Satmex 5

ATTACHMENT A

Technical Information to Supplement Schedule S

1 SCOPE

This Attachment contains additional information required by §25.114(c) and other sections of the FCC §25 rules that cannot be entered into the Schedule S submission.

2 GENERAL DESCRIPTION

The Satmex 5 satellite will operate at the 114.9° W.L. orbital location and is intended as a replacement to the Solidaridad 2 satellite that currently operates at 114.9° W.L. The Satmex 5 is a hybrid satellite which will provide DTH and a range of digital FSS services to various countries within ITU Region 2 using the conventional C- and Ku-band frequencies. The satellite employs twenty-four 36 MHz C-band transponders and twenty-four 36 MHz Ku-band transponders using both linear polarizations thereby providing dual frequency re-use.

The satellite has one C-band beam which provides coverage of most of the Americas and two Ku-band beams: a North American beam (KU1) and a Hemispheric beam (KU2). Eight transponders have fixed connectivity between the KU1 beams (uplink and downlink) and eight transponders have fixed connectivity between the KU2 beams (uplink and downlink). The remaining eight transponders can be individually switched between the KU1 and KU2 beams. The satellite's frequency plan and beam connectivity are provided in the associated Schedule S form.

3 PREDICTED SPACE STATION ANTENNA GAIN CONTOURS

The Satmex 5 antenna relative gain contours for the receive and transmit beams, as required by §25.114(d)(3), are given in GXT format and are provided in the associated Schedule S form. In addition, Annex 1 provides diagrams of the relative gain contours.

4 SERVICES TO BE PROVIDED

The Satmex 5 satellite will provide a variety of digital FSS and DTH services. Representative link budgets, which include details of the transmission characteristics, performance objectives and earth station characteristics, are provided in the associated Schedule S form.

5 TT&C CHARACTERISTICS

The Satmex 5 TT&C sub-system provides for communications during on-station operations, as well as during spacecraft emergencies. C-band telecommand transmissions are received by the spacecraft through a near omni-directional antenna during emergency operations. On-station TT&C operations are conducted via the C-band beam.

TT&C operations will be conducted from Mexican territory. Satmex does not seek Commission authorization for TT&C transmissions. Contact details for the control stations are provided below:

Centro de Control Iztapalapa Av. de las Telecomunicaciones S/N
CONTEL – Edificio SGA-II
Col. Leyes de Reforma
México, DF. CP 09310
Phone: 1 52 (55) 5804 7300

Centro de Control de Hermosillo
Carretera a Bahía Kino Km 5.5
Col. El Llano CP 83210
Hermosillo, Sonora México
Phone: 01 (662) 2600289

6 SATELLITE TRANSPONDER FREQUENCY RESPONSES

The transponder frequency responses specified over the various channel bandwidths are shown in Tables 6-1 and 6-2. In addition, the frequency tolerances of §25.202(e) and the out-of-band emission limits of §25.202(f)(1), (2) and (3) will be met.

Table 6-1. C-Band Transponder Frequency Response

Frequency offset from channel center	Gain relative to channel center frequency (dB)		Comments
	Receive	Transmit	
CF±12 MHz	-0.4	-0.7	In-Band
CF±16 MHz	-0.65	-1.2	
CF±18 MHz	-0.9	-2.4	
CF±22 MHz	-15	-23	Out-of-Band
CF±26 MHz	-30	-50	
CF±30 MHz	-40	-65	
CF±50 MHz	-40	-65	

Table 6-2. Ku-Band Transponder Frequency Response

Frequency offset from channel center	Gain relative to channel center frequency (dB)		Comments
	Receive	Transmit	
CF±12 MHz	-0.45	-0.85	In-Band
CF±16 MHz	-1.0	-1.90	
CF±18 MHz	-2.0	-4.3	
CF±22 MHz	-10	-19.5	Out-of-Band
CF±25 MHz	-25	-42	
CF±58 MHz	-45	-70	
CF±100 MHz	-51	-70	

7 MAXIMUM POWER LEVELS AND TWO-DEGREE COMPATIBILITY

7.1 Maximum Power Levels

All Satmex 5 traffic will be operated consistent with current and future coordination agreements obtained with adjacent satellite operators, taking account of the satellite's increased east-west station-keeping tolerance of ±0.1 degrees. In any case, for the C-band, the uplink input power density for traffic operating with Satmex 5 will not exceed -38.7 dBW/Hz and the satellite's downlink EIRP density will not exceed -32 dBW/Hz. For the Ku-band, the uplink input power density for traffic operating with Satmex 5 will not exceed -42 dBW/Hz and the satellite's downlink EIRP density will not exceed -20 dBW/Hz.

7.2 Two-Degree Compatibility

There are no operational satellites that operate two-degrees away from 114.9° W.L. and which use the same frequency bands as the Satmex 5 satellite. In fact, the two immediately adjacent operational satellites are/will be the Satmex 6 satellite at 113° W.L. and the planned Satmex 8 satellite at 116.8° W.L., both 1.9 degrees away from 114.9° W.L., and both operated and controlled by Satmex. Satmex will internally self-coordinate all traffic between these three satellite networks to ensure unacceptable interference does not occur between them. Nonetheless, a demonstration that the Satmex 5 satellite network is two-degree compatible is housed in the link budgets embedded in the associated Schedule S form. The link budgets assume two adjacent satellites located nominally two degrees away from 114.9° W.L. and have identical maximum transmission levels and beam characteristics of the Satmex 5 satellite network. The interference portion of the link budgets take into account the satellite's increased east-west station-keeping tolerance of ±0.1 degrees. In all cases the link budgets have an adequate amount of link margin, demonstrating that the Satmex 5 satellite is two-degree compatible.

8 C-BAND PFD ANALYSES

The maximum C-band downlink EIRP density transmitted by the Satmex 5 satellite will not exceed -32 dWB/Hz. The maximum theoretical PFD in 4 kHz that could possibly occur anywhere on the Earth is therefore -32 + 10*log (4E3) - 162.06 = -158 $dBW/m^2/4$ kHz. This PFD value is 6 dB less than the most stringent PFD limit of Part 25.208(a) and therefore demonstrates that Satmex 5 operations will be compliant with all the limits of Part 25.208(a).

9 ORBITAL DEBRIS MITIGATION PLAN

9.1 Spacecraft Hardware Design

Satmex can confirm that the satellite will not undergo any planned release of debris during its operation. In conjunction with Boeing, Satmex has assessed and limited the probability of the satellite becoming a source of debris by collisions with small debris or meteoroids of less than one centimeter in diameter that could cause loss of control and prevent post-mission disposal. The satellite manufacturer has taken steps to limit the effects of such collisions through shielding, the placement of components, and the use of redundant systems.

The Satmex 5 satellite includes separate TT&C and propulsion subsystems that are necessary for end-of-life disposal. The spacecraft TT&C system, vital for orbit raising, is extremely rugged with regard to meteoroids smaller than 1 cm, by virtue of its redundancy, shielding, separation of components and physical characteristics. Omni-directional antennas are mounted on opposite sides of the spacecraft. These antennas, each providing greater than hemispherical coverage patterns, are extremely rugged and capable of providing adequate coverage even if struck, bent or otherwise damaged by a small or medium sized particle. Either one of the two omni-directional antennas, for both command and telemetry, will be sufficient to enable orbit raising. The command receivers and decoders and telemetry encoders and transmitters will be located within a shielded area and will be totally redundant and physically separated.

9.2 Minimizing Accidental Explosions

In conjunction with Boeing, Satmex has assessed and limited the probability of accidental explosions during and after completion of mission operations. The satellite manufacturer has taken steps to ensure that debris generation will not result from the conversion of energy sources on board the satellite into energy that fragments the satellite. In particular, the satellite manufacturer advises that burst tests are performed on all pressure vessels during qualification testing to demonstrate a margin of safety against burst. Bipropellant mixing is prevented by the use of valves that prevent backwards flow in propellant lines and pressurization lines. Pyrotechnics are nominally used in the mission only as part of the initial deployment process. After orbit-raising to the disposal orbit, all unfired pyrotechnics will be fired as part of the final satellite decommission. All batteries and fuel tanks are monitored for pressure and temperature. Excessive battery charging or discharging is limited by a monitoring and control system which will automatically limit the possibility of fragmentation. Corrective action, if not automatically undertaken, will be immediately undertaken by the spacecraft operator to avoid destruction and fragmentation. Thruster temperatures, impulse and thrust duration are carefully monitored, and any thruster may be turned off via redundant valves. Consequently, there is no possibility of explosion during the operating mission. Boeing has also conducted a failure mode effects and criticality analysis as part of the design process.

In order to ensure that the spacecraft has no explosive risk after it has been successfully deorbited, all stored energy onboard the spacecraft will be removed. Upon successful de-orbit of the spacecraft, all propulsion lines and latch valves will be vented and left open. All battery chargers will be turned off and batteries will be left in a permanent discharge state.

9.3 Safe Flight Profiles

In considering current and planned satellites that may have a station-keeping volume that overlaps the Satmex 5 satellite, Satmex has reviewed the lists of FCC licensed satellite networks, as well as those that are currently under consideration by the FCC. In addition, non-Mexican networks for which a request for coordination has been published by the ITU within ±0.15 degrees of 114.9° W.L. have also been reviewed. Only those networks that either operate, or are planned to operate, and have an overlapping station-keeping volume with the Satmex 5 satellite, have been taken into account in the analysis.

Based on these reviews, the only operational satellite within ±0.15° of 114.9° W.L. is the Solidaridad 2 satellite which is controlled and operated by Satmex. This satellite will be de-orbited before the Satmex 5 satellite arrives at 114.9° W.L. There are no pending applications before the Commission requesting authorization to use an orbital location within ±0.15 degrees of 114.9° W.L. Within this sub-arc, there are numerous non-Mexico networks submitted to the ITU, however Satmex can find no evidence that a satellite for any of these networks is being constructed and progressed towards launch.

Based on the preceding, it is concluded that physical coordination of the Satmex 5 satellite with another party is not required at the present time.

9.4 Post Mission Disposal Plan

The disposal orbit altitude for Satmex 5 is based on the following calculation, as required in §25.283:

Total Solar Pressure Area "A" = 62 m^2

"M" = Dry Mass of Satellite = 1910.1 kg

"C_R" = Solar Pressure Radiation Coefficient = 1.24

Therefore the Minimum Disposal Orbit Perigee Altitude:

= 36,021 km + 1000 x C_R x A/M

= 36,021 km + 1000 x 1.24 x 62/1910.1

= 36,061 km

= 275 km above GSO (35,786 km)

At the end of the operational life of the Satmex 5 satellite, Satmex will maneuver the satellite to a disposal orbit with a minimum perigee of 300 km above the normal GSO operational orbit.

Satmex has reserved 6.11 kg of bipropellant to provide the first 200 km of perigee altitude increase, taking account of all fuel measurement uncertainties. Additionally, Satmex plans to use, 23.4 kg of Xenon and 4.8 kg of Helium to augment the bipropellant deorbit altitude up to the 300 km minimum disposal orbit perigee altitude.

10 ESTIMATED OPERATIONAL LIFETIME AND RELIABILITY

The satellite was designed for a lifetime of 15 years. The probability of the entire satellite successfully operating to that date is estimated at better than 0.74 based upon a bus reliability of better than 0.84 and a payload reliability better than 0.87. These numbers are based on a detailed reliability analysis performed by the spacecraft manufacturer of all critical components in the satellite bus and payload.

11 ITU FILING

The Satmex 5 satellite will operate pursuant to the MEXSAT-114.9 C-KU ITU network (CR/C/1296 and CR/C/1296 MOD-1). This network has been notified and recorded in the ITU's Master Register.

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this application and that it is complete and accurate to the best of my knowledge and belief.

/s/
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Stephen D. McNeil
Telecomm Strategies Canada, Inc.
Ottawa, Ontario, Canada
(613) 270-1177

ANNEX 1

SATMEX 5 Beam Coverage Maps

Figure 1. C-Band Uplink Beam. HPOL. Peak Gain = 31.4 dBi. Peak G/T = 3.3 dB/K.

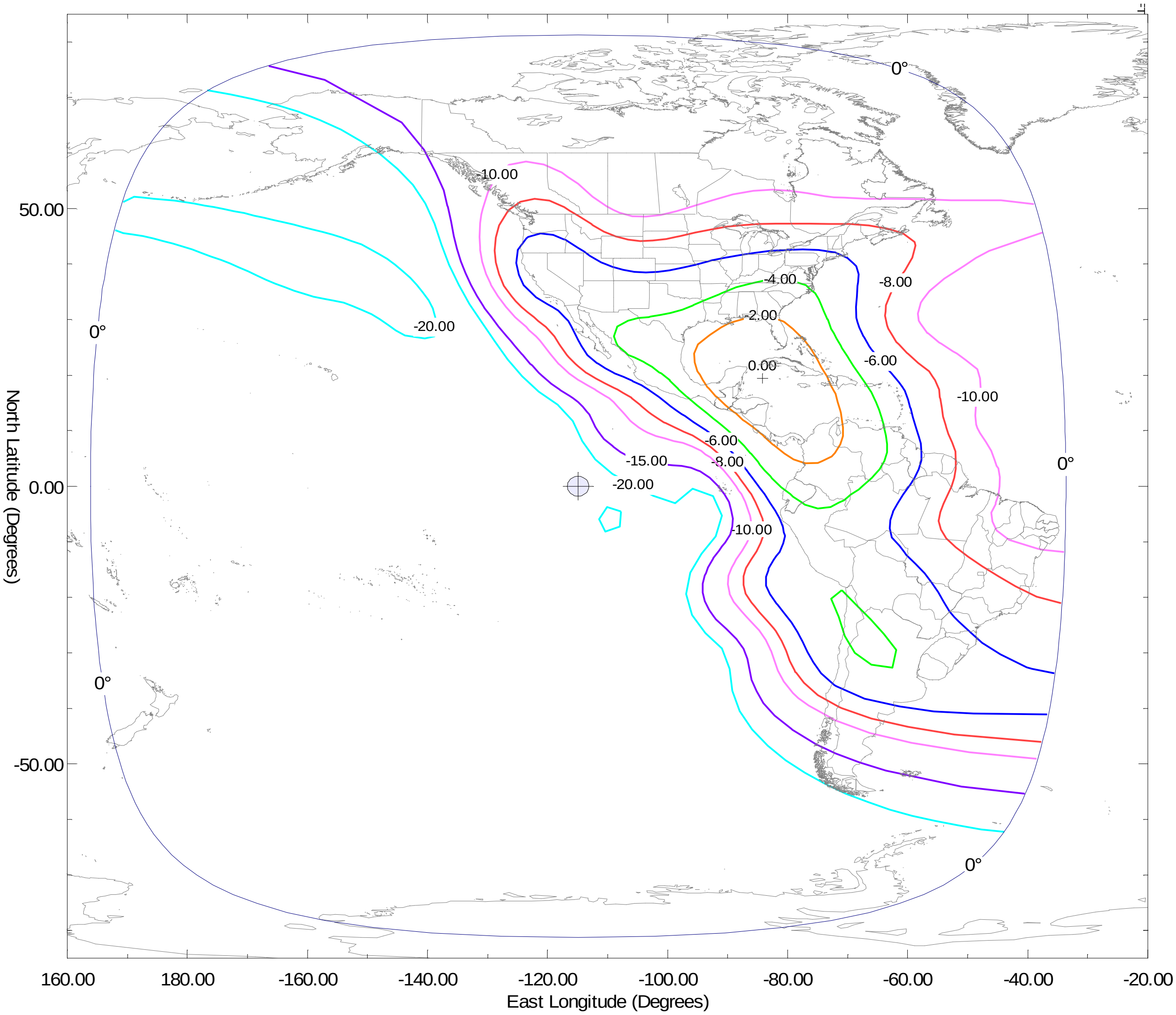

Figure 2. C-Band Uplink Beam. VPOL. Peak Gain = 31.4 dBi. Peak G/T = 3.3 dB/K.

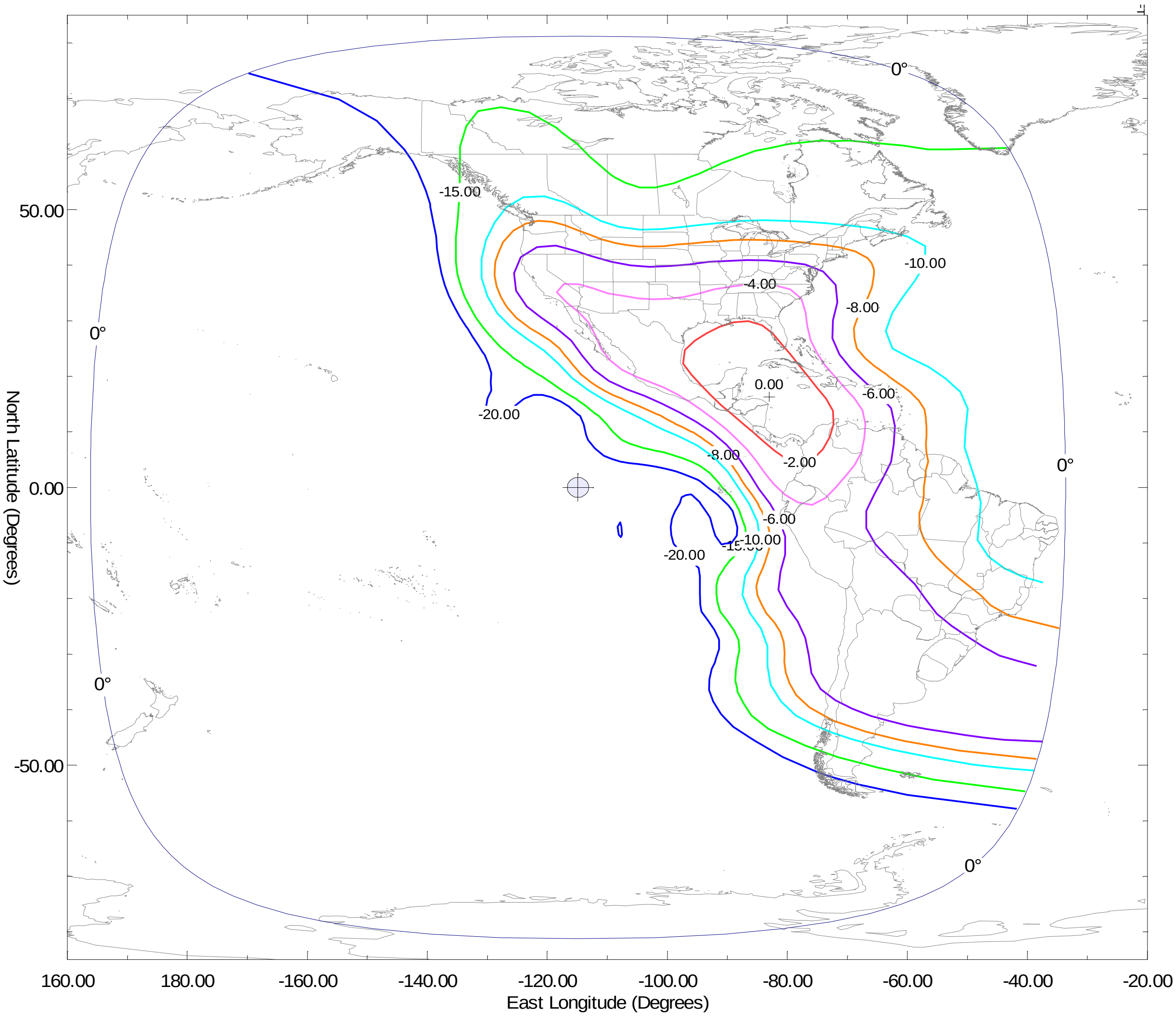

Figure 3. Ku-Band Uplink Beam (KU1H). HPOL. Peak Gain = 33.5 dBi. Peak G/T = 6.0 dB/K.

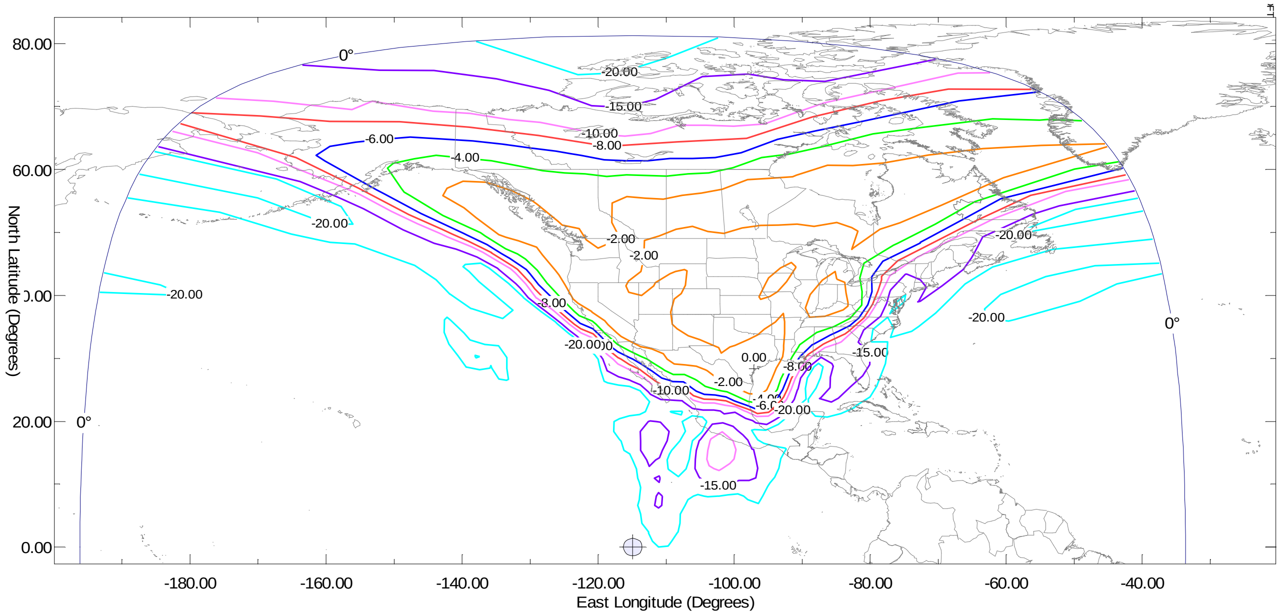

Figure 4. Ku-Band Uplink Beam (KU1V). VPOL. Peak Gain = 34.0 dBi. Peak G/T = 6.5 dB/K.

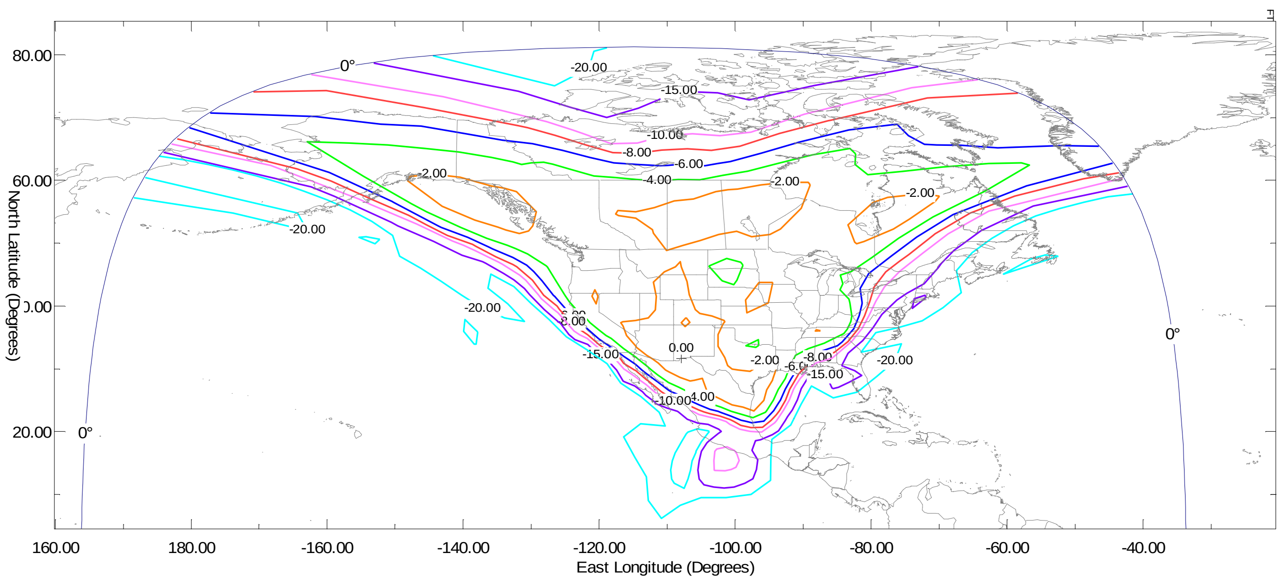

Figure 5. Ku-Band Uplink Beam (KU2H). HPOL. Peak Gain = 30.2 dBi. Peak G/T = 2.6 dB/K.

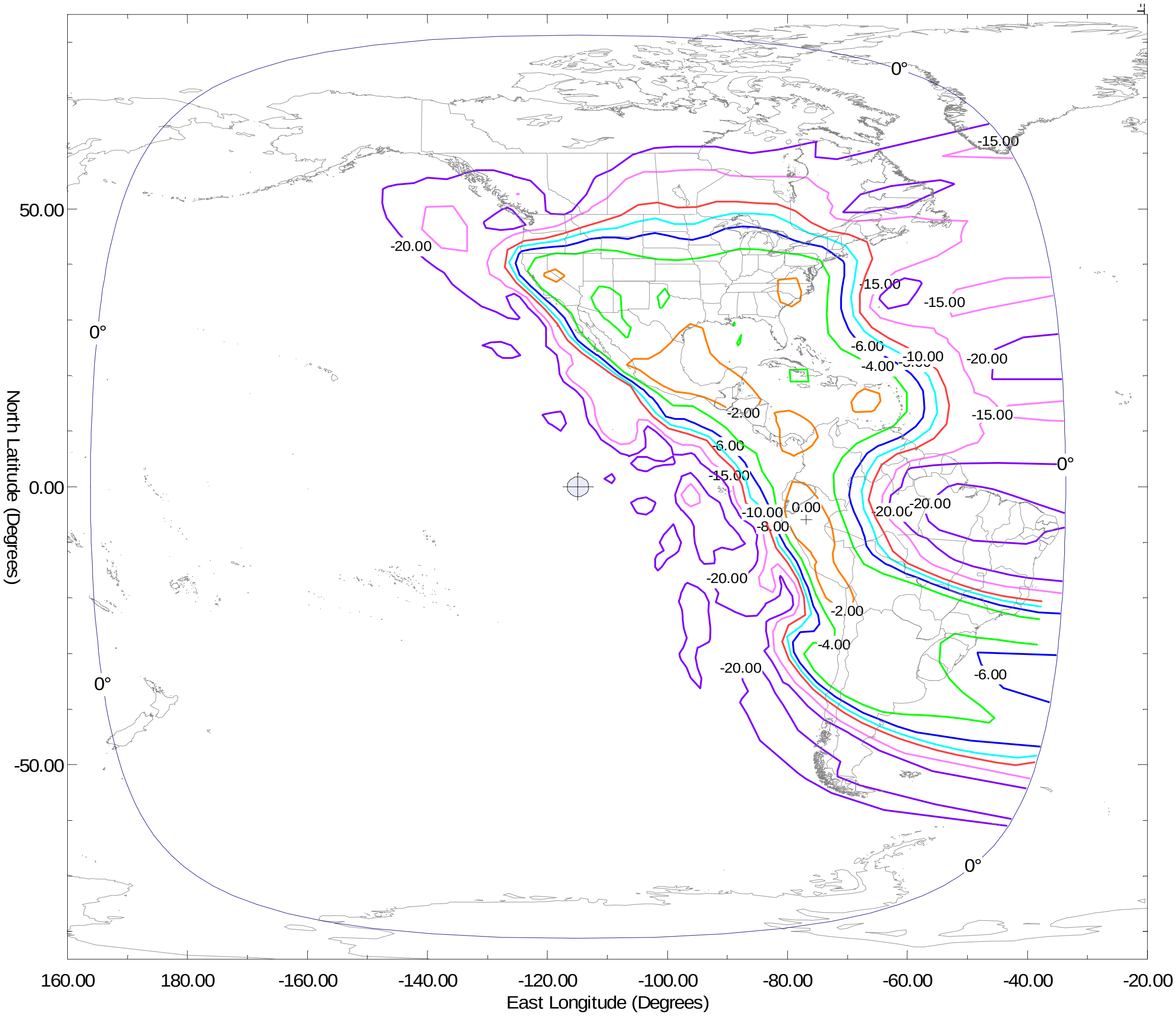

Figure 6. Ku-Band Uplink Beam (KU2V). VPOL. Peak Gain = 31.5 dBi. Peak G/T = 4.1 dB/K.

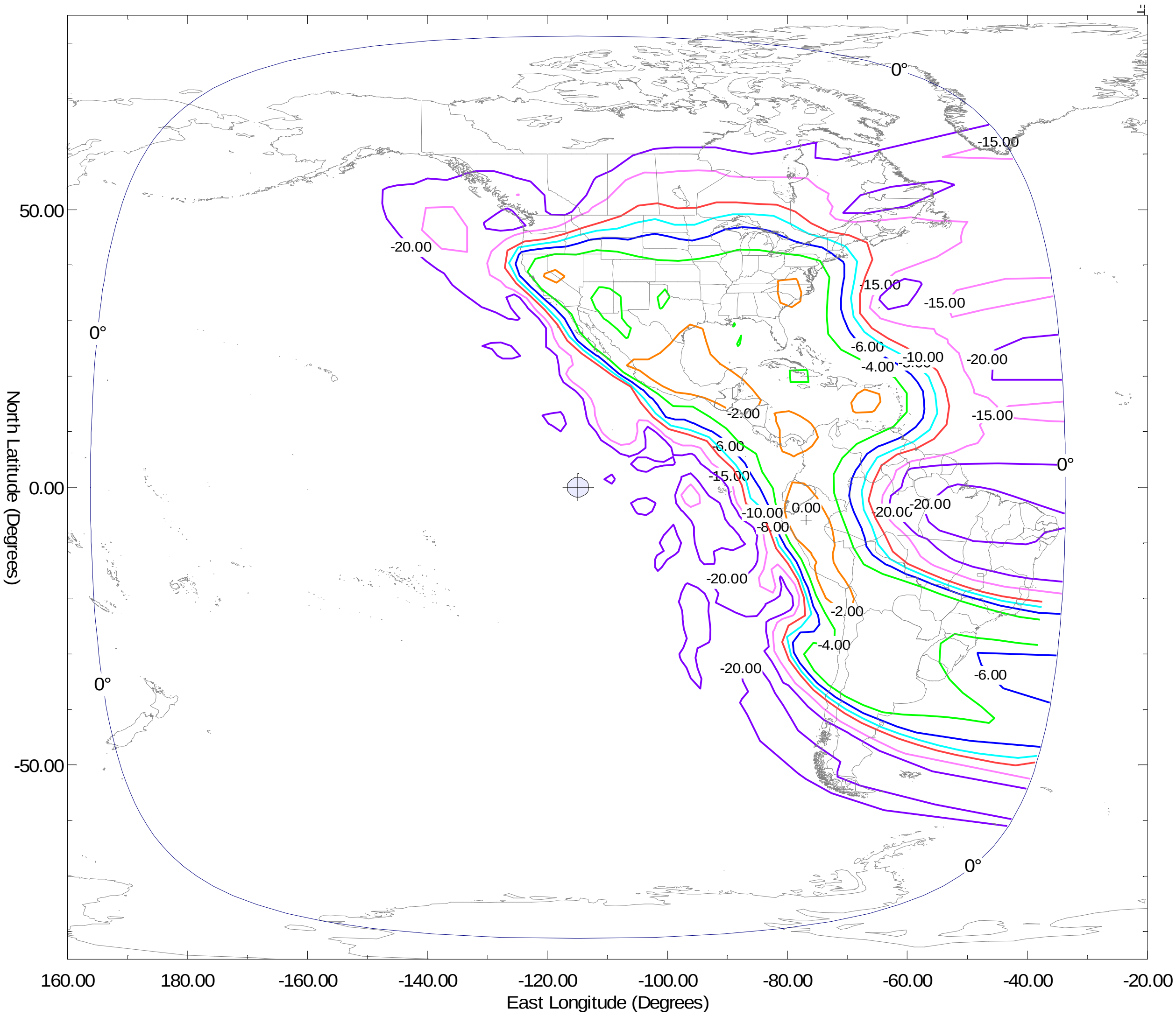

Figure 7. C-Band Downlink Beam. HPOL. Peak Gain = 27.7 dBi. Peak EIRP = 41.9 dB/K.

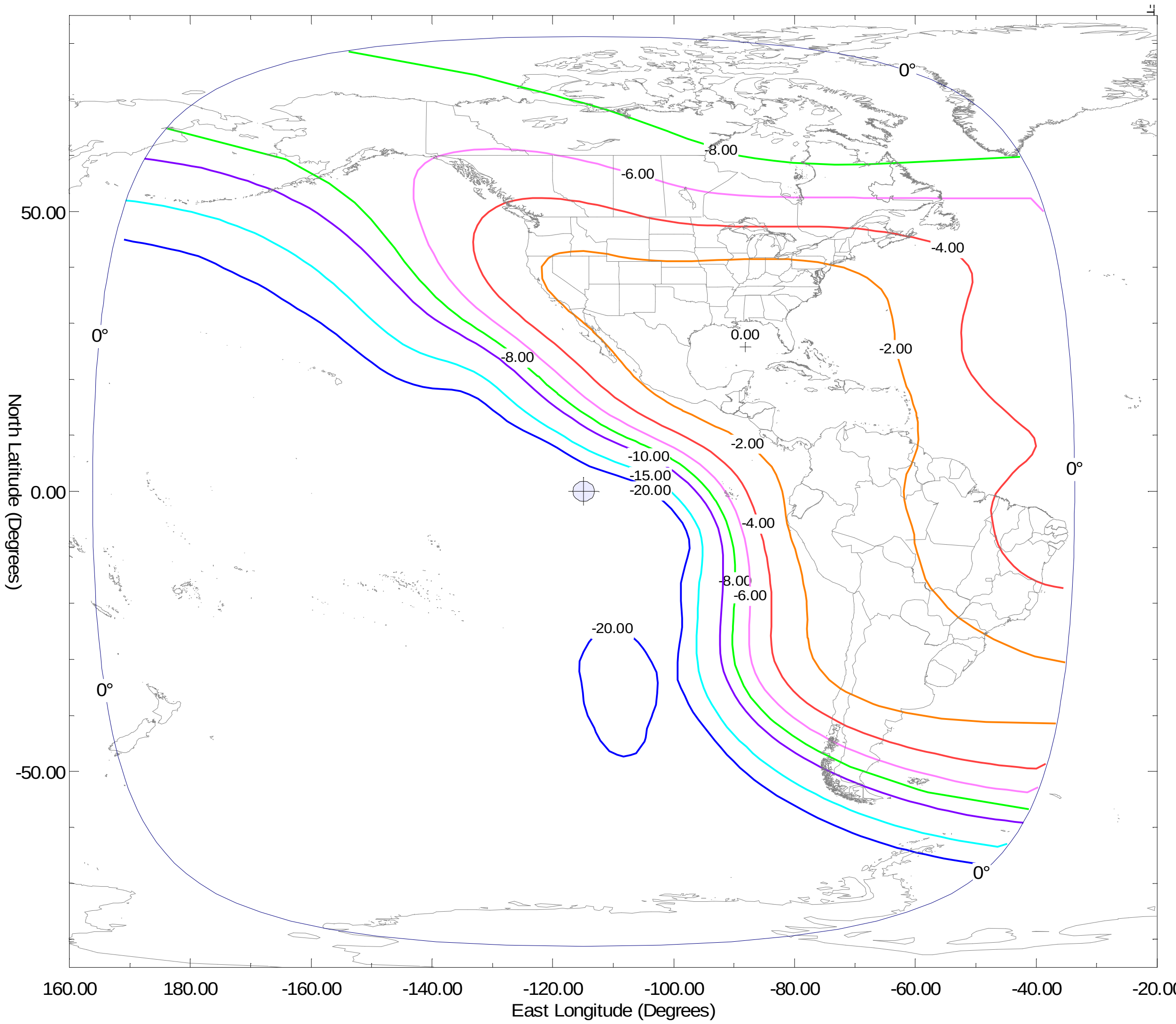

Figure 8. C-Band Downlink Beam. VPOL. Peak Gain = 27.7 dBi. Peak EIRP = 41.8 dB/K.

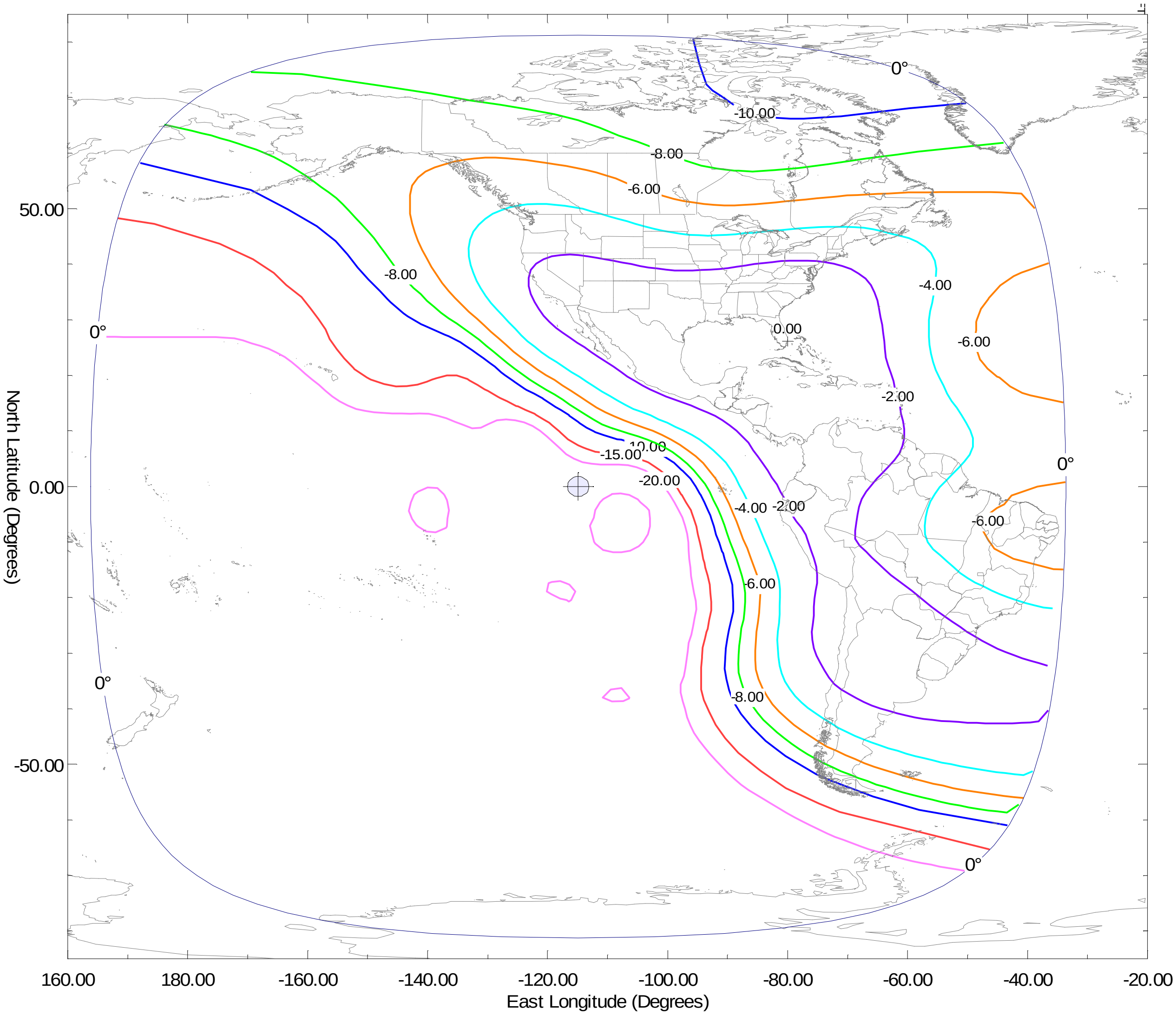

Figure 9. Ku-Band Downlink Beam (KD1H). HPOL. Peak Gain = 32.7 dBi. Peak EIRP = 52.4 dB/K.

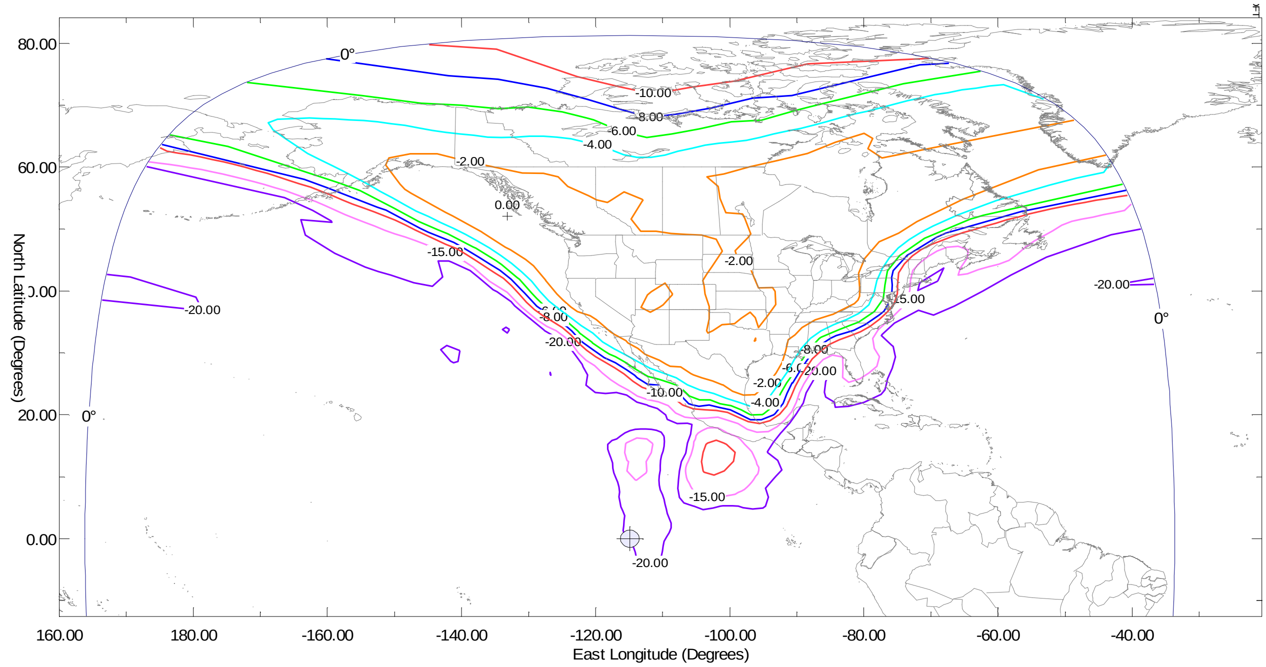

Figure 10. Ku-Band Downlink Beam (KD1V). VPOL. Peak Gain = 32.9 dBi. Peak EIRP = 52.2 dB/K.

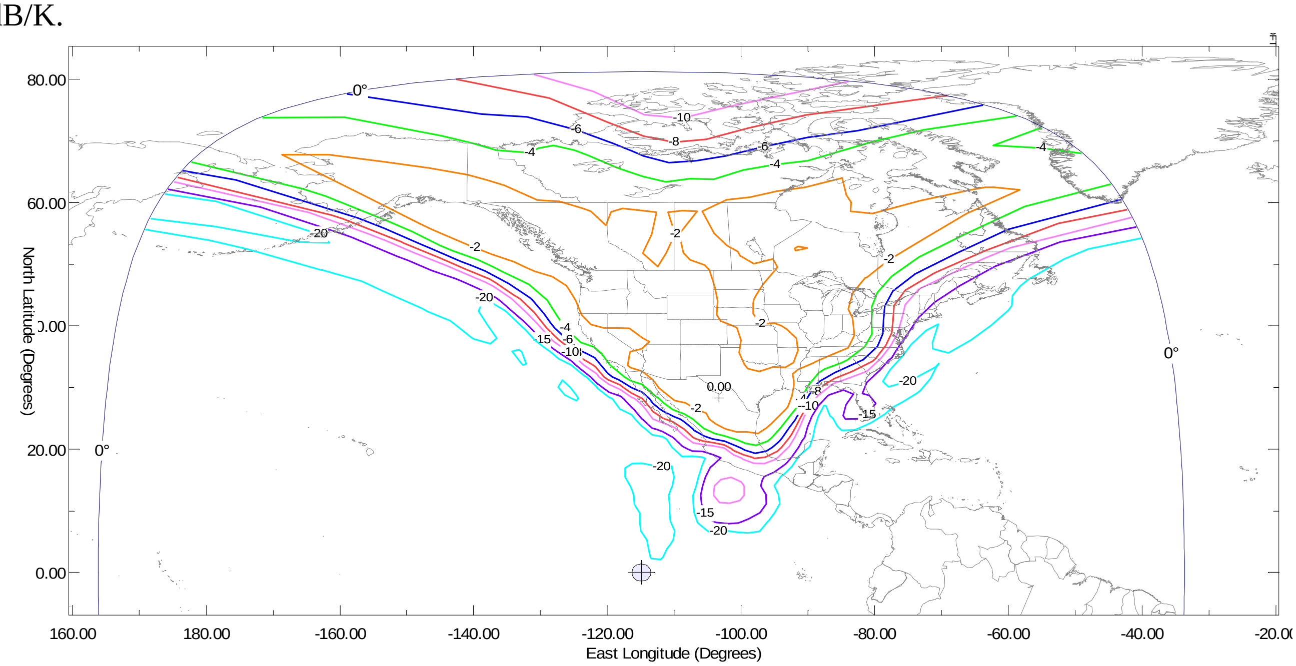

Figure 11. Ku-Band Downlink Beam (KD2H). HPOL. Peak Gain = 29.6 dBi. Peak EIRP = 49.0 dB/K.

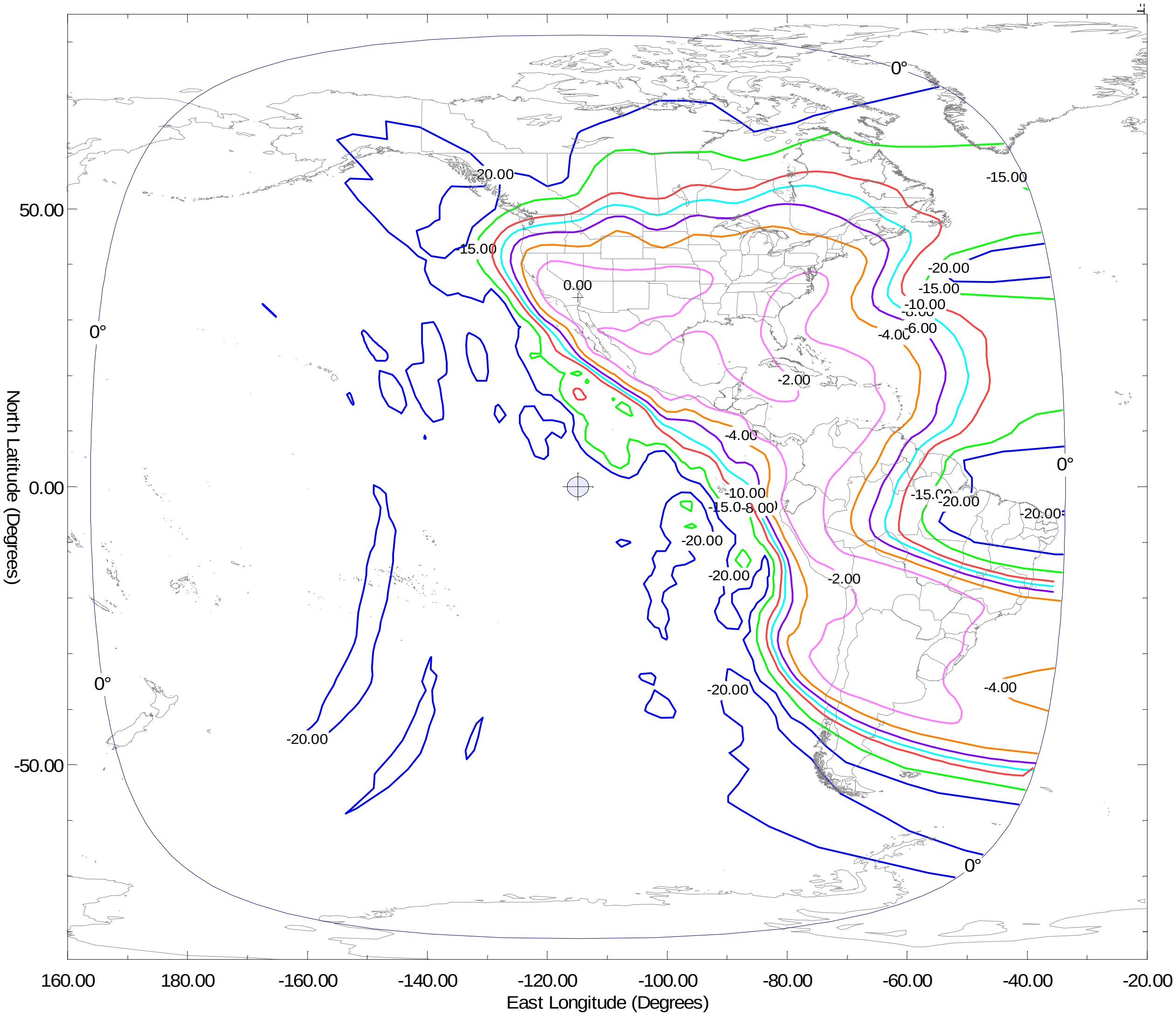

Figure 12. Ku-Band Downlink Beam (KD2V). VPOL. Peak Gain = 29.7 dBi. Peak EIRP = 49.2 dB/K.