REQUEST FOR SPECIAL TEMPORARY AUTHORITY

Gogo LLC ("Gogo"), which holds a license to operate an earth station aboard aircraft ("ESAA") network,[1] hereby requests special temporary authority ("STA") for a period of 60 days commencing no later than August 29, 2016, to permit up to 200 ESAA terminals[2] to communicate with the Luxembourg-licensed ASTRA 4A satellite located at 4.8° E.L. Grant of the requested STA will serve the public interest by allowing Gogo to initiate service to a new fleet customer. Gogo is preparing an application to modify its ESAA license to add ASTRA 4A and other satellites as authorized points of communications, and seeks STA pending submission of and action on that modification application.

Background

Gogo is currently authorized to operate two types of Ku-band terminals with specified satellites for ESAA service in U.S. airspace, foreign airspace, and the airspace over international waters. Gogo's license was issued based on its demonstration that its proposed network would enhance competition in the provision of in-flight broadband service to air travelers and airline crew members. Gogo also showed that its planned operations were fully consistent with technical standards designed to ensure protection of other authorized communications networks. In order to enhance and expand its ESAA operations, Gogo is preparing an application to modify the Gogo ESAA License to add new satellites as points of communication for the Gogo network.

STA Request

Gogo seeks STA to commence communications with ASTRA 4A in the near term while it is completing preparation of the upcoming modification application. ASTRA 4A does not have coverage of the United States and is not on the Commission's Permitted Space Station List, but its licensing administration, Luxembourg, is a member of the World Trade Organization ("WTO"). Accordingly, under the Commission's *DISCO II* market access framework, there is a presumption that allowing the satellite to communicate with U.S.-licensed earth stations for services covered by the WTO Basic Telecommunications Agreement will serve the public interest.[3]

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1 *See* Call Sign E120106, File No. SES-MFS-20151022-00735, granted June 30, 2016 (the "Gogo ESAA License").

2 Gogo is licensed for two ESAA terminals, the 0.24 meter AeroSat model HR6400 and the 0.74 meter ThinKom model 2Ku, and requests authority for both models, up to a combined total of 200 terminals.

3 *See Amendment of the Commission's Policies to Allow Non-U.S. Licensed Space Stations providing Domestic and International Service in the United States,* Report & Order, 12 FCC Rcd 24094, 24112, ¶ 39 (1997) ("*DISCO II*").

Gogo seeks authority to use ASTRA 4A capacity for ESAA operations on a primary basis in the 14-14.25 GHz uplink spectrum and in the 11.7-12.2 GHz downlink spectrum, consistent with the Commission's orders in the ESAA proceeding.[4] Gogo also seeks authority to use ASTRA 4A capacity for ESAA operations on a nonconforming basis in the 12.2-12.75 GHz downlink spectrum. Communications with the satellite will be supported by an SES teleport in Betzdorf, Luxembourg.

ASTRA 4A will provide coverage of Europe. In support of this STA request, Gogo is attaching the following information:

- A letter confirming that operation of the Gogo ESAA terminals is consistent with coordination agreements with satellites operated within six degrees of ASTRA 4A;
- A coverage map showing the ASTRA 4A beam that will be used by Gogo;
- Link budgets for the two Gogo ESAA terminals' operations with ASTRA 4A; and
- An orbital debris mitigation statement for ASTRA 4A.

The technical parameters of the proposed operations with ASTRA 4A are provided in the following table:

Antenna	**Maximum EIRP Density Per Carrier (dBW/4 kHz)**	**EIRP (dBW)**	**Emission Designator**
AES 1	15.56	42.67	2M05G7W
AES 2	14.58	41.7	2M05G7W

Gogo proposes to use ASTRA 4A for coverage of Europe. Gogo requires the ability to use additional capacity in Europe on an urgent basis to accommodate the scheduled initiation of service to a new airline customer. Gogo's existing European capacity is heavily used, and Gogo needs access to supplemental capacity in order to ensure a high quality of service for its new customer and to allow Gogo to continue to compete effectively in the ESAA market. Gogo does not propose to use the satellite in U.S. airspace.

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[4] *Revisions to Parts 2 and 25 of the Commission's Rules to Govern the Use of Earth Stations Aboard Aircraft Communicating with Fixed-Satellite Service Geostationary-Orbit Space Stations Operating in the 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz and 14-14.5 GHz Frequency Bands*, Notice of Proposed Rulemaking and Report and Order, IB Docket Nos. 12-376 & 05-20, 27 FCC Rcd 16510 (2012) ("ESAA Order"); Second Report and Order and Order on Reconsideration, IB Docket No. 12-376, 29 FCC Rcd 4226 (2014) ("ESAA Second Order," and with the ESAA Order, the "ESAA Decisions").

Gogo emphasizes that the scope of this STA request is limited. Gogo is only seeking authority to add ASTRA 4A as an authorized point of communication for a limited number of ESAA terminals. Gogo is otherwise prepared to operate consistently with the terms and conditions set forth in the existing Gogo ESAA License. In addition, Gogo is willing to operate pursuant to the STA on an unprotected, non-harmful interference basis.

Waiver Requests

Gogo seeks limited waivers of the Commission's rules in connection with its request for an STA to add ASTRA 4A as an authorized point of communication for the Gogo ESAA network. Specifically, Gogo seeks a waiver of the Table of Allocations for its proposed operations in the 12.2-12.75 GHz spectrum and a waiver of orbital debris mitigation requirements because ASTRA 4A cannot fully vent propellants and relieve pressure vessels at end of life. Grant of these 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.[5]

Section 2.106: Gogo requests waiver of the Table of Allocations in Section 2.106 of the Commission's rules to permit use of downlink spectrum in the 12.2-12.75 GHz band for ESAA operations. Prior to adoption of the ESAA decisions, the Commission granted waivers for downlink operations in the 11.7-12.2 GHz conventional Ku-band downlink spectrum "based upon either a showing that the proposed AMSS downlink transmissions will not exceed the 10 dBW/4 kHz limit for routine processing in Section 25.134(g)(2) of the Commission's rules or proof that adjacent satellite operators have consented to the operations."[6] ESAA operators were also permitted to use extended Ku-band frequencies for ESAA downlinks pursuant to the same rationale.[7] The Commission has recognized that "terminals on U.S.-registered aircraft may need

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[5] *PanAmSat Licensee Corp.*, 17 FCC Rcd 10483, 10492 (Sat. Div. 2002) (footnotes omitted).

[6] *See, e.g., Panasonic Avionics Corporation, Application for Authority to Operate Up to 50 Technically Identical Aeronautical Mobile-Satellite Service Aircraft Earth Stations in the 14.0-14.4 GHz and 11.7-12.2 GHz Frequency Bands,* Order and Authorization, 26 FCC Rcd 12557 (IB and OET 2011) at ¶ 11.

[7] *See* Row 44 Inc., File No. SES-MFS-20100715-00903, Call Sign E080100, Attachment at 3 (requesting expansion of the waiver of Section 2.106 that Row 44 was granted for conventional

to access foreign satellites while traveling outside of the United States (*e.g.*, over international waters), and therefore may need to downlink in the extended Ku-band in certain circumstances."[8]

The Commission's ESAA Decisions modified the Table of Allocations to permit ESAA operations in the conventional Ku-band, as well as in the 10.95-11.2 GHz and 11.45-11.7 GHz segments of the extended Ku-band. The Commission acknowledged that ESAA operators may also wish to use other downlink spectrum, particularly for reception of transmissions from space stations with little or no U.S. coverage.[9] Although the Commission had not requested comment on changing the allocation status of this downlink spectrum, it specifically contemplated that access to such spectrum could be granted "on a case-by-case basis under Part 25 licensing rules."[10] For example, the Commission has authorized Gogo and other ESAA providers to receive signals in the 12.2-12.75 GHz band.[11]

Consistent with these past rulings, Gogo requests a waiver of the Table of Allocations to permit its terminals to receive transmissions from ASTRA 4A in the 12.2-12.75 GHz band. As noted above, Gogo does not propose to use ASTRA 4A in U.S. airspace, and SES has confirmed that Gogo's proposed ESAA operations are consistent with SES's coordination agreements with satellites within six degrees. Authorizing Gogo to receive signals from ASTRA 4A will not alter the technical characteristics of the satellite's operations in any way, and therefore will not create harmful interference to other authorized users of the spectrum. Furthermore, Gogo will not claim interference protection from such authorized users. Under these circumstances, grant of a Section 2.106 waiver is justified to permit use of the 12.2-12.75 GHz band for downlinks from ASTRA 4A.

Section 25.283(c): Section 25.283(c) specifies requirements relating to venting stored energy sources at the spacecraft's end of life. Specifically, the rule provides that upon completion of a satellite's mission, "a space station licensee shall ensure, unless prevented by technical failures beyond its control, that all stored energy sources on board the satellite are

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Ku-band downlinks to cover the proposed use of the 11.45-11.7 GHz band), granted Dec. 23, 2010.

8 *Service Rules and Procedures to Govern the Use of Aeronautical Mobile Satellite Service Earth Stations in Frequency Bands Allocated to the Fixed Satellite Service*, IB Docket No. 05-20, Notice of Proposed Rulemaking, 20 FCC Rcd 2906 (2005) at ¶ 18 (footnote omitted).

9 *See ESAA Order* at n.43.

10 *Id.*

11 *See, e.g.*, Gogo Blanket License, Section B (authorizing use of the 12.2-12.75 GHz band); *Panasonic Avionics Corporation*, File No. SES-MFS-20130930-00845, Call Sign E100089, granted Sept. 24, 2014 (the "Panasonic ESAA Grant"), Section B (authorizing use of the 10.7-12.75 GHz band).

discharged, by venting excess propellant, discharging batteries, relieving pressure vessels, and other appropriate measures."[12] Gogo requests any necessary waiver of this requirement in connection with its request to communicate with ASTRA 4A, an in-orbit spacecraft that was not designed to allow complete venting at end of life.

ASTRA 4A is a Lockheed Martin A2100 model spacecraft. As described in more detail in the attached Orbital Debris Mitigation Statement, the oxidizer tanks on the ASTRA 4A spacecraft were sealed following completion of the launch phase and will therefore retain residual pressure when the spacecraft is retired. Given the spacecraft design, it is physically impossible to vent the oxidizer tanks in order to comply with Section 25.283(c).

Under Commission precedent, grant of a waiver is warranted. In a number of cases involving various spacecraft models with similar limitations, the Commission has waived Section 25.283(c) to permit launch and operation of spacecraft that do not allow for full venting of pressure vessels at end of life, based on a finding that modifying the space station design at a late stage of construction would pose an undue hardship.[13] In the case of ASTRA 4A, which is currently in-orbit, there is no question of bringing the satellite into compliance with the rule. The Commission has expressly recognized this, finding a waiver of Section 25.283(c) to be justified for in-orbit spacecraft that cannot satisfy the rule's requirements. For example, in a decision involving the AMC-2 satellite, which is a Lockheed Martin A2100 design like ASTRA 4A, the Commission waived Section 25.283(c) on its own motion, observing that venting the spacecraft's sealed oxidizer tanks "would require direct retrieval of the satellite, which is not currently possible."[14]

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[12] 47 C.F.R. § 25.283(c).

[13] *See, e.g., EchoStar Satellite Operating Corp.,* File No. SAT-LOA-20071221-00183, Call Sign S2746, grant-stamped Mar. 12, 2008, Attachment at ¶ 4 (granting a partial waiver of Section 25.283(c) for AMC-14, a Lockheed Martin A2100 model spacecraft, on grounds that requiring modification of satellite would present an undue hardship); *DIRECTV Enterprises LLC*, File No. SAT-LOA-20090807-00086, Call Sign S2797, grant-stamped Dec. 15, 2009, Attachment at ¶ 4 (same for DIRECTV 12, a Boeing 702 model spacecraft); *PanAmSat Licensee Corp*., File Nos. SAT-MOD-20070207-00027, SAT-AMD-20070716-00102, Call Sign S2237, grant-stamped Oct. 4, 2007, Attachment at ¶ 7 (same for Intelsat 11, an Orbital Sciences Star model spacecraft).

[14] File No. SAT-MOD-20101215-00261, Call Sign S2134, grant-stamped Mar. 8, 2011, Attachment at ¶ 4. *See also XM Radio Inc.,* File No. SAT-MOD-20100722-00165, Call Sign S2616, grant-stamped Oct. 14, 2010, Attachment at ¶ 2 (waiving Section 25.283(c) for XM-4, a Boeing 702 model spacecraft, because "modification of the spacecraft would present an undue hardship, since XM-4 is an in-orbit space station and venting XM-4's helium and xenon tanks would require direct retrieval of the satellite, which is not currently possible").

The same practical obstacle is present here. Because ASTRA 4A is already in orbit, it cannot be modified to enable full venting of residual pressure. Given this reality, a waiver is clearly warranted.

Public Interest Showing

Grant of the requested STA is consistent with Commission policy and will not adversely affect other authorized operations. Gogo's proposed operations with ASTRA 4A are consistent with SES's coordination agreements with adjacent satellite operators and will also conform to the terms of Gogo's agreements with the National Science Foundation and the National Aeronautics and Space Administration, as required by the Gogo ESAA License.[15] In addition, Gogo will comply with power flux density limits to protect terrestrial services outside the U.S.

Grant of the proposed STA will allow Gogo to initiate high-quality, reliable service to a new airline customer, promoting competition in the provision of aeronautical services and expanding the availability of in-flight broadband to air travelers and crew members.

Gogo understands that any Commission grant of this STA will be without prejudice to the ultimate determination the Commission will make regarding Gogo's future modification application. In addition, Gogo acknowledges that any action taken pursuant to a grant of the requested STA will be at Gogo's own risk.

[15] Gogo ESAA License at 7, condition 90057.

Patrick van Niftrik
Vice President Spectrum Management & Development, EMEA

Federal Communications Commission
International Bureau
445 12th Street, S.W.
Washington, D.C. 20554
United States

29 July 2016

Subject: **Engineering Certification of SES for the ASTRA-4A satellite**

To whom it may concern,

This letter confirms that SES is aware that Gogo LLC ("Gogo"), licensed by the Federal Communications Commission ("FCC") as Gogo LLC, is planning to file an application seeking a modification to its blanket authorization (the "Modification Application") to operate two types of Ku-band Earth Stations Aboard Aircraft ("ESAA") transmit/receive terminals (Call Sign E120106) pursuant to ITU RR 5.504A and Section 25.227 of the Commission's rules, on domestic and international flights. Among other changes, the Modification Application will seek authority for Gogo's ESAA terminals to communicate with the ASTRA-4A satellite at 4.8°E.L., under the current ESAA rules, including Section 25.227.

Based upon the representations made to SES by Gogo concerning how it will operate on ASTRA-4A according to its letters dated 28 July 2016:

- SES acknowledges that the proposed operation of the Gogo ESAA terminals has the potential to create harmful interference to satellite networks adjacent to ASTRA-4A that may be unacceptable.
- SES certifies that it has completed coordination as required under the FCC's rules and that the power density levels specified by Gogo are consistent with existing coordination agreements to which SES is a party with all adjacent satellite operators within +/- 6 degrees of orbital separation from ASTRA-4A.
- If the FCC authorizes the operations proposed by Gogo, SES will include the power density levels specified by Gogo in all future satellite network coordination with other operators of satellites adjacent to ASTRA-4A.

Yours Sincerely,

Patrick van Niftrik

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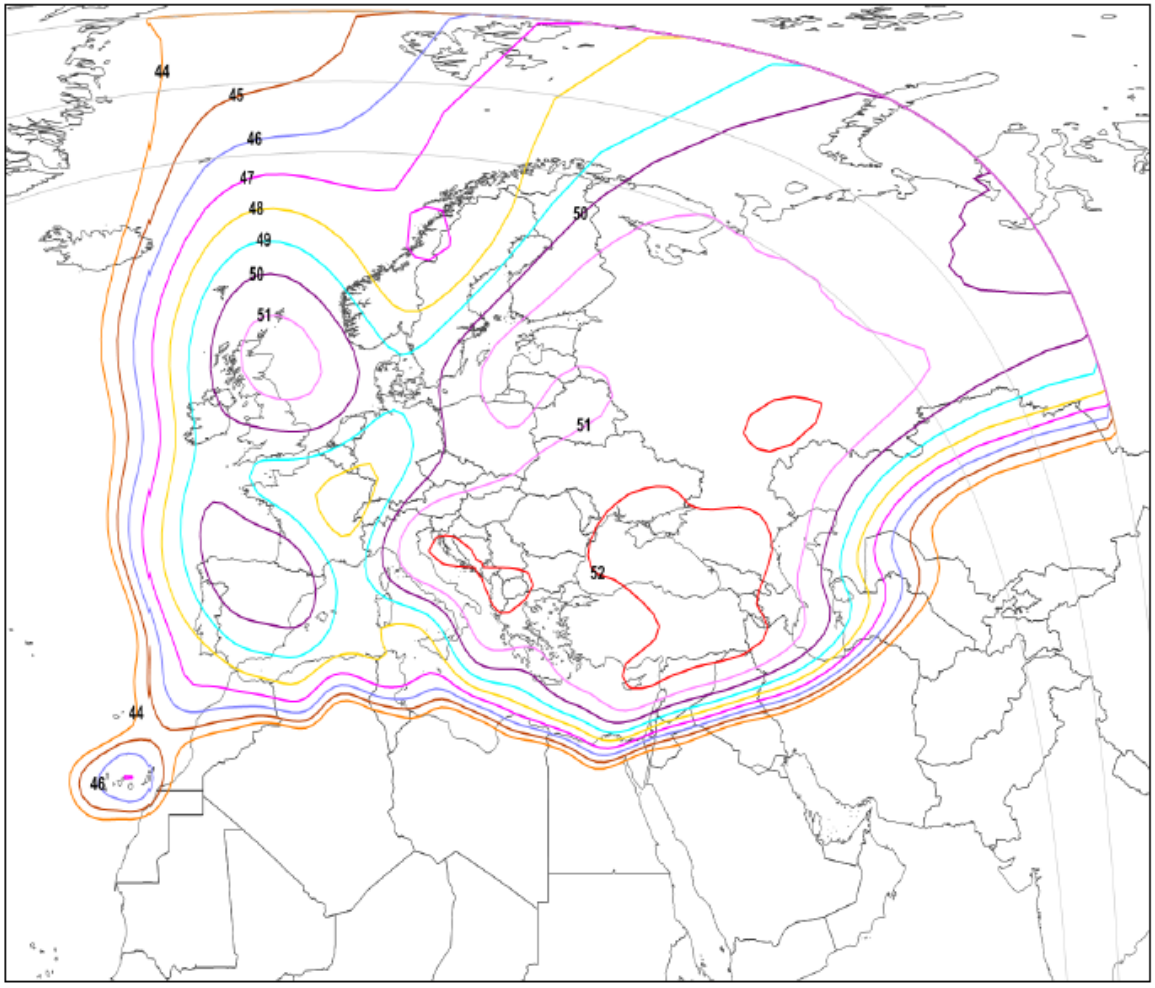
ASTRA 4A Coverage Map

Ku band: ECEE (EU) beam EIRP

SES



Contours Shown

EIRP [dBW]

52.7 Beam peak

52
51
50
49
48
47
46
45
44

Notes

The adjacent plot shows the measured performance of a typical satellite transponder. Performance differences should be expected between individual transponders.

Elevation Angles are shown at 0, 5 and 10 Degrees.

ASTRA 4A Link Budgets

AeroSat Antenna

Forward Link Budget

Hub	Betzdorf, Luxembourg	
Required Eb/No	.9	dB
Modulation	4-PSK	
Info Rate	22.74	Mbps
FEC Rate	0.41	
Carrier Rolloff	1.2	
Satellite SFD @ 0 dB/K	-91.7	dBW/m^2
Transponder Atten	11.0	dB
Transponder ID	4.224/4.224	

Hub Transmit

Frequency	17.77	GHz
Satellite G/T	6.1	dB/^{o}K
Antenna Diameter	9.0	m
Carrier EIRP	75.33	dBW
Ant. Input PFD	-25.67	dBW/4kHz
Path Loss	209	dB
Atm/Point/Pol Loss	0.5	dB

Aircraft Receive Terminal

Frequency	12.52	GHz
Satellite EIRP	52.8	dBW
Downlink PFD@ Beam Center	13.41	dBW/4kHz
Receive Gain	29	dBi
Terminal G/T	11.7	dB/^{o}K
Path Loss	206	dB
Other Losses	0.7	dB

Transponder

Total OPBO	1	dB
Carrier OPBO	1	dB
C/No Thermal Up	100.5	dB-Hz
C/No Thermal Dn	77	dB-Hz
C/Io Total	86.3	dB-Hz
C/No+Io	76.6	dB-Hz
Add'l Link Margin	1.0	dB
% BW per cxr	100	%
% Power per cxr	100	%
Xpdr BW Alloc	33	MHz

Return Link Budget

Terminal	Ku	
Required Eb/No	3.5	dB
Modulation	2-PSK	
Info Rate	1.03	KMps
FEC Rate	.5	
Carrier Spacing	1.3	
Carrier Spreading	0.0	
Satellite SFD @ 0 dB/K	-79	dBW/m^2
Transponder Atten	13	dB
Transponder ID	4.306/4.306	

Aircraft Transmit Terminal

Frequency	14.2	GHz
Satellite G/T	2.3	dB/^{o}K
Antenna Diameter	0.74	m
Carrier EIRP	42.7	dBW
Ant Input PFD	-13.3	dBW/4kHz
Path Loss	207.0	dB
Atm/Point/Pol Loss	0.7	dB

Hub Receive

Frequency	12.7	GHz
Satellite EIRP	50	dBW
Downlink PFD@ Beam Center	-12.7	dBW/4kHz
Hub G/T	38.4	dB/^{o}K
Path Loss	206.2	dB
Other Losses	0.8	dB

Transponder

Total OPBO	4.4	dB
Carrier OPBO	38.8	dB
C/No Thermal Up	66.0	dB-Hz
C/No Thermal Dn	71.3	dB-Hz
C/Io Total	83.3	dB-Hz
C/No+Io	64..8	dB-Hz
Add"l Link Margin	1.2	dB
% BW per cxr	3.7	%
% Power per cxr	0.04	%
Xpdr BW Alloc	2.67	MHz

ASTRA 4A Link Budgets

ThinKom Antenna

Forward Link Budget

Hub	Betzdorf, Luxembourg	
Required Eb/No	1.7	dB
Modulation	4-PSK	
Info Rate	22.74	Mbps
FEC Rate	0.41	
Carrier Rolloff	1.2	
Satellite SFD @ 0 dB/K	-91.7	dBW/m²
Transponder Atten	11.0	dB
Transponder ID	4.224/4.224	

Hub Transmit

Frequency	17.76	GHz
Satellite G/T	6.1	dB/°K
Antenna Diameter	9.0	m
Carrier EIRP	75.33	dBW
Ant. Input PFD	-25.67	dBW/4kHz
Path Loss	209	dB
Atm/Point/Pol Loss	0.2	dB

Aircraft Receive Terminal

Frequency	12.52	GHz
Satellite EIRP	51	dBW
Downlink PFD@ Beam Center	13.41	dBW/4kHz
Receive Gain	33	dBi
Terminal G/T	6.1	dB/°K
Path Loss	206	dB
Other Losses	0.7	dB

Transponder

Total OPBO	1	dB
Carrier OPBO	1	dB
C/No Thermal Up	100.5	dB-Hz
C/No Thermal Dn	77	dB-Hz
C/Io Total	86.3	dB-Hz
C/No+Io	76.9	dB-Hz
Add'l Link Margin	.6	dB
% BW per cxr	100	%
% Power per cxr	100	%
Xpdr BW Alloc	33	MHz

Return Link Budget

Terminal	2Ku	
Required Eb/No	3.5	dB
Modulation	2-PSK	
Info Rate	1.03	KMps
FEC Rate	.5	
Carrier Spacing	1.3	
Carrier Spreading	2.0	
Satellite SFD @ 0 dB/K	-80.8	dBW/m²
Transponder Atten	4.0	dB
Transponder ID	4.306/4.306	

Aircraft Transmit Terminal

Frequency	14.2	GHz
Satellite G/T	4.1	dB/°K
Antenna Diameter	0.74	m
Carrier EIRP	41.7	dBW
Ant Input PFD	-13.3	dBW/4kHz
Path Loss	207.6	dB
Atm/Point/Pol Loss	0.4	dB

Hub Receive

Frequency	12.7	GHz
Satellite EIRP	50	dBW
Downlink PFD@ Beam Center	-12.7	dBW/4kHz
Hub G/T	38.4	dB/°K
Path Loss	206.2	dB
Other Losses	0.8	dB

Transponder

Total OPBO	4.4	dB
Carrier OPBO	38.8	dB
C/No Thermal Up	66	dB-Hz
C/No Thermal Dn	71.3	dB-Hz
C/Io Total	85.6	dB-Hz
C/No+Io	64..8	dB-Hz
Add"l Link Margin	1.2	dB
% BW per cxr	3.7	%
% Power per cxr	0.04	%
Xpdr BW Alloc	2.67	MHz

This document contains the information required under Section 25.114(d)(14) of the Federal Communications Commission's Rules for the ASTRA 4A satellite operating at 4.8° E.L.

Spacecraft Hardware Design: SES has assessed and limited the amount of debris released in a planned manner during normal operations of ASTRA 4A. No debris is generated during normal on-station operations, and the spacecraft will be in a stable configuration. On-station operations require station keeping within the +/- 0.05 degree E-W and N-S control box, thereby ensuring adequate collision avoidance distance from other satellites in geosynchronous orbit. In the event that co-location within the same stationkeeping volume of this and another satellite is required, use of the proven Inclination-Eccentricity (I-E) separation method can be employed. This strategy is presently in use by SES to ensure proper operation and safety of multiple satellites within one orbital box.

SES has also assessed and limited the probability of the space station becoming a source of orbital debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal. SES requires that spacecraft manufacturers assess the probability of micrometeorite damage that can cause any loss of functionality. This probability is then factored into the ultimate spacecraft probability of success. Any significant probability of damage would need to be mitigated in order for the spacecraft design to meet the required probability of success of the mission. The design of the spacecraft locates all sources of stored energy within the body of the structure, which provides protection from small orbital debris. Steps have been taken to limit the effects of any collisions through shielding, the placement of components, and the use of redundant systems.

Minimizing Accidental Explosions: SES has assessed and limited the probability of accidental explosions during and after completion of mission operations. As part of the Safety Data Package, an extensive analysis is completed by the spacecraft manufacturer, reviewing each potential hazard relating to accidental explosions. A matrix is generated indicating the worst-case effect, the hazard cause, and the hazard controls available to minimize the severity and the probability of occurrence. Each subsystem is analyzed for potential hazards, and the Safety Design Package is provided for each phase of the program running from design phase, qualification, manufacturing and operational phase of the spacecraft. Also, the spacecraft manufacturer generates a Failure Mode Effects and Criticality Analysis for the spacecraft to identify all potential mission failures. The risk of accidental explosion is included as part of this analysis. This analysis indicates failure modes, possible causes, methods of detection, and compensating features of the spacecraft design.

The design of the ASTRA 4A spacecraft is such that the risk of explosion is minimized both during and after mission operations. In designing and building the spacecraft, the manufacturer took 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. All propulsion subsystem pressure

vessels, which have high margins of safety at launch, have even higher margins in orbit, since use of propellants and pressurants during launch decreases the propulsion system pressure. 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 and pressurization lines. All pressures, including those of the batteries, are monitored by telemetry.

At the end of operational life, after the satellite has reached its final disposal orbit, on-board sources of stored energy will be depleted or secured, and the batteries will be discharged. However, at the end of ASTRA 4A's operational life, there will be oxidizer remaining in the tanks that cannot be vented. Following insertion of the spacecraft into orbit, the spacecraft manufacturer permanently sealed the oxidizer tanks by firing pyrotechnic valves. This is a design feature of the Lockheed A2100 series spacecraft that cannot now be changed or remedied. Information regarding the residual oxidizer in the tanks is as follows:

Item	Total Volume [l]	Pressure [bar]	Temp. [deg C]	Total Mass [kg]
Oxidizer (in two interconnected tanks)	657	19	21.5	12

The oxidizer tanks are well shielded, and the residual pressure in the tanks will be well below their maximum rating. The oxidizer in the tanks is MON-3 (N_2O_4 with 3% NO_2). In addition to the oxidizer, the tanks include helium pressurant, which has a residual mass of approximately 1.9 kg. Given the tank temperature, the majority of the residual oxidizer (over 8 liters) is in a liquid form. Accordingly, the pressure results above reflect the combined pressure of the helium gas and the vapor pressure from the oxidizer that is in gas form, using a tank volume of approximately 649 liters (657 liters less the 8 liters occupied by the liquid oxidizer).

Safe Flight Profiles: SES has assessed and limited the probability of the space station becoming a source of debris by collisions with large debris or other operational space stations. Specifically, SES has assessed the possibility of collision with satellites located at, or reasonably expected to be located at, 4.8° E.L. or assigned in the vicinity of that location.

Regarding avoidance of collisions with controlled objects, in general, if a geosynchronous satellite is controlled within its specified longitude and latitude stationkeeping limits, collision with another controlled object (excluding where the satellite is collocated with another object) is the direct result of that object entering the allocated space.

At 4.8° E.L., ASTRA 4A operates at an offset from SES's SES-5 satellite operating at the nominal 5.0° E.L. During regular operation there are no other satellites assigned to or reasonably

expected to be located at 4.8° E.L. or to nearby orbital locations such that there would be an overlap with the stationkeeping volume of ASTRA 4A at 4.8° E.L.

SES uses the Space Data Center ("SDC") system from the Space Data Association to monitor the risk of close approach of its satellites with other objects. Any close encounters (separation of less than 10 km) are flagged and investigated in more detail. If required, avoidance maneuvers are performed to eliminate the possibility of collisions.

During any relocation, the moving spacecraft is maneuvered such that it is at least 30 km away from the synchronous radius at all times. In most cases, much larger deviation from the synchronous radius is used. In addition, the SDC system is used to ensure no close encounter occurs during the move. When de-orbit of a spacecraft is required, the initial phase is treated as a satellite move, and the same precautions are used to ensure collision avoidance.

Post-Mission Disposal: Post-mission disposal of the satellite from operational orbit will be accomplished by carrying out maneuvers to a higher orbit. The upper stage engine remains part of the satellite, and there is no re-entry phase for either component.

Post-mission disposal of the satellite from operational orbit will be accomplished by carrying out maneuvers to a higher orbit. The fuel budget for this operation is included in the satellite design. SES plans to maneuver ASTRA 4A to a disposal orbit with a minimum perigee of 258 km above the normal operational altitude. This proposed disposal orbit altitude is based on the following calculation pursuant to § 25.283 of the Commission's Rules.

Area of the satellite (average aspect area): 54 m^2
Mass of the spacecraft: 2261.4 kg
CR (solar radiation pressure coefficient): 0.98

Therefore the Minimum Disposal Orbit Perigee Altitude, as calculated under the IADC formula is:

36,021 km + (1000 x CR x A/m) = 36,044 km, or 258 km above the GSO arc (35,786 km)

SES intends to reserve 5.3 kg of fuel in order to account for post-mission disposal of ASTRA 4A. SES has assessed fuel gauging uncertainty and has provided an adequate margin of fuel reserve to address the assessed uncertainty.