-4.0	-4.0
Receive Earth Station			
Antenna Diameter (m)	6.00	6.00	6.00
Rain Rate (mm/hr)	41.9	41.9	41.9
Peak Antenna Gain (dBi)	60.1	60.1	60.1
D/Lamda	399.0	399.0	399.0
S/C Relative Gain from Peak towards E/S (dB)	-4.0	-4.0	-4.0
System (LNA_Sky) Noise Temp	150.0	150.0	150.0
Temperature due to rain fade and gases	20.7	20.7	151.6
G/T of ES (dB/K)	37.8	37.8	35.3
C/N Uplink Per Carrier			
Uplink EIRP per carrier (EOC, dBW)	42.6	49.0	42.6
Pathloss at uplink frequency (dB)	213.4	213.4	213.4
Uplink gazeous atttenuation (dB)	0.3	0.3	0.3
Uplink rain attenuation (dB)	0.0	6.3	0.0
Uplink control correction (dB)	0.0	6.2	0.0
Gain of 1 m2 antenna (dB)	50.9	50.9	50.9
Per carrier input back-off (dB)	-40.6	-40.6	-40.6
C/N uplink, thermal (EOC, dB)	5.2	5.1	5.2
C/N Downlink Per Carrier			
Transponder BP saturation EIRP (dBW)	61.2	61.2	61.2
Per carrier output back-off (dB)	-35.5	-35.5	-35.5
Per carrier EIRP (EOC, dBW)	21.7	21.7	21.7
Pointing Error (dB)	-0.5	-0.5	-0.5
Pathloss at downlink frequency (dB)	210.0	210.0	210.0
Downlink gazeous attenuation (dB)	0.3	0.3	0.3
Downlink rain attenuation (dB)	0.0	0.0	2.9
ES G/T (dB/K)	37.8	37.8	35.3
C/N downlink, thermal (EOC, dB)	22.5	22.5	17.1
C/I Other links (re-use, IM)	16.0	16.0	16.0
INTERFERING SATELLITE #1			
Orbital Separation (degrees)	2.05	2.05	2.05
G (AP-7) (dBi)	21.2	21.2	21.2
Interfering Uplink power density (dBW/Hz)	-56.5	-56.5	-56.5
Interfering D/L eirp density (dBW/Hz)	-15.9	-15.9	-15.9
C/I ASI uplink (dB)	22.9	29.1	22.9
C/I ASI downlink (dB)	21.7	21.7	21.7
INTERFERING SATELLITE #2			
Orbital Separation (degrees)	2.16	2.16	2.16
G (AP-7) (dBi)	20.6	20.6	20.6
Interfering Uplink power density (dBW/Hz)	-56.5	-56.5	-56.5
Interfering D/L eirp density (dBW/Hz)	-15.9	-15.9	-15.9
C/I ASI uplink (dB)	22.9	29.1	22.9
C/I ASI downlink (dB)	22.3	22.3	22.3
Total C/N			
C/N available per carrier (dB)	4.5	4.5	4.3
Margin for other losses (dB)	1.1	1.1	1.1
C/N total (clear-sky, dB)	3.4	3.4	3.2
PSD (EOC, dBW/Hz)	-56.7	-50.3	-56.7
ESD at beam peak (dBW/Hz)	-29.1	-29.1	-29.1
# of carriers	275	275	275

Notes:

1) Carrier modulation is BPSK
2) The orbital location listed for each adjacent satellite corresponds to the topocentric location corresponding to a 2 degree geocentric separation with respect to Galaxy Ka and incorporating 0.05 degrees of stationkeeping accuracy as well as 0.05 degrees of receive antenna mispointing towards one of the adjacent satellites (and 0.05 degree of mispointing away from the other adjacent satellite).