Engineering Statement

1) Introduction

Intelsat License LLC ("Intelsat") seeks authority in this application to launch and operate a new satellite designated as Intelsat 23. This spacecraft will operate from 53° W.L and will replace the Intelsat 707 spacecraft currently operating at that location. After start of Intelsat 23's operation, Intelsat 707 will be relocated to another orbital location. The characteristics of the Intelsat 23 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

Intelsat 23 is Orbital model Star 2e spacecraft that operates on the C-band frequencies of 5925 – 6425 MHz, 3700 – 4200 MHz; and Ku-band frequencies of 14000 – 14500 MHz and 11450 – 12200 MHz. The spacecraft utilizes 24 C-band channels to provide service to North and South America, Europe and Africa; 15 Ku-band channels to provide service to Mexico, Central America, Argentina, northern South America and the southern portion of United States.

2.1) Structure

Intelsat 23 is a 3-axis stabilized type spacecraft that has a rectangular outer body structure. Internally, the spacecraft is comprised of a central cylinder to which a number of panels are attached. Intelsat 23 utilizes two four-panel deployable solar array wings and two deployable antennas.

The structural design of Intelsat 23 provides mechanical support for all subsystems. The structure externally supports the communication antennas, solar arrays, and the thrusters. It also provides a stable platform for preserving the alignment of critical elements of the spacecraft.

A summary of the basic spacecraft characteristics is provided in Exhibit 1. The Intelsat 23 mass budget is provided in Exhibit 2.

2.2) Thermal Subsystem

Thermal control is accomplished through the use of thermal control coatings, blankets, shields, heaters, heat pipes, special paint/coating and heat rejection surfaces. Heat pipes are embedded in a number of key equipment panels. High thermal dissipation components are located directly on the north and south communication panels. Optical Solar Reflectors ("OSRs") are used on the outer faces of these panels. Multilayer Insulation ("MLI") blankets are used on the external east, west, and aft surfaces of the spacecraft. Special paint/coating is applied to the surface of the nadir panel.

The traveling wave tube amplifiers ("TWTAs") of the Ku-band communication subsystem are equipped with radiators protruding from the spacecraft body which radiate a large percentage of the TWTA heat directly to space. The TWTAs supporting the C-band communications subsystem are conduction cooled via direct contact with the spacecraft panels and heat pipe network. Heaters are employed throughout the spacecraft in order to ensure that temperature variations of the bus and communication units are maintained within appropriate limits throughout the operational life of the satellite. Battery temperatures are maintained within limits through the combined use of heat pipes, heaters, blankets and OSRs.

2.3) <u>Power Subsystem</u>

The Electrical Power Subsystem ("EPS") generates, stores, conditions and protects the satellite's electrical power. It provides the energy required to operate the satellite during all modes of operation. The EPS consists of the solar array, batteries, associated power electronics, and power harnesses that integrate and regulate the systems.

Intelsat 23 utilizes 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 is composed of four main panels. The panels support the requisite solar cells. During launch, the solar array wings are in the stowed position. However, during transfer orbit 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.

During eclipse periods, the primary source of power to the spacecraft is through batteries. Intelsat 23 utilizes two 18-cell Lithium ion batteries.

The Intelsat 23 EPS has been 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 Intelsat 23 are provided in Exhibit 3.

2.4) Attitude Control Subsystem

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

The ACS is composed of primary and redundant sun and Earth sensors, 2-for-1, 4-for-3 scalable space inertial reference units (i.e., gyros), 4-for-3 redundant reaction wheels, bipropellant thrusters, and associated electronics. Control of the spacecraft attitude and orientation is accomplished through the use of reaction wheels and by pulsed or continuous firing of selected bipropellant thrusters by the ACS.

2.5) Propulsion Subsystem

The propulsion subsystem provides impulse for the spacecraft maneuvering during all phases of the mission beginning with launch vehicle separation through the operational lifetime of the satellite. The major components of the propulsion subsystem are as follows: 1) two high pressure helium tanks, 2) one fuel tank, 3) two oxidizer tanks, 4) a single 445-N thruster, 5) two dual mode 22-N thrusters, 6) four 22-N mono-propellant thrusters, 7) twelve 0.9-N monopropellant thrusters, 8) four improved performance electro-thermal 0.48-N thrusters and 9) associated pressure regulators, filters, flow control components, and pressure transducers.

The bipropellant system utilizes a combination of Nitrogen Tetroxide and Monomethyl Hydrazine as propellants. The system utilizes Helium gas to pressurize the propellant tanks.

During transfer orbit operations, the propulsion system will either be operated in bi-propellant mode or (mono-propellant) blow-down mode. During normal on-station operations, the spacecraft will be operated in blow-down, mono-propellant mode.

The architecture of the propulsion system is based on a low risk approach with many of the units having been flight proven. The system utilizes space qualified components and incorporates full redundancy for all critical components.

2.6) Communication Subsystem

2.6.1) Overview

Intelsat 23 provides 24 active communication channels at C-band frequencies, 15 active channels at Ku-band frequencies. The C-band payload employs channels having bandwidths of 36 MHz, 41 MHz, 72 MHz and 77 MHz. The Ku-band payload employs channels having bandwidths of 72 MHz, 77 MHz and 112 MHz. The Intelsat 23 frequency and polarization plans are provided in Exhibits 4A and 4B.

At C-band, the Intelsat 23 receive and transmit beams provide coverage of North and South America, Europe, and Africa. At Ku-band, the spacecraft provides coverage of Mexico, Central America, Argentina, northern South America and the southern portion of the United States.

At C-band and Ku-band frequencies, Intelsat 23 employs full frequency reuse through the use of orthogonal polarization within the same beam and/or through the use of spatially isolated beams. Accordingly, Intelsat 23 is compliant with Section 25.210(f) of the Commission's rules.

Intelsat 23 is not compliant with Section 25.210 (a)(3) of the Commission's rules that requires a space station providing domestic service using the frequency bands 3700 – 4200 MHz and 5925 – 6425 MHz to be capable of switching polarization upon ground command. Accordingly, Intelsat requests a waiver of Section 25.210(a)(3).

Except for Intelsat 707 that will be located at 53º W.L. only during transfer of traffic to Intelsat 23, the nearest co-frequency satellites adjacent to Intelsat 23 are Intelsat 805, located at 55.5º W.L, and Intelsat 1R, located at 50º W.L. Both Intelsat 805 and Intelsat 1R are licensed to Intelsat. Intelsat will internally coordinate the transmissions to/from these spacecraft and Intelsat 23 in order to ensure that excessive levels of interference are not generated. Hence, Intelsat believes that its request for a waiver of Section 25.210(a)(3) of the rules is justified.

With respect to the use of the 11450 – 11700 MHz band, the United States Table of Frequency Allocations, contained in Section 2.106 of the Commission's rules, permits the use of this band by non-federal fixed satellite service for international systems only (see note NG 104). However, given that communication links that operate on this band will originate and terminate outside of the United States, the provisions of note NG 104 are not applicable to Intelsat 23.

Intelsat 23 is compliant with Section 25.210(a)(2) of the Commission's rules. Additionally, Intelsat shall ensure that the placement of analog video carriers in the 3700 – 4200 MHz is compliant with 25.211(a) of the Commission's rules.

Intelsat 23 is not compliant with Section 25.210(a)(1) of the Commission's rules. This section of rules requires that space stations in the fixed satellite service used for domestic service in the 3700 – 4200 MHz and 5925 – 6425 MHz band shall use orthogonal linear polarization. Intelsat 23 utilizes circular polarization in these two frequency bands. Accordingly, Intelsat requests a waiver of Section 25.210(a)(1).

As noted above, the nearest co-frequency satellites adjacent to Intelsat 23 are Intelsat 805, located at 55.5º W.L, and Intelsat 1R, located at 50º W.L. – both of which are licensed to Intelsat. Intelsat will internally coordinate the transmissions to/from these spacecraft and Intelsat 23 in order to ensure that excessive levels of interference are not generated.

Moreover, the use of circular polarization on Intelsat 23 will make the spacecraft's transmissions similar to those of other Intelsat spacecraft, such as Intelsat 707, in the 5925 – 6425 MHz and 3700 – 4200 MHz bands. This will minimize any impact on users during the transfer of traffic from Intelsat 707 to Intelsat 23. Hence, Intelsat believes that its request for a waiver of Section 25.210(a)(1) of the rules is justified.

2.6.2) Antennas and Beam Coverages

Intelsat 23 utilizes two dual feed C-band transmit/receive reflector antennas, one C-band transmit global horn antenna, one C-band receive global horn antenna, and one dual feed Ku-band transmit/receive reflector antenna. The coverage beams of the Intelsat 23 antennas are shown in Exhibits 5A-1 through 5A-20, in the format prescribed in Section 25.114(d)(3) of the Commission's rules.

The performance characteristics for each beam are provided in Exhibits 5A-1 through 5A-20. For the uplink beams, 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 32 dB

Exhibit 6 provides a detailed calculation of the EIRP, G/T and SFD of the Intelsat 23 uplink and downlink beams.

A number of the Intelsat 23 beams do not fully comply with the antenna cross-polarization requirement of Section 25.210(i)(1) of the Commission's rules. Specifically, the minimum cross-polarization isolation within limited regions of the primary coverage area of each of the aforementioned beams is as listed below:

Beam Name / Polarization	Beam Type	Minimum Cross Polarization Isolation (dB)
East Hemi (LHCP)	Transmit	≥ 27
East Hemi (RHCP)	Transmit	≥ 27
Mexico (V)	Transmit	≥ 28
Argentina (H)	Transmit	≥ 26
Argentina (V)	Transmit	≥ 24

The cross-polarization contours for the above transmit beams are shown in Exhibits D-1 through D-5. The labels in the contours shown in these Exhibits are absolute levels of cross-polarization isolation.

Section 25.210(i)(1) of the Commission's rules requires that the cross-polarization of each beam be at least 30 dB within its primary coverage area. Accordingly, with respect to the East Hemi, Mexico and Argentina transmit beams, Intelsat requests a waiver of this section of the rules.

The level of cross-polarization isolation achieved for the non-compliant beams was the best that the satellite manufacturer could achieve without causing excessive degradation in the co-polarized gain of the beam and/or in the size of its coverage area. As a result, a reduction in the cross-polarization isolation with respect to the 30 dB requirement was considered to be the best approach for making efficient use of the orbit/spectrum resources by Intelsat 23.

Moreover, as the Commission has previously recognized, "failure to meet the cross-polarization isolation requirements will not adversely impact any other operator and the only party to suffer an increase in interference" is the applicant itself.[1] The reduction in Intelsat 23's cross-polarization isolation in the affected portions of its coverage area will slightly increase the interference to Intelsat 23 carriers from its own oppositely polarized carriers as well as from emissions (of other operators) generated by adjacent satellites. By controlling the power level of Intelsat 23's carriers, however, Intelsat can compensate for this factor, thereby meeting its transmission objectives and the requirements of its customers.

The Commission previously has granted waivers of the requirement in Section 25.210(i)(1) based on the same reasoning that supports the waiver Intelsat is requesting in this application. Accordingly, Commission precedent supports a grant of Intelsat's waiver request.

2.6.3) <u>Transponder description</u>

2.6.3.1) <u>C-Band</u>

The output of the C-band (transmit/receive) antenna is divided into its polarization specific receive signal components through the use of an Ortho-mode Transducer ("OMT"). The (receive) input signal is fed through an input test coupler and then to a transmit reject filter that is designed to further reject the transmit frequency band and other undesired signals and prevent the overloading of the receive section. The output of the transmit reject filter is connected to a C-band receiver. Intelsat 23 utilizes three 4-for-2 redundant C-band receivers.

The receivers convert the uplink frequency to the appropriate downlink frequency. The Intelsat 23 C-band frequency down-converters are able to maintain over the life of the spacecraft the frequency of the transmitted (down converted) signal to within +/- 0.002% of the desired value.

[1] *See, e.g.*, *Application of SES Americom, Inc. for Authority to Launch and Operate a Ku-Band Replacement Satellite*, File No. SAT-LOA-20030219-00013 at ¶ 5 (stamp grant with conditions, Aug. 18, 2004).

Accordingly, Intelsat 23 is compliant with Section 25.202(e) of the Commission's rules.

The output of each receiver is routed to a bank of Input Multiplexers ("IMUXs"). The IMUXs are filters that provide frequency band separation for each channel. For the switchable channels, the output of the receiver is connected to a switch bank prior to the IMUX.

The output of each IMUX channel is connected to a corresponding Linearized Channel Amplifier / Traveling Tube Amplifier ("LCAMP/TWTA") pair through a redundancy switching network. The switching network allows for the output of each IMUX to be routed to a redundant LCAMP/TWTA should the primary unit fail.

The LCAMP/TWTAs are configured in two interconnected redundancy rings of 16-for-12. Each LCAMP/TWTA is comprised of an LCAMP that feeds a 50 Watt, conduction cooled, C-band TWTA.

The LCAMP provides high gain, and amplitude and gain expansion to compensate for the selected TWTA. The LCAMP may only be operated in the Fixed Gain Mode ("FGM"), whereby the output of the LCAMP may be adjusted by ground command from 0 to 32 dB in 1dB increments. Accordingly, Intelsat 23 is compliant with the provisions of Section 25.210(c) of the Commission's rules.

The output of each LCAMP/TWTA is then routed through a bank of switches to an Output Multiplexer ("OMUX"). The switching network allows the output of a redundant LCAMP/TWTA to be forwarded to the appropriate OMUX should the primary LCAMP/TWTA unit fail. Additionally, for the C-band switchable channels, the switching network, in conjunction with the switching network prior to the IMUXes, enables the connection of the LCAMP/TWTA to the appropriate OMUX.

The output of each OMUX is fed in succession to a receive reject filter, a test coupler, an OMT and the antenna feed for transmission to Earth.

2.6.3.2) <u>Ku-Band</u>

The output of each Ku-band (receive) antenna is divided into its polarization specific receive signal components through the use of an OMT. The input receive signal is fed through a diplexer, an input test coupler and then to a transmit reject filter that is designed to reject the transmit frequency band and other undesired signals, and prevent overloading of the receive section.

The output of the transmit reject filter is connected to a receiver. Intelsat 23 utilizes two 4-for-2 redundant Ku-band receivers. The receivers convert the uplink frequency to the appropriate downlink frequency. The Intelsat 23 Ku-band frequency down-converters are able to maintain over the life of the spacecraft the frequency of the transmitted (down converted) signal to within +/- 0.002% of the desired value. Accordingly, Intelsat 23 is compliant with Section 25.202(e) of the Commission's rules.

For channels 13K and 15K which may be configured to operate in the 11450 – 11700 MHz band, the signal is fed to a 2-for-1 redundant frequency down-converter (through one of the output ports of the Ku-band receiver that does not down-convert the frequency of the incoming signal). For this case, the overall frequency stability of the transmitted signal is set by the frequency down-converter, which is able to maintain over the life of the spacecraft the frequency of the transmitted (down-converted) signal to within +/- 0.002% of the desired value. Accordingly, Intelsat 23 is compliant with Section 25.202(e) of the Commission's rules.

The output of each receiver or frequency down-converter is routed to a bank of IMUXs. The IMUX is a filter that provides frequency band separation for each channel. For the switchable channels, the output of the receiver is connected to a switch bank prior to the IMUX.

The output of each IMUX channel is connected to a corresponding LCAMP/TWTA pair. Intelsat 23 utilizes a mixture of 130Watt and 150 Watt radiation cooled Ku-band TWTAs. Those LCAMP/TWTAs that utilize 150 Watt TWTAs are arranged in one 10-for-8 redundancy ring and one 4-for-3 redundancy ring. Those LCAMP/TWTAs that utilize 130 Watt TWTAs are arranged in a 5-for-4 redundancy ring (although the redundant TWTA is a 150 Watt unit).

The LCAMP provides high gain, and amplitude and gain expansion to compensate for the selected TWTA. The LCAMP may be operated in the Fixed Gain Mode ("FGM") or in the Automatic Level Control ("ALC") mode. In the FGM mode, the output of the LCAMP may be adjusted by ground command from 0 to 32 dB in 1 dB increments. Accordingly, Intelsat 23 is compliant with the provisions of Section 25.210(c) of the Commission's rules. In the ALC mode, the LCAMP automatically adjusts its gain depending on the power level of the input signal in order to maintain a constant output power in the presence of varying uplink power. When operating in the ALC mode, the amplifier operating point may be adjusted (by ground command) over a 38 dB range.

The output of each LCAMP/TWTA is routed to a switch bank which permits connection of the channel to the appropriate OMUX (and downlink beam). Additionally, for the Ku-band switchable channels, the switching network, in conjunction with the switching network prior to the IMUXes, enables the connection of the LCAMP/TWTA to the appropriate OMUX.

The output of each OMUX is fed to two receive reject filters, a test coupler, and then to the diplexer and OMT mentioned above. From there the signal is sent to the antenna feed for transmission to Earth.

2.7) 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.
3) Reception, processing and distribution of telecommands.

The TC&R subsystem consists of the following elements: 1) two wide coverage command antennas, one located on the nadir side of the spacecraft and the other on the aft side, 2) two wide coverage telemetry antennas, one located on the aft side of the spacecraft and the other on the nadir side, 3) one Omni command antenna, 4) one Omni telemetry antenna, 5) one global horn command antenna, 6) one global horn telemetry antenna from the communications payload, 7) two single frequency command receivers, 8) one dual frequency command receiver, 9) two dual frequency telemetry transmitters, 10) baseband digital data handling system, and 11) microwave components including filters, switches, couplers, isolators, cables and waveguide.

2.7.1) Antennas

The coverage patterns of the command and telemetry beams are provided in Exhibits 5B-1 through 5B-6, in the format prescribed in Section 25.114(d)(3) of the Commission's rules. When on-station, the command signal is received by a dedicated global horn antenna and the telemetry signal is transmitted through the communication payload's global horn antenna. The coverage pattern of the on-station command and telemetry beams are shown in Exhibits 5B-1 and 5B-4, respectively.

During emergencies and transfer orbit operations, command and telemetry signals are received and transmitted through the Omni antenna and through the wide coverage antennas. Representative receive and transmit gain graphs for the Omni antenna are provided in Exhibits 5B-2 and 5B-5, respectively. Representative receive and transmit gain graphs for the wide coverage antennas are provided in Exhibits 5B-3 and 5B-6, respectively.

2.7.2) Command

The Intelsat 23 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 sent to the spacecraft by transmission of two independent FM signals on the frequencies of 6173.7 MHz and 6176.3 MHz. The command signals are routed to three command receivers through a series of hybrids. The receivers amplify and demodulate the signal, and convert the command signal into a digital stream. The output of the command receivers is forwarded to the baseband digital data handling system, where the commands are decoded and sent to the appropriate unit.

During transfer orbit and 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 Omni and wide coverage antennas.

The Intelsat 23 command frequencies are not compliant with Section 25.202(g) of the Commission's rules. The Intelsat 23 command frequencies are identical to those utilized by Intelsat 707, the spacecraft that Intelsat 23 is replacing. As noted above, the nearest co-frequency satellites adjacent to Intelsat 23 are Intelsat 805, located at 55.5º W.L, and Intelsat 1R, located at 50º W.L. – both of which are licensed to Intelsat. Intelsat will internally coordinate the transmissions to/from these spacecraft and Intelsat 23 in order to ensure that excessive levels of interference are not generated. Hence, Intelsat believes that its request for a waiver of Section 25.202(g) is justified.

2.7.3) Telemetry

The Intelsat 23 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 one of two frequency pairs: 3947.5/3948.0 MHz or 3952.0/3952.5 MHz. The telemetry baseband functions are implemented in the baseband digital data handling system, where data from the various spacecraft units are collected, processed, multiplexed, formatted and encoded onto subcarriers. The output of the baseband digital data handling system is routed to the telemetry transmitters where the signal is modulated onto the main carrier frequencies.

Intelsat 23 utilizes two telemetry transmitters, each having the capability to operate at any of the four telemetry frequencies. The telemetry transmitters are able to maintain the downlink transmit frequency to within +/- 0.002% of the desired frequency over the life of the spacecraft.

Each telemetry transmitter has a low power output port and a high power output port. During emergency operations, the signal from the high power output port of each telemetry transmitter is routed to the Omni and wide coverage antennas through a series of hybrids. During on-station operations, the signal from the low power output port of the transmitter is routed to the appropriate C-band payload OMUX for transmission back to Earth through the Global transmit beam antenna.

The Intelsat 23 telemetry frequencies are not compliant with the provisions of Section 25.202(g) of the Commission's rules. The Intelsat 23 telemetry frequencies are identical to those utilized by Intelsat 707, the spacecraft that Intelsat 23 is replacing. As noted above in Section 2.7.2), Intelsat is requesting a waiver of Section 25.202(g).

2.7.4) Ranging

During all phases of the mission, the slant range of the spacecraft can 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 Intelsat 23 command, telemetry and ranging subsystems are provided in Exhibit 7.

2.8) Uplink Power Control Subsystem ("ULPC")

2.8.1 Antennas

Intelsat 23 utilizes a dedicated global horn antenna to generate the C-band global ULPC beam. Similarly, at Ku-band, a dedicated Ku-band global horn antenna is utilized to generate the Ku-band global ULPC beam. The coverage pattern of the C-band and Ku-band ULPC beams are provided in Exhibits 5C-1 and 5C-2, respectively.

2.8.2 ULPC System Description

Intelsat 23 provides two Ku-band beacons and one C-band beacon which can be used for uplink power control by customers transmitting to the spacecraft. The C-Band ULPC beacon operates on the frequency of 3950 MHz. The Ku-Band ULPC beacon operates on the frequencies of 11700 MHz. Detailed calculation of the EIRP for each ULPC beam is provided in Exhibit 6.

The Intelsat 23 C-band and Ku-band ULPC beacon transmitters are able to maintain the downlink transmit frequency to within +/- 0.002% of the desired frequency over the life of the spacecraft. Accordingly, Intelsat 23 is compliant with the provisions of Section 25.202(e) of the Commission's rules.

The C- and Ku-band band ULPC subsystems each utilize a dedicated 2-for-1 redundant transmitter to generate the beacon signal. The output signal from the ULPC transmitter is directed, in sequence, to a series of filters and then to the transmitting antenna for transmission to Earth.

2.9) Satellite Station-Keeping

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

The attitude of the spacecraft will be maintained with accuracy consistent with the achievement of the specified communications performance, after taking into account all error sources (i.e., attitude perturbations, thermal distortions, misalignments, orbital tolerances and thruster perturbations).

2.10) Satellite Useful Lifetime

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 15 years. To enhance the probability of survival, equipment/unit redundancy is incorporated into the spacecraft design where possible. Materials and processes have been selected so that aging or wearing effects will not adversely affect spacecraft performance over the estimated life.

2.11) Spacecraft Reliability

Intelsat 23 is designed for an operational and mission life of 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 have a minimum design life of 15 years. Redundancy concepts are applied to all critical components. All avoidable single-point failure modes have been eliminated.

The projected reliability of the C- and Ku-band payloads is 86.1% and 92.0%, respectively. The projected reliability of the bus system is 84.8%. The overall reliability of the Intelsat 23 spacecraft is projected to be 79.2%. The subsystem reliability assessments were based upon the use of failure rates, modeling assumptions from previous spacecraft programs and those specific to Intelsat 23. Failure rates for spacecraft equipment have been calculated using actual electrical stress and operating temperature conditions for each part.

3.0) Services and Emission Designators

Intelsat 23 is to be a general purpose communications satellite and has been designed to support various services offered within Intelsat's satellite system. Depending upon the needs of the users, the transponders on Intelsat 23 can accommodate television, radio, voice or data communications. Typical communication services to be offered include:

a) Frequency modulated television (TV/FM)
b) Compressed digital video
c) High speed digital data
d) Digital single channel per carrier ("SCPC") data channels
e) Digital SCPC with 64 kbps and T1 data rates

Emission designators and allocated bandwidths for representative communication carriers are provided in Exhibit 9.

4.0) Power Flux Density ("PFD")

The power flux density ("PFD") limits for space stations operating in the 3700 – 4200 MHz and 11450 - 11700 MHz bands are contained in Section 25.208 of the Commission's rules. Neither the Commission's rules nor the ITU Radio Regulations specify any pfd limits for the 11700 – 12200 MHz band applicable to geostationary satellites operating in the fixed satellite service.

The maximum PFD levels for the Intelsat 23 transmissions were calculated for a number of TV/FM and/or digital carriers listed in Exhibit 9 operating in the 3700 – 4200 MHz and 11450 – 11700 MHz bands. These carriers were chosen because they generally produce high PFD levels on the Earth's surface. The PFD levels were also calculated for the Intelsat 23 telemetry and ULPC carriers. The results are provided in Exhibit 10 and show that the downlink power flux density levels of the Intelsat 23 carriers do not exceed limits specified in Section 25.208 of the Commission's rules.

5.0) Emission Limitations

The Intelsat 23 receiver and transmitter channel filter response characteristics are provided in Exhibit 11, as required under Section 25.114 (4)(vii) of the Commission's rules.

Intelsat shall comply with the provisions of Section 25.202(f) of the Commission's rules with regard to Intelsat 23 emissions.

6.0) Service Area

At C-band, the primary service area of Intelsat 23 is North and South America, Europe and Africa. At Ku-band, the primary service area is Mexico, Central America, Argentina, northern South America and the southern portion of United States.

7.0) Orbital Location

Intelsat requests that it be assigned the 53° W.L orbital location for Intelsat 23. After transfer of traffic to Intelsat 23, the Intelsat 707 spacecraft, which currently operates from 53º W.L., will be deployed at another orbital location. The 53° W.L location satisfies Intelsat 23 requirements for optimizing coverage, elevation angles and service availability and ensures that maximum operational, economic and public interest benefits will be derived.

8.0) Orbital Arc Limitations

Intelsat 23 is intended to provide video, audio and data services to satellite users within its coverage area. The 53° W.L position affords reasonable earth station angles to the region. The attractiveness of Intelsat 23 to this market would be severely diminished if service to this area is not possible.

9.0) Intelsat 23 Link Budgets and Interference Analysis

Link analysis for Intelsat 23 was conducted for a number of representative carriers, at C- and Ku-band. Excluding Intelsat 707 that will be replaced by Intelsat 23, the nearest co-frequency satellites to Intelsat 23 are Intelsat 1R, located at 50º W.L, Intelsat 805, located at 55.5º W.L, and Intelsat 9, located at 58º W.L.

At C-band, it was assumed that the nearest co-frequency satellites to Intelsat 23 were two hypothetical satellites – one located at 51º W.L and the other located at 55º W.L. The hypothetical satellites were assumed to have same operational parameters as Intelsat 23. It was further assumed that each of the hypothetical satellites utilized digital carriers having a maximum uplink power density of -38.7 dBW/Hz, as specified in Section 25.212(d) of the Commission's rules, and a maximum downlink (beam peak) EIRP density of

-29.5 dBW/Hz.

At Ku-band, it was assumed that the nearest co-frequency satellites to Intelsat 23 were two hypothetical satellites – one located at 51º W.L and the other located at 55º W.L. The hypothetical satellites were assumed to have the same operational parameters as Intelsat 23. It was further assumed that each of the hypothetical satellites utilized digital carriers having a maximum uplink power density -45 dBW/Hz. The maximum downlink EIRP density of the hypothetical satellites was assumed to be -20 dBW/Hz.

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

a) In the plane of the geostationary satellite orbit, all C and Ku-band transmitting and receiving earth station antennas have off-axis co-polar gains that are compliant with the limits specified in Section 25.209(a)(1) or (a)(2) of the FCC's rules, depending on the frequency band under consideration.
b) All transmitting and receiving earth stations have a cross-polarization isolation value of at least 30 dB within their main beam.
c) At C-band frequencies, degradation due to rain is not considered, given that rain attenuation effects are insignificant at C-band.
d) At Ku-band frequencies rain attenuation predictions are derived using Recommendation ITU-R 618-8.
e) At Ku-band frequencies, increase in noise temperature of the receiving earth station due to rain is 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.

At C- and Ku-band frequencies, the impact of the TV/FM carriers from the adjacent satellites at 51° W.L and 55° W.L on the transmissions of Intelsat 23 was not considered due to the fact that TV/FM carriers are known to be high-density carriers with most of the energy contained within the near vicinity of the carrier center frequency. Operation of sensitive narrow-band carriers is typically precluded within these high power density areas of the TV/FM carrier. Accordingly, placement and operation of TV/FM carriers are normally achieved through internal coordination and/or coordination discussions with the adjacent satellite operator, whichever may be the case, rather than through C/I calculations – since the results of such calculations would show that narrow-band carriers typically could not operate on a co-frequency basis with TV/FM carriers.

As shown in Exhibits 4A and 4B, Intelsat 23 has a number of beam connectivity capabilities. In order to keep the number the Intelsat 23 link calculations to a manageable number, worst-case performance values were assumed for each beam type. The worst-case beam parameters were derived from the beam parameters listed in Exhibit 5 and chosen in such a manner that would make carrier links utilizing any specific uplink / downlink beam combination as sensitive to adjacent satellite interference as possible. This would ensure that the link performance objectives would be achieved for all possible Intelsat 23 uplink and downlink beam combinations. The worst-case beam performance for each Intelsat 23 beam type is provided below:

Beam Name	Aggregate Beam Designation	Worst-Case Beam Peak G/T (dB/K)	Worst-Case Beam SFD Range @ Peak G/T (dBW/m^2)	Worst-Case Beam Peak EIRP (dBW)
West Hemi (LHCP)	**West Hemi**	**1.8**	**-106 to -74**	**43.1**
West Hemi (RHCP)				
East Hemi (LHCP)	**East Hemi**	**2.8**	**-107.1 to -75.1**	**45.0**
East Hemi (RHCP)				
Global (LHCP)	**Global**	**-5.0**	**-103.9 to -71.9**	**37.1**
Global (RHCP)				
Mexico (H)	**Mexico**	**7.1**	**-106.1 to -74.1**	**53.0**
Mexico (V)				
Argentina (H)	**Argentina**	**8.2**	**-105.7 to -73.7**	**53.6**
Argentina (V)				

As shown in Exhibits 4A and 4B, Intelsat 23 employs with each beam channels having varying bandwidths. In an effort to keep the number of link calculations to a manageable level, link calculations were not performed for each channel size, but rather for only one channel size. The channel size chosen for each beam was based upon the level of adjacent satellite downlink interference. As an example, if a channel having a bandwidth of 77 MHz and a channel having a bandwidth of 72 MHz have the same associated adjacent satellite downlink interfering EIRP density, then link budgets were performed only for emissions that were transmitted through the 77 MHz channel, since power density levels would typically be smaller (uplink and downlink) in comparison to those which would be transmitted through the 72 MHz channel; and thus the impact of the adjacent satellite interference would be greater on the former. As a second example, if the level of downlink interfering EIRP density to which the 72 MHz channel was subjected was larger than that for the 77 MHz channel, and if this additional level of interference was larger than ten times the logarithmic ratio of the two channel bandwidths (i.e., 10log[77/72]), then link calculations were performed only for the emissions of the 72 MHz channel, since the impact of adjacent satellite interference is greater on emissions of this channel (in comparison to those being transmitted through the 77 MHz channel).

The results of the C-band and Ku-band analysis are shown in Exhibit 12 and demonstrate that operation of the Intelsat 23 satellite from 53° W.L. would permit the intended services to achieve their respective performance objectives while maintaining sufficient link margin. Additionally, the power and EIRP density levels of the carriers listed in Exhibit 12 comply with the limits contained in Sections 25.212(c) and (d) of the Commission's rules.

10.0) <u>Adjacent Satellite Link Analysis</u>

At C- and Ku-band, the impact of the proposed Intelsat 23 emissions on the transmissions of hypothetical adjacent satellites located at 51º W.L and 55º W.L was analyzed. It was assumed that each of these satellites had the same operating characteristics as the proposed Intelsat 23 spacecraft.

For the satellite located at 51º W.L, it was assumed that the adjacent satellites were Intelsat 23, located at 53º W.L, and a hypothetical satellite having the same operating characteristics as Intelsat 23 located at 49º W.L. For the satellite located at 55º W.L, it was assumed that the adjacent satellites were Intelsat 23, located at 53º W.L, and a hypothetical satellite having the same operating characteristics as Intelsat 23 located at 57º W.L.

The impact of Intelsat 23 emissions on the TV/FM carriers of the adjacent satellites at 51º W.L and 55º W.L was not considered for the reasons articulated in section 9.0 above. The assumptions made in section 9.0 pertaining to Earth station off-axis gain performance, Earth station cross-polarization performance and rain attenuation were also applied in the analysis.

The results of the analysis are given in Exhibits 13 and 14. The Intelsat 23 transmissions will be limited to those levels contained in Sections 25.212(c) and (d), as applicable, unless higher levels are coordinated with affected adjacent satellite operators. In any case, pursuant to the results in Exhibits 13 and 14, the uplink power density of the Intelsat 23 digital carriers operating in the 5925 – 6425 MHz and 14000 – 14500 MHz band will not exceed -38.7 dBW/Hz and -45 dBW/Hz, respectively. Within the 3700 – 4200 MHz band the downlink EIRP density of the Intelsat 23 digital carriers will not exceed -29.5 dBW/Hz; and within the 11450 – 12200 MHz band the downlink EIRP density of the Intelsat 23 digital carriers will not exceed -20 dBW/Hz.

11.0) Schedule S Submission

Intelsat is providing with its application a Schedule S for the operations of Intelsat 23 from 53º W.L. 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 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 are located inside the protective body of the spacecraft and properly shielded; and (2) all spacecraft subsystems have redundant components to ensure no single-point failures. The spacecraft does not use any subsystems for end-of-life disposal that are not used for normal operations.

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 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.

12.3) <u>Safe Flight Profiles</u>

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. With the exception of Intelsat 707 during the transition of traffic period, Intelsat 23 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.

During the transition of traffic from Intelsat 707, Intelsat will take all the necessary steps, e.g., "pass-in-the-night maneuver" or slight relocation of Intelsat 707 and/or Intelsat 23, to minimize the risk of collision between Intelsat 23 and Intelsat 707.

With the exception of Intelsat 707, 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 Intelsat 23. Intelsat is also not aware of any system with an overlapping station-keeping volume with Intelsat 23 that is the subject of an ITU filing and that is either in orbit or progressing towards launch.

12.4) <u>Post Mission Disposal</u>

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. Intelsat has reserved 6.8 kilograms of fuel for this purpose. The reserved fuel figure was determined by the spacecraft manufacturer and 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 ratio (Cr*A/M) of the Intelsat 23 spacecraft is 0.03 m^2/kg, resulting in a minimum perigee disposal altitude under the IADC formula of at most 238.2 kilometers above the geostationary arc, which is lower than the 300 kilometer above geostationary disposal altitude specified by Intelsat in this filing. Accordingly, the Intelsat 23 planned disposal orbit complies with the FCC's rules.

13) ITU Filing

Intelsat also does not have an ITU filing for a satellite network operating in the Fixed Satellite Service ("FSS") that operates in the 11950 - 12200 MHz band in ITU Region 2.

Intelsat will separately submit to the Commission the Advanced Publication Information ("API") for a new FSS satellite network that utilizes the 11950 – 12200 MHz band at 53° W.L.

Certification Statement

I hereby certify that I am a technically qualified person and am familiar with Part 25 of the Commission's Rules and Regulations. 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	July 15, 2011
Jose Albuquerque Intelsat Senior Director Spectrum Strategy	Date

EXHIBIT 1: SUMMARY OF SPACECRAFT CHARACTERISTICS

GENERAL	
Spacecraft Name	Intelsat 23
Orbital Location	53° W.L.
Spacecraft Manufacturer	Orbital
Spacecraft Model	Star 2e
Spacecraft Type	3-axis stabilized
Spacecraft Dimensions	
Length	23.6m
Width	8.9m
Depth	5.6m
Spacecraft Expected Lifetime	≥15 years
Eclipse Capability	100%
Station-keeping	
North-South	±0.05°
East-West	±0.05°
Antenna Pointing Accuracy	
North-South, East-West, Rotational	0.09°, 0.08º, 0.18º
Spacecraft Reliability	67.2%
Payload Reliability	79.2%
C-Band	86.1%
Ku-Band	92.0%
Bus Reliability	84.8%
Propulsion Type	Bi-propellant
Deployed Area of Solar Array	29.7 m^2
Ranging Accuracy	≤ 10 meters

EXHIBIT 2: SPACECRAFT MASS BUDGET

Mass of Spacecraft without Fuel (kg)	1503
Mass of Fuel and Disposables (kg)	1237
Launch Mass (kg)	2740
Mass of Fuel, in orbit, at Beginning of Life (kg)	1155

EXHIBIT 3: SPACECRAFT POWER BUDGET

	BEGINNING OF LIFE		END OF LIFE	
	AUTUMN EQUINOX	SUMMER SOLSTICE	AUTUMN EQUINOX	SUMMER SOLSTICE
PAYLOAD (WATTS)	4753	4753	4753	4753
BUS (WATTS)	1016	464	1016	464
TOTAL POWER (WATTS)	5769	5217	5769	5217
SOLAR ARRAY POWER (WATTS)	6841	6195	6642	6011
DEPTH OF BATTERY DISCHARGE (%)	69.6%	N/A	70.5%	N/A

EXHIBIT 4A: FREQUENCY PLAN

C-Band Frequency Plan

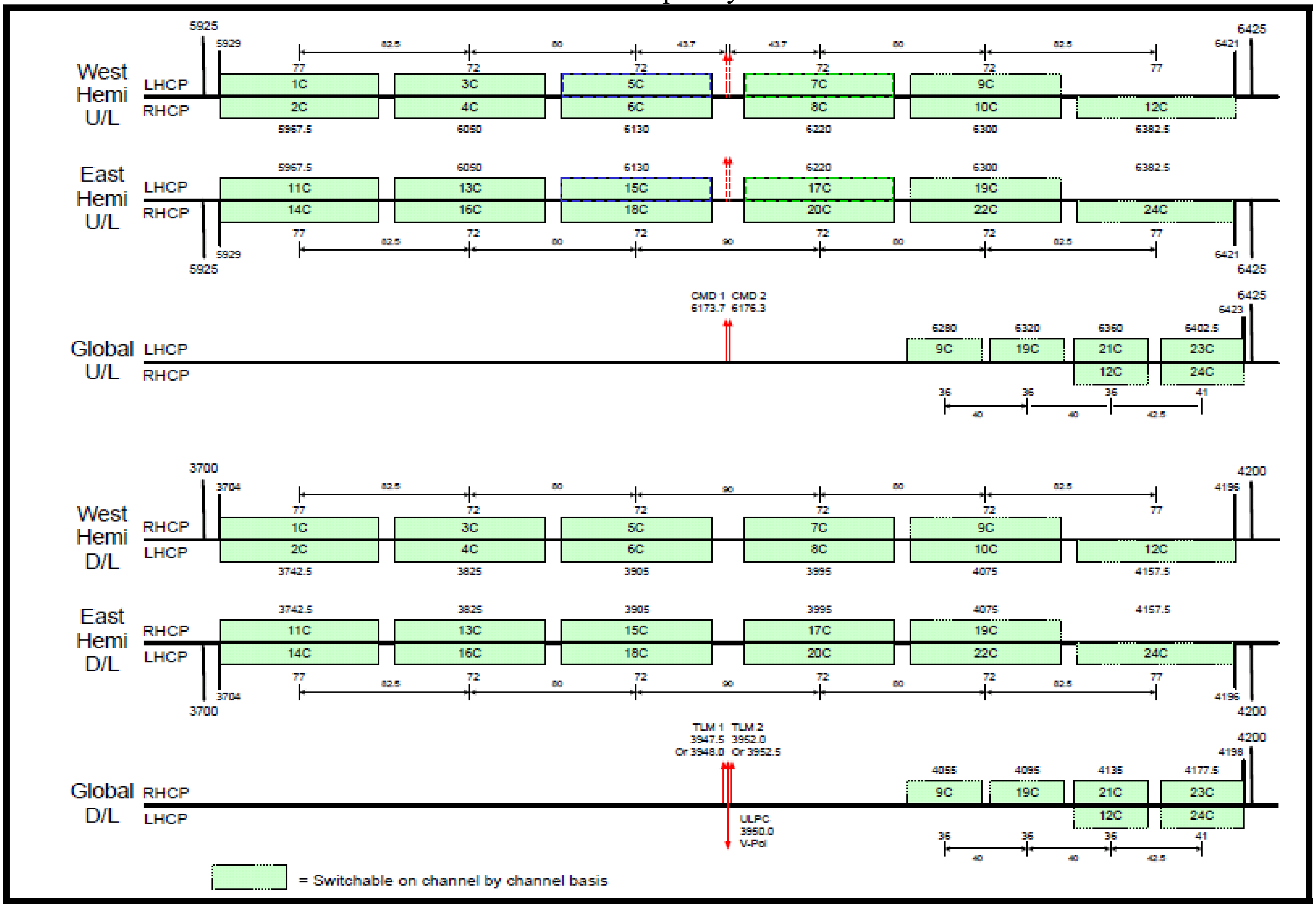


EXHIBIT 4A: FREQUENCY PLAN (continued)

Ku-Band Frequency Plan

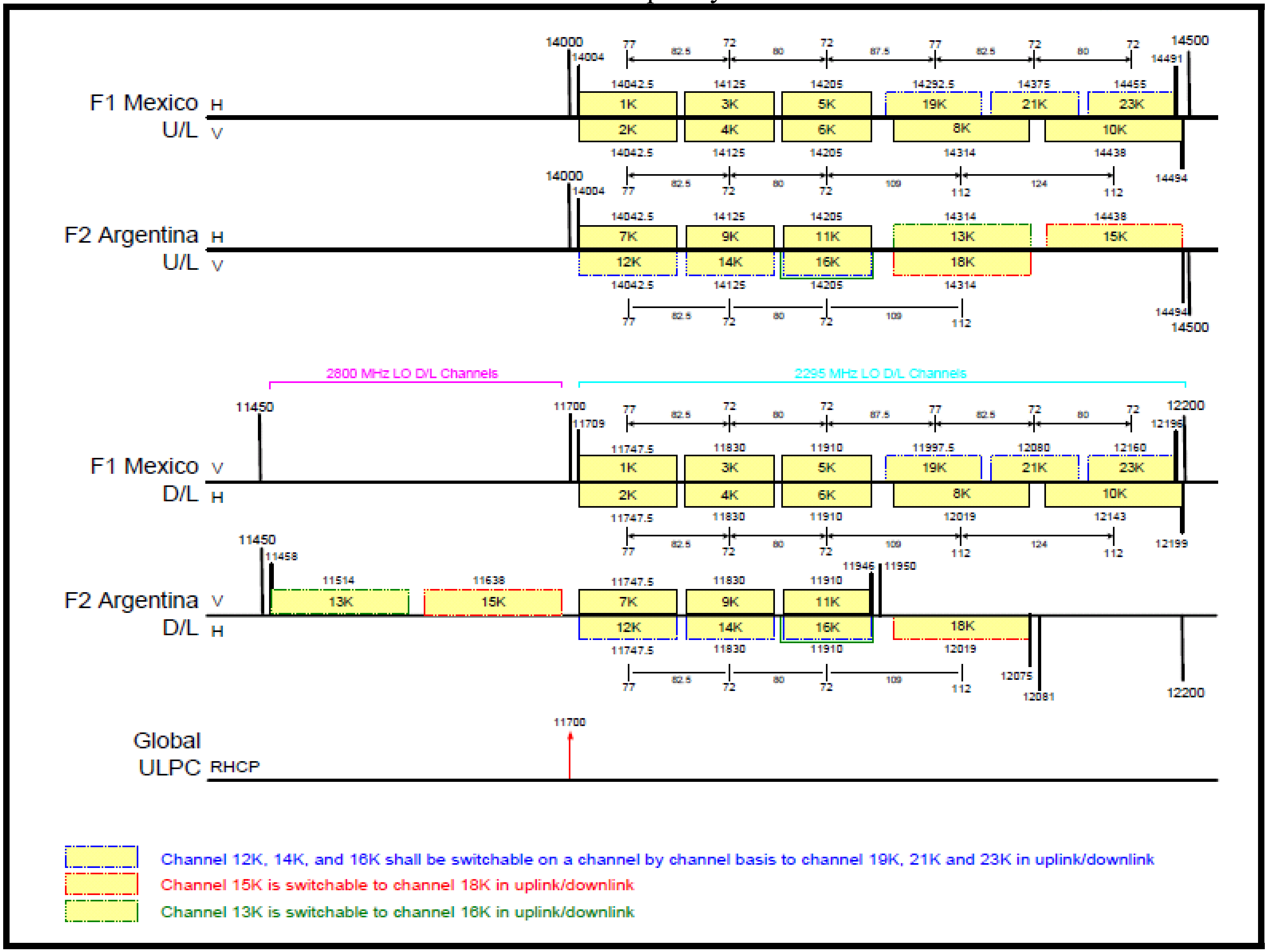


EXHIBIT 4B: FREQUENCY ASSIGNMENTS

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)
1C	West Hemi	Left Hand Circular	5967.5	1C	West Hemi	Right Hand Circular	3742.5	77	132.0
3C	West Hemi	Left Hand Circular	6050	3C	West Hemi	Right Hand Circular	3825	72	132.0
5C	West Hemi	Left Hand Circular	6130	5C	West Hemi	Right Hand Circular	3905	72	132.0
7C	West Hemi	Left Hand Circular	6220	7C	West Hemi	Right Hand Circular	3995	72	132.0
9C	West Hemi	Left Hand Circular	6300	9C	West Hemi	Right Hand Circular	4075	72	132.0
2C	West Hemi	Right Hand Circular	5967.5	2C	West Hemi	Left Hand Circular	3742.5	77	132.1
4C	West Hemi	Right Hand Circular	6050	4C	West Hemi	Left Hand Circular	3825	72	132.1
6C	West Hemi	Right Hand Circular	6130	6C	West Hemi	Left Hand Circular	3905	72	132.1
8C	West Hemi	Right Hand Circular	6220	8C	West Hemi	Left Hand Circular	3995	72	132.1
10C	West Hemi	Right Hand Circular	6300	10C	West Hemi	Left Hand Circular	4075	72	132.1
12C	West Hemi	Right Hand Circular	6382.5	12C	West Hemi	Left Hand Circular	4157.5	77	132.1
11C	East Hemi	Left Hand Circular	5967.5	11C	East Hemi	Right Hand Circular	3742.5	77	132.1
13C	East Hemi	Left Hand Circular	6050	13C	East Hemi	Right Hand Circular	3825	72	132.1
15C	East Hemi	Left Hand Circular	6130	15C	East Hemi	Right Hand Circular	3905	72	132.1
17C	East Hemi	Left Hand Circular	6220	17C	East Hemi	Right Hand Circular	3995	72	132.1
19C	East Hemi	Left Hand Circular	6300	19C	East Hemi	Right Hand Circular	4075	72	132.1
14C	East Hemi	Right Hand Circular	5967.5	14C	East Hemi	Left Hand Circular	3742.5	77	132.1
16C	East Hemi	Right Hand Circular	6050	16C	East Hemi	Left Hand Circular	3825	72	132.1
18C	East Hemi	Right Hand Circular	6130	18C	East Hemi	Left Hand Circular	3905	72	132.1
20C	East Hemi	Right Hand Circular	6220	20C	East Hemi	Left Hand Circular	3995	72	132.1
22C	East Hemi	Right Hand Circular	6300	22C	East Hemi	Left Hand Circular	4075	72	132.1
24C	East Hemi	Right Hand Circular	6382.5	24C	East Hemi	Left Hand Circular	4157.5	77	132.1
9C	Global	Left Hand Circular	6280	9G	Global	Right Hand Circular	4055	36	137.0
19C	Global	Left Hand Circular	6320	19G	Global	Right Hand Circular	4095	36	137.0
21C	Global	Left Hand Circular	6360	21G	Global	Right Hand Circular	4135	36	137.0
23C	Global	Left Hand Circular	6402.5	23G	Global	Right Hand Circular	4177.5	41	137.0
12C	Global	Right Hand Circular	6360	12G	Global	Left Hand Circular	4135	36	136.9
24C	Global	Right Hand Circular	6402.5	24G	Global	Left Hand Circular	4177.5	41	136.9
5C	West Hemi	Left Hand Circular	6130	15C	East Hemi	Right Hand Circular	3905	72	132.1
7C	West Hemi	Left Hand Circular	6220	17C	East Hemi	Right Hand Circular	3995	72	132.1
15C	East Hemi	Left Hand Circular	6130	5C	West Hemi	Right Hand Circular	3905	72	132.2
17C	East Hemi	Left Hand Circular	6220	7C	West Hemi	Right Hand Circular	3995	72	132.2
9C	Global	Left Hand Circular	6280	9C	West Hemi	Right Hand Circular	4055	34	136.9
19C	Global	Left Hand Circular	6320	19C	East Hemi	Right Hand Circular	4095	34	137.0
12C	Global	Right Hand Circular	6360	12C	West Hemi	Left Hand Circular	4135	34	136.9
24C	Global	Right Hand Circular	6402.5	24C	East Hemi	Left Hand Circular	4177.5	34	137.0
9C	West Hemi	Left Hand Circular	6280	9C	Global	Right Hand Circular	4055	34	132.1
12C	West Hemi	Right Hand Circular	6360	12C	Global	Left Hand Circular	4135	34	132.3
19C	East Hemi	Left Hand Circular	6320	19C	Global	Right Hand Circular	4095	34	132.3
24C	East Hemi	Right Hand Circular	6402.5	24C	Global	Left Hand Circular	4177.5	34	132.4
CMD1	Global	Left Hand Circular	6173.7					1	
CMD2	Global	Left Hand Circular	6176.3					1	
				TLM1	Global	Right Hand Circular	3947.5	0.5	
				TLM2	Global	Right Hand Circular	3948	0.5	
				TLM3	Global	Right Hand Circular	3952	0.5	
				TLM4	Global	Right Hand Circular	3952.5	0.5	
				UPC1	Global	Vertical	3950	0.025	

EXHIBIT 4B: FREQUENCY ASSIGNMENTS (continued)

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)
1K	Mexico	Horizontal	14042.5	1K	Mexico	Vertical	11747.5	77	137.0
3K	Mexico	Horizontal	14125	3K	Mexico	Vertical	11830	72	137.0
5K	Mexico	Horizontal	14205	5K	Mexico	Vertical	11910	72	137.0
19K	Mexico	Horizontal	14292.5	19K	Mexico	Vertical	11997.5	77	137.0
21K	Mexico	Horizontal	14375	21K	Mexico	Vertical	12080	72	137.0
23K	Mexico	Horizontal	14455	23K	Mexico	Vertical	12160	72	137.0
2K	Mexico	Vertical	14042.5	2K	Mexico	Horizontal	11747.5	77	137.0
4K	Mexico	Vertical	14125	4K	Mexico	Horizontal	11830	72	137.0
6K	Mexico	Vertical	14205	6K	Mexico	Horizontal	11910	72	137.0
8K	Mexico	Vertical	14314	8K	Mexico	Horizontal	12019	112	137.0
10K	Mexico	Vertical	14438	10K	Mexico	Horizontal	12143	112	137.0
7K	Argentina	Horizontal	14042.5	7K	Argentina	Vertical	11747.5	77	135.5
9K	Argentina	Horizontal	14125	9K	Argentina	Vertical	11830	72	135.5
11K	Argentina	Horizontal	14205	11K	Argentina	Vertical	11910	72	135.5
13K	Argentina	Horizontal	14314	13K	Argentina	Vertical	11514	112	135.5
15K	Argentina	Horizontal	14438	15K	Argentina	Vertical	11638	112	135.5
12K	Argentina	Vertical	14042.5	12K	Argentina	Horizontal	11747.5	77	135.5
14K	Argentina	Vertical	14125	14K	Argentina	Horizontal	11830	72	135.5
16K	Argentina	Vertical	14205	16K	Argentina	Horizontal	11910	72	135.5
18K	Argentina	Vertical	14314	18K	Argentina	Horizontal	12019	112	135.5
12K	Argentina	Vertical	14042.5	19K	Mexico	Vertical	11997.5	77	135.4
14K	Argentina	Vertical	14125	21K	Mexico	Vertical	12080	72	135.4
16K	Argentina	Vertical	14205	23K	Mexico	Vertical	12160	72	135.4
19K	Mexico	Horizontal	14292.5	12K	Argentina	Horizontal	11747.5	77	137.1
21K	Mexico	Horizontal	14375	14K	Argentina	Horizontal	11830	72	137.1
23K	Mexico	Horizontal	14455	16K	Argentina	Horizontal	11910	72	137.1
15K	Argentina	Horizontal	14438	18K	Argentina	Horizontal	12019	112	135.6
18K	Argentina	Vertical	14314	15K	Argentina	Vertical	11638	112	135.6
13K	Argentina	Horizontal	14314	16K	Argentina	Horizontal	11910	72	135.6
16K	Argentina	Vertical	14205	13K	Argentina	Vertical	11514	72	135.5
				UPK1	Global	Right Hand Circular	11700	0.025	

EXHIBIT 5A-1: WEST HEMI RECEIVE BEAM
(Schedule S Beam ID: WLUL)

Beam Polarization: Left Hand Circular
Peak Beam Gain: 27.8 dBi
Peak Beam G/T: 1.8 dB/K
Saturated Flux Density @ Peak Beam G/T: -74 to -106 dBW/m^2

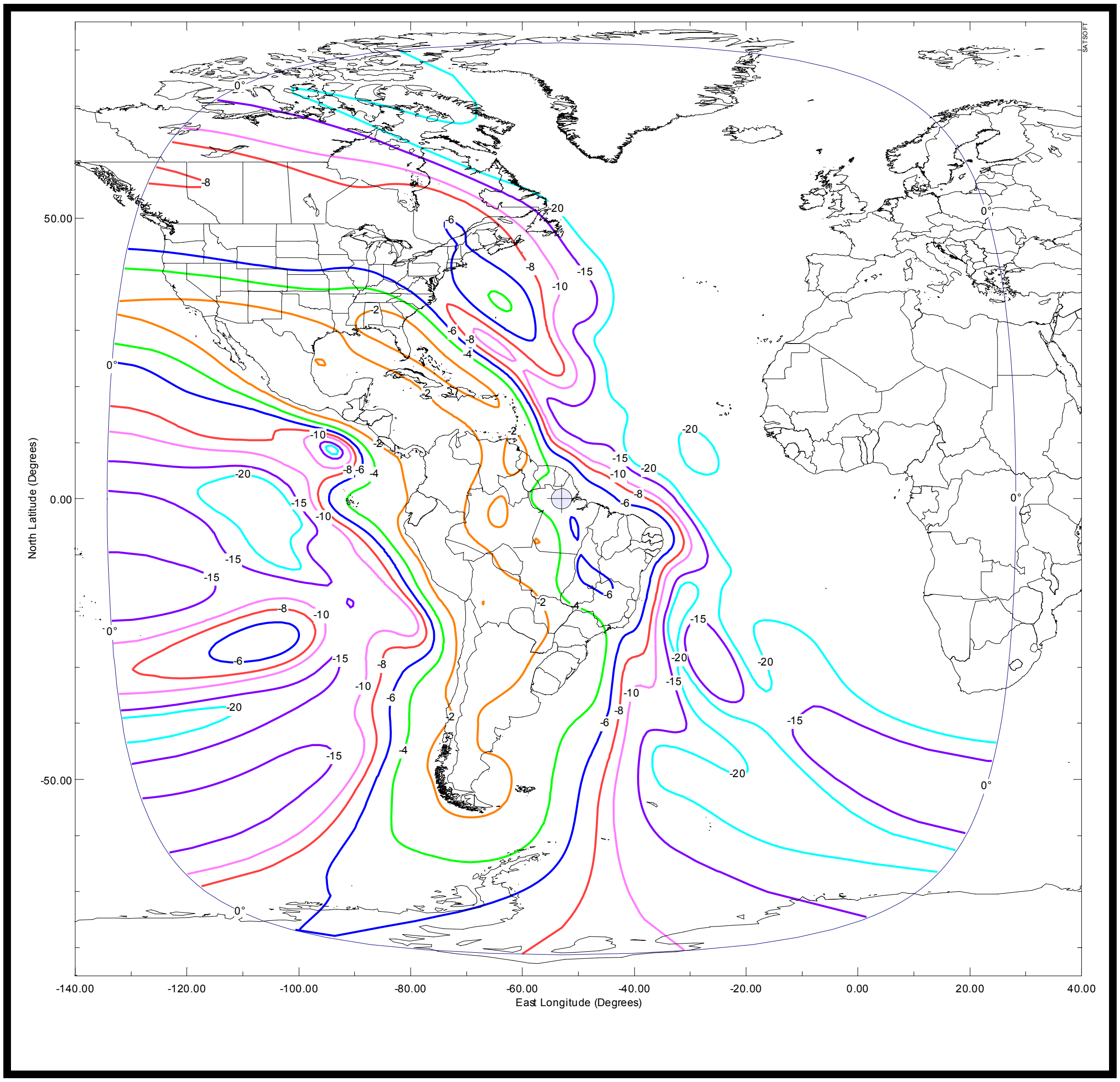


EXHIBIT 5A-2: WEST HEMI RECEIVE BEAM
(Schedule S Beam ID: WRUL)

Beam Polarization: Right Hand Circular
Peak Beam Gain: 27.7 dBi
Peak Beam G/T: 1.7 dB/K
Saturated Flux Density @ Peak Beam G/T: -74 to -106 dBW/m^2

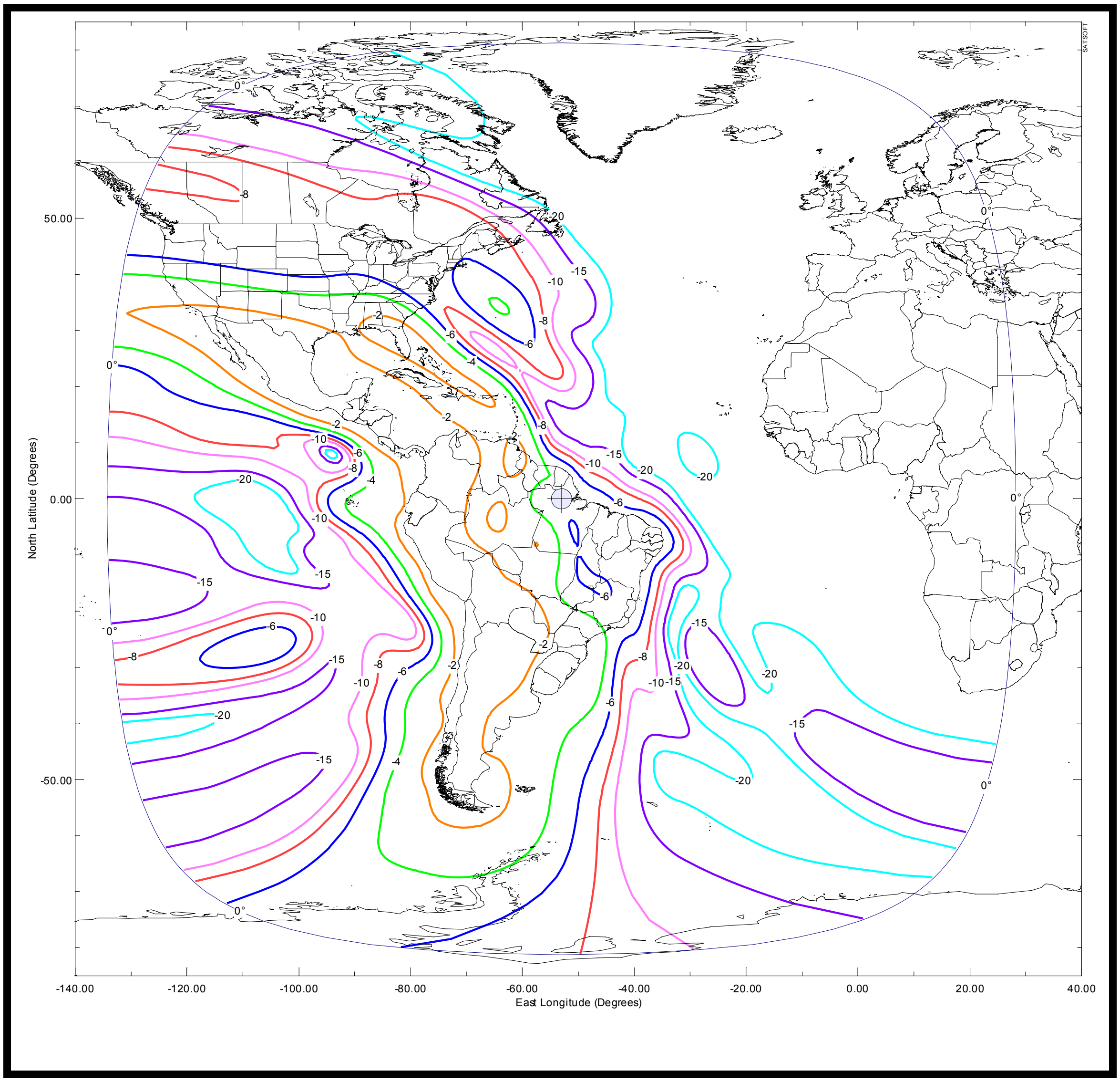


EXHIBIT 5A-3: EAST HEMI RECEIVE BEAM
(Schedule S Beam ID: ELUL)

Beam Polarization: Left Hand Circular
Peak Beam Gain: 28.8 dBi
Peak Beam G/T: 2.8 dB/K
Saturated Flux Density @ Peak Beam G/T: -75.1 to -107.1 dBW/m^2

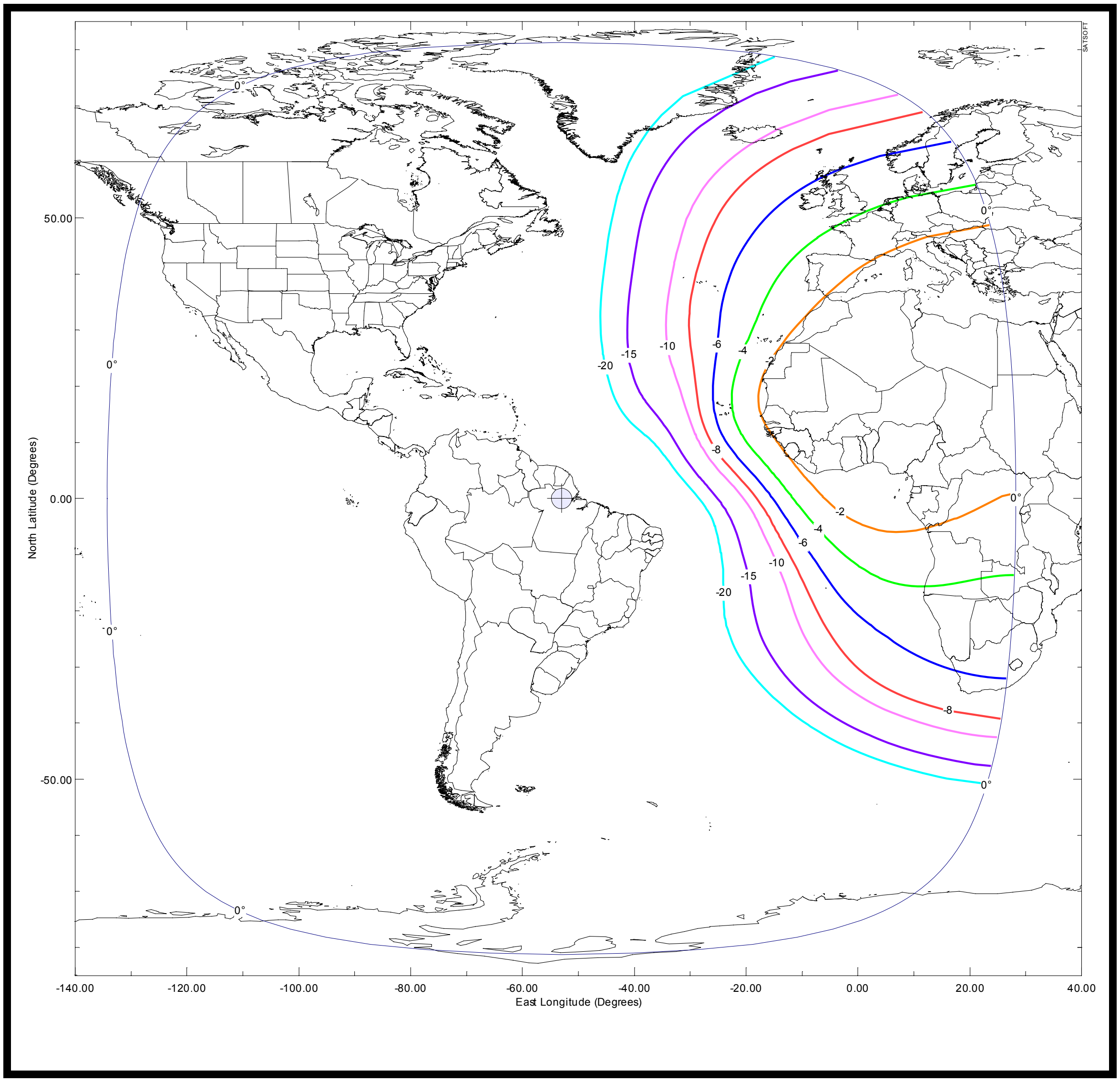


EXHIBIT 5A-4: EAST HEMI RECEIVE BEAM
(Schedule S Beam ID: ERUL)

Beam Polarization: Right Hand Circular
Peak Beam Gain: 28.8 dBi
Peak Beam G/T: 2.8 dB/K
Saturated Flux Density @ Peak Beam G/T: -75.1 to -107.1 dBW/m^2

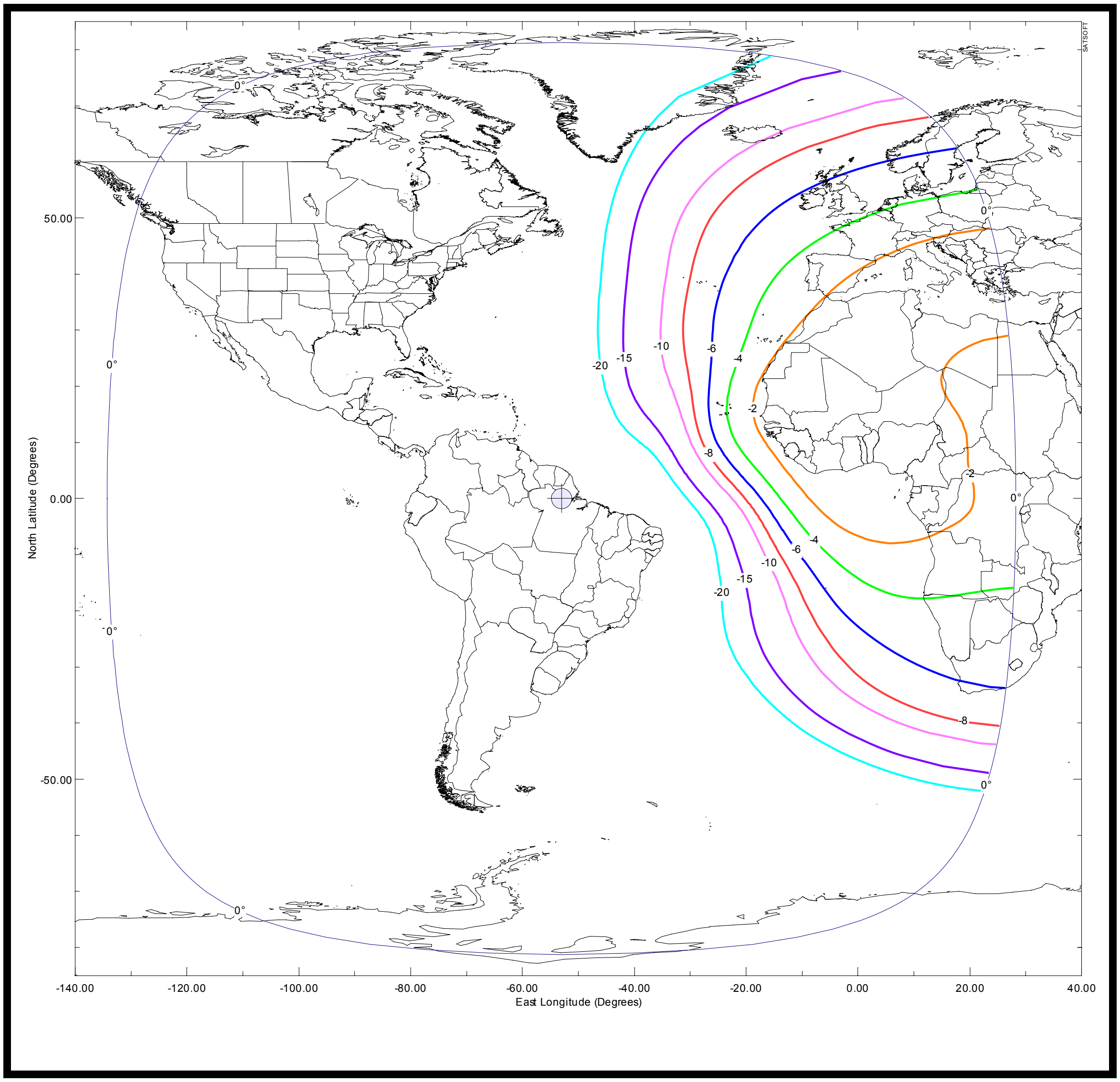


EXHIBIT 5A-5: GLOBAL RECEIVE BEAM
(Schedule S Beam ID: GLUL)

Beam Polarization: Left Hand Circular
Peak Beam Gain: 20.9 dBi
Peak Beam G/T: -5.1 dB/K
Saturated Flux Density @ Peak Beam G/T: -71.9 to -103.9 dBW/m^2

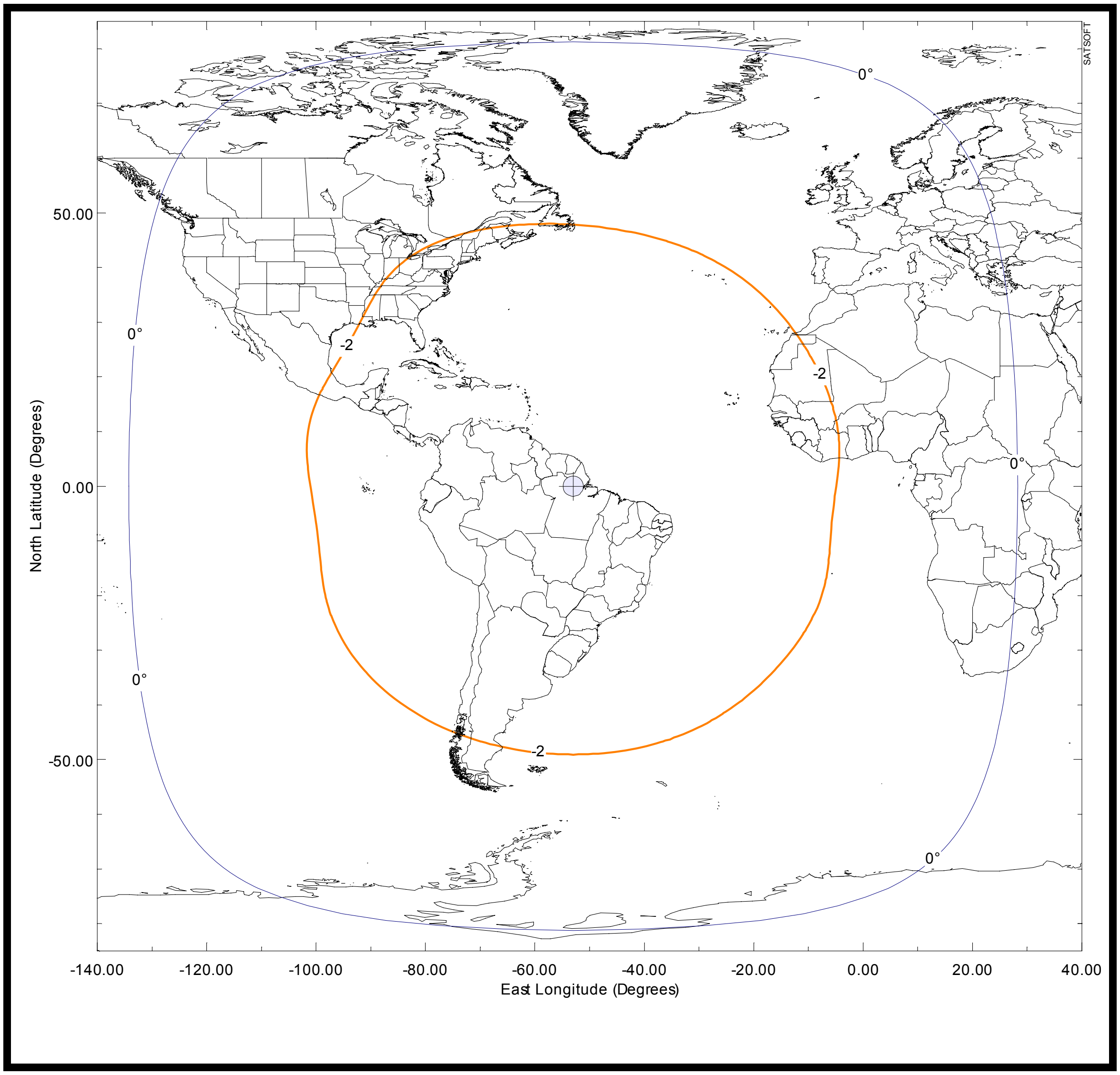


EXHIBIT 5A-6: GLOBAL RECEIVE BEAM
(Schedule S Beam ID: GRUL)

Beam Polarization: Right Hand Circular
Peak Beam Gain: 21.0 dBi
Peak Beam G/T: -5.0 dB/K
Saturated Flux Density @ Peak Beam G/T: -71.9 to -103.9 dBW/m^2

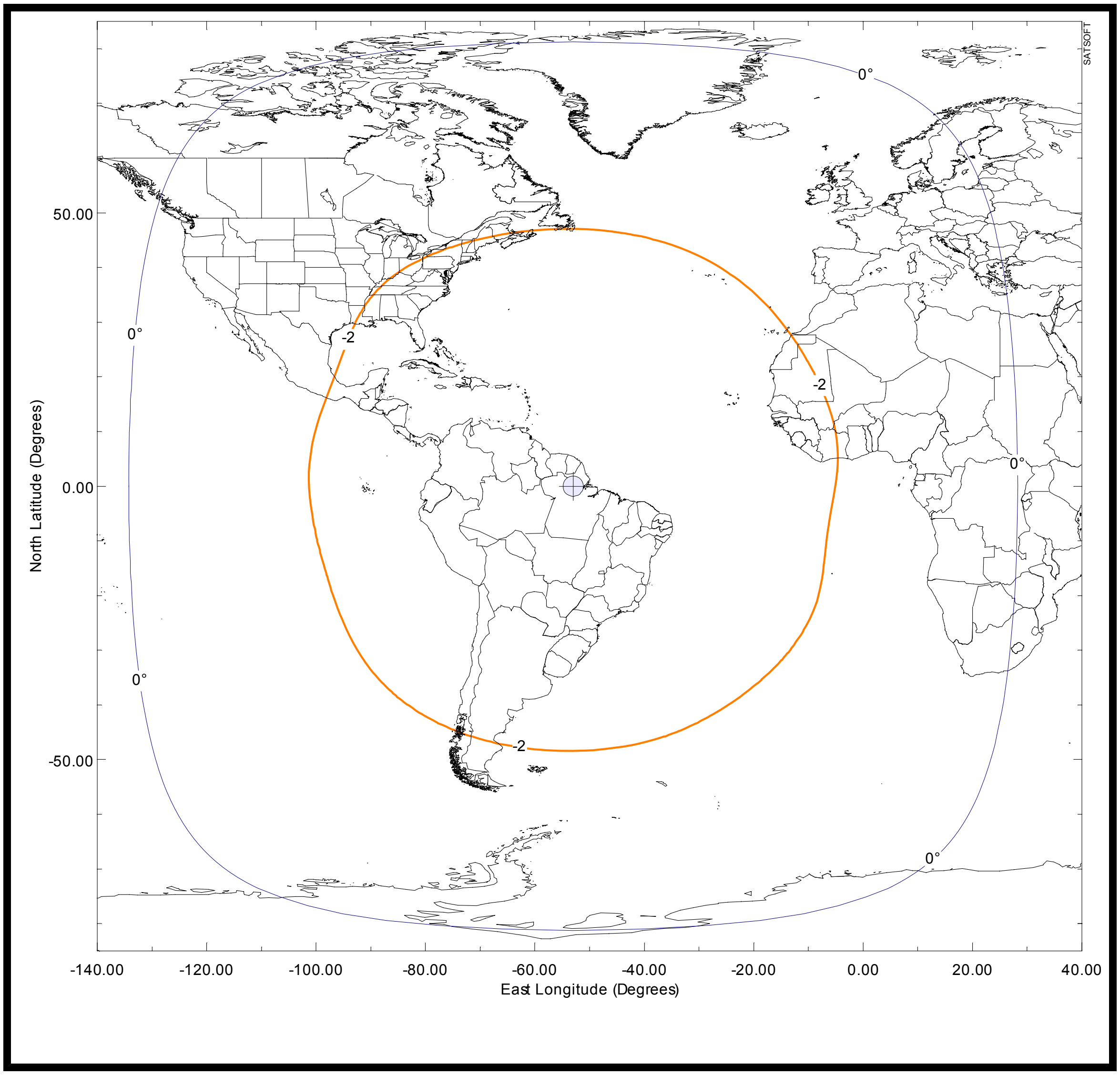


EXHIBIT 5A-7: MEXICO RECEIVE BEAM
(Schedule S Beam ID: MHUL)

Beam Polarization: Horizontal
Peak Beam Gain: 34.1 dBi
Peak Beam G/T: 7.1 dB/K
Saturated Flux Density @ Peak Beam G/T: -74.1 to -106.1 dBW/m^2

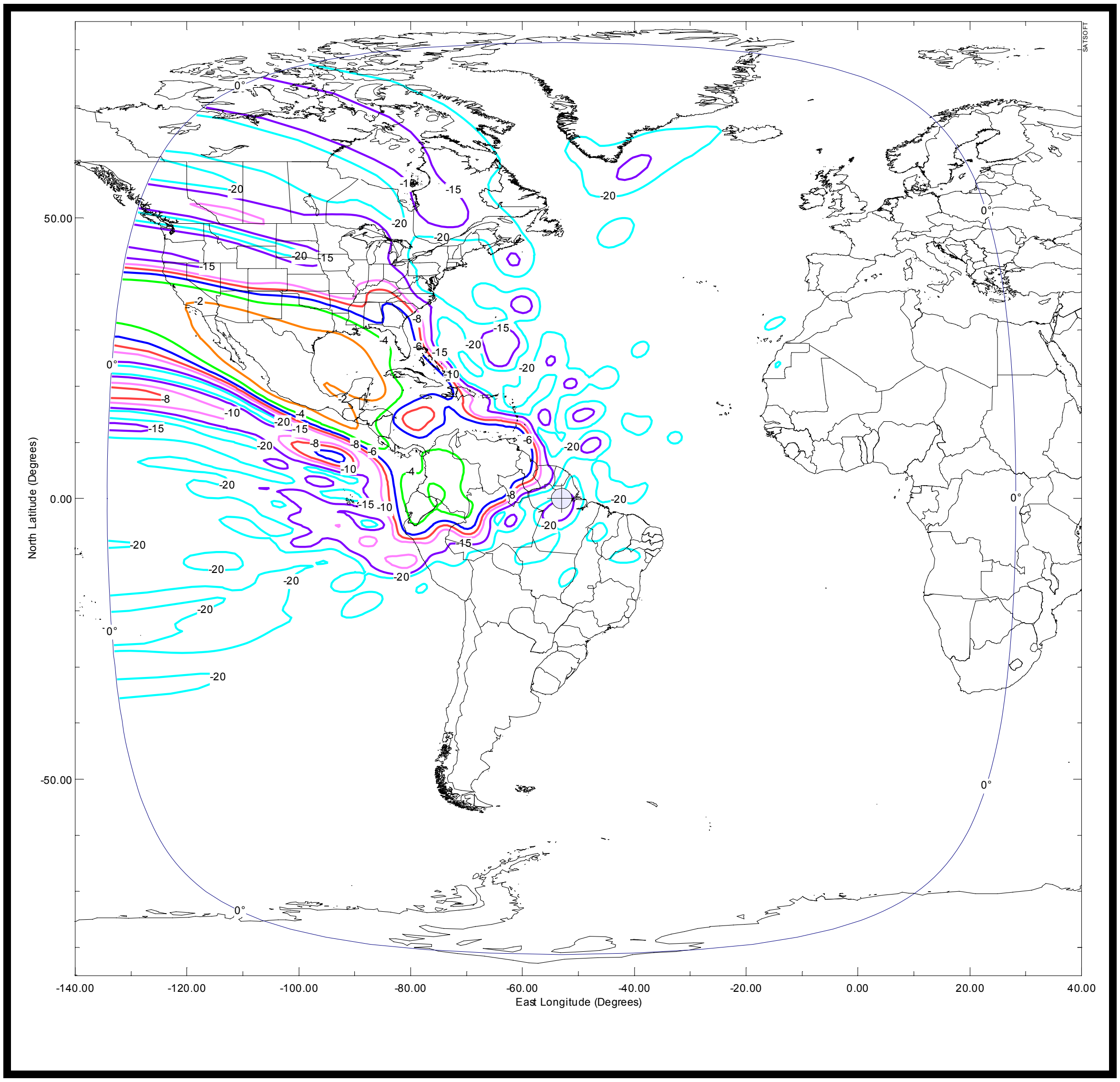


EXHIBIT 5A-8: MEXICO RECEIVE BEAM
(Schedule S Beam ID: MVUL)

Beam Polarization: Vertical
Peak Beam Gain: 34.1 dBi
Peak Beam G/T: 7.1 dB/K
Saturated Flux Density @ Peak Beam G/T: -74.1 to -106.1 dBW/m^2

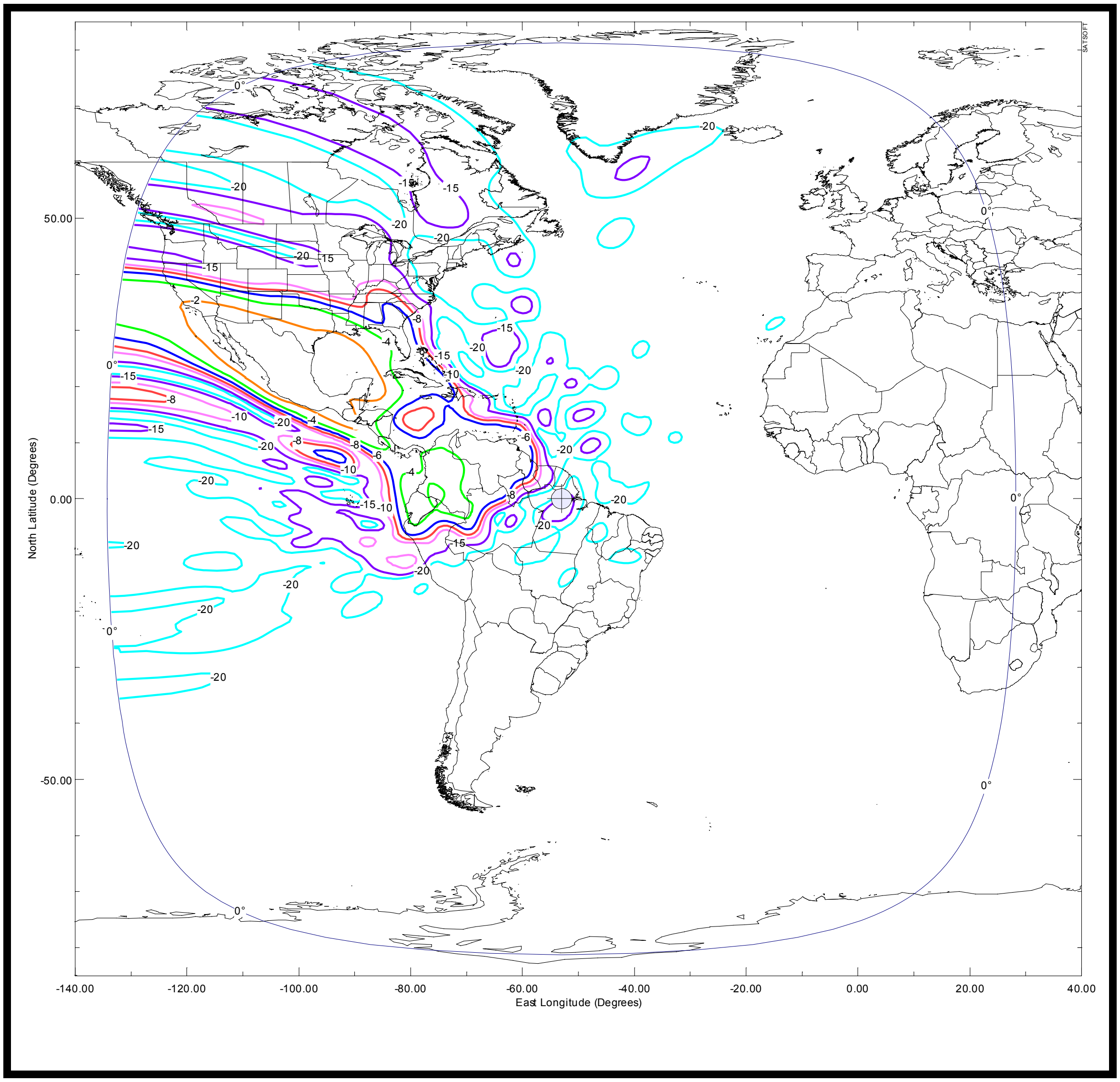


EXHIBIT 5A-9: ARGENTINA RECEIVE BEAM
(Schedule S Beam ID: AHUL)

Beam Polarization: Horizontal
Peak Beam Gain: 35.2 dBi
Peak Beam G/T: 8.2 dB/K
Saturated Flux Density @ Peak Beam G/T: -73.7 to -105.7 dBW/m^2

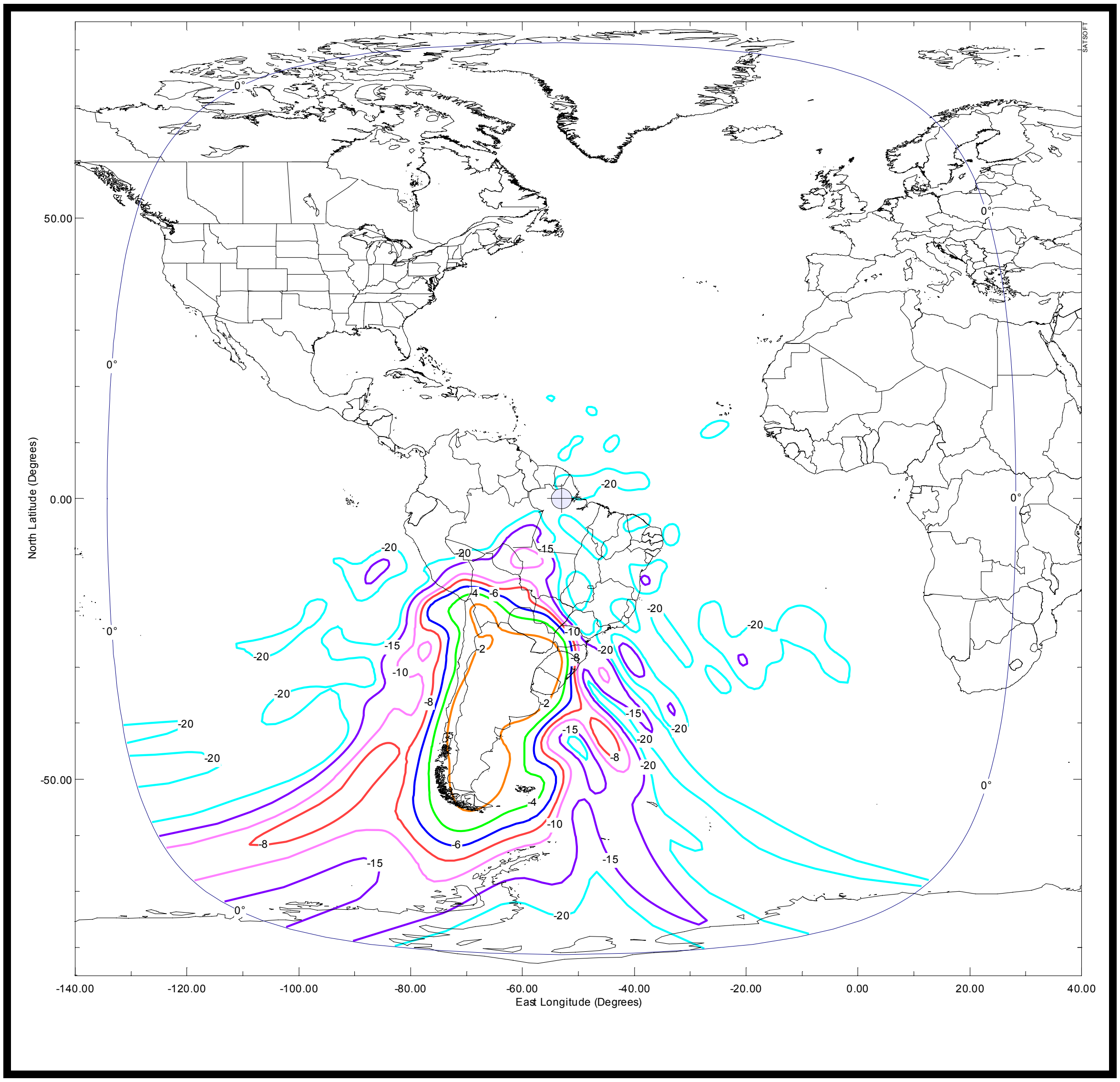


EXHIBIT 5A-10: ARGENTINA RECEIVE BEAM
(Schedule S Beam ID: AVUL)

Beam Polarization: Vertical
Peak Beam Gain: 35.2 dBi
Peak Beam G/T: 8.2 dB/K
Saturated Flux Density @ Peak Beam G/T: -73.7 to -105.7 dBW/m^2

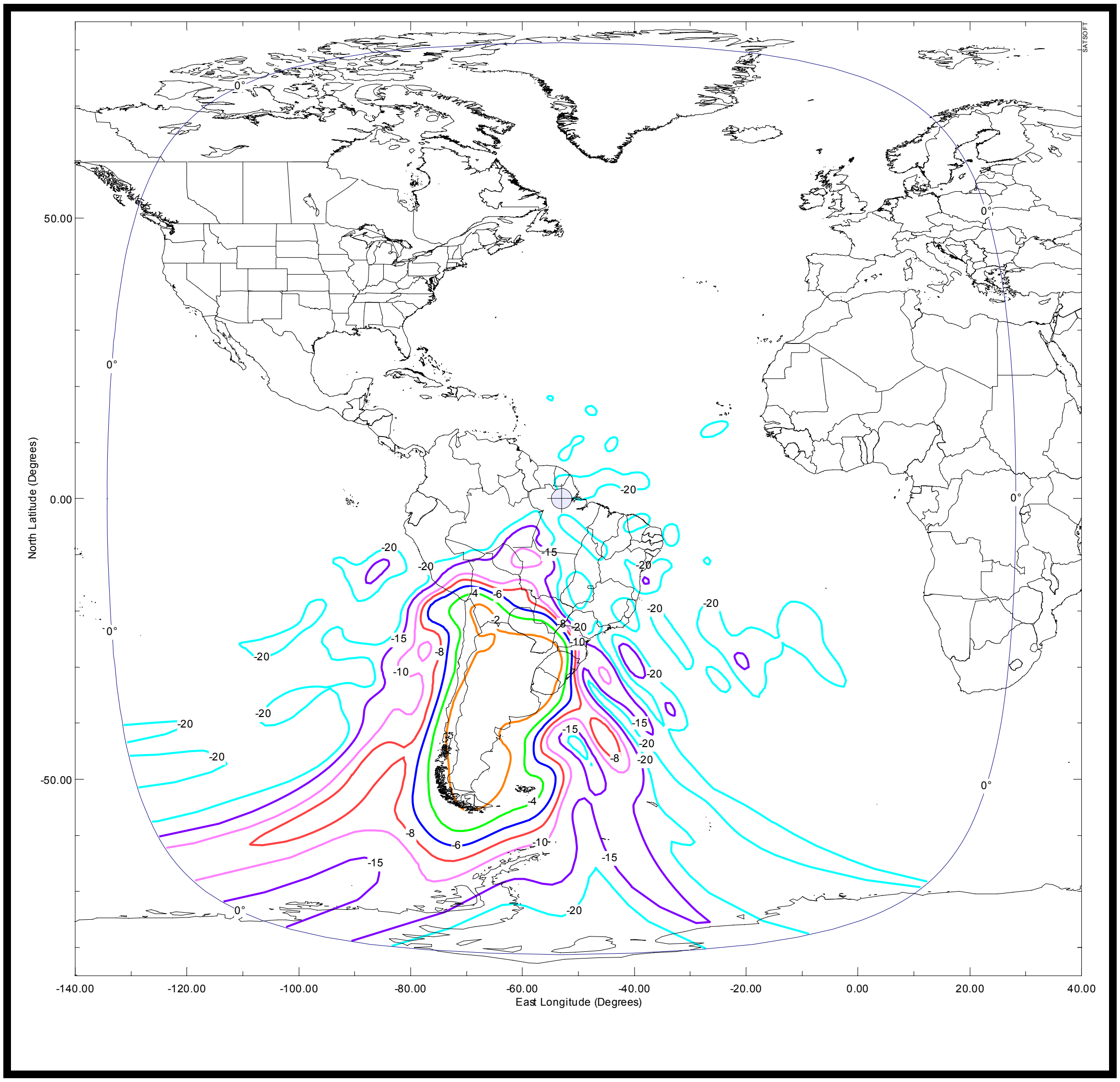


EXHIBIT 5A-11: WEST HEMI TRANSMIT BEAM
(Schedule S Beam ID: WLDL)

Beam Polarization: Left Hand Circular
Peak Beam Gain: 26.8 dBi
Peak Beam EIRP: 43.3 dBW

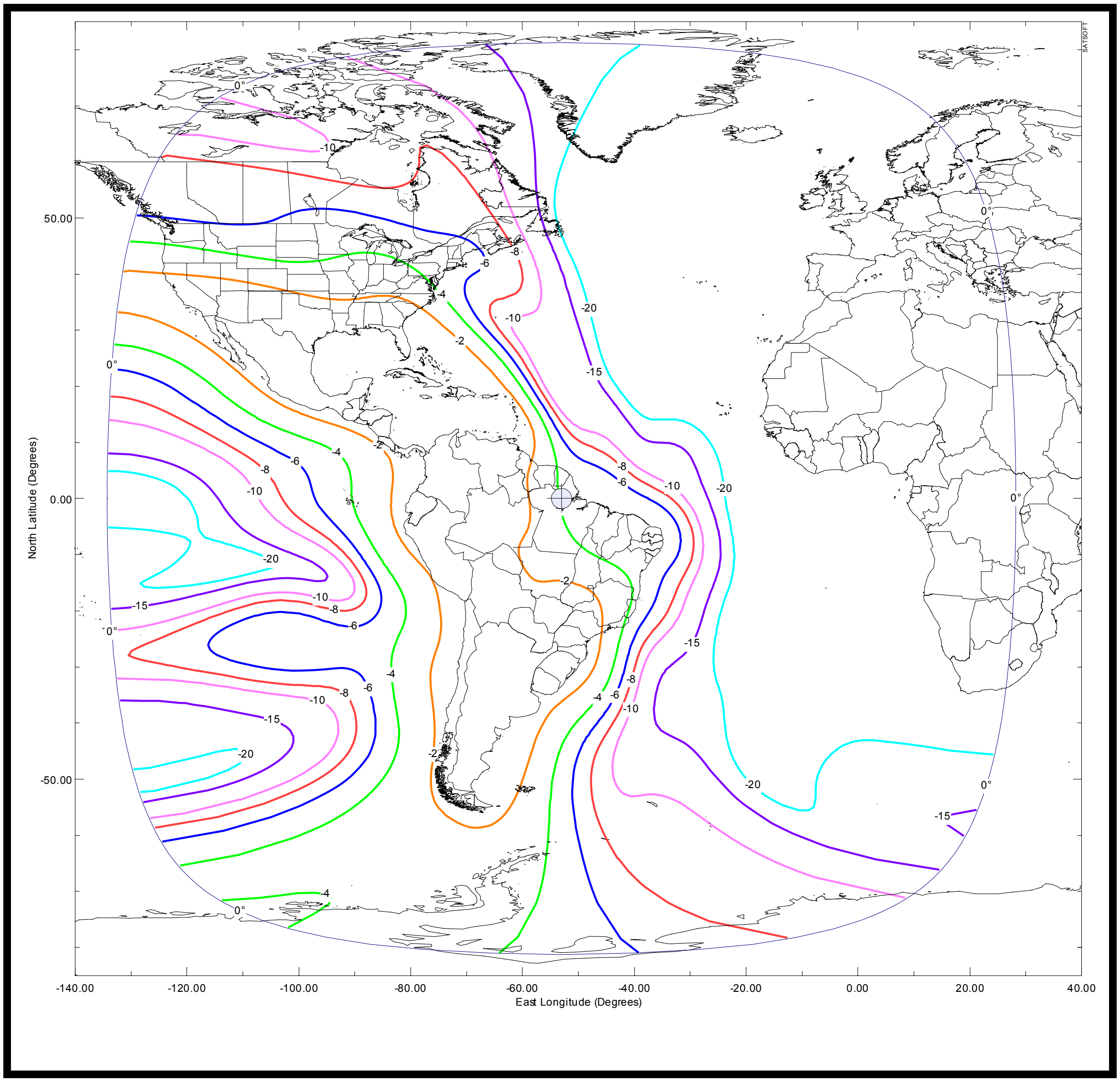


EXHIBIT 5A-12: WEST HEMI TRANSMIT BEAM
(Schedule S Beam ID: WRDL)

Beam Polarization: Right Hand Circular
Peak Beam Gain: 26.6 dBi
Peak Beam EIRP: 43.1 dBW

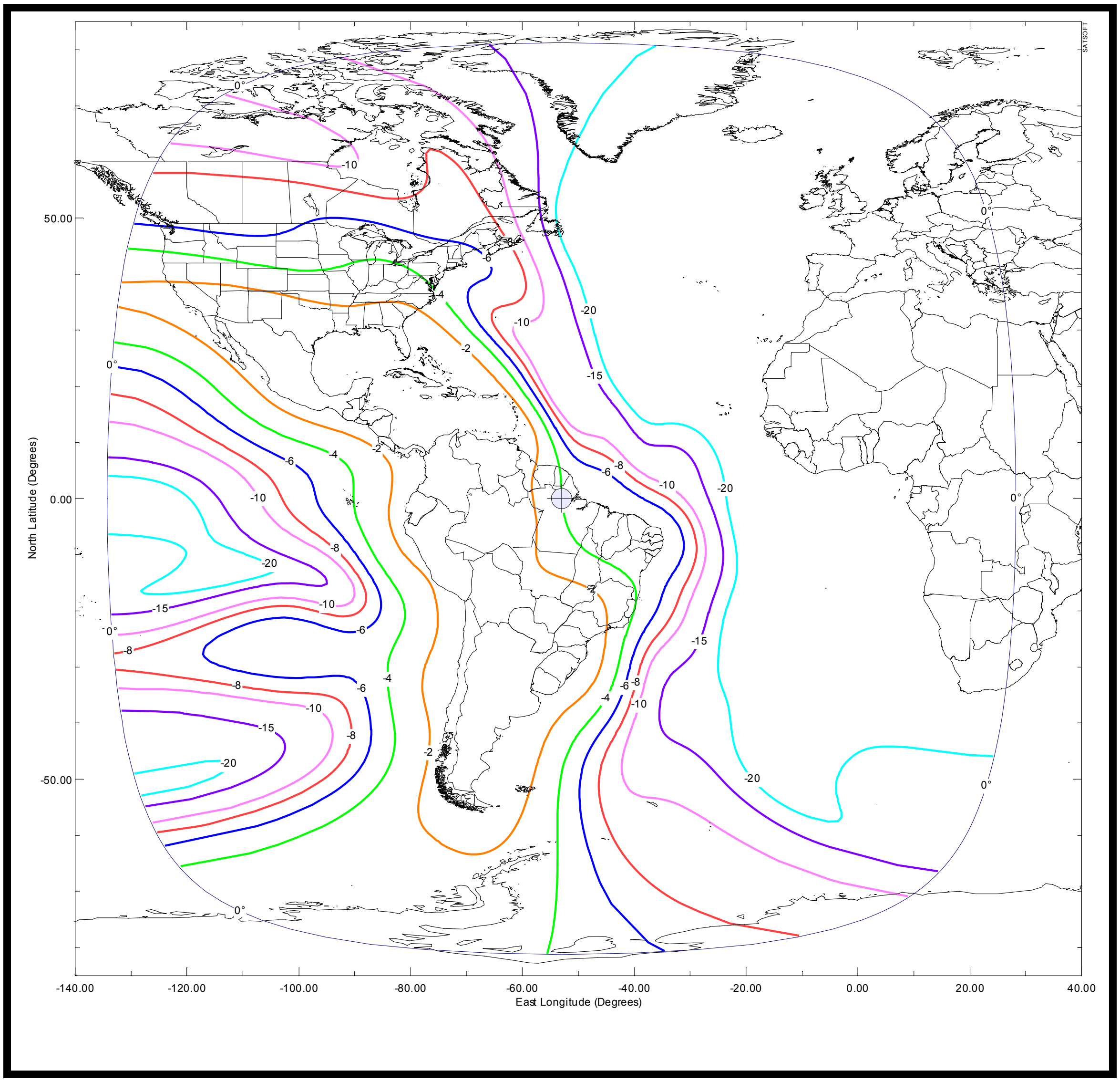


EXHIBIT 5A-13: EAST HEMI TRANSMIT BEAM
(Schedule S Beam ID: ELDL)

Beam Polarization: Left Hand Circular
Peak Beam Gain: 28.5 dBi
Peak Beam EIRP: 45.0 dBW

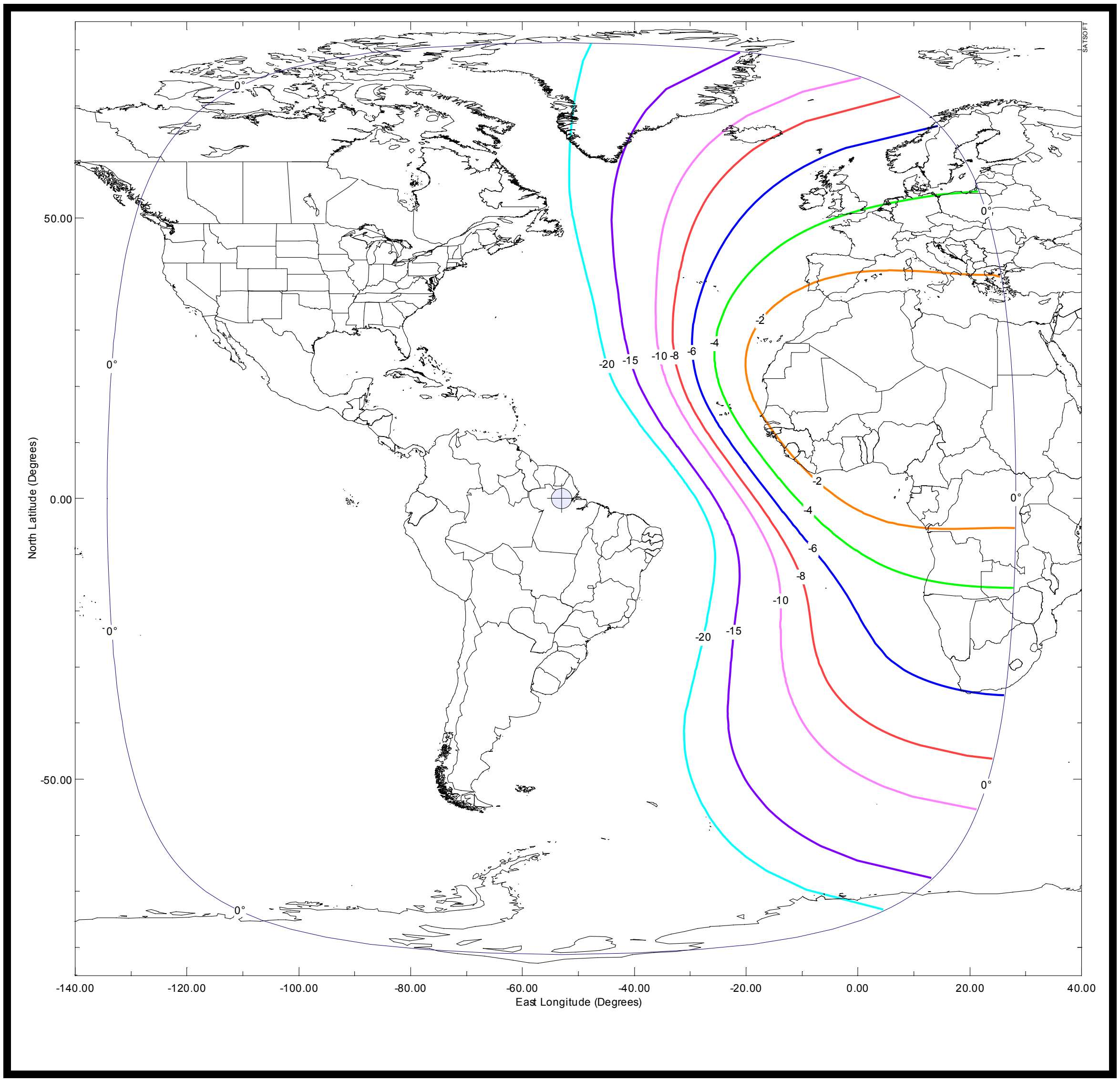


EXHIBIT 5A-14: EAST HEMI TRANSMIT BEAM
(Schedule S Beam ID: ERDL)

Beam Polarization: Right Hand Circular
Peak Beam Gain: 28.5 dBi
Peak Beam EIRP: 45.0 dBW

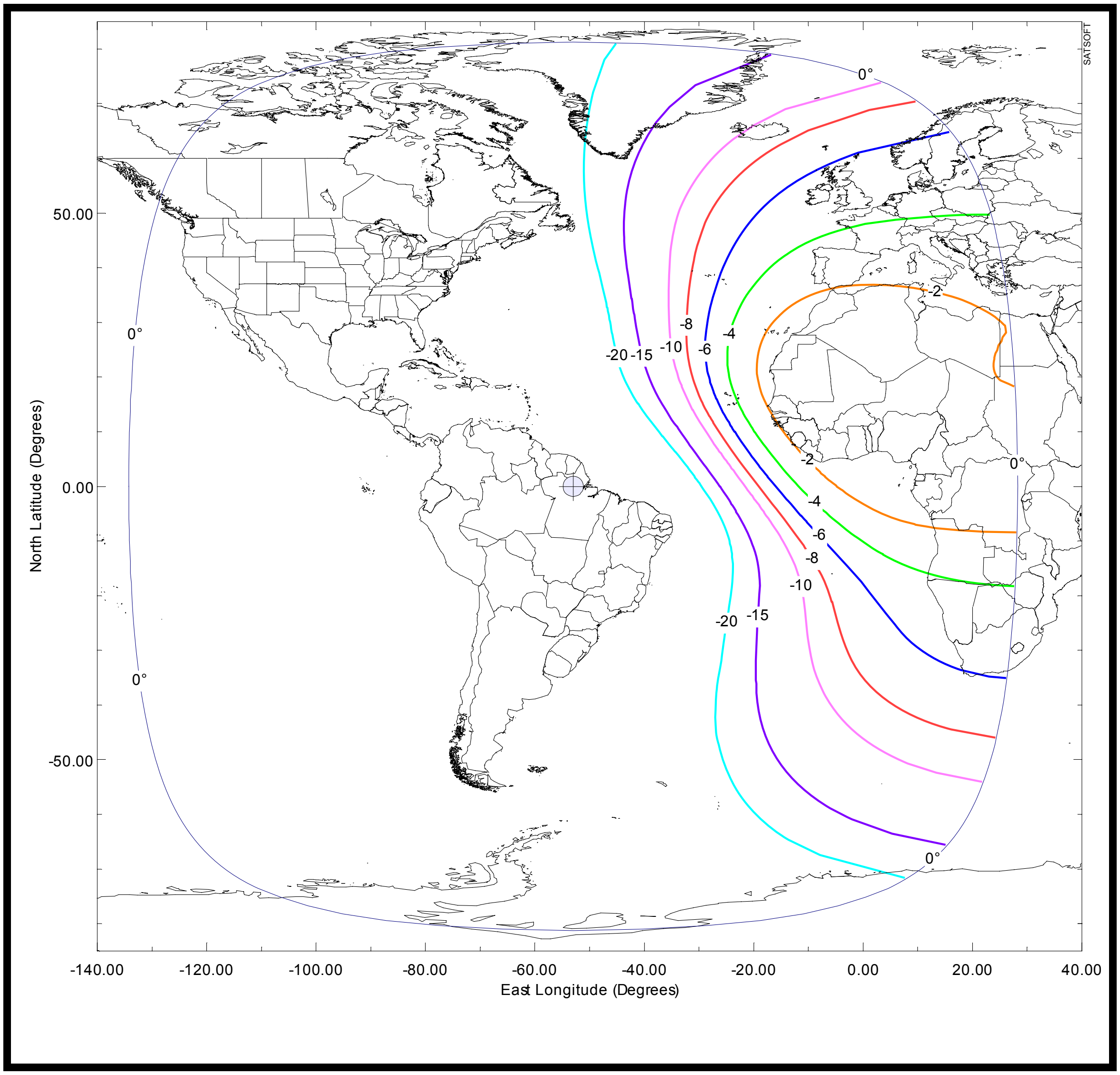


EXHIBIT 5A-15: GLOBAL TRANSMIT BEAM
(Schedule S Beam ID: GLDL)

Beam Polarization: Left Hand Circular
Peak Beam Gain: 20.6dBi
Peak Beam EIRP: 37.1 dBW

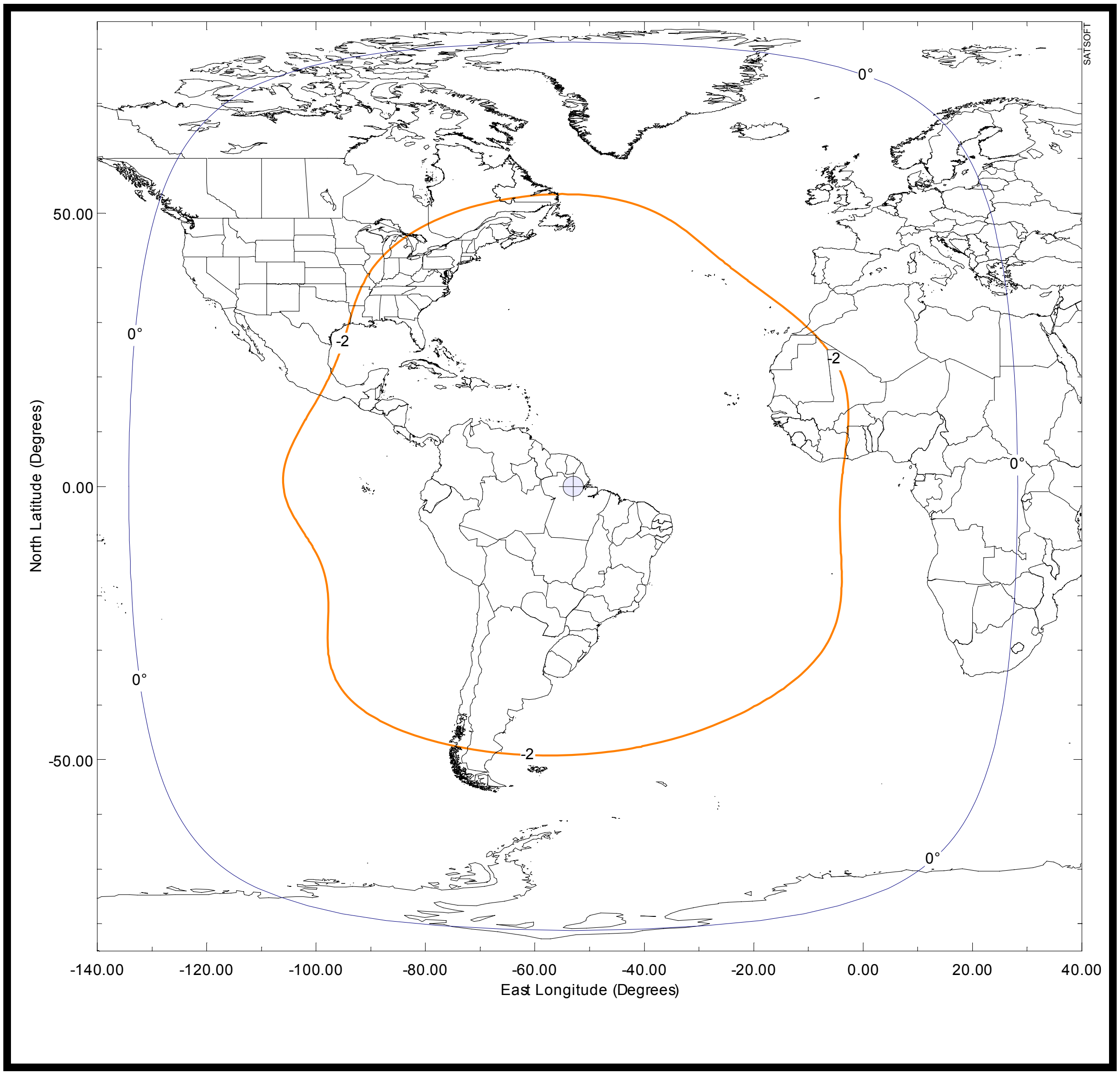


EXHIBIT 5A-16: GLOBAL TRANSMIT BEAM
(Schedule S Beam ID: GRDL)

Beam Polarization: Right Hand Circular
Peak Beam Gain: 20.6 dBi
Peak Beam EIRP: 37.1 dBW

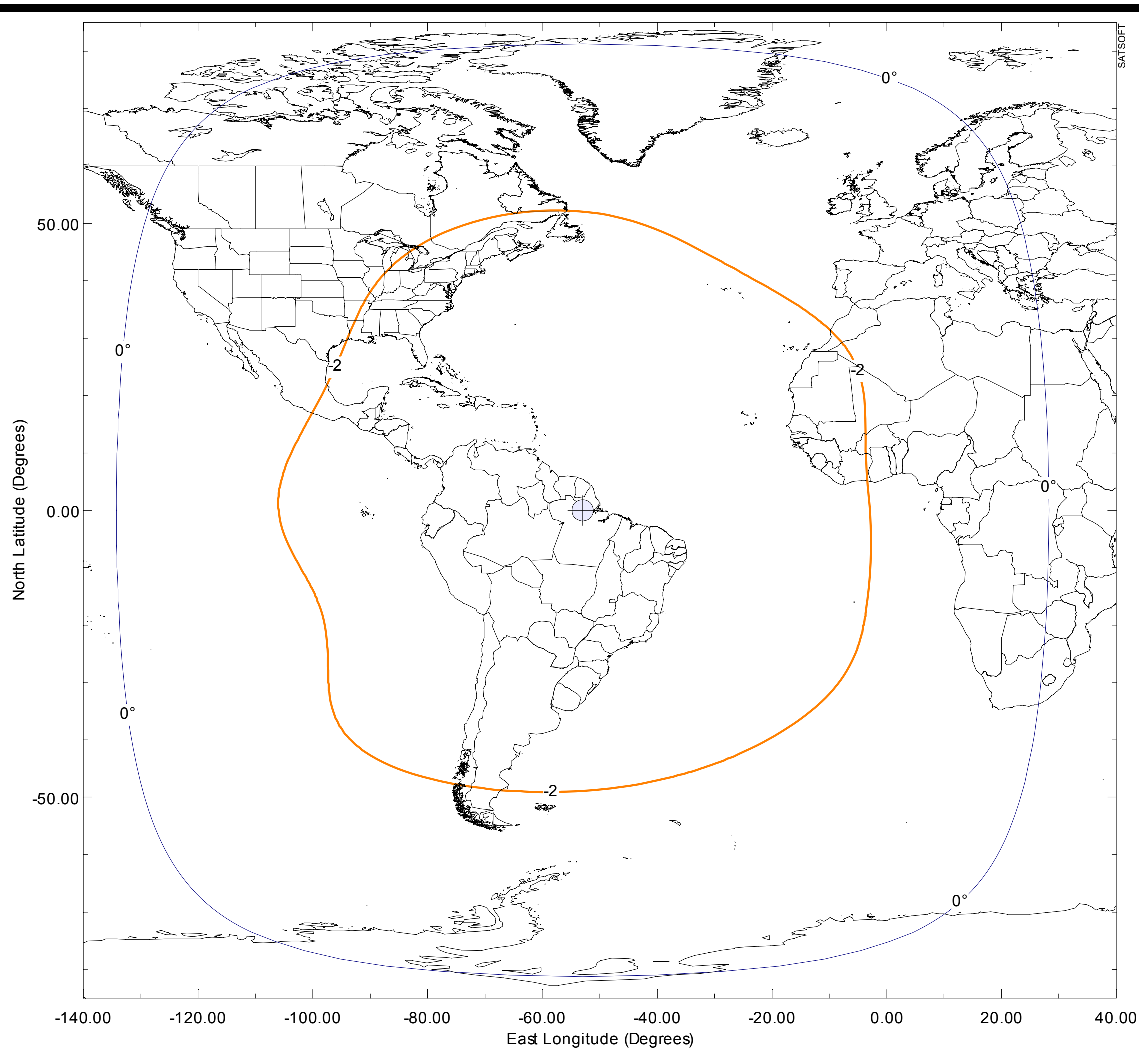


EXHIBIT 5A-17: MEXICO TRANSMIT BEAM
(Schedule S Beam ID: MHDL)

Beam Polarization: Horizontal
Peak Beam Gain: 32.5 dBi
Peak Beam EIRP: 53.0 dBW

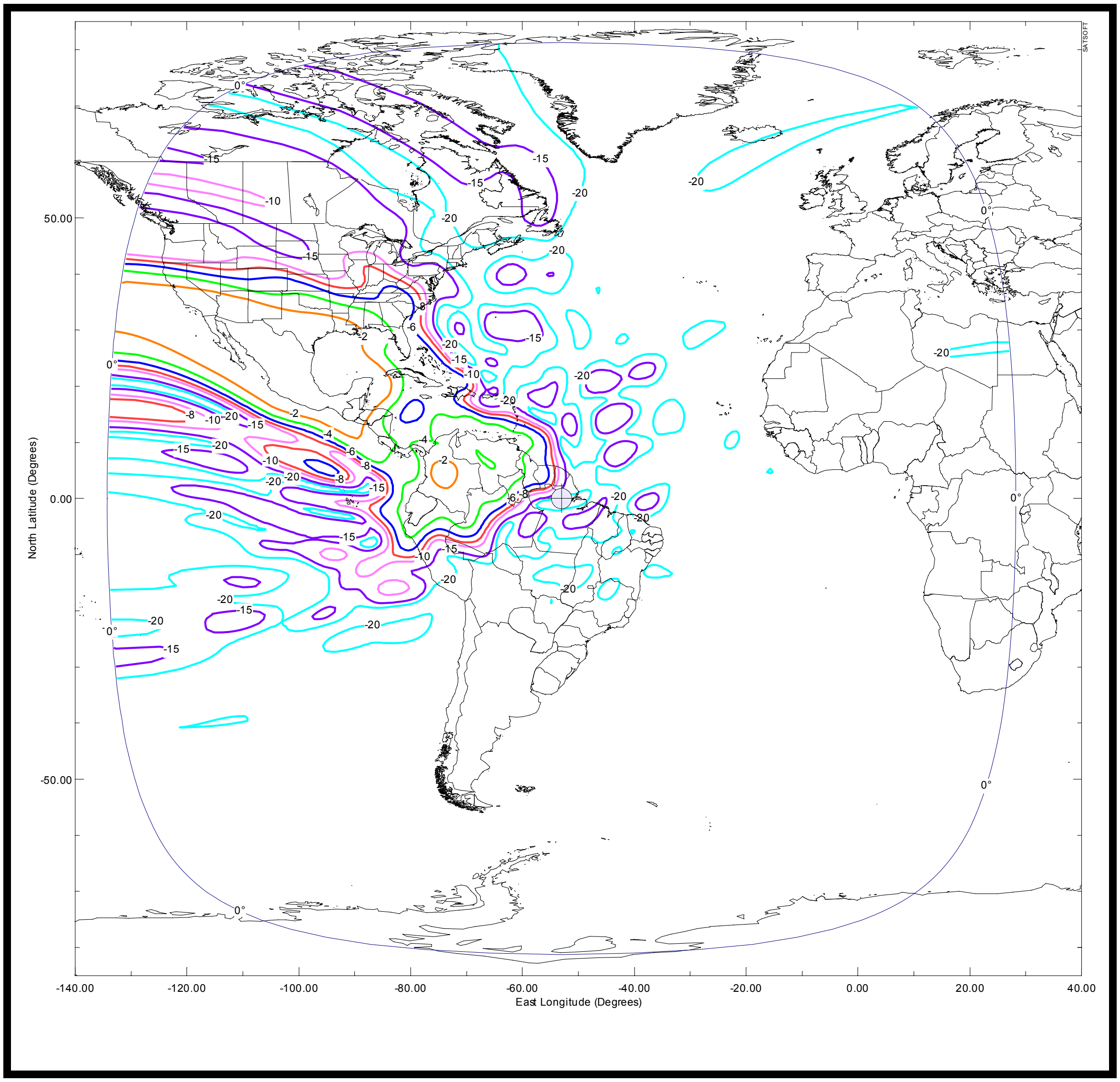


EXHIBIT 5A-18: MEXICO TRANSMIT BEAM
(Schedule S Beam ID: MVDL)

Beam Polarization: Vertical
Peak Beam Gain: 32.5 dBi
Peak Beam EIRP: 53.0 dBW

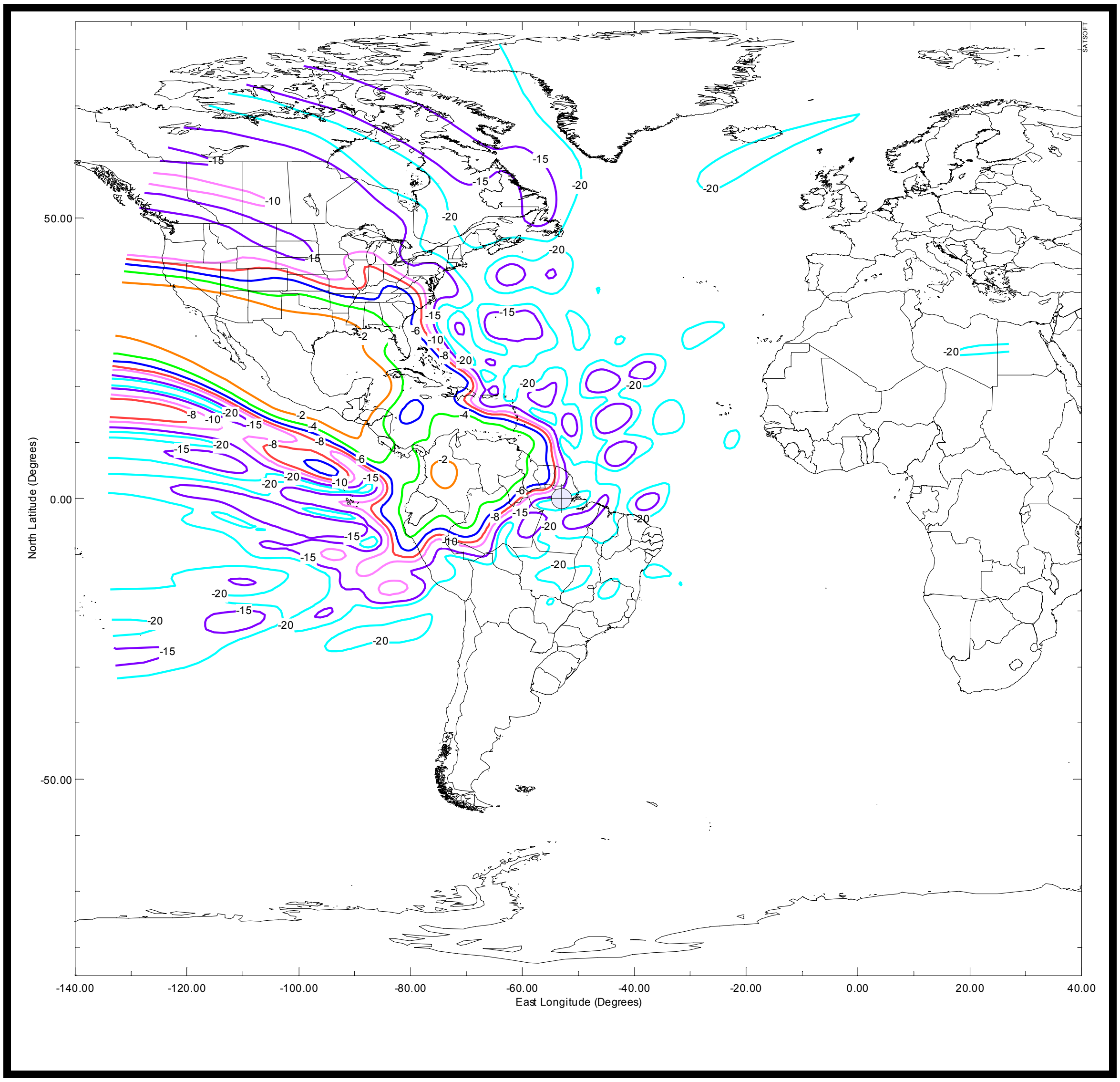


EXHIBIT 5A-19: ARGENTINA TRANSMIT BEAM
(Schedule S Beam ID: AHDL)

Beam Polarization:Horizontal
Peak Beam Gain: 33.1 dBi
Peak Beam EIRP: 53.6 dBW

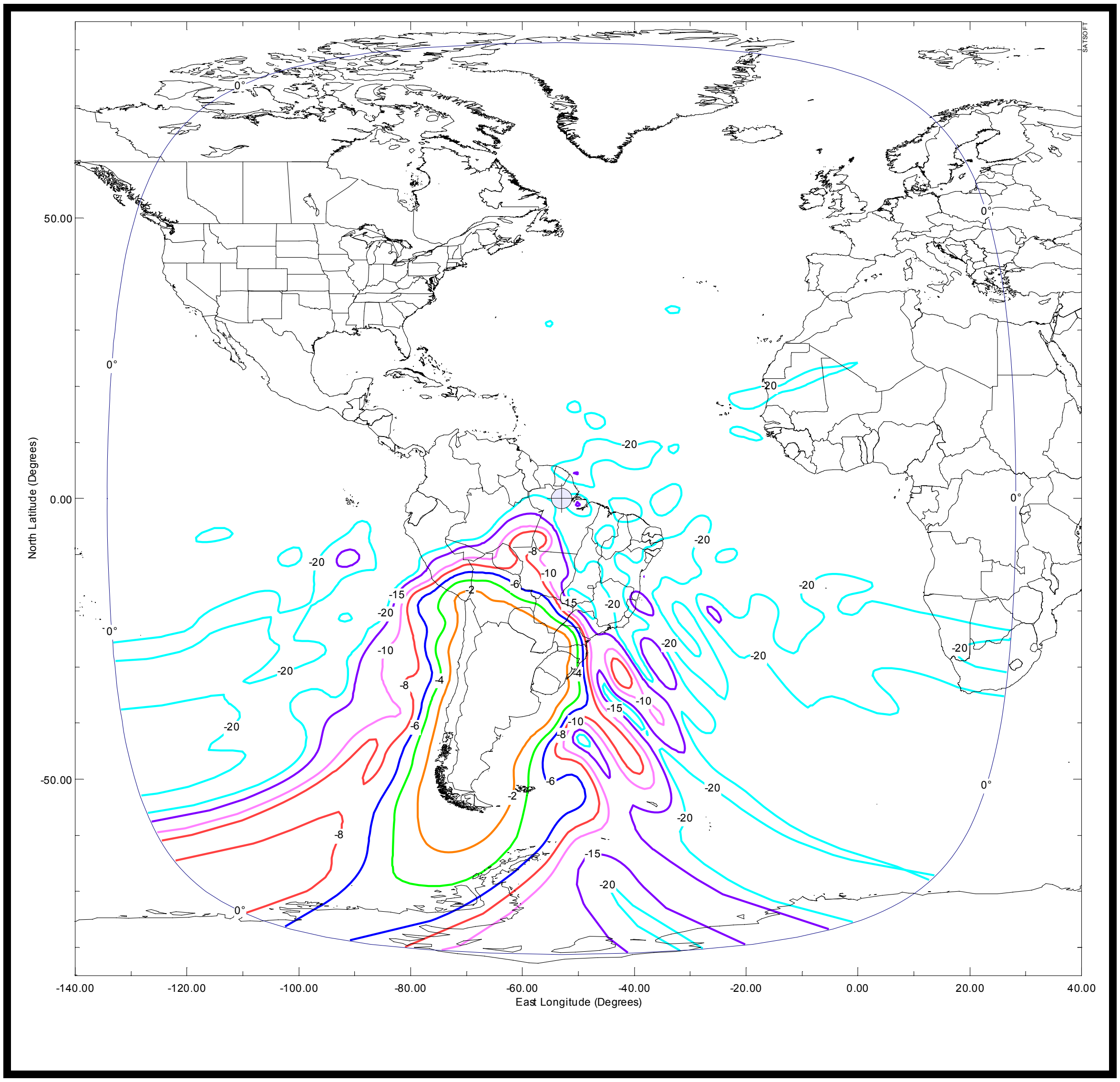


EXHIBIT 5A-20: ARGENTINA TRANSMIT BEAM
(Schedule S Beam ID: AVDL)

Beam Polarization:Vertical
Peak Beam Gain: 33.1 dBi
Peak Beam EIRP: 53.6 dBW

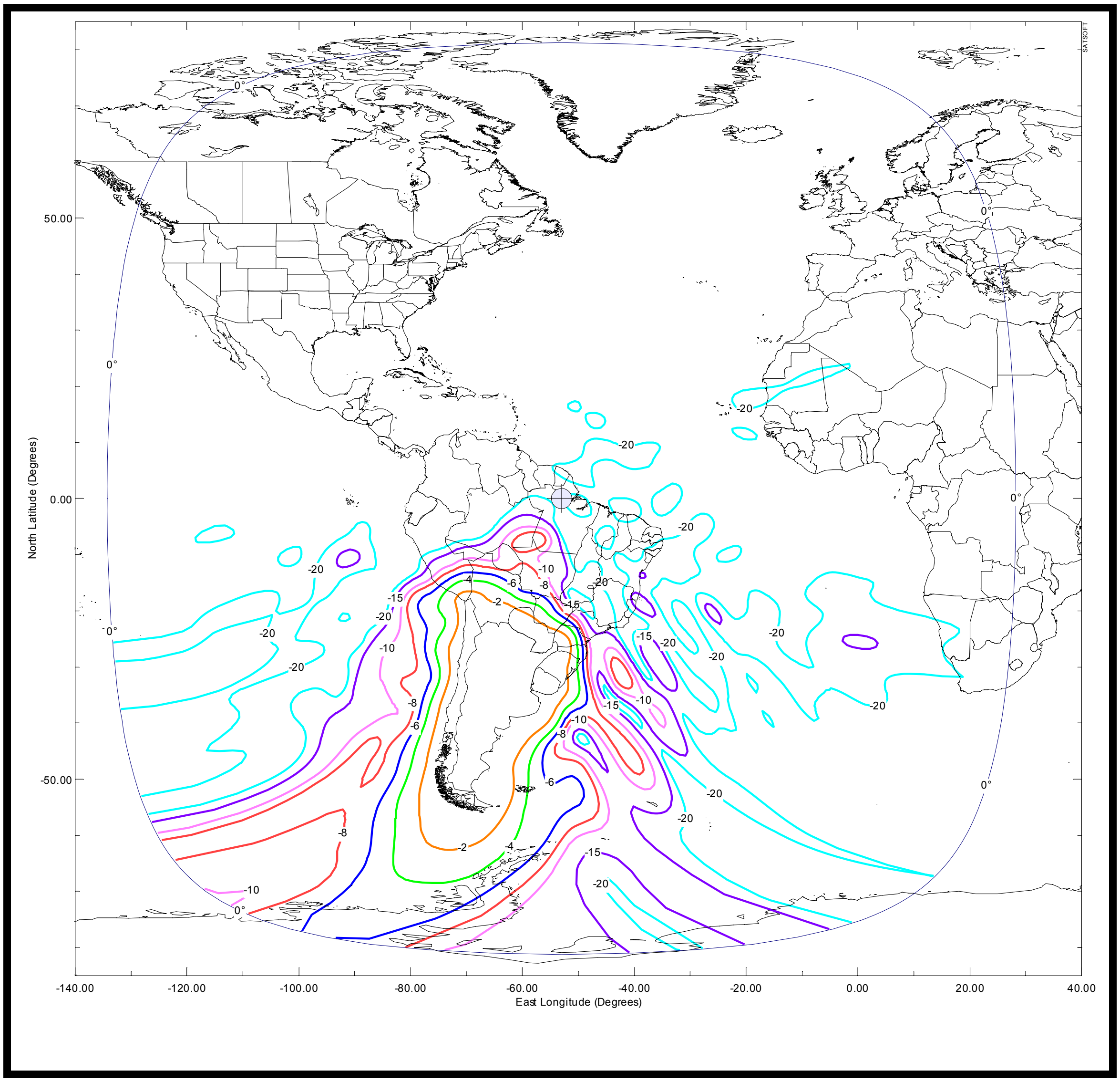


EXHIBIT 5B-1: COMMAND RECEIVE BEAM (Global Horn Antenna) (Schedule S Beam ID: CMDG)

Beam Polarization: Left Hand Circular
Peak Beam Gain: 20.9 dBi
Peak Beam G/T: -16.1 dB/K
Command Threshold Flux Density @ Peak Beam G/T: -110.9 dBW/m^2

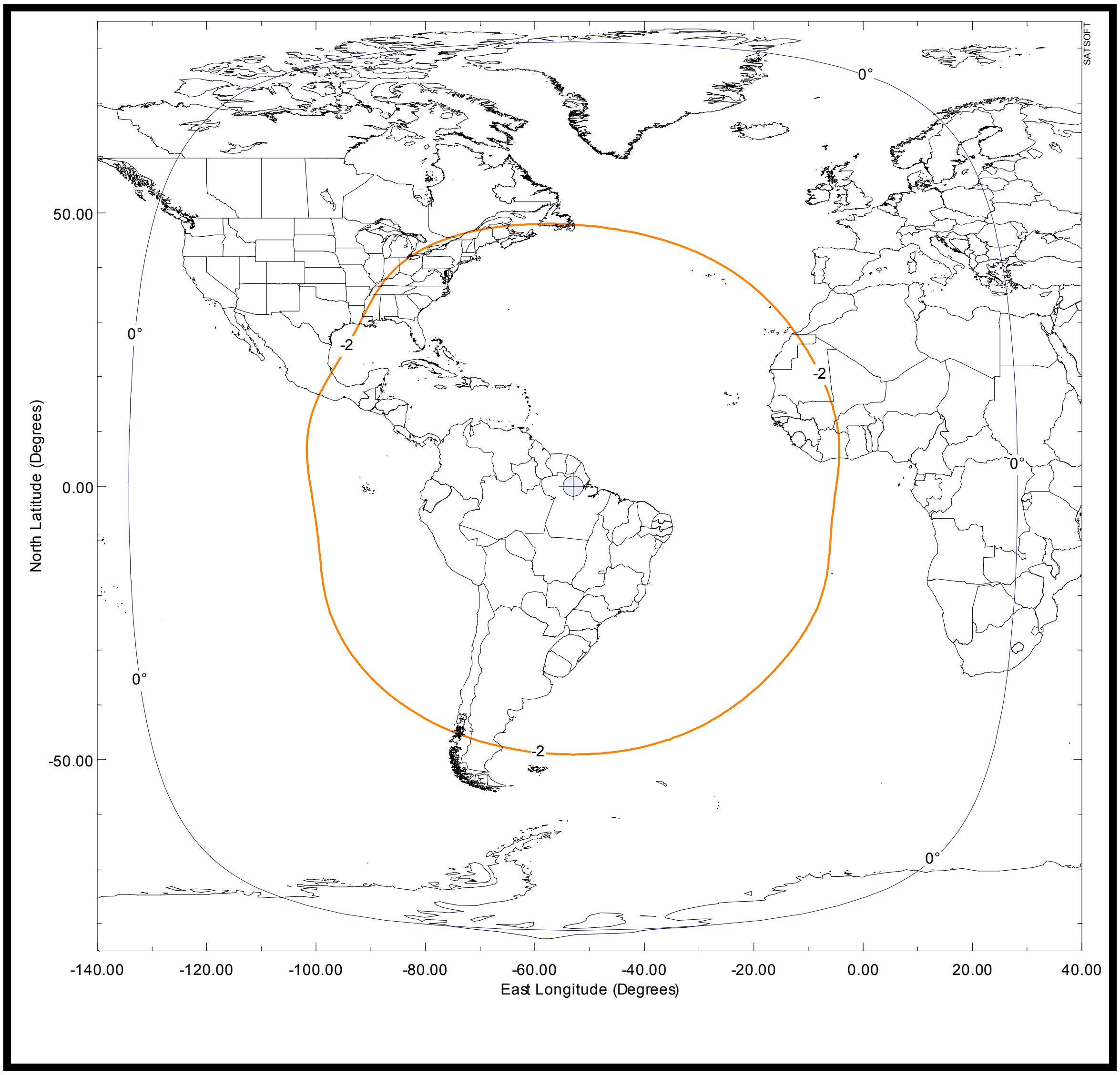


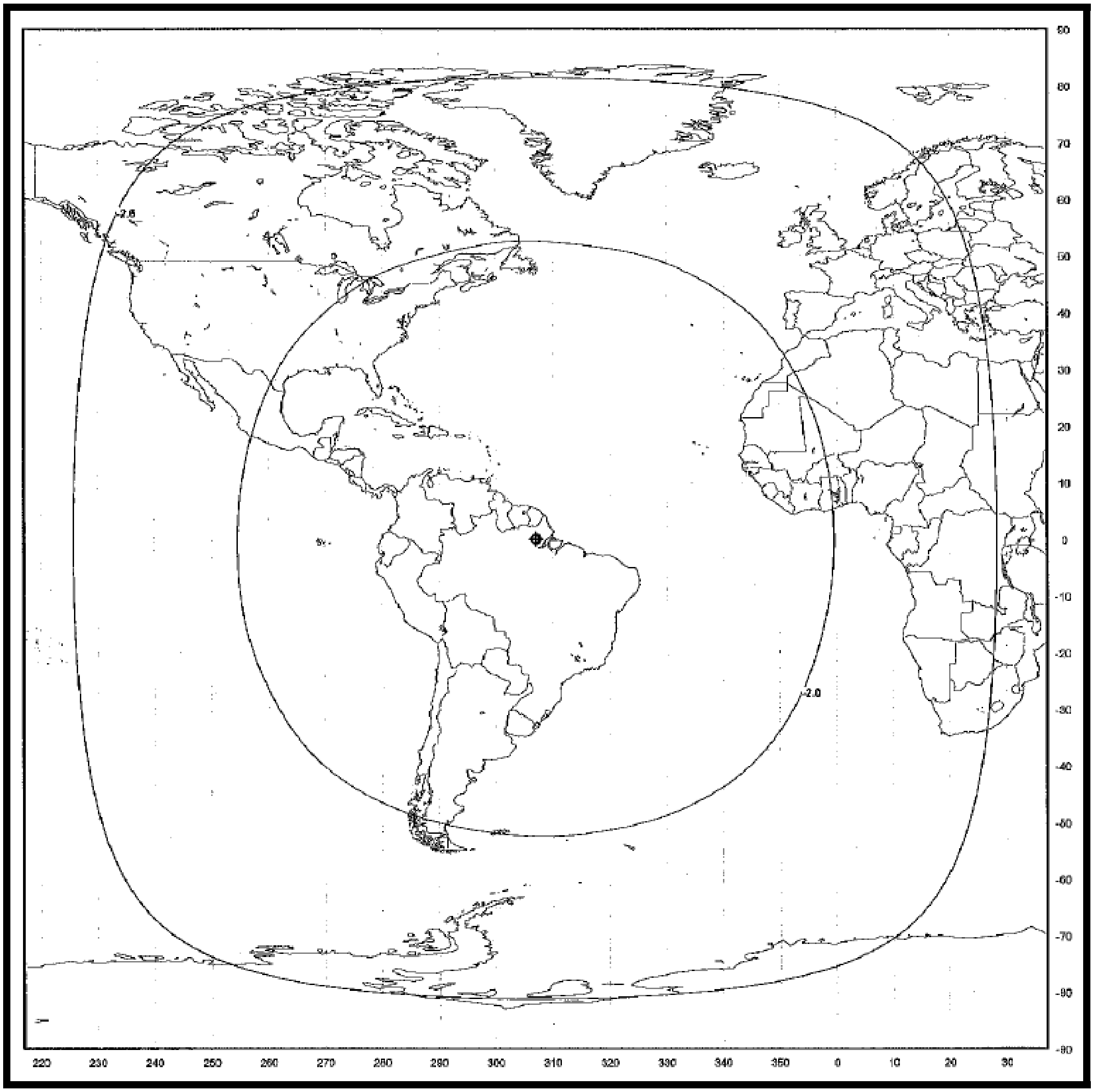
EXHIBIT 5B-2: COMMAND RECEIVE BEAM (Omni Antenna)
(Schedule S Beam ID: CMDO)

Beam Polarization: Left Hand Circular
Peak Beam Gain: 2.0 dBi
Peak Beam G/T: -33.9 dB/K
Command Threshold Flux Density @ Peak Beam G/T: -95.6 dBW/m^2

Relative gain contour shown: -1 dB

EXHIBIT 5B-3: COMMAND RECEIVE BEAM (Wide Coverage Antenna)
(Schedule S Beam ID: CMDW)

Beam Polarization: Left Hand Circular
Peak Beam Gain: 13.0 dBi
Peak Beam G/T: -22.9 dB/K
Command Threshold Flux Density @ Peak Beam G/T: -105 dBW/m^2



Relative gain contours showns: -2, -2.6 dB

EXHIBIT 5B-4: TELEMETRY TRANSMIT BEAM (Global Horn Antenna) (Schedule S Beam ID: TLMG)

Beam Polarization: Right Hand Circular
Peak Beam Gain: 20.6 dBi
Peak Beam EIRP: 13.4 dBW

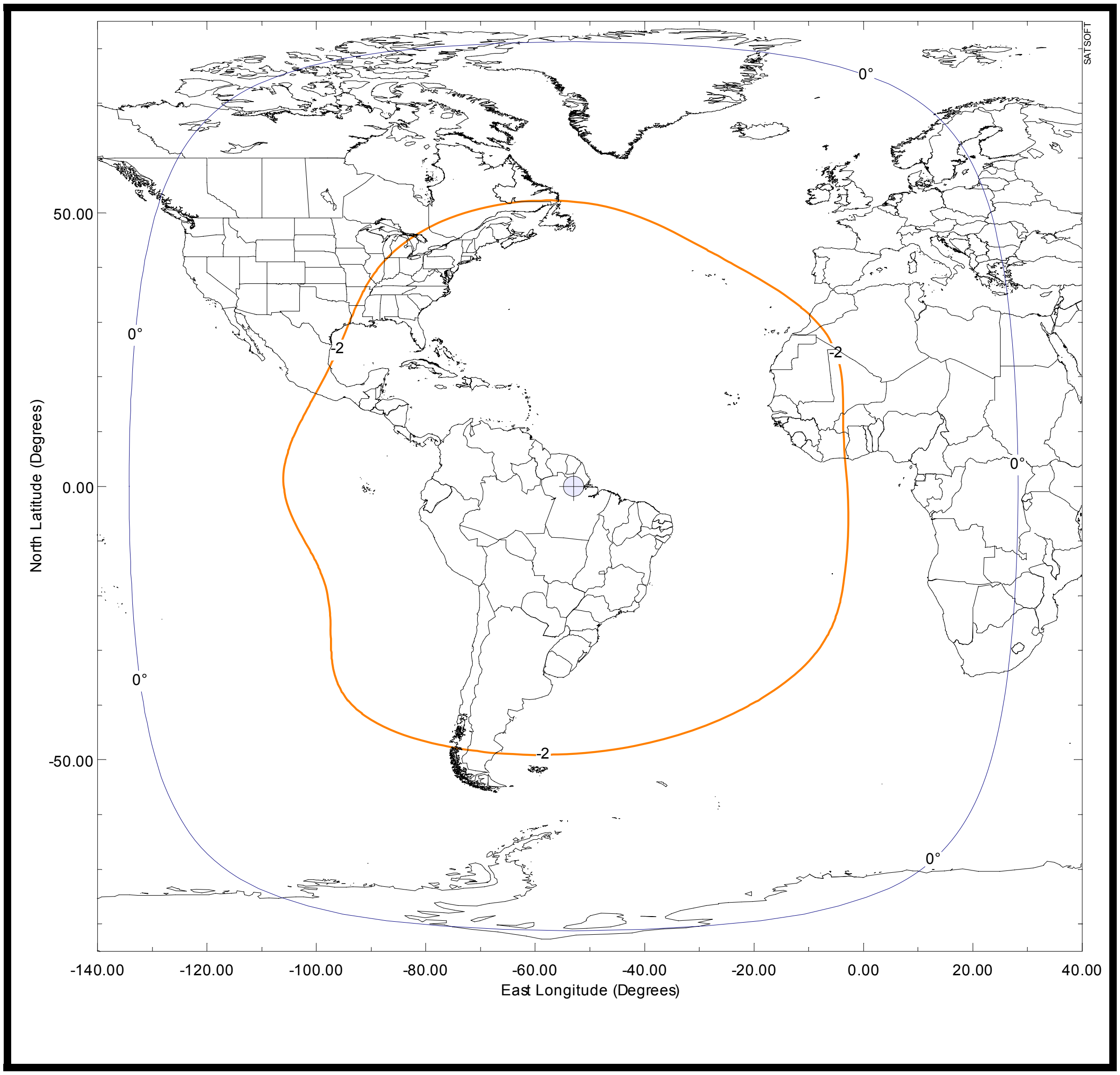
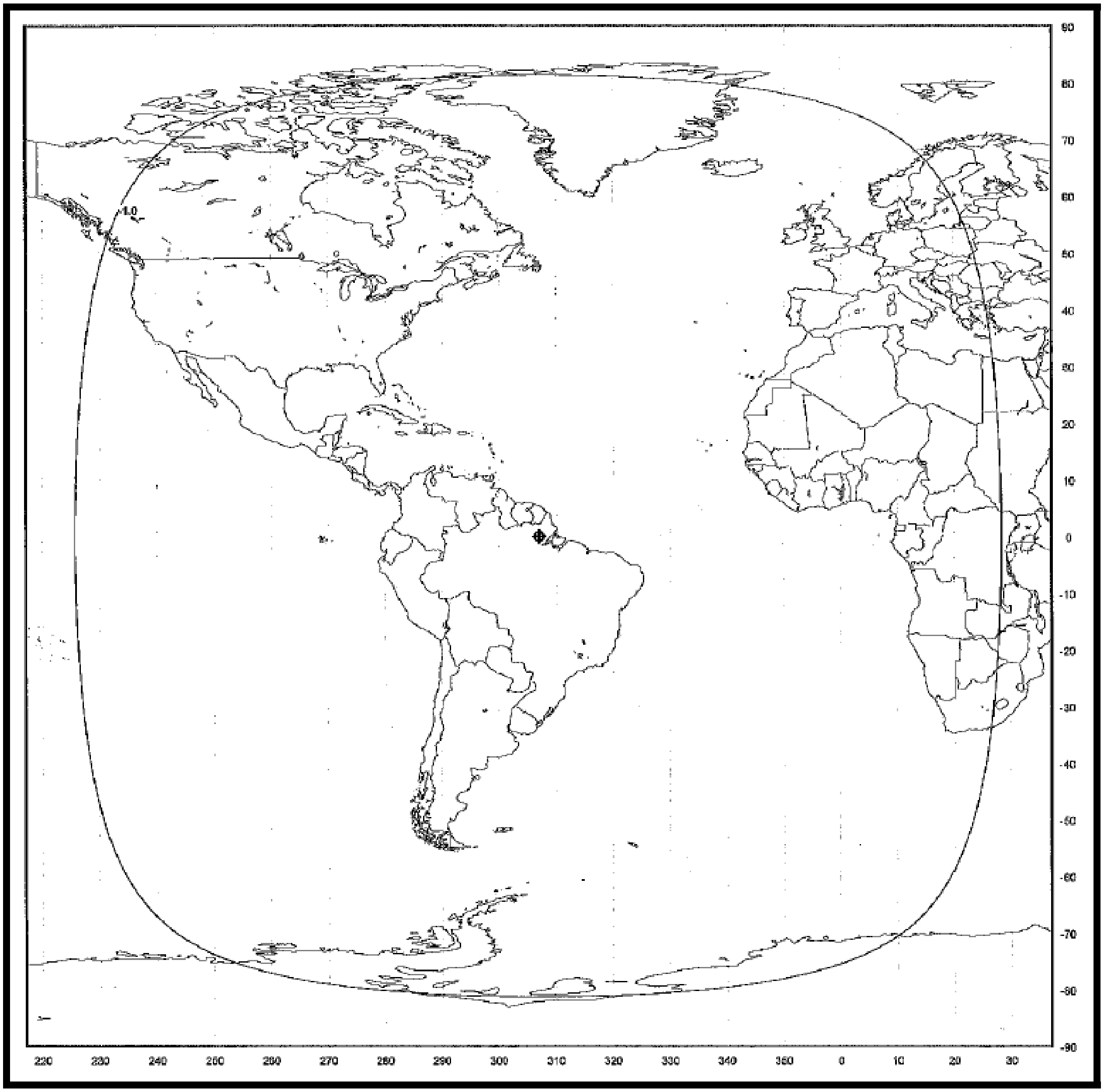


EXHIBIT 5B-5: TELEMETRY TRANSMIT BEAM (Omni Antenna)
(Schedule S Beam ID: TLMO)

Beam Polarization: Right Hand Circular
Peak Beam Gain: 2.0 dBi
Peak Beam EIRP: 7.4 dBW



Relative gain contour shown: -1 dB

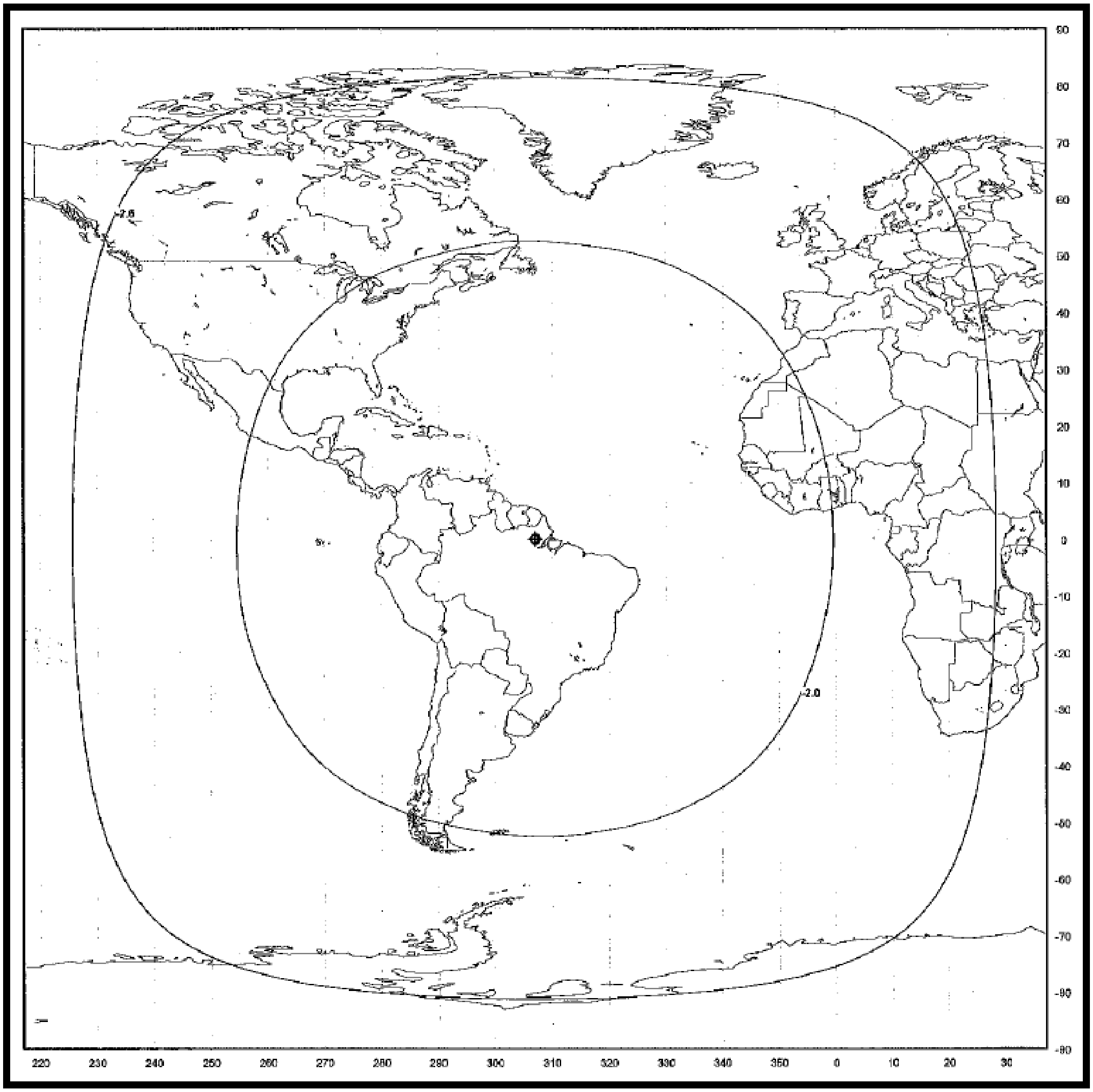
EXHIBIT 5B-6: TELEMETRY TRANSMIT BEAM (Wide Coverage Antenna) (Schedule S Beam ID: TLMW)

Beam Polarization: Right Hand Circular
Peak Beam Gain: 13.0 dBi
Peak Beam EIRP: 16.1 dBW

Relative gain contours shown: -2, -2.6 dB

EXHIBIT 5C-1: C-BAND ULPC TRANSMIT BEAM
(Schedule S Beam ID: UPC)

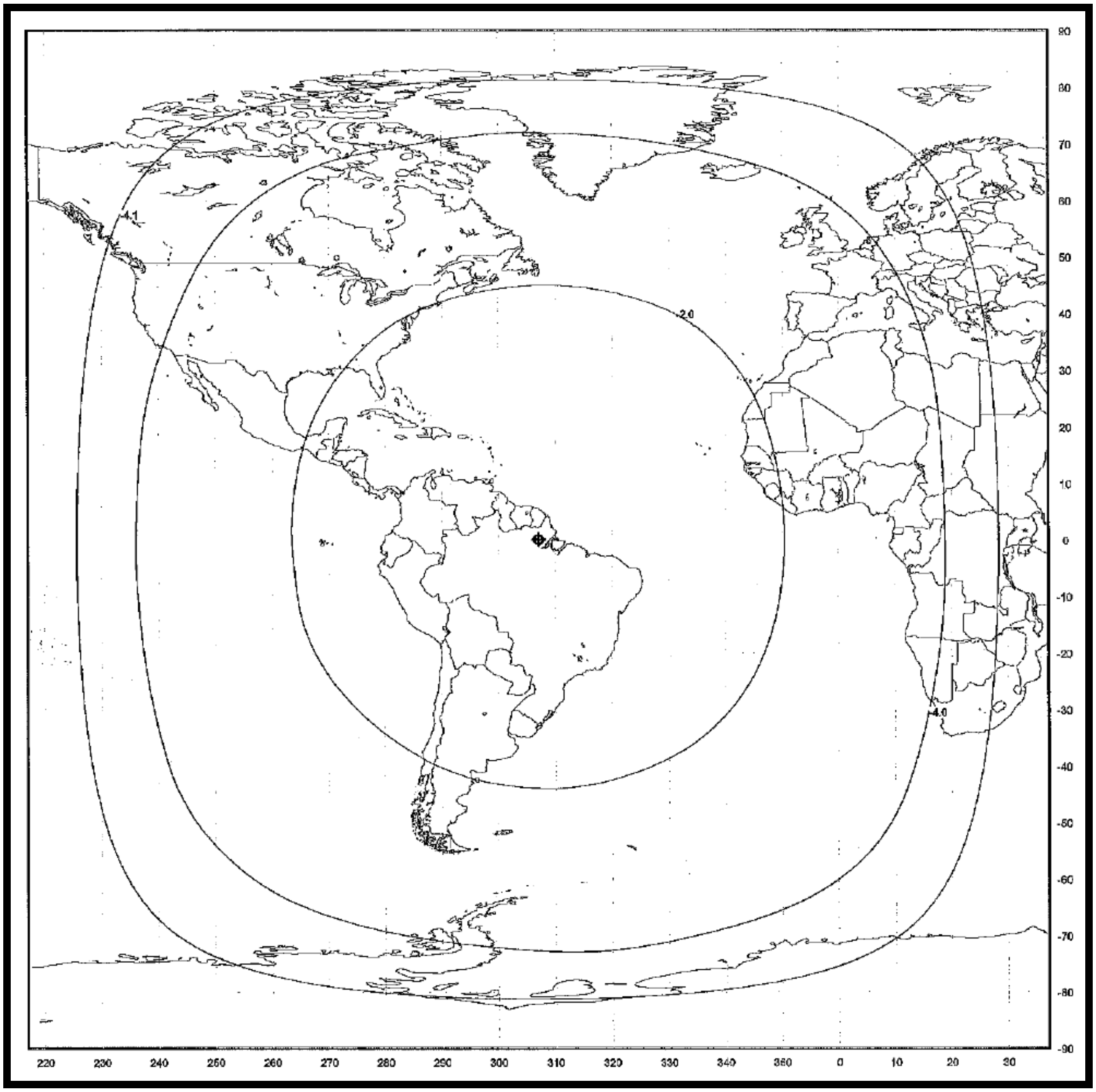
Beam Polarization: Vertical
Peak Beam Gain: 13.0 dBi
Peak Beam EIRP: 13.3 dBW



Relative gain contours shown: -2, -2.6 dB

EXHIBIT 5C-2: Ku-BAND ULPC TRANSMIT BEAM
(Schedule S Beam ID: UPK)

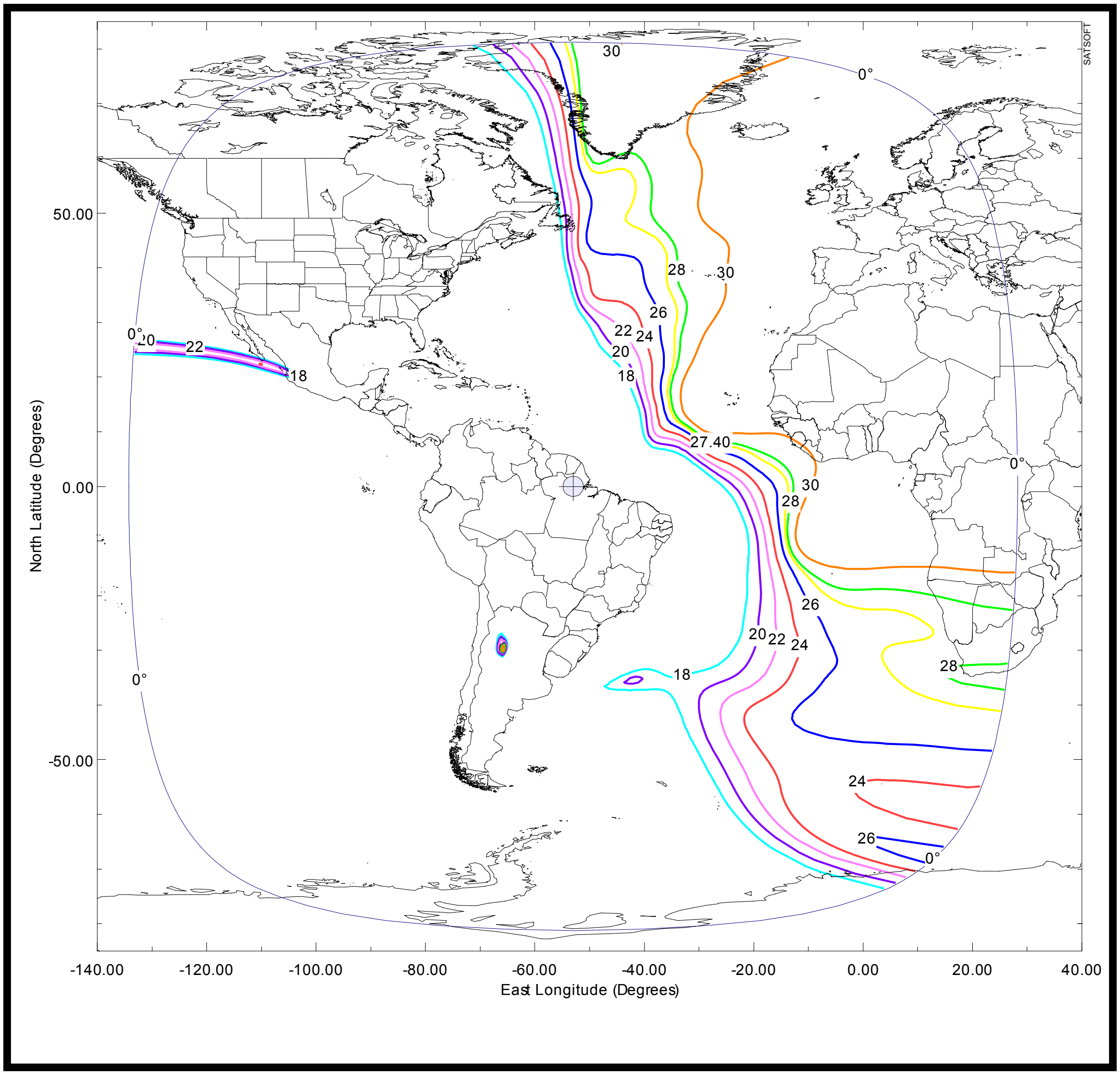
Beam Polarization: Right Hand Circular
Peak Beam Gain: 21.2 dBi
Peak Beam EIRP: 16.6 dBW



Relative gain contours shown: -2, -4.0, -4.1 dB

EXHIBIT 5D-1: C-BAND EAST HEMI TRANSMIT BEAM
(cross polarization isolation contours)
(Schedule S Beam ID: ELDX)

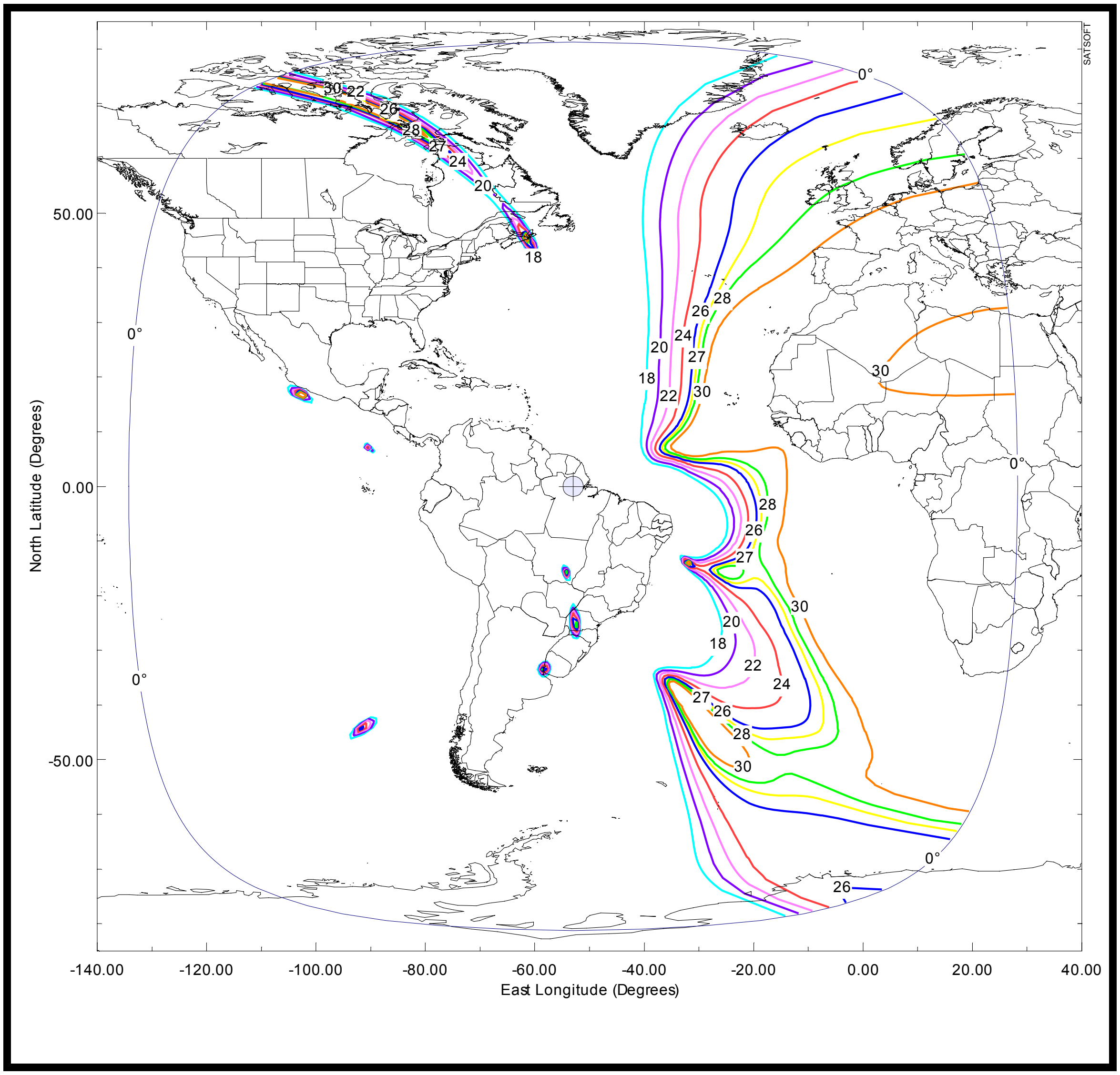
Beam Polarization: Left Hand Circular



Absolute cross-polarization isolation contours shown: 30, 28, 26, 24, 22, 20, 18 dB.

EXHIBIT 5D-2: C-BAND EAST HEMI TRANSMIT BEAM
(cross polarization isolation contours)
(Schedule S Beam ID: ERDX)

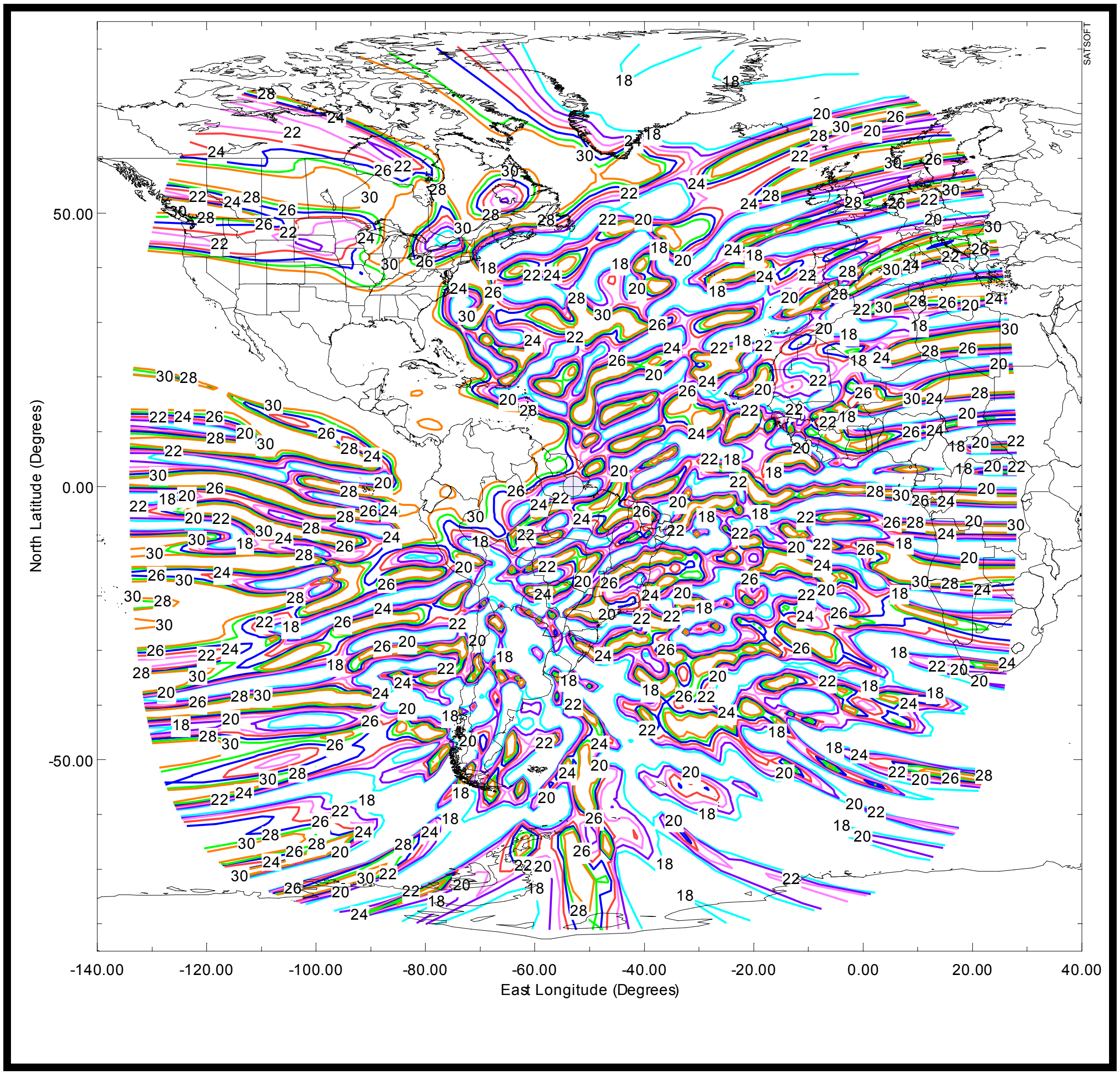
Beam Polarization: Right Hand Circular



Absolute cross-polarization isolation contours shown: 30, 28, 26, 24, 22, 20, 18 dB.

EXHIBIT 5D-3: Ku-BAND MEXICO TRANSMIT BEAM
(cross polarization isolation contours)
(Schedule S Beam ID: MVDX)

Beam Polarization: Vertical



Absolute cross-polarization isolation contours shown: 30, 28, 26, 24, 22, 20, 18 dB.