Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
SES AMERICOM, INC.	)	File No. SAT-MOD-___________
	)	Call Sign S2134
Application for Modification of AMC-2	)	
Fixed-Satellite Space Station License	)	

APPLICATION OF SES AMERICOM, INC.

SES Americom, Inc. ("SES Americom," doing business as "SES") respectfully requests a modification of its license for the AMC-2 fixed-satellite space station to reassign the spacecraft to 80.85° W.L. with an east-west stationkeeping tolerance of +/- 0.15 degrees, where it will be co-located with SES's AMC-5 satellite. SES intends to file a separate application to modify its AMC-5 authorization to permit both satellites to be flown within the same 80.85° W.L. +/-0.15 degrees box. At that location, the AMC-2 satellite will continue to be flown in inverted mode in order to provide C- and Ku-band service to South America. SES requests authority to perform Telemetry, Tracking and Command ("TT&C") using certain C-band and Ku-band frequencies[1] in order to relocate AMC-2 from 19.2º E.L. to 80.85° W.L., and authority to operate both the TT&C and communications payloads on AMC-2 after it has arrived. SES will operate AMC-2 at 80.85° W.L. in accordance with the International Telecommunication Union ("ITU") filings and coordination agreements of the Argentine Administration. Grant of the requested authority will serve the public interest by allowing SES to use AMC-2 to meet the requirements

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[1] The AMC-2 TT&C frequencies and nominal polarizations are as follows:
Command: 6423.5 MHz (vertical polarization; uplink)
Telemetry: 3700.5 MHz (vertical polarization; downlink), 4199.5 MHz (vertical polarization; downlink), and 12198.0 MHz (horizontal polarization; downlink).

of its customer, Empresa Argentina de Soluciones Satelitales S.A. ("AR-SAT"), and expand the services available from the nominal 81° W.L. orbital location.

A completed FCC Form 312 is attached, and SES incorporates by reference the technical information previously provided in support of AMC-2.[2] In addition, SES is providing here technical information relating to the proposed modification to the AMC-2 license on Schedule S and in narrative form pursuant to Section 25.114 of the Commission's Rules.

MODIFICATION

AMC-2 is a hybrid C/Ku-band satellite that is currently licensed by the FCC to operate at 19.0° E.L. with an east-west stationkeeping tolerance of +/- 0.1 degrees under the ITU satellite network filings of the Luxembourg Administration.[3] SES proposes to relocate AMC-2 to the nominal 81° W.L. orbital location (at 80.85° W.L. to be precise), where it will operate under the ITU satellite network filings of the Argentine Administration. The redeployment of AMC-2 will not impact continuity of operations at the nominal 19.2° E.L. location as any traffic on that satellite will be transferred to other spacecraft in the SES fleet prior to relocation.

Relocation Authority. Grant of the requested authority to relocate and operate AMC-2 will serve the public interest and is consistent with Commission precedent. The Commission has repeatedly observed that its policy is to allow "satellite operators to rearrange

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[2] The most recent technical information regarding AMC-2 is found in File No. SAT-MOD-20120524-00087. *See also* File Nos.SAT-LOA-19940310-00008; SAT-AMD-19941114-00065; SAT-MOD-20050527-00110; SAT-MOD-20080124-00030; SAT-AMD-20080311-00070; SAT-MOD-20100324-00056; SAT-MOD-20101215-00261; & SAT-MOD-20111025-00209.

[3] *See* File No. SAT-MOD-20120524-00087, grant-stamped July 25, 2012 (the "*AMC-2 19.2° E.L. Grant*").

satellites in their fleet to reflect business and customer considerations where no public interest factors are adversely affected."[4] As the International Bureau has explained:

> the Commission attempts, when possible, to leave spacecraft design decisions to the space station licensee because the licensee is in a better position to determine how to tailor its system to meet the particular needs of its customers. Consequently the Commission will generally grant a licensee's request to modify its system, provided there are no compelling countervailing public interest considerations.[5]

Here, the proposed change will allow SES to make efficient use of AMC-2 in order to expand the available capacity at the nominal 81° W.L. orbital location. At that location, AMC-2 will supplement the service being provided by the Ku-band only AMC-5 spacecraft by adding South American C-band and Ku-band coverage to AMC-5's North American Ku-band coverage.[6] SES will coordinate internally to ensure compatibility of Ku-band operations between AMC-2 and AMC-5.

Reassignment of AMC-2 to 81.2º W.L. will not adversely affect other operators. SES will operate only the TT&C frequencies of AMC-2 during the drift. SES will follow standard industry practices for coordination of TT&C transmissions during the relocation process.

Proposed Operations at 80.85º W.L.: At the nominal 81° W.L. orbital location, SES will operate the AMC-2 satellite under Argentina's ITU satellite network filings and coordination agreements. SES has entered into an agreement with AR-SAT regarding operation

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4 *SES Americom, Inc.*, Order and Authorization, DA 06-757 (IB rel. Apr. 7, 2006) at 4, ¶ 8, *citing Amendment of the Commission's Space Station Licensing Rules and Policies,* Second Report and Order, 18 FCC Rcd 12507, 12509, ¶ 7 (2003).

5 *AMSC Subsidiary Corp.,* Order and Authorization, DA 98-493, 13 FCC Rcd 12316 (IB 1998) at 12318, ¶ 8 (footnote omitted).

6 *See* File No. SAT-MOD-20110929-00192, grant-stamped Mar. 2, 2012.

of AMC-2 and AMC-5 at 80.85º W.L. pursuant to the ITU filings of the Argentine Administration.[7] AR-SAT holds an authorization from the Argentine Government to operate a satellite at the nominal 81º W.L. orbital location.[8] The Technical Appendix demonstrates that the AMC-2 network is compliant with Commission rules for operation in a two-degree spacing environment and is compatible with co-frequency satellites adjacent to the nominal 81º W.L. orbital location.

Co-location of AMC-2 and AMC-5: As explained in the Technical Appendix, SES is proposing to operate both AMC-2 and AMC-5 within the same 80.85° W.L. +/- 0.15 degrees east-west station keeping box. As noted above, SES intends to file for a modification of its AMC-5 license to permit such co-location. The proposed stationkeeping volume for AMC-2 and AMC-5 will not overlap with the stationkeeping volume of any other spacecraft.[9] This relaxed stationkeeping tolerance enables both spacecraft to be operated safely in their inclined orbits while conserving fuel for future operations. It will also enable SES's customer, AR-SAT, to deploy another satellite to 81.1° W.L., as it has indicated it intends to do. SES herein seeks a waiver of Section 25.210(j) of the Commission's rules to permit AMC-2 to operate with a +/- 0.15 degree stationkeeping tolerance at 80.85º W.L.

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7 *See* Letter of N. Pablo Tognetti, AR-SAT, to Suzanne Malloy, SES, dated Feb. 25, 2013, attached hereto as Annex 1.

8 Evidence of AR-SAT's authority is already on file with the Commission. *See PanAmSat Licensee Corp.*, File No. SAT-STA-20100402-00063 ("Intelsat 3R STA") at Attachment 2.

9 *See* Technical Appendix at Section 8.

WAIVER REQUESTS

SES requests limited waivers of the Commission's requirements in connection with the instant modification application. Grant of the waivers is consistent with Commission policy:

> The Commission may waive a rule for good cause shown. Waiver is appropriate if special circumstances warrant a deviation from the general rule and such deviation would better serve the public interest than would strict adherence to the general rule. Generally, the Commission may grant a waiver of its rules in a particular case if the relief requested would not undermine the policy objective of the rule in question and would otherwise serve the public interest.[10]

<u>Section 25.114(d)(3)</u>: SES requests a limited waiver of Section 25.114(d)(3) of the Commission's rules. That provision requires submission of predicted antenna gain contours for each transmit and receive antenna beam and specifies that for geostationary orbit satellites, the information must be provided in a .gxt format. As discussed in Section 4 of the Technical Appendix, SES has provided antenna gain information in the required .gxt format with one exception. The gain characteristics for the global horn antenna are not provided as a .gxt file because the .gxt data is not available from the spacecraft manufacturer. Instead, gain versus off-set angle information is provided as a figure in Annex A to the Technical Appendix.

The Commission has previously waived the requirements of Section 25.114(d)(3) in similar factual circumstances, including with respect to AMC-2.[11] In acting on these requests,

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[10] *PanAmSat Licensee Corp*., 17 FCC Rcd10483, 10492 (Sat. Div. 2002) (footnotes omitted).

[11] *See, e.g., AMC-2 19.2° E.L. Grant*, Attachment at ¶ 5 (waiving Section 25.114(d)(3) with respect to AMC-2 global horn antenna); *PanAmSat Licensee Corp*., File No. SAT-RPL-20061219-00155, grant stamp dated April 24, 2007 ("*Galaxy 17 Grant*") at ¶ 5 (waiving Section 25.114(d)(3) to allow submission of gain information for omni antenna in non-.gxt format where manufacturer did not provide .gxt data); *see also Spectrum Five, LLC*, Order and Authorization, DA 06-2439, 21 FCC Rcd 14023, 14033 at ¶ 17 (IB 2006) (conditionally accepting antenna gain information not filed in .gxt format).

the Commission recognized that the purpose of the rule is to ensure that adequate information is available to allow evaluation of the potential for harmful interference.[12] Here, in lieu of the single .gxt file that cannot be provided, SES has submitted alternative data sufficient to permit the Commission and any interested party to evaluate the antenna's interference potential. Accordingly, SES requests that the Commission grant a limited waiver of Section 25.114(d)(3).

Section 25.210(j): Section 25.210(j) specifies that geostationary space stations "must be maintained within 0.05º of their assigned orbital longitude in the east/west direction, unless specifically authorized by the Commission to operate with a different longitudinal tolerance."[13] Here, SES is seeking authority to operate AMC-2 together with AMC-5 in an expanded stationkeeping box of +/- 0.15°. The Commission has previously waived Section 25.210(j) based on a finding that allowing an increased stationkeeping volume would "not adversely affect the operations of other spacecraft, and would conserve fuel for future operations."[14] Indeed, it has granted SES a previous waiver of this rule to allow AMC-2 and AMC-4 to operate together at 100.95° W.L. within a total east-west stationkeeping range of 0.15 degrees.[15]

The facts here fit squarely within this precedent. As discussed above, allowing AMC-2 to be maintained within an increased stationkeeping volume together with AMC-5 will not harm other operators. AMC-2's stationkeeping volume will not overlap with that of any

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[12] *Galaxy 17 Grant* at n.5.

[13] 47 C.F.R. § 25.210(j).

[14] *See, e.g., SES Americom, Inc. Application for Modification of Satcom SN-4 Fixed Satellite Space Station License*, 20 FCC Rcd 11542, 11545 (Sat. Div. 2005).

[15] *See* File Nos. SAT-MOD-20080124-00030, SAT-AMD-20080311-00070, grant-stamped May 19, 2008, Attachment at ¶ 1.

other satellites except for AMC-5.[16] Allowing AMC-2 and AMC-5 to be flown at 80.85° W.L. in an expanded east-west stationkeeping volume of +/-0.15 degrees will facilitate safe co-location of the satellites in their inclined orbits and help conserve fuel for the spacecraft. SES and its affiliates have significant experience in flying multiple spacecraft in close formation and will carefully control the two satellites to ensure their safe joint operation. Under these circumstances, grant of any necessary waiver of Section 25.210(j) will serve the public interest.

CONCLUSION

For the foregoing reasons, SES seeks a modification of the AMC-2 license to reassign the spacecraft to 80.85° W.L. +/- 0.15 degrees for operations in the C- and Ku-band, as described in the attached materials.

Respectfully submitted,

SES AMERICOM, INC.

By: *<u>/s/ Daniel C.H. Mah</u>*

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[16] As noted above, AR-SAT has informed SES that it intends to arrange for another satellite to be deployed to the 81.1° W.L. orbital location later this year. AR-SAT has indicated that the stationkeeping volume for that satellite will not overlap with the requested stationkeeping volume for AMC-2 and AMC-5.

AR-SAT

Buenos Aires, 25 de febrero de 2013.-

NOTA AR-SAT N° 126 /2013.-

Señores:
SES
Atención: Suzanne Malloy
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ESTADOS UNIDOS DE AMERICA

De mi consideración,

Por medio de la presente, AR-SAT certifica que posee una autorización emitida por el Gobierno Argentina para operar un satélite en la posición orbital nominal 81° L.O. y que dicha autorización se encuentra en plena vigencia.

Además, AR-SAT manifiesta que la empresa SES puede operar los satélite AMC-5 y AMC-2 autorizados por los Estados Unidos en la posición orbital 80.85° L.O. en los términos y condiciones establecidos en la Orden de Servicio L100022-0000, suscripta el 15 de febrero de 2013. Si cualquier uno de los dos satélites tuviera que ser de-orbitado desde la posición 80.85° L.O., este procedimiento será realizado de acuerdo a las normas y procedimientos establecidos por la FCC.

AR-SAT hereby certifies that it holds the authorization issued by the Government of Argentina to operate satellites at the nominal 81 W.L. and that said authorization is in full force and effect. AR-SAT further states that SES may operate the U.S. licensed AMC-2 and AMC-5 satellites at the 80.85 W.L. +/-0.15 degrees under the terms and conditions established in the Service Order L100022-0000, signed on 1S February 2013. If either satellite will be de-orbited from the 80.85 W.L. location, it will be done according to FCC standards and procedures.

Sin ningún otro particular, saluda a Ud. atentamente.

N. Pablo Tognetti
Presidente Ejecutivo
AR-SAT

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TECHNICAL APPENDIX

AMC-2 AT 80.85° W.L.

1.0 Overall Description (§25.114(d)(1))

This technical appendix is submitted in support of the modification application of SES Americom, Inc. ("SES Americom" doing business as SES) seeking reassignment of AMC-2 to 80.85° W.L. from its current orbital position of 19.0º E.L. SES hereby incorporates by reference the technical information it has already provided with respect to AMC-2,[1] and provides here technical information relating to operation of AMC-2 at 80.85° W.L consistent with the proposed modification.

AMC-2 is equipped with twenty-four 36 MHz C-band transponders and twenty-four 36 MHz Ku-band transponders. At 80.85° W.L, the spacecraft will be flown in inverted mode, and the C- and Ku-band transponders will provide coverage of Southern South America.

2.0 Schedule S (§25.114(c))

The Schedule S database is included with this filing. This section describes the main updates in the Schedule S relating to the proposed operation of AMC-2 at 80.85° W.L. with respect to previous Schedule S submissions for this spacecraft, and addresses some items not covered in the Schedule S.

1. *Transponder frequency plan.* No changes.
2. *Telemetry and Telecommand (TT&C) frequencies and beams.* The TT&C link budgets are included in the Schedule S. A global horn antenna is used for receiving C-band telecommand carriers ("GBLRV"), as well as for C-band telemetry ("GBLTV"). The communication antennas ("KTV" and "KTH") are used for transmitting telemetry carriers in Ku-band; however, the Ku band telemetry carrier at 12198 MHz will not be used for telemetry at 80.85° W.L because the spacecraft's Ku-band communications

[1] The most recent technical information regarding AMC-2 is found in File No. SAT-MOD-20120524-00087. *See also* File Nos.SAT-LOA-19940310-00008; SAT-AMD-19941114-00065; SAT-MOD-20050527-00110; SAT-MOD-20080124-00030; SAT-AMD-20080311-00070; SAT-MOD-20100324-00056; SAT-MOD-20101215-00261 & SAT-MOD-20111025-00209.

antennas will not have coverage of the TT&C earth stations. Instead, that frequency will be used as a tracking beacon, as needed. Table 1 below shows the TT&C carrier center frequencies and bandwidths.

Table 1: TT&C Carrier Frequencies

	Frequency, MHz	Nominal polarization
Command carriers (bandwidth: 800KHz, 1.2 MHz capture range)		
C-band	6423.5	H
Beacons/Telemetry (bandwidth: 300 KHz)		
C-band pair	3700.5	V
	4199.5	V
Ku-band	12198	H

Note: C-band telemetry carriers can also be transmitted through the communications antennas. In that case, the 3700.5 MHz carrier is horizontally polarized.

3. *PFD limits in C-band.* The C-band PFD values are provided in Section S8 of Schedule S, and Section 3.0 below (Table 2) demonstrates that these values comply with §25.208.

4. *Conversion of G/T values to Saturation Flux Density values.* Same as at 101°W.L.[2]

5. *Transponder frequency response of C- and Ku-transponder*. Same as at 101°W.L.[3]

6. *Carrier parameters and link budgets.* The carrier parameters and link budgets as displayed in Sections S11 and S13 have been updated based on the planned operations of AMC-2 at 80.85° W.L.

7. *Beam diagrams.* The attached beam diagrams in Section S8 have been updated to reflect the projected coverage areas at 80.85° W.L.

2 File No. SAT-MOD-20080124-00030, Technical Appendix at Page 3.
3 *Id*.

8. *TT&C Station Locations.* Information is provided in Section S14 regarding the TT&C earth stations in the United States that will be used with AMC-2 at 80.85° W.L.

3.0 PFD limits (§25.114(d)(5) and §25.208)

Table 2 demonstrates that the PFD values for the C-band carriers from AMC-2 at 80.85° W.L. comply with §25.208.

Table 2: Maximum PFD values and margins relative to permissible limits of §25.208

Beam: CTV				
Elevation angle (°)	Max. EIRP density (dBW/4 kHz)	Max. PFD (dBW/m^2-4 kHz)	Permissible PFD (dBW/m^2-4 kHz)	Margin (dB)
5	-1.9	-171.0	-152.0	19.0
10	-1.9	-170.7	-149.5	21.2
15	-1.9	-170.1	-147.0	23.1
20	-1.9	-168.9	-144.5	24.4
25	-1.9	-167.8	-142.0	25.8

Beam: CTH				
Elevation angle (°)	Max. EIRP density (dBW/4 kHz)	Max. PFD (dBW/m^2-4 kHz)	Permissible PFD (dBW/m^2-4 kHz)	Margin (dB)
5	-1.9	-169.1	-152.0	17.1
10	-1.9	-168.8	-149.5	19.3
15	-1.9	-168.2	-147.0	21.2
20	-1.9	-167.4	-144.5	22.9
25	-1.9	-166.5	-142.0	24.5

Beam: GBLTV				
Elevation angle (°)	Max. EIRP density (dBW/4 kHz)	Max. PFD (dBW/m^2-4 kHz)	Permissible PFD (dBW/m^2-4 kHz)	Margin (dB)
5	-7.0	-170.3	-152.0	18.3
10	-7.0	-170.2	-149.5	20.7
15	-7.0	-170.0	-147.0	23.0
20	-7.0	-169.9	-144.5	25.4
25	-7.0	-169.8	-142.0	27.8

No PFD limits for the 11700 – 12200 MHz band are specified in Section 25.208 of the FCC Rules or in No. 21.16 of the ITU Radio Regulations with respect to the operation of geostationary satellites.

4.0 Satellite Antenna Gain Contours (§25.114(d)(3))

Annex A shows the typical antenna gain contours for the AMC-2 space station beams. The peak EIRP and G/T values of the beams are shown in Table 3.

Table 3: Maximum EIRP and G/T

Beam ID	Band	Pol.	Link Direction	GXT Filename	Max. EIRP (dBW)	Max. G/T (dB/K)
KRV	Ku	V	Receive	AMC-2 KRV.gxt		3.5
KRH	Ku	H	Receive	AMC-2 KRH.gxt		5.9
KTV	Ku	V	Transmit	AMC-2 KTV.gxt	49.2	
KTH	Ku	H	Transmit	AMC-2 KTH.gxt	49.7	
CRV	C	V	Receive	AMC-2 CRV.gxt		4.1
CRH	C	H	Receive	AMC-2 CRH.gxt		5.8
CTV	C	V	Transmit	AMC-2 CTV.gxt	42.1	
CTH	C	H	Transmit	AMC-2 CTH.gxt	40.8	

The gain characteristics for the global horn antenna ("GBLR") and ("GBLT") are not provided as a GXT file because the GXT data is not available from the spacecraft manufacturer. Instead, gain vs. off-set angle information is provided as Figure A-7 in Annex A. SES requests a waiver to permit this substitution. As discussed in the narrative section of this modification application, grant of the requested waiver is consistent with Commission precedent.

5.0 Emission Designators and Link Budgets (§25.114(d)(4))

Annex B shows typical link budgets, including emissions designators. Further carrier details and the link budgets are included in the Schedule S, Section S13.

6.0 Maximum Theoretical Operation Levels

AMC-2 will be operated consistently with coordination agreements with adjacent satellites. In any case, in the 11.7-12.2 GHz band, the downlink EIRP density of the AMC-2 digital carriers will not exceed -22.8 dBW/Hz; and in the 14-14.5 GHz band, the input power density of the uplink digital carriers of earth stations operating with AMC-2 will not exceed -47 dBW/Hz. In the 3700-4200 MHz band, the downlink EIRP density of the AMC-2 digital carriers will not exceed -30.5 dBW/Hz; and in the 5925-6425 MHz band, the input power density of the uplink digital carriers of earth stations operating with AMC-2 will not exceed -38.7 dBW/Hz.

7.0 Two Degree Spacing Analysis (§25.114(d)(7) and §25.140(b)(2))

Annex C provides analyses demonstrating the compatibility of AMC-2 at 80.85° W.L. with neighboring spacecraft.

8.0 Mitigation of Orbital Debris (§25.114(d)(14)

The information required under Section 25.114(d)(14) of the Commission's Rules is already on file with the Commission.[4] SES incorporates that information by reference and provides below a few minor updates to its previous showing.

§25.114(d)(14)(iii): SES intends to co-locate the AMC-2 satellite with the AMC-5 satellite within a single station-keeping box centered at 80.85º W.L. with a tolerance of +/- 0.15 degrees. Both spacecraft are in inclined orbit. In order to facilitate safe co-location of the spacecraft while minimizing fuel consumption, the two SES satellites will be operated in more eccentric and inclined orbits than are typically used, which necessitates a wider longitudinal tolerance. SES has successfully used this method to co-locate other spacecraft within its fleet. .

SES understands that its customer, AR-SAT, intends to bring another satellite to the nominal 81° W.L. orbital location (to be operated at 81.1° W.L. +/- 0.1 degrees). SES will coordinate closely with the operator of that other satellite to ensure safe stationkeeping, including using accurate spacecraft ephemeris data from the Space Data Center to ensure adequate separation at all times.

[4] *See* File No. SAT-MOD-20100324-00056, Technical Appendix, Section 7.

§25.114(d)(14)(iv): SES plans to relocate AMC-2 at its end of life to a disposal orbit with a minimum perigee altitude of at least 150 km above the geostationary arc. SES has previously provided the supporting information for this disposal plan.[5]

[5] *See id.*

ANNEX A

Space Station Antenna Beam Diagrams

Figure A-1
Receive Beam: KRV
Ku-band, V-pol, Peak Gain: 30.9 dBi, Peak G/T = 3.5 dB/K

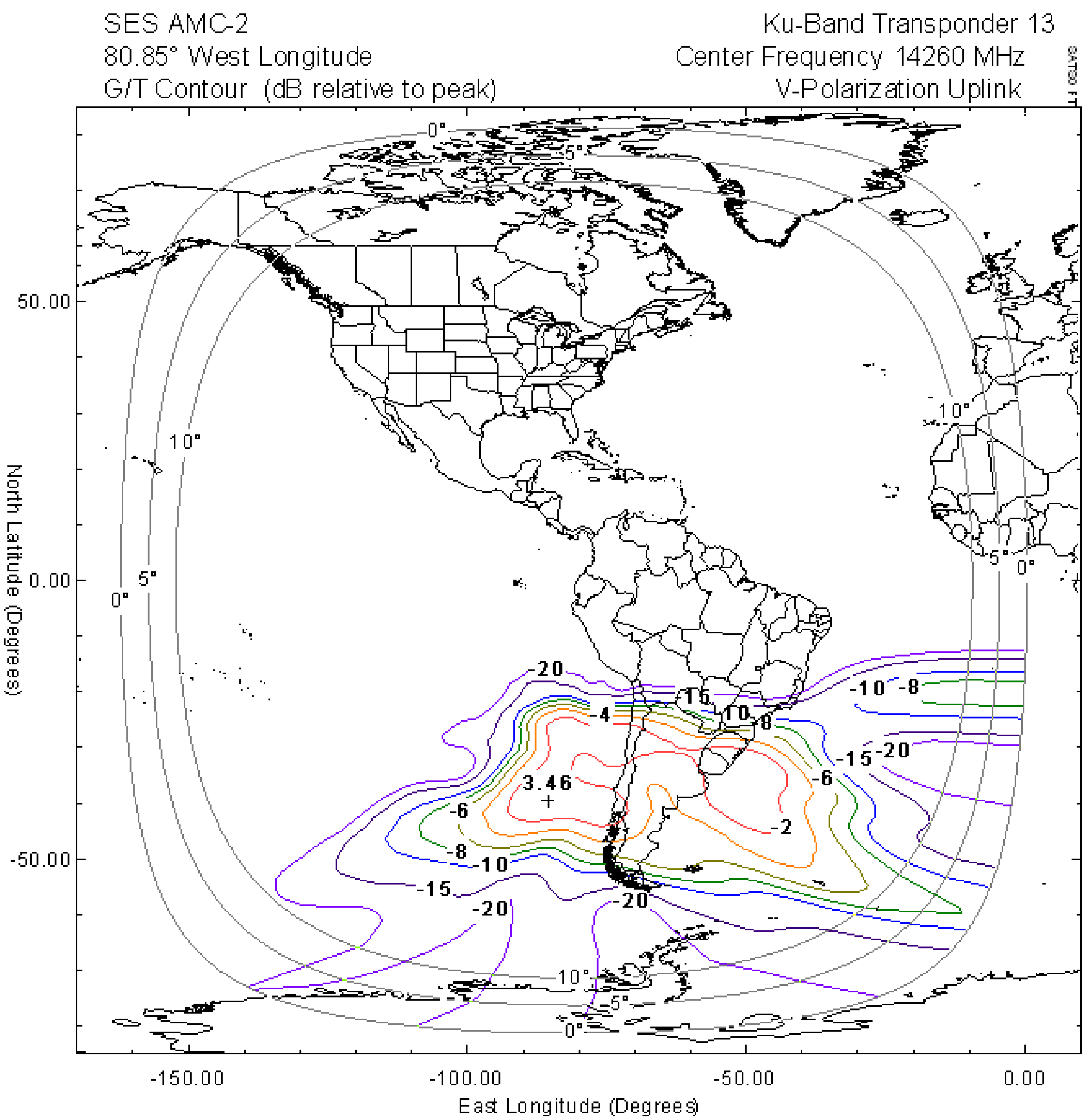

Figure A-2
Receive Beam: KRH
Ku-band, H-pol, Peak Gain: 33.6 dBi, Peak G/T = 5.9 dB/K

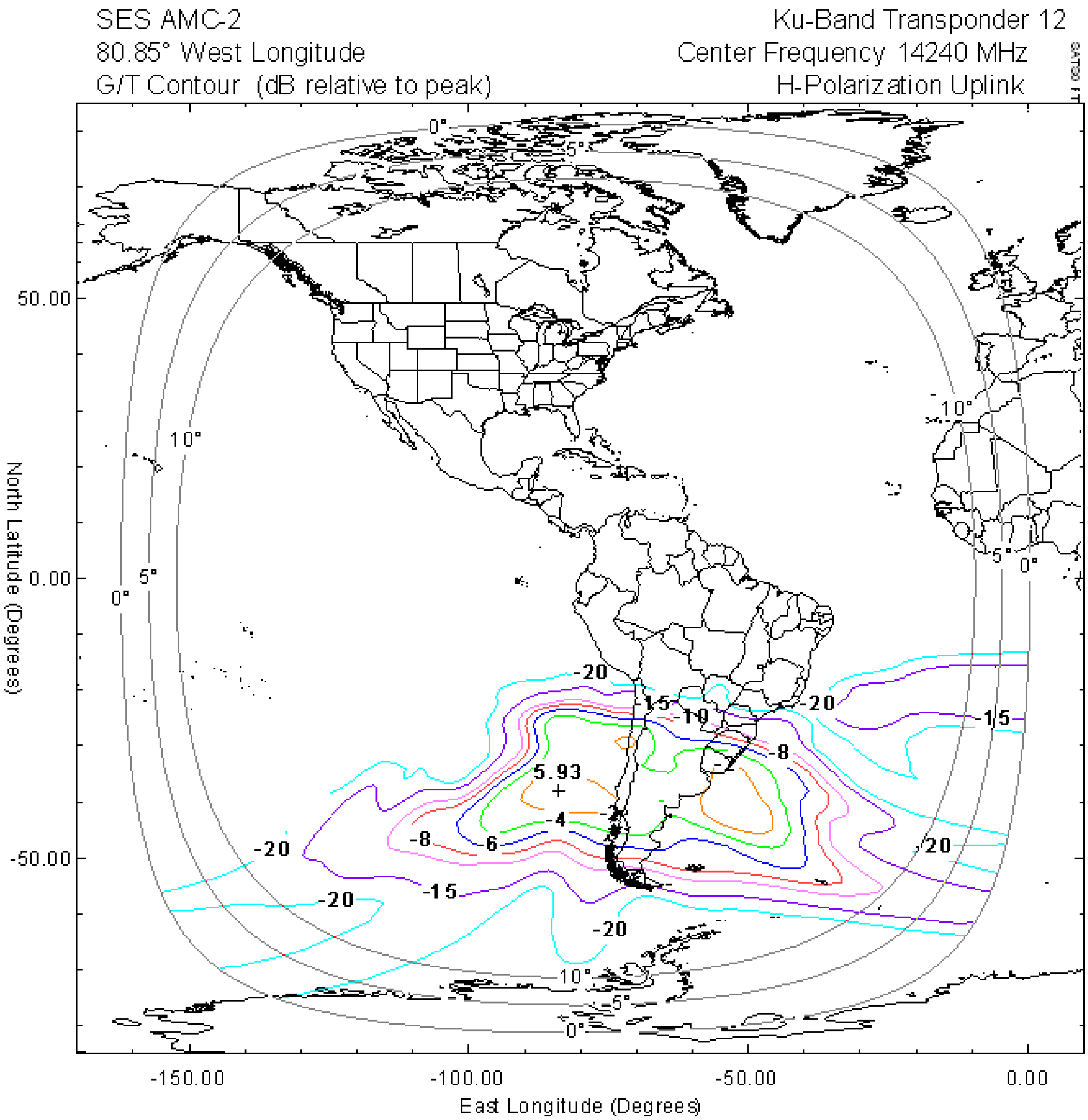

Figure A-3
Transmit Beam: KTV
Ku-band, V-pol, Peak Gain: 33.0 dBi, Peak EIRP = 49.2 dBW

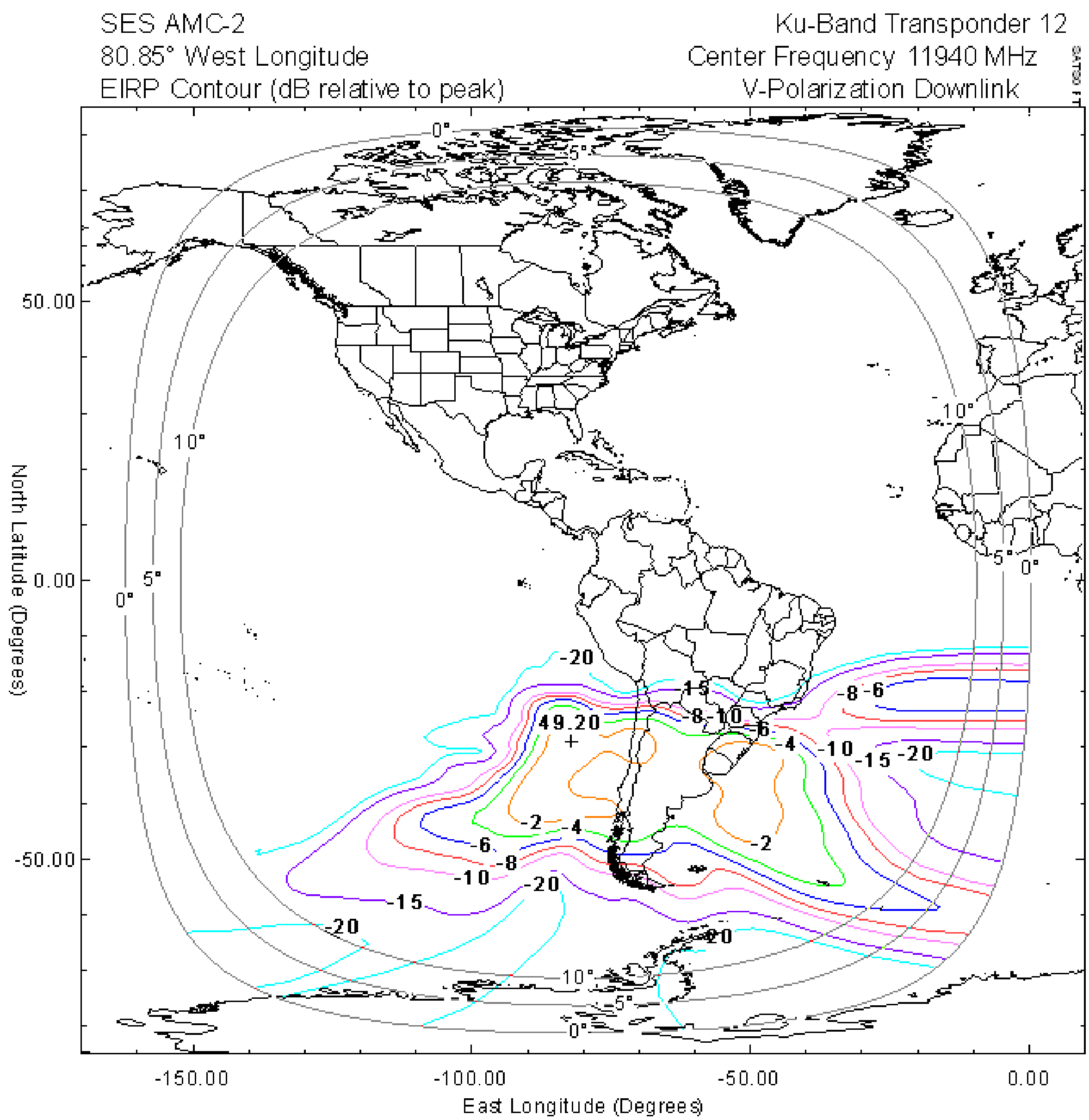

Figure A-4
Transmit Beam: KTH
Ku-band, H-pol, Peak Gain: 33.3 dBi, Peak EIRP = 49.7 dBW

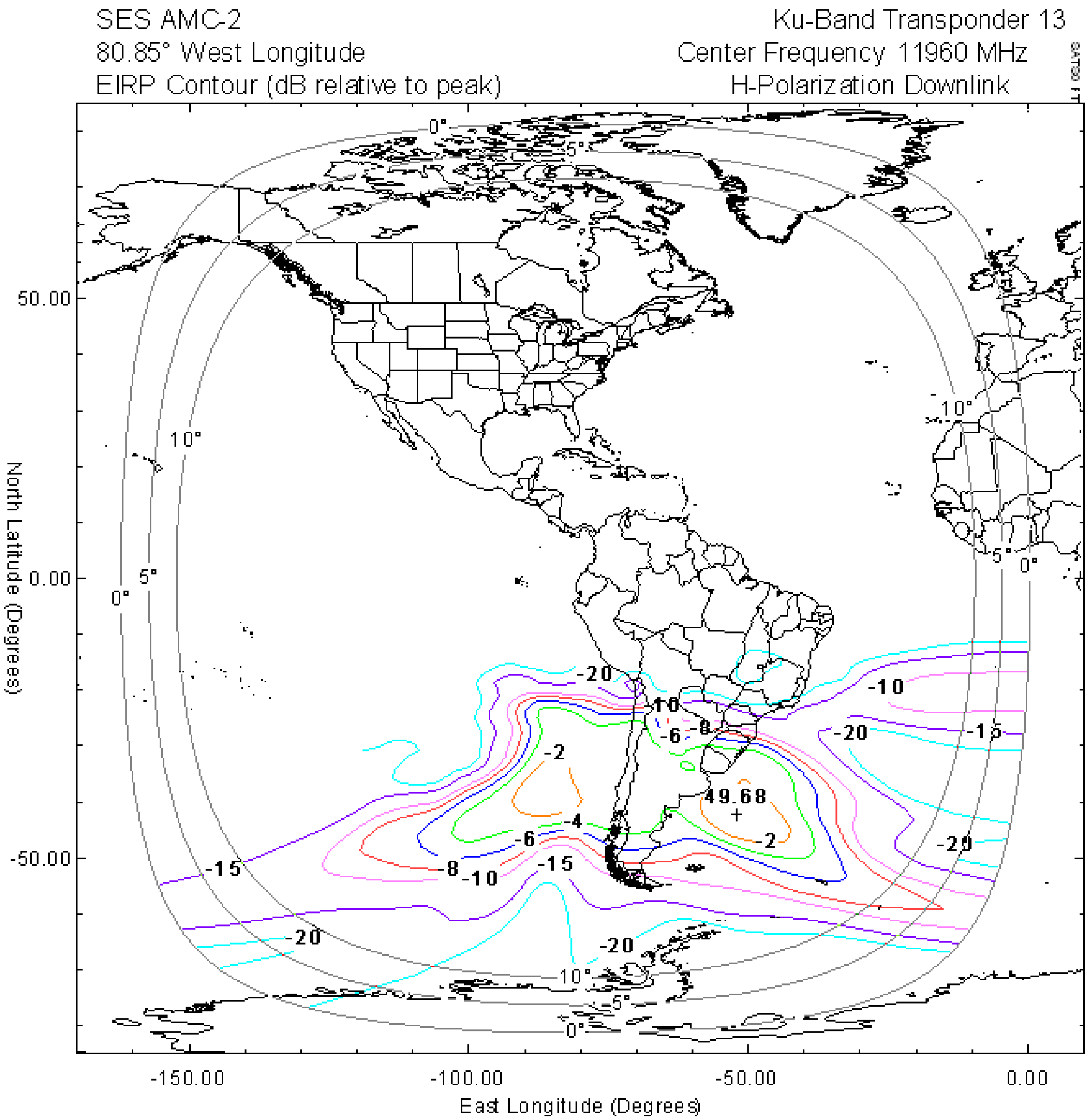

Figure A-5
Receive Beam: CRV
C-band, V-pol, Peak Gain: 31.3 dBi, Peak G/T = 4.1 dB/K

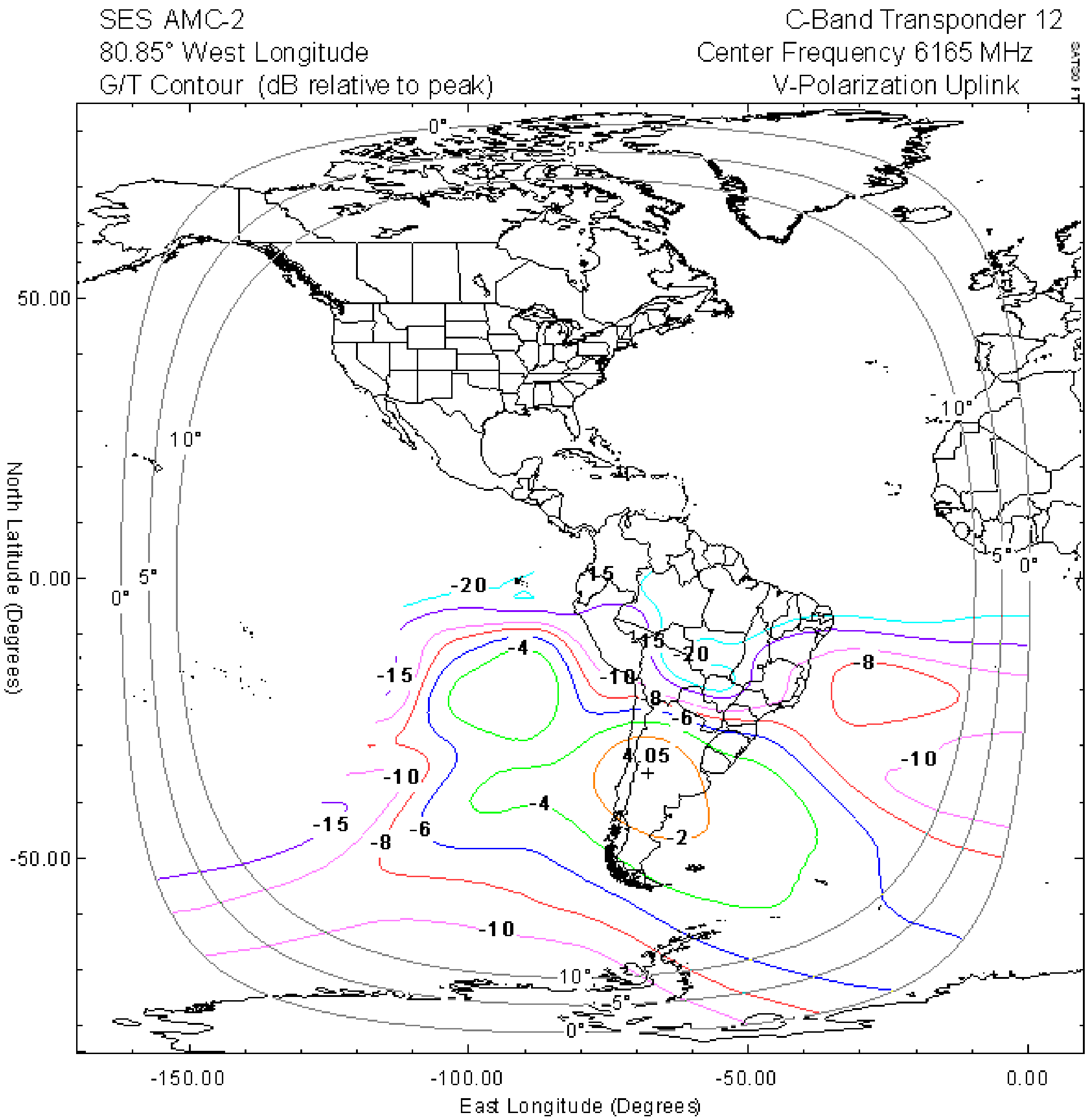

Figure A-6
Receive Beam: CRH
C-band, H-pol, Peak Gain: 32.9 dBi, Peak G/T = 5.8 dB/K

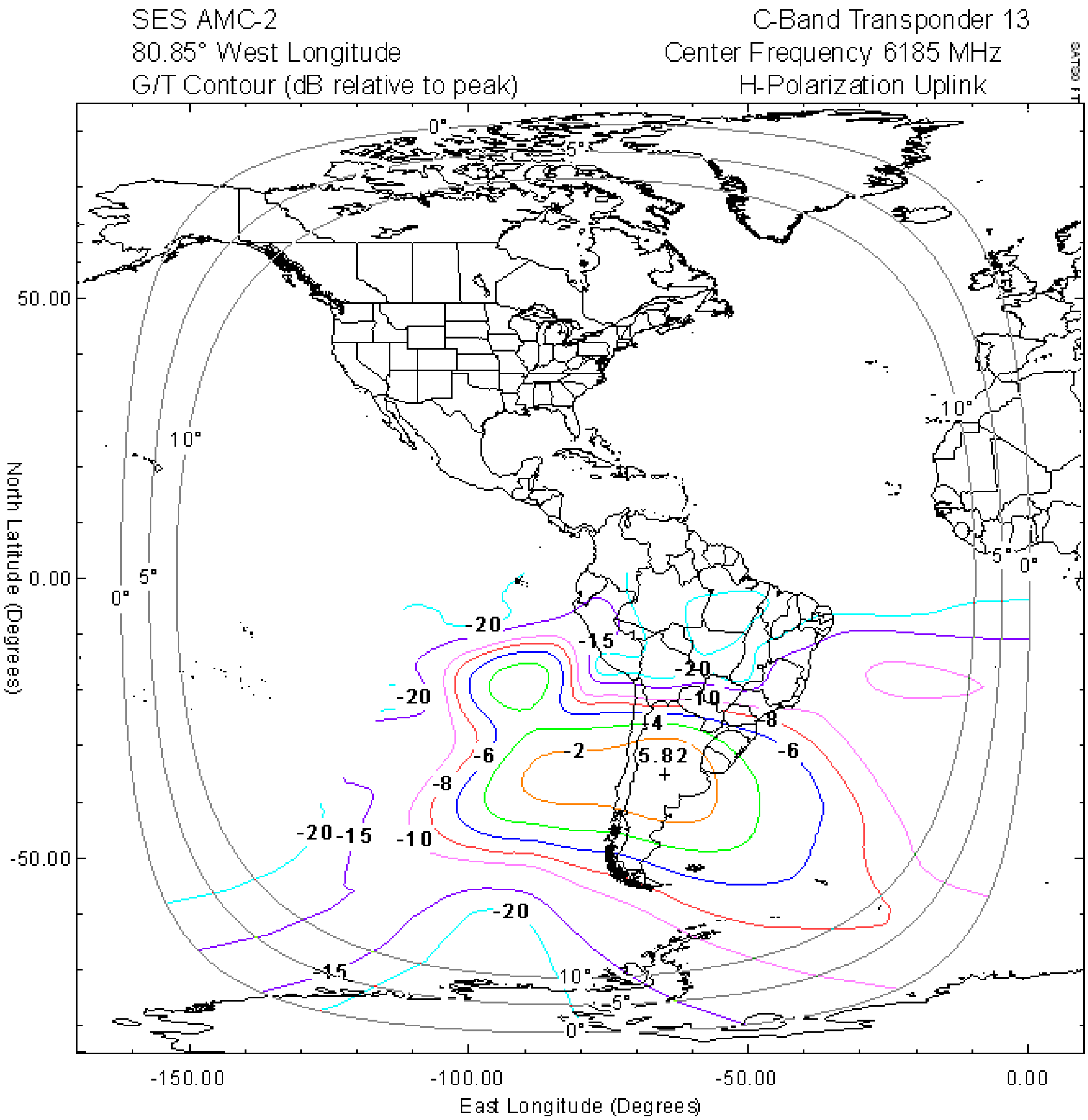

Figure A-7
Transmit Beam: CTV
C-band, V-pol, Peak Gain: 31.0 dBi, Peak EIRP = 42.1 dBW

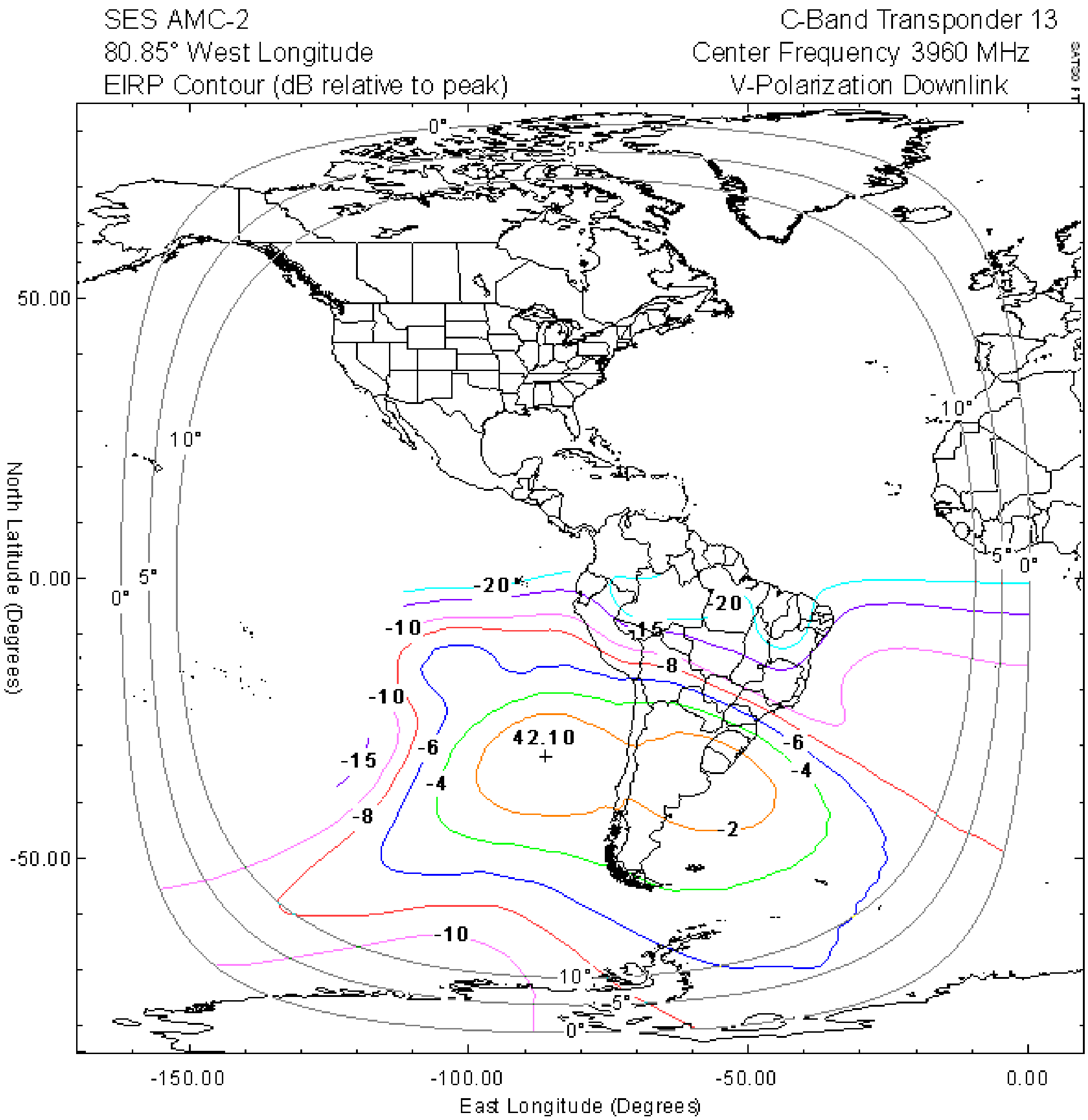

Figure A-8
Transmit Beam: CTH
C-band, H-pol, Peak Gain: 30.3 dBi, Peak EIRP = 40.8 dBW

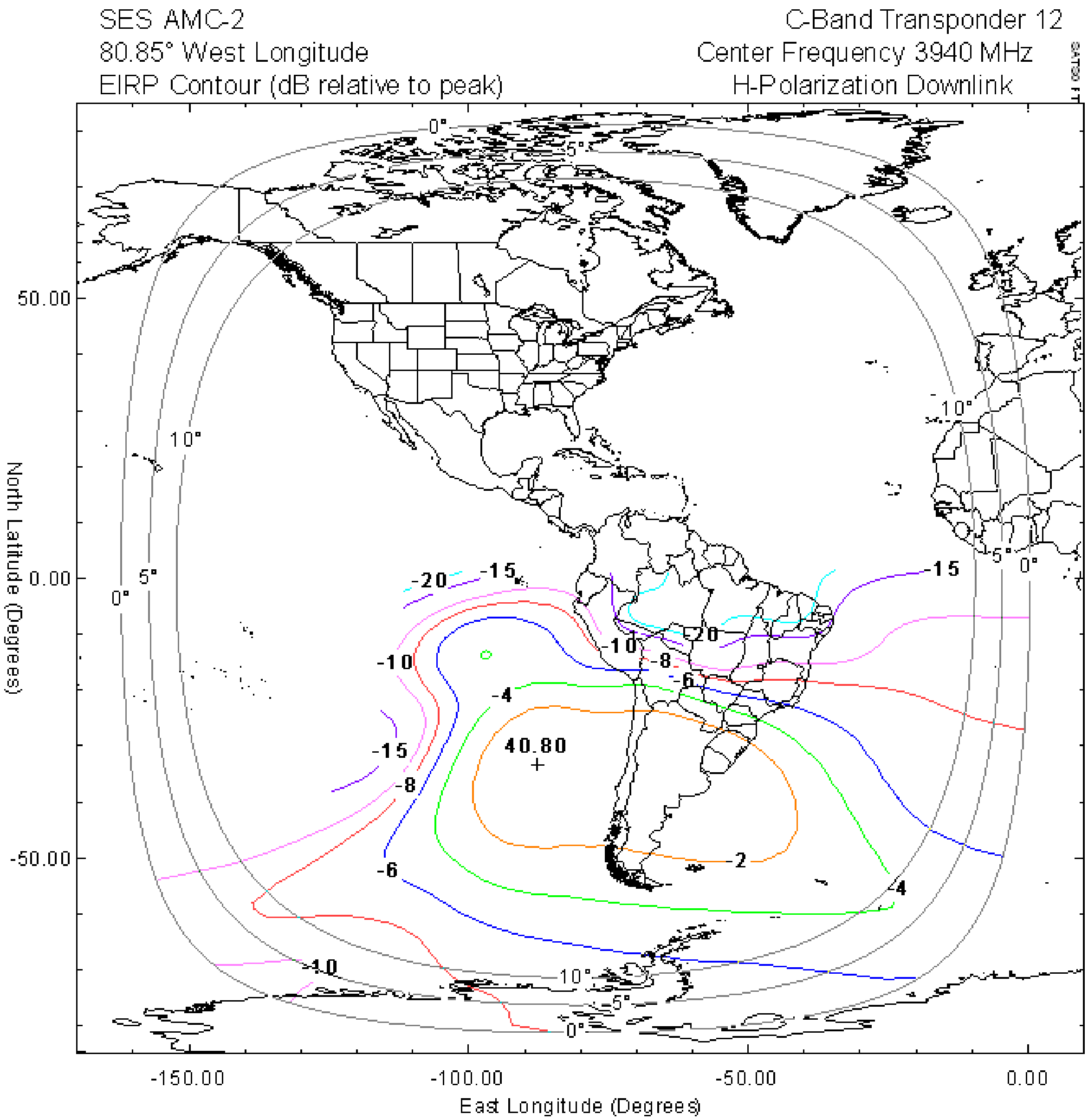

Figure A-9
Global Horn Characteristics

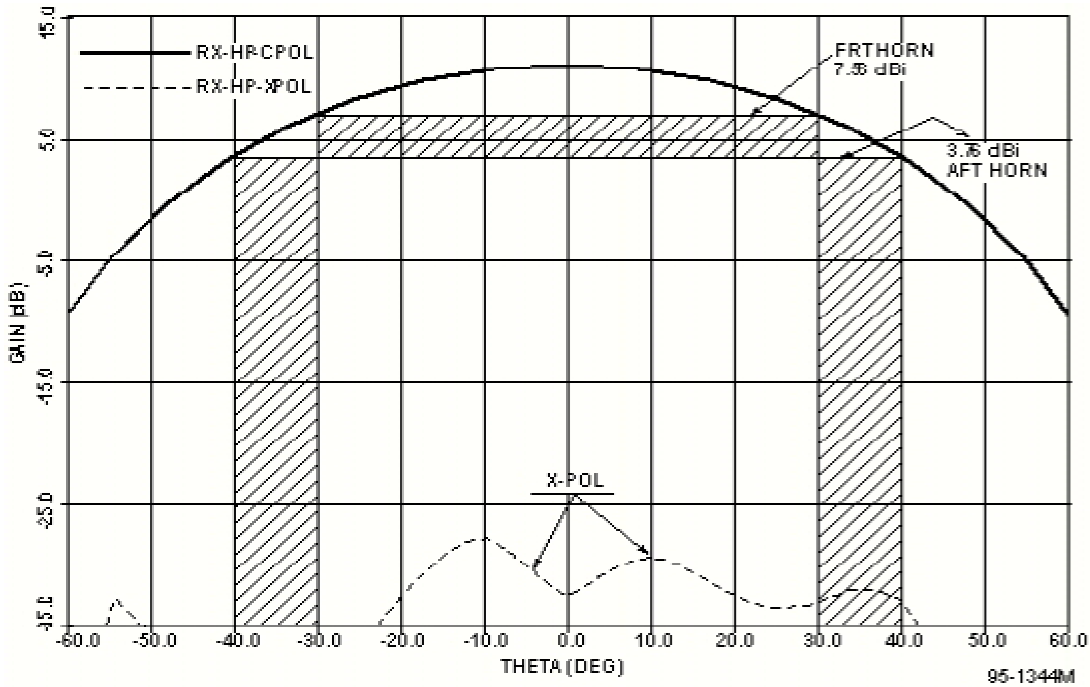

Figure 2.3-4. Measured Performance of Command Horn

ANNEX B

Link Budgets

Table B-1
Ku-Band Link Budgets

Link Parameters	Units	Ku-band				
		6M95G7W	5M04G1W	100KG1W	1M40G7W	36M0G7W
Uplink Frequency	GHz	14.240	14.240	14.240	14.240	14.240
Downlink Frequency	GHz	11.940	11.940	11.940	11.940	11.940
Carrier Allocated Bandwidth	kHz	6950.0	5040.0	55.0	1400.0	36000.0
Energy Dispersal	MHz	n/a	n/a	n/a	n/a	n/a
Uplink:						
Nominal E/S e.i.r.p. per carrier	dBW	61.6	60.2	40.1	54.7	74.8
Earth Station Diameter	m	2.4	2.4	2.4	3.8	6.1
Earth Station Gain	dBi	49.1	49.1	49.1	53.1	57.3
Uplink Input Power per Carrier	dBW	12.5	11.1	-9.0	1.5	17.5
Free Space Loss	dB	206.9	206.9	206.9	206.9	206.9
G/T Satellite	dB/K	0.0	0.0	0.0	0.0	3.0
C/N Thermal Uplink	dB	15.6	15.6	15.6	16.2	24.7
C/I XPOL, ACI, IM, ASI	dB	20.0	20.0	20.0	20.6	26.1
C/(N+I) uplink	dB	14.3	14.3	14.3	14.9	22.3
Downlink:						
Satellite e.i.r.p. per carrier	dBW	35.6	34.2	14.0	28.7	48.5
Maximum e.i.r.p. density	dBW/4kHz	6.9	6.9	6.9	7.4	9.7
Free Space Loss	dB	205.5	205.5	205.5	205.5	205.5
Earth Station Diameter	m	2.4	2.4	2.4	3.8	1.2
Earth Station Gain	dBi	47.7	47.7	47.7	51.7	41.7
Noise Temperature	K	120.0	120.0	120.0	120.0	120.0
Earth Station G/T	dB/K	26.9	26.9	26.9	30.9	20.9
C/N Thermal Downlink	dB	18.0	18.0	18.0	22.6	17.7
C/I XPOL, ACI, IM, ASI	dB	17.7	17.7	17.7	22.2	17.4
C/(N+I) downlink	dB	14.8	14.8	14.8	19.4	14.6
Adjacent Satellite Interference:						
Uplink Inp. Pwr. Dens. @ 2 degrees	dBW/Hz	-50	-50	-50	-50	-50
Downlink e.i.r.p. Dens @ 2 degrees	dBW/Hz	-26	-26	-26	-26	-26
C/I up (single satellite)	dB	23.0	23.0	23.0	23.6	29.1
C/I dn (single satellite)	dB	20.7	20.7	20.7	25.2	20.4
Aggregate C/I up	dB	20.0	20.0	20.0	20.6	26.1
Aggregate C/I down	dB	17.7	17.7	17.7	22.2	17.4
Overall:						
C/(N+I) overall	dB	11.5	11.5	11.5	13.5	13.9
C/(N+I) required	dB	6.9	6.9	6.9	9.3	6.9
System Margin	dB	4.6	4.6	4.6	4.3	7.0

Table B-2
C-Band Link Budgets

Link Parameters	Units	C-band				
		9M00G7W	1M51G7W	100KG1D	4M05G7W	36M0G7W
Uplink Frequency	GHz	6.185	6.185	6.185	6.185	6.250
Downlink Frequency	GHz	3.960	3.960	3.960	3.960	3.950
Carrier Allocated Bandwidth	kHz	9000.0	1510.0	55.0	4050.0	36000.0
Energy Dispersal	MHz	n/a	n/a	n/a	n/a	n/a
Uplink:						
Nominal E/S e.i.r.p. per carrier	dBW	57.1	52.3	38.7	53.4	76.1
Earth Station Diameter	m	3.8	3.8	3.8	3.8	9.0
Earth Station Gain	dBi	45.9	45.9	45.9	45.9	53.5
Uplink Input Power per Carrier	dBW	11.3	6.4	-7.2	7.5	22.6
Free Space Loss	dB	199.7	199.7	199.7	199.7	199.7
G/T Satellite	dB/K	0.0	0.0	-2.9	2.1	1.3
C/N Thermal Uplink	dB	17.8	20.7	18.6	19.6	31.6
C/I XPOL, ACI, IM, ASI	dB	12.0	14.8	15.7	14.6	24.4
C/(N+I) uplink	dB	11.0	13.8	13.9	13.4	23.7
Downlink:						
Satellite e.i.r.p. per carrier	dBW	25.3	20.5	4.0	17.6	37.0
Maximum e.i.r.p. density	dBW/4kHz	-4.8	-1.9	-4.0	-9.0	-1.8
Free Space Loss	dB	195.9	195.9	195.9	195.9	195.9
Earth Station Diameter	m	3.8	3.8	3.8	3.8	3.8
Earth Station Gain	dBi	42.1	42.1	42.1	42.1	42.1
Noise Temperature	K	100.0	100.0	100.0	100.0	100.0
Earth Station G/T	dB/K	22.1	22.1	22.1	22.1	22.1
C/N Thermal Downlink	dB	11.9	14.8	12.7	7.7	17.0
C/I XPOL, ACI, IM, ASI	dB	12.2	15.1	13.0	9.0	17.3
C/(N+I) downlink	dB	9.1	11.9	9.9	5.3	14.2
Adjacent Satellite Interference:						
Uplink Inp. Pwr. Dens. @ 2 degrees	dBW/Hz	-47	-47	-47	-50	-47
Downlink e.i.r.p. Dens @ 2 degrees	dBW/Hz	-37	-37	-37	-38	-37
C/I up (single satellite)	dB	15.0	17.8	18.7	17.6	27.4
C/I dn (single satellite)	dB	15.2	18.1	16.0	12.0	20.3
Aggregate C/I up	dB	12.0	14.8	15.7	14.6	24.4
Aggregate C/I down	dB	12.2	15.1	13.0	9.0	17.3
Overall:						
C/(N+I) overall	dB	6.9	9.8	8.4	4.7	13.7
C/(N+I) required	dB	4.1	6.9	6.9	4.1	6.9
System Margin	dB	2.7	2.9	1.5	0.5	6.8

Table B-3
TT&C Link Budgets

Link Parameters	Units	TT&C		
		800KF9D	**300KF9D**	**300KF9D**
Uplink Frequency	GHz	6.424		
Downlink Frequency	GHz		3.701	12.198
Carrier Allocated Bandwidth	kHz	800.0	300.0	300.0
Energy Dispersal	MHz	n/a	n/a	n/a
Uplink:				
Nominal E/S e.i.r.p. per carrier	dBW	72.0		
Earth Station Diameter	m	9.0		
Earth Station Gain	dBi	53.0		
Uplink Input Power per Carrier	dBW	19.0		
Free Space Loss	dB	199.7		
G/T Satellite	dB/K	-17.5		
C/N Thermal Uplink	dB	24.4		
C/I XPOL, ACI, IM, ASI	dB	36.0		
C/(N+I) uplink	dB	24.1		
Downlink:				
Satellite e.i.r.p. per carrier	dBW		11.8	12.4
Maximum e.i.r.p. density	dBW/4kHz		-7.0	-6.4
Free Space Loss	dB		195.9	205.5
Earth Station Diameter	m		9.0	9.0
Earth Station Gain	dBi		49.0	59.3
Noise Temperature	K		100.0	120.0
Earth Station G/T	dB/K		29.0	38.5
C/N Thermal Downlink	dB		18.7	19.3
C/I XPOL, ACI, IM, ASI	dB		19.0	19.0
C/(N+I) downlink	dB		15.8	16.2
Adjacent Satellite Interference:				
Uplink Inp. Pwr. Dens. @ 2 degrees	dBW/Hz	-47	-47	-50
Downlink e.i.r.p. Dens @ 2 degrees	dBW/Hz	-37	-37	-26
C/I up (single satellite)	dB	39.0	999.0	999.0
C/I dn (single satellite)	dB	999.0	22.0	22.0
Aggregate C/I up	dB	36.0	999.0	999.0
Aggregate C/I down	dB	999.0	19.0	19.0
Overall:				
C/(N+I) overall	dB	24.1	15.8	16.2
C/(N+I) required	dB	10.0	9.0	9.0
System Margin	dB	14.1	6.8	7.2

ANNEX C

Interference Analysis

Interference Analysis

The interference analysis is divided into two sections. The first estimates interference levels using a generic approach, *i.e.*, the two adjacent systems are assumed to be identical and spaced at two degrees. The second section investigates the specific case of interference between AMC-2 and two adjacent systems, AMC-9 and DIRECTV KU-79, using published emission characteristics.

<u>Generic Two Degree Spacing Analysis</u>

This portion of the analysis intends to provide a rough estimate of the interference between two networks with an orbital longitude separation of two degrees. Several simplifying assumptions are made:

- The power densities of the wanted and interfering networks are assumed to be the same.
- Any difference in propagation loss between the wanted and interfering networks is ignored.
- Stationkeeping tolerance and earth station pointing errors are ignored.

Uplink

The uplink C/I ratio is calculated from the following equations:

$$C/N_{UP} = PD_{ES,W} + G_{ES,W}(\theta_W) - PL + G/T_{SS,W} - k$$

$$I/N_{UP} = PD_{ES,I} + G_{ES,I}(\theta_I) - PL + G/T_{SS,I} - k$$

$$C/I_{UP} = C/N_{UP} - I/N_{UP}$$

where:

C/N_{UP} = uplink wanted carrier-to-noise ratio, dB

$PD_{ES,W}$ = power density of wanted earth station emission, dBW/Hz

$G_{ES,W}(\theta_W)$ = gain of wanted earth station in direction of wanted space station, dBi

PL = propagation loss, dB

$G/T_{SS,W}$ = wanted space station G/T in direction of wanted earth station, dB/K

k = Boltzmann constant, dBJ/K

I/N_{UP} = uplink interference-to-noise ratio, dB

$PD_{ES,I}$ = power density of interfering earth station emission, dBW/Hz

$G_{ES,I}(\theta_I)$ = gain of interfering earth station in direction of wanted space station, dBi

$G/T_{SS,I}$ = wanted space station G/T in direction of interfering earth station, dB/K

C/I_{UP} = uplink carrier-to-interference ratio, dB

Assuming that the power densities of the wanted and interfering emissions are the same, and ignoring any difference in propagation loss between the wanted space station and the wanted and interfering earth stations, C and I can be combined to give:

$$C/I_{UP} = G_{ES,W}(\theta_W) - G_{ES,I}(\theta_I) + \Delta G/T$$

with:

$$\Delta G/T = G/T_{SS,W} - G/T_{SS,I}$$

Thus, the uplink C/I can be estimated using the gains of the earth stations and an assumption defining the locations of the wanted and interfering earth stations relative to the wanted space station beam boresight (*i.e.*, on which G/T contour the earth stations are located).

Ignoring pointing errors ($\theta_W = 0$), the wanted earth station gain is just the peak value. For a longitude separation of 2.0 degrees, the topocentric angle is approximately 2.2 degrees.

Assuming an antenna gain reference pattern of 29 – 25 * log(φ),[6] the gain of the interfering earth station toward the wanted space station is 29 – 25 * log(2.2) = 20.4 dBi.

Using these values in the expression for C/I_{UP} gives:

$$C / I_{UP} = G_{ES,W}(0) - 20.4 + \Delta G / T$$

This relationship can be used to estimate the uplink C/I for typical earth station antenna gain values with varying levels of G/T contour mismatch between the two satellites:

[6] According to Section 29.209(c)(1), receiving earth stations are afforded protection to the extent that they meet the 25.209(a) and (b) masks at 1.5 degrees off-axis.

Table C-1: Uplink C/I at Two Degree Spacing

Uplink			
Parameter		Value	Value
Orbital separation (◦)		2.0	2.0
Topocentric angle (◦)		2.2	2.2
Off-axis gain (dB)		20.4	20.4
Ku-band			
ΔG/T (dB)		-2.0	0.0
Earth station			
Diameter (m)	Gain (dBi)	C/I (dB)	C/I (dB)
1.2	43.2	20.8	22.8
1.8	46.7	24.3	26.3
2.4	49.2	26.8	28.8
4.5	54.7	32.2	34.2
6.0	57.2	34.7	36.7
C-band			
ΔG/T (dB)		-1.0	0.0
Earth station			
Diameter (m)	Gain (dBi)	C/I (dB)	C/I (dB)
3.8	46.0	24.6	25.6
4.5	47.5	26.1	27.1
6.0	50.0	28.6	29.6
7.5	51.9	30.5	31.5
9.0	53.5	32.1	33.1
Worst-case			
C/I (dB)		20.8	22.8
Assumed C/N (dB)		8.0	8.0
I/N (dB)		-12.8	-14.8
ΔT/T (%)		5.3	3.3
Increase in noise temperature (dB)		0.22	0.14

Assuming that the minimum (*i.e.*, threshold) C/N for a digital service is 8 dB, the effect of the worst-case Ku-band C/I (20.8 dB) from the 1.2 m diameter earth station in Table C-1 above would only degrade the C/N by 0.22 dB, equivalent to an increase of 5.3% in the wanted system noise temperature.

For C-band, the worst-case C/I (24.6 dB) into the 3.8 m diameter earth station in Table C-1 above would degrade the C/N by 0.09 dB, equivalent to an increase of 2.2% in the wanted system noise temperature.

These values are less than the ITU coordination trigger criteria; *i.e.*, internationally, if a 6% increase in noise temperature is not exceeded, then coordination is not needed between the concerned networks.

Downlink

For the downlink, the C/I ratio is estimated based on the wanted and interfering receive power densities:

$$C_{DN} = ED_{SS,W} + GC_{SS,W} - PL + G_{ES,W}(\theta_W)$$

$$I_{DN} = ED_{SS,I} + GC_{SS,I} - PL + G_{ES,W}(\theta_I)$$

$$C/I_{DN} = C_{DN} - I_{DN}$$

where:

C_{DN} = downlink wanted receive power density, dBW/Hz

$ED_{SS,W}$ = peak EIRP density of wanted space station emission, dBW/Hz

$GC_{SS,W}$ = gain contour of wanted space station in direction of wanted earth station (non-positive number), dB

I_{DN} = downlink interfering receive power density, dBW/Hz

$ED_{SS,I}$ = peak EIRP density of interfering space station emission, dBW/Hz

$GC_{SS,I}$ = gain contour of interfering space station in direction of wanted earth station (non-positive number), dB

$G_{ES,W}(\theta_I)$ = gain of wanted earth station in direction of interfering space station, dBi

C/I_{DN} = downlink carrier-to-interference ratio, dB

Again, assuming equal signal power densities and propagation losses between the competing networks, the downlink C/I can be expressed as:

$$C/I_{DN} = G_{ES,W}(\theta_W) - G_{ES,W}(\theta_I) + \Delta GC$$

with:

$$\Delta GC = GC_{SS,W} - GC_{SS,I}$$

Thus, the downlink C/I can be estimated using the gain of the wanted earth station and an assumption defining the location of the wanted earth station relative to the wanted and interfering space station beam boresights (*i.e.*, on which EIRP contours the earth station is located).

Ignoring the earth station pointing error and using a gain reference pattern of 29 – 25 * log(φ)), the downlink C/I can be reduced to:

$$C / I_{DN} = G_{ES,W}(0) - 20.4 + \Delta GC$$

This relationship can be used to estimate the downlink C/I for typical earth station antenna gain values with varying levels of EIRP (ΔGC) degradation:

Table C-2: Downlink C/I at Two Degree Spacing

Downlink			
Parameter		Value	Value
Orbital separation (◦)		2.0	2.0
Topocentric angle (◦)		2.2	2.2
Off-axis gain (dB)		20.4	20.4
Ku-band			
ΔGC (dB)		-2.0	0.0
Earth station			
Diameter (m)	Gain (dBi)	C/I (dB)	C/I (dB)
1.2	41.7	19.2	21.2
1.8	45.2	22.7	24.7
2.4	47.7	25.2	27.2
4.5	53.1	30.7	32.7
6.0	55.6	33.2	35.2
C-band			
ΔGC (dB)		-1.0	0.0
Earth station			
Diameter (m)	Gain (dBi)	C/I (dB)	C/I (dB)
3.8	42.1	21.6	21.6
4.5	43.5	23.1	23.1
6.1	46.2	25.7	25.7
7.5	48.0	27.5	27.5
Worst-case			
C/I (dB)		19.2	21.2
Assumed C/N (dB)		8.0	8.0
I/N (dB)		-11.2	-13.2
ΔT/T (%)		7.5	4.8
Increase in noise temperature (dB)		0.32	0.20

Assuming that the minimum (*i.e.*, threshold) C/N for a digital service is 8 dB, the effect of the worst-case Ku-band C/I (19.2 dB) into the 1.2 m diameter earth station in Table C-2 above would degrade the C/N by 0.32 dB, equivalent to an increase of 7.5% in the wanted system noise temperature. Although this is above the typical criteria of 6%, the wanted system link degradation is still less than 0.5 dB, which is likely to be significantly less than the link margin.

For C-band, the worst-case C/I (21.6 dB) into the 3.8 m diameter earth station in Table C-2 above would degrade the C/N by 0.18 dB, equivalent to an increase of 4.3% in the wanted system noise temperature, which is within the 6% coordination threshold.

Specific C/I Analysis

For this portion of the analysis, the carrier-to-interference ratio between two adjacent systems is estimated for a set of competing emissions. The analysis methodology consists of defining the emission characteristics for each network and computing the interference levels resulting from co-channel operation. C/I levels are calculated for each combination of overlapping emissions (*i.e.*, the same frequency band and link direction). Results are presented in tables providing the interference levels for combinations of emissions pairs.

The worst-case geometry for the earth and space stations is assumed. That is, the space stations are positioned closer to each other by their respective stationkeeping tolerances and the earth station is mispointed toward the interfering space station by an assumed pointing error.

The equations and parameter definitions presented above can be used to express the uplink and downlink C/I as follows:

$$C/I_{UP} = (PD_{ES,W} - PD_{ES,I}) + (G_{ES,W}(\theta_W) - G_{ES,I}(\theta_I)) + \Delta G/T$$

$$C/I_{DN} = (ED_{SS,W} - ED_{SS,I}) + (G_{ES,W}(\theta_W) - G_{ES,W}(\theta_I)) + \Delta GC$$

Here the uplink C/I is estimated using the emission power densities and gains of the earth stations, and an assumption defining the locations of the wanted and interfering earth stations relative to the wanted space station beam boresight. And the downlink C/I is estimated using the wanted and interfering space station emission EIRP densities, the gain of the wanted earth station, and an assumption defining the location of the wanted earth station relative to the wanted and interfering space station beam boresights.

The off-axis performance of the earth station antenna is modeled using Part 25 Section 25.209. According to Section 29.209(c)(1), receiving earth stations are afforded protection to the extent that they meet the 25.209(a) and (b) masks at 1.5 degrees off-axis. Therefore, all receiving earth stations are assumed to meet this mask in the interference analysis contained herein. Note that this antenna pattern does not define gain values for angles less than 1.5 degrees. In order to account for earth station pointing errors, a parabolic main beam model is used for gain values at small off-axis angles ($G_{MAX} – 0.0025 * (D/\lambda * \varphi) ^ 2$).

Earth station topocentric off-axis angles are approximated by adding 10% to the geocentric angular separation, taking into account the satellite stationkeeping tolerance and earth station pointing error.

System characteristics used in the analysis are shown in the following tables. Three networks are considered: AMC-2 and two adjacent systems, AMC-9 and DIRECTV KU-79W.

Table C-3 provides the space station name and orbital information, and assumed earth station parameters of the networks.

Table C-3: Station Parameters

Parameter	System 1A	System 1B	System 2
Space station name	AMC-9	DIRECTV KU-79W	AMC-2
Nominal orbit location (+E, -W)	-83.00	-79.00	-80.85
Stationkeeping tolerance (◦)	0.05	0.05	0.15
Earth station pointing error (◦)	0.10	0.10	0.10
Earth station antenna efficiency (fraction)	0.65	0.65	0.65

This analysis considers the digital emissions signals of both networks. Analog TV/FM signals are coordinated on a case-by-case basis with nearby spacecraft, and are therefore not addressed in this analysis. Digital signals are more robust and operate typically down to much lower C/N ratios than analog signals, and therefore are more tolerant of interference.

Tables C-4a and C-4b show the AMC-9 and DIRECTV KU-79W emission characteristics considered here (derived from the respective Schedule S files).

Table C-4a: AMC-9 Typical Emissions

Ku-band							
Uplink				Downlink			
Emission	Frequency (MHz)	ES power density (dBW/Hz)	ES gain (dBi)	Emission	Frequency (MHz)	SS EIRP density (dBW/Hz)	ES gain (dBi)
36M0G7W	14020.0	-48.6	57.3	36M0G7W	11720.0	-21.3	37.9
6M95G1W	14020.0	-52.7	53.0	6M95G1W	11720.0	-20.8	46.4
36M0G7W	14020.0	-49.1	57.3	36M0G7W	11720.0	-21.8	45.6
36M0G7W	14020.0	-52.7	60.7	36M0G7W	11720.0	-22.0	53.6
100KG1W	14020.0	-42.1	46.7	100KG1W	11720.0	-18.4	39.6
1M35G7W	14020.0	-46.5	46.7	1M35G7W	11720.0	-20.9	45.6

C-band							
Uplink				Downlink			
Emission	Frequency (MHz)	ES power density (dBW/Hz)	ES gain (dBi)	Emission	Frequency (MHz)	SS EIRP density (dBW/Hz)	ES gain (dBi)
36M0G7W	5945.0	-47.9	53.8	36M0G7W	3720.0	-33.2	42.3
6M95G1W	5945.0	-56.4	53.8	6M95G1W	3720.0	-32.7	43.7
36M0G7W	5945.0	-48.4	53.8	36M0G7W	3720.0	-33.7	49.8
36M0G7W	5945.0	-48.6	53.8	36M0G7W	3720.0	-33.9	49.8
100KG1W	5945.0	-47.9	47.8	100KG1W	3720.0	-30.3	42.3
1M35G7W	5945.0	-47.1	47.8	1M35G7W	3720.0	-32.8	42.3

Source: AMC-9 Schedule S

Table C-4b: DIRECTV KU-79W Typical Emissions

Ku-band							
Uplink				Downlink			
Emission	Frequency (MHz)	ES power density (dBW/Hz)	ES gain (dBi)	Emission	Frequency (MHz)	SS EIRP density (dBW/Hz)	ES gain (dBi)
36M0G7W	14020.0	-58.6	59.8	36M0G7W	11720.0	-21.6	34.8
36M0G7W	14020.0	-58.6	59.8	36M0G7W	11720.0	-21.6	34.8
1M30F9D	14005.0	-48.9	59.8	106KG9D	11704.0	-35.0	55.9

Source: DIRECTV KU-79W Schedule S

Table C-5 shows the AMC-2 emission characteristics considered here (derived from the Schedule S file).

Table C-5: AMC-2 Typical Emissions

Ku-band							
Uplink				Downlink			
Emission	Frequency (MHz)	ES power density (dBW/Hz)	ES gain (dBi)	Emission	Frequency (MHz)	SS EIRP density (dBW/Hz)	ES gain (dBi)
6M95G7W	14020.0	-55.1	49.1	6M95G7W	11720.0	-29.1	47.7
5M04G1W	14020.0	-55.1	49.1	5M04G1W	11720.0	-29.1	47.7
100KG1W	14020.0	-55.1	49.1	100KG1W	11720.0	-29.2	47.7
1M40G7W	14020.0	-58.6	53.1	1M40G7W	11720.0	-28.5	51.7
36M0G7W	14020.0	-57.3	57.3	36M0G7W	11720.0	-26.3	41.7
				300KF9D	12198.0	-42.4	58.5

C-band							
Uplink				Downlink			
Emission	Frequency (MHz)	ES power density (dBW/Hz)	ES gain (dBi)	Emission	Frequency (MHz)	SS EIRP density (dBW/Hz)	ES gain (dBi)
9M00G7W	5945.0	-56.9	45.9	9M00G7W	3720.0	-40.8	42.1
1M51G7W	5945.0	-54.1	45.9	1M51G7W	3720.0	-37.9	42.1
100KG1D	5945.0	-53.3	45.9	100KG1D	3720.0	-40.0	42.1
4M05G7W	5945.0	-57.3	45.9	4M05G7W	3720.0	-45.1	42.1
36M0G7W	5945.0	-52.2	53.5	36M0G7W	3720.0	-37.8	42.1
800KF9D	6423.5	-40.0	53.0	300KF9D	3700.5	-43.0	49.0

Source: AMC-2 Schedule S

Applying the methodology present above to the emission characteristics shown in Tables C-4 and C-5 results in the C/I levels shown in Appendix 1 to this Annex (Tables A1-1 through A1-4 for AMC-9/AMC-2 and Tables A1-5 and A1-6 for DIRECTV KU-79W/AMC-2). A separate table is provided for each frequency band/link direction pair that shows the C/I level for each emission pair.

The worst-case C/I levels extracted from the tables in Appendix 1 for each band and link direction are summarized in Table C-6. This table also shows the resulting impact to the wanted links assuming a threshold C/N of 8 dB.

Table C-6: Worst-Case C/I and Impact to Wanted Links

Worst-case interference from AMC-2 into AMC-9					
Link	Worst-case C/I (dB)	C/N (dB)	I/N (dB)	ΔT/T (%)	Inc. in Noise (dB)
Ku-band uplink	50.4	8.0	-42.4	0.0	0.00
Ku-band downlink	38.6	8.0	-30.6	0.1	0.00
C-band uplink	32.2	8.0	-24.2	0.4	0.02
C-band downlink	42.6	8.0	-34.6	0.0	0.00

Worst-case interference from AMC-9 into AMC-2					
Link	Worst-case C/I (dB)	C/N (dB)	I/N (dB)	ΔT/T (%)	Inc. in Noise (dB)
Ku-band uplink	31.5	8.0	-23.5	0.4	0.02
Ku-band downlink	27.5	8.0	-19.5	1.1	0.05
C-band uplink	31.3	8.0	-23.3	0.5	0.02
C-band downlink	23.0	8.0	-15.0	3.2	0.13

Worst-case interference from AMC-2 into DIRECTV KU-79W					
Link	Worst-case C/I (dB)	C/N (dB)	I/N (dB)	ΔT/T (%)	Inc. in Noise (dB)
Ku-band uplink	46.5	8.0	-38.5	0.0	0.00
Ku-band downlink	33.3	8.0	-25.3	0.3	0.01

Worst-case interference from DIRECTV KU-79W into AMC-2					
Link	Worst-case C/I (dB)	C/N (dB)	I/N (dB)	ΔT/T (%)	Inc. in Noise (dB)
Ku-band uplink	36.5	8.0	-28.5	0.1	0.01
Ku-band downlink	28.8	8.0	-20.8	0.8	0.04

As can be seen from these results, the interference between the networks is well below the 6% coordination threshold. This is essentially due to the isolation between the competing networks' space station beams. The adjacent networks serve divergent geographic regions, which provides at least 20 dB of isolation (a conservative assumption of 17 dB is used in the analysis).

APPENDIX 1

C/I CALCULATIONS

Table A1-1: AMC-9/AMC-2 Ku-Band Uplink C/I

Ku-band Uplink C/I	System 1	System 2
Space station name	AMC-9	AMC-2
Nominal orbit location (+E, -W)	-83.00	-80.85
Stationkeeping tolerance (◦)	0.05	0.15
Assumed orbit location (+E, -W)	-82.95	-81.00
Longitude separation (◦)	1.95	1.95
Earth station pointing error (◦)	0.10	0.10
Earth station antenna efficiency (fraction)	0.65	0.65
Earth station angle toward wanted space station(◦)	2.05	2.05
Difference in wanted space station G/T toward wanted and interfering earth stations (dB)	17.0	17.0

AMC-2 into AMC-9

Wanted AMC-9 Emisssions				Interfering AMC-2 Emisssions				
Emission				6M95G7W	5M04G1W	100KG1W	1M40G7W	36M0G7W
	Frequency (MHz)			14020.0	14020.0	14020.0	14020.0	14020.0
		ES power density (dBW/Hz)		-55.1	-55.1	-55.1	-58.6	-57.3
			ES gain (dBi)	49.1	49.1	49.1	53.1	57.3
36M0G7W	14020.0	-48.6	57.3	57.5	57.5	57.5	61.0	59.6
6M95G1W	14020.0	-52.7	53.0	50.4	50.4	50.4	53.9	52.5
36M0G7W	14020.0	-49.1	57.3	57.0	57.0	56.9	60.5	59.1
36M0G7W	14020.0	-52.7	60.7	54.3	54.3	54.3	57.8	56.4
100KG1W	14020.0	-42.1	46.7	55.3	55.3	55.3	58.8	57.5
1M35G7W	14020.0	-46.5	46.7	50.9	50.9	50.9	54.4	53.1

AMC-9 into AMC-2

Interfering AMC-9 Emisssions				Wanted AMC-2 Emisssions				
Emission				6M95G7W	5M04G1W	100KG1W	1M40G7W	36M0G7W
	Frequency (MHz)			14020.0	14020.0	14020.0	14020.0	14020.0
		ES power density (dBW/Hz)		-55.1	-55.1	-55.1	-58.6	-57.3
			ES gain (dBi)	49.1	49.1	49.1	53.1	57.3
36M0G7W	14020.0	-48.6	57.3	38.0	38.0	38.1	38.1	42.3
6M95G1W	14020.0	-52.7	53.0	42.2	42.1	42.2	42.2	46.4
36M0G7W	14020.0	-49.1	57.3	38.6	38.5	38.6	38.6	42.8
36M0G7W	14020.0	-52.7	60.7	42.2	42.2	42.2	42.2	46.4
100KG1W	14020.0	-42.1	46.7	31.5	31.5	31.5	31.5	35.8
1M35G7W	14020.0	-46.5	46.7	35.9	35.9	35.9	35.9	40.2

Table A1-2: AMC-9/AMC-2 Ku-Band Downlink C/I

Ku-band Downlink C/I	System 1	System 2
Space station name	AMC-9	AMC-2
Nominal orbit location (+E, -W)	-83.00	-80.85
Stationkeeping tolerance (◦)	0.05	0.15
Assumed orbit location (+E, -W)	-82.95	-81.00
Longitude separation (◦)	1.95	1.95
Earth station pointing error (◦)	0.10	0.10
Earth station antenna efficiency (fraction)	0.65	0.65
Earth station angle toward interfering space station (◦)	2.05	2.05
Difference in wanted and interfering space station gain toward wanted earth station (dB)	17.0	17.0

AMC-2 into AMC-9									
Wanted AMC-9 Emisssions				Interfering AMC-2 Emisssions					
Emission				6M95G7W	5M04G1W	100KG1W	1M40G7W	36M0G7W	300KF9D
	Frequency (MHz)			11720.0	11720.0	11720.0	11720.0	11720.0	12198.0
		SS EIRP density (dBW/Hz)		-29.1	-29.1	-29.2	-28.5	-26.3	-42.4
			ES gain (dBi)	47.7	47.7	47.7	51.7	41.7	58.5
36M0G7W	11720.0	-21.3	37.9	41.4	41.4	41.5	40.8	38.6	54.7
6M95G1W	11720.0	-20.8	46.4	50.3	50.3	50.4	49.7	47.4	63.5
36M0G7W	11720.0	-21.8	45.6	48.5	48.5	48.6	47.9	45.7	61.8
36M0G7W	11720.0	-22.0	53.6	55.6	55.6	55.6	55.0	52.7	68.8
100KG1W	11720.0	-18.4	39.6	46.1	46.1	46.1	45.5	43.2	59.3
1M35G7W	11720.0	-20.9	45.6	49.5	49.5	49.5	48.9	46.6	62.7

AMC-9 into AMC-2									
Interfering AMC-9 Emisssions				Wanted AMC-2 Emisssions					
Emission				6M95G7W	5M04G1W	100KG1W	1M40G7W	36M0G7W	300KF9D
	Frequency (MHz)			11720.0	11720.0	11720.0	11720.0	11720.0	12198.0
		SS EIRP density (dBW/Hz)		-29.1	-29.1	-29.2	-28.5	-26.3	-42.4
			ES gain (dBi)	47.7	47.7	47.7	51.7	41.7	58.5
36M0G7W	11720.0	-21.3	37.9	35.4	35.4	35.4	39.7	32.4	30.5
6M95G1W	11720.0	-20.8	46.4	34.9	34.9	34.9	39.2	32.0	30.0
36M0G7W	11720.0	-21.8	45.6	35.9	35.9	35.9	40.2	33.0	31.0
36M0G7W	11720.0	-22.0	53.6	36.1	36.1	36.1	40.4	33.2	31.2
100KG1W	11720.0	-18.4	39.6	32.5	32.5	32.4	36.7	29.5	27.5
1M35G7W	11720.0	-20.9	45.6	35.0	35.0	34.9	39.2	32.0	30.0

Table A1-3: AMC-9/AMC-2 C-Band Uplink C/I

C-band Uplink C/I	System 1	System 2
Space station name	AMC-9	AMC-2
Nominal orbit location (+E, -W)	-83.00	-80.85
Stationkeeping tolerance (◦)	0.05	0.15
Assumed orbit location (+E, -W)	-82.95	-81.00
Longitude separation (◦)	1.95	1.95
Earth station pointing error (◦)	0.10	0.10
Earth station antenna efficiency (fraction)	0.65	0.65
Earth station angle toward wanted space station(◦)	2.05	2.05
Difference in wanted space station G/T toward wanted and interfering earth stations (dB)	17.0	17.0

AMC-2 into AMC-9									
Wanted AMC-9 Emisssions				Interfering AMC-2 Emisssions					
Emission				9M00G7W	1M51G7W	100KG1D	4M05G7W	36M0G7W	800KF9D
	Frequency (MHz)			5945.0	5945.0	5945.0	5945.0	5945.0	6423.5
		ES power density (dBW/Hz)		-56.9	-54.1	-53.3	-57.3	-52.2	-40.0
			ES gain (dBi)	45.9	45.9	45.9	45.9	53.5	53.0
36M0G7W	5945.0	-47.9	53.8	57.7	54.8	54.0	58.0	52.9	40.7
6M95G1W	5945.0	-56.4	53.8	49.1	46.3	45.5	49.5	44.4	32.2
36M0G7W	5945.0	-48.4	53.8	57.1	54.3	53.5	57.5	52.4	40.2
36M0G7W	5945.0	-48.6	53.8	56.9	54.1	53.3	57.3	52.2	40.0
100KG1W	5945.0	-47.9	47.8	52.4	49.5	48.7	52.7	47.6	35.5
1M35G7W	5945.0	-47.1	47.8	53.2	50.3	49.5	53.5	48.4	36.3

AMC-9 into AMC-2									
Interfering AMC-9 Emisssions				Wanted AMC-2 Emisssions					
Emission				9M00G7W	1M51G7W	100KG1D	4M05G7W	36M0G7W	800KF9D
	Frequency (MHz)			5945.0	5945.0	5945.0	5945.0	5945.0	6423.5
		ES power density (dBW/Hz)		-56.9	-54.1	-53.3	-57.3	-52.2	-40.0
			ES gain (dBi)	45.9	45.9	45.9	45.9	53.5	53.0
36M0G7W	5945.0	-47.9	53.8	32.5	35.3	36.1	32.2	44.1	55.9
6M95G1W	5945.0	-56.4	53.8	41.0	43.9	44.6	40.7	52.6	64.4
36M0G7W	5945.0	-48.4	53.8	33.0	35.9	36.7	32.7	44.7	56.4
36M0G7W	5945.0	-48.6	53.8	33.2	36.1	36.9	32.9	44.9	56.6
100KG1W	5945.0	-47.9	47.8	32.5	35.3	36.1	32.1	44.1	55.8
1M35G7W	5945.0	-47.1	47.8	31.7	34.5	35.3	31.3	43.3	55.0

Table A1-4: AMC-9/AMC-2 C-Band Downlink C/I

C-band Downlink C/I	System 1	System 2
Space station name	AMC-9	AMC-2
Nominal orbit location (+E, -W)	-83.00	-80.85
Stationkeeping tolerance (◦)	0.05	0.15
Assumed orbit location (+E, -W)	-82.95	-81.00
Longitude separation (◦)	1.95	1.95
Earth station pointing error (◦)	0.10	0.10
Earth station antenna efficiency (fraction)	0.65	0.65
Earth station angle toward interfering space station (◦)	2.05	2.05
Difference in wanted and interfering space station gain toward wanted earth station (dB)	17.0	17.0

AMC-2 into AMC-9									
Wanted AMC-9 Emisssions				Interfering AMC-2 Emisssions					
Emission				9M00G7W	1M51G7W	100KG1D	4M05G7W	36M0G7W	300KF9D
	Frequency (MHz)			3720.0	3720.0	3720.0	3720.0	3720.0	3700.5
		SS EIRP density (dBW/Hz)		-40.8	-37.9	-40.0	-45.1	-37.8	-43.0
			ES gain (dBi)	42.1	42.1	42.1	42.1	42.1	49.0
36M0G7W	3720.0	-33.2	42.3	45.6	42.7	44.8	49.9	42.6	47.8
6M95G1W	3720.0	-32.7	43.7	47.5	44.5	46.6	51.7	44.4	49.6
36M0G7W	3720.0	-33.7	49.8	52.3	49.3	51.5	56.5	49.2	54.4
36M0G7W	3720.0	-33.9	49.8	52.1	49.1	51.3	56.3	49.0	54.2
100KG1W	3720.0	-30.3	42.3	48.6	45.6	47.7	52.8	45.5	50.7
1M35G7W	3720.0	-32.8	42.3	46.1	43.1	45.2	50.3	43.0	48.2

AMC-9 into AMC-2									
Interfering AMC-9 Emisssions				Wanted AMC-2 Emisssions					
Emission				9M00G7W	1M51G7W	100KG1D	4M05G7W	36M0G7W	300KF9D
	Frequency (MHz)			3720.0	3720.0	3720.0	3720.0	3720.0	3700.5
		SS EIRP density (dBW/Hz)		-40.8	-37.9	-40.0	-45.1	-37.8	-43.0
			ES gain (dBi)	42.1	42.1	42.1	42.1	42.1	49.0
36M0G7W	3720.0	-33.2	42.3	30.2	33.1	31.0	26.0	33.2	34.7
6M95G1W	3720.0	-32.7	43.7	29.7	32.6	30.5	25.5	32.8	34.2
36M0G7W	3720.0	-33.7	49.8	30.7	33.7	31.5	26.5	33.8	35.2
36M0G7W	3720.0	-33.9	49.8	30.9	33.9	31.7	26.7	34.0	35.4
100KG1W	3720.0	-30.3	42.3	27.2	30.2	28.1	23.0	30.3	31.8
1M35G7W	3720.0	-32.8	42.3	29.7	32.7	30.6	25.5	32.8	34.3

Table A1-5: DIRECTV KU-79W/AMC-2 Ku-Band Uplink C/I

Ku-band Uplink C/I	System 1	System 2
Space station name	DIRECTV KU-79W	AMC-2
Nominal orbit location (+E, -W)	-79.00	-80.85
Stationkeeping tolerance (◦)	0.05	0.15
Assumed orbit location (+E, -W)	-79.05	-80.70
Longitude separation (◦)	1.65	1.65
Earth station pointing error (◦)	0.10	0.10
Earth station antenna efficiency (fraction)	0.65	0.65
Earth station angle toward wanted space station(◦)	1.71	1.71
Difference in wanted space station G/T toward wanted and interfering earth stations (dB)	17.0	17.0

AMC-2 into DIRECTV KU-79W								
Wanted DIRECTV KU-79W Emisssions				Interfering AMC-2 Emisssions				
Emission				6M95G7W	5M04G1W	100KG1W	1M40G7W	36M0G7W
	Frequency (MHz)			14020.0	14020.0	14020.0	14020.0	14020.0
		ES power density (dBW/Hz)		-55.1	-55.1	-55.1	-58.6	-57.3
			ES gain (dBi)	49.1	49.1	49.1	53.1	57.3
36M0G7W	14020.0	-58.6	59.8	46.5	46.5	46.5	50.0	48.6
36M0G7W	14020.0	-58.6	59.8	46.5	46.5	46.5	50.0	48.6
1M30F9D	14005.0	-48.9	59.8	56.1	56.1	56.1	59.6	58.3

DIRECTV KU-79W into AMC-2								
Interfering DIRECTV KU-79W Emisssions				Wanted AMC-2 Emisssions				
Emission				6M95G7W	5M04G1W	100KG1W	1M40G7W	36M0G7W
	Frequency (MHz)			14020.0	14020.0	14020.0	14020.0	14020.0
		ES power density (dBW/Hz)		-55.1	-55.1	-55.1	-58.6	-57.3
			ES gain (dBi)	49.1	49.1	49.1	53.1	57.3
36M0G7W	14020.0	-58.6	59.8	46.1	46.1	46.1	46.1	50.4
36M0G7W	14020.0	-58.6	59.8	46.1	46.1	46.1	46.1	50.4
1M30F9D	14005.0	-48.9	59.8	36.5	36.5	36.5	36.5	40.7

Table A1-6: DIRECTV KU-79W/AMC-2 Ku-Band Downlink C/I

Ku-band Downlink C/I	System 1	System 2
Space station name	DIRECTV KU-79W	AMC-2
Nominal orbit location (+E, -W)	-79.00	-80.85
Stationkeeping tolerance (◦)	0.05	0.15
Assumed orbit location (+E, -W)	-79.05	-80.70
Longitude separation (◦)	1.65	1.65
Earth station pointing error (◦)	0.10	0.10
Earth station antenna efficiency (fraction)	0.65	0.65
Earth station angle toward interfering space station (◦)	1.71	1.71
Difference in wanted and interfering space station gain toward wanted earth station (dB)	17.0	17.0

AMC-2 into DIRECTV KU-79W									
Wanted DIRECTV KU-79W Emisssions				Interfering AMC-2 Emisssions					
Emission				6M95G7W	5M04G1W	100KG1W	1M40G7W	36M0G7W	300KF9D
	Frequency (MHz)			11720.0	11720.0	11720.0	11720.0	11720.0	12198.0
		SS EIRP density (dBW/Hz)		-29.1	-29.1	-29.2	-28.5	-26.3	-42.4
			ES gain (dBi)	47.7	47.7	47.7	51.7	41.7	58.5
36M0G7W	11720.0	-21.6	34.8	36.2	36.2	36.3	35.6	33.3	49.4
36M0G7W	11720.0	-21.6	34.8	36.2	36.2	36.3	35.6	33.3	49.4
106KG9D	11704.0	-35.0	55.9	42.4	42.4	42.5	41.8	39.6	55.7

DIRECTV KU-79W into AMC-2									
Interfering DIRECTV KU-79W Emisssions				Wanted AMC-2 Emisssions					
Emission				6M95G7W	5M04G1W	100KG1W	1M40G7W	36M0G7W	300KF9D
	Frequency (MHz)			11720.0	11720.0	11720.0	11720.0	11720.0	12198.0
		SS EIRP density (dBW/Hz)		-29.1	-29.1	-29.2	-28.5	-26.3	-42.4
			ES gain (dBi)	47.7	47.7	47.7	51.7	41.7	58.5
36M0G7W	11720.0	-21.6	34.8	33.8	33.8	33.7	38.0	30.8	28.8
36M0G7W	11720.0	-21.6	34.8	33.8	33.8	33.7	38.0	30.8	28.8
106KG9D	11704.0	-35.0	55.9	47.1	47.1	47.1	51.4	44.2	42.2

DECLARATION

I, Roger LeClair, hereby certify under penalty of perjury that I am the technically qualified person responsible for preparation of the technical information contained in the foregoing exhibit; that I am familiar with the technical requirements of Part 25; and that I either prepared or reviewed the technical information contained in the exhibit and that it is complete and accurate to the best of my knowledge, information and belief.

_*/s/*____________________

Roger LeClair
President
LeClair Telecom

Dated: February 25, 2013