Engineering Statement

1) Introduction

Intelsat North America LLC ("Intelsat") proposes to operate a new satellite designated as Intelsat 25 ("IS 25") from 31.5° W.L. Intelsat 25 is an existing in-orbit satellite that Intelsat recently purchased from another operator.

Intelsat 25 would, from the orbital location of 31.5° W.L., provide service to Africa in the frequency bands 5845 – 6645 MHz and 3400 – 4200 MHz; to the eastern United States in the frequency bands 5850 – 6645 MHz and 3600 – 4200 MHz; and to the northwestern portion of Africa in the frequency bands 13750 – 14500 MHz, 11450 – 11700 MHz and 12250 – 12750 MHz. Intelsat 25 would essentially replace the Intelsat 801 spacecraft, which is licensed to Intelsat (see FCC File Number: SAT-AMD-20000119-00037).

2) Spacecraft Overview

Intelsat 25 is a Space Systems Loral FS-1300 spacecraft that operates on C-band frequencies of 5845 – 6645 MHz and 3400 – 4200 MHz and Ku-band frequencies of 13750 – 14500 MHz, 11450 – 11700 MHz and 12250 – 12750 MHz. At C-band, it utilizes thirty four 36 MHz transponders and two 72 MHz transponders to provide service to Africa and the eastern United States. At Ku-band, it utilizes ten 36 MHz transponders and six 72 MHz transponders to provide service to northwestern Africa. The spacecraft's two 72 MHz-wide C-band and two 72-MHz wide Ku-band transponders can be cross-strapped.

Intelsat 25 is a 3-axis stabilized type spacecraft, with a main body that supports the antennas and electronics for the various subsystems. It utilizes two deployable reflector antennas, a dual gridded nadir mounted reflector antenna, two deployable solar array wings and a bi-propellant propulsion system. The on-orbit configuration of the Intelsat 25 spacecraft is provided in Exhibit 1. A summary of the basic spacecraft characteristics is provided in Exhibit 2.

2.1) Structure

The structural design of Intelsat 25 provides mechanical support for all subsystems. The structure externally supports the communication antennas, solar arrays, and thrusters. It also provides a stable platform for preserving the alignment of critical elements of the spacecraft.

The primary structure of the spacecraft is composed of the following subassemblies: 1) central cylinder, 2) ACS panel, 3) anti-Earth panel, 4) Earth panel, 5) communications module, 6) Earth deck antenna support module, 7) battery panels, 8) OMUX support panels, 9) east and west feed support structures, 10) momentum wheel support structures, 11) east and west access panels, 12) main thruster support structure, 13) solar wings and 14) communication antenna (reflectors)

The central cylinder serves as the spacecraft's primary load carrying structure to which a number of other structural panels are attached. It houses two propellant tanks and provides the spacecraft's interface to the launch vehicle.

The ACS panel is attached to the central cylinder near the aft end of the spacecraft. This panel provides interfaces for a number of propulsion subsystem components as well as the Attitude Control Subsystem ("ACS") electronics.

The anti-Earth panel is attached to the central cylinder at the aft end of the spacecraft. This panel receives the thrusters and propulsion lines at this level of the assembly. It also provides a mounting surface for the placement of a number of sensors, thrusters, and Telemetry, Command and Ranging ("TC&R") antennas.

The Earth panel is attached to the central cylinder at the front end of the spacecraft. This panel supports a number of thrusters, propulsion lines and propulsion units, as well as a number of components associated with the spacecraft's communication and TC&R subsystems. It also provides mounting interfaces for the antenna support structure.

The communications module consists of a north and south communication panel and shear web panels. These panels support the various components associated with the communications subsystem, the TC&R subsystem, the power subsystem, and the data handling subsystem ("DHS").

The Earth deck antenna support module is composed of an antenna support structure to which the following components have been integrated: C-band antenna, Ku-band sub-reflectors, Earth sensor assembly, sun sensor assembly and TC&R antennas. The antenna support structure interfaces with the main body structure at attach points on the Earth panel.

The battery panels are composed of an east and west panel that are located near the aft end of the spacecraft. The battery panels provide the necessary support platform for the batteries.

There are two OMUX support panels – one located on the east side of the spacecraft and the other on the west side. These panels support the Ku-band Output Multiplexer units.

The east and west feed support structures are attached near the front (nadir) section of the central cylinder on the east and west sides of the spacecraft. They provide the requisite mounting surfaces for the antenna feeds.

Two momentum wheel support structures provide the component mounting interface and the support structure for the momentum wheels used aboard the spacecraft. These two momentum wheel support structures are located between the ACS and the anti-earth panels, near the aft end of the spacecraft, and attached directly to the central cylinder.

The east and west access panels are located on the east and west sides of the spacecraft, respectively. These panels stabilize the free edges of the north and south communication panel, the Earth panel and the ACS panel. The east and west access panels are easily removed and provide access to the interior of the spacecraft during final integration and test.

The main thruster support structure is located in the aft section of the spacecraft and is mechanically fastened to the inside of the central cylinder. This structure provides the mounting surface for the main thruster.

The spacecraft utilizes two deployable solar wings, which are extended during transfer orbit. One solar wing is located on the north side of the spacecraft and the other is located on the south side of the spacecraft. The solar wings provide the mounting surfaces for the solar cells. Each solar wing is connected to the corresponding communication panel through the Solar Array Drive Assembly ("SADA").

Intelsat 25 utilizes two deployable Ku-band reflector antennas. The antennas are supported by two main reflector support structures, one located on the east side and the other on the west side of the spacecraft. These supporting structures are connected directly onto the central cylinder via a network of struts and secondary connecting platforms. The spacecraft also utilizes a C-band antenna mounted onto the Earth deck antenna support module.

The Intelsat 25 mass budget is provided in Exhibit 3.

2.2) Thermal Subsystem

Thermal control is 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 and the east and west OMUX panels are 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. is spread over the north and south (communication module) panels by means of heat pipes that are embedded in the panels. The Ku-band TWTAs employed aboard the spacecraft are radiation cooled, whereby most the heat generated by these amplifiers is emitted directly into space. Additionally, the earth deck heat pipe network provides cross-coupling between the north and south panels for heat load sharing. In addition, it increases the heat rejection capability of the spacecraft. MLI blankets cover all external areas, except radiative areas. Heaters are 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") 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 arrays, batteries, associated power electronics, and power harnesses that integrate and regulate the systems.

Intelsat 25 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 and one mini-panel. Each panel supports an array of solar cells. The solar wings extend 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, two 34 cell Nickel-Hydrogen batteries are the primary source of power to the spacecraft. The battery packs are located near the aft section of the spacecraft and are mounted on the north and south battery panels below the base panel.

The Intelsat 25 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 25 are provided in Exhibit 4.

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 employs primary and redundant sun and earth sensors as well as a Digital Integrating Rate Assembly ("DIRA") to perform all attitude determination functions. Control of spacecraft attitude is accomplished through the use of three fixed momentum/reaction wheels and pulsed or continuous firing of selected 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 and through the operational lifetime of the satellite. The spacecraft employs a bi-propellant propulsion subsystem. The major features of the propulsion system are: 1) a single cylindrical fuel tank, 2) a single cylindrical oxidizer tank, 3) three cylindrical Helium gas tanks, 4) a 490N Main Satellite Thruster ("MST") that is utilized during transfer orbit and 5) twelve 22N thrusters.

Prior to the start of the transfer orbit, the normally closed valves that isolate the fuel and oxidizer tanks from the thrusters are opened to vent any residual gasses. Following venting, these valves are closed again. The propellant tanks are then pressurized by the activation of the pressure blow-down system, whereby pressurized Helium is injected into the fuel and oxidizer tanks. The system is then operated in bi-propellant mode using the 490N main thruster. In case of an anomaly with the main (MST) thruster, the 22N thrusters are utilized as back-up to complete the transfer orbit maneuvers.

Upon completion of transfer orbit operations, the MST is isolated from the on-orbit operation system by closing a number of valves upstream of the engine. This leaves the propulsion system in its on-orbit configuration, whereby orbit maneuvers are performed through the use of 22N thrusters.

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 (*e.g.*, Tempo and Intelsat VIIA satellites). The system incorporates full redundancy for all critical components. All thrusters 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

Intelsat 25 provides 36 active communication channels at C-band frequencies and 16 active communication channels at Ku-band frequencies. At C-band, 34 channels have a bandwidth of 36 MHz and 2 of the channels have a bandwidth of 72 MHz. At Ku-band, the bandwidth of 10 channels is

36 MHz and the bandwidth of the remaining 6 channels is 72 MHz. The Intelsat 25 frequency and polarization plans are provided in Exhibits 5A and 5B. The Intelsat 25 C-band receive and transmit beams provide coverage of the Africa and eastern United States, while the Ku-band receive and transmit beams provide coverage of northwestern Africa.

Intelsat 25 employs full frequency reuse through the use of orthogonal polarization within the same beam. The C-band and Ku-band beams utilize linear (horizontal and vertical) polarization, whereby the polarization of the uplink is opposite that of the downlink. The electric field component of the linear horizontally polarized signal is parallel to the equatorial plane and the electric field component of the linear vertically polarized signal is orthogonal to the equatorial plane. Accordingly, Intelsat 25 is compliant with the provisions of Section 25.210(f) of the Commission's rules.

Section 25.210(a)(3) of the Commission's rules stipulates that spacecraft used for domestic service and operating in the 3700 – 4200 MHz band be capable of switching polarization sense upon ground command. As shown in Exhibits 5A and 5B, the polarization of the Intelsat 25 C-band transponders are static and cannot be changed. Accordingly, waiver of Section 25.210(a)(3) of the rules is requested. Such a waiver is warranted given that Intelsat 25 is currently in orbit and its design cannot be altered.

In the frequency band 3700 – 4200 MHz, Section 25.211(a) of the Commission's rules requires that downlink analog video transmissions to be transmitted only on a center frequency of 3700+20N, where N=1 to 24. However, in view of the fact that Intelsat 25 utilizes transponders that have a bandwidth of 72 MHz, Intelsat 25 may not be compliant with the provisions of this rule with respect to these channels and requests a waiver of the provisions of Section 25.211(a). It is noted that the nearest satellites to Intelsat 25 that utilize the 3700 – 4200 MHz band will be Intelsat 801 at 29.5°[1] and Intelsat 903, located at 34.5º W.L. Both of these spacecraft are licensed to Intelsat. Accordingly, should Intelsat require the transmission of analog TV/FM signals within the 3700 – 4200 MHz band on any of the 72 MHz wide channels, it will internally coordinate such transmissions in order to minimize any impact on the transmissions of Intelsat 903 and Intelsat 801. Moreover, it is noted that Intelsat 25 is an orbiting satellite and its channelization plan cannot be modified. Accordingly, for the foregoing

[1] Intelsat has an application pending at the Commission to relocate Intelsat 801 to 29.5º W.L.

reasons, Intelsat believes that a waiver of Section 25.211(a) of the rules is warranted.

In the Table of Frequency Allocations contained in Section 2.106 of the rules, the frequency band 3600 – 3650 MHz is allocated on a primary basis to the federal radiolocation and radio-navigation services, as well as non-federal fixed satellite service that is limited to international and intercontinental systems. The 3650 – 3700 MHz band is allocated on a primary basis to the non-federal fixed service and the non-federal fixed satellite service, subject to NG169 and NG185. It is noted that Intelsat 801, the spacecraft currently located at 31.5º W.L., has been authorized to operate in the 3625 – 3700 MHz band. In view of the above, Intelsat requests authorization to operate in the 3600-3700 GHz band.

With respect to the 5850 – 5925 MHz band, the Table of Frequency Allocations specifies the use of this frequency band to the non-federal fixed satellite service, non-federal mobile service and federal radiolocation service. The use of this band by the fixed satellite service is limited to international and intercontinental systems. This frequency band is currently being utilized by Intelsat 801, the spacecraft currently located at 31.5º W.L.. In view of the above, Intelsat requests authorization to operate in the 5850-5925 GHz band.

The Table of Frequency Allocations allocates the use of 6425 – 6525 MHz band to the non-federal fixed satellite service and the non-federal mobile service. The 6525 – 6645 MHz band is allocated to the non-federal fixed satellite service and the non-federal fixed service. Accordingly, Intelsat will coordinate any Intelsat 25 U.S. operations in the 6425 – 6645 MHz with the other users of the band.

The the nearest satellites to Intelsat 25 that utilize all or a portion of the 5850 - 6425 MHz and 3400 – 4200 MHz bands will be Intelsat 903 and 801 – satellites that are licensed to Intelsat. Intelsat will internally coordinate the transmissions of Intelsat 25 with each of these satellites.

With respect to the 6425 – 6645 MHz band, the nearest satellite to Intelsat 25 that utilizes all or a portion of this band is NSS 806, located at 40.5º W.L. In view of the fact that there would be an orbital separation of 9 degrees between Intelsat 25 and NSS 806, Intelsat does not believe that any transmissions to Intelsat 25 would have any significant impact on the co-frequency transmissions of NSS 805.

2.6.2) Antennas and Beam Coverage

Intelsat 25 utilizes a deployable reflector antenna deployed off the west side of the spacecraft; a deployable reflector antenna deployed off the east side of the spacecraft; and a dual gridded reflector antenna mounted on the nadir side of the spacecraft. The coverage beams of the Intelsat 25 antennas are shown in Exhibits 6A through 6J, in the format prescribed in Section 25.114(d)(3) of the Commission's rules. These exhibits also provide the beam peak antenna gain, the beam peak G/T and SFD ("Saturated Flux Density") for the uplink beams, and the beam peak EIRP for the downlink beams.

With regard to the Intelsat 25 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)
(At C-band, the attenuator range is from 0 to 36 dB, in 1 dB steps. At Ku-band, the attenuator range is from 0 to 31 dB, in 1 dB steps when the transponder is operating in the fixed gain mode.)

Exhibit 7 provides a detailed calculation of the EIRP, G/T and SFD of the Intelsat 25 uplink and downlink beams.

The minimum cross-polarization isolation of the C-band and Ku-band uplink and downlink beams is 30 dB or greater within the primary coverage area and is compliant with Section 25.210(i) of the Commission's rules.

2.6.3) Transponder description

2.6.3.1) C-band Uplink to C-band Downlink Configuration

Signals uplinked to the spacecraft are received by the appropriate receiving antenna. The output of the receive antenna is routed through a diplexer to a test coupler, a preselect filter and then to a set of 4-for-2 redundant wide band low noise amplifiers ("LNAs"). The LNA primarily establishes the system noise figure.

Following the LNA, the signal is routed to one of two sets of 4-for-2 redundant frequency down-converters. One set of frequency converters down-converts the uplink frequency band of 5845 – 6425 MHz to the downlink frequency of 3620 – 4200 MHz – a frequency translation of 2225 MHz; the other set of frequency converters down-converts the uplink frequency band of 6425 – 6645 MHz to 3400 – 3620 MHz – a frequency translation of 3025 MHz.

Given that the frequency down-converter translates the uplink frequency to the downlink frequency band, the frequency stability of the transmitted signal is controlled primarily by the frequency down-converter. The Intelsat 25 frequency down-converter 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 25 is compliant with the provisions of Section 25.202(e) of the Commission's rules.

The output of each frequency down-converter is routed to a network of hybrids and then to a bank of Input Muliplexers ("IMUXs"). The IMUXs are filters that provide frequency band separation for each channel.

The output of each IMUX is connected, through a bank of redundancy switches, to a channel amplifier ("CAMP") and a Traveling Wave Tube Amplifier ("TWTA") pair. The redundancy switching permits the output of the IMUX to be routed to a redundant CAMP-TWTA pair should the primary units fail or malfunction. Each CAMP contains commandable attenuators that control the channel gain.

Intelsat 25 utilizes a combination of 37 Watt and 40 Watt conduction cooled TWTAs. Specifically, Intelsat 25 utilizes 44x37 watt TWTAs and 6x40 watt TWTAs, for a total of 50 TWTAs. The CAMP-TWTA pairs are configured in two 18-for-13 redundancy rings and two 7-for-5 redundancy rings.

Each C-band channel can only operate in the Fixed Gain Mode ("FGM"). In this mode, the gain of each channel (and its associated transponder saturation flux density) may be independently adjusted by changing the setting of an adjustable attenuator within the CAMP by ground command. The gain of each C-band channel may be varied by over a range of 36 dB in 1 dB increments. Accordingly, the C-band channels of Intelsat 25 are compliant with the provisions of Section 25.210(c) of the Commission's rules.

The output of each TWTA is routed through a bank of switches and to the appropriate Output Multiplexer ("OMUX"). Intelsat 25 employs 4 output multiplexers. The switching network allows the output of a redundant CAMP-TWTA pair to be forwarded to the appropriate OMUX should the primary pair fail or malfunction.

The output of each OMUX is routed to a band-pass filter, a diplexer, a direction filter, where the spacecraft telemetry channel is added, a test coupler, and then to another diplexer and finally to the transmitting antenna.

2.6.3.2) <u>Ku-band Uplink to Ku-band Downlink Configuration</u>

Signals uplinked to the spacecraft are received by the appropriate receiving antenna. The 13750 – 14000 MHz uplinks are received by the horizontally and vertically polarized Atlantic beam antenna feeds and the 14000 – 14500 MHz uplink signals are received by the West Africa beam antenna feed.

The output of the horizontally polarized port of the Atlantic receive beam antenna is routed through a diplexer to a test coupler, a preselect filter and then to a set of 4-for-2 redundant LNA–frequency down-converter pair. The output of the vertically polarized port of the Atlantic receive beam antenna is routed to a triplexer, a test coupler, a preselect filter and then to the 4-for-2 redundant set of LNA–frequency down-converter pair. The output of the horizontally polarized West Africa receive beam antenna is routed to a test coupler, a preselect filter and then to a set of 2-for-1 redundant LNA–frequency down-converter pair.

One set of frequency converters down-converts the uplink frequency band of 13750 – 14000 MHz to the downlink frequency of 11450 – 11700 MHz – a frequency translation of 2280 MHz; the other set of frequency converters down-converts the uplink frequency band of 14000 – 14500 MHz to 12250 –

12750 MHz – a frequency translation of 1748 MHz. The frequency stability of the transmitted signal is controlled primarily by the frequency down-converter. The Intelsat 25 frequency down-converter 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 25 is compliant with the provisions of Section 25.202(e) of the Commission's rules.

It is noted that the output of the LNA connected to the horizontally polarized port of the Atlantic receive beam antenna is divided, through the use of a hybrid, to feed the Atlantic receive beam antenna down-converters and the West Africa receive beam antenna down-converters. Through ground command, switches in the West Africa beam's antenna receive path can be configured to select the West Africa beam LNA output or the horizontally polarized Atlantic beam LNA output based on the downlink coverage desired. However, Intelsat does not intend to utilize this switching capability to connect the horizontally polarized Atlantic uplink beam to the vertically polarized West Africa downlink beam, since this would lead to the translated downlink channel frequencies falling in the 11700 – 12200 MHz band.

The output of each frequency down-converter is routed to a network of hybrids and then to a bank of IMUXs. The output of each IMUX is connected, through a bank of redundancy switches, to a CAMP–TWTA pair. The redundancy switching permits the output of the IMUX to be routed to a redundant CAMP–TWTA pair should the primary units fail or malfunction.

Intelsat 25 utilizes 26x125Watt radiation cooled TWTAs. The CAMP–TWTA pairs are configured in two 8-for-5 redundancy rings for the channels associated with the horizontally and vertically polarized Atlantic downlink beams, and two 5-for-3 redundancy rings for the channels associated with the horizontally West Africa downlink beam.

Each Ku-band channel can operate in either the fixed gain mode or the automatic level control ("ALC") mode. In the fixed gain mode, the gain of each channel (and its associated transponder saturation flux density) may be independently adjusted by changing the setting of the adjustable attenuator within the CAMP by ground command. The gain of each channel may be varied by over a range of 31 dB in 1 dB increments. Accordingly, the Ku-band channels of Intelsat 25 are compliant with the provisions of Section 25.210(c) of the Commission's rules.

In the ALC mode, the input power into the TWTA may be maintained at a specific level chosen within a range of 15.5 dB, in 0.5 increments. For any chosen value within this range, the input signal level may dynamically vary by up to 22 dB without the TWTA input power level deviating from the chosen value.

The output of each TWTA is routed through a bank of switches and to the appropriate Output Multiplexer ("OMUX"). Intelsat 25 employs 3 output multiplexers. The switching network allows the output of a redundant CAMP-TWTA pair to be forwarded to the appropriate OMUX should the primary pair fail or malfunction.

For the horizontally polarized Atlantic downlink beam, the ULPC beacon channel is added to the OMUX, after which the output of the OMUX is routed to a test coupler, a diplexer and then to the transmitting antenna. For the vertically polarized Atlantic downlink beam, the output of the OMUX is routed to a test coupler, a triplexer and then to the transmitting antenna.

For the vertically polarized West Africa beam, the output of the OMUX is routed to a switch, then to a test coupler and finally to the transmitting antenna. By appropriate configuration of the aforementioned switch, the output of the vertically polarized West Africa beam OMUX can be transmitted through the vertically polarized Atlantic downlink beam.

2.6.3.3) <u>Cross-Strap Configuration</u>

Intelsat 25 has the capability to connect the Ku-band channels 15K and 16K channels to the horizontally and vertically polarized C-band Africa/US downlink beams. This connectivity is commonly referred to as Ku-to-C-band cross strapping. It also has the capability to connect the C-band channels 13A and 13B to the horizontally and vertically polarized Atlantic downlink beams and the vertically polarized West Africa downlink beam – this connectivity is commonly referred to as C-to-Ku band cross-strapping.

For C-to-Ku-band cross strapping, the output of the IMUX associated with C-band channels 13A and 13B is routed, via a commandable switch, to a 2-for-1 redundant frequency up-converter. The output of the up-converter is routed to the CAMP-TWTA input redundancy switching network via a commandable switch, after which the signal takes the normal path associated with the horizontally polarized Atlantic downlink or the vertically polarized Atlantic downlink or the West Africa beam downlink, as described in section 2.6.3.2.

For Ku-to-C-band cross strapping, the output of the IMUX associated with Ku-band channels 15 and 16 is routed, via a commandable switch, to a 2-for-1 redundant frequency down-converter. The output of the down-converter is routed to the CAMP-TWTA input redundancy switching network via a commandable switch, after which the signal takes the normal path associated with the C-band band downlink, as described in section 2.6.3.1.

For C-to-Ku-band cross-strapping, the frequency stability of the transmitted signal is controlled by the combination of the C-band frequency down-converter as well as the C-to-Ku band frequency up-converter. The down-converter-up-converter combination 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 25 is compliant with the provisions of Section 25.202(e) of the Commission's Rules.

For Ku-to-C-band cross-strapping, the frequency stability of the transmitted signal is controlled by the combination of the Ku-band frequency down-converter as well as the Ku-to-C band frequency down-converter. The down-converter-down-converter combination 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 25 is compliant with the provisions of Section 25.202(e) of the Commission's rules.

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

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 linearly polarized wide-beam omni-directional command antennas, one located on the nadir side of the spacecraft and the other on the aft side; 2) two linearly polarized medium-beam omni-directional command antennas, located on the aft side; 3) two linearly polarized wide-beam omni-directional telemetry antennas, located on the nadir side of the spacecraft; 4) two linearly polarized medium-beam omni-directional antennas, located on the aft side; 5) two linearly polarized transmit communication antennas; 6) two command receivers; 7) two telemetry transmitters; 8) Two sets of 2-for-1 redundant CAMP-TWTA pairs – one 37 Watt and the other 40 Watt – from the C-band communication payload; 9) spacecraft electronics ("SCE") subsystem; and 10) microwave components including filters, switches, couplers, isolators, cables and waveguide.

2.7.1) Antennas

When on-station, command signals are received through two linearly polarized wide-beam omni-directional antennas, located on the nadir side of the spacecraft. The telemetry signals are transmitted through the C-band communication antennas. Representative gain plot of the wide-beam command antennas is provided in Exhibit 6K and 6L, in the format specified in Section 25.114(d)(3). Similarly, the coverage pattern for the telemetry antennas is shown in Exhibits 6O and 6P.

During emergencies and transfer orbit operations, command and telemetry signals are received and transmitted through the wide-beam and medium-beam omni-directional antennas. For command, two wide-beam antennas, located on the nadir side of the spacecraft, and two medium-beam antennas, located on the aft section, are utilized. Similarly for telemetry, two wide-beam antennas, located on the nadir side of the spacecraft, and two medium-beam antennas, located on the aft side of the spacecraft, are utilized. Representative gain graphs for the command and telemetry wide-beam and medium-beam antennas are provided in Exhibits 6K, 6L, 6M, 6N, 6Q, 6R, 6S and 6T in the format specified in Section 25.114(d)(3).

2.7.2) Command

The Intelsat 25 command subsystem performance summary is provided in Exhibit 9. Detailed calculation of the G/T and command threshold flux density for each command beam is provided in Exhibit 10.

During on-station and emergency operations, commands are transmitted to the spacecraft by transmission of two independent, linearly polarized, FM signals on the frequencies of 5850.5 MHz and 6419 MHz. The command signals are received by the spacecraft through the wide coverage command antennas. The command signals are then routed to the two command receivers – one receiver for each command frequency. The receivers amplify and demodulate the signal, and convert the command signal into a digital stream. The outputs of the command receivers are forwarded to the SCE, where the commands are decoded and sent to the appropriate unit. Exhibits 5A and 5B provide the frequency and polarization plan for the Intelsat 25 command channels.

To the extent necessary, Intelsat requests a waiver of Section 25.202(g) with respect to the command frequency of 6419 MHz. Section 25.202(g) requires telemetry, tracking and telecommand functions to be "conducted at either or both edges of the allocated band(s). The Intelsat 25 C-band uplink frequency band spans from 5845 to 6645 MHz. Given that Intelsat 25 is currently in orbit, its command frequencies cannot be modified. Moreover, the nearest satellites to Intelsat 25 that will utilize the 5850 – 6425 MHz band are Intelsat 903 and 801, which are both licensed to Intelsat. Given that Intelsat utilizes earth stations with very large diameters, with high off-axis gain discrimination, to send commands to its spacecraft, the impact of any command transmissions on the existing operations of Intelsat 903 and 801 is expected to be minimal. In any case, Intelsat will internally coordinate the transmissions of each of these satellites. Accordingly, for these reasons, and to the extent necessary, good cause exists to waive Section 25.202(g) to permit operation of Intelsat 25's command at the frequency of 6419 MHz.

2.7.3) Telemetry

The Intelsat 25 telemetry subsystem performance summary is provided in Exhibit 9. Detailed calculation of the EIRP for each telemetry beam is provided in Exhibit 10.

During on-station operations, telemetry is transmitted by the spacecraft on two independent, linearly polarized, PM signals on the frequencies of 3630 MHz and 4198.5 MHz. The telemetry baseband functions are implemented in the C&DH, where data from the various spacecraft units are collected, processed, multiplexed, formatted and encoded onto subcarriers. The output of the SCE is then routed to two telemetry transmitters, one for each command frequency, where the signal is modulated onto the main carrier frequencies of 3630 MHz and 4198.5 MHz. The telemetry transmitter has two output ports – a high power port and a low power port. For on-station operations, the high power output port is utilized. The signal from the high output port of the telemetry transmitter is routed to the C-band communication transmit antennas for transmission to Earth.

During emergency operations, the operation of the telemetry subsystem is similar to that for on-station operations, except that the signal from the low power output port of the telemetry transmitter is utilized. The transmitter output is amplified by a TWTA – one for each telemetry transmitter – from the communications subsystem and transmitted to Earth through the Wide-Beam and Medium-Beam omni-directional antennas. It is noted that the output of the TWTA is maintained at 37 Watts. Exhibits 5A and 5B provide the frequency and polarization plan for the Intelsat 25 telemetry channels.

To the extent necessary, Intelsat requests a waiver of Section 25.202(g) with respect to the telemetry frequency of 3630 MHz. Section 25.202(g) requires telemetry, tracking and telecommand functions to be “conducted at either or both edges of the allocated band(s). The Intelsat 25 C-band downlink frequency band spans from 3400 to 4200 MHz. Given that Intelsat 25 is currently in orbit, its telemetry frequencies cannot be modified. Moreover, the nearest satellites to Intelsat 25 that utilize the 3625 – 4200 MHz band will be Intelsat 903 and 801, which are both licensed to Intelsat. In view of the fact that the power level of the Intelsat 25 telemetry signal is typically lower than the power level of a typical communication signal, the impact of the telemetry transmissions of Intelsat 25 on the existing operations of Intelsat 903 and 801 is expected to be minimal. In any case, Intelsat shall internally coordinate the transmissions of each of these satellites. Accordingly, for these reasons, and to the extent necessary, good cause exists to waive Section 25.202(g) to permit operation of Intelsat 25’s telemetry at the frequency of 3630 MHz.

2.7.4) <u>Ranging</u>

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 25 command, telemetry and ranging subsystems are provided in Exhibit 9.

2.8) Uplink Power Control ("ULPC") Subsystem

Intelsat 25 provides two Ku-band beacons which can be used for uplink power control by customers transmitting at Ku-band frequencies to the spacecraft. The ULPC beacons are linearly polarized and operate on the frequencies of 11698 MHz and 12254 MHz.

The characteristics of the ULPC beacon are provided in Exhibit 2. Detailed calculation of the EIRP for the ULPC beams is provided in Exhibit 7.

The ULPC subsystem utilizes two dedicated sets of 2-for-1 redundant transmitters to generate each beacon. The output of the transmitters are multiplexed with other communication channels and transmitted to Earth through the appropriate Ku-band communication transmit antenna. The coverage pattern for each of the ULPC beams is provided in Exhibits 6U, 6V and 6W.

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 the provisions of Section 25.210(j) of the Commission's rules.

The attitude of the spacecraft will be maintained with an 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 stationkeeping 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 have been selected so that aging or wearing effects will not adversely affect spacecraft performance over the estimated life.

2.11) Spacecraft Reliability

Intelsat 25 is 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 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 payload is 85.9%. The projected reliability of the bus system, which includes the TT&C systems, is 85.0%. The overall reliability of the Intelsat 25 spacecraft is projected to be 73%. The subsystem reliability assessments were based upon the use of failure rates, modeling assumptions from previous spacecraft programs and those specific to Intelsat 25.

3.0) Emission Limitations

The receiver and transmitter channel filter response characteristics of Intelsat 25 are provided in Exhibit 8, as required under Section 25.114(c)(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 25 emissions.

4.0) Services and Emission Designators

Intelsat 25 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 Intelsat 25 can accommodate television, radio, voice or data communications. Typical types of 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 data rates

Emission designators and allocated bandwidths for representative communication carriers, telemetry and command signals are provided in Exhibit 11.

5.0) 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. With respect to the 3400 – 3700 MHz and 12250 – 12750 MHz band, there are PFD limits specified in No. 21.16 of the ITU Radio Regulations[2].

The maximum PFD levels for the Intelsat 25 transmissions were calculated for a number of TV/FM and digital carriers listed in Exhibit 11 operating in the 3400 – 3700 MHz, 3700 – 4200 MHz, 11450 – 11700 MHz and 12250 – 12750 MHz bands. These carriers were chosen because they generally produce high PFD levels on the Earth's surface. In addition, the PFD levels of the Intelsat 25 telemetry and ULPC carriers were calculated. The results are provided in Exhibit 12 and show that the downlink power flux density

[2] Limits in the band 12.25-12.50 GHz are only applicable in countries of the ITU Region 3, which actually is not covered by IS 25.

levels of the Intelsat 25 carriers do not exceed limits specified in Section 25.208 of the Commission's rules or No. 21.16 of the ITU Radio Regulations.

5.0) <u>Service Area</u>

At C-band, the primary service area of Intelsat 25 is Africa and eastern United States. At Ku-band, the primary service area is northwestern Africa.

6.0) <u>Orbital Location</u>

Intelsat requests that it be assigned the 31.5° W.L. orbital location for Intelsat 25. This location is currently occupied the Intelsat 801 spacecraft, which will be moved to another location prior to the arrival of Intelsat 25 at 31.5° W.L. The 31.5° W.L. location satisfies Intelsat 25 requirements for optimizing coverage, elevation angles and service availability and ensures that maximum operational, economic and public interest benefits will be derived.

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

Intelsat 25 is intended to provide video, audio and data services to satellite users in the Africa and the eastern portion of the United States. The 31.5° W.L. position affords reasonable earth station angles to the region. The attractiveness of Intelsat 25 to this market would be severely diminished if service to this area is not possible.

8.0) <u>Intelsat 25 Carrier Link Analysis</u>

Link analysis for Intelsat 25 was conducted for a number of representative carriers. For the analysis, it was assumed that the nearest satellites to Intelsat 25 were a hypothetical satellite operating from 29.5°W.L. and a hypothetical satellite operating from 33.5° E.L. The hypothetical satellites were assumed to have the same operational parameters as Intelsat 25.

For C-band calculations, the uplink power density of the emissions to each of the hypothetical satellites was assumed to be -38.7 dBW/Hz, the maximum level specified in Section 25.212(d) of the Commission's rules for digital C-band carriers. For Ku-band calculations, the uplink power density of the emissions to each of the hypothetical satellites was assumed to be -50 dBW/Hz, the maximum level specified in Section 25.212(c) of the Commission's rules for digital Ku-band carriers. Additionally, at Ku-band, the maximum downlink EIRP density of the emissions from each of the hypothetical satellites was assumed to be -26 dBW/Hz, the maximum level specified in Section 25.212(c) of the Commission's rules.

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)(1) 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 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.
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.

The impact of the TV/FM carriers from the adjacent satellites at 29.5° W.L. and 33.5° W.L on the transmissions of Intelsat 25 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 5A and 5B, Intelsat 25 beams can be interconnected in a number of ways. Moreover, the performance of the orthogonally polarized C-band beams and the orthogonally polarized Ku-band beams are quite similar. Hence, in order to keep the number of Intelsat 25 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 6 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 25 uplink and downlink beam combinations. The worst-case beam performance for each Intelsat 25 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 EIRP (dBW)
Africa/US (H)	Africa/US	-0.5	-65 to -101	40
Africa/US (V)				
Atlantic (H)	Atlantic/ West Africa	12	-78 to -109	55.6
Atlantic (V)				
West Africa				

As shown in Exhibits 5A and 5B, Intelsat 25 employs channels with 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 72 MHz and a channel having a bandwidth of 36 MHz have the same associated adjacent satellite downlink interfering EIRP density, then link budgets were performed only for emissions that were transmitted through the 72 MHz channel, since the carrier level would typically have less (uplink and downlink) power in comparison to those which would be transmitted through the 36 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 36 MHz channel was subjected was larger than that for the 72 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[72/36]), then link calculations were performed only for the emissions of the 36 MHz channel, since the impact of adjacent satellite interference is greater on emissions of this channel (in comparison to those being transmitted through the 72 MHz channel).

As previously mentioned, Intelsat 25 can utilize the C-band frequency bands of 5845 – 6645 MHz and 3400 – 4200 MHz; and the Ku-band frequency bands of 13750 – 14500 MHz, 11450 – 11700 MHz and 12250 – 12750 MHz. In order to keep the number of Intelsat 25 link calculations to a manageable number, all Ku-band link calculations were conducted at the single representative uplink frequency of 14125 MHz and downlink frequency of 12377 MHz. At C-band, all calculations were conducted at the single representative frequency of 6205 MHz for the uplink and 3800 MHz for the downlink.

The results of the C and Ku-band analysis are shown in Exhibit 13 and demonstrate that operation of the Intelsat 25 satellite from 31.5º W.L. 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 11 comply with the limits contained in Section 25.212(c) of the Commission's rules.

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

The impact of the Intelsat 25 emissions on the transmissions of adjacent satellites was not analyzed because the power levels of Intelsat 25 transmissions will be limited to those levels contained in Sections 25.212(c) and (d) of the FCC's rules. In those cases where Intelsat may require to transmit carriers with power levels in excess of those in Sections 25.212(c) and (d), it will coordinate with the affected adjacent satellite operators as part of the normal coordination process, so as to limit the level of interference that is mutually caused and received by Intelsat 25 and any future satellite that may operate from 29.5° W.L. and/or 33.5° W.L.

10.0) <u>Schedule S Submission</u>

Intelsat is providing with its application a Schedule S for the operations of Intelsat 25 from 31.5º 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 of 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).

11.0) 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:

11.1) 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.

11.2) 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 turning off all active units.

11.3) 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. With the exception of Intelsat 801, Intelsat 25 will not be located at the same orbital location as another satellite or at an orbital location that has an overlapping stationkeeping volume with another satellite.

The proposed orbital location for Intelsat 25 is 31.5° W.L. Currently Intelsat 801 operates from 31.5° W.L. However, before Intelsat 25 arrives at this location, Intelsat 801 will be drifted to another orbital location.

With the exception of Intelsat 801, 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 stationkeeping volume with Intelsat 25. Intelsat is also not aware of any system with an overlapping stationkeeping volume with Intelsat 25 that is the subject of an ITU filing and that is either in orbit or progressing towards launch.

11.4) 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. Intelsat has reserved 14.8 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 ratios (Cr*A/M) of the Intelsat 25 spacecraft is 0.041 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 Intelsat 25 planned disposal orbit complies with the FCC's rules.

12) ITU Filing

Intelsat currently has no filing with the ITU for a satellite network that specifies operation on the frequency band 12250-12500 MHz. This band will be utilized in ITU Region 1 where it is allocated to the Broadcast Satellite Service ("BSS"). Intelsat also does not have an ITU filing for a satellite network operating in the Fixed Satellite Service ("FSS") that operates in the 5845 – 5850 MHz band in ITU Region 1.

Intelsat will separately submit to the Commission the necessary coordination filing for a new BSS satellite network that utilizes the frequency band 12250 – 12500 MHz and the Advanced Publication Information ("API") for a new FSS satellite network that utilizes the 5845 – 5850 MHz band at 31.5° 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	December, 2009
Jose Albuquerque Intelsat Corporation Senior Director, Spectrum Engineering	Date

EXHIBIT 1: SPACECRAFT CONFIGURATION

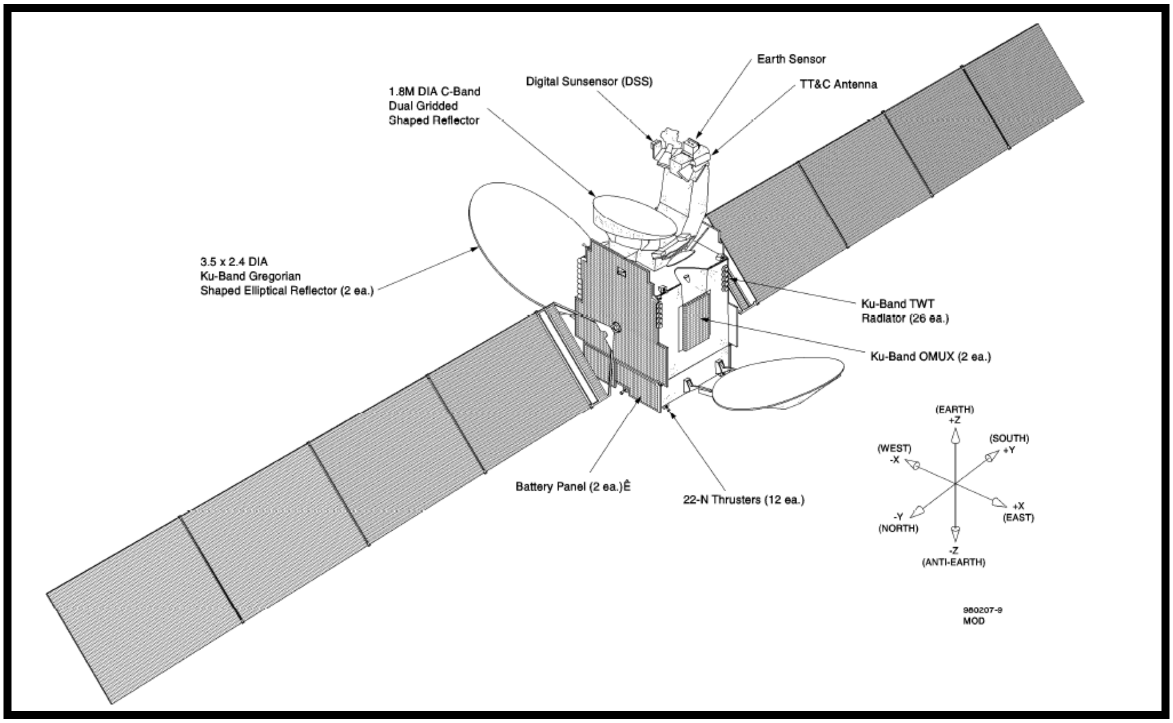


EXHIBIT 2: SUMMARY OF SPACECRAFT CHARACTERISTICS

GENERAL	
Spacecraft Name	Intelsat 25
Orbital Location	31.5° W.L.
Spacecraft Manufacturer	Space System Loral
Spacecraft Model	FS1300 Bus
Spacecraft Type	3-axis stabilized
Spacecraft Dimensions	
Length	31.1 meters
Width	6.2 meters
Depth	10.8 meters
Spacecraft Mass	
Mass w/o fuel	1764 kg
Mass w/ fuel	4180 kg
Spacecraft Expected Lifetime	≥ 15 years
Eclipse Capability	100%
Station-keeping	
North-South	±0.05°
East-West	±0.05°
Antenna Pointing Accuracy	
North-South	0.15°
East-West	0.15°
Rotational	0.15°
Spacecraft Reliability	73.0 %
Payload Reliability	85.9 %
Bus Reliability	85.0 %
Propulsion Type	Bi-propellant
Maximum Solar Array Power	
Beginning of Life	7904 Watts
End of Life	7728 Watts
Deployed Area of Solar Array	17.9 m^2

EXHIBIT 2: SUMMARY OF SPACECRAFT CHARACTERISTICS (continued)

COMMUNICATION	
Frequency Bands	
Uplink	5845 – 6645 MHz 13750 – 14500 MHz
Downlink	3400 – 4200 MHz 11450 – 11700 MHz 12250 – 12750 MHz
Polarization	
Uplink	Linear Horizontal / Linear Vertical
Downlink	Linear Horizontal / Linear Vertical
Coverage Area	
C-Band	
Uplink	Africa, Eastern United States
Downlink	Africa, Eastern United States
Ku-Band	
Uplink	Northwestern Africa
Downlink	Northwestern Africa
Beam Cross-Polarization Isolation	
Uplink	≥ 30 dB
Downlink	≥ 30 dB
Number of Channels	
C-Band	36
Ku-Band	16
Channel Bandwidth	
C-Band	36 MHz & 72 MHz
Ku-Band	36 MHz & 72 MHz
Maximum Downlink EIRP	
C-Band	
Africa/US Beam (H-Pol.)	40.0 dBW
Africa/US Beam (V-Pol.)	40.5 dBW
Ku Band	
Atlantic Beam (H-Pol.)	55.6 dBW
Atlantic Beam (V-Pol.)	55.6 dBW
West Africa Beam (V-Pol.)	56.2 dBW

EXHIBIT 2: SUMMARY OF SPACECRAFT CHARACTERISTICS (continued)

COMMUNICATION	
Maximum Uplink G/T	
C-Band	
Africa/US Beam (H-Pol.)	-0.5 dB/K
Africa/US Beam (V-Pol.)	-1.0 dB/K
Ku Band	
Atlantic Beam (H-Pol.)	10.0 dB/K
Atlantic Beam (V-Pol.)	10.0 dB/K
West Africa Beam (V-Pol.)	12.0 dB/K
Uplink SFD Range @ Maximum G/T	
C-Band	
Africa/US Beam (H-Pol.)	-65.0 to -101.0 dBW/m^2
Africa/US Beam (V-Pol.)	-65.0 to -101.0 dBW/m^2
Ku-Band	
Atlantic Beam (H-Pol.)	-78.0 to -109.0 dBW/m^2
Atlantic Beam (V-Pol.)	-78.0 to -109.0 dBW/m^2
West Africa Beam (V-Pol.)	-76.0 to -107.0 dBW/m^2
Transponder Range	
C-band	36 dB in 1 dB increments
Ku-Band	
Fixed Gain Mode	31 dB in 1 dB increments
Automatic Level Control Mode	22 dB
Transponder Gain	
C-Band	
Africa/US (H) Uplink – Africa/US (V) Downlink	86.5 – 122.5 dB
Africa/US (V) Uplink – Africa/US (H) Downlink	86.8 – 122.8 dB
Ku-Band	
Atlantic (H) Uplink – Atlantic (V) Downlink	102.1 – 133.1 dB
Atlantic (V) Uplink – Atlantic (H) Downlink	102.1 – 133.1 dB
W. Africa (H) Uplink – W. Africa (V) Downlink	97.9 – 128.9 dB
W. Africa (H) Uplink – W. Africa (V) Downlink	98.6 – 129.6 dB
Cross-strap Configuration	
Africa/US (H) Uplink – Atlantic (V) Downlink	96.2 – 127.2 dB
Africa/US (H) Uplink – W. Africa (V) Downlink	95.5 – 126.5 dB

Africa/US (V) Uplink – Atlantic (V) Downlink	96.8 – 127.8 dB
Africa/US (V) Uplink – W. Africa (V) Downlink	96.1 – 127.1 dB
W. Africa (H) Uplink – Africa/US (H) Downlink	88.6 – 124.6 dB
W. Africa (H) Uplink – Africa/US (V) Downlink	88.9 – 124.9 dB
Unit Redundancy	
Low Noise Amplifier	
C-Band	1x4-for-2
Ku-Band	1x4-for-2, 1x2-for-1
Frequency Converter	
C-Band	2x4-for-2
Ku-Band	1x4-for-2, 1x2-for-1, 2x2-for-1
Amplifier	
C-Band	2x18-for-13, 2x7-for-5
Ku-Band	2x5-for-3, 2x8-for-5,
Maximum Power of Last Amplifier Stage	
C-Band	37 Watts & 40 Watts
Ku-Band	125 Watts
Transmit Frequency Stability	< 0.002%

EXHIBIT 2: SUMMARY OF SPACECRAFT CHARACTERISTICS (continued)

TELEMETRY, COMMAND & RANGING	
Command Frequency	
Wide Beam Omni Antenna	5850.5 / 6419 MHz
Medium-Beam Omni Antenna	5850.5 / 6419 MHz
Command Polarization	
Wide Beam Omni Antenna	Horizontal / Vertical
Medium-Beam Omni Antenna	Horizontal / Vertical
Command Carrier Modulation	FM
Command Carrier Bandwidth	
Occupied Bandwidth	860 kHz
Allocated Bandwidth	1000 kHz
Command Antennas	
Transfer Orbit / Emergency	Wide-Beam and Medium-Beam Omni Antenna
On-Station	Wide-Beam Omni Antenna
Command Threshold at Beam Peak	
Wide Beam Omni Antenna	-108.7 dBW/m^2
Medium-Beam Omni Antenna	-105.2 dBW/m^2
Command G/T at Beam Peak	
Wide Beam Omni Antenna	-28.2 dB/K
Medium-Beam Omni Antenna	-30.7 dB/K
Telemetry Frequency	
Wide Beam Omni Antenna	3630 / 4198.5 MHz
Medium-Beam Omni Antenna	3630 / 4198.5 MHz
Communication Antenna	3630 / 4198.5 MHz
Telemetry Polarization	
Wide Beam Omni Antenna	Vertical / Horizontal
Medium-Beam Omni Antenna	Vertical / Horizontal
Communication Antenna	Vertical / Horizontal
Telemetry Modulation	PM

EXHIBIT 2: SUMMARY OF SPACECRAFT CHARACTERISTICS
(continued)

TELEMETRY, COMMAND & RANGING	
Telemetry Carrier Bandwidth	
Occupied Bandwidth	300 kHz
Allocated Bandwidth	500 kHz
Telemetry Antenna	
Transfer Orbit / Emergency	Wide-Beam and Medium-Beam Omni Antenna
On-Station	Communication Antenna
Telemetry EIRP at Beam Peak	
Wide Beam Omni Antenna	12.4 dBW
Medium-Beam Omni Antenna	15.8 dBW
Communication Antenna	20.4 dBW (H-Pol.) / 20.6 dBW (Vertical)
Ranging Accuracy	≤ 30 meters

EXHIBIT 2: SUMMARY OF SPACECRAFT CHARACTERISTICS (continued)

ULPC	
Frequency	11698 / 12254 MHz
Polarization	Horizontal / Vertical
Coverage Area	Northwestern Africa
Number of channels	2
Channel Bandwidth	≤ 25 kHz
Maximum Downlink EIRP	26.8 dBW (ULPC 1 Beam) 26.6 dBW (UPLC 2 Beam) 28.7 dBW (ULPC 3 Beam)

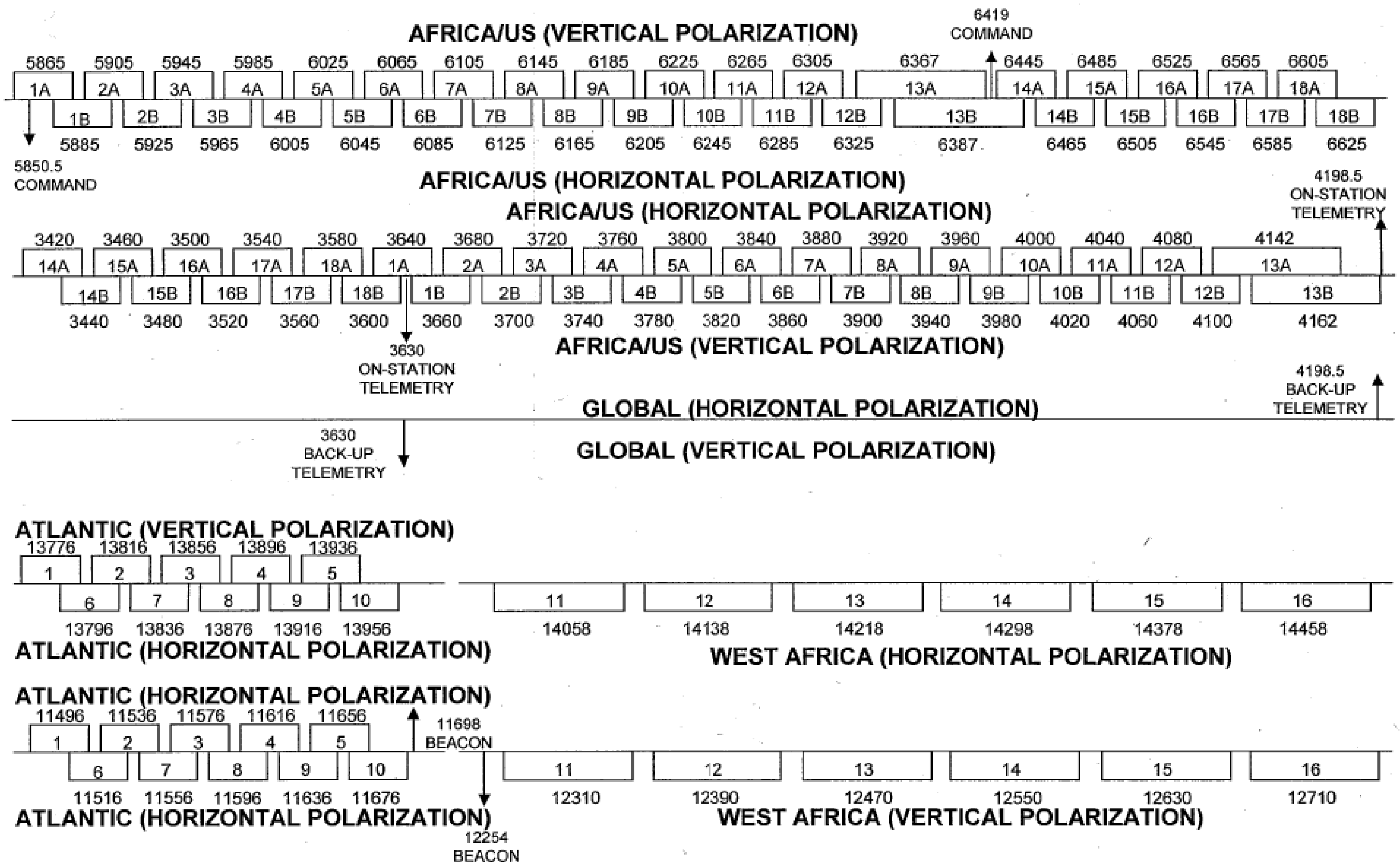
EXHIBIT 3: SPACECRAFT MASS BUDGET

Mass of Spacecraft without Fuel (kg)	1764
Mass of Fuel and Disposables (kg)	2416
Launch Mass (kg)	4180
Mass of Fuel, in orbit, at Beginning of Life (kg)	765

EXHIBIT 4: SPACECRAFT POWER BUDGET

	BEGINNING OF LIFE		END OF LIFE	
	AUTUMN EQUINOX	SUMMER SOLSTICE	AUTUMN EQUINOX	SUMMER SOLSTICE
PAYLOAD (WATTS)	5671	5671	5671	5671
BUS (WATTS)	1561	770	1561	770
TOTAL POWER (WATTS)	7232	6441	7232	6441
SOLAR ARRAY POWER (WATTS)	7904	7110	7728	6948
DEPTH OF BATTERY DISCHARGE (%)	67.2%	N/A	73.9%	N/A

EXHIBIT 5A: FREQUENCY PLAN



NOTES
1) ALL FREQUENCIES ARE IN MEGAHERTZ.
2) CHANNELS 15 AND 16 CAN BE CROSS-STRAPPED TO CHANNELS 13A AND 13B, RESPECTIVELY.
3) CHANNELS 13A AND 13B CAN BE CROSS-STRAPPED TO CHANNELS 15 AND 16, RESPECTIVELY.
4) CHANNELS 11 – 16 CAN BE CONNECTED TO EITHER THE K2H DOWNLINK BEAM OR THE K1H DOWNLINK BEAM.

NOT DRAWN TO SCALE

EXHIBIT 5B: FREQUENCY ASSIGNMENTS

Uplink Channel Designation	Uplink Beam Name	Uplink Beam Polarization	Uplink Center Frequency (MHz)	Downlink Channel Designation	Downlink Beam Name	Downlink Beam Polarization	Downlink Center Frequency (MHz)	Channel Bandwidth (MHz)	Maximum Channel Gain (dB)
1A	Africa/US	Vertical	5865	1A	Africa/US	Horizontal	3640	36	122.8
2A	Africa/US	Vertical	5905	2A	Africa/US	Horizontal	3680	36	122.8
3A	Africa/US	Vertical	5945	3A	Africa/US	Horizontal	3720	36	122.8
4A	Africa/US	Vertical	5985	4A	Africa/US	Horizontal	3760	36	122.8
5A	Africa/US	Vertical	6025	5A	Africa/US	Horizontal	3800	36	122.8
6A	Africa/US	Vertical	6065	6A	Africa/US	Horizontal	3840	36	122.8
7A	Africa/US	Vertical	6105	7A	Africa/US	Horizontal	3880	36	122.8
8A	Africa/US	Vertical	6145	8A	Africa/US	Horizontal	3920	36	122.8
9A	Africa/US	Vertical	6185	9A	Africa/US	Horizontal	3960	36	122.8
10A	Africa/US	Vertical	6225	10A	Africa/US	Horizontal	4000	36	122.8
11A	Africa/US	Vertical	6265	11A	Africa/US	Horizontal	4040	36	122.8
12A	Africa/US	Vertical	6305	12A	Africa/US	Horizontal	4080	36	122.8
13A	Africa/US	Vertical	6367	13A	Africa/US	Horizontal	4142	72	122.8
14A	Africa/US	Vertical	6445	14A	Africa/US	Horizontal	3420	36	122.8
15A	Africa/US	Vertical	6485	15A	Africa/US	Horizontal	3460	36	122.8
16A	Africa/US	Vertical	6525	16A	Africa/US	Horizontal	3500	36	122.8
17A	Africa/US	Vertical	6565	17A	Africa/US	Horizontal	3540	36	122.8
18A	Africa/US	Vertical	6605	18A	Africa/US	Horizontal	3580	36	122.8
1B	Africa/US	Horizontal	5885	1B	Africa/US	Vertical	3660	36	122.5
2B	Africa/US	Horizontal	5925	2B	Africa/US	Vertical	3700	36	122.5
3B	Africa/US	Horizontal	5965	3B	Africa/US	Vertical	3740	36	122.5
4B	Africa/US	Horizontal	6005	4B	Africa/US	Vertical	3780	36	122.5
5B	Africa/US	Horizontal	6045	5B	Africa/US	Vertical	3820	36	122.5
6B	Africa/US	Horizontal	6085	6B	Africa/US	Vertical	3860	36	122.5
7B	Africa/US	Horizontal	6125	7B	Africa/US	Vertical	3900	36	122.5
8B	Africa/US	Horizontal	6165	8B	Africa/US	Vertical	3940	36	122.5
9B	Africa/US	Horizontal	6205	9B	Africa/US	Vertical	3980	36	122.5
10B	Africa/US	Horizontal	6245	10B	Africa/US	Vertical	4020	36	122.5
11B	Africa/US	Horizontal	6285	11B	Africa/US	Vertical	4060	36	122.5
12B	Africa/US	Horizontal	6325	12B	Africa/US	Vertical	4100	36	122.5
13B	Africa/US	Horizontal	6387	13B	Africa/US	Vertical	4162	72	122.5
14B	Africa/US	Horizontal	6465	14B	Africa/US	Vertical	3440	36	122.5
15B	Africa/US	Horizontal	6505	15B	Africa/US	Vertical	3480	36	122.5
16B	Africa/US	Horizontal	6545	16B	Africa/US	Vertical	3520	36	122.5
17B	Africa/US	Horizontal	6585	17B	Africa/US	Vertical	3560	36	122.5
18B	Africa/US	Horizontal	6625	18B	Africa/US	Vertical	3600	36	122.5
1	Atlantic	Vertical	13776	1	Atlantic	Horizontal	11496	36	133.1
2	Atlantic	Vertical	13816	2	Atlantic	Horizontal	11536	36	133.1
3	Atlantic	Vertical	13856	3	Atlantic	Horizontal	11576	36	133.1
4	Atlantic	Vertical	13896	4	Atlantic	Horizontal	11616	36	133.1
5	Atlantic	Vertical	13936	5	Atlantic	Horizontal	11656	36	133.1
6	Atlantic	Horizontal	13796	6	Atlantic	Vertical	11516	36	133.1
7	Atlantic	Horizontal	13836	7	Atlantic	Vertical	11556	36	133.1
8	Atlantic	Horizontal	13876	8	Atlantic	Vertical	11596	36	133.1
9	Atlantic	Horizontal	13916	9	Atlantic	Vertical	11636	36	133.1
10	Atlantic	Horizontal	13956	10	Atlantic	Vertical	11676	36	133.1
11	West Africa	Horizontal	14058	11	West Africa	Vertical	12310	72	128.9
12	West Africa	Horizontal	14138	12	West Africa	Vertical	12390	72	128.9
13	West Africa	Horizontal	14218	13	West Africa	Vertical	12470	72	128.9
14	West Africa	Horizontal	14298	14	West Africa	Vertical	12550	72	128.9
15	West Africa	Horizontal	14378	15	West Africa	Vertical	12630	72	128.9
16	West Africa	Horizontal	14458	16	West Africa	Vertical	12710	72	128.9

EXHIBIT 5B: FREQUENCY ASSIGNMENTS (continued)

Uplink Channel Designation	Uplink Beam Name	Uplink Beam Polarization	Uplink Center Frequency (MHz)	Downlink Channel Designation	Downlink Beam Name	Downlink Beam Polarization	Downlink Center Frequency (MHz)	Channel Bandwidth (MHz)	Maximum Channel Gain (dB)
11	West Africa	Horizontal	14058	11	Atlantic	Vertical	12310	72	129.6
12	West Africa	Horizontal	14138	12	Atlantic	Vertical	12390	72	129.6
13	West Africa	Horizontal	14218	13	Atlantic	Vertical	12470	72	129.6
14	West Africa	Horizontal	14298	14	Atlantic	Vertical	12550	72	129.6
15	West Africa	Horizontal	14378	15	Atlantic	Vertical	12630	72	129.6
16	West Africa	Horizontal	14458	16	Atlantic	Vertical	12710	72	129.6
15	West Africa	Horizontal	14378	13A	Africa/US	Horizontal	4142	72	124.6
16	K2H	Horizontal	14458	13B	Africa/US	Vertical	4162	72	124.9
13A	Africa/US	Vertical	6367	15	West Africa	Vertical	12630	72	127.1
13B	Africa/US	Horizontal	6387	16	West Africa	Vertical	12710	72	126.5
13A	Africa/US	Vertical	6367	15	Atlantic	Vertical	12630	72	127.8
13B	Africa/US	Horizontal	6387	16	Atlantic	Vertical	12710	72	127.2
CMD1	W-B Global	Horizontal	5850.5						
CMD2	W-B Global	Vertical	6419						
CMD3	M-B Global	Horizontal	5850.5						
CMD4	M-B Global	Vertical	6419						
				TM1	Africa/US	Vertical	3630	500	
				TM2	Africa/US	Horizontal	4198.5	500	
				TM3	W-B Global	Vertical	3630	500	
				TM4	W-B Global	Horizontal	4198.5	500	
				TM3	M-B Global	Vertical	3630	500	
				TM4	M-B Global	Horizontal	4198.5	500	
				UPC1	Atlantic	Horizontal	11698	25	
				UPC2	Atlantic	Vertical	12254	25	
				UPC3	West Africa	Vertical	12254	25	

EXHIBIT 6A: C-BAND AFRICA/US RECEIVE BEAM

Beam Polarization: Horizontal

Peak Antenna Gain: 29.4 dBi

Peak G/T: -0.5 dB/K

Saturated Flux Density at Peak G/T: -65 to -101 dBW/m^2

(Schedule S Beam Designation: CHUL)

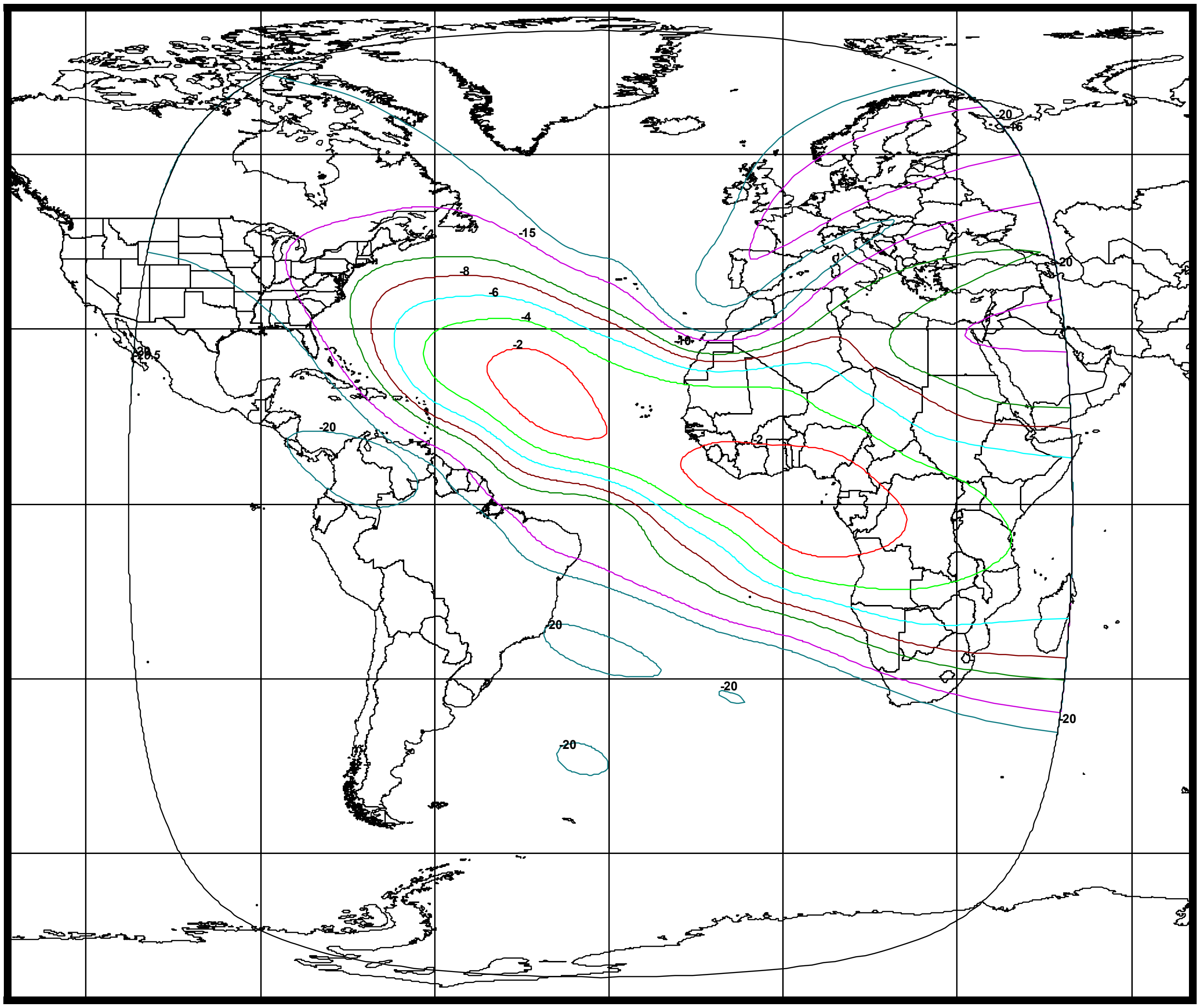


EXHIBIT 6B: C-BAND AFRICA/US RECEIVE BEAM

Beam Polarization: Vertical
Peak Antenna Gain: 28.8 dBi
Peak G/T: -1.0 dB/K
Saturated Flux Density at Peak G/T: -65 to -101 dBW/m^2
(Schedule S Beam Designation: CVUL)

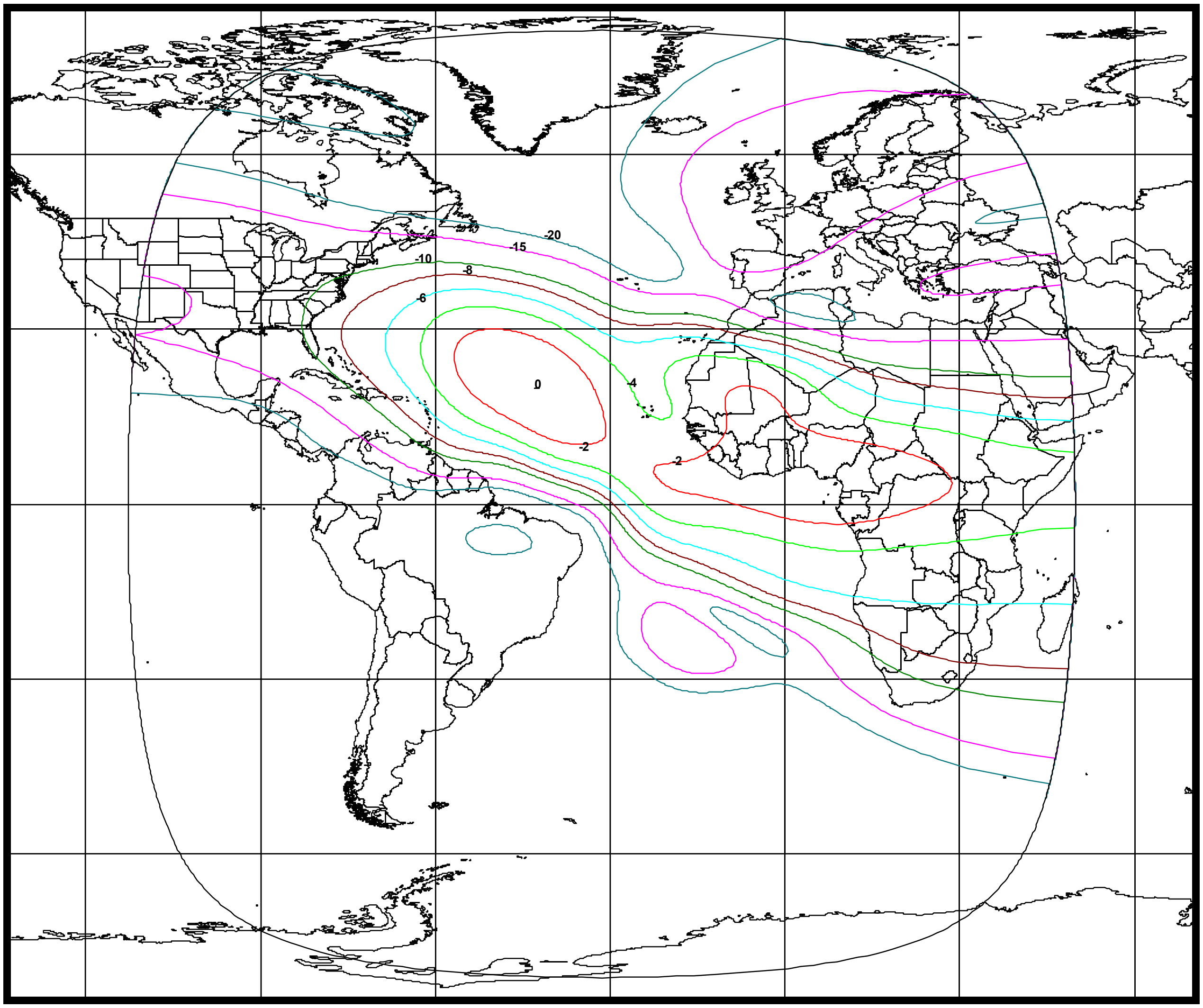


EXHIBIT 6C: KU-BAND ATLANTIC RECEIVE BEAM

Beam Polarization: Horizontal

Peak Antenna Gain: 38.6 dBi

Peak G/T: 10.0 dB/K

Saturated Flux Density at Peak G/T: -78 to -109 dBW/m^2

(Schedule S Beam Designation: K1HU)

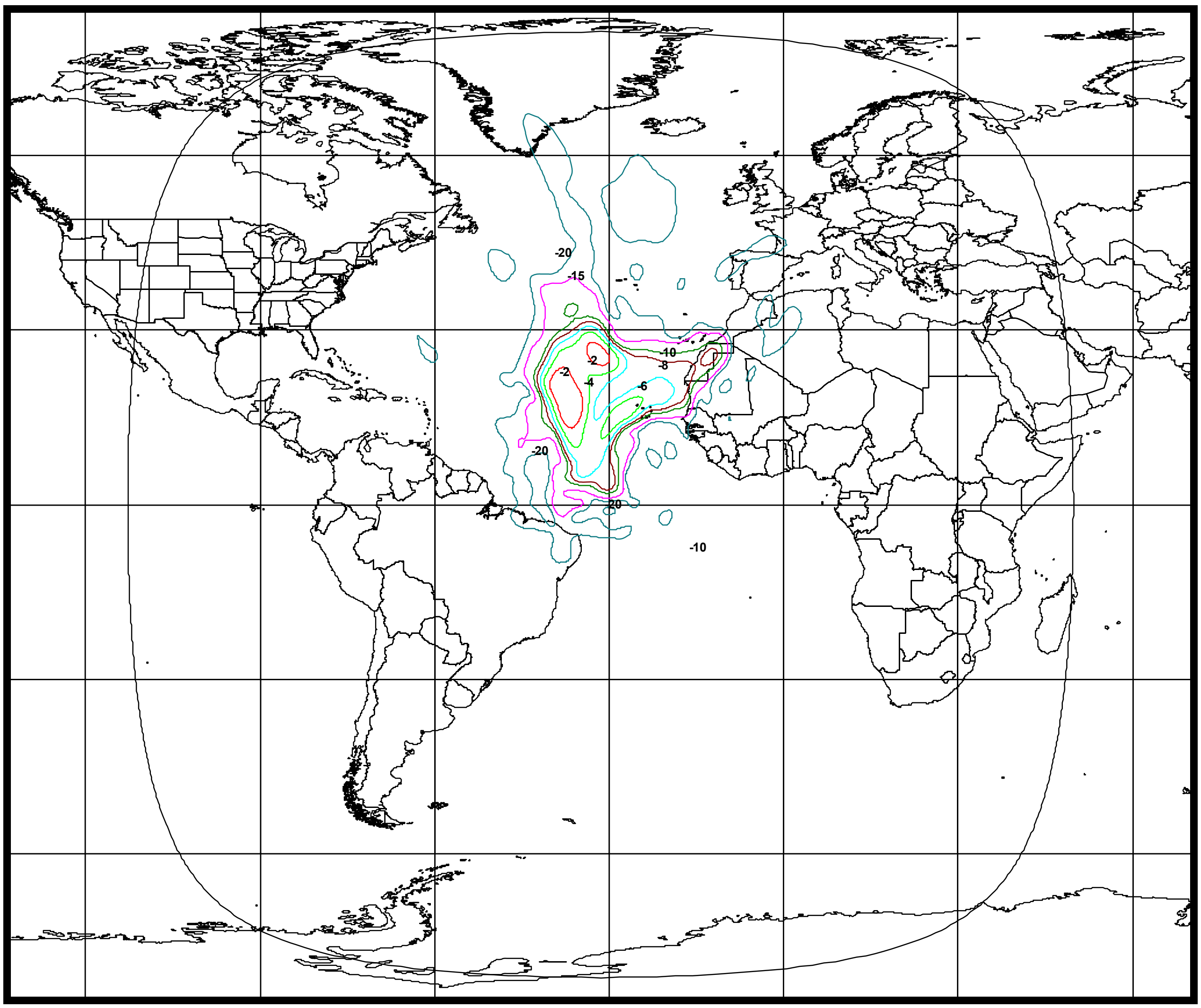


EXHIBIT 6D: KU-BAND ATLANTIC RECEIVE BEAM

Beam Polarization: Vertical

Peak Antenna Gain: 38.6 dBi

Peak G/T: 10.0 dB/K

Saturated Flux Density at Peak G/T: -78 to -109 dBW/m^2

(Schedule S Beam Designations: K1VU)

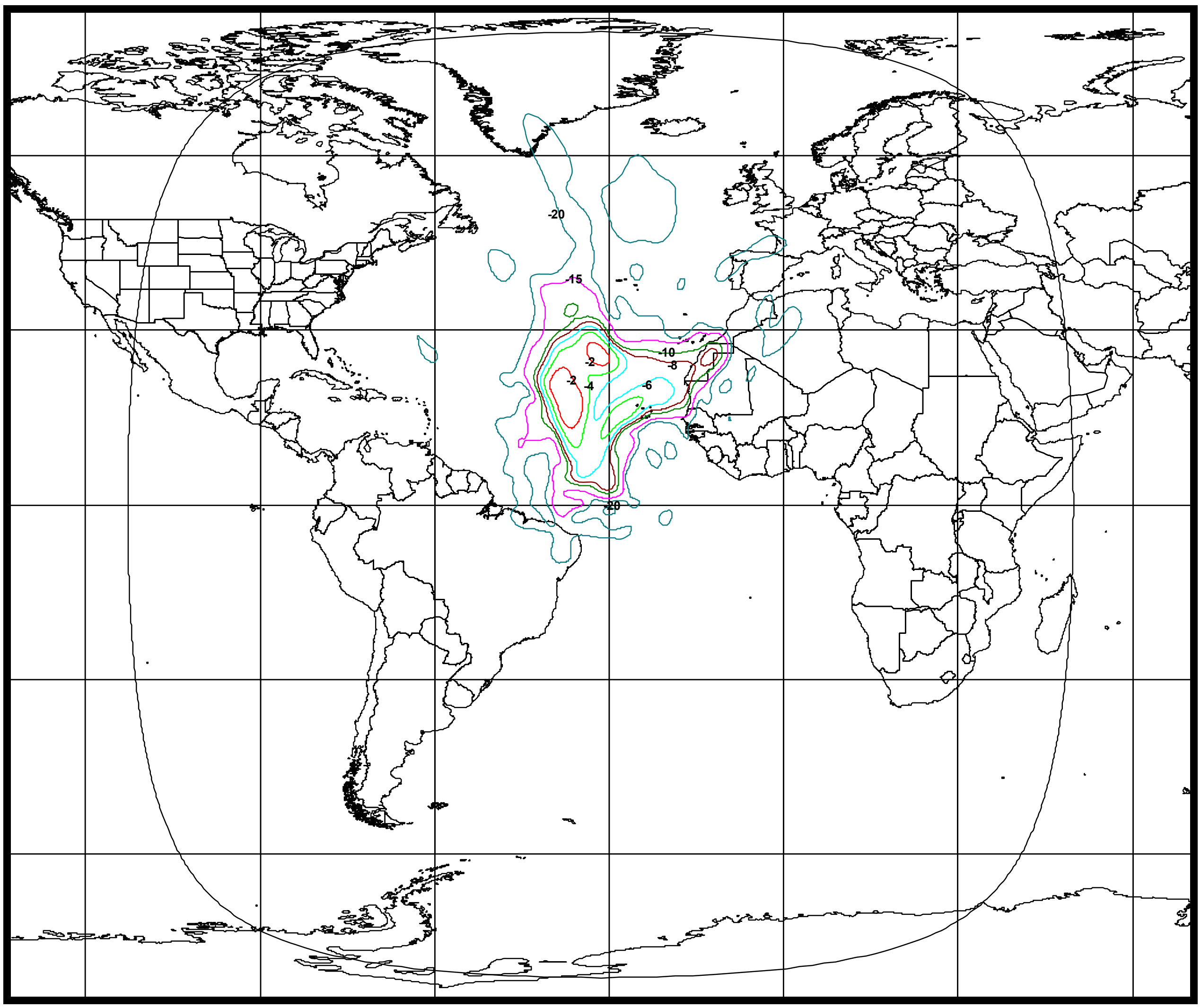


EXHIBIT 6E: KU-BAND WEST AFRICA RECEIVE BEAM

Beam Polarization: Horizontal
Peak Antenna Gain: 40.3 dBi
Peak G/T: 12.0 dB/K
Saturated Flux Density at Peak G/T: -76 to -107 dBW/m^2
(Schedule S Beam Designations: K2HU)

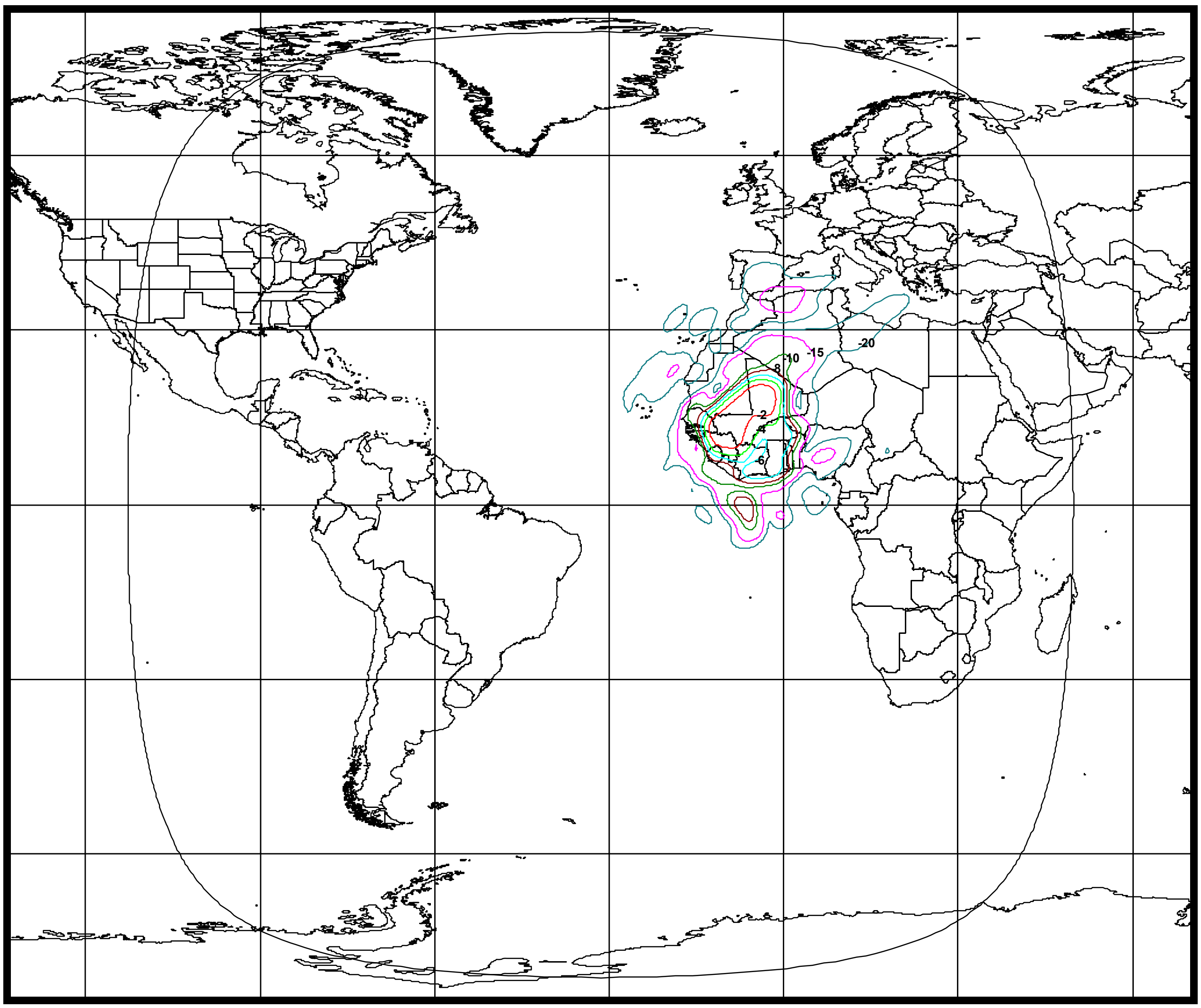


EXHIBIT 6F: C-BAND AFRICA/US TRANSMIT BEAM

Beam Polarization: Horizontal
Peak Antenna Gain: 26.6 dBi
Peak EIRP: 40.0 dBW
(Schedule S Beam Designation: CHDL)

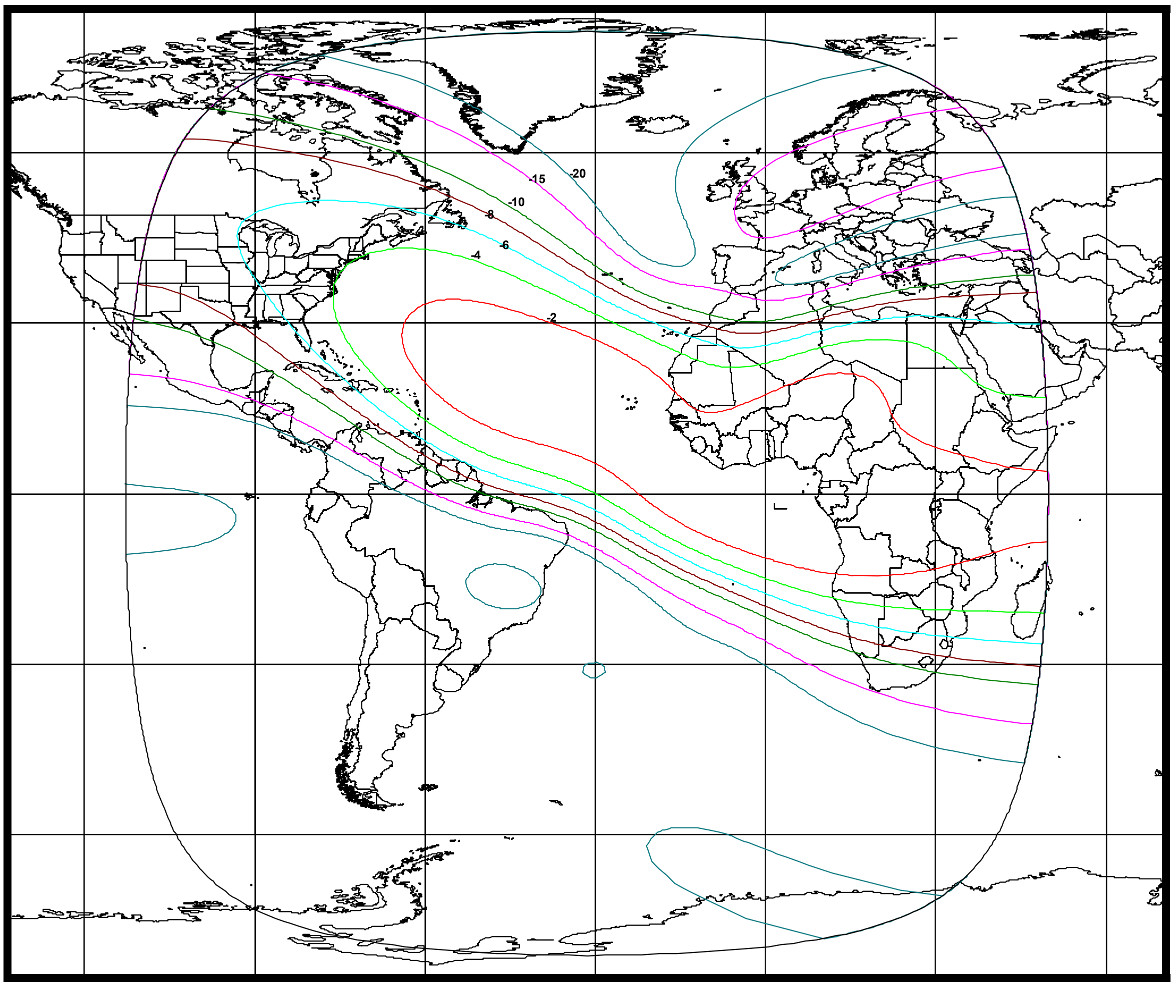


EXHIBIT 6G: C-BAND AFRICA/US TRANSMIT BEAM

Beam Polarization: Vertical

Peak Antenna Gain: 26.8 dBi

Peak EIRP: 40.5 dBW

(Schedule S Beam Designation: CVDL)

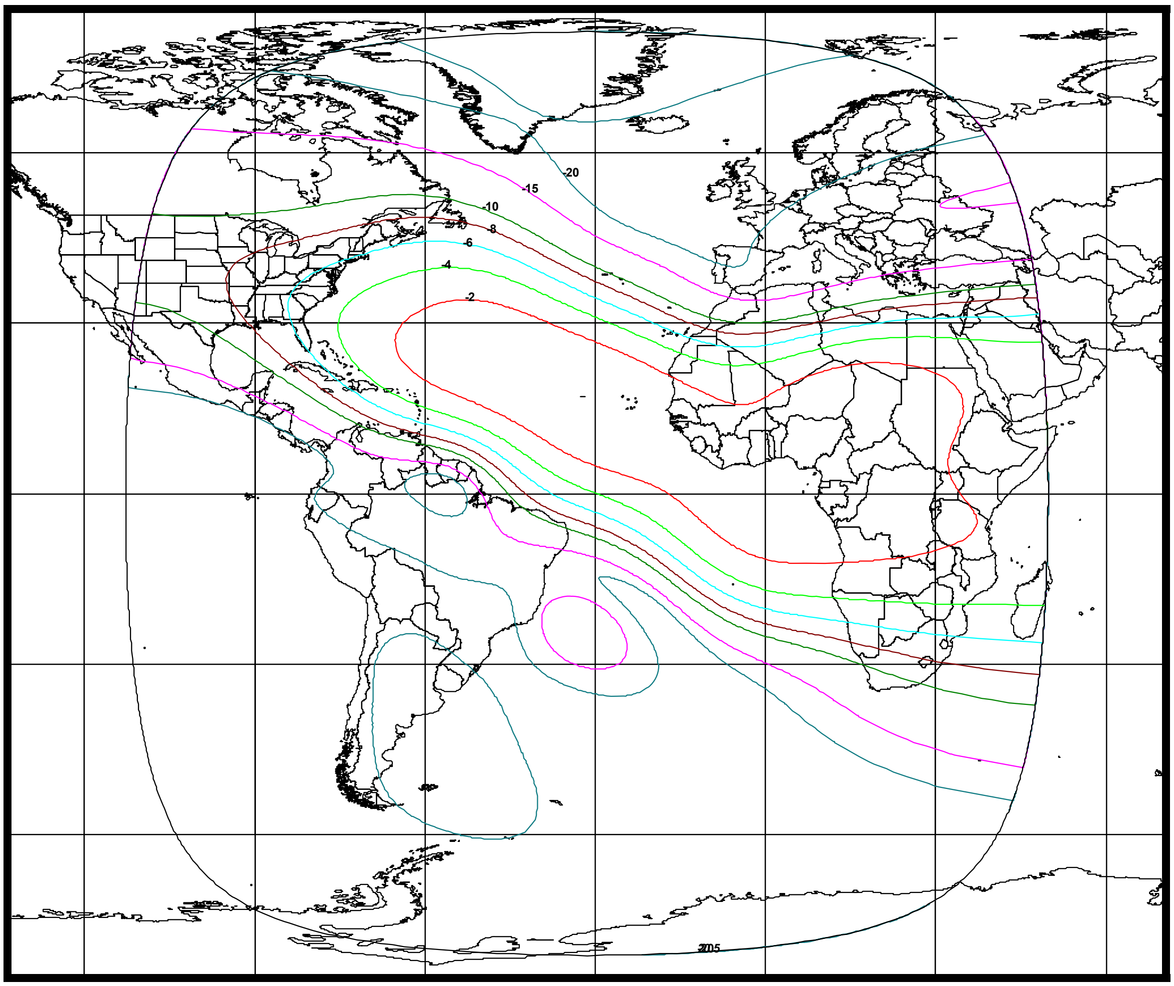


EXHIBIT 6H: KU-BAND ATLANTIC TRANSMIT BEAM

Beam Polarization: Horizontal
Peak Antenna Gain: 37.2 dBi
Peak EIRP: 55.6 dBW
(Schedule S Beam Designation: K1HD)

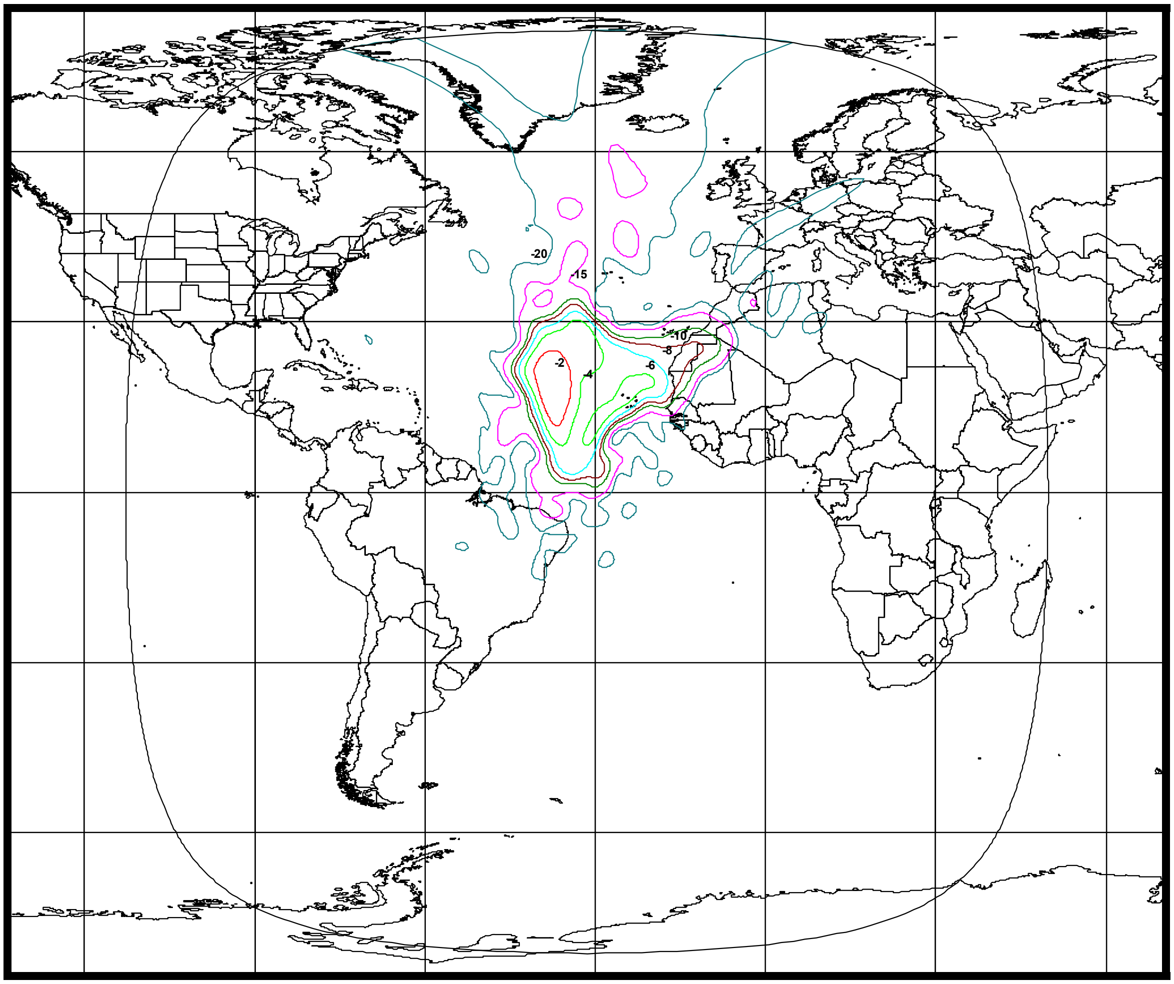


EXHIBIT 6I: KU-BAND ATLANTIC TRANSMIT BEAM

Beam Polarization: Vertical

Peak Antenna Gain: 37.2 dBi

Peak EIRP: 55.6 dBW

(Schedule S Beam Designation: K1VD)

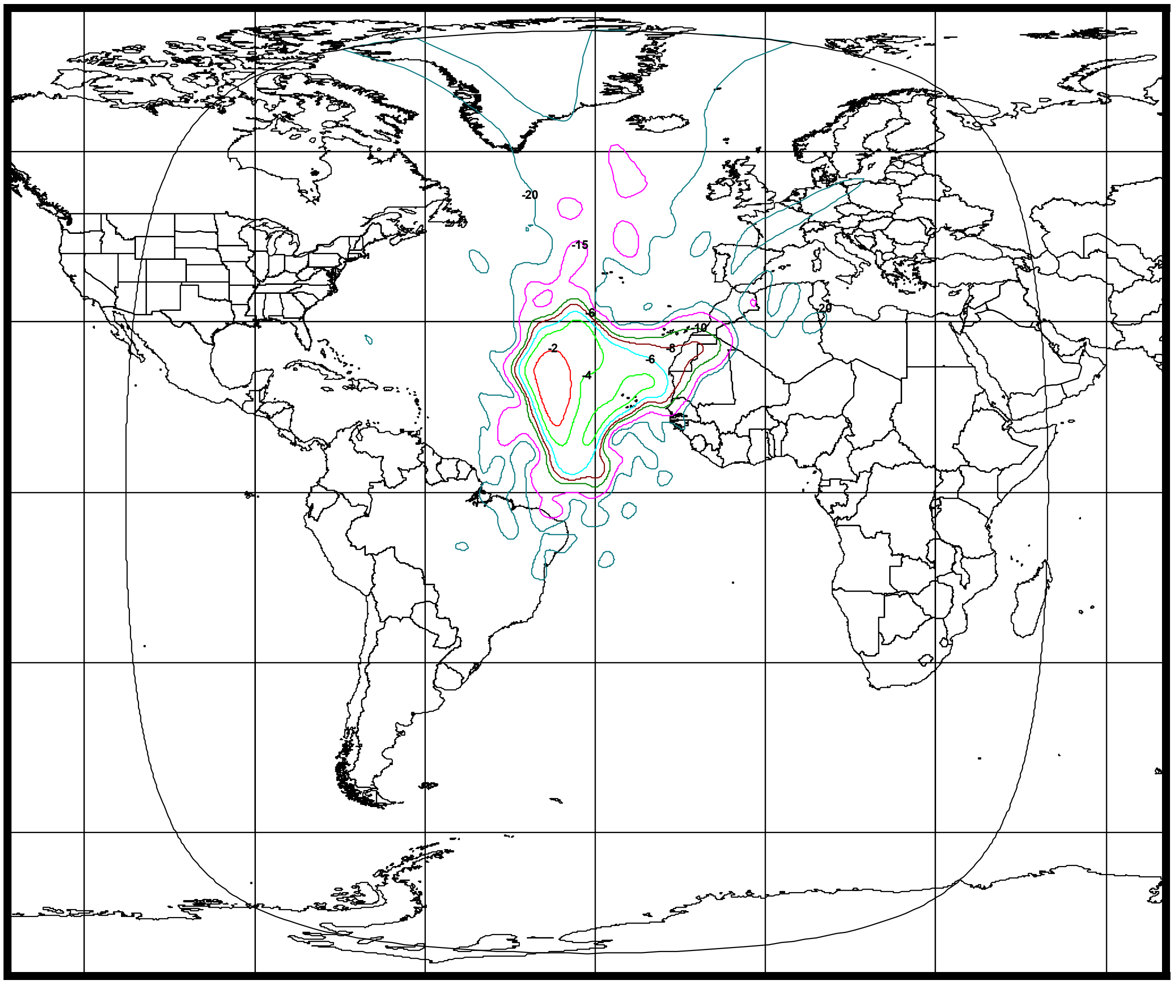


EXHIBIT 6J: KU-BAND WEST AFRICA TRANSMIT BEAM

Beam Polarization: Vertical

Peak Antenna Gain: 38.5 dBi

Peak EIRP: 56.2 dBW

(Schedule S Beam Designation: K2VD)

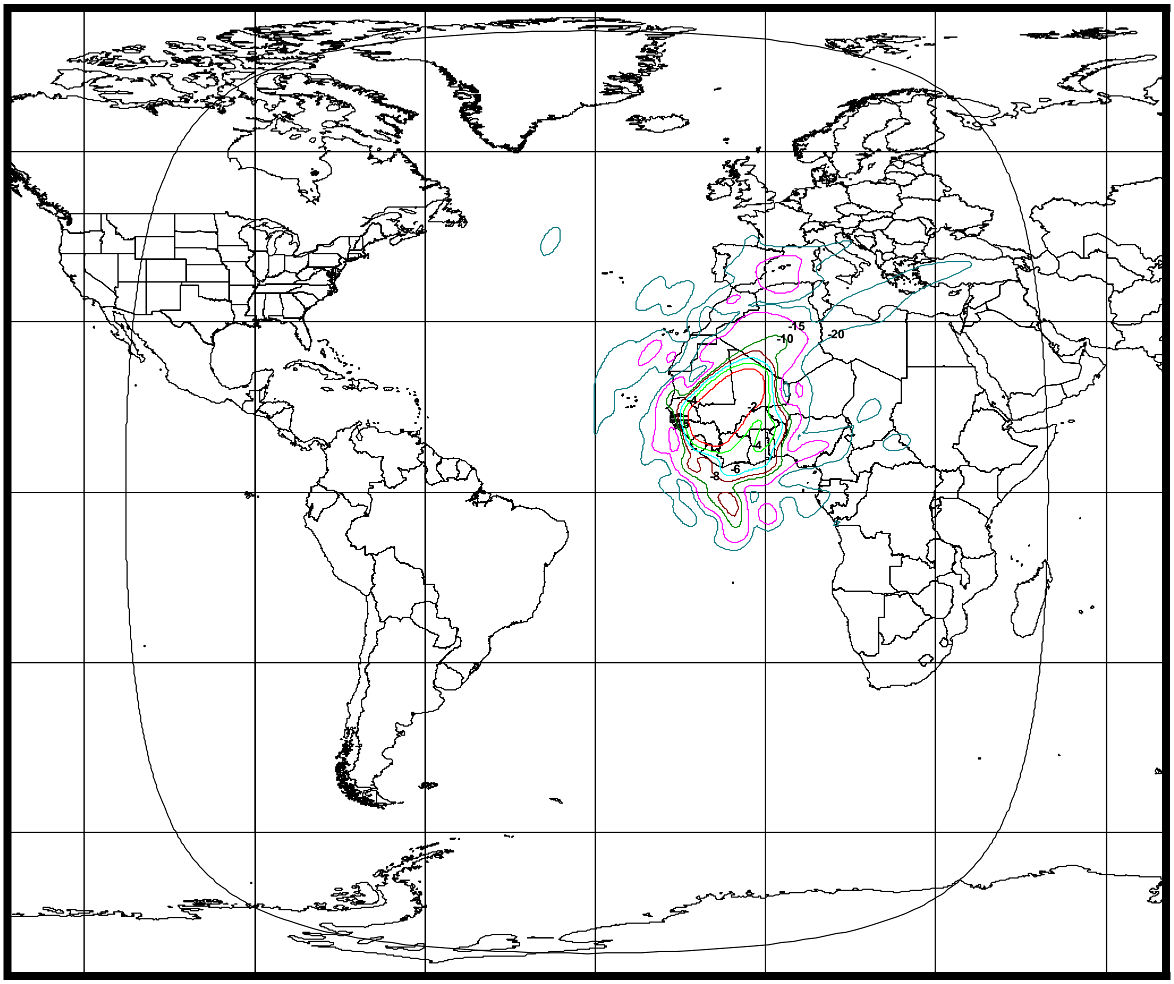


EXHIBIT 6K: WIDE-BEAM COMMAND BEAM (On-Station)

Beam Polarization: Horizontal
Peak Antenna Gain: 4.0 dBi
Peak G/T: -28.2 dB/K
Command Threshold Flux Density at Peak G/T: -108.7 dBW/m^2
(Schedule S Beam Designations: WHCD)

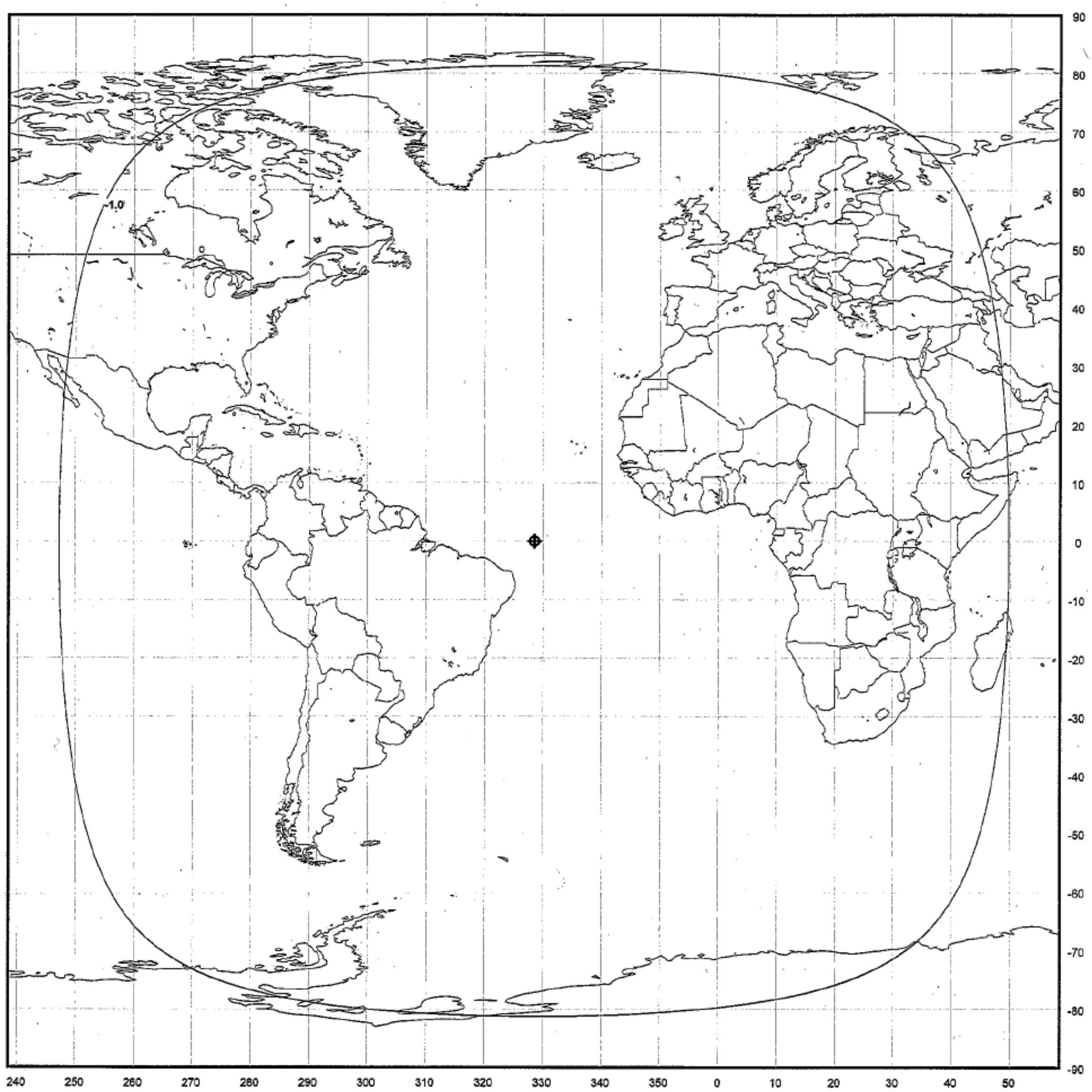


EXHIBIT 6L: WIDE-BEAM COMMAND BEAM (On-Station)

Beam Polarization: Vertical

Peak Antenna Gain: 4.0 dBi

Peak G/T: -28.2 dB/K

Command Threshold Flux Density at Peak G/T: -108.7 dBW/m^2

(Schedule S Beam Designations: WVCD)

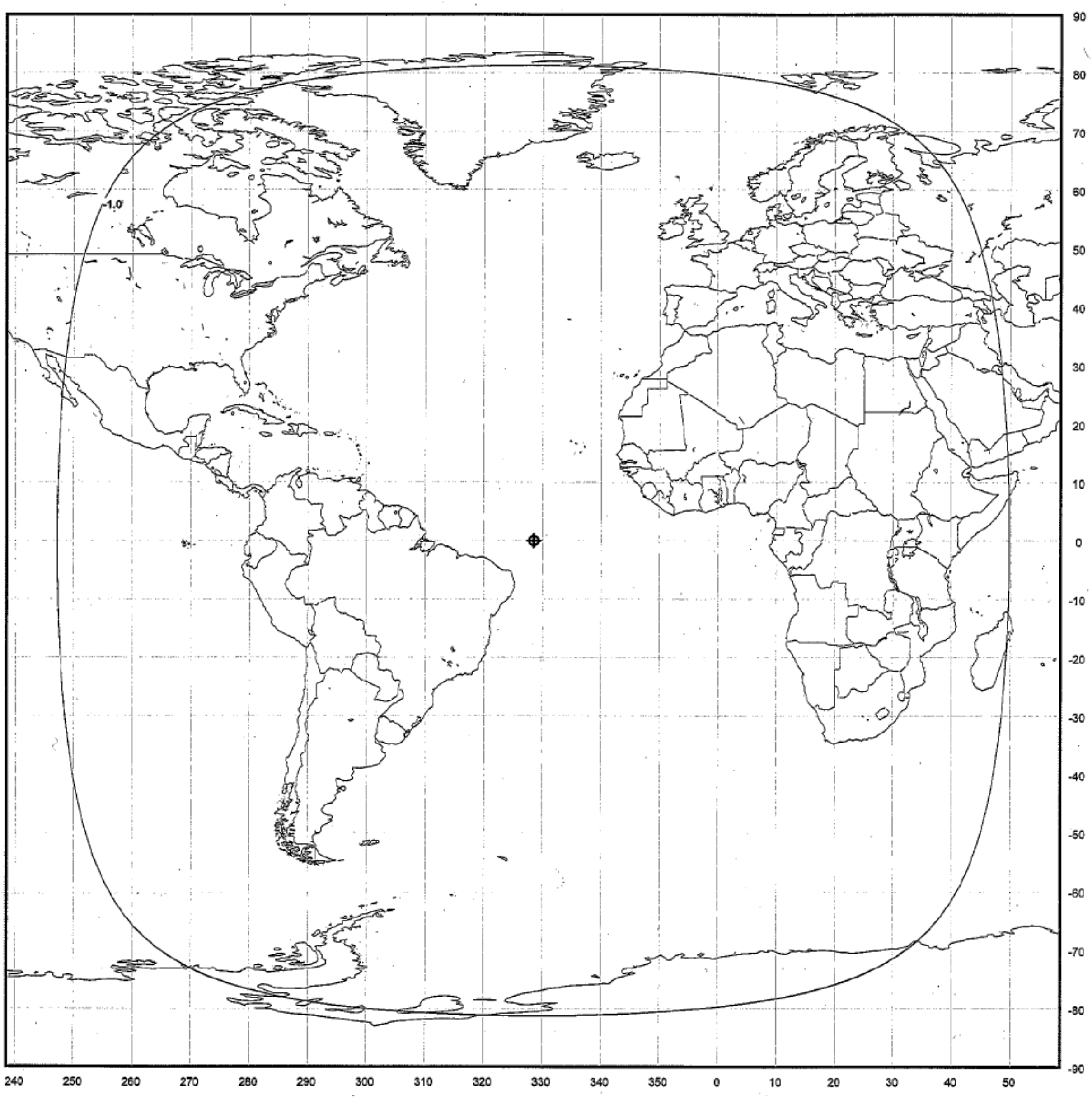


EXHIBIT 6M: MEDIUM-BEAM COMMAND BEAM (Emergency)

Beam Polarization: Horizontal
Peak Antenna Gain: 7.6 dBi
Peak G/T: -30.7 dB/K
Command Threshold Flux Density at Peak G/T: -105.2 dBW/m^2
(Schedule S Beam Designations: MHCD)

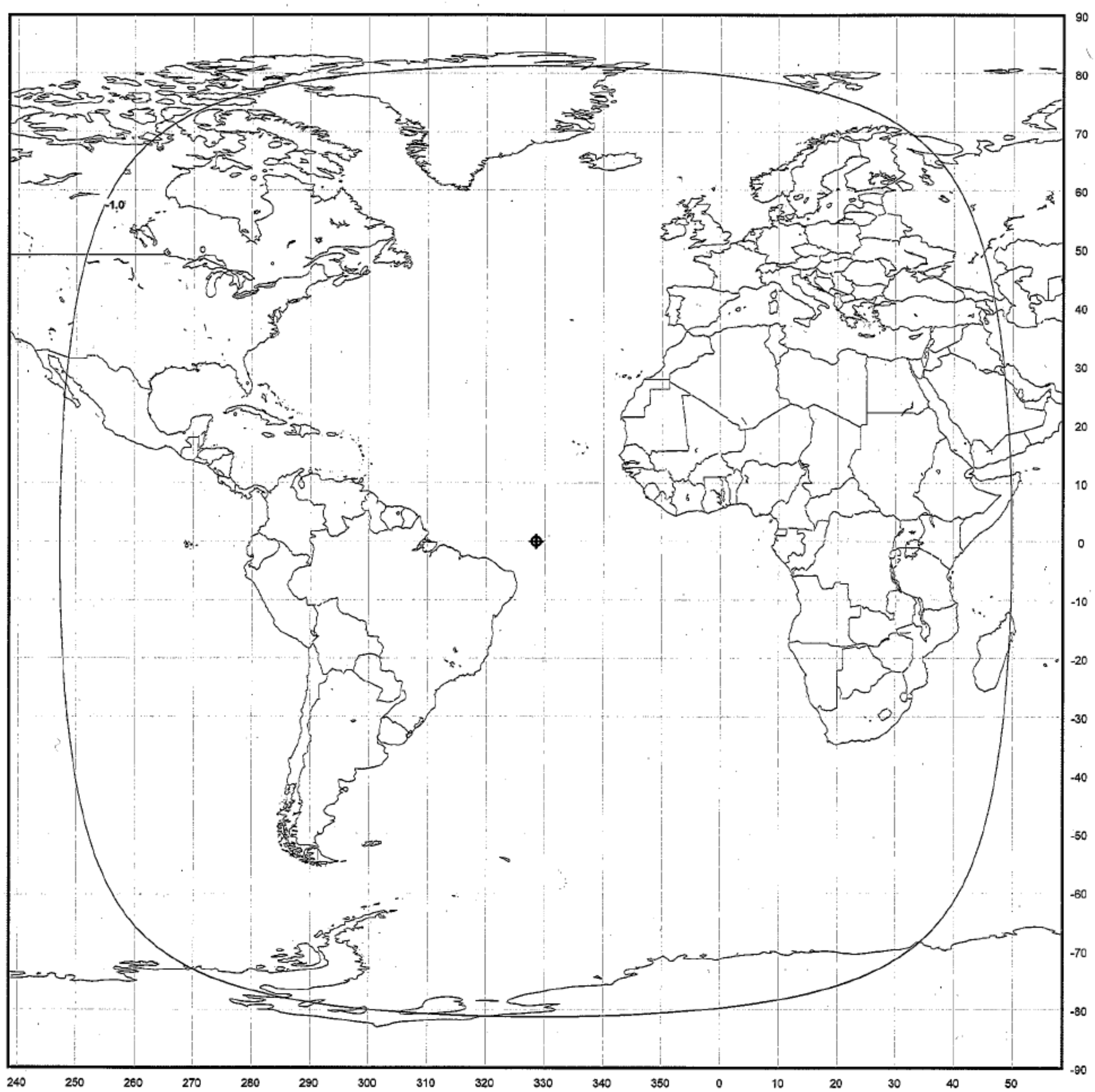


EXHIBIT 6N: MEDIUM-BEAM COMMAND BEAM (Emergency)

Beam Polarization: Vertical

Peak Antenna Gain: 7.6 dBi

Peak G/T: -30.7 dB/K

Command Threshold Flux Density at Peak G/T: -105.2 dBW/m^2

(Schedule S Beam Designations: MVCD)

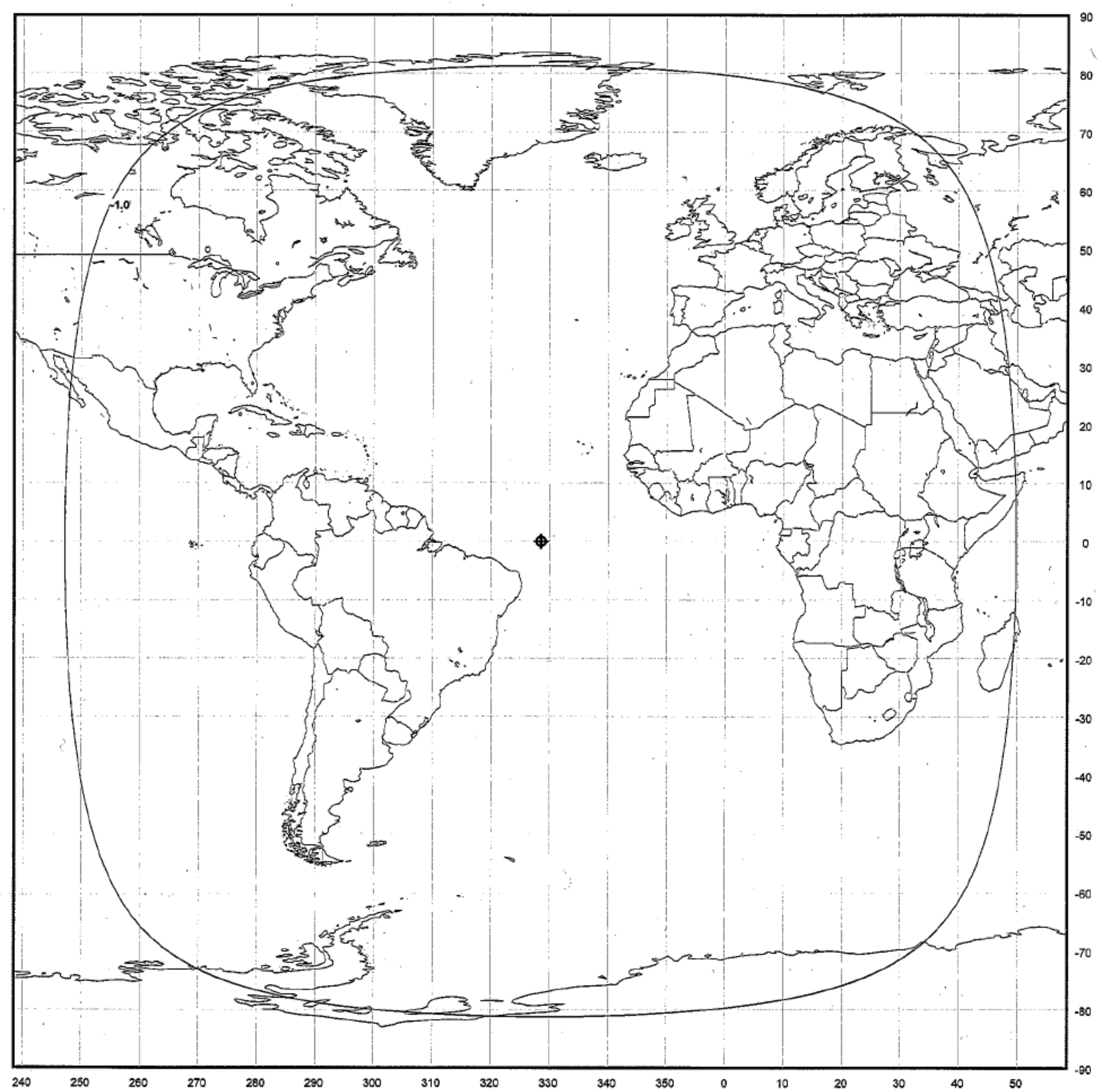


EXHIBIT 6O: ON-STATION TELEMETRY BEAM

Beam Polarization: Horizontal
Peak Antenna Gain: 26.6 dBi
Peak EIRP: 20.4 dBW
(Schedule S Beam Designation: RHTM)

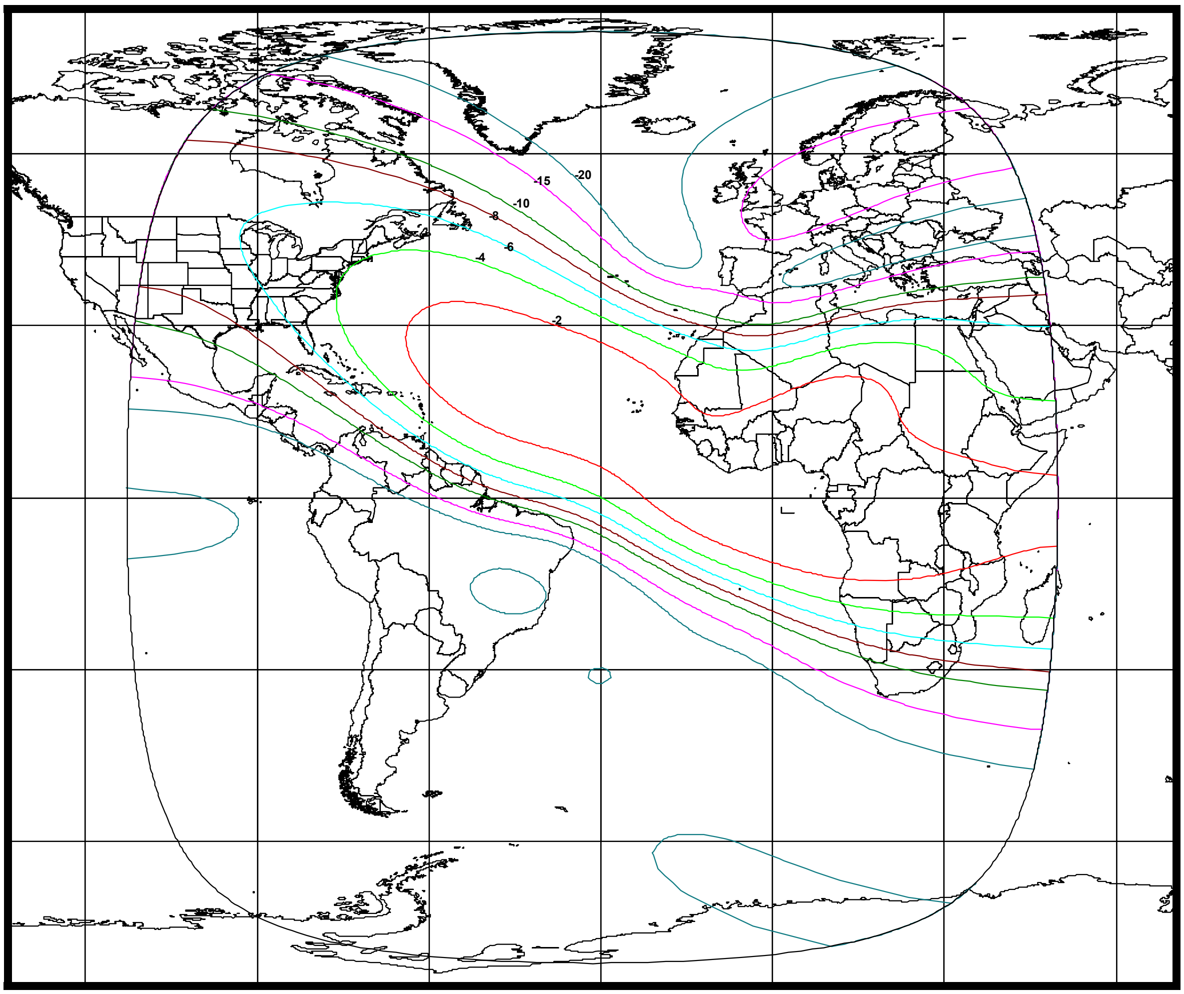


EXHIBIT 6P: ON-STATION TELEMETRY BEAM

Beam Polarization: Vertical

Peak Antenna Gain: 26.8 dBi

Peak EIRP: 20.6 dBW

(Schedule S Beam Designation: RVTM)

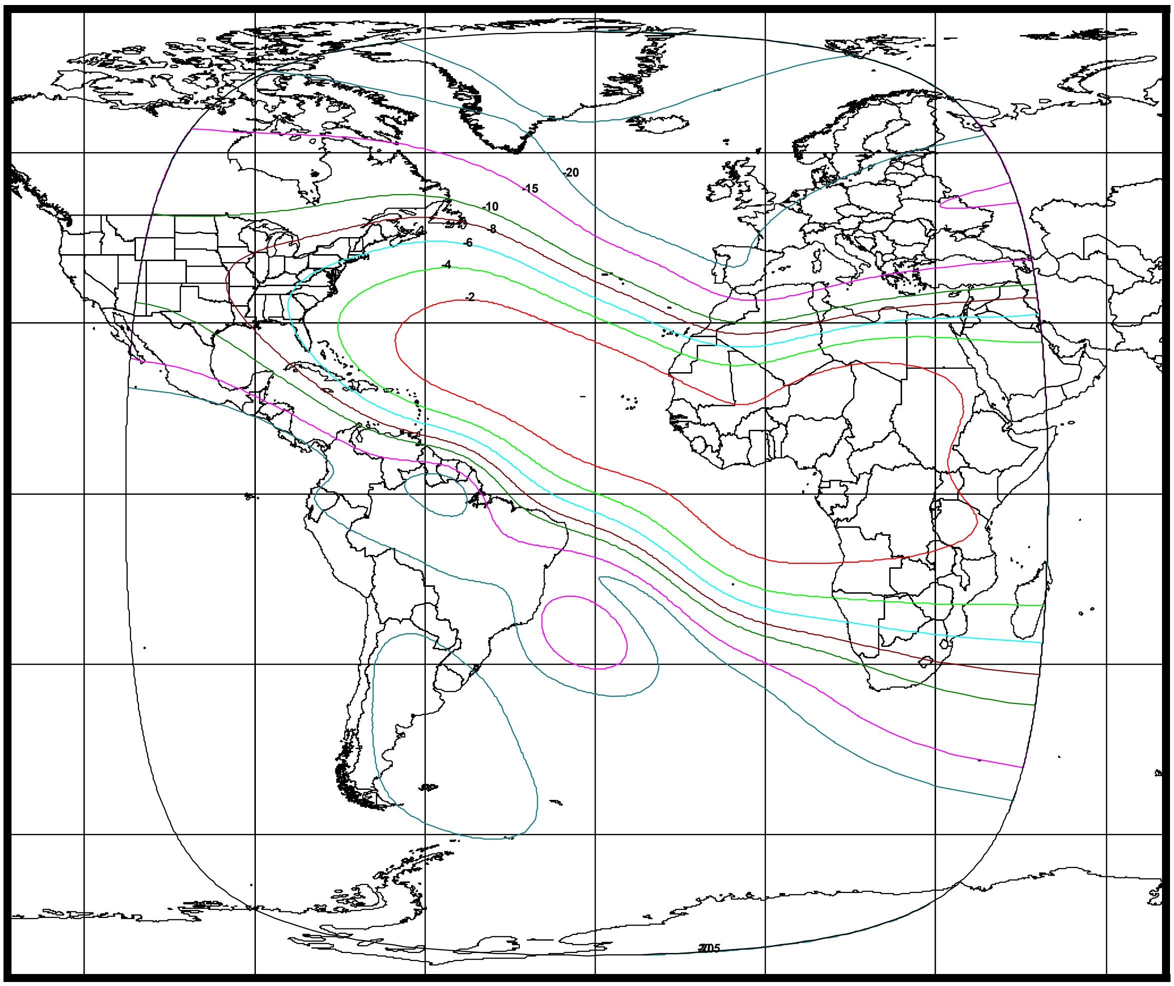


EXHIBIT 6Q: WIDE-BEAM TELEMETRY BEAM (Emergency)

Beam Polarization: Horizontal

Peak Antenna Gain: 2.0 dBi

Peak EIRP: 12.4 dBW

(Schedule S Beam Designation: WHTM)

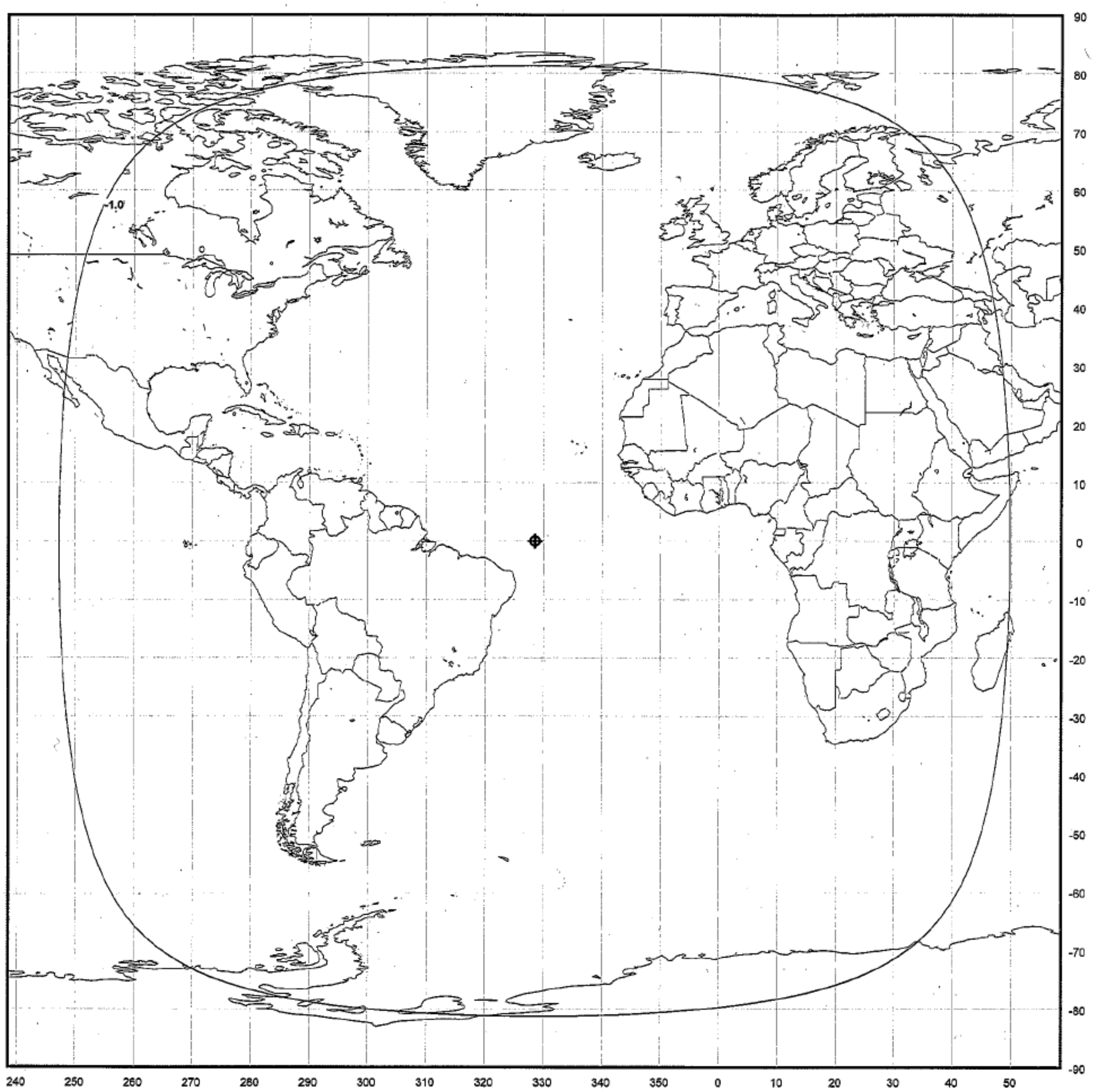


EXHIBIT 6R: WIDE-BEAM TELEMETRY BEAM (Emergency)

Beam Polarization: Vertical

Peak Antenna Gain: 2.0 dBi

Peak EIRP: 12.4 dBW

(Schedule S Beam Designation: WVTM)

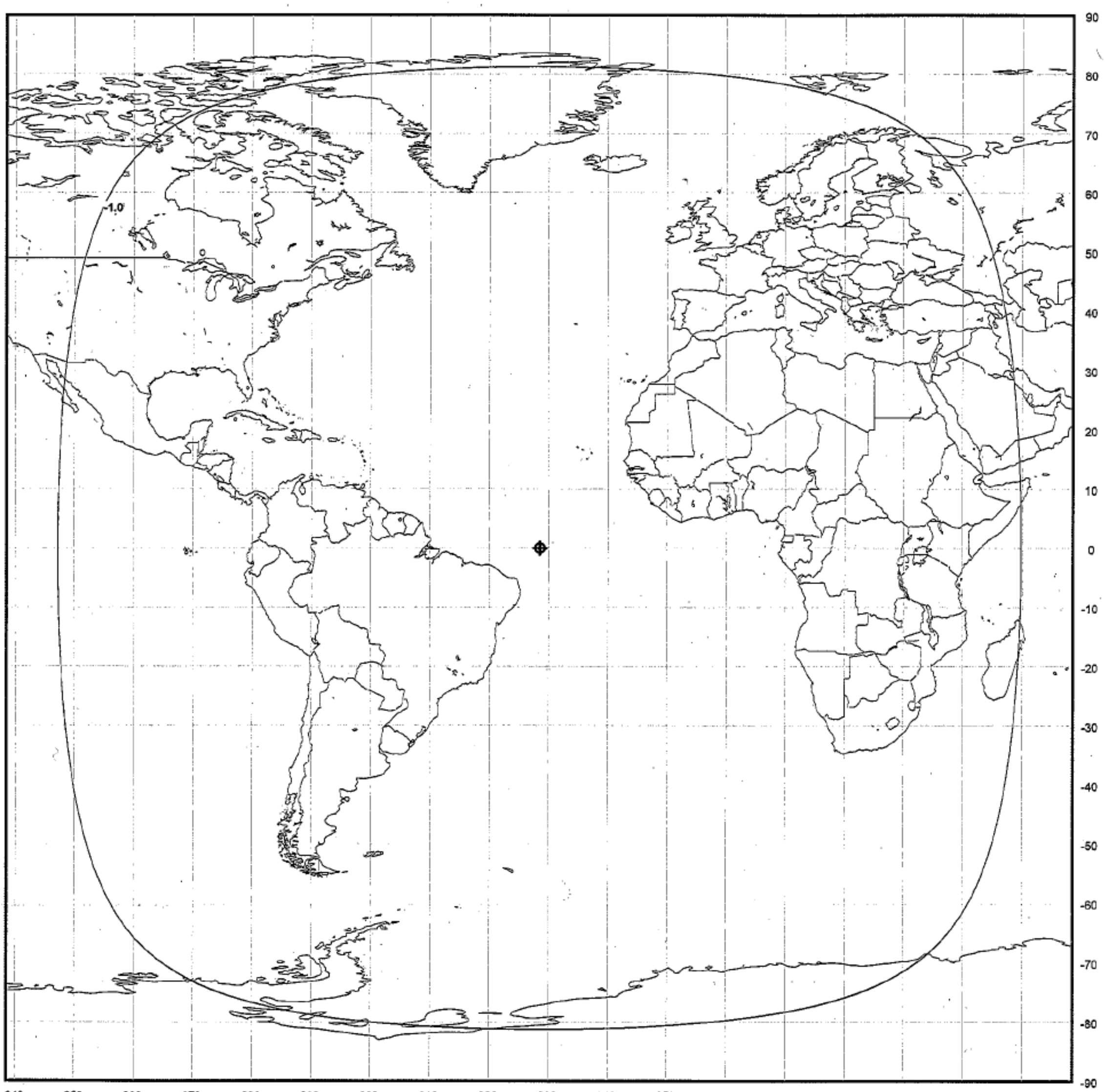


EXHIBIT 6S: MEDIUM-BEAM TELEMETRY BEAM

Beam Polarization: Horizontal
Peak Antenna Gain: 9.4 dBi
Peak EIRP: 15.8 dBW
(Schedule S Beam Designation: MHTM)

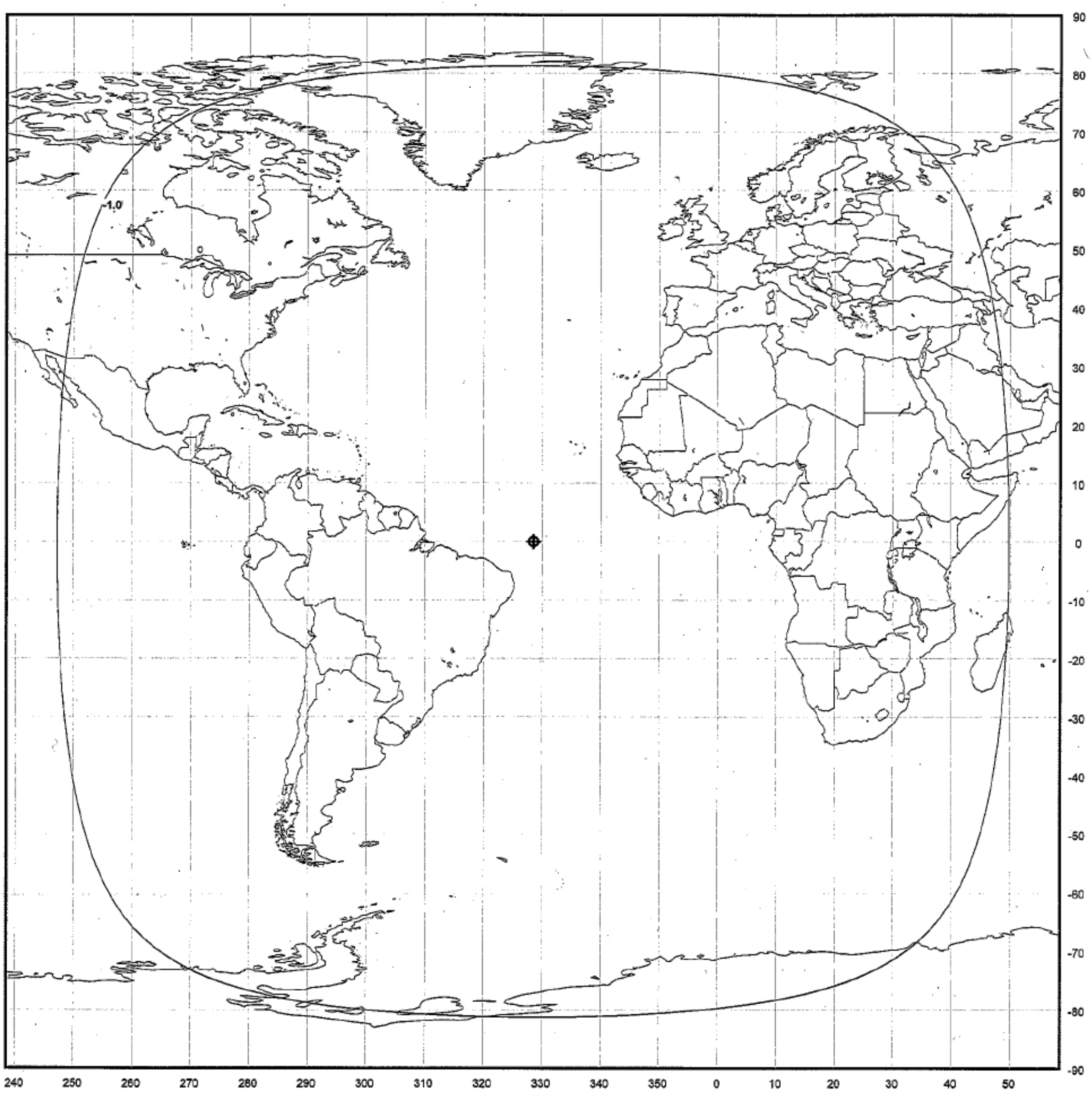


EXHIBIT 6T: MEDIUM-BEAM TELEMETRY BEAM

Beam Polarization: Vertical
Peak Antenna Gain: 9.4 dBi
Peak EIRP: 15.8 dBW
(Schedule S Beam Designation: MVTM)

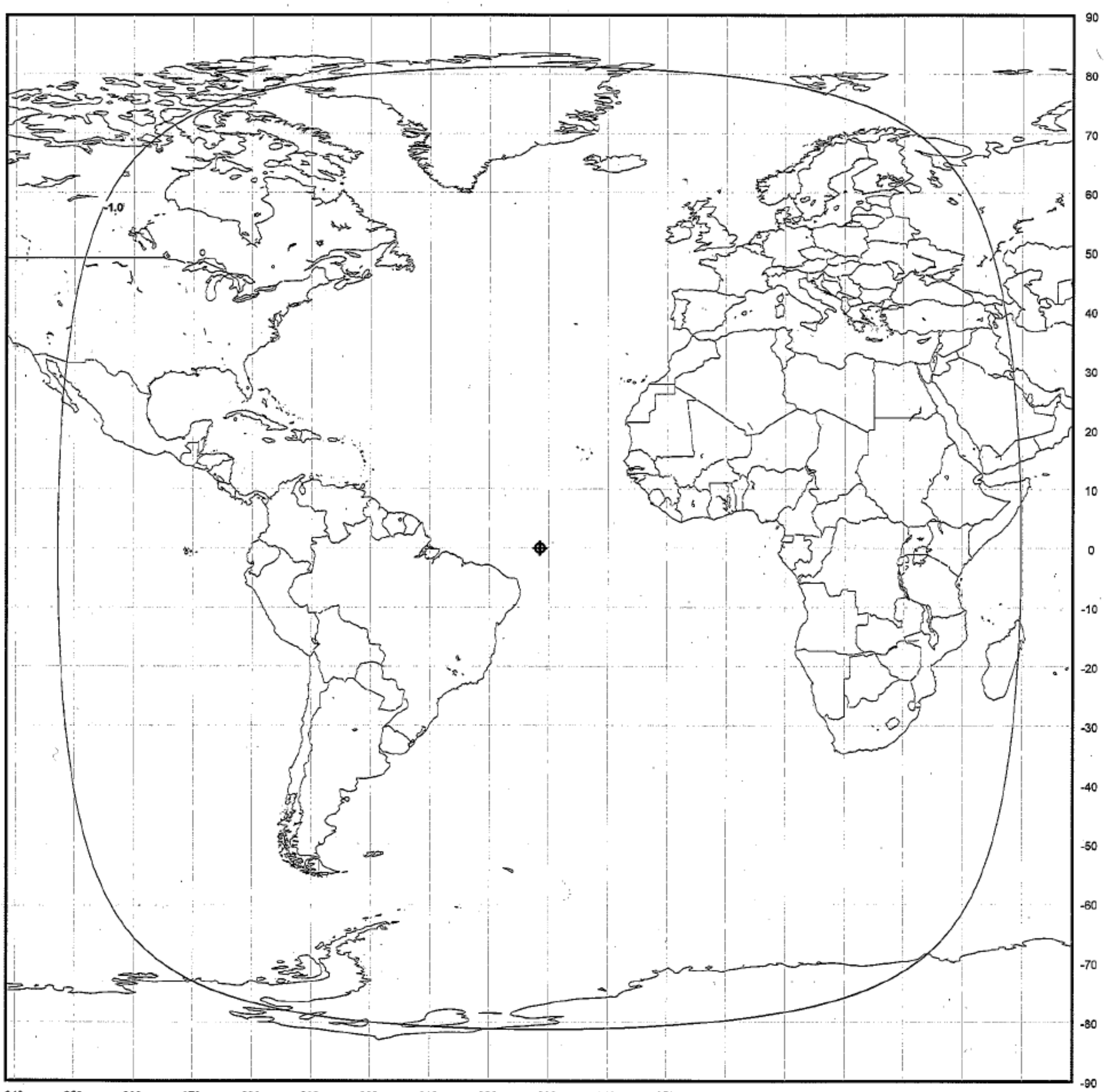


EXHIBIT 6U: UPLINK POWER CONTROL BEAM 1

Beam Polarization: Horizontal
Peak Antenna Gain: 37.2 dBi
Peak EIRP: 26.8 dBW
(Schedule S Beam Designation: UPC1)

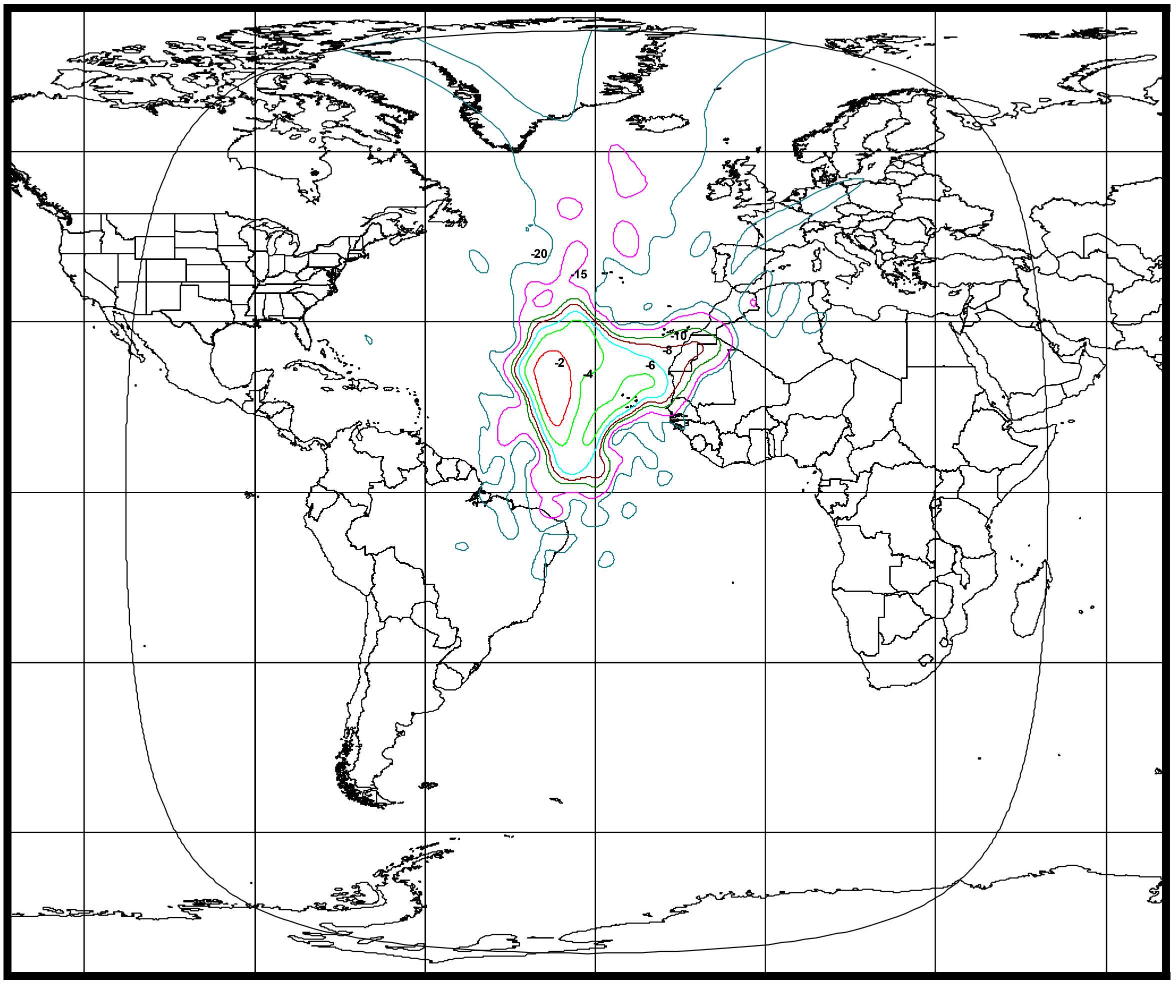


EXHIBIT 6V: UPLINK POWER CONTROL BEAM 2

Beam Polarization: Vertical
Peak Antenna Gain: 37.2 dBi
Peak EIRP: 26.6 dBW
(Schedule S Beam Designation: UPC2)

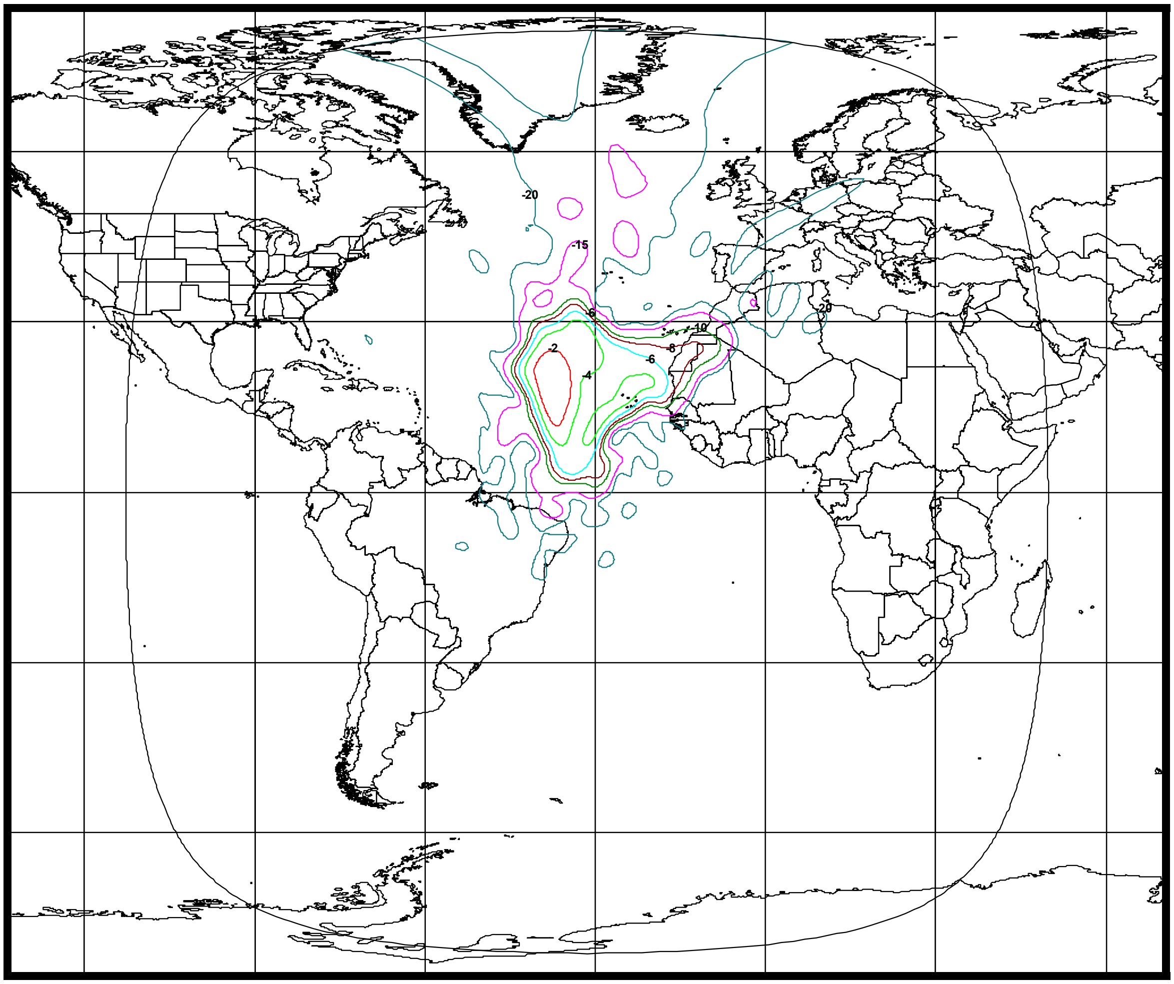


EXHIBIT 6W: UPLINK POWER CONTROL BEAM 3

Beam Polarization: Vertical

Peak Antenna Gain: 38.5 dBi

Peak EIRP: 28.7 dBW

(Schedule S Beam Designation: UPC3)

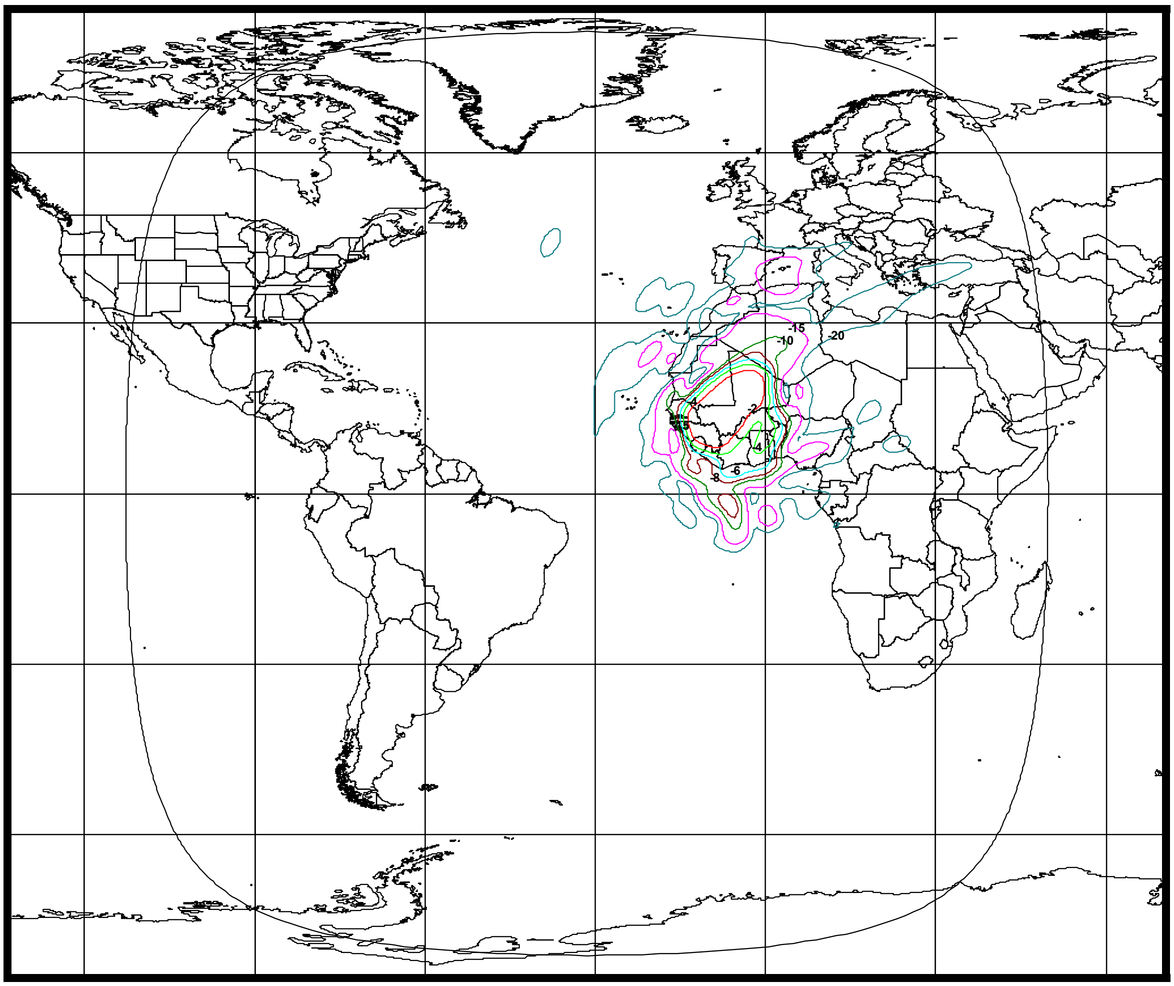


EXHIBIT 7: COMMUNICATION SUBSYSTEM EIRP AND G/T BUDGETS

Beam Name	Africa/US	Africa/US	Atlantic	Atlantic	West Africa
Frequency Band (MHz)	5845 - 6645	5845 - 6645	13750 - 14000	13750 - 14000	14000 - 14500
Polarization	Horizontal	Vertical	Horizontal	Vertical	Horizontal
Channel Bandwidth (MHz)	36 & 72	36 & 72	36	36	72
Antenna Noise Temperature (°Kelvin)	290	290	290	290	290
Receiver Noise Temperature (°Kelvin)	687	661	434	434	389
Total System Noise Temperature (°Kelvin)	977	951	724	724	679
Total System Noise Temperature (dB/K)	29.9	29.8	28.6	28.6	28.3
Peak Gain of Satellite Receive Antenna (dBi)	29.4	28.8	38.6	38.6	40.3
Peak G/T (dB/K)	-0.5	-1.0	10.0	10.0	12.0
Minimum SFD [G/T: Peak, Attn: 0 dB] -- (dBW/m^2)	-101.0	-101.0	-109.0	-109.0	-107.0
Beam Name	Africa/US	Africa/US	Africa/US	Africa/US	
Frequency Band (MHz)	3400 – 4200	3400 – 4200	3400 – 4200	3400 – 4200	
Polarization	Horizontal	Horizontal	Vertical	Vertical	
Channel Bandwidth (MHz)	36 & 72	36 & 72	36 & 72	36 & 72	
Maximum Power At The Output of Last Stage Amplifier (dBW)	15.7	16.0	15.7	16.0	
Loss From Last Stage Amplifier To Transmit Antenna Interface (dB)	2.3	2.6	2.0	2.3	
Power Into Transmit Antenna (dBW)	13.4	13.4	13.7	13.7	
Peak Gain of Satellite Transmit Antenna (dBi)	26.6	26.6	26.8	26.8	
Maximum Downlink EIRP (dBW)	40.0	40.0	40.5	40.5	
Beam Name	Atlantic	Atlantic	West Africa		
Frequency Band (MHz)	11450 – 11700	11450 – 11700	11450 – 11700		
Polarization	Horizontal	Vertical	Vertical		
Channel Bandwidth (MHz)	36	36	72		
Maximum Power At The Output of Last Stage Amplifier (dBW)	21.0	21.0	21.0		
Loss From Last Stage Amplifier To Transmit Antenna Interface (dB)	2.6	2.6	3.3		
Power Into Transmit Antenna (dBW)	18.4	18.4	17.7		
Peak Gain of Satellite Transmit Antenna (dBi)	37.2	37.2	38.5		
Maximum Downlink EIRP (dBW)	55.6	55.6	56.2		
Beam Name	ULPC 1	ULPC 2	ULPC 3		
Frequency Band (MHz)	11698	12254	12554		
Polarization	Horizontal	Vertical	Vertical		
Channel Bandwidth (MHz)	25	25	25		
Maximum Power At The Output of Last Stage Amplifier (dBW)	-4.0	-4.0	-4.0		
Loss From Last Stage Amplifier To Transmit Antenna Interface (dB)	6.4	6.6	5.8		
Power Into Transmit Antenna (dBW)	-10.4	-10.6	-9.8		
Peak Gain of Satellite Transmit Antenna (dBi)	37.2	37.2	38.5		
Maximum Downlink EIRP (dBW)	26.8	26.6	28.7		

EXHIBIT 8: CHANNEL FREQUENCY RESPONSE CHARACTERISTIC

	Attenuation Relative To Peak Level (dB)	
Frequency Offset Relative to Channel Center Frequency (MHz)	Input Section	Output Section
C-Band: 36 MHz Channel		
±14	0.3	0.6
±16	0.4	0.8
±18	0.6	1.5
±23	9.0	11.0
±25	31.0	20.0
±30	43.0	26.0
C-Band: 72 MHz Channel		
±26.6	0.5	0.4
±28.8	0.5	0.5
±36	0.5	1.1
±46	28.0	11.0
±50	31.0	18.0
±60	39.0	27.0
Ku-Band: 36 MHz Channel		
±10.7	0.3	0.6
±13.3	0.3	0.6
±16	0.7	1.4
±18	1.3	3.8
±25	20.0	7.0
±30	35.0	20.0
Ku-Band: 72 MHz Channel		
±26	0.5	0.3
±28.8	0.6	0.5
±32.4	0.6	0.7
±36	1.3	1.7
±46	28.0	5.0
±50	30.0	10.0
±60	40.0	20.0

EXHIBIT 9: TC&R SUBSYSTEM CHARACTERISTICS

	Spacecraft Antenna		
	Communication	**Wide-Beam Omni**	**Medium-Beam Omni**
Command Frequency (MHz) / Polarization (see note)			
Transfer Orbit / Emergency	n/a	5850.5 (H) 6419.0 (V)	5850.5 (H) 6419.0 (V)
On-Station	n/a	5850.5 (H) 6419.0 (V)	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	n/a	-108.7	-105.2
Edge of Coverage	n/a	-103.7	-100.2
Command G/T (dB/K)			
Beam Peak	n/a	-28.2	-30.7
Edge of Coverage	n/a	-33.2	-35.7
Telemetry Frequency (MHz) / Polarization (see note)			
Transfer Orbit / Emergency	n/a	3630.0 (V) 4198.5 (H)	3630.0 (V) 4198.5 (H)
On-Station	3630.0 (V) 4198.5 (H)	n/a	n/a
Telemetry Modulation	PM	PM	PM
Bandwidth of Telemetry Carrier (kHz)			
Occupied	300	300	300
Allocated	500	500	500
Telemetry EIRP			
Beam Peak	20.4 / 20.6 [Note]	12.4	15.8
Edge of Coverage	10.4 / 10.6 [Note]	7.4	10.8
On-Station Ranging Accuracy (meters)	≤ 30	≤ 30	≤ 30

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

Note: The EIRP levels correspond to the Wide-Beam / Medium-Beam telemetry antennas.

EXHIBIT 10: TC&R SUBSYSTEM EIRP and G/T BUDGETS

Antenna Type	Wide-Beam Omni	Medium-Beam Omni	Communication	Communication
Frequency Band (MHz)	3630 / 4198.5	3630 / 4198.5	4198.5	3630
Polarization (see note)	Horizontal/Vertical	Horizontal/Vertical	Horizontal	Vertical
Maximum Power At The Output of Last Stage Amplifier (dBW)	15.7	15.7	-4	-4
Loss From Last Stage Amplifier To Transmit Antenna Interface (dB)	5.3	9.3	2.2	2.2
Power into Transmit Antenna (dBW)	10.4	6.4	-6.2	-6.2
Peak Gain of Satellite Transmit Antenna (dBi)	2.0	9.4	26.6	26.8
Maximum Downlink EIRP (dBW)	12.4	15.8	20.4	20.6
Antenna Type	Wide-Beam Omni	Medium-Beam Omni		
Frequency Band (MHz)	5850.5 / 6419	5850.5 / 6419		
Polarization (see Note)	Horizontal/Vertical	Horizontal/Vertical		
Peak Gain of Satellite Receive Antenna (dBi)	4.0	7.6		
Antenna Noise Temperature (°Kelvin)	290	290		
Receiver Noise Temperature (°Kelvin)	1364	6462		
Total System Noise Temperature (°Kelvin)	1654	6752		
Total System Noise Temperature (dBK)	32.2	38.3		
Peak G/T (dB/K)	-28.2	-30.7		
Command Threshold Flux Density at Peak G/T (dBW/m^2)	-108.7	-105.2		

EXHIBIT 11: EMISSION DESIGNATORS

Signal Type	Emission Designator	Allocated Bandwidth (kHz)
Analog TV/FM Carrier	36M0F3F	36000
Digital MCPC	36M0G7W	36000
Digital MCPC	72M0G7W	72000
SCPC	10M3G7W	10300
64 kbps carrier	100KG7W	100
Digital (out-route) carrier	1M45G7W	1450
Digital (in-route) carrier	400KG7W	400

EXHIBIT 12: POWER FLUX DENSITY CALCULATIONS

FREQUENCY BAND : 3.4 - 4.2 GHz							
Africa/US Beam (Horizontal Polarization): 36M0F3F							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Occupied Bandwidth (kHz)	4000	4000	4000	4000	4000	4000	4000
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)	-153.4	-153.3	-153.2	-153.0	-152.9	-152.8	-152.1
PFD Limit (dBW/m^2/4kHz)	-152	-152	-149.5	-147.0	-144.5	-142.0	-142.0
Margin (dB)	1.4	1.3	3.7	6.0	8.4	10.8	10.1
Africa/US Beam (Horizontal Polarization): 36M0G7W							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Occupied Bandwidth (kHz)	30133	30133	30133	30133	30133	30133	30133
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)	-162.2	-162.0	-161.9	-161.8	-161.7	-161.6	-160.8
PFD Limit (dBW/m^2/4kHz)	-152	-152	-149.5	-147.0	-144.5	-142.0	-142.0
Margin (dB)	10.2	10.0	12.4	14.8	17.2	19.6	18.8

EXHIBIT 12: POWER FLUX DENSITY CALCULATIONS (continued)

FREQUENCY BAND : 3.4 - 4.2 GHz							
Africa/US Beam (Vertical Polarization): 36M0F3F							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	40.5	40.5	40.5	40.5	40.5	40.5	40.5
Occupied Bandwidth (kHz)	4000	4000	4000	4000	4000	4000	4000
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)	-152.9	-152.8	-152.7	-152.5	-152.4	-152.3	-151.6
PFD Limit (dBW/m^2/4kHz)	-152	-152	-149.5	-147.0	-144.5	-142.0	-142.0
Margin (dB)	0.9	0.8	3.2	5.5	7.9	10.3	9.6
Africa/US Beam (Vertical Polarization): 36M0G7W							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	40.5	40.5	40.5	40.5	40.5	40.5	40.5
Occupied Bandwidth (kHz)	30133	30133	30133	30133	30133	30133	30133
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)	-161.7	-161.5	-161.4	-161.3	-161.2	-161.1	-160.3
PFD Limit (dBW/m^2/4kHz)	-152	-152	-149.5	-147.0	-144.5	-142.0	-142.0
Margin (dB)	9.7	9.5	11.9	14.3	16.7	19.1	18.3

EXHIBIT 12: POWER FLUX DENSITY CALCULATIONS (continued)

FREQUENCY BAND : 3.4 - 4.2 GHz							
Telemetry – Comm. Antenna (Horizontal Polarization)							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	20.4	20.4	20.4	20.4	20.4	20.4	20.4
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)	-160.9	-160.8	-160.7	-160.6	-160.5	-160.4	-159.6
PFD Limit (dBW/m^2/4kHz)	-152	-152	-149.5	-147.0	-144.5	-142.0	-142.0
Margin (dB)	8.9	8.8	11.2	13.6	16.0	18.4	17.6
Telemetry – Comm. Antenna (Vertical Polarization)							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	20.6	20.6	20.6	20.6	20.6	20.6	20.6
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)	-160.7	-160.6	-160.5	-160.4	-160.3	-160.2	-159.4
PFD Limit (dBW/m^2/4kHz)	-152	-152	-149.5	-147.0	-144.5	-142.0	-142.0
Margin (dB)	8.7	8.6	11.0	13.4	15.8	18.2	17.4

EXHIBIT 12: POWER FLUX DENSITY CALCULATIONS (continued)

FREQUENCY BAND : 3.4 - 4.2 GHz							
Telemetry - Wide Beam (Horizontal Polarization)							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	12.4	12.4	12.4	12.4	12.4	12.4	12.4
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)	-168.9	-168.8	-168.7	-168.6	-168.5	-168.4	-167.6
PFD Limit (dBW/m^2/4kHz)	-152	-152	-149.5	-147.0	-144.5	-142.0	-142.0
Margin (dB)	16.9	16.8	19.2	21.6	24.0	26.4	25.6
Telemetry - Wide Beam (Vertical Polarization)							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	12.4	12.4	12.4	12.4	12.4	12.4	12.4
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)	-168.9	-168.8	-168.7	-168.6	-168.5	-168.4	-167.6
PFD Limit (dBW/m^2/4kHz)	-152	-152	-149.5	-147.0	-144.5	-142.0	-142.0
Margin (dB)	16.9	16.8	19.2	21.6	24.0	26.4	25.6

EXHIBIT 12: POWER FLUX DENSITY CALCULATIONS (continued)

FREQUENCY BAND : 3.4 - 4.2 GHz							
Telemetry - Medium Beam (Horizontal Polarization)							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	15.8	15.8	15.8	15.8	15.8	15.8	15.8
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)	-165.5	-165.4	-165.3	-165.2	-165.1	-165.0	-164.2
PFD Limit (dBW/m^2/4kHz)	-152	-152	-149.5	-147.0	-144.5	-142.0	-142.0
Margin (dB)	13.5	13.4	15.8	18.2	20.6	23.0	22.2
Telemetry - Medium Beam (Vertical Polarization)							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	15.8	15.8	15.8	15.8	15.8	15.8	15.8
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)	-165.5	-165.4	-165.3	-165.2	-165.1	-165.0	-164.2
PFD Limit (dBW/m^2/4kHz)	-152	-152	-149.5	-147.0	-144.5	-142.0	-142.0
Margin (dB)	13.5	13.4	15.8	18.2	20.6	23.0	22.2

EXHIBIT 12: POWER FLUX DENSITY CALCULATIONS (continued)

FREQUENCY BAND : 11.45 - 11.70 GHz							
Atlantic Beam (Horizontal Polarization): 36M0F3F							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	43.4*	43.3*	45.7*	48.0*	50.4*	52.8*	52.1*
Occupied Bandwidth (kHz)	4000	4000	4000	4000	4000	4000	4000
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)	-150.0	-150.0	-147.5	-145.0	-142.5	-140.0	-140.0
PFD Limit (dBW/m^2/4kHz)	-150	-150	-147.5	-145.0	-142.5	-140.0	-140.0
Margin (dB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Atlantic Beam (Horizontal Polarization): 36M0G7W							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	52.2*	52.0*	54.4*	55.6	55.6	55.6	55.6
Occupied Bandwidth (kHz)	30133	30133	30133	30133	30133	30133	30133
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)	-150.0	-150.0	-147.5	-146.2	-146.1	-146.0	-145.2
PFD Limit (dBW/m^2/4kHz)	-150	-150	-147.5	-145.0	-142.5	-140.0	-140.0
Margin (dB)	0.0	0.0	0.0	1.2	3.6	6.0	5.2

EXHIBIT 12: POWER FLUX DENSITY CALCULATIONS (continued)

FREQUENCY BAND : 11.45 - 11.70 GHz							
Atlantic Beam (Vertical Polarization): 72M0G7W							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	55.2*	55.1*	55.6	55.6	55.6	55.6	55.6
Occupied Bandwidth (kHz)	60266	60266	60266	60266	60266	60266	60266
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)	-150.0	-150.0	-149.3	-149.2	-149.1	-149.0	-148.2
PFD Limit (dBW/m^2/4kHz)	-150	-150	-147.5	-145.0	-142.5	-140.0	-140.0
Margin (dB)	0.0	0.0	1.8	4.2	6.6	9.0	8.2
Atlantic Beam (Horizontal Polarization) ULPC							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	21.3*	21.2*	23.6*	26.0*	26.8	26.8	26.8
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^2/4kHz)	-150.0	-150.0	-147.5	-145.0	-144.1	-144.0	-143.2
PFD Limit (dBW/m^2/4kHz)	-150	-150	-147.5	-145.0	-142.5	-140.0	-140.0
Margin (dB)	0.0	0.0	0.0	0.0	1.6	4.0	3.2

EXHIBIT 12: POWER FLUX DENSITY CALCULATIONS (continued)

FREQUENCY BAND : 11.45 - 11.70 GHz							
Atlantic Beam (Vertical Polarization) ULPC							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	21.3*	21.2*	23.6*	26.0*	26.6	26.6	26.6
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^2/4kHz)	-150.0	-150.0	-147.5	-145.0	-144.3	-144.2	-143.4
PFD Limit (dBW/m^2/4kHz)	-150	-150	-147.5	-145.0	-142.5	-140.0	-140.0
Margin (dB)	0.0	0.0	0.0	0.0	1.8	4.2	3.4
FREQUENCY BAND : 12.250 - 12.750 GHz							
West Africa Beam (Vertical Polarization): 36M0F3F							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	45.4*	45.3*	47.7*	50.0*	52.4*	54.8*	54.1*
Occupied Bandwidth (kHz)	4000	4000	4000	4000	4000	4000	4000
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)	-148.0	-148.0	-145.5	-143.0	-140.5	-138.0	-138.0
PFD Limit (dBW/m^2/4kHz)	-148	-148	-145.5	-143.0	-140.5	-138.0	-138.0
Margin (dB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

EXHIBIT 12: POWER FLUX DENSITY CALCULATIONS (continued)

FREQUENCY BAND : 12.50 - 12.750 GHz							
West Africa Beam (Vertical Polarization): 72M0G7W							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	56.2	56.2	56.2	56.2	56.2	56.2	56.2
Occupied Bandwidth (kHz)	60266	60266	60266	60266	60266	60266	60266
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)	-149.0	-148.9	-148.7	-148.6	-148.5	-148.4	-147.6
PFD Limit (dBW/m^2/4kHz)	-148	-148	-145.5	-143.0	-140.5	-138.0	-138.0
Margin (dB)	1.0	0.9	3.2	5.6	8.0	10.4	9.6
West Africa Beam (Vertical Polarization): ULPC							
Elevation Angle (degrees)	0	5	10	15	20	25	90
Assumed EIRP (dBW)	23.3*	23.2*	25.6*	28.0*	28.7	28.7	28.7
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^2/4kHz)	-148.0	-148.0	-145.5	-143.0	-142.2	-142.1	-141.3
PFD Limit (dBW/m^2/4kHz)	-148	-148	-145.5	-143.0	-140.5	-138.0	-138.0
Margin (dB)	0.0	0.0	0.0	0.0	1.7	4.1	3.3

* This is the maximum allowable EIRP level at the specified elevation angle. The actual EIRP level of the beam at this particular elevation angle will be equal to or lower than the value listed in the table as a result of the actual (EIRP) performance of the beam at the specific elevation angle and/or the deliberate reduction in the output power of the channel.

EXHIBIT 13: LINK BUDGETS

UPLINK BEAM INFORMATION				
Uplink Beam Name	AFRICA/US	AFRICA/US	AFRICA/US	AFRICA/US
Uplink Frequency (GHz)	6.205	6.205	6.205	6.205
Uplink Beam Polarization	Linear	Linear	Linear	Linear
Uplink Relative Contour Level (dB)	-15.0	-15.0	-15.0	-15.0
Uplink Contour G/T (dB/K)	-15.5	-15.5	-15.5	-15.5
Uplink SFD (dBW/m2)	-69	-80	-74	-74
Rain Rate (mm/hr)	n/a	n/a	n/a	n/a
DOWNLINK BEAM INFORMATION				
Downlink Beam Name	AFRICA/US	AFRICA/US	AFRICA/US	AFRICA/US
Downlink Frequency (GHz)	3.800	3.800	3.800	3.800
Downlink Beam Polarization	Linear	Linear	Linear	Linear
Downlink Relative Contour Level (dB)	-10.0	-10.0	-10.0	-10.0
Downlink Contour EIRP (dBW)	30.0	30.0	30.0	30.0
Rain Rate (mm/hr)	n/a	n/a	n/a	n/a
ADJACENT SATELLITE 1	SAT-1	SAT-1	SAT-1	SAT-1
Satellite 1 Orbital Location	29.5W	29.5W	29.5W	29.5W
Uplink Power Density (dBW/Hz)	-38.7	-38.7	-38.7	-38.7
Uplink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
Downlink EIRP Density (dBW/Hz)	-44.8	-44.8	-44.8	-44.8
Downlink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
ADJACENT SATELLITE 2	SAT-2	SAT-2	SAT-2	SAT-2
Satellite 1 Orbital Location	33.5W	33.5W	33.5W	33.5W
Uplink Power Density (dBW/Hz)	-38.7	-38.7	-38.7	-38.7
Uplink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
Downlink EIRP Density (dBW/Hz)	-44.8	-44.8	-44.8	-44.8
Downlink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
CARRIER INFORMATION				
Carrier ID	36M0F3F	36M0G7W	10M3G7W	100KG7W
Carrier Modulation	TV/FM	QPSK	QPSK	QPSK
Peak to Peak Bandwidth of EDS (MHz)	4	N/A	N/A	N/A
Information Rate(kbps)	N/A	24575	6000	64
Code Rate	N/A	1/2 w/ RS	1/2 w/ RS	1/2 w/ RS
Occupied Bandwidth(kHz)	36000	30133	6771.1	75.4
Allocated Bandwidth(kHz)	36000	36000	10300	100
Minimum C/N, Clear Sky (dB)	10.0	3.36	3.87	2.99
Minimum C/N, Rain (dB)	10.0	3.36	3.57	2.79
UPLINK EARTH STATION				
Earth Station Diameter (meters)	18.3	15.2	15.2	15.2
Earth Station Gain (dBi)	60.2	58.4	58.4	58.4
Earth Station Elevation Angle	20	20	20	20
DOWNLINK EARTH STATION				
Earth Station Diameter (meters)	15.2	3.5	3.5	3.5
Earth Station Gain (dBi)	54.7	40.8	40.8	40.8
Earth Station G/T (dB/K)	34.2	20.7	20.7	20.7
Earth Station Elevation Angle	20	20	20	20
LINK FADE TYPE	Clear Sky	Clear Sky	Clear Sky	Clear Sky
UPLINK PERFORMANCE				
Uplink Earth Station EIRP (dBW)	85.7	82.9	77.0	56.6
Uplink Path Loss, Clear Sky (dB)	-200.3	-200.3	-200.3	-200.3
Uplink Rain Attenuation	0.0	0.0	0.0	0.0
Satellite G/T(dB/K)	-15.5	-15.5	-15.5	-15.5
Boltzman Constant(dBW/K-Hz)	228.6	228.6	228.6	228.6
Carrier Noise Bandwidth (dB-Hz)	-75.6	-74.8	-68.3	-48.8
Uplink C/N(dB)	23.0	21.0	21.6	20.7
DOWNLINK PERFORMANCE				
Downlink EIRP per Carrier (dBW)	27.5	30.0	22.8	2.4
Antenna Pointing Error (dB)	-.5	-.5	-.5	-.5
Downlink Path Loss, Clear Sky (dB)	-196.0	-196.0	-196.0	-196.0
Downlink Rain Attenuation	0.0	0.0	0.0	0.0
Earth Station G/T (dB/K)	34.2	20.7	20.7	20.7
Boltzman Constant(dBW / K - Hz)	228.6	228.6	228.6	228.6
Carrier Noise Bandwidth (dB-Hz)	-75.6	-74.8	-68.3	-48.8
Downlink C / N(dB)	18.2	8.0	7.3	6.4
COMPOSITE LINK PERFORMANCE				
C/N Uplink (dB)	23.0	21.0	21.6	20.7
C/N Downlink (dB)	18.2	8.0	7.3	6.4
C/I Intermodulation (dB)	N/A	N/A	20.2	19.3
C/I Uplink Co-Channel (dB)*	27.0	27.0	28.8	28.5
C/I Downlink Co-Channel (dB)*	27.0	27.0	28.8	28.5
C/I Uplink Adjacent Satellite 1 (dB)	15.8	13.8	14.4	13.5
C/I Downlink Adjacent Satellite 1 (dB)	29.5	14.9	14.2	13.3
C/I Uplink Adjacent Satellite 2 (dB)	15.8	13.8	14.4	13.5
C/I Downlink Adjacent Satellite 2 (dB)	30.2	20.8	20.1	19.2
C/(N+I) Composite (dB)	11.1	5.3	4.9	4.0
Required System Margin (dB)	-1.0	-1.0	-1.0	-1.0
Net C/(N+I) Composite (dB)	10.1	4.3	3.9	3.0
Minimum Required C/N (dB)	-10.0	-3.4	-3.9	-3.0
Excess Link Margin (dB)	.1	.9	0.0	0.0
Number of Carriers	1	1.0	2.3	255.7
CARRIER DENSITY LEVELS				
Uplink Power Density (dBW/Hz)	-40.6	-50.3	-49.7	-50.6
Downlink EIRP Density At Beam Peak (dBW/Hz)	-28.5	-34.8	-35.5	-36.4

EXHIBIT 13: LINK BUDGETS (continued)

UPLINK BEAM INFORMATION				
Uplink Beam Name	AFRICA/US	AFRICA/US	AFRICA/US	AFRICA/US
Uplink Frequency (GHz)	6.205	6.205	6.205	6.205
Uplink Beam Polarization	LINEAR	LINEAR	LINEAR	LINEAR
Uplink Relative Contour Level (dB)	-15.0	-15.0	-15.0	-15.0
Uplink Contour G/T (dB/K)	-15.5	-15.5	-15.5	-15.5
Uplink SFD (dBW/m2)	-66	-71	-69	-69
Rain Rate (mm/hr)	n/a	n/a	n/a	n/a
DOWNLINK BEAM INFORMATION				
Downlink Beam Name	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA
Downlink Frequency (GHz)	12.377	12.377	12.377	12.377
Downlink Beam Polarization	LINEAR	LINEAR	LINEAR	LINEAR
Downlink Relative Contour Level (dB)	-8.0	-8.0	-8.0	-8.0
Downlink Contour EIRP (dBW)	47.6	47.6	47.6	47.6
Rain Rate (mm/hr)	42.0	42.0	42.0	42.0
ADJACENT SATELLITE 1	SAT-1	SAT-1	SAT-1	SAT-1
Satellite 1 Orbital Location	29.5W	29.5W	29.5W	29.5W
Uplink Power Density (dBW/Hz)	-38.7	-38.7	-38.7	-38.7
Uplink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
Downlink EIRP Density (dBW/Hz)	-26.0	-26.0	-26.0	-26.0
Downlink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
ADJACENT SATELLITE 2	SAT-2	SAT-2	SAT-2	SAT-2
Satellite 1 Orbital Location	33.5W	33.5W	33.5W	33.5W
Uplink Power Density (dBW/Hz)	-38.7	-38.7	-38.7	-38.7
Uplink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
Downlink EIRP Density (dBW/Hz)	-26.0	-26.0	-26.0	-26.0
Downlink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
CARRIER INFORMATION				
Carrier ID	36M0F3F	72M0G7W	10M3G7W	100KG7W
Carrier Modulation	TV/FM	QPSK	QPSK	QPSK
Peak to Peak Bandwidth of EDS (MHz)	4	N/A	N/A	N/A
Information Rate(kbps)	N/A	49138	6000	64
Code Rate	N/A	1/2 w/ RS	1/2 w/ RS	1/2 w/ RS
Occupied Bandwidth(kHz)	36000	60251	6771.1	75.4
Allocated Bandwidth(kHz)	36000	72000	10300	100
Minimum C/N, Clear Sky (dB)	10.0	3.36	3.87	2.99
Minimum C/N, Rain (dB)	10.0	3.36	3.57	2.79
UPLINK EARTH STATION				
Earth Station Diameter (meters)	18.3	15.2	15.2	15.2
Earth Station Gain (dBi)	60.2	58.4	58.4	58.4
Earth Station Elevation Angle	20	20	20	20
DOWNLINK EARTH STATION				
Earth Station Diameter (meters)	9.0	3.0	1.8	1.8
Earth Station Gain (dBi)	59.3	49.5	45.1	45.1
Earth Station G/T (dB/K)	36.9	27.0	22.6	22.6
Earth Station Elevation Angle	20	20	20	20
LINK FADE TYPE	Clear Sky	Clear Sky	Clear Sky	Clear Sky
UPLINK PERFORMANCE				
Uplink Earth Station EIRP (dBW)	85.7	81.9	77.3	56.9
Uplink Path Loss, Clear Sky (dB)	-200.3	-200.3	-200.3	-200.3
Uplink Rain Attenuation	0.0	0.0	0.0	0.0
Satellite G/T(dB/K)	-15.5	-15.5	-15.5	-15.5
Boltzman Constant(dBW/K-Hz)	228.6	228.6	228.6	228.6
Carrier Noise Bandwidth (dB-Hz)	-75.6	-77.8	-68.3	-48.8
Uplink C/N(dB)	23.0	16.9	21.8	21.0
DOWNLINK PERFORMANCE				
Downlink EIRP per Carrier (dBW)	41.4	43.5	34.1	13.8
Antenna Pointing Error (dB)	-.5	-.5	-.5	-.5
Downlink Path Loss, Clear Sky (dB)	-206.3	-206.3	-206.3	-206.3
Downlink Rain Attenuation	0.0	0.0	0.0	0.0
Earth Station G/T (dB/K)	36.9	27.0	22.6	22.6
Boltzman Constant(dBW / K - Hz)	228.6	228.6	228.6	228.6
Carrier Noise Bandwidth (dB-Hz)	-75.6	-77.8	-68.3	-48.8
Downlink C / N(dB)	24.6	14.5	10.2	9.4
COMPOSITE LINK PERFORMANCE				
C/N Uplink (dB)	23.0	16.9	21.8	21.0
C/N Downlink (dB)	24.6	14.5	10.2	9.4
C/I Intermodulation (dB)	N/A	N/A	24.9	24.2
C/I Uplink Co-Channel (dB)*	27.0	27.0	27.0	26.8
C/I Downlink Co-Channel (dB)*	27.0	27.0	27.0	26.8
C/I Uplink Adjacent Satellite 1 (dB)	15.8	9.8	14.7	13.9
C/I Downlink Adjacent Satellite 1 (dB)	29.5	19.1	14.3	13.6
C/I Uplink Adjacent Satellite 2 (dB)	15.8	9.8	14.7	13.9
C/I Downlink Adjacent Satellite 2 (dB)	29.9	20.2	16.3	15.5
C/(N+I) Composite (dB)	11.7	5.4	6.2	5.5
Required System Margin (dB)	-1.0	-1.0	-1.0	-1.0
Net C/(N+I) Composite (dB)	10.7	4.4	5.2	4.5
Minimum Required C/N (dB)	-10.0	-3.4	-3.9	-3.0
Excess Link Margin (dB)	.7	1.0	1.4	1.5
Number of Carriers	2	1.0	7.0	720.0
CARRIER DENSITY LEVELS				
Uplink Power Density (dBW/Hz)	-40.6	-54.3	-49.5	-50.3
Downlink EIRP Density At Beam Peak (dBW/Hz)	-16.6	-26.3	-26.2	-27.0

EXHIBIT 13: LINK BUDGETS (continued)

UPLINK BEAM INFORMATION				
Uplink Beam Name	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA
Uplink Frequency (GHz)	14.125	14.125	14.125	14.125
Uplink Beam Polarization	LINEAR	LINEAR	LINEAR	LINEAR
Uplink Relative Contour Level (dB)	-8.0	-8.0	-8.0	-8.0
Uplink Contour G/T (dB/K)	4.0	4.0	4.0	4.0
Uplink SFD (dBW/m2)	-78	-82	-88	-88
Rain Rate (mm/hr)	42.0	42.0	42.0	42.0
DOWNLINK BEAM INFORMATION				
Downlink Beam Name	AFRICA/US	AFRICA/US	AFRICA/US	AFRICA/US
Downlink Frequency (GHz)	3.800	3.800	3.800	3.800
Downlink Beam Polarization	LINEAR	LINEAR	LINEAR	LINEAR
Downlink Relative Contour Level (dB)	-10.0	-10.0	-10.0	-10.0
Downlink Contour EIRP (dBW)	30.0	30.0	30.0	30.0
Rain Rate (mm/hr)	n/a	n/a	n/a	n/a
ADJACENT SATELLITE 1	SAT-1	SAT-1	SAT-1	SAT-1
Satellite 1 Orbital Location	29.5W	29.5W	29.5W	29.5W
Uplink Power Density (dBW/Hz)	-50.0	-50.0	-50.0	-50.0
Uplink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
Downlink EIRP Density (dBW/Hz)	-47.8	-47.8	-47.8	-47.8
Downlink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
ADJACENT SATELLITE 2	SAT-2	SAT-2	SAT-2	SAT-2
Satellite 1 Orbital Location	33.5W	33.5W	33.5W	33.5W
Uplink Power Density (dBW/Hz)	-50.0	-50.0	-50.0	-50.0
Uplink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
Downlink EIRP Density (dBW/Hz)	-47.8	-47.8	-47.8	-47.8
Downlink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
CARRIER INFORMATION				
Carrier ID	36M0F3F	72M0G7W	10M3G7W	100KG7W
Carrier Modulation	TV/FM	QPSK	QPSK	QPSK
Peak to Peak Bandwidth of EDS (MHz)	4	N/A	N/A	N/A
Information Rate(kbps)	N/A	49138	6000	64
Code Rate	N/A	1/2 w/ RS	1/2 w/ RS	1/2 w/ RS
Occupied Bandwidth(kHz)	36000	60251	6771.1	75.4
Allocated Bandwidth(kHz)	36000	72000	10300	100
Minimum C/N, Clear Sky (dB)	10.0	3.36	3.87	2.99
Minimum C/N, Rain (dB)	10.0	3.36	3.57	2.79
UPLINK EARTH STATION				
Earth Station Diameter (meters)	7.0	7.0	7.0	7.0
Earth Station Gain (dBi)	58.0	58.0	58.0	58.0
Earth Station Elevation Angle	20	20	20	20
DOWNLINK EARTH STATION				
Earth Station Diameter (meters)	11.0	4.5	6.1	6.1
Earth Station Gain (dBi)	51.6	43.6	46.2	46.2
Earth Station G/T (dB/K)	30.7	23.3	25.9	25.9
Earth Station Elevation Angle	20	20	20	20
LINK FADE TYPE	Clear Sky	Clear Sky	Clear Sky	Clear Sky
UPLINK PERFORMANCE				
Uplink Earth Station EIRP (dBW)	81.9	80.9	59.7	39.5
Uplink Path Loss, Clear Sky (dB)	-207.4	-207.4	-207.4	-207.4
Uplink Rain Attenuation	0.0	0.0	0.0	0.0
Satellite G/T(dB/K)	4.0	4.0	4.0	4.0
Boltzman Constant(dBW/K-Hz)	228.6	228.6	228.6	228.6
Carrier Noise Bandwidth (dB-Hz)	-75.6	-77.8	-68.3	-48.8
Uplink C/N(dB)	31.5	28.3	16.6	15.9
DOWNLINK PERFORMANCE				
Downlink EIRP per Carrier (dBW)	25.8	30.0	17.9	-2.3
Antenna Pointing Error (dB)	-.5	-.5	-.5	-.5
Downlink Path Loss, Clear Sky (dB)	-196.0	-196.0	-196.0	-196.0
Downlink Rain Attenuation	0.0	0.0	0.0	0.0
Earth Station G/T (dB/K)	30.7	23.3	25.9	25.9
Boltzman Constant(dBW / K - Hz)	228.6	228.6	228.6	228.6
Carrier Noise Bandwidth (dB-Hz)	-75.6	-77.8	-68.3	-48.8
Downlink C / N(dB)	13.0	7.6	7.6	6.9
COMPOSITE LINK PERFORMANCE				
C/N Uplink (dB)	31.5	28.3	16.6	15.9
C/N Downlink (dB)	13.0	7.6	7.6	6.9
C/I Intermodulation (dB)	N/A	N/A	26.4	25.7
C/I Uplink Co-Channel (dB)*	27.0	27.0	28.5	28.4
C/I Downlink Co-Channel (dB)*	27.0	27.0	28.5	28.4
C/I Uplink Adjacent Satellite 1 (dB)	30.3	27.1	15.4	14.7
C/I Downlink Adjacent Satellite 1 (dB)	27.6	20.7	21.1	20.4
C/I Uplink Adjacent Satellite 2 (dB)	30.3	27.1	15.4	14.7
C/I Downlink Adjacent Satellite 2 (dB)	28.6	23.3	23.0	22.3
C/(N+I) Composite (dB)	12.2	7.1	5.7	5.0
Required System Margin (dB)	-1.0	-1.0	-1.0	-1.0
Net C/(N+I) Composite (dB)	11.2	6.1	4.7	4.0
Minimum Required C/N (dB)	-10.0	-3.4	-3.9	-3.0
Excess Link Margin (dB)	1.2	2.7	.8	1.0
Number of Carriers	2	1.0	5.0	524.4
CARRIER DENSITY LEVELS				
Uplink Power Density (dBW/Hz)	-42.1	-54.9	-66.6	-67.3
Downlink EIRP Density At Beam Peak (dBW/Hz)	-30.2	-37.8	-40.4	-41.1

EXHIBIT 13: LINK BUDGETS (continued)

UPLINK BEAM INFORMATION				
Uplink Beam Name	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA
Uplink Frequency (GHz)	14.125	14.125	14.125	14.125
Uplink Beam Polarization	LINEAR	LINEAR	LINEAR	LINEAR
Uplink Relative Contour Level (dB)	-8.0	-8.0	-8.0	-8.0
Uplink Contour G/T (dB/K)	4.0	4.0	4.0	4.0
Uplink SFD (dBW/m2)	-78	-70	-83	-83
Rain Rate (mm/hr)	42.0	42.0	42.0	42.0
DOWNLINK BEAM INFORMATION				
Downlink Beam Name	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA
Downlink Frequency (GHz)	12.377	12.377	12.377	12.377
Downlink Beam Polarization	LINEAR	LINEAR	LINEAR	LINEAR
Downlink Relative Contour Level (dB)	-8.0	-8.0	-8.0	-8.0
Downlink Contour EIRP (dBW)	47.6	47.6	47.6	47.6
Rain Rate (mm/hr)	42.0	42.0	42.0	42.0
ADJACENT SATELLITE 1	SAT-1	SAT-1	SAT-1	SAT-1
Satellite 1 Orbital Location	29.5W	29.5W	29.5W	29.5W
Uplink Power Density (dBW/Hz)	-50	-50	-50	-50
Uplink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
Downlink EIRP Density (dBW/Hz)	-26	-26	-26	-26
Downlink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
ADJACENT SATELLITE 2	SAT-2	SAT-2	SAT-2	SAT-2
Satellite 1 Orbital Location	33.5W	33.5W	33.5W	33.5W
Uplink Power Density (dBW/Hz)	-50	-50	-50	-50
Uplink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
Downlink EIRP Density (dBW/Hz)	-26	-26	-26	-26
Downlink Polarization Advantage (dB)	0.0	0.0	0.0	0.0
CARRIER INFORMATION				
Carrier ID	36M0F3F	72M0G7W	10M3G7W	100KG7W
Carrier Modulation	TV/FM	QPSK	QPSK	QPSK
Peak to Peak Bandwidth of EDS (MHz)	4	N/A	N/A	N/A
Information Rate(kbps)	N/A	49138	6000	64
Code Rate	N/A	1/2 w/ RS	1/2 w/ RS	1/2 w/ RS
Occupied Bandwidth(kHz)	36000	60251	6771.1	75.4
Allocated Bandwidth(kHz)	36000	72000	10300	100
Minimum C/N, Clear Sky (dB)	10.0	3.36	3.87	2.99
Minimum C/N, Rain (dB)	10.0	3.36	3.57	2.79
UPLINK EARTH STATION				
Earth Station Diameter (meters)	7.0	7.0	7.0	7.0
Earth Station Gain (dBi)	58.0	58.0	58.0	58.0
Earth Station Elevation Angle	20	20	20	20
DOWNLINK EARTH STATION				
Earth Station Diameter (meters)	3.0	1.2	1.8	1.8
Earth Station Gain (dBi)	49.5	41.6	45.1	45.1
Earth Station G/T (dB/K)	27.0	19.1	22.6	22.6
Earth Station Elevation Angle	20	20	20	20
LINK FADE TYPE	Clear Sky	Clear Sky	Clear Sky	Clear Sky
UPLINK PERFORMANCE				
Uplink Earth Station EIRP (dBW)	81.9	82.9	63.4	43.1
Uplink Path Loss, Clear Sky (dB)	-207.4	-207.4	-207.4	-207.4
Uplink Rain Attenuation	0.0	0.0	0.0	0.0
Satellite G/T(dB/K)	4.0	4.0	4.0	4.0
Boltzman Constant(dBW/K-Hz)	228.6	228.6	228.6	228.6
Carrier Noise Bandwidth (dB-Hz)	-75.6	-77.8	-68.3	-48.8
Uplink C/N(dB)	31.5	30.3	20.3	19.5
DOWNLINK PERFORMANCE				
Downlink EIRP per Carrier (dBW)	43.4	43.5	34.2	13.9
Antenna Pointing Error (dB)	-.5	-.5	-.5	-.5
Downlink Path Loss, Clear Sky (dB)	-206.3	-206.3	-206.3	-206.3
Downlink Rain Attenuation	0.0	0.0	0.0	0.0
Earth Station G/T (dB/K)	27.0	19.1	22.6	22.6
Boltzman Constant(dBW / K - Hz)	228.6	228.6	228.6	228.6
Carrier Noise Bandwidth (dB-Hz)	-75.6	-77.8	-68.3	-48.8
Downlink C / N(dB)	16.7	6.6	10.3	9.6
COMPOSITE LINK PERFORMANCE				
C/N Uplink (dB)	31.5	30.3	20.3	19.5
C/N Downlink (dB)	16.7	6.6	10.3	9.6
C/I Intermodulation (dB)	N/A	N/A	25.1	24.3
C/I Uplink Co-Channel (dB)*	27.0	27.0	27.1	27.0
C/I Downlink Co-Channel (dB)*	27.0	27.0	27.1	27.0
C/I Uplink Adjacent Satellite 1 (dB)	30.3	29.1	19.1	18.3
C/I Downlink Adjacent Satellite 1 (dB)	21.2	10.2	14.5	13.7
C/I Uplink Adjacent Satellite 2 (dB)	30.3	29.1	19.1	18.3
C/I Downlink Adjacent Satellite 2 (dB)	22.4	13.2	16.4	15.7
C/(N+I) Composite (dB)	13.8	4.3	7.2	6.4
Required System Margin (dB)	-1.0	-1.0	-1.0	-1.0
Net C/(N+I) Composite (dB)	12.8	3.3	6.2	5.4
Minimum Required C/N (dB)	-10.0	-3.4	-3.9	-3.0
Excess Link Margin (dB)	2.8	0.0	2.3	2.4
Number of Carriers	2	1.0	6.8	720.0
CARRIER DENSITY LEVELS				
Uplink Power Density (dBW/Hz)	-42.1	-52.9	-62.9	-63.7
Downlink EIRP Density At Beam Peak (dBW/Hz)	-14.6	-26.3	-26.1	-26.9

EXHIBIT 13: LINK BUDGETS (continued)

UPLINK BEAM INFORMATION		
Uplink Beam Name	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA
Uplink Frequency (GHz)	14.125	14.125
Uplink Beam Polarization	LINEAR	LINEAR
Uplink Relative Contour Level (dB)	-8.0	-8.0
Uplink Contour G/T (dB/K)	4.0	4.0
Uplink SFD (dBW/m2)	-83	-83
Rain Rate (mm/hr)	42.0	42.0
DOWNLINK BEAM INFORMATION		
Downlink Beam Name	ATLANTIC/W. AFRICA	ATLANTIC/W. AFRICA
Downlink Frequency (GHz)	12.377	12.377
Downlink Beam Polarization	LINEAR	LINEAR
Downlink Relative Contour Level (dB)	-8.0	-8.0
Downlink Contour EIRP (dBW)	47.6	47.6
Rain Rate (mm/hr)	42.0	42.0
ADJACENT SATELLITE 1	SAT-1	SAT-1
Satellite 1 Orbital Location	29.5W	29.5W
Uplink Power Density (dBW/Hz)	-50	-50
Uplink Polarization Advantage (dB)	0.0	0.0
Downlink EIRP Density (dBW/Hz)	-26	-26
Downlink Polarization Advantage (dB)	0.0	0.0
ADJACENT SATELLITE 2	SAT-2	SAT-2
Satellite 1 Orbital Location	33.5W	33.5W
Uplink Power Density (dBW/Hz)	-50	-50
Uplink Polarization Advantage (dB)	0.0	0.0
Downlink EIRP Density (dBW/Hz)	-26	-26
Downlink Polarization Advantage (dB)	0.0	0.0
CARRIER INFORMATION		
Carrier ID	1M45G7W	400KG7W
Carrier Modulation	BPSK	BPSK
Peak to Peak Bandwidth of EDS (MHz)	N/A	N/A
Information Rate(kbps)	512	128
Code Rate	R1/2	R1/2
Occupied Bandwidth(kHz)	1229.0	307.0
Allocated Bandwidth(kHz)	1450.0	400.0
Minimum C/N, Clear Sky (dB)	3.4	3.4
Minimum C/N, Rain (dB)	2.7	2.7
UPLINK EARTH STATION		
Earth Station Diameter (meters)	7.0	1.8
Earth Station Gain (dBi)	58.0	46.3
Earth Station Elevation Angle	20	20
DOWNLINK EARTH STATION		
Earth Station Diameter (meters)	1.8	7.0
Earth Station Gain (dBi)	45.1	57.3
Earth Station G/T (dB/K)	22.6	34.9
Earth Station Elevation Angle	20	20
LINK FADE TYPE	Clear Sky	Clear Sky
UPLINK PERFORMANCE		
Uplink Earth Station EIRP (dBW)	55.1	42.7
Uplink Path Loss, Clear Sky (dB)	-207.4	-207.4
Uplink Rain Attenuation	0.0	0.0
Satellite G/T(dB/K)	4.0	4.0
Boltzman Constant(dBW/K-Hz)	228.6	228.6
Carrier Noise Bandwidth (dB-Hz)	-60.9	-54.9
Uplink C/N(dB)	19.4	13.0
DOWNLINK PERFORMANCE		
Downlink EIRP per Carrier (dBW)	25.9	13.5
Antenna Pointing Error (dB)	-.5	-.5
Downlink Path Loss, Clear Sky (dB)	-206.3	-206.3
Downlink Rain Attenuation	0.0	0.0
Earth Station G/T (dB/K)	22.6	34.9
Boltzman Constant(dBW / K - Hz)	228.6	228.6
Carrier Noise Bandwidth (dB-Hz)	-60.9	-54.9
Downlink C / N(dB)	9.5	15.4
COMPOSITE LINK PERFORMANCE		
C/N Uplink (dB)	19.4	13.0
C/N Downlink (dB)	9.5	15.4
C/I Intermodulation (dB)	24.2	17.8
C/I Uplink Co-Channel (dB)*	27.4	20.6
C/I Downlink Co-Channel (dB)*	27.4	20.6
C/I Uplink Adjacent Satellite 1 (dB)	18.2	11.8
C/I Downlink Adjacent Satellite 1 (dB)	13.6	20.2
C/I Uplink Adjacent Satellite 2 (dB)	18.2	11.8
C/I Downlink Adjacent Satellite 2 (dB)	15.6	20.7
C/(N+I) Composite (dB)	6.3	5.8
Required System Margin (dB)	-1.0	-1.0
Net C/(N+I) Composite (dB)	5.3	4.8
Minimum Required C/N (dB)	-3.4	-3.4
Excess Link Margin (dB)	1.9	1.4
Number of Carriers	45.3	180.0
CARRIER DENSITY LEVELS		
Uplink Power Density (dBW/Hz)	-63.8	-58.5
Downlink EIRP Density At Beam Peak (dBW/Hz)	-27.0	-33.4