Panasonic Avionics Corporation
ESAA Blanket License Modification Application

Technical Appendix

I. Apstar 6C

APSTAR
by APT Satellite

亞太通信衛星有限公司
APT SATELLITE COMPANY LIMITED
香港新界大埔工業村大貴街22號
No.22 Dai Kwai Street, Tai Po Industrial Estate
Tai Po, NT, Hong Kong

August 17, 2018

Federal Communications Commission
International Bureau
445 12th Street, SW
Washington, D.C.
20554

Re: Engineering Certification of APT Satellite Company Limited.

To Whom It May Concern:

This letter certifies that APT Satellite Company Limited is aware that Panasonic Avionics Corporation ("Panasonic") is planning to modify its earth stations aboard aircraft ("ESAA") blanket license from the Federal Communication Commission ("FCC"), Call Sign E100089, to add the APSTAR-6C satellite, located at 134° E.L., as an authorized point of communication for its PPA and SPA ESAA terminals. APT Satellite Company Ltd understands that Panasonic will file the modification application pursuant to the FCC rules governing ESAA operations, including Section 25.227.

APT Satellite Company Limited, confirms and hereby certifies that the power density levels of the proposed operations are consistent with existing satellite coordination agreements with the satellites with +/-6 degrees of the APSTAR-6C satellite's orbit location, and acknowledges that the proposed operation of Panasonic's PPA and SPA ESAA terminals has the potential to create and receive harmful interference from adjacent satellite networks that may be unacceptable.

If the FCC authorizes the operation proposed by Panasonic, APT Satellite Company Limited will include the power density levels specified by Panasonic, defined within the satellite coordination agreements, in all future satellite network coordination with operators of satellite that are adjacent to the satellite addressed by this letter.

Sincerely,

Shilin Zhang

Vice President

APT Satellite Company Limited.

APSTAR
by APT Satellite

Statement on Conformity of APSTAR-6C Satellite with FCC Rules regarding Orbital Debris Mitigation

APT Satellite Company Limited ("APT") provides the following showing regarding compliance with 47 C.F.R. § 25.114(d)(14)(i)-(iv) and §25.283 of the Federal Communications Commission's ("FCC") rules regarding the orbital debris mitigation/end-of-life disposal of the APSTAR-6C satellite. In addition, APT acknowledges that the APSTAR-6C orbital debris mitigation/end-of-life disposal plan is consistent with guidelines issued by the Office of Telecommunications Authority ("OFTA") of Hong Kong in July 2007.

(http://tel_archives.ofca.gov.hk/en/report-paperguide/guidance-notes/gn_200706.pdf)

a. Debris Release Assessment-§25.114(d)(14)(i).

APT has assessed the operations of APSTAR-6C and has determined that no debris has been released by the spacecraft. All separation and deployment mechanisms were fully controlled by China Academy of Space Technology and the launching service provider and no debris is planned to leave the spacecraft after the commission of service.

In the spacecraft integration and manufacturing phase, the stiffness and strength of the satellite structure are verified by a series of test, including the vibration and acoustics test. These tests prove that the structure is tough enough to provide the protection of the satellite components and capable to reduce generation of space debris to the maximum extent possible during a collision.
All critical components (i.e. the Service Module, the Communication Module and the Upper Module) are built within the structure.

The APSTAR-6C spacecraft can be controlled through both the dish antennas and omni antennas. In the different control mode (Normal Mode, Earth Pointing Mode, Inertial Attitude Acquisition Mode and Sun Acquisition Mode), the omni and dish antennas can be used accordingly.

Furthermore, the spacecraft redundancy scheme protects against the failure of any one component by having spare components available. In case, if the primary component fails, the other redundant unit remains functional to maintain the satellites mission. The reliability has been assessed for each subsystem and for each phase of the mission, based on the analysis, the bus reliability is greater than 0.71 at 15 years. According to the goal of the design, there is no item in the bus whose failure will cause loss of the satellite mission unless that item has a probability of success that is superior or equal to 0.99 for 15 years. This redundancy scheme should ensure the control and de-orbit capability of the satellite after a collision.

b. Accidental Explosion Assessment-§25.114(d)(14)(ii).

APT has conducted the assessment the possibility of an accidental explosion onboard APSTAR-6C via reviewing failure modes for all equipment. In order to ensure that the spacecraft does not explode on orbit, the designers of the spacecraft have taken specific precautions. All batteries and fuel tanks are monitored for pressure or temperature variations. Alarms in the SCC (Satellite Control Center) inform controllers of any variations. Additionally, long-term trending analysis will be performed to monitor for any unexpected trends. Operationally, batteries will be operated utilizing the manufacturer's automatic recharging scheme during eclipse season. This scheme will ensure that the batteries will not over-charge. Under the FDIR process, in the event that an overcharge condition is detected, overcharge protection will be triggered to prevent from overheated and do not raise its internal pressure for Li-Ion battery cells.

APSTAR-6C uses a bipropellant system. In order to protect the propulsion system, fuel tanks will all be operated in a blow down mode. At the completion of orbit raising, the helium tanks were isolated from the propulsion system by firing of pyrotechnic valves. This causes the pressure in the propellant tanks to decrease over the life of the spacecraft. In order to ensure that the spacecraft has no explosive risk after it has been successfully de-orbited, all stored energy onboard the spacecraft will be removed except for a small amount of pressurant remaining when the valves were sealed after orbit raising, discussed below in Section (d).

Upon successful de-orbit of the spacecraft, based on the procedure, 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. These steps will ensure that no buildup of energy can occur resulting in an explosion after the spacecraft de-orbited.

c. Assessment Regarding Collision with Larger Debris and Other Space Stations-§25.114(d)(14)(iii).

APT has also conducted the assessment of the probability of APSTAR-6C becoming a source of debris by collisions with large debris or other operational space stations. The probability of the collision between APSTAR-6C and other Space stations is negligible as Orbital Analyst regularly determines the satellite's orbit trends and assess the risk of collision based on ranging result. As a standard practice, in case of other satellite flyby or collocation with APSTAR-6C, the orbital ephemeris data of both sides is exchanged prior to and during operations and the avoidance maneuver is planned accordingly.

APT will maintain APSTAR-6C within 0.05° of the assigned orbital position (134 E.L.) in both the longitude and latitude, this orbit is mainly for geo-stationary satellite, all of the necessary coordination agreements have been successfully completed and signed to ensure the stable and interference-free operation of APSTAR-6C at this orbital slot, and all such notification information has been filed and registered with ITU. APT will continue to monitor launch details to verify that no new spacecraft takes residence in the vicinity of the APSTAR-6C spacecraft unless ongoing operational coordination is conducted with the nearby satellite(s).

d. Post-Mission Disposal Plans-§25.114(d)(14)(iv) and §25.283.

At the completion of its mission, APSTAR-6C will be removed from its geostationary orbit at 134 E.L. to a perigee altitude no less than 262.4 km above the standard geostationary orbit of 35,786 km. This post-disposal perigee takes into account gravitational perturbations and solar radiation pressure that could alter the satellite orbit in the years after decommissioning. APT has planned the tracking telemetry and control transmissions required for end-of-life repositioning so as to avoid electrical interference to other space stations, and coordinated with any potentially affected satellite networks.

Further, in accordance with Section 25.283(c), the minimum post-mission disposal altitude above the geostationary-Earth orbit (i.e., minimum perigee) is calculated as follows (using the relevant IADC formula):

235 km + (1000·CR·A/M)
=235 km +1000×59.1/2155
=262.4 km Here:

CR =Solar radiation pressure coefficient;

A= Average cross sectional area based on deployed on-station configuration;

Notes: **CR·A is a parameter derived by Orbital determination software** ≈59.1 m^2**;**

M= Satellite dry mass ≈2,155 kg (the satellite mass at de-orbit);

The amount of fuel reserved for the post-mission orbital raising is shown below:
Disposal altitude: GEO + 300 km (set 300 km as a target to instead 262.4 km to cover uncertainties);
Required Delta V: 10.94 m/s.
Required fuel (reserved): **11.04 kg**.

The propellant needed to achieve the minimum deorbit altitude is based on the delta-V required and specified by the spacecraft manufacturer, the required mass of propellant for de-orbit operation will be reserved in the tank before the end of life. Propellant tracking is accomplished using a bookkeeping method, this method is provided by the satellite manufacture with a good accuracy.
Any propellant in excess of expected bookkeeping values will be consumed by further raising the orbit until combustion is no longer possible.

Finally, all stored energy sources on board the satellite will be discharged by venting excess propellant, discharging batteries, relieving pressure vessels, and other appropriate measures. The table below provides further information regarding the amount of helium (pressure, container and volume) from the APSTAR-6C propulsion system remaining at end-of-life:

APSTAR-6C (SB4000C2)		
container		**status on end of life**
1	**fuel**	vent by leaving thruster valve open
2	**oxidizer**	vent by leaving thruster valve open
3	**helium**	sealed: 50litre,6Mbar,0-40°C
4	**helium**	sealed: 50litre,6Mbar,0-40°C
5	**helium**	sealed: 50litre,6Mbar,0-40°C

As noted above, propellant and oxidizer tanks will be vented at end-of-life by leaving the thruster valve open. The three (3) helium tanks, however, are sealed after orbit raising, cannot be reopened and will have residual helium at a pressure of 6MPa until the end-of-life. The existence of residual helium is a result of the satellite design – isolating the helium tanks after orbit-raising for reducing the risks associated with valves between these tanks and pressurized fuel/oxidizer tanks during the long operating life. The remaining helium pressure is far below tank's qualified pressure tolerance at 30MPa. Accordingly, APT requests a waiver of §25.283 of the Commission's rules with respect to the remaining helium.

Yours truly,

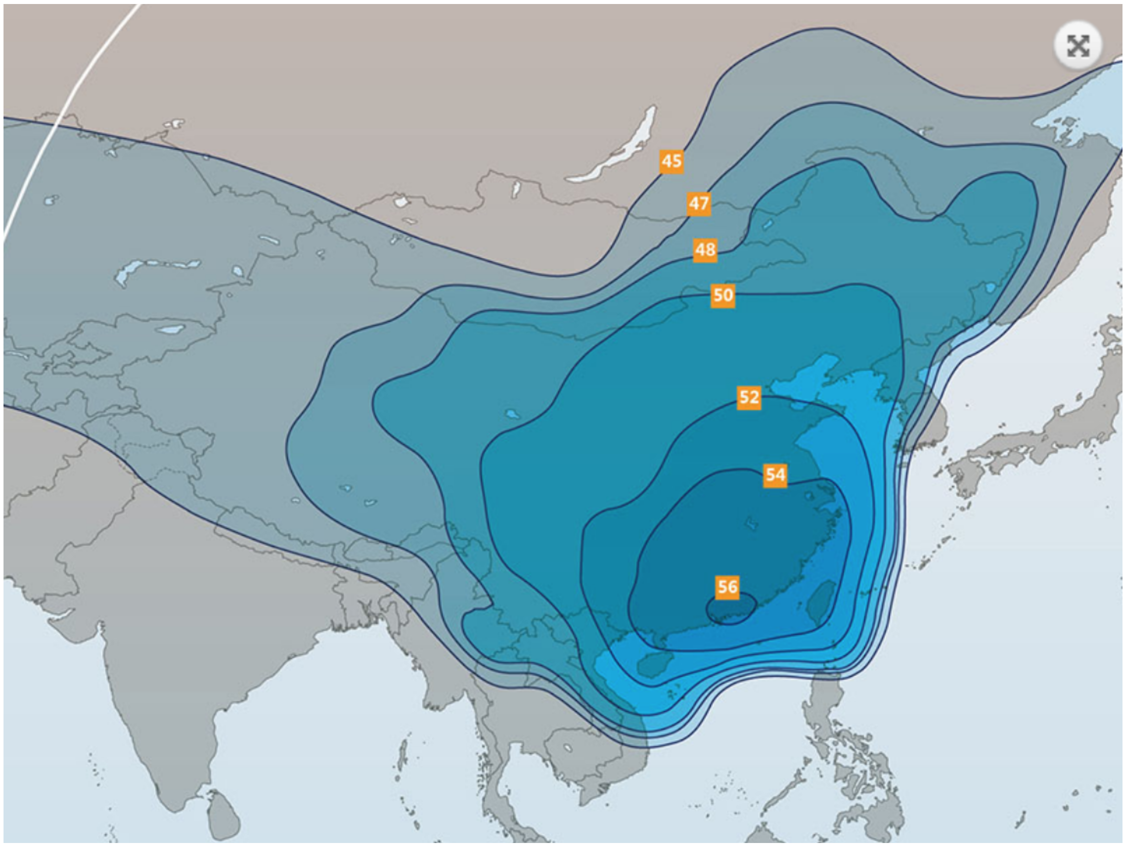
Su Peng

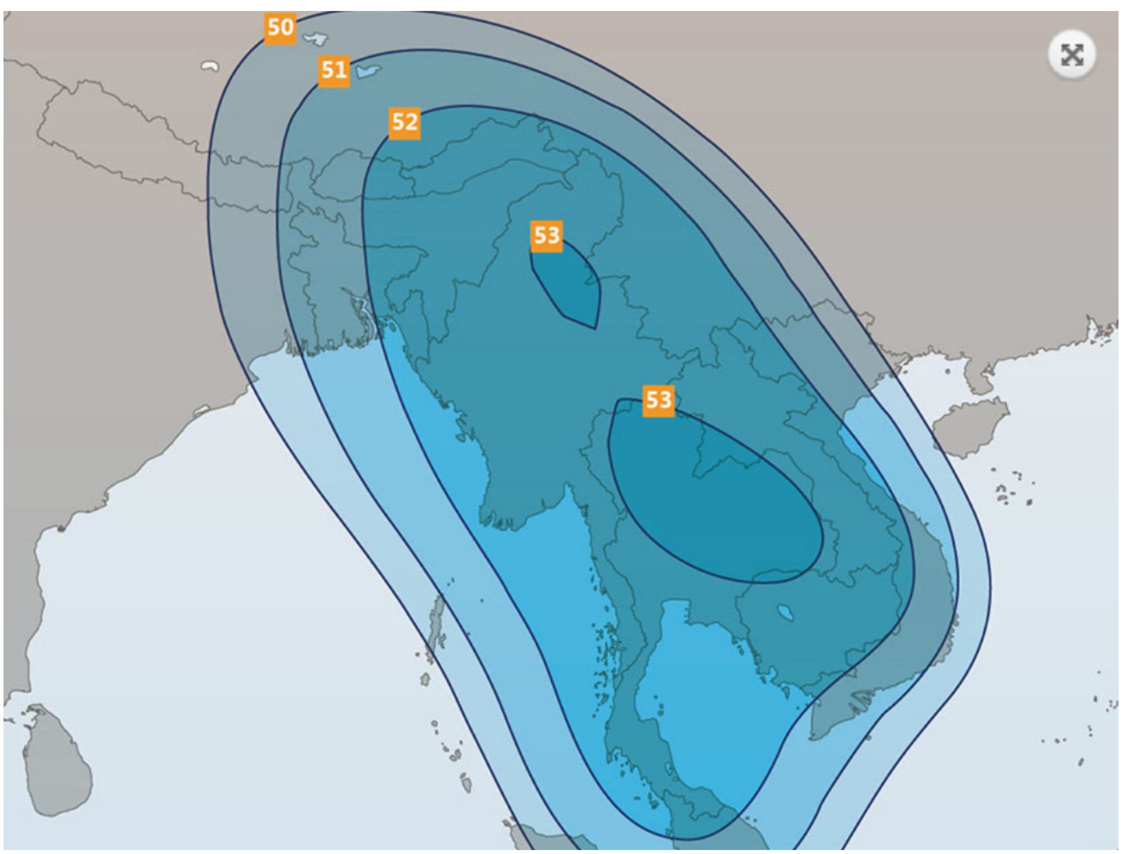
Su Peng

APT ETO SCC Director

APT Satellite Company Limited

3. Coverage Maps





4. Link Budgets

Forward Link Budget

eXConnect Terminal		
Antenna Type	DPA	
Lat	26.1	deg
Lon	119.0	deg
EIRP max	47.2	dBW
G/T	11.3	dB/K
Satellite		
Name	APSTAR-6C	
Longitude	134.0	deg
Hub Earth Station		
Site	Beijing	
Lat	40.05	deg
Lon	116.27	deg
EIRP max	80.0	dBW
G/T	37.4	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	16APSK	
Bits per symbol	4	
Spread Factor	1	
Coding Rate	0.60	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	2.16	bps/Hz
Data Rate	1.11E+08	bps
Information Rate (Data + Overhead)	1.23E+08	bps
Symbol Rate	5.14E+07	Hz
Chip Rate (Noise Bandwidth)	5.14E+07	Hz
Occupied Bandwidth	5.40E+07	Hz
Power Equivalent Bandwidth	5.40E+07	Hz
C/N Threshold	7.2	dB
Uplink		
Frequency	14.063	GHz
Back off	9.2	dB
EIRP Spectral Density	29.7	dBW/4kHz
Slant Range	37771	km
Space Loss, Ls	207.0	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.9	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	3.0	dB/K
Thermal Noise, C/No	92.5	dBHz
C/(No+Io)	92.0	dBHz
Satellite		
Flux Density	-94.7	dBW/m2
SFD @ Hub	-90.9	dBW/m2
Small Signal Gain (IBO/OBO)	2.5	dB
OBO	1.2	dB
Downlink		
Frequency	12.315	GHz
Transponder Sat. EIRP @ Beam Peak	57.2	dBW
Transponder Sat. EIRP @ Terminal	55.0	dBW
DL PSD Limit	19.7	dBW/4kHz
DL PSD @ Beam Peak	14.8	dBW/4kHz
Carrier EIRP @ Beam Peak	55.9	dBW
Carrier EIRP @ Terminal	53.8	dBW
Slant Range	36775	km
Space Loss, Ls	205.6	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	87.4	dBHz
C/(No+Io)	87.2	dBHz
End to End		
End to End C/(No+Io)	86.0	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	7.4	dB
Link Margin	0.2	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	DPA	
Lat	26.1	deg
Lon	119.0	deg
EIRP max	47.2	dBW
G/T	11.3	dB/K
Satellite		
Name	APSTAR-6C	
Longitude	134.0	deg
Hub Earth Station		
Site	Beijing	
Lat	40.05	deg
Lon	116.27	deg
EIRP max	80.0	dBW
G/T	37.4	dB/K
Signal		
Waveform	MxDMA	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.50	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	0.90	bps/Hz
Data Rate	6.86E+06	bps
Information Rate (Data + Overhead)	7.62E+06	bps
Symbol Rate	7.62E+06	Hz
Chip Rate (Noise Bandwidth)	7.62E+06	Hz
Occupied Bandwidth	8.00E+06	Hz
Power Equivalent Bandwidth	1.68E+06	Hz
C/N Threshold	1.6	dB
Uplink		
Frequency	14.063	GHz
Back off	0.0	dB
EIRP Spectral Density	14.4	dBW/4kHz
Slant Range	36775	km
Space Loss, Ls	206.7	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	9.0	dB/K
Thermal Noise, C/No	77.5	dBHz
C/(No+Io)	77.0	dBHz
Satellite		
Flux Density	-115.7	dBW/m2
SFD @ Terminal	-96.9	dBW/m2
Small Signal Gain (IBO/OBO)	2.5	dB
OBO	16.3	dB
Downlink		
Frequency	12.315	GHz
Transponder Sat. EIRP @ Beam Peak	57.2	dBW
Transponder Sat. EIRP @ Hub	51.0	dBW
DL PSD Limit	19.7	dBW/4kHz
DL PSD @ Beam Peak	8.0	dBW/4kHz
Carrier EIRP @ Beam Peak	40.8	dBW
Carrier EIRP @ Hub	34.7	dBW
Slant Range	37771	km
Space Loss, Ls	205.8	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	3.5	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	91.4	dBHz
C/(No+Io)	86.3577	dBHz
End to End		
End to End C/(No+Io)	76.5	dBHz
Implementation Loss	5.5	dB
End to End C/N w/ Imp Loss	2.2	dB
Link Margin	0.6	dB

Forward Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	26.1	deg
Lon	119.0	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	APSTAR-6C	
Longitude	134.0	deg
Hub Earth Station		
Site	Beijing	
Lat	40.05	deg
Lon	116.27	deg
EIRP max	80.0	dBW
G/T	37.4	dB/K
Signal		
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Back off	9.2	dB
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Slant Range	37771	km
Space Loss, Ls	207.0	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.9	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	3.0	dB/K
Thermal Noise, C/No	92.5	dBHz
C/(No+Io)	92.0	dBHz
Satellite		
Flux Density	-94.7	dBW/m2
SFD @ Hub	-90.9	dBW/m2
Small Signal Gain (IBO/OBO)	2.5	dB
OBO	1.2	dB
Downlink		
Frequency	12.315	GHz
Transponder Sat. EIRP @ Beam Peak	57.2	dBW
Transponder Sat. EIRP @ Terminal	55.0	dBW
DL PSD Limit	19.7	dBW/4kHz
DL PSD @ Beam Peak	14.8	dBW/4kHz
Carrier EIRP @ Beam Peak	55.9	dBW
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Slant Range	36775	km
Space Loss, Ls	205.6	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	87.7	dBHz
C/(No+Io)	87.2	dBHz
End to End		
End to End C/(No+Io)	86.0	dBHz
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Link Margin	0.2	dB

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eXConnect Terminal		
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Power Equivalent Bandwidth	1.00E+06	Hz
C/N Threshold	1.6	dB
Uplink		
Frequency	14.063	GHz
Back off	0.0	dB
EIRP Spectral Density	12.2	dBW/4kHz
Slant Range	36775	km
Space Loss, Ls	206.7	dB
Pointing Loss, Lpnt	0.2	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	9.0	dB/K
Thermal Noise, C/No	75.2	dBHz
C/(No+Io)	74.7	dBHz
Satellite		
Flux Density	-118.0	dBW/m2
SFD @ Terminal	-96.9	dBW/m2
Small Signal Gain (IBO/OBO)	2.5	dB
OBO	18.6	dB
Downlink		
Frequency	12.315	GHz
Transponder Sat. EIRP @ Beam Peak	57.2	dBW
Transponder Sat. EIRP @ Hub	51.0	dBW
DL PSD Limit	19.7	dBW/4kHz
DL PSD @ Beam Peak	5.8	dBW/4kHz
Carrier EIRP @ Beam Peak	38.6	dBW
Carrier EIRP @ Hub	32.4	dBW
Slant Range	37771	km
Space Loss, Ls	205.8	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	3.5	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	89.1	dBHz
C/(No+Io)	84.1021	dBHz
End to End		
End to End C/(No+Io)	74.2	dBHz
Implementation Loss	3.5	dB
End to End C/N w/ Imp Loss	1.9	dB
Link Margin	0.4	dB

II. Apstar 6D

1. Satellite Operator Certification Letter

APSTAR
by APT Mobile SatCom Limited

APT MOBILE SATCOM LIMITED

18th Floor,Building C,Shenye U Center, Shenzhen, China
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Fax: +86-755-23508989
Tel: +86-755-23508900

September 17, 2018

Federal Communications Commission
International Bureau
445 12th Street, SW
Washington, D.C. 20554

Re: Engineering Certification of APT MOBILE SATCOM LIMITED ("APSATCOM")

To Whom It May Concern:

This letter certifies that APSATCOM is aware that Panasonic Avionics Corporation ("Panasonic") is planning to modify its earth stations aboard aircraft ("ESAA") blanket license from the Federal Communication Commission ("FCC"), Call Sign E100089, to add the APSTAR-6D satellite, located at 134° E.L., as an authorized point of communication for its PPA and SPA ESAA terminals. APSATCOM understands that Panasonic will file the modification application pursuant to the FCC rules governing ESAA operations, including Section 25.227.

APSATCOM confirms and hereby certifies that the power density levels of the proposed operations are consistent with existing satellite coordination agreements with the satellites with +/-6 degrees of the APSTAR-6D satellite's orbit location, and acknowledges that the proposed operation of Panasonic's PPA and SPA ESAA terminals has the potential to create and receive harmful interference from adjacent satellite networks that may be unacceptable.

If the FCC authorizes the operation proposed by Panasonic, APSATCOM will include the power density levels specified by Panasonic, defined within the satellite coordination agreements, in all future satellite network coordination with operators of satellite that are adjacent to the satellite addressed by this letter.

Sincerely,

Li Jie
President
APT Mobile Satcom Limited

2. Orbital Debris Mitigation Statement

编 号 Reference	WT-APSTAR-6DJB042
密 级 Level	
阶段标记 Phase	Z
页 数 Pages	8

型号代号 PROJECT	APSTAR-6D
文件名称 TITLE	Satellite EOL Mitigation and Disposal Plan

会 签 Confirm

编 写 Written	侯芬 20171126
校 对 Checked	经姚翔 20171128
审 核 Audit	刘建功 20171129
标 审 Standard	魏鑫 20171130
批 准 Approval	魏强 20171201

中国航天科技集团公司第五研究院
China Academy of Space Technology

内容概要 / SUMMARY

This document gives the description of EOL mitigation and disposal of APSTAR-6D with respect to space debris mitigation regulation rules.

主题词 / KEY WORDS

APSTAR-6D，Satellite Mitigation, Satellite Disposal

更改栏 / CHANGE

更改单号 Serial No.	更改日期 Date	更改人 Changed by	更改办法 Methods

CONTENT

Satellite EOL Mitigation and disposal plan (CDR)

1 INTRODUCTION

APSTAR-6D is a telecommunication satellite which is based on DFH4E platform and has a dry mass of 2744 kg. Its designed life time is 15 years, and it's scheduled to carry out space debris mitigation and disposal plan at the end of its life according to the related international conventions.

This document describes the content of EOL disposal, including the minimum propellant requirement budget, de-orbiting manipulation and energy storage components disposals with respect to space debris mitigation regulation rules. And this document also provides inputs to support the satellite operator.

2 APPLICABLE AND REFERENCE DOCUMENTS

GJB 421A-1997 SATELLITE GLOSSARY

GJB 1702-1993 SPACECRAFT ORBIT GLOSSARY

QJ 3221-2005 SPACE DEBRIS MITIGATION REQUIREMENTS

3 GLOSSARY AND DEFINITION

3.1 DISPOSAL PHASE

Satellite EOL disposal phase starts from the end of satellite life until corresponding measures taken to avoid potential damage to other spacecrafts.

3.2 POST-MISSION DISPOSAL

EOL disposal includes satellite de-orbiting measure, and the energy storage components passivation and shutting off satellite downlink signal.

3.3 GLOSSARIES

GEO: the orbit with its inclination and eccentricity close to 0, and period close to Earth rotation period. Those synchronous orbits with small orbit inclination and small orbit eccentricity are generally classified into GEO.

GEO region: the region decided by the GEO radius ±40km, and ±0.1 °of sub-satellite latitude.

GEO protected region: means the annular region defined by the GEO orbit radius ±200km and ±15 °of sub-satellite latitude.

3.4 PASSIVATION

Satellite passivation measures includes exhausting the remnant propellant and helium in pressure tank, elimination of energy in storage battery, shutting the wheels and pyro disposal.

3.5 STORED ENERGY DEVICES

Stored energy devices include: propellant tank, pressure helium tank, storage battery and whirling wheel.

4 GENERAL REQUIREMENTS

4.1 EOL DISPOSAL PLANNING

EOL disposal plan is supposed to be scheduled together by satellite customer and satellite producer, and its contents should include:

a) The criterion of mission end；

b) The opportunity and condition to start satellite EOL disposal；

c) The capability and corresponding subsystem status for completing EOL disposal；

d) Grave orbit design；

e) The estimation of propellant requirement for de-orbiting；

f) Energy stored devices disposal requirement and method；

g) Orbit maneuver strategy；

i) Other devices status setting。

4.2 EMERGENCY DISPOSAL PLANNING

The emergency disposal plan deals with the situation of mission ending ahead of schedule, and its content should include:

a) The start condition for emergency disposal；

b) The minimum requirements of satellite status for carrying out the emergency disposal；

c) It is supposed to re-design the grave orbit and maneuver strategy to minimize the effect exerted by the emergency situation, if the satellite has not the capability of transferring into the required grave orbit under emergency situation；

d) Orbit maneuver strategy；

e) Emergency disposal program of stored energy devices；

i) Other devices on-board status setting。

4.3 DISPOSAL REPORT

EOL disposal report include:

a) Process description of satellite EOL disposal；

b) The time of satellite de-orbit；

c) The satellite ephemeris after de-orbit；

d) The status of shutting off of devices on-board；

e) The power supply status of satellite(including storage battery)；

f) The status of propellant exhaust；

g) The status of movable devices；

h) The status of high pressure tank and stored energy devices;

i) The shut off of satellite downlink signal。

5 DETAILED REQUIREMENTS

5.1 SATELLITE DE-ORBITING

5.1.1 REQUIREMENT OF EOL DISPOSAL ORBIT

The satellite that has finished its mission is supposed to deviate from the GEO protected region in avoidance of disturbing the working spacecraft in GEO.

The perigee height increase should satisfy the following equation:
ΔH = 235+（1000 CRA/m）
Among which:

ΔH ——the minimum increase of perigee height, km；

CR——The coefficient of Sun radiation pressure；

A/m——The ratio of satellite area under Sun radiation pressure with satellite dry mass, m2/kg；

235km—— The sum of the up limit height of GEO protected region above GEO and the maximal descend height caused by the third body gravitation and the Earth gravitation.。

And the final orbit eccentricity should be smaller than 0.003.

5.1.2 REQUIREMENT OF MINIMUM PROPELLANT

By the end of satellite mission, it is supposed to budget enough propellant for EOL disposal. Generally the remnant propellant should afford a Delta Velocity of 10m/s at least.

5.1.3 THE EOL DE-ORBIT STRATEGY PLANNING

The strategy of raising perigee height by every half orbit period is proper to satellite de-orbit, and it is reasonable to carry out each orbit maneuver when the right ascension of satellite is close to 90/270 degree. Considering the precision of remnant propellant estimation and for the sake of the security of satellite de-orbit manipulation, the alternation of each orbit maneuver should be determined carefully, especially not more than 5m/s. Thus the orbit will gain a height increase of 275km after 2 times of orbit maneuvers with an eccentricity near to 0. Then the next orbit maneuvers should be taken to implement the propellant exhaustion at the same time of raising orbit height.

During the process of de-orbit, the satellite should be in the field of TC&R.

5.2 SATELLITE PASSIVATION

In order to minimize the risk to the other working spacecrafts caused by satellite de-orbit manipulation or unexpected satellite disassembly after emergency disposal, all the stored energy devices on-board should carry out passivation measures by the end of de-orbit.

The main content of passivation program should include at least the following:

a) Farther orbit maneuvers are supposed to taken to carry out remnant propellant exhaustion. If Delta Velocities are along to the direction of orbit tangent, and the requirement of grave orbit eccentricity smaller than 0.003 should be considered together with the uncertainty of remnant propellant；

b) Storage battery discharge should be carry out in avoidance of causing satellite disassembly；

c) By the end of EOL disposal, the recharging circuitry of storage battery should be shut off；

d) Gas exhaustion of high pressure tank should be carry out；

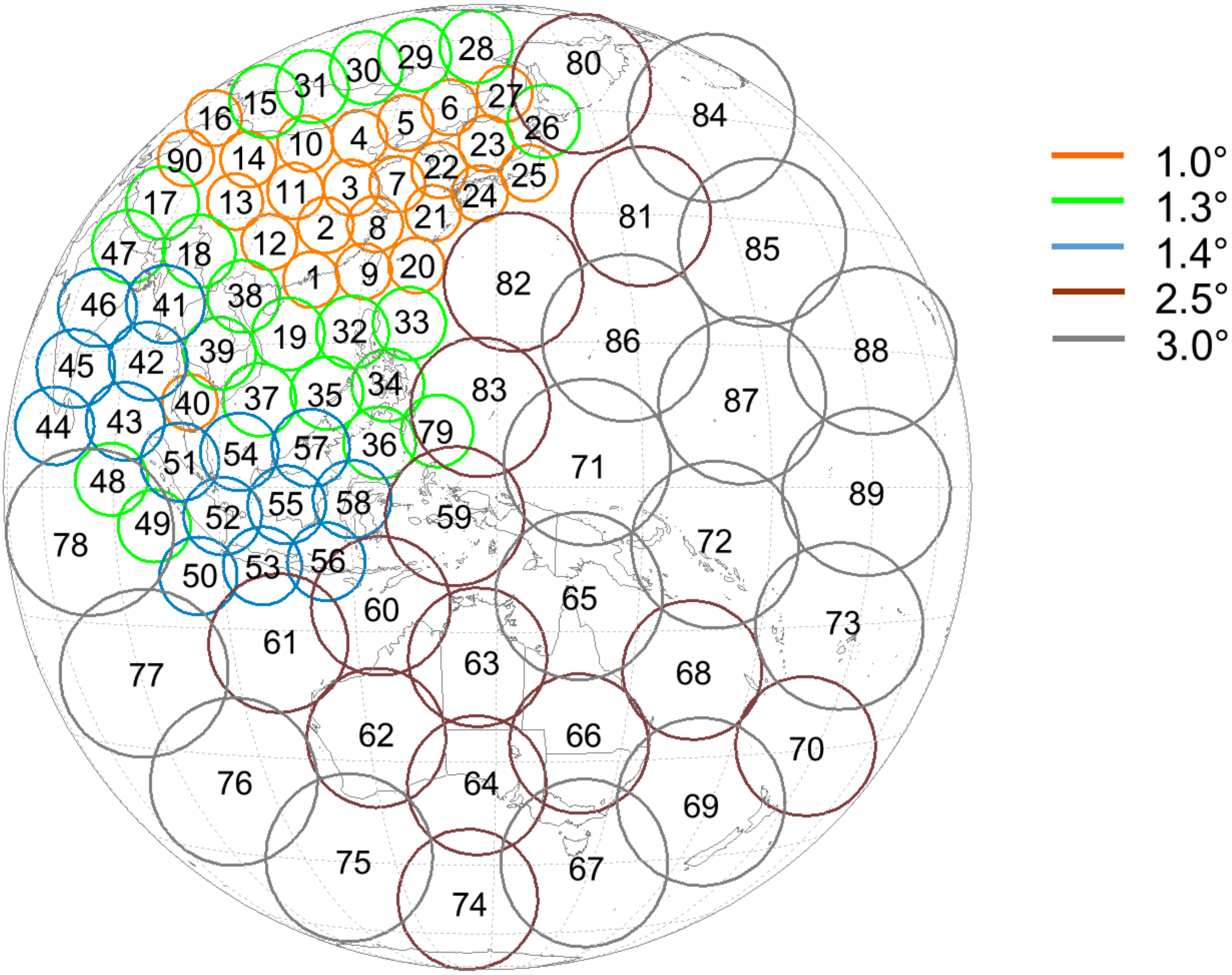
e) Momentum wheels should be shut down；

f) Evaluation of other stored energy devices without passivation being implemented。

5.3 CUTTING OFF DOWN-LINK SIGNAL

Satellite down-link signal should be cut off by the end of EOL disposal, including payload and telemetry in avoidance of disturbing other working spacecrafts.

3. Coverage Map



4. Link Budgets

Forward Link Budget

eXConnect Terminal		
Antenna Type	PPA	
Lat	30.4	deg
Lon	153.6	deg
EIRP max	47.0	dBW
G/T	11.0	dB/K
Satellite		
Name	APSTAR-6D	
Longitude	134.0	deg
Hub Earth Station		
Site	Perth	
Lat	-31.9186	deg
Lon	115.9159	deg
EIRP max	80.0	dBW
G/T	40.0	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.45	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	0.81	bps/Hz
Data Rate	1.08E+08	bps
Information Rate (Data + Overhead)	1.20E+08	bps
Symbol Rate	1.33E+08	Hz
Chip Rate (Noise Bandwidth)	1.33E+08	Hz
Occupied Bandwidth	1.40E+08	Hz
Power Equivalent Bandwidth	1.40E+08	Hz
C/N Threshold	0.0	dB
Uplink		
Frequency	28.500	GHz
Back off	4.7	dB
EIRP Spectral Density	30.0	dBW/4kHz
Slant Range	37214	km
Space Loss, Ls	213.0	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	7.9	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	17.0	dB/K
Thermal Noise, C/No	100.0	dBHz
C/(No+Io)	99.5	dBHz
Satellite		
Flux Density	-95.1	dBW/m2
SFD @ Hub	-87.0	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	5.1	dB
Downlink		
Frequency	11.325	GHz
Transponder Sat. EIRP @ Beam Peak	55.2	dBW
Transponder Sat. EIRP @ Terminal	55.0	dBW
DL PSD Limit	14.0	dBW/4kHz
DL PSD @ Beam Peak	4.9	dBW/4kHz
Carrier EIRP @ Beam Peak	50.2	dBW
Carrier EIRP @ Terminal	49.9	dBW
Slant Range	37172	km
Space Loss, Ls	204.9	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	84.0	dBHz
C/(No+Io)	83.6	dBHz
End to End		
End to End C/(No+Io)	83.4	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	0.7	dB
Link Margin	0.7	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	PPA	
Lat	30.4	deg
Lon	153.6	deg
EIRP max	47.0	dBW
G/T	11.0	dB/K
Satellite		
Name	APSTAR-6D	
Longitude	134.0	deg
Hub Earth Station		
Site	Perth	
Lat	-31.9186	deg
Lon	115.9159	deg
EIRP max	80.0	dBW
G/T	40.0	dB/K
Signal		
Waveform	MxDMA	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	3	
Coding Rate	0.35	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	0.21	bps/Hz
Data Rate	4.20E+06	bps
Information Rate (Data + Overhead)	4.67E+06	bps
Symbol Rate	6.67E+06	Hz
Chip Rate (Noise Bandwidth)	2.00E+07	Hz
Occupied Bandwidth	2.10E+07	Hz
Power Equivalent Bandwidth	7.42E+06	Hz
C/N Threshold	-5.6	dB
Uplink		
Frequency	14.125	GHz
Back off	0.0	dB
EIRP Spectral Density	10.0	dBW/4kHz
Slant Range	37172	km
Space Loss, Ls	206.9	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	6.0	dB/K
Thermal Noise, C/No	74.1	dBHz
C/(No+Io)	73.6	dBHz
Satellite		
Flux Density	-116.1	dBW/m2
SFD @ Terminal	-86.0	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	27.1	dB
Downlink		
Frequency	18.500	GHz
Transponder Sat. EIRP @ Beam Peak	65.0	dBW
Transponder Sat. EIRP @ Hub	65.0	dBW
DL PSD Limit	14.0	dBW/4kHz
DL PSD @ Beam Peak	0.9	dBW/4kHz
Carrier EIRP @ Beam Peak	37.9	dBW
Carrier EIRP @ Hub	37.9	dBW
Slant Range	37214	km
Space Loss, Ls	209.2	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	5.7	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	91.6	dBHz
C/(No+Io)	85.3563	dBHz
End to End		
End to End C/(No+Io)	73.3	dBHz
Implementation Loss	5.5	dB
End to End C/N w/ Imp Loss	-5.2	dB
Link Margin	0.4	dB

Forward Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	30.4	deg
Lon	153.6	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	APSTAR-6D	
Longitude	134.0	deg
Hub Earth Station		
Site	Perth	
Lat	-31.9186	deg
Lon	115.9159	deg
EIRP max	80.0	dBW
G/T	40.0	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.50	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	0.90	bps/Hz
Data Rate	1.20E+08	bps
Information Rate (Data + Overhead)	1.33E+08	bps
Symbol Rate	1.33E+08	Hz
Chip Rate (Noise Bandwidth)	1.33E+08	Hz
Occupied Bandwidth	1.40E+08	Hz
Power Equivalent Bandwidth	1.40E+08	Hz
C/N Threshold	0.8	dB
Uplink		
Frequency	28.500	GHz
Back off	4.7	dB
EIRP Spectral Density	30.0	dBW/4kHz
Slant Range	37214	km
Space Loss, Ls	213.0	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	7.9	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	17.0	dB/K
Thermal Noise, C/No	100.0	dBHz
C/(No+Io)	99.5	dBHz
Satellite		
Flux Density	-95.1	dBW/m2
SFD @ Hub	-87.0	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	5.1	dB
Downlink		
Frequency	11.325	GHz
Transponder Sat. EIRP @ Beam Peak	55.2	dBW
Transponder Sat. EIRP @ Terminal	55.0	dBW
DL PSD Limit	14.0	dBW/4kHz
DL PSD @ Beam Peak	4.9	dBW/4kHz
Carrier EIRP @ Beam Peak	50.2	dBW
Carrier EIRP @ Terminal	49.9	dBW
Slant Range	37169	km
Space Loss, Ls	204.9	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	84.5	dBHz
C/(No+Io)	84.0	dBHz
End to End		
End to End C/(No+Io)	83.9	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	1.1	dB
Link Margin	0.3	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	30.4	deg
Lon	153.6	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	APSTAR-6D	
Longitude	134.0	deg
Hub Earth Station		
Site	Perth	
Lat	-31.9186	deg
Lon	115.9159	deg
EIRP max	80.0	dBW
G/T	40.0	dB/K
Signal		
Waveform	MxDMA	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	3	
Coding Rate	0.35	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	0.21	bps/Hz
Data Rate	4.20E+06	bps
Information Rate (Data + Overhead)	4.67E+06	bps
Symbol Rate	6.67E+06	Hz
Chip Rate (Noise Bandwidth)	2.00E+07	Hz
Occupied Bandwidth	2.10E+07	Hz
Power Equivalent Bandwidth	4.67E+06	Hz
C/N Threshold	-5.6	dB
Uplink		
Frequency	14.125	GHz
Back off	0.0	dB
EIRP Spectral Density	8.0	dBW/4kHz
Slant Range	37169	km
Space Loss, Ls	206.9	dB
Pointing Loss, Lpnt	0.2	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	6.0	dB/K
Thermal Noise, C/No	72.1	dBHz
C/(No+Io)	71.6	dBHz
Satellite		
Flux Density	-118.1	dBW/m2
SFD @ Terminal	-86.0	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	29.1	dB
Downlink		
Frequency	18.500	GHz
Transponder Sat. EIRP @ Beam Peak	65.0	dBW
Transponder Sat. EIRP @ Hub	65.0	dBW
DL PSD Limit	14.0	dBW/4kHz
DL PSD @ Beam Peak	-1.1	dBW/4kHz
Carrier EIRP @ Beam Peak	35.9	dBW
Carrier EIRP @ Hub	35.9	dBW
Slant Range	37214	km
Space Loss, Ls	209.2	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	5.7	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	89.6	dBHz
C/(No+Io)	83.3422	dBHz
End to End		
End to End C/(No+Io)	71.3	dBHz
Implementation Loss	3.5	dB
End to End C/N w/ Imp Loss	-5.2	dB
Link Margin	0.4	dB

III. AsiaSat 9

1. Satellite Operator Certification Letter

ASIASAT
Reaching Further, Bringing You Closer

Ref: TM21/220818/0054

22th Aug, 2018

Federal Communications Commission
International Bureau
445 12th Street, SW
Washington, D.C. 20554

Re: Engineering Certification of Asia Satellite Telecommunications Co. Ltd

To Whom It May Concern:

This letter certifies that Asia Satellite Telecommunications Co. Ltd (herein after "AsiaSat") is aware that Panasonic Avionics Corporation ("Panasonic") is planning to modify its earth stations aboard aircraft ("ESAA") blanket license from the Federal Communication Commission ("FCC"), Call Sign E100089, to add the ASIASAT-9 satellite, located at 122° E.L., as an authorized point of communication for its DPA and SPA ESAA terminals. AsiaSat understands that Panasonic will file the modification application pursuant to the FCC rules governing ESAA operations, including Section 25.227.

AsiaSat confirms and hereby certifies that the power density levels of the proposed operations are consistent with existing satellite coordination agreements with the satellites with +/-6 degrees of the ASIASAT-9 satellite's orbit location, and acknowledges that the proposed operation of Panasonic's DPA and SPA ESAA terminals has the potential to create and receive harmful interference from adjacent satellite networks that may be unacceptable.

If the FCC authorizes the operation proposed by Panasonic, AsiaSat will include the power density levels specified by Panasonic, defined within the satellite coordination agreements, in all future satellite network coordination with operators of satellite that are adjacent to the satellite addressed by this letter.

Sincerely,

Wai Fai, NG
Manager, Communications Engineering

Asia Satellite Telecommunications Company Limited
12/F, Harbour Centre
25 Harbour Road, Wanchai, Hong Kong
T (852) 2500 0888
F (852) 2576 4111
www.asiasat.com

2. Orbital Debris Mitigation Statement

AsiaSat 9 Orbital Debris Mitigation Plan

47 C.F.R. Section 25.114(d)(14): A description of the design and operational strategies that will be used to mitigate orbital debris, including the following information:

(i) A statement that the space station operator has assessed and limited the amount of debris released in a planned manner during normal operations, and has assessed and limited the probability of the space station becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal;

(ii) A statement that the space station operator has assessed and limited the probability of accidental explosions during and after completion of mission operations. This statement must include a demonstration that debris generation will not result from the conversion of energy sources on board the spacecraft into energy that fragments the spacecraft. Energy sources include chemical, pressure, and kinetic energy. This demonstration should address whether stored energy will be removed at the spacecraft's end of life, by depleting residual fuel and leaving all fuel line valves open, venting any pressurized system, leaving all batteries in a permanent discharge state, and removing any remaining source of stored energy, or through other equivalent procedures specifically disclosed in the application;

(iii) A statement that the space station operator 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. Where a space station will be launched into a low-Earth orbit that is identical, or very similar, to an orbit used by other space stations, the statement must include an analysis of the potential risk of collision and a description of what measures the space station operator plans to take to avoid in-orbit collisions. If the space station operator is relying on coordination with another system, the statement must indicate what steps have been taken to contact, and ascertain the likelihood of successful coordination of physical operations with, the other system. The statement must disclose the accuracy—if any—with which orbital parameters of non-geostationary satellite orbit space stations will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s). In the event that a system is not able to maintain orbital tolerances, *i.e.*, it lacks a propulsion system for orbital maintenance, that fact should be included in the debris mitigation disclosure. Such systems must also indicate the anticipated evolution over time of the orbit of the proposed satellite or satellites. Where a space station requests the assignment of a geostationary-Earth orbit location, it must assess whether there are any known satellites located at, or reasonably expected to be located at, the requested orbital location, or assigned in the vicinity of that location, such that the station keeping volumes of the respective satellites might overlap. If so, the statement must include a statement as to the identities of those parties and the measures that will be taken to prevent collisions;

(iv) A statement detailing the post-mission disposal plans for the space station at end of life, including the quantity of fuel—if any—that will be reserved for post-mission disposal maneuvers. For geostationary-Earth orbit space stations, the statement must disclose the altitude selected for a post-mission disposal orbit and the calculations that are used in deriving the disposal altitude. The statement must also include a casualty risk assessment if planned post-mission disposal involves

atmospheric re-entry of the space station. In general, an assessment should include an estimate as to whether portions of the spacecraft will survive re-entry and reach the surface of the Earth, as well as an estimate of the resulting probability of human casualty.

The AsiaSat 9 spacecraft is a reliable Space Systems/Loral ("SSL") 1300 spacecraft, which is widely known as a mature product and one of the most reliable satellite platforms, and is designed and has been demonstrated to withstand the harsh space environment. In general, the SSL 1300 spacecraft design has taken orbital debris mitigation into account and is aligned with general industry practices and standards.

(i) Debris Release Assessment

AsiaSat has assessed and limited the amount of debris released in a planned manner during normal operations, and has assessed and limited the probability of the space station becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal. The satellite has been designed such that no debris will be released by the spacecraft under the normal operation of the satellite. In the event of collisions with small debris or meteoroids, the spacecraft hardware has been designed with redundant units such that individual faults will not cause the loss of the entire spacecraft and the spacecraft will retain the post-mission disposal capability. All critical components (e.g. on-board processors and control devices etc.) have been built within the structure and shielded from external influences. External items that could not be installed within the spacecraft structure nor shielded (e.g. antennas and attitude sensors etc.) are able to withstand impact. The spacecraft can be controlled through both the normal communications payload antennas and the wide angle omni antennas. The likelihood of both being damaged during a collision with small debris or meteoroids is minimal.

(ii) Accidental Explosion Assessment

AsiaSat has assessed and limited the probability of accidental explosions during and after completion of mission operations. The failure modes for all equipment have been reviewed to assess the possibility of an accidental explosion onboard the spacecraft. In order to ensure that the spacecraft does not explode on-orbit AsiaSat will continue to operate the satellite in accordance with SSL's recommended procedures. All batteries and propellant tanks are monitored for pressure or temperature variations. All critical satellite parameters are telemetered from the spacecraft and limits are checked by the real-time computers in the SOC (Satellite Operations Centre) and any out-of-limit conditions will alert the on-duty SOC controllers to take the required action. Additionally, long term trending analysis will be performed to monitor for any unexpected or anomalous trends.

Batteries are operated under SSL's automatic recharging scheme. This means normal battery charging termination does not require ground commanding to ensure no additional heat and pressure build up in the battery cells. Furthermore, each battery cell is protected by individual over voltage and over current protection circuits. As this process occurs wholly within the spacecraft, it also affords protection from command link failures from the ground station.

To protect the propulsion subsystem, propellant tanks are operated in a blow down mode during on-orbit operation. At the completion of orbit raising, the pressurant was isolated from the propellant tanks. Therefore the pressure in the propellant tanks will decrease as the propellant is consumed during the stationkeeping manoeuvres over the life of the spacecraft. There is also a regulator installed between the pressurant tanks and the propellant tanks such that if a pressure valve fails open the propellant tanks would not be over-pressurized.

To ensure that the spacecraft has no explosive risk after it has been successfully de-orbited, all stored energy onboard the spacecraft will be removed. Firstly, all latch valves will be open to ensure all residual propellant and pressurant are vented out and released. All battery chargers will be turned off and batteries will be left in a permanent discharge state. All remaining active pyrotechnics will be fired to eliminate explosive risk. All reaction wheels will be turned off to release all stored kinetic energy. These steps will ensure that no build-up of energy can occur resulting in an explosion in the years after the spacecraft is de-orbited.

(iii) Assessment Regarding Collision with Large Debris and Other Space Stations

AsiaSat 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.

AsiaSat 9 is operating at GEO at longitude of 122 deg E +/-0.1 deg and using industry standard and time proven techniques in the station-keeping maneuvering and orbit determination. These are the same techniques that AsiaSat has and continues to use for all its spacecraft fleet.

To minimize the possibility of a large body impact collision, the proximity of other known Space Stations / satellites has been assessed. In addition to working with other satellite operators of all known neighbouring satellites, AsiaSat utilizes other methods to identify the collision risk. All satellites in GEO or near GEO are tracked by downloading the orbital parameters from the NORAD database every day, and an internal satellite movement report is generated to AsiaSat's Engineering and Operations staff. AsiaSat will also get alerts from the JSpOC for any approaching bodies.

Any new spacecraft launch or satellite relocation will be closely monitored to verify that no new spacecraft will be introduced in the vicinity of AsiaSat 9. In the event that some spacecraft does locate within the vicinity of AsiaSat 9, AsiaSat will coordinate and work closely with that satellite operator on orbit control and stationkeeping strategies as it has done in the past with many other operators.

(iv) Post-Mission Disposal Plans

As a licensed satellite operator in Hong Kong, AsiaSat complies with the requirements as stipulated by the "Guidelines for De-commissioning of Satellite" (the "Guidelines") issued by OFCA (Hong Kong Office of Communications Authority) and adheres to prevailing international best practices and standards to reduce space debris.

According to the Guidelines, which are also consistent with the FCC requirement in §25.283 of the Commission's rules pertaining to end-of-life satellite disposal, any expired satellite which has to be de-orbited to outer space shall be disposed to an orbit with a delta-perigee (Δa) higher than geosynchronous orbit of no less than:

$$235 \text{ km} + (1000 \times CR \times A/m)$$

where CR is the solar pressure radiation coefficient of the spacecraft, and A/m is the solar pressure area-to-mass ratio, in square meters per kilogram, of the spacecraft.

AsiaSat will take into account this requirement for any de-orbit of the AsiaSat 9 satellite and will reserve sufficient propellant in order to conform to the regulations set forth in the Guidelines:

	Δa requirement	Propellant Needed
AsiaSat 9	279 km	12.17 kg

Any remaining propellant will be consumed by further raising the orbit until combustion is no longer possible. The remaining species of propellant, i.e. Oxidizer (N_2O_4) or Fuel (MMH), will be vented, placing the spacecraft's propulsion subsystem in a "safe" state.

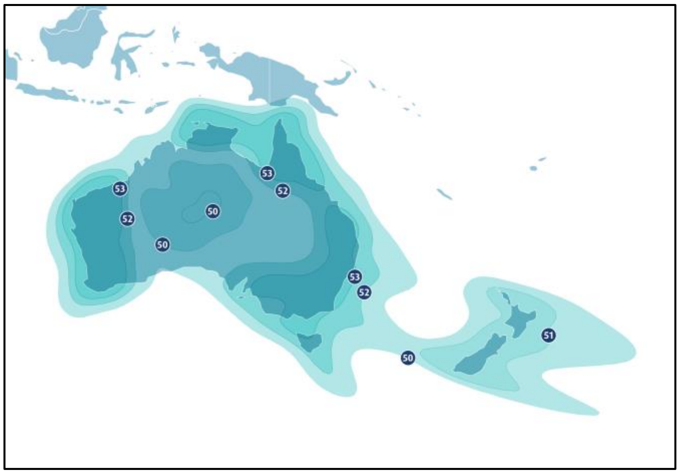
Propellant tracking is accomplished using a bookkeeping method. This method will track the number of jet seconds utilized for stationkeeping, momentum control and other attitude control events. From jet seconds, amount of propellant consumed is determined. This process has been calibrated using data collected from thruster tests conducted on the ground.

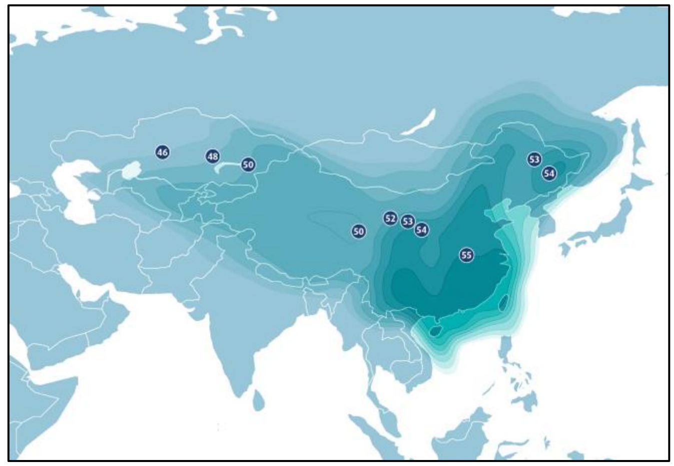
Asia Satellite Telecommunications Company Limited

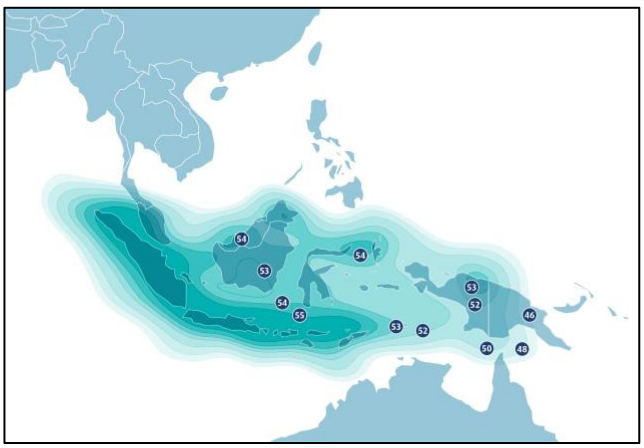
Will Ma

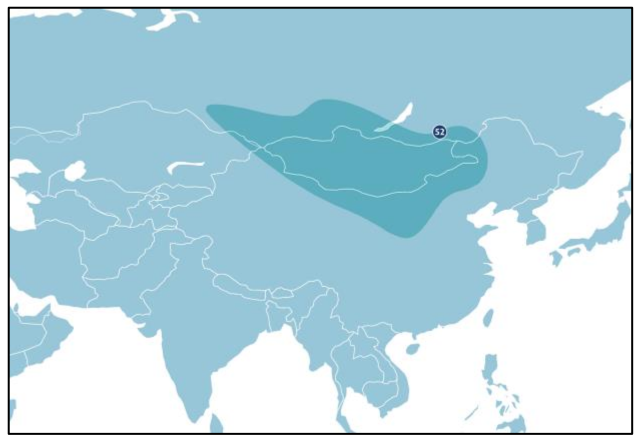
William Ma
Satellite Engineering & Orbital Dynamics Manager

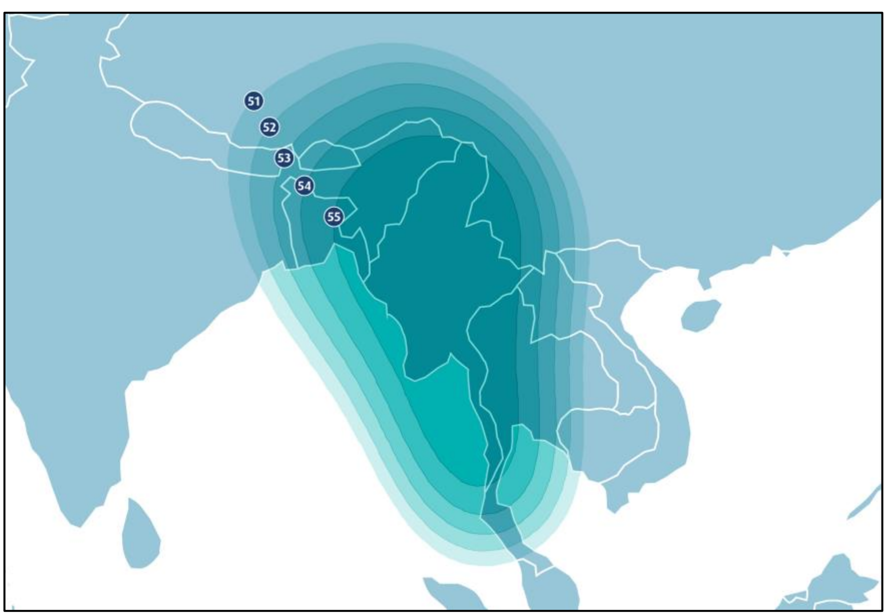
3. Coverage Maps











4. Link Budgets

Forward Link Budget

eXConnect Terminal		
Antenna Type	DPA	
Lat	25.6	deg
Lon	113.8	deg
EIRP max	47.3	dBW
G/T	11.4	dB/K
Satellite		
Name	A9	
Longitude	122.1	deg
Hub Earth Station		
Site	Beijing	
Lat	40.05	deg
Lon	116.27	deg
EIRP max	80.0	dBW
G/T	36.8	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	16APSK	
Bits per symbol	4	
Spread Factor	1	
Coding Rate	0.67	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	2.40	bps/Hz
Data Rate	1.23E+08	bps
Information Rate (Data + Overhead)	1.37E+08	bps
Symbol Rate	5.14E+07	Hz
Chip Rate (Noise Bandwidth)	5.14E+07	Hz
Occupied Bandwidth	5.40E+07	Hz
Power Equivalent Bandwidth	5.40E+07	Hz
C/N Threshold	8.2	dB
Uplink		
Frequency	14.330	GHz
Back off	9.7	dB
EIRP Spectral Density	29.2	dBW/4kHz
Slant Range	37540	km
Space Loss, Ls	207.1	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.8	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	7.0	dB/K
Thermal Noise, C/No	96.0	dBHz
C/(No+Io)	95.5	dBHz
Satellite		
Flux Density	-95.0	dBW/m2
SFD @ Hub	-91.0	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	1.0	dB
Downlink		
Frequency	12.582	GHz
Transponder Sat. EIRP @ Beam Peak	55.0	dBW
Transponder Sat. EIRP @ Terminal	55.0	dBW
DL PSD Limit	16.0	dBW/4kHz
DL PSD @ Beam Peak	12.9	dBW/4kHz
Carrier EIRP @ Beam Peak	54.0	dBW
Carrier EIRP @ Terminal	54.0	dBW
Slant Range	36593	km
Space Loss, Ls	205.7	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	87.6	dBHz
C/(No+Io)	87.6	dBHz
End to End		
End to End C/(No+Io)	87.0	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	8.4	dB
Link Margin	0.2	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	DPA	
Lat	25.6	deg
Lon	113.8	deg
EIRP max	47.3	dBW
G/T	11.4	dB/K
Satellite		
Name	A9	
Longitude	122.1	deg
Hub Earth Station		
Site	Beijing	
Lat	40.05	deg
Lon	116.27	deg
EIRP max	80.0	dBW
G/T	36.8	dB/K
Signal		
Waveform	MxDMA	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.45	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	0.81	bps/Hz
Data Rate	6.17E+06	bps
Information Rate (Data + Overhead)	6.86E+06	bps
Symbol Rate	7.62E+06	Hz
Chip Rate (Noise Bandwidth)	7.62E+06	Hz
Occupied Bandwidth	8.00E+06	Hz
Power Equivalent Bandwidth	2.99E+06	Hz
C/N Threshold	0.9	dB
Uplink		
Frequency	14.210	GHz
Back off	0.0	dB
EIRP Spectral Density	14.5	dBW/4kHz
Slant Range	36593	km
Space Loss, Ls	206.8	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	8.0	dB/K
Thermal Noise, C/No	76.5	dBHz
C/(No+Io)	76.0	dBHz
Satellite		
Flux Density	-115.6	dBW/m2
SFD @ Terminal	-98.0	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	15.6	dB
Downlink		
Frequency	12.462	GHz
Transponder Sat. EIRP @ Beam Peak	55.0	dBW
Transponder Sat. EIRP @ Hub	54.0	dBW
DL PSD Limit	16.0	dBW/4kHz
DL PSD @ Beam Peak	6.6	dBW/4kHz
Carrier EIRP @ Beam Peak	39.4	dBW
Carrier EIRP @ Hub	38.4	dBW
Slant Range	37540	km
Space Loss, Ls	205.9	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	4.7	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	93.2	dBHz
C/(No+Io)	88.6164	dBHz
End to End		
End to End C/(No+Io)	75.8	dBHz
Implementation Loss	5.5	dB
End to End C/N w/ Imp Loss	1.5	dB
Link Margin	0.6	dB

Forward Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	25.6	deg
Lon	113.8	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	A9	
Longitude	122.1	deg
Hub Earth Station		
Site	Beijing	
Lat	40.05	deg
Lon	116.27	deg
EIRP max	80.0	dBW
G/T	36.8	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	16APSK	
Bits per symbol	4	
Spread Factor	1	
Coding Rate	0.67	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	2.40	bps/Hz
Data Rate	1.23E+08	bps
Information Rate (Data + Overhead)	1.37E+08	bps
Symbol Rate	5.14E+07	Hz
Chip Rate (Noise Bandwidth)	5.14E+07	Hz
Occupied Bandwidth	5.40E+07	Hz
Power Equivalent Bandwidth	5.40E+07	Hz
C/N Threshold	8.2	dB
Uplink		
Frequency	14.330	GHz
Back off	9.7	dB
EIRP Spectral Density	29.2	dBW/4kHz
Slant Range	37540	km
Space Loss, Ls	207.1	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.8	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	7.0	dB/K
Thermal Noise, C/No	96.0	dBHz
C/(No+Io)	95.5	dBHz
Satellite		
Flux Density	-95.0	dBW/m2
SFD @ Hub	-91.0	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	1.0	dB
Downlink		
Frequency	12.582	GHz
Transponder Sat. EIRP @ Beam Peak	55.0	dBW
Transponder Sat. EIRP @ Terminal	55.0	dBW
DL PSD Limit	16.0	dBW/4kHz
DL PSD @ Beam Peak	12.9	dBW/4kHz
Carrier EIRP @ Beam Peak	54.0	dBW
Carrier EIRP @ Terminal	54.0	dBW
Slant Range	36591	km
Space Loss, Ls	205.7	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	87.8	dBHz
C/(No+Io)	87.8	dBHz
End to End		
End to End C/(No+Io)	87.1	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	8.5	dB
Link Margin	0.3	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	25.6	deg
Lon	113.8	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	A9	
Longitude	122.1	deg
Hub Earth Station		
Site	Beijing	
Lat	40.05	deg
Lon	116.27	deg
EIRP max	80.0	dBW
G/T	36.8	dB/K
Signal		
Waveform	MxDMA	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.45	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	0.81	bps/Hz
Data Rate	6.17E+06	bps
Information Rate (Data + Overhead)	6.86E+06	bps
Symbol Rate	7.62E+06	Hz
Chip Rate (Noise Bandwidth)	7.62E+06	Hz
Occupied Bandwidth	8.00E+06	Hz
Power Equivalent Bandwidth	1.73E+06	Hz
C/N Threshold	0.9	dB
Uplink		
Frequency	14.210	GHz
Back off	0.0	dB
EIRP Spectral Density	12.2	dBW/4kHz
Slant Range	36591	km
Space Loss, Ls	206.8	dB
Pointing Loss, Lpnt	0.2	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	8.0	dB/K
Thermal Noise, C/No	74.2	dBHz
C/(No+Io)	73.7	dBHz
Satellite		
Flux Density	-117.9	dBW/m2
SFD @ Terminal	-98.0	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	17.9	dB
Downlink		
Frequency	12.462	GHz
Transponder Sat. EIRP @ Beam Peak	55.0	dBW
Transponder Sat. EIRP @ Hub	54.0	dBW
DL PSD Limit	16.0	dBW/4kHz
DL PSD @ Beam Peak	4.2	dBW/4kHz
Carrier EIRP @ Beam Peak	37.1	dBW
Carrier EIRP @ Hub	36.1	dBW
Slant Range	37540	km
Space Loss, Ls	205.9	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	4.7	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	90.9	dBHz
C/(No+Io)	86.2496	dBHz
End to End		
End to End C/(No+Io)	73.4	dBHz
Implementation Loss	3.5	dB
End to End C/N w/ Imp Loss	1.1	dB
Link Margin	0.2	dB

IV. ChinaSat 10

中国卫通集团股份有限公司
中国航天 China Satellite Communications Co.,Ltd.

September 28, 2018

Federal Communications Commission
International Bureau
445 12th Street, SW
Washington, D.C. 20554

Re: Engineering Certification of China Satcom

To Whom It May Concern:

This letter certifies that China Satcom is aware that Panasonic Avionics Corporation ("Panasonic") is planning to modify its earth stations aboard aircraft ("ESAA") blanket license from the Federal Communication Commission ("FCC"), Call Sign E100089, to add the Chinasat-10 satellite, located at 110.5° E.L., as an authorized point of communication for its PPA and SPA ESAA terminals. China Satcom understands that Panasonic will file the modification application pursuant to the FCC rules governing ESAA operations, including Section 25.227.

China Satcom confirms and hereby certifies that the power density levels of the proposed operations are consistent with existing satellite coordination agreements with the satellites with +/-6 degrees of the Chinasat-10 satellite's orbit location, and acknowledges that the proposed operation of Panasonic's PPA and SPA ESAA terminals has the potential to create and receive harmful interference from adjacent satellite networks that may be unacceptable.

If the FCC authorizes the operation proposed by Panasonic, China Satcom will include the power density levels specified by Panasonic, defined within the satellite coordination agreements, in all future satellite network coordination with operators of satellite that are adjacent to the satellite addressed by this letter.

Sincerely,

Li Si

地址：北京市海淀区知春路65号 中国卫星通信大厦A座 电话：010-62586600 传真：010-62586677
Add: Building A,China Satellite Communications Tower,No.65 Zhichun Road, Haidian District, Beijing,China

中国卫通集团股份有限公司
中国航天 China Satellite Communications Co.,Ltd.

Chinasat-10@110.5E Space Debris Mitigation Plan

1. Introduction

This document describes the space debris mitigation plan that Chinsatcom shall apply to the Chinasat-10 satellite at 110.5E longitude orbital location.

Chinasat-10 is based on the DFH 4 bus and it was manufactured by China Academy of Space Technology. The satellite is 3-axis stabilized and uses bi-propellant chemical propulsion for attitude and on-station control.

ChinaSat-10 was launched on June21, 2011. It provides communications services with C-band and Ku-band transponders for commercial usage. The satellite service area includes China (Hong Kong and Taiwan are included) and Asia.

2. Chinasat-10 Operations

Chinsatcom operates the satellite to control and limit the amount of debris released in a planned manner during normal operations, and assesses and limits the probability of the space station becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal.

Chinsatcom has assessed the amount of debris released in a planned manner and no intentional debris will be released during normal operations of the Chinsat-10 spacecraft. A sage operational configuration of the satellite system is ensured thanks to the hardware design and operational procedures.

Chinsatcom minimizes the probability of the satellite becoming a source of debris by collisions with large debris or other operational satellites. Chinsatcom assessed and determined that there are no other satellites located at or sufficiently near Chinsat-10 planned orbital location that might result in overlap of satellite orbit control windows.

Chinsat-10 will be controlled within its orbit control window(110.5E +/- 0.05°) by standard routine periodic orbit correction maneuvers. In case of anticipated violation of the window, correction maneuvers would be implemented to avoid such violation.

Chinsatcom has assessed the probability of accidental explosions during and after completion of mission operations. Thanks to design safety margins, the probability of occurrence of accidental explosion of the Chinasat-10 satellite is negligible.

Satellite design is such that high levels of thruster activity and orbit perturbation do not result when foreseeable on-board events occur.

3. Chinsat-10 End of life disposal

The post-mission disposal activities have been planned as follows

1) PLANNING

a) De-orbit (EWSK) maneuver planning, including number and duration of maneuvers, fuel usage planning. Maneuver timing, including ranging and orbit determination.

b) Compile de-orbit coordination contact lists, including internal leads/management and also other satellite operators.

c) Antenna visibility assessment. Antenna prediction files creation and distribution.

d) Coordinate with other operators to determine TT&C configurations and/or command/telemetry blackout periods.

e) De-orbit drift Sun/Moon interference planning (manual/automatic/Macro/TEMA control of ESA/SSA determination).

f) De-orbit drift pointing planning to assure TT&C coverage/link closure.

2) INITIAL SETUP

a) Inclination NSSKs, including as-needed momentum adjusts as desired.

b) Update Macros/TEMAs as needed (including TT&C coverage Macro, ESA/SSA Sun/Moon inhibit control, and no-contact "phone home" Macro)

c) TT&C reconfigurations for de-orbit drift: use of horns or Omni antenna as needed.

Note: Set one transmitter to Omni to increase ability to command S/C.

d) Pointing reconfiguration for de-orbit drift as needed

Note: If T&C antenna beams are global coverage beams, Earth target pointing may not be necessary. Nadir pointing would be sufficient. If T&C beams are not global beams, Earth target pointing is needed.

e) Payload reconfiguration (RCVRs OFF, TWTAs OFF, panel heaters reconfiguration if needed)

3) DE-ORBIT MANEUVERS

a) T+0 hours: Execute EWSK utilizing East-facing REAs to raise apogee ~100 km. Collect range data, perform orbit determination.

b) T+12 hours: Execute 2nd ESWK to circularize the orbit. Ranging/OD.

c) Maneuver reconstruction. Update maneuver plans based on actual REA performance.

d) T+48 hours: Execute EWSK to raise apogee ~100 km. Ranging/OD.

e) T+60 hours: Execute EWSK to circularize the orbit. Ranging/OD.

f) Maneuver reconstruction. Update maneuver plans based on actual REA performance.

g) T+96 hours: Execute EWSK to raise apogee ~100 km. Ranging/OD.

h) T+108 hours: Execute EWSK to circularize the orbit. Ranging/OD.

i) As needed throughout de-orbit maneuvers:

i) update pointing for TT&C coverage

ii) ESA/SSA Sun/Moon interference commanding

iii) Solar array position adjustments

iv) Coordinate with other operators for TT&C configurations and blackout periods.

4) TANK DEPLETION MANEUVERS

a) Execute alternating EWSK cancellation maneuvers, or NSSKs to deplete the remaining fuel.

b) Tank repressurization to depressurize GHe tank, as needed.

c) Continue maneuvers to deplete fuel and depressurize tanks. Time constraints include antenna visibility limits, and command/telemetry coordination.

5) SPACECRAFT SAFING

a) Solar Array positioning and spacecraft loading

i) Slew solar arrays to East or West facing (array angles of 180° or 360°), and stop SADA rotation when arrays are edge onto sun in final spin axis.

ii) Turn off SADAs 1 & 2 (disable control circuit relays via SADNSPB_DS).

iii) Turn on heaters to load power bus. [Not needed since RIU power loss will open the FET for the heaters]

b) Non-Critical Equipment OFF

i) Disable ESA/SSA REDMAN (commands ESSA_COMT_DS, ESSA_RTST_DS, ESSA_SST_DS and ES_FLMCR_DS)

ii) SSA 2 OFF

iii) ESA 2 OFF

iv) Thruster control disabled.

v) Battery Charge rates to 0 A.

vi) Enable and Turn On Battery letdown resistors

vii) Disable PT, PT load shed, AHSOC, AHSOC load shed, TCI, SCM, and BOTP.

c) Critical Equipment OFF

i) Close Latch Valves: LV1 and LV2

ii) Stop all Macros

iii) Disable all TEMA tests and Global TEMA

iv) Disable REDMAN (REDMAN_DS), Disable all REDMAN tests, disable Hardware Switching (HDWR_SWCH_DS), send REDMAN disable Macro commands.

v) Disable RT-RT transfers with Monitor OBC (command BOBC_XFER_DS)

vi) OBC Monitor OFF.

6) FINAL SHUTOFF

a) SSA OFF

b) ESA OFF

c) RWAs 1-4 OFF

d) IMU OFF

e) RIUs OFF

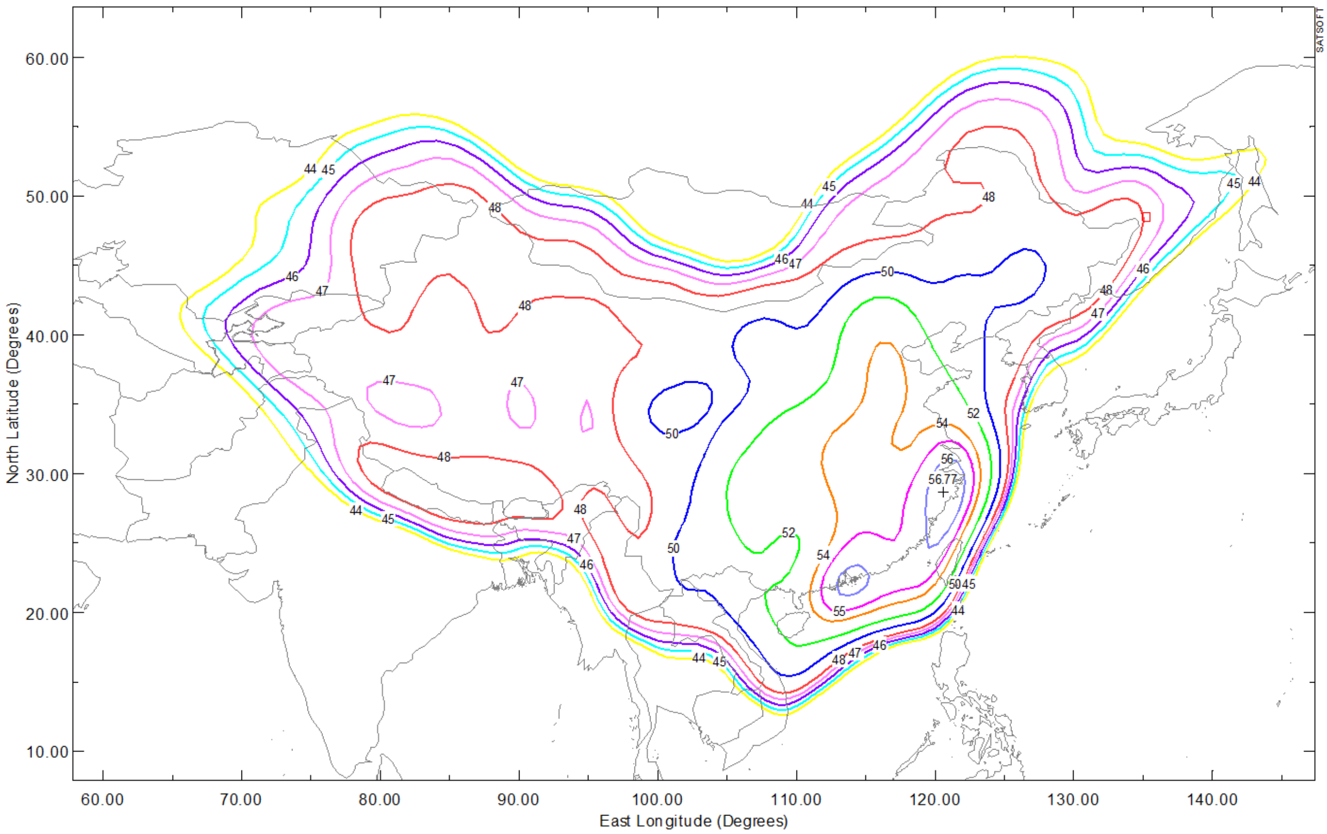
f) BPCs OFF (use commands BPCn_OFF)

g) OBC Control OFF

h) Telemetry Beacon Transmitter OFF

Traffic Operation Center
Chinasat-10 Engineer
Signature:

3. Coverage Map



4. Link Budgets

Forward Link Budget

eXConnect Terminal		
Antenna Type	DPA	
Lat	28.7	deg
Lon	120.6	deg
EIRP max	47.2	dBW
G/T	11.2	dB/K
Satellite		
Name	ChinaSat-10	
Longitude	110.5	deg
Hub Earth Station		
Site	Beijing	
Lat	40.05	deg
Lon	116.27	deg
EIRP max	80.0	dBW
G/T	37.0	dB/K
Signal		
Waveform	DVB-S2	
Modulation	16APSK	
Bits per symbol	4	
Spread Factor	1	
Coding Rate	0.67	
Overhead Rate	0.94	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	2.50	bps/Hz
Data Rate	1.12E+08	bps
Information Rate (Data + Overhead)	1.20E+08	bps
Symbol Rate	4.50E+07	Hz
Chip Rate (Noise Bandwidth)	4.50E+07	Hz
Occupied Bandwidth	5.40E+07	Hz
Power Equivalent Bandwidth	4.88E+07	Hz
C/N Threshold	9.6	dB
Uplink		
Frequency	14.023	GHz
Back off	8.6	dB
EIRP Spectral Density	30.9	dBW/4kHz
Slant Range	37540	km
Space Loss, Ls	206.9	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.8	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	4.0	dB/K
Thermal Noise, C/No	94.3	dBHz
C/(No+Io)	93.8	dBHz
Satellite		
Flux Density	-93.9	dBW/m2
SFD @ Hub	-90.0	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	0.9	dB
Downlink		
Frequency	12.273	GHz
Transponder Sat. EIRP @ Beam Peak	56.9	dBW
Transponder Sat. EIRP @ Terminal	56.0	dBW
DL PSD Limit	15.5	dBW/4kHz
DL PSD @ Beam Peak	15.5	dBW/4kHz
Carrier EIRP @ Beam Peak	56.0	dBW
Carrier EIRP @ Terminal	55.1	dBW
Slant Range	36806	km
Space Loss, Ls	205.5	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	88.8	dBHz
C/(No+Io)	88.4	dBHz
End to End		
End to End C/(No+Io)	87.3	dBHz
Implementation Loss	1.0	dB
End to End C/N w/ Imp Loss	9.8	dB
Link Margin	0.2	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	DPA	
Lat	28.7	deg
Lon	120.6	deg
EIRP max	47.2	dBW
G/T	11.2	dB/K
Satellite		
Name	ChinaSat-10	
Longitude	110.5	deg
Hub Earth Station		
Site	Beijing	
Lat	40.05	deg
Lon	116.27	deg
EIRP max	80.0	dBW
G/T	37.0	dB/K
Signal		
Waveform	iDirect	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.75	
Overhead Rate	0.82	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	1.23	bps/Hz
Data Rate	8.19E+06	bps
Information Rate (Data + Overhead)	1.00E+07	bps
Symbol Rate	6.67E+06	Hz
Chip Rate (Noise Bandwidth)	6.67E+06	Hz
Occupied Bandwidth	8.00E+06	Hz
Power Equivalent Bandwidth	7.98E+05	Hz
C/N Threshold	5.9	dB
Uplink		
Frequency	14.023	GHz
Back off	0.0	dB
EIRP Spectral Density	15.0	dBW/4kHz
Slant Range	36806	km
Space Loss, Ls	206.7	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	8.0	dB/K
Thermal Noise, C/No	76.5	dBHz
C/(No+Io)	76.0	dBHz
Satellite		
Flux Density	-115.8	dBW/m2
SFD @ Terminal	-94.0	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	18.8	dB
Downlink		
Frequency	12.273	GHz
Transponder Sat. EIRP @ Beam Peak	56.9	dBW
Transponder Sat. EIRP @ Hub	52.0	dBW
DL PSD Limit	15.5	dBW/4kHz
DL PSD @ Beam Peak	5.9	dBW/4kHz
Carrier EIRP @ Beam Peak	38.2	dBW
Carrier EIRP @ Hub	33.2	dBW
Slant Range	37540	km
Space Loss, Ls	205.7	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	4.0	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	89.2	dBHz
C/(No+Io)	83.4604	dBHz
End to End		
End to End C/(No+Io)	75.3	dBHz
Implementation Loss	1.0	dB
End to End C/N w/ Imp Loss	6.0	dB
Link Margin	0.1	dB

Forward Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	28.7	deg
Lon	120.6	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	ChinaSat-10	
Longitude	110.5	deg
Hub Earth Station		
Site	Beijing	
Lat	40.05	deg
Lon	116.27	deg
EIRP max	80.0	dBW
G/T	37.0	dB/K
Signal		
Waveform	DVB-S2	
Modulation	16APSK	
Bits per symbol	4	
Spread Factor	1	
Coding Rate	0.67	
Overhead Rate	0.94	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	2.50	bps/Hz
Data Rate	1.12E+08	bps
Information Rate (Data + Overhead)	1.20E+08	bps
Symbol Rate	4.50E+07	Hz
Chip Rate (Noise Bandwidth)	4.50E+07	Hz
Occupied Bandwidth	5.40E+07	Hz
Power Equivalent Bandwidth	4.88E+07	Hz
C/N Threshold	9.6	dB
Uplink		
Frequency	14.023	GHz
Back off	8.6	dB
EIRP Spectral Density	30.9	dBW/4kHz
Slant Range	37540	km
Space Loss, Ls	206.9	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.8	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	4.0	dB/K
Thermal Noise, C/No	94.3	dBHz
C/(No+Io)	93.8	dBHz
Satellite		
Flux Density	-93.9	dBW/m2
SFD @ Hub	-90.0	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	0.9	dB
Downlink		
Frequency	12.273	GHz
Transponder Sat. EIRP @ Beam Peak	56.9	dBW
Transponder Sat. EIRP @ Terminal	56.0	dBW
DL PSD Limit	15.5	dBW/4kHz
DL PSD @ Beam Peak	15.5	dBW/4kHz
Carrier EIRP @ Beam Peak	56.0	dBW
Carrier EIRP @ Terminal	55.1	dBW
Slant Range	36806	km
Space Loss, Ls	205.5	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	89.1	dBHz
C/(No+Io)	88.5	dBHz
End to End		
End to End C/(No+Io)	87.4	dBHz
Implementation Loss	1.0	dB
End to End C/N w/ Imp Loss	9.9	dB
Link Margin	0.3	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	28.7	deg
Lon	120.6	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	ChinaSat-10	
Longitude	110.5	deg
Hub Earth Station		
Site	Beijing	
Lat	40.05	deg
Lon	116.27	deg
EIRP max	80.0	dBW
G/T	37.0	dB/K
Signal		
Waveform	iDirect	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.50	
Overhead Rate	0.83	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.83	bps/Hz
Data Rate	5.55E+06	bps
Information Rate (Data + Overhead)	6.67E+06	bps
Symbol Rate	6.67E+06	Hz
Chip Rate (Noise Bandwidth)	6.67E+06	Hz
Occupied Bandwidth	8.00E+06	Hz
Power Equivalent Bandwidth	4.77E+05	Hz
C/N Threshold	3.6	dB
Uplink		
Frequency	14.023	GHz
Back off	0.0	dB
EIRP Spectral Density	12.8	dBW/4kHz
Slant Range	36806	km
Space Loss, Ls	206.7	dB
Pointing Loss, Lpnt	0.2	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	8.0	dB/K
Thermal Noise, C/No	74.2	dBHz
C/(No+Io)	73.7	dBHz
Satellite		
Flux Density	-118.0	dBW/m2
SFD @ Terminal	-94.0	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	21.0	dB
Downlink		
Frequency	12.273	GHz
Transponder Sat. EIRP @ Beam Peak	56.9	dBW
Transponder Sat. EIRP @ Hub	52.0	dBW
DL PSD Limit	15.5	dBW/4kHz
DL PSD @ Beam Peak	3.7	dBW/4kHz
Carrier EIRP @ Beam Peak	35.9	dBW
Carrier EIRP @ Hub	31.0	dBW
Slant Range	37540	km
Space Loss, Ls	205.7	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	4.0	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	86.9	dBHz
C/(No+Io)	81.2243	dBHz
End to End		
End to End C/(No+Io)	73.0	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	4.8	dB
Link Margin	1.2	dB

V. SES-12

SES

Philippe Secher
Senior Manager, Spectrum Management & Development, Americas

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

19 November 2018

Subject: Engineering Certification of SES Americom, Inc. for the SES-12 and SES-14 Satellites

To whom it may concern,

This letter confirms that SES is aware that Panasonic Avionics Corporation ("Panasonic Avionics"), licensed by the Federal Communications Commission ("FCC") as Panasonic Avionics Corporation, is planning to file an application seeking a modification to its blanket authorization (the "Modification Application") to operate technically identical Ku-band Earth Stations Aboard Aircraft ("ESAA") pursuant to ITU RR 5.504A and Section 25.227 of the Commission's rules (Call Sign E100089). The Modification Application will seek authority for Panasonic Avionics' ESAA terminals to communicate with the SES-12 satellite at 95° E.L. and the SES-14 satellite at 47.5° W.L., under the current ESAA rules, including Section 25.227.

Based upon the representations made to SES by Panasonic Avionics concerning how it will operate on SES-12 and SES-14 according to its letter dated November 15, 2018:

- SES certifies that it has completed coordination as required under the FCC's rules and that the power density levels specified by Panasonic Avionics are consistent with any existing coordination agreements to which SES is a party with adjacent satellite operators within +/- 6 degrees of orbital separation from SES-12 and SES-14.

- If the FCC authorizes the operations proposed by Panasonic Avionics, SES will include the power density levels specified by Panasonic Avionics in all future satellite network coordination with other operators of satellites adjacent to SES-12 and SES-14.

Yours Sincerely,

Philippe Secher
Senior Manager
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2. Orbital Debris Mitigation Statement

SES-12 ORBITAL DEBRIS ANALYSIS REPORT

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

Spacecraft Hardware design. SES has assessed and limited the amount of debris that will be released in a planned manner during normal operations of SES-12. During the satellite ascent, after separation from the launcher, no debris will be generated. As with all recent SES satellite launches, all deployments will be conducted using pyrotechnic devices designed to retain all physical debris. No debris is generated during normal on-station operations, and the spacecraft will be in a stable configuration.

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. The design of SES's recent spacecraft locates all sources of stored energy within the body of the structure, which provides protection from small orbital debris. 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 SES's required probability of success of the mission. SES has taken the following steps to limit the effects of such collisions: (1) critical spacecraft components are located inside the protective body of the spacecraft and properly shielded; and (2) all spacecraft subsystems have redundant components to ensure no single-point failures. The spacecraft will not use any subsystems for end-of-life disposal that are not used for normal operations.

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 submission for SES spacecraft, 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 SES-12 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. 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, will be monitored by telemetry. At the end of operational life, after the satellite has reached its final disposal orbit, all on-board sources of stored energy will be depleted or secured, excess propellant remaining in the chemical propulsion tanks will be vented, excess pressurant remaining in the helium tanks will be vented, and the batteries will be discharged.

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, the requested orbital location 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 station-keeping 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.

SES-12 will be positioned at 95.0° E.L. In considering current and planned satellites that may have a station-keeping volume that overlaps the SES-12 satellite, SES has reviewed publicly available databases for satellite networks operating at 95° E.L. In addition, networks for which a request for coordination has been published by the ITU within ±0.15 degrees of 95.0° E.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 SES-12 satellite, have been taken into account in the analysis. Based on these reviews, the satellites operating nominally at 95° W.L. are NSS-6, SES-8, which are also controlled and operated by SES. The Luch 5V and Skynet 5A satellites are also operating near the nominal 95° E.L. orbital location at 94.7° E.L.+/- 0.1° and 95.25°E.L.+/- 0.1° respectively. Based on the preceding, it is concluded that physical coordination of the SES-12 satellite with another party is not required at the present time.

On-station operations require station-keeping within the +/- 0.1 degree N-S and +/- 0.05 degree E-W control box, thereby ensuring adequate collision avoidance distance from other satellites in geosynchronous orbit. SES will use the proven inclination-eccentricity technique to ensure adequate separation between the satellites. This strategy is presently in use by SES at several orbital locations to ensure proper operation and safety of multiple satellites within one orbital box.

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. The fuel budget for elevating the satellite to a disposal orbit is included in the satellite design. SES plans to maneuver SES-12 to a disposal orbit with a minimum perigee of 264 km above the normal GSO operational orbit. This proposed disposal orbit altitude results from application of the IADC formula based on the following calculation:

Total Solar Pressure Area "A" = 121.0 m^2

"M" = Dry Mass of Satellite = 4178.0 kg

"CR" = Solar Pressure Radiation Coefficient = 1.00

Therefore the Minimum Disposal Orbit Perigee Altitude:

= 36,021 km + 1000 x CR x A / m

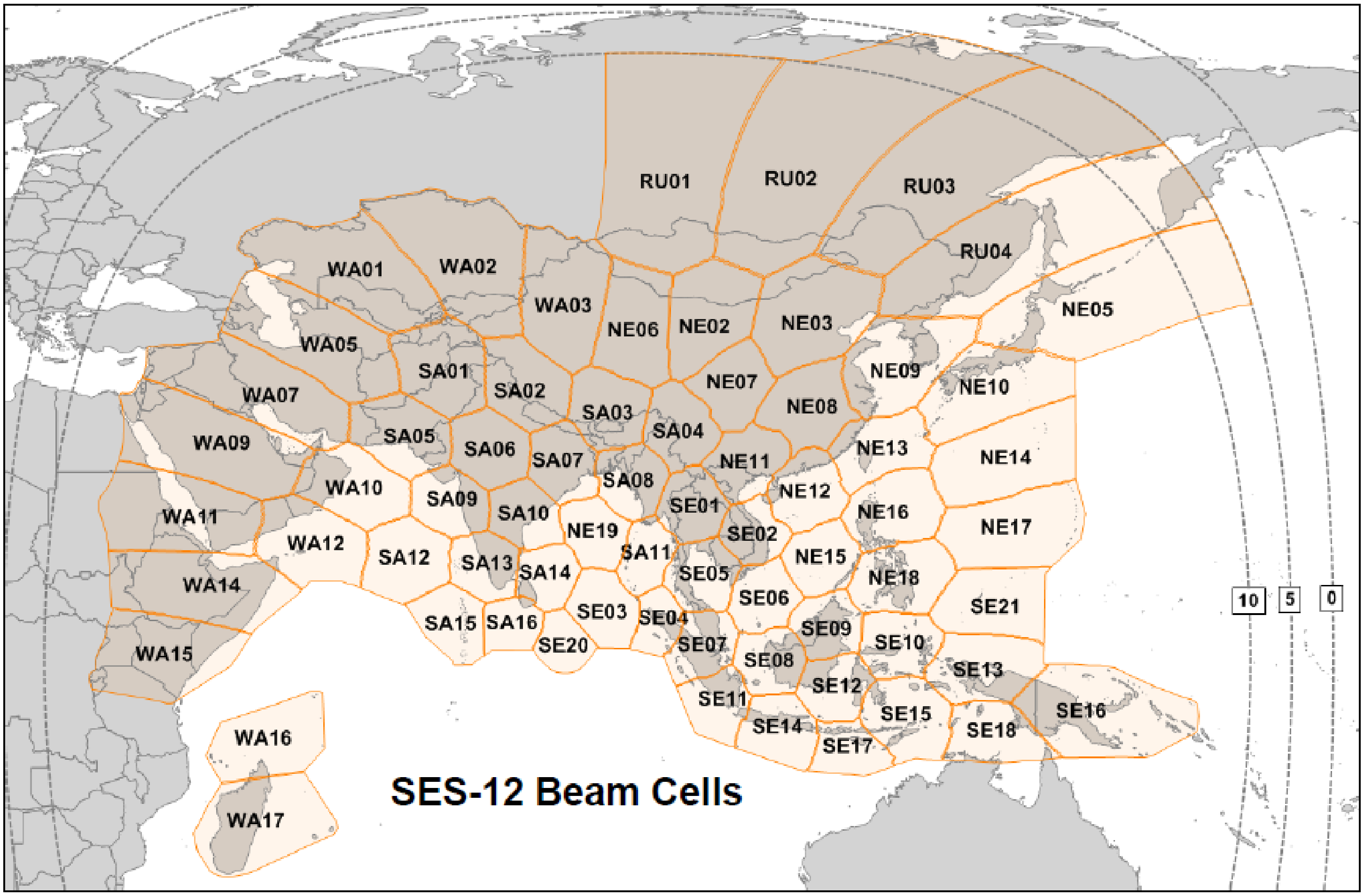
= 36,021 km + 1000 x 1.00 x 121.0 / 4178.0

= 36,050 km

= 264 km above GSO (35,786 km)

SES intends to reserve 15.5 kg of propellant in order to account for post-mission disposal of SES-12. SES has assessed fuel-gauging uncertainty and has provided an adequate margin of fuel reserve to address the assessed uncertainty.

3. Coverage Map



4. Link Budgets

Forward Link Budget

eXConnect Terminal		
Antenna Type	PPA	
Lat	4.5	deg
Lon	96.7	deg
EIRP max	47.9	dBW
G/T	11.9	dB/K
Satellite		
Name	SES-12	
Longitude	95.0	deg
Hub Earth Station		
Site	Adelaide	
Lat	-34.7677	deg
Lon	138.6978	deg
EIRP max	80.0	dBW
G/T	40.0	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.67	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	1.20	bps/Hz
Data Rate	1.60E+08	bps
Information Rate (Data + Overhead)	1.77E+08	bps
Symbol Rate	1.33E+08	Hz
Chip Rate (Noise Bandwidth)	1.33E+08	Hz
Occupied Bandwidth	1.40E+08	Hz
Power Equivalent Bandwidth	5.92E+07	Hz
C/N Threshold	2.9	dB
Uplink		
Frequency	28.500	GHz
Back off	0.0	dB
EIRP Spectral Density	34.8	dBW/4kHz
Slant Range	38721	km
Space Loss, Ls	213.3	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	9.1	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	13.3	dB/K
Thermal Noise, C/No	99.4	dBHz
C/(No+Io)	98.9	dBHz
Satellite		
Flux Density	-91.9	dBW/m2
SFD @ Hub	-89.3	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	-0.4	dB
Downlink		
Frequency	11.000	GHz
Transponder Sat. EIRP @ Beam Peak	51.5	dBW
Transponder Sat. EIRP @ Terminal	51.0	dBW
DL PSD Limit	12.5	dBW/4kHz
DL PSD @ Beam Peak	6.7	dBW/4kHz
Carrier EIRP @ Beam Peak	51.9	dBW
Carrier EIRP @ Terminal	51.4	dBW
Slant Range	35820	km
Space Loss, Ls	204.4	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	87.0	dBHz
C/(No+Io)	86.4	dBHz
End to End		
End to End C/(No+Io)	86.1	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	3.4	dB
Link Margin	0.5	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	PPA	
Lat	4.5	deg
Lon	96.7	deg
EIRP max	47.9	dBW
G/T	11.9	dB/K
Satellite		
Name	SES-12	
Longitude	95.0	deg
Hub Earth Station		
Site	Adelaide	
Lat	-34.7677	deg
Lon	138.6978	deg
EIRP max	80.0	dBW
G/T	40.0	dB/K
Signal		
Waveform	MxDMA	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.50	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	0.90	bps/Hz
Data Rate	1.80E+07	bps
Information Rate (Data + Overhead)	2.00E+07	bps
Symbol Rate	2.00E+07	Hz
Chip Rate (Noise Bandwidth)	2.00E+07	Hz
Occupied Bandwidth	2.10E+07	Hz
Power Equivalent Bandwidth	8.24E+06	Hz
C/N Threshold	1.6	dB
Uplink		
Frequency	14.000	GHz
Back off	0.0	dB
EIRP Spectral Density	10.9	dBW/4kHz
Slant Range	35820	km
Space Loss, Ls	206.5	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	14.0	dB/K
Thermal Noise, C/No	83.4	dBHz
C/(No+Io)	82.0	dBHz
Satellite		
Flux Density	-114.8	dBW/m2
SFD @ Terminal	-87.0	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	24.8	dB
Downlink		
Frequency	18.500	GHz
Transponder Sat. EIRP @ Beam Peak	59.9	dBW
Transponder Sat. EIRP @ Hub	59.9	dBW
DL PSD Limit	12.5	dBW/4kHz
DL PSD @ Beam Peak	-1.9	dBW/4kHz
Carrier EIRP @ Beam Peak	35.1	dBW
Carrier EIRP @ Hub	35.1	dBW
Slant Range	38721	km
Space Loss, Ls	209.6	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	6.5	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	87.7	dBHz
C/(No+Io)	86.5166	dBHz
End to End		
End to End C/(No+Io)	80.7	dBHz
Implementation Loss	5.5	dB
End to End C/N w/ Imp Loss	2.1	dB
Link Margin	0.6	dB

Forward Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	4.5	deg
Lon	96.5	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	SES-12	
Longitude	95.0	deg
Hub Earth Station		
Site	Adelaide	
Lat	-34.7677	deg
Lon	138.6978	deg
EIRP max	80.0	dBW
G/T	40.0	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.67	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	1.20	bps/Hz
Data Rate	1.60E+08	bps
Information Rate (Data + Overhead)	1.77E+08	bps
Symbol Rate	1.33E+08	Hz
Chip Rate (Noise Bandwidth)	1.33E+08	Hz
Occupied Bandwidth	1.40E+08	Hz
Power Equivalent Bandwidth	5.92E+07	Hz
C/N Threshold	2.9	dB
Uplink		
Frequency	28.500	GHz
Back off	0.0	dB
EIRP Spectral Density	34.8	dBW/4kHz
Slant Range	38721	km
Space Loss, Ls	213.3	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	9.1	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	13.3	dB/K
Thermal Noise, C/No	99.4	dBHz
C/(No+Io)	98.9	dBHz
Satellite		
Flux Density	-91.9	dBW/m2
SFD @ Hub	-89.3	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	-0.4	dB
Downlink		
Frequency	11.000	GHz
Transponder Sat. EIRP @ Beam Peak	51.5	dBW
Transponder Sat. EIRP @ Terminal	51.0	dBW
DL PSD Limit	12.5	dBW/4kHz
DL PSD @ Beam Peak	6.7	dBW/4kHz
Carrier EIRP @ Beam Peak	51.9	dBW
Carrier EIRP @ Terminal	51.4	dBW
Slant Range	35820	km
Space Loss, Ls	204.4	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	86.5	dBHz
C/(No+Io)	85.9	dBHz
End to End		
End to End C/(No+Io)	85.6	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	2.9	dB
Link Margin	0.0	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	4.5	deg
Lon	96.5	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	SES-12	
Longitude	95.0	deg
Hub Earth Station		
Site	Adelaide	
Lat	-34.7677	deg
Lon	138.6978	deg
EIRP max	80.0	dBW
G/T	40.0	dB/K
Signal		
Waveform	MxDMA	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.65	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	1.17	bps/Hz
Data Rate	2.34E+07	bps
Information Rate (Data + Overhead)	2.60E+07	bps
Symbol Rate	2.00E+07	Hz
Chip Rate (Noise Bandwidth)	2.00E+07	Hz
Occupied Bandwidth	2.10E+07	Hz
Power Equivalent Bandwidth	4.19E+06	Hz
C/N Threshold	3.5	dB
Uplink		
Frequency	14.000	GHz
Back off	0.0	dB
EIRP Spectral Density	8.0	dBW/4kHz
Slant Range	35820	km
Space Loss, Ls	206.5	dB
Pointing Loss, Lpnt	0.2	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	14.0	dB/K
Thermal Noise, C/No	80.5	dBHz
C/(No+Io)	79.5	dBHz
Satellite		
Flux Density	-117.8	dBW/m2
SFD @ Terminal	-87.0	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	27.8	dB
Downlink		
Frequency	18.500	GHz
Transponder Sat. EIRP @ Beam Peak	59.9	dBW
Transponder Sat. EIRP @ Hub	59.9	dBW
DL PSD Limit	12.5	dBW/4kHz
DL PSD @ Beam Peak	-4.9	dBW/4kHz
Carrier EIRP @ Beam Peak	32.1	dBW
Carrier EIRP @ Hub	32.1	dBW
Slant Range	38721	km
Space Loss, Ls	209.6	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	6.5	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	84.7	dBHz
C/(No+Io)	83.5760	dBHz
End to End		
End to End C/(No+Io)	78.0	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	3.5	dB
Link Margin	0.0	dB

VI. SES-14

SES

Philippe Secher
Senior Manager, Spectrum Management & Development, Americas

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

19 November 2018

Subject: Engineering Certification of SES Americom, Inc. for the SES-12 and SES-14 Satellites

To whom it may concern,

This letter confirms that SES is aware that Panasonic Avionics Corporation ("Panasonic Avionics"), licensed by the Federal Communications Commission ("FCC") as Panasonic Avionics Corporation, is planning to file an application seeking a modification to its blanket authorization (the "Modification Application") to operate technically identical Ku-band Earth Stations Aboard Aircraft ("ESAA") pursuant to ITU RR 5.504A and Section 25.227 of the Commission's rules (Call Sign E100089). The Modification Application will seek authority for Panasonic Avionics' ESAA terminals to communicate with the SES-12 satellite at 95° E.L. and the SES-14 satellite at 47.5° W.L., under the current ESAA rules, including Section 25.227.

Based upon the representations made to SES by Panasonic Avionics concerning how it will operate on SES-12 and SES-14 according to its letter dated November 15, 2018:

- SES certifies that it has completed coordination as required under the FCC's rules and that the power density levels specified by Panasonic Avionics are consistent with any existing coordination agreements to which SES is a party with adjacent satellite operators within +/- 6 degrees of orbital separation from SES-12 and SES-14.

- If the FCC authorizes the operations proposed by Panasonic Avionics, SES will include the power density levels specified by Panasonic Avionics in all future satellite network coordination with other operators of satellites adjacent to SES-12 and SES-14.

Yours Sincerely,

Philippe Secher
Senior Manager
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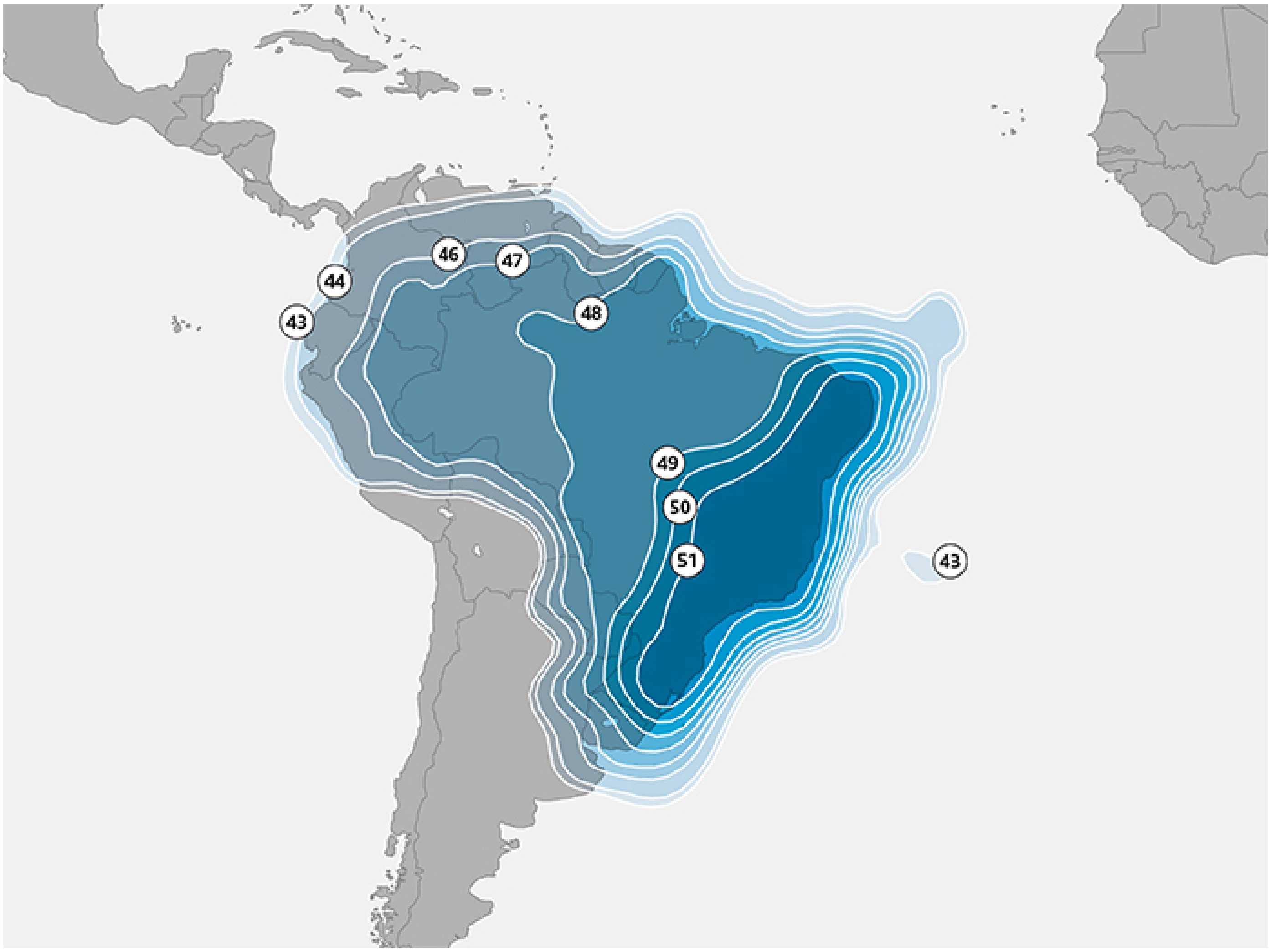
2. **Coverage Map**



3. Link Budgets

Forward Link Budget

eXConnect Terminal		
Antenna Type	PPA	
Lat	-2.2	deg
Lon	-50.3	deg
EIRP max	47.9	dBW
G/T	12.0	dB/K
Satellite		
Name	SES14	
Longitude	-47.5	deg
Hub Earth Station		
Site	Miami	
Lat	25.77	deg
Lon	-80.19	deg
EIRP max	80.0	dBW
G/T	37.5	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.33	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	0.60	bps/Hz
Data Rate	7.98E+07	bps
Information Rate (Data + Overhead)	8.87E+07	bps
Symbol Rate	1.33E+08	Hz
Chip Rate (Noise Bandwidth)	1.33E+08	Hz
Occupied Bandwidth	1.40E+08	Hz
Power Equivalent Bandwidth	1.95E+07	Hz
C/N Threshold	-1.6	dB
Uplink		
Frequency	14.000	GHz
Back off	0.0	dB
EIRP Spectral Density	34.8	dBW/4kHz
Slant Range	37566	km
Space Loss, Ls	206.9	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	4.9	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	8.0	dB/K
Thermal Noise, C/No	104.8	dBHz
C/(No+Io)	104.3	dBHz
Satellite		
Flux Density	-87.4	dBW/m2
SFD @ Hub	-81.0	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	4.4	dB
Downlink		
Frequency	11.000	GHz
Transponder Sat. EIRP @ Beam Peak	52.6	dBW
Transponder Sat. EIRP @ Terminal	51.0	dBW
DL PSD Limit	14.0	dBW/4kHz
DL PSD @ Beam Peak	3.0	dBW/4kHz
Carrier EIRP @ Beam Peak	48.2	dBW
Carrier EIRP @ Terminal	46.6	dBW
Slant Range	35808	km
Space Loss, Ls	204.4	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	82.2	dBHz
C/(No+Io)	81.9	dBHz
End to End		
End to End C/(No+Io)	81.9	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	-0.8	dB
Link Margin	0.8	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	PPA	
Lat	-2.2	deg
Lon	-50.3	deg
EIRP max	47.9	dBW
G/T	12.0	dB/K
Satellite		
Name	SES14	
Longitude	-47.5	deg
Hub Earth Station		
Site	Miami	
Lat	25.77	deg
Lon	-80.19	deg
EIRP max	80.0	dBW
G/T	37.5	dB/K
Signal		
Waveform	MxDMA	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.70	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	1.26	bps/Hz
Data Rate	2.52E+07	bps
Information Rate (Data + Overhead)	2.80E+07	bps
Symbol Rate	2.00E+07	Hz
Chip Rate (Noise Bandwidth)	2.00E+07	Hz
Occupied Bandwidth	2.10E+07	Hz
Power Equivalent Bandwidth	6.61E+06	Hz
C/N Threshold	4.1	dB
Uplink		
Frequency	14.000	GHz
Back off	0.0	dB
EIRP Spectral Density	10.9	dBW/4kHz
Slant Range	35808	km
Space Loss, Ls	206.5	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	13.0	dB/K
Thermal Noise, C/No	82.4	dBHz
C/(No+Io)	81.2	dBHz
Satellite		
Flux Density	-114.8	dBW/m2
SFD @ Terminal	-91.0	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	21.8	dB
Downlink		
Frequency	11.800	GHz
Transponder Sat. EIRP @ Beam Peak	55.0	dBW
Transponder Sat. EIRP @ Hub	55.0	dBW
DL PSD Limit	14.0	dBW/4kHz
DL PSD @ Beam Peak	-3.8	dBW/4kHz
Carrier EIRP @ Beam Peak	33.2	dBW
Carrier EIRP @ Hub	33.2	dBW
Slant Range	37566	km
Space Loss, Ls	205.4	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	5.6	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	88.3	dBHz
C/(No+Io)	86.9097	dBHz
End to End		
End to End C/(No+Io)	80.1	dBHz
Implementation Loss	2.5	dB
End to End C/N w/ Imp Loss	4.6	dB
Link Margin	0.5	dB

Forward Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	-2.2	deg
Lon	-50.3	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	SES14	
Longitude	-47.5	deg
Hub Earth Station		
Site	Miami	
Lat	25.77	deg
Lon	-80.19	deg
EIRP max	80.0	dBW
G/T	37.5	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.33	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	0.60	bps/Hz
Data Rate	7.98E+07	bps
Information Rate (Data + Overhead)	8.87E+07	bps
Symbol Rate	1.33E+08	Hz
Chip Rate (Noise Bandwidth)	1.33E+08	Hz
Occupied Bandwidth	1.40E+08	Hz
Power Equivalent Bandwidth	1.95E+07	Hz
C/N Threshold	-1.6	dB
Uplink		
Frequency	14.000	GHz
Back off	0.0	dB
EIRP Spectral Density	34.8	dBW/4kHz
Slant Range	37566	km
Space Loss, Ls	206.9	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	4.9	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	8.0	dB/K
Thermal Noise, C/No	104.8	dBHz
C/(No+Io)	104.3	dBHz
Satellite		
Flux Density	-87.4	dBW/m2
SFD @ Hub	-81.0	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	4.4	dB
Downlink		
Frequency	11.000	GHz
Transponder Sat. EIRP @ Beam Peak	52.6	dBW
Transponder Sat. EIRP @ Terminal	51.0	dBW
DL PSD Limit	14.0	dBW/4kHz
DL PSD @ Beam Peak	3.0	dBW/4kHz
Carrier EIRP @ Beam Peak	48.2	dBW
Carrier EIRP @ Terminal	46.6	dBW
Slant Range	35808	km
Space Loss, Ls	204.4	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	81.7	dBHz
C/(No+Io)	81.4	dBHz
End to End		
End to End C/(No+Io)	81.4	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	-1.3	dB
Link Margin	0.3	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	-2.2	deg
Lon	-50.3	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	SES14	
Longitude	-47.5	deg
Hub Earth Station		
Site	Miami	
Lat	25.77	deg
Lon	-80.19	deg
EIRP max	80.0	dBW
G/T	37.5	dB/K
Signal		
Waveform	MxDMA	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.60	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	1.08	bps/Hz
Data Rate	2.16E+07	bps
Information Rate (Data + Overhead)	2.40E+07	bps
Symbol Rate	2.00E+07	Hz
Chip Rate (Noise Bandwidth)	2.00E+07	Hz
Occupied Bandwidth	2.10E+07	Hz
Power Equivalent Bandwidth	3.34E+06	Hz
C/N Threshold	2.9	dB
Uplink		
Frequency	14.000	GHz
Back off	0.0	dB
EIRP Spectral Density	8.0	dBW/4kHz
Slant Range	35808	km
Space Loss, Ls	206.5	dB
Pointing Loss, Lpnt	0.2	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	13.0	dB/K
Thermal Noise, C/No	79.5	dBHz
C/(No+Io)	78.6	dBHz
Satellite		
Flux Density	-117.7	dBW/m2
SFD @ Terminal	-91.0	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	24.7	dB
Downlink		
Frequency	11.800	GHz
Transponder Sat. EIRP @ Beam Peak	55.0	dBW
Transponder Sat. EIRP @ Hub	55.0	dBW
DL PSD Limit	14.0	dBW/4kHz
DL PSD @ Beam Peak	-6.8	dBW/4kHz
Carrier EIRP @ Beam Peak	30.3	dBW
Carrier EIRP @ Hub	30.3	dBW
Slant Range	37566	km
Space Loss, Ls	205.4	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	5.6	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	85.3	dBHz
C/(No+Io)	83.9518	dBHz
End to End		
End to End C/(No+Io)	77.5	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	3.0	dB
Link Margin	0.0	dB

VII. eXConnect System Satellites and Gateway Tables

Table 1. Satellite Points of Communication

Satellite	Licensing Admin.	Orbital Location	Downlink Freq. (GHz)	ITU Satellite Network	ITU Region	Service to U.S.
Express AM5	Russia	140° E	10.95-11.2; 11.45-11.7; 12.5-12.75	EXPRESS-10B	1	No
Express AM6	Russia	53° E	10.95-11.2; 11.45-11.7; 12.5-12.75	EXPRESS-5B	1	No
Anik G1	Canada	107.3° W	11.7-12.2	CANSAT-34	2	No
Apstar 6	China	134° E	10.7-12.75	APSTAR-2	3	No
Apstar 6C	China	134° E	12.25-12.75	G4SAT-134E	3	No
Apstar 6D	China	134° E	10.7-12.75	APSTAR-2, CHINASAT-134E, G4SAT-134E	3	No
Apstar 7	China	76.5° E	10.7-12.75	APSTAR-4	1, 3	No
AsiaSat 5	China	100.5° E	11.45-12.2	ASIASAT-EKX	1	No
AsiaSat 7	China	105.5° E	12.25-12.75	ASIASAT-CKX	3	No
AsiaSat 9	China	122° E	10.95-11.2 11.45-11.7 12.25-12.75	ASIASAT-AKX	3	No
ChinaSat 10	China	110.5° E	12.25-12.75	CHINASAT-2, CHINASAT-6, DFH-3A-OB	3	No
Eutelsat 10A	France	10° E	11.7-12.2; 10.95-11.7; 12.5-12.75	EUTELSAT 2-10E / EUTELSAT 3-10E	1, 3	No
Eutelsat 70B	France	70.5° E	10.95-11.7; 12.5-12.75	EUTELSAT 3-70.5E	1, 3	No
Eutelsat 115WB	Mexico	114.9° W	11.7-12.2	MEXSAT-114.9-KU-EXT	2	Yes
Eutelsat 117WA	Mexico	116.8° W	11.7-12.2	MEXSAT-116.8-KU-EXT	2	Yes
Eutelsat 172B	U.S.	172° E	10.95-11.7; 12.2-12.75	U.S.-licensed	1, 2, 3	Yes
Eutelsat 172B	France	172° E	11.2-11.45	F-SAT-E-30B-172E	1, 3	No

Galaxy 16	U.S.	99° W	11.7-12.2	U.S.-licensed	2	Yes
IS-14	U.S.	45° W	11.45-11.95; 12.25-12.75	U.S.-licensed	1, 2	No
IS-15	U.S.	85° E	12.25-12.75	U.S.-licensed	3	No
IS-21	U.S.	58° W	11.45-12.2	U.S.-licensed	1, 2	Yes
IS-29e	U.S.	50° W	10.95-12.2	U.S.-licensed	1, 2	Yes
IS-33e	U.S.	60° E	10.95-11.2; 11.45-12.2; 12.5-12.6	U.S.-licensed	1, 3	No
JCSAT-2B	Japan	154° E	11.45-11.7	N-SAT-154E	3	No
JCSAT-5A	Japan	132° E	12.25-12.75	N-STAR-A	1	No
NSS-6	Netherlands	95° E	11.45-12.75	NSS-9	3	No
SES-12	Netherlands	95° E	10.7-11.45	NSS-G2-18	3	No
SES-14	Brazil & Netherlands	47.5° E	10.95-11.2; 11.45-12.45	B-SAT-1 W-2; NSS-BSS 47.5W	2	No
SES-15	Gibraltar	129.15°W	10.7-12.2	GIBSAT-129W	Yes	2
Superbird C2	Japan	144° E	12.2-12.75	N-SAT2-144E	3	No
Telstar 11N	U.S.	37.5° W	11.45-12.2	U.S.-licensed	1, 2	Yes
Telstar 12V	U.S.	15° W	10.95-12.2	U.S.-licensed	1	No
Telstar 14R	Brazil	63° W	11.45-12.2	B-SAT1	2	Yes
Yamal 300K	Netherlands	183° E	10.95-11.7	NSS-19	1, 2	Yes
Yamal 401	Russia	90° E	10.95-11.2; 11.45-12.75	EXPRESS-7C	1, 3	No

Table 2. Gateway Earth Stations Table

Satellite	Satellite Operator	Gateway Earth Station Location	Country	Gateway Operator	FCC Call Sign
Ekspress AM5	RSCC	Khabarovsk	Russia	AltegroSky	N/A
Ekspress AM6	RSCC	Moscow	Russia	AltegroSky	N/A
Anik G1	Telesat	Lima	Peru	NewCom	N/A
Apstar 6	APT	Beijing	China	ChinaTelecom Satellite	N/A
Aptar 6C	APT	Beijing	China	ChinaTelecom Satellite	N/A
Apstar 6D	APT	Hong Kong	China	Speedcast	N/A
Apstar 7	APT	Kofinou	Cyprus	Stellar	N/A
AsiaSat 5	AsiaSat	Kofinou	Cyprus	Stellar	N/A
AsiaSat 7	AsiaSat	Beijing	China	China Telecom Satellite	N/A
AsiaSat 9	AsiaSat	Hong Kong	China	China Telecom Satellite	N/A
ChinaSat 10	China SatCom	Beijing	China	China SatCom	N/A
Eutelsat 10A	Eutelsat	Cologne	Germany	Stellar	N/A
Eutelsat 70B	Eutelsat	Kofinou	Cyprus	Stellar	N/A
Eutelsat 115WB	Eutelsat Americas	Brewster, WA	U.S.	USEI	E120043
Eutelsat 117WA	Eutelsat Americas	Brewster, WA	U.S.	USEI	E120043
Eutelsat 172B (Spot/Wide)	Eutelsat S.A.	Kapolei, HI	U.S.	Hawaii Pacific Teleport LP	E010236

Satellite	**Satellite Operator**	**Gateway Earth Station Location**	**Country**	**Gateway Operator**	**FCC Call Sign**
Eutelsat 172B (NP/SEP)	Eutelsat S.A.	Brewster, WA	U.S.	USEI	E120043
Eutelsat 172B (SP)	Eutelsat S.A.	Bayswater	Australia	SpeedCast	N/A
Galaxy 16	Intelsat	Brewster, WA	U.S.	U.S. Electrodynamics	E120043
IS-14	Intelsat	Cologne	Germany	Stellar	N/A
IS-15	Intelsat	Kofinou	Cyprus	Stellar	N/A
IS-21	Intelsat	Sussex, NJ	U.S.	USEI	E150116
IS-29E	Intelsat	Hagerstown, MD	U.S.	Intelsat	E140121
IS-33E	Intelsat	Cologne	Germany	Stellar	N/A
JCSAT-2B	SKY Perfect JSAT	Kapolei, HI	U.S.	Hawaii Pacific Teleport LP	E010236
JCSAT-5A	SPJSAT	Yokohama	Japan	SPJSAT	N/A
NSS-6	SES	Kofinou	Cyprus	Stellar	N/A
SES-12	SES	Adelaide	China	China SatCom	N/A
SES-14 (MI)	SES	Port St. Lucie	U.S.	United Teleports	E160081
SES-14 (WN)	SES	Mount Airy, MD	U.S.	SES Americom	E050287
SES-14 (SW)	SES	Mount Airy, MD	U.S.	SES Americom	E050287
SES-15 (Beam 51)	SES	Somis, CA	U.S.	SES Americom	KA318

Satellite	Satellite Operator	Gateway Earth Station Location	Country	Gateway Operator	FCC Call Sign
SES-15 (Beam 48)	SES	Mount Airy, MD	U.S.	SES Americom	E050287
SES-15 (Beam 52)	SES	Brewster, WA	U.S.	SES Americom	E920585
Superbird C2	SPJSAT	Hong Kong	China	PCCW	N/A
Telstar 11N – (CA/US)	Skynet	Cologne	Germany	Stellar	N/A
Telstar 11N (AO)	Skynet	Ellenwood, GA	U.S.	Intelsat	E990365
Telstar 12V (MW, MC, ME, MN)	Skynet	Mt. Jackson, VA	U.S.	Telesat	E030029
Telstar 12V (NS)	Skynet	Chalfont	U.K.	Arqiva	N/A
Telstar 14R	Telesat	Mt. Jackson, VA	U.S.	Telesat	E030029
Yamal 300K	Gazprom	Brewster, WA	U.S.	USEI	E120043
Yamal 401	Gazprom	Moscow	Russia	RuSat	N/A

VIII. Section 25.227 Certifications

Panasonic Avionics Corporation ("Panasonic"), pursuant to Section 25.227 of the FCC's Rules, hereby certifies the following:

1. In accordance with Section 25.227(a)(15), as the operator of an ESAA system operating over international waters, Panasonic has confirmed with its target space station operators that its existing and proposed operations are within coordinated parameters for adjacent satellites up to six degrees away (+/- 6°) on the geostationary arc.

2. In accordance with Section 25.227(b)(7), Panasonic certifies that its proposed operations comply with the following requirements of Section 25.227:

    - Per Section 25.227(a)(6), for each ESAA transmitter, Panasonic will time annotate and maintain a record for a period of not less than one year of the vehicle location (i.e., latitude/longitude/altitude), transmit frequency, channel bandwidth and satellite used. Records will be recorded at time intervals no greater than one (1) minute while the ESAA is transmitting. Panasonic will make this data available in the requisite format within 24 hours of a request from the Commission, NTIA, or a frequency coordinator for purposes of resolving harmful interference events.
    - Per Section 25.227(a)(9), each ESAA terminal will automatically cease transmitting within 100 milliseconds upon loss of reception of the satellite downlink signal or when it detects that unintended satellite tracking has happened or is about to happen.
    - Per Section 25.227(a)(10), each ESAA terminal will be subject to the monitoring and control by an NCMC. Each terminal will be able to receive "enable transmission" and "disable transmission" commands from the NCMC and must automatically cease transmissions immediately on receiving any "parameter change command", which may cause harmful interference during the change, until it receives an "enable transmission" command from its NCMC. In addition, the NCMC will be able to monitor the operation of an ESAA terminal to determine if it is malfunctioning.
    - Per Section 25.227(a)(11), each ESAA terminal shall be self-monitoring and, should a fault which can cause harmful interference to FSS networks be detected, the terminal will automatically cease transmissions.

By: __/s/______________________

Mark DeFazio
Panasonic Avionics Corporation

Nov. 26, 2018