TECHNICAL APPENDIX

ANNEX A:
PROPOSED SATELLITE POINTS OF

ANNEX A-1: Eutelsat 70B

A. Eutelsat 70B Coverage Map

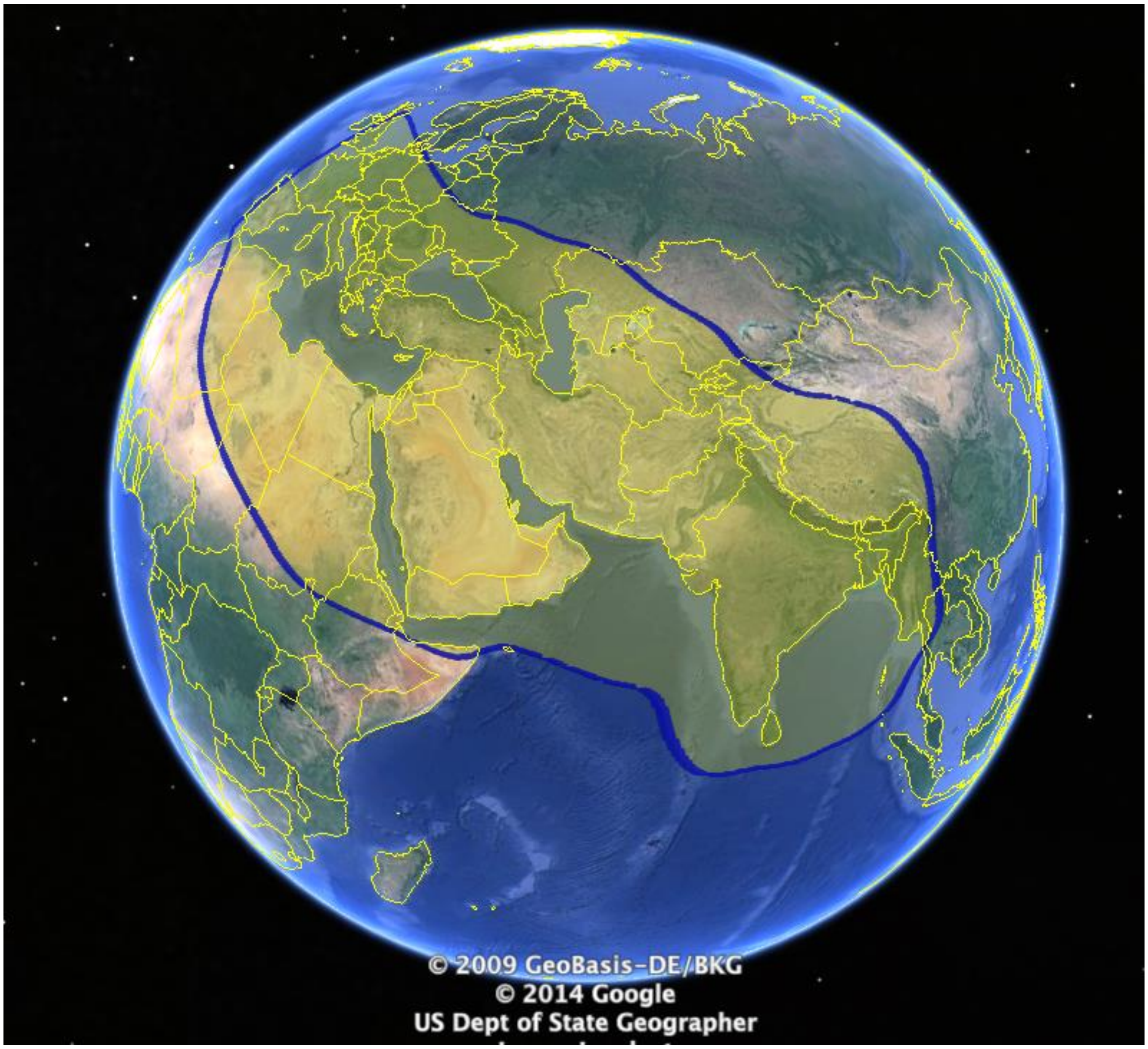

Figure 1: Eutelsat 70B at Wide Beam

B. Eutelsat 70B Link Budget

Forward Link Budget

eXConnect Terminal

Antenna Type	AURA LE	
Lat	31.4	deg
Lon	44.4	deg
EIRP max	46.8	dBW
G/T	10.3	dB/K

Satellite

Name	E70B	
Longitude	70.5	deg

Hub Earth Station

Site	Cyprus	
Lat	34.859	deg
Lon	33.384	deg
EIRP max	85.2	dBW
G/T	37.4	dB/K

Signal

Waveform	DVB-S2	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.67	
Overhead Rate	0.94	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	1.26	bps/Hz
Data Rate	5.66E+07	bps
Information Rate (Data + Overhead)	6.00E+07	bps
Symbol Rate	4.50E+07	Hz
Chip Rate (Noise Bandwidth)	4.50E+07	Hz
Occupied Bandwidth	5.40E+07	Hz
Power Equivelent Bandwidth	5.40E+07	Hz
C/N Threshold	3.5	dB

Uplink

Frequency	13.125	GHz
Back off	11.4	dB
EIRP Spectral Density	33.3	dBW/4kHz
Slant Range	38300	km
Space Loss, Ls	206.5	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	1.9	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	3.8	dB/K
Thermal Noise, C/No	97.8	dBHz
C/(No+Io)	97.3	dBHz

Satellite

Flux Density	-90.8	dBW/m2
SFD @ Hub	-87.8	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	1.0	dB

Downlink

Frequency	11.325	GHz
Transponder Sat. EIRP @ Beam Peak	50.0	dBW
Transponder Sat. EIRP @ Terminal	49.0	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	8.4	dBW/4kHz
Carrier EIRP @ Beam Peak	49.0	dBW
Carrier EIRP @ Terminal	48.0	dBW
Slant Range	37505	km
Space Loss, Ls	205.0	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	81.8	dBHz
C/(No+Io)	81.7	dBHz

End to End

End to End C/(No+Io)	81.6	dBHz
Implementation Loss	1.0	dB
End to End C/N w/ Imp Loss	4.1	dB
Link Margin	0.6	dB

Return Link Budget

eXConnect Terminal

Antenna Type	AURA LE	
Lat	31.4	deg
Lon	44.4	deg
EIRP max	46.8	dBW
G/T	10.3	dB/K

Satellite

Name	E70B	
Longitude	70.5	deg

Hub Earth Station

Site	Cyprus	
Lat	34.859	deg
Lon	33.384	deg
EIRP max	85.2	dBW
G/T	37.4	dB/K

Signal

Waveform	iDirect	
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	1	
Coding Rate	0.67	
Overhead Rate	0.77	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.51	bps/Hz
Data Rate	3.43E+06	bps
Information Rate (Data + Overhead)	4.44E+06	bps
Symbol Rate	6.67E+06	Hz
Chip Rate (Noise Bandwidth)	6.67E+06	Hz
Occupied Bandwidth	8.00E+06	Hz
Power Equivelent Bandwidth	9.75E+05	Hz
C/N Threshold	2.4	dB

Uplink

Frequency	14.500	GHz
Back off	0.0	dB
EIRP Spectral Density	14.6	dBW/4kHz
Slant Range	37505	km
Space Loss, Ls	207.2	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
Transponder G/T @ Terminal	3.8	dB/K
Thermal Noise, C/No	71.9	dBHz
C/(No+Io)	71.4	dBHz

Satellite

Flux Density	-115.8	dBW/m2
SFD @ Terminal	-92.8	dBW/m2
Small Signal Gain (IBO/OBO)	1.9	dB
OBO	21.1	dB

Downlink

Frequency	12.625	GHz
Transponder Sat. EIRP @ Beam Peak	50.0	dBW
Transponder Sat. EIRP @ Hub	49.0	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-3.4	dBW/4kHz
Carrier EIRP @ Beam Peak	28.8	dBW
Carrier EIRP @ Hub	27.8	dBW
Slant Range	38300	km
Space Loss, Ls	206.1	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	3.3	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	84.4	dBHz
C/(No+Io)	81.3686	dBHz

End to End

End to End C/(No+Io)	71.0	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	2.7	dB
Link Margin	0.3	dB

C. Eutelsat 70B Coordination Letter

eutelsat
communications via satellite

June 3rd, 2015

Mark DeFazio
Manager, GCS Regulatory and Business Operations
Panasonic Avionics Corporation
26200 Enterprise Way
Lake Forest, CA 92630

Re: Engineering Certification of Eutelsat

Dear Mr. DeFazio,

This letter certify that Eutelsat is aware that Panasonic Avionics Corporation ("Panasonic") is planning to seek a modification to its blanket authorization from the Federal Communication Commission ("FCC") to operate technically identical Ku-band transmit/receive earth stations aboard aircraft ("ESAAs"), Call Sign E100089, with the Eutelsat 70B satellite at 70.5°E. Eutelsat understands that Panasonic will file the modification pursuant to the FCC rules governing ESAA operations, including Section 25.227.

Eutelsat confirms and hereby certifies the following with respect to the operation proposed in the above referenced application:

a) The proposed Ku-band Earth Station Aboard Aircraft (ESAA) operation of Panasonic Avionics Corporation has the potential to create harmful interference to satellite networks adjacent to the target satellite(s) that may be unacceptable;
b) Panasonic Avionics Corporation is currently using Eutelsat capacity on Eutelsat 70B satellite at 70° East.

Eutelsat certify that the proposed operation of the ESAA transmit/receive terminals at the power density levels defined in the agreement between Panasonic Avionics Corporation ("Panasonic") and Eutelsat is consistent with existing satellite coordination agreements with the adjacent satellites to Eutelsat 70B.

If the FCC authorizes the operation proposed by Panasonic Avionics Corporation, Eutelsat 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 those satellites addressed by this letter.

Sincerely,

For Eutelsat
Filipe De Oliveira
Head of the Resources Engineering Group

D. Eutelsat 70B Orbital Debris Mitigation and Satellite End-of-Life Statement

Eutelsat 70B Space Debris Mitigation Plan (prepared for the Federal Communications Commission)

ISSUE/REVISION: Issue 1, Rev. 0

ISSUE DATE: 23 February 2015

Prepared by:	*Position*	*Signature*	*Date*
D. Zamora	Head of Flight Dynamics	V. Chechik	23/02/2015

Approved by:	*Position*	*Signature*	*Date*
L.R. Pattinson	Director of Satellite Operations		23/2/2015.

CHANGE RECORD

Date	*Issue/rev*	*Pages affected*	*Description*
23/02/2015	1/0	All	First issue.

TABLE OF CONTENTS

1. Introduction

This document describes the space debris mitigation plan that Eutelsat shall apply to the **Eutelsat 70B ("E70B")** space station.

E70B is based on the Airbus Eurostar 3000 bus and it was manufactured according to European standards and specifications. The satellite is 3-axis stabilized and uses bi-propellant chemical propulsion for attitude and on-station control.

E70B was launched in 2012 and the end of its operational life is not expected to be before beginning 2032.

2. Related documents

2.1. Applicable Documents

1. EUTELSAT Space Debris Mitigation Plan. Issue 1.3. EUT_CTL_SAT_QMS_PLN_00021, 26 July 2010.
2. FCC. Orbital Debris Mitigation Standard Practices. FCC 04-130. June 21, 2004.

2.2. Reference Documents

1. European Code of Conduct for Space Debris Mitigation. Issue 1.0. 28 June 2004.
2. IADC Space Debris Mitigation Guidelines. IADC-02-01. Revision 1. September 2007.
3. Space Product Assurance. Safety. ECSS-Q-40A. 19 April 1996.
4. Orbital Debris Mitigation Standard Practices. FCC 04-130. 21 June 2004.
5. NASA Safety Standard. Guidelines and Assessment Procedures for limiting Orbital Debris. NSS 1740.14. Aug 1995.
6. ITU Environment Protection of the Geostationary Orbit. S.1003. 1993.
7. UNCOPUOS. Technical Report on Space Debris. 1999.

3. Eutelsat 70B operations

- Eutelsat operates in order 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.
- Eutelsat has assessed the amount of debris released in a planned manner and no intentional debris will be released during normal operations of the E70B spacecraft. A safe operational configuration of the satellite system is ensured thanks to the hardware design and operational procedures

- Eutelsat minimizes the probability of the satellite becoming a source of debris by collisions with large debris or other operational satellites. Eutelsat assessed for E70B whether there were any known satellites located at the requested orbital location or might overlap.
- E70B is controlled within its ITU allocated orbit control window (70.5°E +/- 0.1°) by standard routine periodic orbit correction maneuvers. In case of anticipated violation of the window, correction maneuvers would be implemented to avoid such violation.
- Eutelsat has assessed the probability of accidental explosions during and after completion of mission operations. Thanks to design safety margins and enough safety barriers, the probability of occurrence of accidental explosion of the E70B satellite is negligible.
- Satellite design is such that high levels of thruster activity and orbit perturbations do not occur as a result of foreseeable on-board events.

4. Eutelsat 70B End-of-Life Disposal

The post-mission disposal activities have been planned as follows:

1. The orbit of the satellite will be raised by 300 km in order to ensure that the spacecraft will not re-enter into the GEO protected region (GEO height +/- 200 km) in the long term. A mass of 10.6 kg of propellant have been allocated and reserved with a confidence level of 99% to carry-out the post-mission disposal maneuvers. The FCC will be informed of any significant change to the above quantity of propellant.

   The minimum perigee height to avoid re-entering into the GEO protected region can be computed using the IADC formula applied to this satellite:

   $$\text{Delta\_H (km)} = 235 + 1000.(A/m)_{eff} = 271 \text{ km},$$

   where the final term is the effective area/mass ratio of the satellite. Therefore, the planned 300 km above GEO height is sufficient to satisfy the 271 km requirement.

   During the satellite lifetime, Eutelsat regularly monitor propellant remaining in the tanks.

2. As part of the end of life (EOL) activities, E70B energy sources will be rendered inactive, such that debris generation will not result from the conversion of energy sources on board the spacecraft into energy that fragments the satellite. For E70B, this involves the following:

A. Depleting the chemical propulsion system, and where possible leaving open fuel lines and valves.

Before switch-off of the E70B satellite, thrusters will be fired as much as possible to deplete the propellant and depressurize the tanks. The Orbital Debris Plan for E70B satellite states that "where possible" fuel lines and valves will be left open.

The following table shows the characteristics of the pressurant tank, propellant tanks and propellant lines at EOL. It shall be noted that during the passivation the four propellant tanks will be depressurized as much as possible.

Element	Total Volume (l)	Material contained at EOL	Predicted mass of material at EOL (kg)
NTO Propellant tank 1	650	NTO He	4.59 1.15
MMH propellant tank 2	650	MMH He	1.89 1.15
NTO propellant tank 3	650	NTO He	4.59 1.15
MMH propellant tank 4	650	MMH He	1.89 1.15
NTO lines MMH lines	1.60 1.58	NTO MMH	2.33 1.40
Pressurant tank	178	He	1.27

Eutelsat employs a combination of methods, including bookkeeping and PVT measurements and, where possible, measurements of tanks thermal inertia, to calculate the predicted EOL mass values. The figures in the last column of the Table can be considered as worst-case post-passivation remaining mass for NTO and MMH after final shutdown of the satellite. They correspond to the static residuals of NTO and MMH at the end-of-life. The helium mass in the pressurant tank corresponds to the value measured at the end of Launch and Early Orbit Phase ("LEOP"). The pressurant tank is isolated just after the completion of LEOP operations and cannot be passivated as part of the EOL operations.

The residual pressure statement (less than 1 Bar) corresponds to a temperature of 9.5° C. The predicted pressures at end-of-life for the remaining materials are as follows: 12.3 Bars before passivation for NTO propellant tanks; 11.2 Bars before passivation for MMH propellant tanks; and 45 bars for the pressurant tank. The EOL values given for masses, pressures and temperatures are when the satellite is taken out of service. Then, Eutelsat starts the orbit raise activity and finishes the passivation exercise by emptying the fuel and oxidizer tanks as far as possible. During the satellite life, Eutelsat performs gauging activities to monitor the remaining liquid quantities to determine the remaining masses in the tanks.

The passivation exercise is not a closed system due to the fact that matter is expelled. Eutelsat expels the remaining liquid as it evaporates at lower pressures, then expels as much pressurant as possible to lower the tank pressures down to 1 bar or below. All the tanks have been designed, manufactured, and validated according to the MIL-STD-1522 standard with a break-up security coefficient of 1.5 for the whole mission; i.e., including full-load and maximum-pressure conditions. Clearly, the security coefficient is much higher than this (by orders of magnitude) for depleted conditions where the pressure is around 1 bar, but no analysis exists to provide the actual value.

The design of the Eutelsat 70B spacecraft, fully consistent with EOL passivation requirements as existed at the time of construction, does not allow passive venting once the spacecraft has been switched-off. The thruster propellant flow control valves for the MMH and NTO tanks are left closed after switching off the spacecraft because power is needed to open them. Therefore, none of the elements that appear on the previous Table can be vented over time once the spacecraft has been switched-off. Nevertheless, as part of the passivation of the spacecraft during the EOL operations, Eutelsat always makes best efforts to vent the propellant remaining in the propellant tanks and lines as much as possible.

Additionally, it should be noted that the Lithium-Ion batteries mounted on this satellite cannot be depressurized. Nevertheless, they have been designed with a security coefficient greater than 3 and the batteries are "leak before burst" designed. The heatpipes, which use ammonia as working fluid, cannot be depressurized either. They have been designed with a security coefficient greater than 4, the risk of break-up is considered negligible.

B. Leaving all batteries in a state of permanent discharge by isolation of the battery charge circuits and leaving certain loads connected to the batteries.

3. The satellite tracking, TM and TC usage are planned so as to avoid electrical interference to other satellites and coordinated with any potential affected satellite networks.

4. During the orbit raising maneuvers the tracking, TM and TC frequencies will be limited to those where the satellite is authorized to operate.

5. Notifications

EUTELSAT undertakes to provide the relevant bodies as required (UNCOPUOS, FCC, ITU, French ANFR, etc) with all appropriate notifications as required by law or regulations for Eutelsat satellites including but not limited to those concerning initial entry of service, location, relocations, inclined orbit operations and re-orbiting operations.

ANNEX A-2: Galaxy 16

A. Galaxy 16 Coverage Map

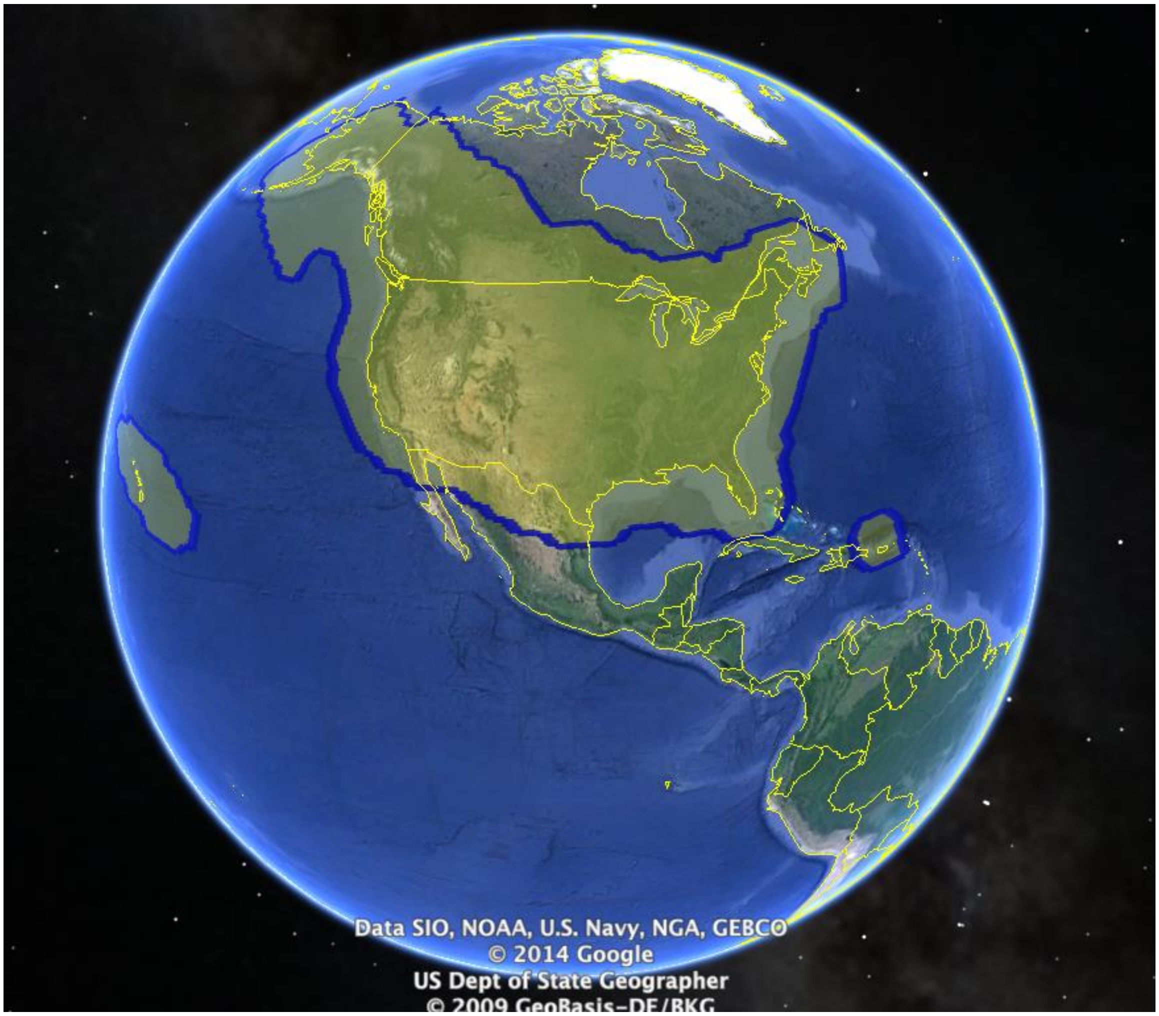

Figure 2: Galaxy 16 at North America Beam

B. Galaxy 16 Link Budget

Forward Link Budget

eXConnect Terminal		
Antenna Type	AURA LE	
Lat	26.9	deg
Lon	-81.8	deg
EIRP max	47.2	dBW
G/T	10.7	dB/K
Satellite		
Name	G-16	
Longitude	-99.0	deg
Hub Earth Station		
Site	Brewster	
Lat	33.663	deg
Lon	-84.226	deg
EIRP max	80.1	dBW
G/T	33.4	dB/K
Signal		
Waveform	DVB-S2	
Modulation	8PSK	
Bits per symbol	3	
Spread Factor	1	
Coding Rate	0.67	
Overhead Rate	0.94	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	1.88	bps/Hz
Data Rate	5.64E+07	bps
Information Rate (Data + Overhead)	6.00E+07	bps
Symbol Rate	3.00E+07	Hz
Chip Rate (Noise Bandwidth)	3.00E+07	Hz
Occupied Bandwidth	3.60E+07	Hz
Power Equivelent Bandwidth	3.60E+07	Hz
C/N Threshold	7.4	dB
Uplink		
Frequency	14.380	GHz
Back off	3.6	dB
EIRP Spectral Density	37.7	dBW/4kHz
Slant Range	37229	km
Space Loss, Ls	207.0	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	4.0	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	4.9	dB/K
Thermal Noise, C/No	99.0	dBHz
C/(No+Io)	98.5	dBHz
Satellite		
Flux Density	-89.9	dBW/m2
SFD @ Hub	-86.9	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	1.0	dB
Downlink		
Frequency	12.080	GHz
Transponder Sat. EIRP @ Beam Peak	52.3	dBW
Transponder Sat. EIRP @ Terminal	51.3	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	12.5	dBW/4kHz
Carrier EIRP @ Beam Peak	51.3	dBW
Carrier EIRP @ Terminal	50.3	dBW
Slant Range	36889	km
Space Loss, Ls	205.4	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	84.0	dBHz
C/(No+Io)	83.4	dBHz
End to End		
End to End C/(No+Io)	83.3	dBHz
Implementation Loss	1.0	dB
End to End C/N w/ Imp Loss	7.5	dB
Link Margin	0.1	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	AURA LE	
Lat	26.9	deg
Lon	-81.8	deg
EIRP max	47.2	dBW
G/T	10.7	dB/K
Satellite		
Name	G-16	
Longitude	-99.0	deg
Hub Earth Station		
Site	Brewster	
Lat	33.663	deg
Lon	-84.226	deg
EIRP max	80.1	dBW
G/T	33.4	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 Equivelent Bandwidth	3.34E+05	Hz
C/N Threshold	3.6	dB
Uplink		
Frequency	14.340	GHz
Back off	0.0	dB
EIRP Spectral Density	14.9	dBW/4kHz
Slant Range	36889	km
Space Loss, Ls	206.9	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
Transponder G/T @ Terminal	4.9	dB/K
Thermal Noise, C/No	73.6	dBHz
C/(No+Io)	73.1	dBHz
Satellite		
Flux Density	-115.3	dBW/m2
SFD @ Terminal	-89.0	dBW/m2
Small Signal Gain (IBO/OBO)	2.5	dB
OBO	23.8	dB
Downlink		
Frequency	12.040	GHz
Transponder Sat. EIRP @ Beam Peak	52.3	dBW
Transponder Sat. EIRP @ Hub	51.3	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-3.8	dBW/4kHz
Carrier EIRP @ Beam Peak	28.5	dBW
Carrier EIRP @ Hub	27.5	dBW
Slant Range	37229	km
Space Loss, Ls	205.5	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	4.3	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	79.7	dBHz
C/(No+Io)	79.1794	dBHz
End to End		
End to End C/(No+Io)	72.1	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	3.9	dB
Link Margin	0.3	dB

C. Galaxy 16 Coordination Letter

27th March 2015

INTELSAT
Envision. Connect. Transform.

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

Re: Engineering Certification of Intelsat

To Whom It May Concern:

This letter certifies that Intelsat is aware that Panasonic Avionics Corporation ("Panasonic") is planning to seek a modification to its blanket authorization from the Federal Communications Commission ("FCC") to operate technically identical Ku-band transmit/receive earth stations aboard aircraft ("ESAAs"), Call Sign E100089, with the Galaxy 16 satellite at 99°W. Intelsat understands that Panasonic will file the modification pursuant to the FCC rules governing ESAA operations, including Section 25.227.

Intelsat certifies that the proposed operation of the ESAA transmit/receive terminals at the power density levels proposed is consistent with existing operator-to-operator coordination agreements with all adjacent satellite operators within +/- 6 degrees of orbital separation from Galaxy 16. Intelsat also acknowledges that the proposed operation of the Panasonic ESAA terminal has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable. If the FCC authorizes the operations proposed by Panasonic, Intelsat will include the power density levels specified by Panasonic in all future satellite network coordinations with other adjacent satellite operators.

Sincerely,

Alan Yates
Senior Technical Advisor, Spectrum Strategy
Intelsat

ANNEX A-3: JSAT 5A

A. JSAT 5A Coverage Map

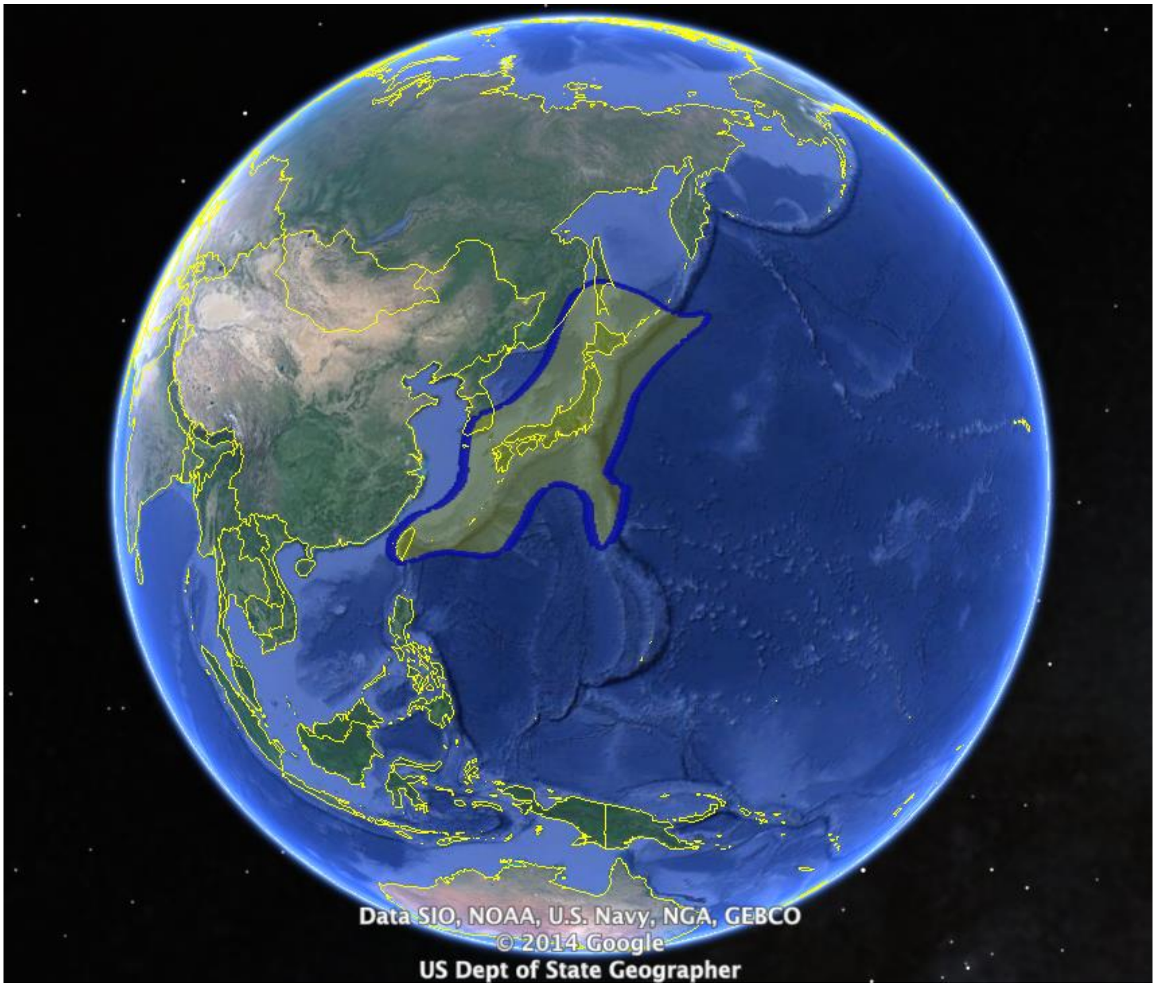

Figure 4: JSAT 5A at Japan Beam

B. JSAT 5A Link Budget

Forward Link Budget

eXConnect Terminal		
Antenna Type	AURA LE	
Lat	35.7	deg
Lon	138.4	deg
EIRP max	47.0	dBW
G/T	10.5	dB/K
Satellite		
Name	JCSAT-5A	
Longitude	132.0	deg
Hub Earth Station		
Site	Tokyo	
Lat	35.74	deg
Lon	139	deg
EIRP max	80.0	dBW
G/T	35.5	dB/K
Signal		
Waveform	DVB-S2	
Modulation	16APSK	
Bits per symbol	4	
Spread Factor	1	
Coding Rate	0.83	
Overhead Rate	0.93	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	3.10	bps/Hz
Data Rate	6.97E+07	bps
Information Rate (Data + Overhead)	7.50E+07	bps
Symbol Rate	2.25E+07	Hz
Chip Rate (Noise Bandwidth)	2.25E+07	Hz
Occupied Bandwidth	2.70E+07	Hz
Power Equivelent Bandwidth	2.70E+07	Hz
C/N Threshold	12.4	dB
Uplink		
Frequency	14.259	GHz
Back off	10.0	dB
EIRP Spectral Density	32.5	dBW/4kHz
Slant Range	37223	km
Space Loss, Ls	206.9	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	3.0	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	10.0	dB/K
Thermal Noise, C/No	98.7	dBHz
C/(No+Io)	98.2	dBHz
Satellite		
Flux Density	-95.4	dBW/m2
SFD @ Hub	-92.0	dBW/m2
Small Signal Gain (IBO/OBO)	2.4	dB
OBO	1.0	dB
Downlink		
Frequency	12.511	GHz
Transponder Sat. EIRP @ Beam Peak	57.5	dBW
Transponder Sat. EIRP @ Terminal	56.0	dBW
DL PSD Limit	19.5	dBW/4kHz
DL PSD @ Beam Peak	19.0	dBW/4kHz
Carrier EIRP @ Beam Peak	56.5	dBW
Carrier EIRP @ Terminal	55.0	dBW
Slant Range	37217	km
Space Loss, Ls	205.8	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	88.2	dBHz
C/(No+Io)	88.1	dBHz
End to End		
End to End C/(No+Io)	87.7	dBHz
Implementation Loss	1.0	dB
End to End C/N w/ Imp Loss	13.2	dB
Link Margin	0.8	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	AURA LE	
Lat	35.7	deg
Lon	138.4	deg
EIRP max	47.0	dBW
G/T	10.5	dB/K
Satellite		
Name	JCSAT-5A	
Longitude	132.0	deg
Hub Earth Station		
Site	Tokyo	
Lat	35.74	deg
Lon	139	deg
EIRP max	80.0	dBW
G/T	35.5	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 Equivelent Bandwidth	8.18E+05	Hz
C/N Threshold	5.9	dB
Uplink		
Frequency	14.259	GHz
Back off	0.0	dB
EIRP Spectral Density	14.7	dBW/4kHz
Slant Range	37217	km
Space Loss, Ls	206.9	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
Transponder G/T @ Terminal	10.0	dB/K
Thermal Noise, C/No	78.5	dBHz
C/(No+Io)	78.0	dBHz
Satellite		
Flux Density	-115.6	dBW/m2
SFD @ Terminal	-91.4	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	21.2	dB
Downlink		
Frequency	12.511	GHz
Transponder Sat. EIRP @ Beam Peak	57.5	dBW
Transponder Sat. EIRP @ Hub	56.0	dBW
DL PSD Limit	19.5	dBW/4kHz
DL PSD @ Beam Peak	4.1	dBW/4kHz
Carrier EIRP @ Beam Peak	36.3	dBW
Carrier EIRP @ Hub	34.8	dBW
Slant Range	37223	km
Space Loss, Ls	205.8	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	3.9	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	89.2	dBHz
C/(No+Io)	76.8376	dBHz
End to End		
End to End C/(No+Io)	74.4	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	6.1	dB
Link Margin	0.2	dB

C. JSAT 5A Coordination Letter

SKY Perfect JSAT
Corporation

SKY Perfect JSAT Corporation
1-14-14, Akasaka, Minato-ku
Tokyo 107-0052, Japan
TEL +81-3-5571-7800

Ref#MD-A-14-035

January 29, 2015

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

Re: Engineering Certification of SKY Perfect JSAT Corporation

To Whom It May Concern:

This letter certifies that SKY Perfect JSAT Corporation ("JSAT") is aware that Panasonic Avionics Corporation ("Panasonic") is planning to seek a modification to its blanket authorization from the Federal Communications Commission ("FCC") to operate technically identical Ku-band transmit/receive earth stations aboard aircraft ("ESAAs"), Call Sign E100089, with the JCSAT-5A satellite at 132°E. JSAT understands that Panasonic will file the modification pursuant to the FCC rules governing ESAA operations, including Section 25.227.

JSAT certifies that the proposed operation of the ESAA transmit/receive terminals at the power density levels specified in the application is consistent with existing operator-to-operator coordination agreements with all adjacent satellite operators within +/- 6 degrees of orbital separation from JCSAT-5A. JSAT also acknowledges that the proposed operation of the Panasonic ESAA terminal has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable. If the FCC authorizes the operations proposed by Panasonic, JSAT will include the power density levels specified by Panasonic in all future satellite network coordinations with other adjacent satellite operators.

Sincerely,

SKY Perfect JSAT Corporation

M. Ishii

Mitsuru Ishii
General Manager
Mobile Business Division
Space & Satellite Group

D. JCSAT-5A Orbital Debris Mitigation and Satellite End-of-Life Statement

SKY Perfect JSAT Corporation

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JCSAT-5A Satellite
End of Life Disposal and Debris Mitigation Plan

This statement is prepared by SKY Perfect JSAT Corporation ("JSAT") for the purpose of demonstrating the end of life disposal and debris mitigation policies associated with the JCSAT-5A telecommunications satellite, in satisfaction of the Federal Communications Commission rules 47 C.F.R 25.114(d)(14) and 25.283(c).

Introduction

The JCSAT-5A satellite operated by JSAT was manufactured and supplied by Lockheed Martin Commercial Space Systems Corporation and based on A2100AX bus platform. It was launched on April 12, 2006 with the designed life to be 12 years after In-Orbit Acceptance Review of the satellite. The satellite is located at orbital slots 132°E.L.

Orbital Debris Mitigation and End-of-Life Disposal

As a licensed operator in Japan, JSAT will comply with the requirements as stipulated by the guidelines issued by IADC and United Nations and adhere to prevailing international best practices and standards to reduce space debris. JSAT provides this plan to demonstrate compliance with United States Federal Communications Commission requirements regarding orbital debris mitigation and satellite end of life disposal.

§25.114(d)(14)(i) – Spacecraft Hardware Design and Debris Release Assessment

JSAT has assessed and limited the amount of debris released in a planned manner during normal operations by the spacecraft. The only phase of the mission in which portions of the spacecraft are separated from the main spacecraft body was during deployment. During deployment, however, all separation and deployment mechanisms were designed to contain all debris generated when activated so as to ensure that no debris leaves the spacecraft. The assessment found no other sources for debris throughout the mission.

JSAT has also assessed and limited the probability of collisions with debris or meteoroids smaller than one centimeter in diameter. To protect from such small body collisions, the spacecraft hardware design of JCSAT-5A will allow for individual faults without losing the entire spacecraft.

All critical components (e.g., computers and control devices) are built within the structure and shielded from external influences. Items that could not be built within the spacecraft nor shielded (e.g., antennas) are able to withstand impact.

The spacecraft can be controlled through both the normal payload antenna and wide angle antennas. The likelihood of both being damaged during a small body collision is minimal. The wide angle antennas on this spacecraft will be open waveguides that point towards the earth. There is one set on the Earth facing panel of the spacecraft and it could be used to successfully de-orbit the spacecraft.

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

JCSAT-5A is 3-axis stabilized and uses mono-propellant chemical propulsion for attitude and on-station control. JSAT has reviewed failure modes for all equipment to assess and limit the possibility of an accidental explosion onboard the spacecraft during and after completion of mission operations. To ensure that energy sources on board the spacecraft do not convert into energy that could fragment the spacecraft in orbit, JSAT is taking the following specific precautions.

All batteries and fuel tank are monitored for pressure or temperature variations. Alarms on the JCSAT-5A satellite inform controllers of any variations. Batteries will be operated utilizing the manufacturer's automatic recharging scheme to ensure that charging terminates normally without building up additional heat and pressure. As this process occurs wholly within the spacecraft, it also affords protection from command link failures (on the ground). Fuel tank will be operated in a blow down mode with one or two repressurizations during the mission.

On JCSAT-5A, the residual helium pressurant is stored in two identical pressure vessels, each with a volume of 4105(inch^3). The total end-of-life mass of helium is 6.12 kg, as calculated using tank temperatures and the common pressure for the system (tank and plumbing) received via telemetry data. (The range of temperature in kelvins used for the pressure calculation is from 263K to 323 K.) The pressure of the helium tank is 720 – 790 psia and the vessels' maximum expected operating pressure is 4500 psia. (The pressure of helium tank is 720 – 790 psia, which is an actual pressure value based on telemetry data.)

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, excepting a de minimis quantity of inert helium pressurant noted above. 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 in the years after the spacecraft is de-orbited.

§25.114(d)(14)(iii) – Safe Flight Profile and Assessment Regarding Collision with Larger Debris and Other Space Stations

JSAT has also assessed and limited the probability of the space station becoming a source of debris by collisions with large debris or other operational space stations. The satellite is located at orbital slot 132° E.L. The TTC operation of JCSAT-5A satellite is performed by JSAT Satellite Control Center at all times through the ground station located in Yokohama, Japan. For station keeping, the satellite is maintained within a box of size of ±0.05 degree.

At this time there no satellites located adjacent to JCSAT-5A such that station-keeping volumes might overlap. The closest satellites are, to the west, VINASAT-1 located at 131.9° E.L and VINASAT-2 located at 131.8° E.L. and, to the east, APSTAR-6 at 134EL.

<u>**Post-Mission and End-of-Life Disposal Plans**</u>

At the scheduled completion of its mission, JCSAT-5A will be removed from its geostationary orbit at 132° E.L. to a perigee altitude no less than 266 km above the standard geostationary orbit of 35,786 km. This altitude was determined by using the IADC formula of

> Minimum Deorbit Altitude= 36,021 km + (1000・CR・A/m)
> CR = solar pressure radiation coefficient of the spacecraft = 1.24
> A/m = area to mass ratio, in square meters per kilogram, of the spacecraft = 0.0246
> Result: (Eq.1) Minimum Deorbit Altitude = 36,021 km + (1000* 1.24*.0246) = 36,052 km
> which is
> 266 km above the geostationary orbit of 35,786 km.

CR is the solar pressure radiation coefficient of the spacecraft, and A/m is the Area to mass ratio, in square meters per kilogram, of the spacecraft. This post-disposal perigee takes into account gravitational perturbations and solar radiation pressure that could alter the satellite orbit in the years after decommissioning.

JSAT will take into account this requirement for any de-orbit operation of this satellite and will reserve sufficient propellant, inclusive of fuel gauging uncertainty, in order to conform to the regulation set forth in Guidelines and comply with the following:

	Δa Requirement	Propellant needed
JCSAT-5A	266 km	12.9 kg

As the satellite is de-orbited, in accordance with to orbital raising operations, JSAT will configure the satellite with residual energy into a passive state. JSAT will implement procedures to eliminate on-board energy in whatever form of electrical, chemical, kinetic etc., which is considered as a potential source of generating harmful debris. These measures include shutting down the power generating subsystems and all power consumed components.

In addition, power to the reaction wheels will be disabled and they will eventually stop spinning, therefore retaining no kinetic energy. Pyrotechnic components would have been exhausted or completely disabled during operations in the initial stage of life. As such, we consider the risk of de-commissioning of the satellite will be kept minimal and conformed to the standard of the industry.

Additional Information for JCSAT-5A

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

Item	Purpose	Tank Volume [l]	Number of Tanks	Initial mass [kg]	End of life mass [kg]	End of life pressure [psia]
Hydrazine	Orbit raising Orbit control Attitude control	1514.1/tank	1	1450.0	38.15	NA(1)
Oxidizer	Orbit raising	328.3/tank	2 - Inter-connected	727.9	22.88	261 (18.0[bar])
Helium	Pressurant	67.3/tank	2 - Inter-connected	6.12	6.12	NA(1)

(1) – Not applicable, as after hydrazine depletion, hydrazine and helium pressures are not guaranteed, however, they will be as low as possible.

- End -

SKY Perfect JSAT Corporation

N. Masuda

Noriko Masuda
General Manager
Satellite Operation Division
8 June, 2015

ANNEX A-4: Yamal 401

A. Yamal 401 Coverage Map

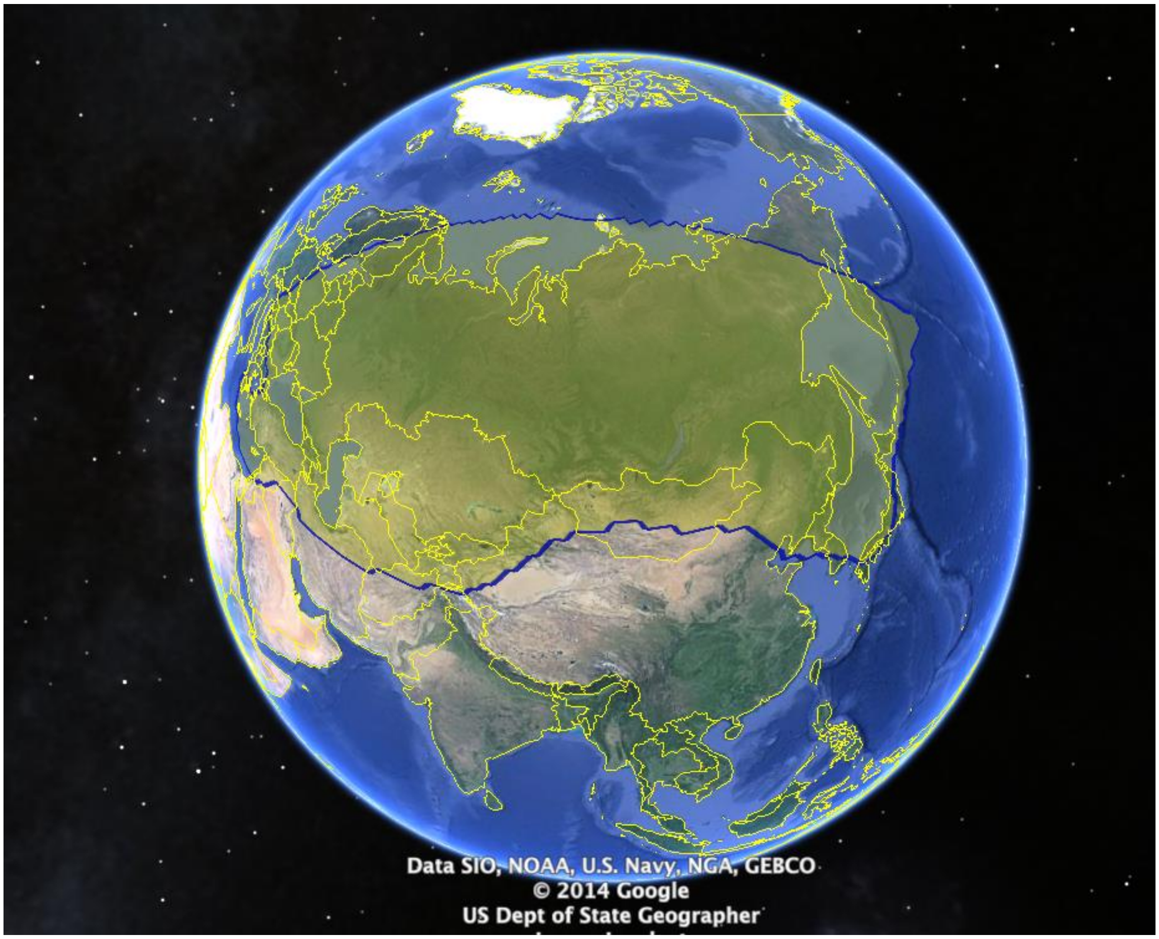

Figure 7: Yamal 401 at Northern Beam

B. Yamal 401 Link Budget

Forward Link Budget

eXConnect Terminal

Antenna Type	AURA LE	
Lat	50.4	deg
Lon	40.3	deg
EIRP max	42.5	dBW
G/T	10.0	dB/K

Satellite

Name	Yamal-401	
Longitude	90.0	deg

Hub Earth Station

Site	Moscow	
Lat	55.8	deg
Lon	37.6	deg
EIRP max	73.8	dBW
G/T	31.7	dB/K

Signal

Waveform	DVB-S2	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.60	
Overhead Rate	0.94	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	1.13	bps/Hz
Data Rate	5.08E+07	bps
Information Rate (Data + Overhead)	5.40E+07	bps
Symbol Rate	4.50E+07	Hz
Chip Rate (Noise Bandwidth)	4.50E+07	Hz
Occupied Bandwidth	5.40E+07	Hz
Power Equivelent Bandwidth	7.20E+07	Hz
C/N Threshold	2.7	dB

Uplink

Frequency	14.180	GHz
Back off	4.6	dB
EIRP Spectral Density	28.7	dBW/4kHz
Slant Range	40424	km
Space Loss, Ls	207.6	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	4.6	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	4.5	dB/K
Thermal Noise, C/No	90.1	dBHz
C/(No+Io)	89.6	dBHz

Satellite

Flux Density	-98.5	dBW/m2
SFD @ Hub	-92.5	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	3.0	dB

Downlink

Frequency	11.130	GHz
Transponder Sat. EIRP @ Beam Peak	52.1	dBW
Transponder Sat. EIRP @ Terminal	51.5	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	8.6	dBW/4kHz
Carrier EIRP @ Beam Peak	49.1	dBW
Carrier EIRP @ Terminal	48.5	dBW
Slant Range	39965	km
Space Loss, Ls	205.4	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	81.6	dBHz
C/(No+Io)	81.1	dBHz

End to End

End to End C/(No+Io)	80.5	dBHz
Implementation Loss	1.0	dB
End to End C/N w/ Imp Loss	3.0	dB
Link Margin	0.3	dB

Return Link Budget

eXConnect Terminal

Antenna Type	AURA LE	
Lat	50.4	deg
Lon	40.3	deg
EIRP max	42.5	dBW
G/T	10.0	dB/K

Satellite

Name	Yamal-401	
Longitude	90.0	deg

Hub Earth Station

Site	Moscow	
Lat	55.8	deg
Lon	37.6	deg
EIRP max	73.8	dBW
G/T	31.7	dB/K

Signal

Waveform	iDirect	
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	2	
Coding Rate	0.67	
Overhead Rate	0.72	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.24	bps/Hz
Data Rate	1.61E+06	bps
Information Rate (Data + Overhead)	2.22E+06	bps
Symbol Rate	3.33E+06	Hz
Chip Rate (Noise Bandwidth)	6.67E+06	Hz
Occupied Bandwidth	8.00E+06	Hz
Power Equivelent Bandwidth	4.89E+05	Hz
C/N Threshold	-1.2	dB

Uplink

Frequency	14.180	GHz
Back off	0.0	dB
EIRP Spectral Density	10.3	dBW/4kHz
Slant Range	39965	km
Space Loss, Ls	207.5	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
Transponder G/T @ Terminal	5.0	dB/K
Thermal Noise, C/No	68.4	dBHz
C/(No+Io)	67.9	dBHz

Satellite

Flux Density	-120.7	dBW/m2
SFD @ Terminal	-93.0	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	24.7	dB

Downlink

Frequency	11.130	GHz
Transponder Sat. EIRP @ Beam Peak	52.1	dBW
Transponder Sat. EIRP @ Hub	51.5	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-4.8	dBW/4kHz
Carrier EIRP @ Beam Peak	27.4	dBW
Carrier EIRP @ Hub	26.8	dBW
Slant Range	40424	km
Space Loss, Ls	205.5	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	4.6	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	77.0	dBHz
C/(No+Io)	74.8883	dBHz

End to End

End to End C/(No+Io)	67.1	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	-1.1	dB
Link Margin	0.1	dB

C. Yamal 401 Coordination Letter

ОТКРЫТОЕ
АКЦИОНЕРНОЕ ОБЩЕСТВО
«ГАЗПРОМ КОСМИЧЕСКИЕ СИСТЕМЫ»

(ОАО «Газпром космические системы»)
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30.03.2015 № УП-06/380/1477

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

Re: Engineering Certification of Gazprom Space Systems

To Whom It May Concern:

This letter certifies that Gazprom Space Systems. ("GSS") is aware that Panasonic Avionics Corporation ("Panasonic") is planning to seek a modification to its blanket authorization from the Federal Communications Commission ("FCC") to operate technically identical Ku-band transmit/receive earth stations aboard aircraft ("ESAAs"), Call Sign E100089, with the Yamal-401 satellite at 90°E and the Yamal-300K satellite at 183°E. GSS understands that Panasonic will file the modification pursuant to the FCC rules governing ESAA operations, including Section 25.227.

GSS certifies that the proposed operation of the ESAA transmit/receive terminals at the power density levels specified in the application are consistent with coordination agreements with affected satellite networks within +/- 6 degrees of orbital separation from the Yamal-401 and Yamal-300K satellites nominal positions. GSS also acknowledges that the proposed operation of the Panasonic ESAA terminal has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable. If the FCC authorizes the operations proposed by Panasonic, GSS will endeavor to ensure that the relevant Administration includes the power density levels specified by Panasonic in all coordinations with the future satellite networks.

Yours sincerely,

Igor Kot
Deputy Director General

D. Yamal 401 – Orbital Debris Mitigation Plan

JSC Gazprom Space Systems
Yamal-401 Spacecraft

Technical Reference and
Orbital Debris Mitigation/End-of-Life Disposal Plan

1. Introduction

This Technical Reference and Orbital Debris Mitigation/End-of-Life Disposal Plan identifies the basic principles and operation of spacecraft Yamal-401 ("Yamal-401") manufactured by JSC Information Satellite Systems ("ISS") and contains information to ensure compliance with Russian State Standard GOST R 52925-2008 "Space Technologies, General Requirements to Space Systems to Limit Technogenic Pollution of Near-Earth Space" in the operation of spacecraft Yamal-401 to reduce GSO pollution.

In addition, this document has been prepared for the purpose of demonstrating the end of life disposal and debris mitigation policies associated with the spacecraft Yamal-401 in satisfaction of the Federal Communications Commission rules 47 C.F.R 25.114(d)(14) and 25.283(c).

2. General Information on Yamal-401 Spacecraft

Yamal-401 has been manufactured in compliance with applicable Russian standards and specifications and has a telecommunications payload manufactured by GSS. The spacecraft has an attitude and orbit control system based on thermocatalytic engines for spacecraft orientation (hydrazine propellant) and plasma thrusters for correction of the spacecraft orbit (xenon propellant). Yamal-401 was launched in December 2014; the estimated active lifetime is 15 years.

3. Operation of Yamal-401

All materials used on spacecraft Yamal-401 are selected in compliance with GOST R 50109-92 and have minimum weight loss factors.

Operation of Yamal-401 in GSO, relocation to a new operating slot in GSO (if necessary), and de-orbit from GSO after completion of normal operation is carried out under constant supervision and control of the ballistic group of Yamal-401 Operations Control Center ("OCC"), which ensures security of the flight and prevents collisions with other spacecraft in orbit.

Yamal-401 is controlled continuously. Orbit correction is carried out in a standard way, in accordance with the orbit correction plan.

4. Orbital Debris Mitigation/End-of-Life Disposal Plan

a. §25.114(d)(14)(i) – Spacecraft Hardware Design and Debris Release Assessment

GSS has assessed the amount of debris released during normal operations by the spacecraft and determined that during operation in GSO and in the process of its deorbiting, any separations of structural or engine elements from Yamal-401 is impossible.

GSS has also assessed and limited the probability of collisions with debris or meteoroids. Flux density, sizes and other parameters of particles for GSO are specified by Russian documents defining spatiotemporal distribution of particles for MM (meteoric material) and TM (technogenic material) (GOST 25645.128 and OST 134-1022 accordingly). To protect from collisions with such small bodies, the spacecraft hardware design will allow for individual faults without losing the entire spacecraft. All critical components (*e.g.*, computers and control devices) are built within the structure and shielded from external influences. Items that could not be built within the spacecraft or shielded (e.g., antennas) are able to withstand the impact.

The spacecraft can be controlled through wide angle antennas. Antennas are made as open-ended waveguides and located by pairs at front and rear side panels of the spacecraft. Probability of both antenna pairs destruction by a single impact of a small body is negligible.

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

GSS has reviewed failure modes for all equipment onboard Yamal-401 to assess and limit the possibility of an accidental explosion onboard the spacecraft during and after completion of mission operations. To ensure that energy sources on board the spacecraft do not convert into energy that could fragment the spacecraft in orbit, GSS is taking the following measures.

All batteries are monitored for pressure or temperature variations, and the batteries are operated utilizing automatic recharging scheme to ensure that charging terminates normally without building up additional heat and pressure. As this process occurs wholly within the spacecraft, it also provides protection from command link failures (on the ground).

In order to protect the propulsion system, fuel tanks will be monitored in a blow down mode. This will cause the pressure in the tanks to decrease over the life of the spacecraft.

The onboard equipment includes tanks under pressure – xenon storage and hydrazine storage and supply tank. The possibility of such equipment destruction is virtually non-existent. This is ensured with significant safety margin between the fill pressure of the tank and the pressure rating for the tank, and has been proven with ground tests.

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. All battery chargers will be turned off and batteries will be left in a permanent discharge state. These steps will ensure that no power generation can occur resulting in an explosion in the years after the spacecraft is de-orbited.

c. §25.114(d)(14)(iii) – Safe Flight Profile and Assessment Regarding Collision with Larger Debris and Other Space Stations

GSS has assessed and limited the probability of the spacecraft becoming a source of debris by collisions with large debris or other operational spacecrafts. Yamal-401 operates in a geostationary orbit at the orbital position 90° E in accordance with the filings to ITU and in accordance with all ITU legal standards. Yamal-401 onboard systems and operation principles are organized in a way so that no single failure or wrongly issued command can lead to unauthorized engine start. Thus, a possibility of collision with other spacecraft due to the fault of GSS is minimized.

GSS will monitor scheduled launches to determine whether other satellites will be located in close proximity to Yamal-401. If a new satellite is close to Yamal-401, GSS will coordinate station keeping activities with the satellite operator to avoid any risk of collision.

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

At the scheduled completion of its mission, Yamal-401 will be removed from its geostationary orbit at 90° E to a perigee altitude no less than 300 km above the standard geostationary orbit of 35,786 km. This altitude exceeds that determined by using the IADC formula included in section 25.283(a) of the FCC rules regarding end-of-life satellite disposal, as described in the attached Appendix.

Sufficient propellant, inclusive of fuel gauging uncertainty, will be reserved to ensure minimum de-orbit altitude is obtained. Any remaining propellant will be consumed by further raising the orbit.

Propellant tracking is accomplished using a bookkeeping method in which the ground control station tracks the number of jet seconds utilized for station keeping, momentum control and other attitude control events. The amount of fuel used is determined from the number of jet seconds. This process has been calibrated using data collected from thruster tests conducted on the ground and has been found to be accurate to within a few months of life on the spacecraft. Additional estimation of residual propellant is accomplished by telemetry data.

4. Yamal-401 De-Orbiting

At the end of its mission, Yamal-401's post-disposal perigee takes into account gravitational perturbations and solar radiation pressure that could alter the satellite orbit in the years after decommissioning. GSS has planned the tracking telemetry and control transmissions required for end-of-life repositioning so as to avoid electrical interference to other spacecrafts, and coordinated with any potentially affected satellite networks.

Finally, as discussed in Section (b) above, and except as detailed in the attached Appendix, all stored energy sources on board the satellite will be discharged by discharging batteries, and other appropriate measures.[1]

GSS provides for the following spacecraft deorbiting operations after its operation completion:

1. The calculations stipulate the necessary reserve of propellant for deorbiting the spacecraft after its operation completion.

2. Telemetry control of propulsion system propellant reserve is performed during the entire period of operation.

3. In accordance with GOST R 52925-2008, orbital radius to which the spacecraft is deorbited must be greater than the GSO radius by at least 235 km plus an additional factor. In view of the Yamal-401 characteristics and allowing for additional margin, the radius of the disposal orbit is customary to be greater than the radius of the geostationary orbit by 300 km. See Appendix.

4. After Yamal-401 is deorbited to the disposal orbit, it will be subject to passivation, specifically:

   - transfer of correction and orientation engines to inoperable condition (switching off the power supply);

   - de-spin momentum wheels and allow them to stop spinning (i.e., have no remaining kinetic energy)

   - fire all unfired pyrotechnic devices

   - final discharge of batteries at after deorbiting the spacecraft from GSO;

   - switch off of onboard equipment.

5. During deorbiting from GSO, operation of radio transmission line will be planned based on excluding the possibility of interference in the frequencies of other spacecraft.

[1] §25.283(c)

APPENDIX

Yamal-401 will be removed from its geostationary orbit at 90E at a perigee altitude no less than 300 km above the standard geostationary orbit of 35786 km. This altitude exceeds that arrived at by using the equation in §25.283 of the FCC rules pertaining to end-of-life satellite disposal (minimum altitude= 235 km + (1000•CR•A/m)) above geostationary orbit).

Minimum Deorbit Altitude= 36,021 km + (1000•CR•A/m)
CR = solar pressure radiation coefficient of the spacecraft = 1.25
A/m = area to mass ratio, in square meters per kilogram, of the spacecraft = 0.032

Result:
Minimum Deorbit Altitude = 36,021 km + (1000•.1.25• 0.032) = 36, 061 km
or 270 km above the geostationary arc

De-orbiting the satellite at 300 km or above provides additional margin to the minimum de-orbit altitude. The propellant needed to achieve the minimum deorbit altitude is based on the delta-V required and specified by the spacecraft manufacturer.

Based on IADC calculation, an estimated end-of-life mass of 2688 kg, and the delta-V required of approximately 11.1 m/s, 3.08 kg of propellant will be reserved to ensure minimum de-orbit altitude is obtained. It should be noted that Yamal-401 utilizes Xips thrusters (instead of normal bi-propellant). Xenon is the basic fuel type, which is much more efficient.

Any remaining propellant will be consumed by further raising the orbit until combustion is no longer possible. By the moment of complete spacecraft deactivation residual propellant on the board shall be as follows:

Item	Purpose	Tank Volume	Number of Tanks / Interconnected	Initial mass of item per tank	End of life mass / volume	Tank pressure rating / units	End of life pressure
Hydrazine (liquid)	Attitude control	26 liters BOL 0.7 litre EOL	3 Tanks / Interconnected Fuel and pressurant are located in common tank and separated by internal membrane.	25 kg	0.7 kg/ 0.7 l	9.0 atm	NA (1)
Nitrogen	Pressurant	14 liters BOL 40 liters EOL		0.25 kg	0.25 kg/ 39,3 l	9,0 atm	2.1 atm
Xenon	Orbit control	38 liters	4 / Yes	71 kg in each tank	1 kg in each tank	140 atm	2.6 atm

(1) – Not applicable, as after hydrazine depletion, membrane-separator of hydrazine and pressurant is completely folded and hydrazine pressure is not guaranteed (at the worst, it does not exceed Nitrogen pressure)

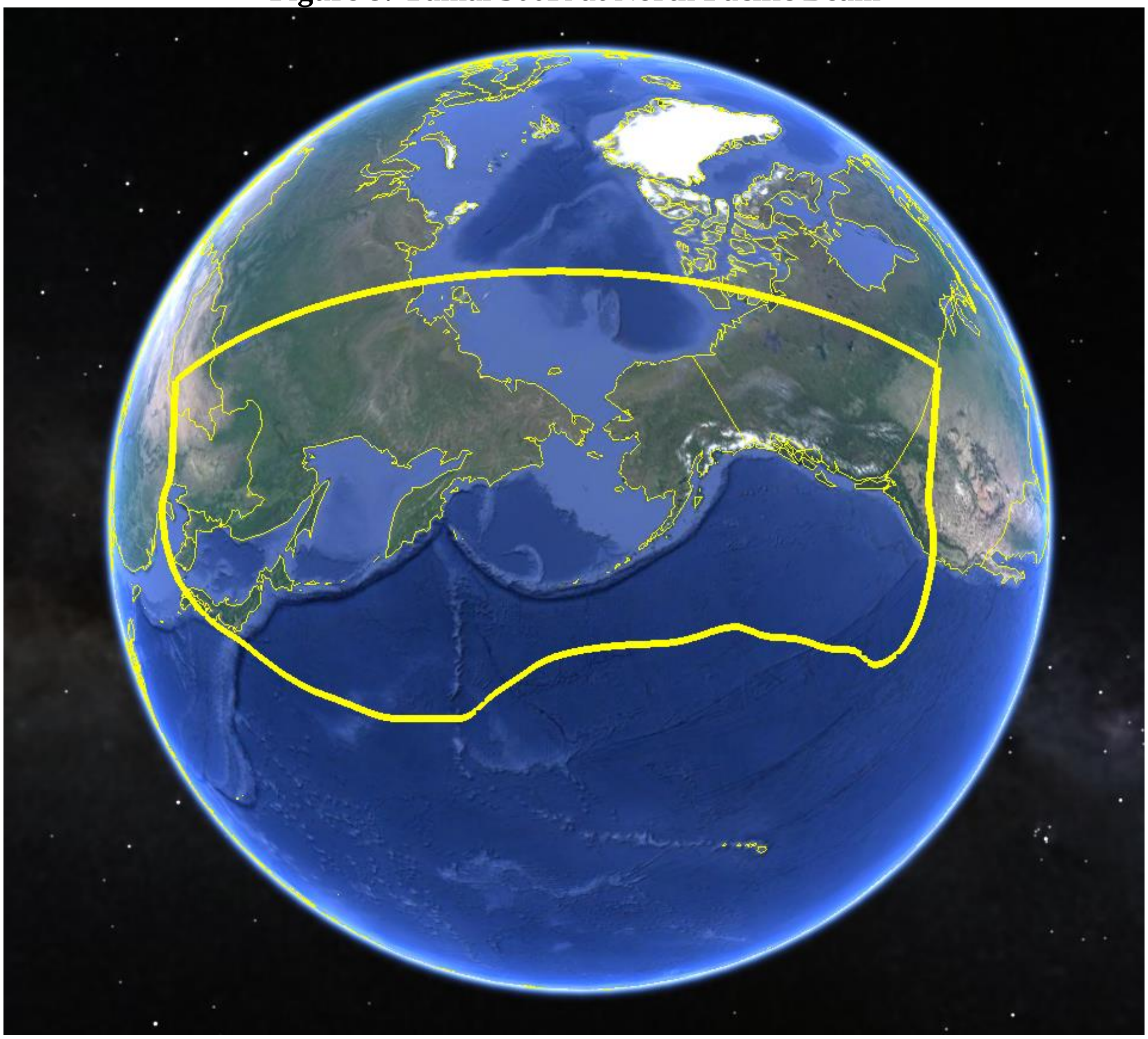
In the case of Xenon propellant, please note that the tanks are interconnected and the residual products are stated as the total dispersed between all tanks. The residual pressures above assume a temperature of 293 degrees K.

During manufacturing the tanks are tested by the pressure 1.5 times higher than fill pressure.

E. ANNEX A-5: Yamal 300

A. Yamal 300K Coverage Map

Figure 8: Yamal 300K at North Pacific Beam



B. Yamal 300K Link Budget

Forward Link Budget

eXConnect Terminal

Antenna Type	AURA LE	
Lat	46.9	deg
Lon	132.0	deg
EIRP max	42.5	dBW
G/T	8.5	dB/K

Satellite

Name	Yamal-300K	
Longitude	183.0	deg

Hub Earth Station

Site	Brewster	
Lat	48.1	deg
Lon	-119.8	deg
EIRP max	80.0	dBW
G/T	37.5	dB/K

Signal

Waveform	DVB-S2	
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	3.72E+07	bps
Information Rate (Data + Overhead)	4.50E+07	bps
Symbol Rate	4.50E+07	Hz
Chip Rate (Noise Bandwidth)	4.50E+07	Hz
Occupied Bandwidth	5.40E+07	Hz
Power Equivelent Bandwidth	7.20E+07	Hz
C/N Threshold	0.9	dB

Uplink

Frequency	14.380	GHz
Back off	14.2	dB
EIRP Spectral Density	25.3	dBW/4kHz
Slant Range	40299	km
Space Loss, Ls	207.7	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	3.2	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	4.0	dB/K
Thermal Noise, C/No	87.5	dBHz
C/(No+Io)	87.0	dBHz

Satellite

Flux Density	-100.5	dBW/m2
SFD @ Hub	-94.5	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	3.0	dB

Downlink

Frequency	11.580	GHz
Transponder Sat. EIRP @ Beam Peak	53.5	dBW
Transponder Sat. EIRP @ Terminal	52.5	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	10.0	dBW/4kHz
Carrier EIRP @ Beam Peak	50.5	dBW
Carrier EIRP @ Terminal	49.5	dBW
Slant Range	39843	km
Space Loss, Ls	205.7	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	80.8	dBHz
C/(No+Io)	80.4	dBHz

End to End

End to End C/(No+Io)	79.6	dBHz
Implementation Loss	1.0	dB
End to End C/N w/ Imp Loss	2.0	dB
Link Margin	1.1	dB

Return Link Budget

eXConnect Terminal

Antenna Type	AURA LE	
Lat	46.9	deg
Lon	132.0	deg
EIRP max	42.5	dBW
G/T	8.5	dB/K

Satellite

Name	Yamal-300K	
Longitude	183.0	deg

Hub Earth Station

Site	Brewster	
Lat	48.1	deg
Lon	-119.8	deg
EIRP max	80.0	dBW
G/T	37.5	dB/K

Signal

Waveform	iDirect	
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	2	
Coding Rate	0.67	
Overhead Rate	0.72	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.24	bps/Hz
Data Rate	1.61E+06	bps
Information Rate (Data + Overhead)	2.22E+06	bps
Symbol Rate	3.33E+06	Hz
Chip Rate (Noise Bandwidth)	6.67E+06	Hz
Occupied Bandwidth	8.00E+06	Hz
Power Equivelent Bandwidth	8.75E+05	Hz
C/N Threshold	-1.2	dB

Uplink

Frequency	14.380	GHz
Back off	0.0	dB
EIRP Spectral Density	10.3	dBW/4kHz
Slant Range	39843	km
Space Loss, Ls	207.6	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
Transponder G/T @ Terminal	5.0	dB/K
Thermal Noise, C/No	68.3	dBHz
C/(No+Io)	67.8	dBHz

Satellite

Flux Density	-120.7	dBW/m2
SFD @ Terminal	-95.5	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	22.2	dB

Downlink

Frequency	11.580	GHz
Transponder Sat. EIRP @ Beam Peak	53.5	dBW
Transponder Sat. EIRP @ Hub	51.5	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-0.9	dBW/4kHz
Carrier EIRP @ Beam Peak	31.3	dBW
Carrier EIRP @ Hub	29.3	dBW
Slant Range	40299	km
Space Loss, Ls	205.8	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	3.4	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	86.2	dBHz
C/(No+Io)	80.0473	dBHz

End to End

End to End C/(No+Io)	67.6	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	-0.7	dB
Link Margin	0.5	dB

C. Yamal 300K Coordination Letter

ОТКРЫТОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО «ГАЗПРОМ КОСМИЧЕСКИЕ СИСТЕМЫ»

(ОАО «Газпром космические системы»)
а/я 1860, ОПС Щелково-12, Московская область, Российская Федерация, 141112
Тел.: (495) 5042906, (495) 5042907, факс: (495) 5042911
E-mail: info@gazprom-spacesystems.ru, www.gazprom-spacesystems.ru

JOINT STOCK COMPANY «GAZPROM SPACE SYSTEMS»

(JSC Gazprom Space Systems)
Box 1860, Shchelkovo Post Office-12, Moscow Region, Russian Federation, 141112
Tel.: +7 (495) 5042906, +7 (495) 5042907, fax: +7 (495) 5042911
E-mail: info@gazprom-spacesystems.ru, www.gazprom-spacesystems.ru

30.03.2015 № УП-06/380/1477

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

Re: Engineering Certification of Gazprom Space Systems

To Whom It May Concern:

This letter certifies that Gazprom Space Systems. ("GSS") is aware that Panasonic Avionics Corporation ("Panasonic") is planning to seek a modification to its blanket authorization from the Federal Communications Commission ("FCC") to operate technically identical Ku-band transmit/receive earth stations aboard aircraft ("ESAAs"), Call Sign E100089, with the Yamal-401 satellite at 90°E and the Yamal-300K satellite at 183°E. GSS understands that Panasonic will file the modification pursuant to the FCC rules governing ESAA operations, including Section 25.227.

GSS certifies that the proposed operation of the ESAA transmit/receive terminals at the power density levels specified in the application are consistent with coordination agreements with affected satellite networks within +/- 6 degrees of orbital separation from the Yamal-401 and Yamal-300K satellites nominal positions. GSS also acknowledges that the proposed operation of the Panasonic ESAA terminal has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable. If the FCC authorizes the operations proposed by Panasonic, GSS will endeavor to ensure that the relevant Administration includes the power density levels specified by Panasonic in all coordinations with the future satellite networks.

Yours sincerely,

Igor Kot
Deputy Director General

ANNEX A-6: NSS-6

A. **NSS-6 Coverage Map**

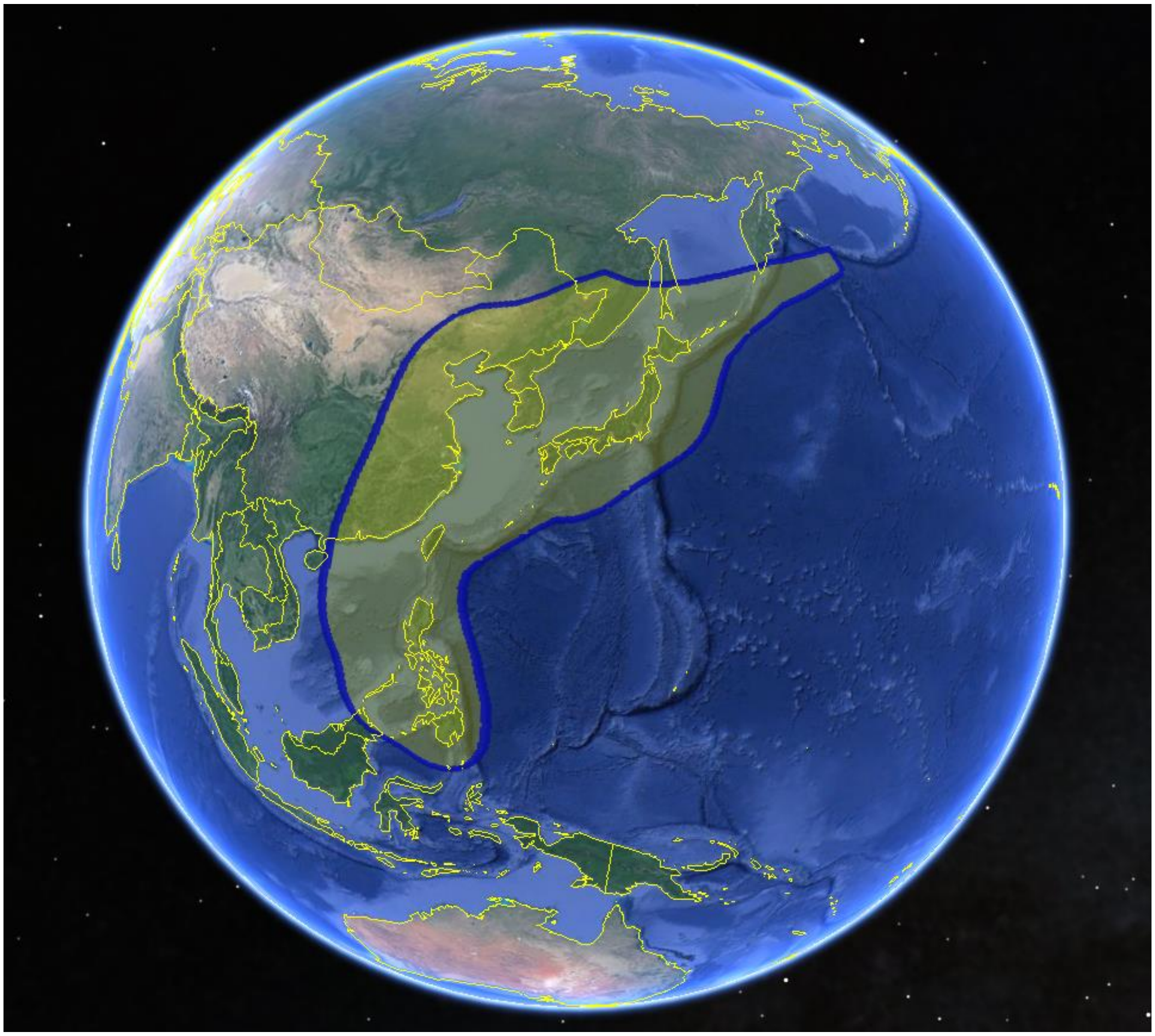


Figure 9: NSS-6 at North East Asia Beam

B. NSS-6 Link Budget

Forward Link Budget

eXConnect Terminal		
Antenna Type	AURA LE	
Lat	36.1	deg
Lon	136.4	deg
EIRP max	46.1	dBW
G/T	9.7	dB/K
Satellite		
Name	NSS-6	
Longitude	95.0	deg
Hub Earth Station		
Site	Cyprus	
Lat	34.859	deg
Lon	33.384	deg
EIRP max	77.6	dBW
G/T	36.0	dB/K
Signal		
Waveform	DVB-S2	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.83	
Overhead Rate	0.93	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	1.56	bps/Hz
Data Rate	4.67E+07	bps
Information Rate (Data + Overhead)	5.00E+07	bps
Symbol Rate	3.00E+07	Hz
Chip Rate (Noise Bandwidth)	3.00E+07	Hz
Occupied Bandwidth	3.60E+07	Hz
Power Equivelent Bandwidth	2.60E+07	Hz
C/N Threshold	5.6	dB
Uplink		
Frequency	13.900	GHz
Back off	0.0	dB
EIRP Spectral Density	38.9	dBW/4kHz
Slant Range	40110	km
Space Loss, Ls	207.4	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	5.5	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	5.0	dB/K
Thermal Noise, C/No	98.3	dBHz
C/(No+Io)	97.8	dBHz
Satellite		
Flux Density	-91.0	dBW/m2
SFD @ Hub	-85.6	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	2.4	dB
Downlink		
Frequency	12.647	GHz
Transponder Sat. EIRP @ Beam Peak	54.5	dBW
Transponder Sat. EIRP @ Terminal	54.0	dBW
DL PSD Limit	14.7	dBW/4kHz
DL PSD @ Beam Peak	13.3	dBW/4kHz
Carrier EIRP @ Beam Peak	52.1	dBW
Carrier EIRP @ Terminal	51.6	dBW
Slant Range	38633	km
Space Loss, Ls	206.2	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	83.5	dBHz
C/(No+Io)	81.7	dBHz
End to End		
End to End C/(No+Io)	81.6	dBHz
Implementation Loss	1.0	dB
End to End C/N w/ Imp Loss	5.8	dB
Link Margin	0.2	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	AURA LE	
Lat	36.1	deg
Lon	136.4	deg
EIRP max	46.1	dBW
G/T	9.7	dB/K
Satellite		
Name	NSS-6	
Longitude	95.0	deg
Hub Earth Station		
Site	Cyprus	
Lat	34.859	deg
Lon	33.384	deg
EIRP max	77.6	dBW
G/T	36.0	dB/K
Signal		
Waveform	iDirect	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.67	
Overhead Rate	0.85	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	1.13	bps/Hz
Data Rate	7.54E+06	bps
Information Rate (Data + Overhead)	8.89E+06	bps
Symbol Rate	6.67E+06	Hz
Chip Rate (Noise Bandwidth)	6.67E+06	Hz
Occupied Bandwidth	8.00E+06	Hz
Power Equivelent Bandwidth	1.18E+06	Hz
C/N Threshold	5.0	dB
Uplink		
Frequency	14.472	GHz
Back off	0.0	dB
EIRP Spectral Density	13.9	dBW/4kHz
Slant Range	38633	km
Space Loss, Ls	207.4	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
Transponder G/T @ Terminal	8.0	dB/K
Thermal Noise, C/No	75.2	dBHz
C/(No+Io)	74.7	dBHz
Satellite		
Flux Density	-116.7	dBW/m2
SFD @ Terminal	-95.9	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	17.8	dB
Downlink		
Frequency	11.676	GHz
Transponder Sat. EIRP @ Beam Peak	50.0	dBW
Transponder Sat. EIRP @ Hub	50.0	dBW
DL PSD Limit	14.7	dBW/4kHz
DL PSD @ Beam Peak	-0.1	dBW/4kHz
Carrier EIRP @ Beam Peak	32.2	dBW
Carrier EIRP @ Hub	32.2	dBW
Slant Range	40110	km
Space Loss, Ls	205.9	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	84.4	dBHz
C/(No+Io)	80.2829	dBHz
End to End		
End to End C/(No+Io)	73.6	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	5.4	dB
Link Margin	0.4	dB

C. NSS-6 Coordination Letter

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

May 08, 2015

Subject: Engineering Certification of SES Americom, Inc.

SES World Skies Singapore Pte Ltd.
501 Orchard Road,
#18-00 Wheelock Place
238880 Singapore
Tel. + 65 6593 3600
Fax + 65 6593 3610
www.ses.com

Company Registration Number (UEN) 200914437G

To Whom It May Concern:

This letter certifies that SES Americom, Inc. ("SES") is aware that Panasonic Avionics Corporation ("Panasonic") is planning to seek a modification to its blanket authorization from the Federal Communications Commission ("FCC") to operate technically identical Ku-band transmit/receive earth stations aboard aircraft ("ESAAs"), Call Sign E100089, with the NSS-6 satellite at 95°E. SES understands that Panasonic will file the modification pursuant to the FCC rules governing ESAA operations, including Section 25.227.

SES certifies that the proposed operation of the ESAA transmit/receive terminals at the uplink off-axis EIRP density levels and downlink EIRP density levels at which Panasonic plans to operate in the NEA beam on NSS-6, which were provided to SES in a letter dated 5 May 2015 from Mark DeFazio of Panasonic, are consistent with existing operator-to-operator coordination agreements with all adjacent satellite operators within +/- 6 degrees of orbital separation from NSS-6. SES also acknowledges that the proposed operation of the Panasonic ESAA terminal has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable. If the FCC authorizes the operations proposed by Panasonic, SES will include the EIRP density levels specified by Panasonic in all future satellite network co-ordinations with other adjacent satellite operators.

Yours sincerely,

Kevin Seow
VP, Spectrum Management and Development Asia-Pacific
SES

D. NSS-6 Orbital Debris Mitigation Plan

The NSS-6 satellite was manufactured by Lockheed Martin pursuant to well-settled U.S. standards and specifications, and is based on the A2100 bus. The satellite was launched on December 17, 2002. The following information describes compliance with the FCC's orbital debris mitigation and satellite end-of-life disposal policies.

§25.114(d)(14)(i): New Skies Satellites B.V. ("SES") has assessed and limited the amount of debris released in a planned manner during normal operations of NSS-6 at 95.0° E.L. No debris is generated during normal on-station operations, and the spacecraft will be in a stable configuration. On-station operations will be maintained within a ±0.05 degree E-W control box, thereby ensuring adequate collision avoidance distance from other satellites in geosynchronous orbit. NSS-6 will be co-located with SES-8 at that orbital control box using the proven Inclination-Eccentricity (I-E) separation method. This strategy is presently in use by SES to ensure proper operation and safety of multiple satellites within one orbital box at other orbital locations.

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 NSS-6 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 steps to limit the effects of any collisions through shielding, the placement of components, and the use of redundant systems.

§25.114(d)(14)(ii): 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 NSS-6 spacecraft is such that the risk of explosion is minimized both during and after mission operations. In designing and building the spacecraft, the manufacturer took steps to ensure that debris generation will not result from the conversion of energy sources on board the satellite into energy that fragments the satellite. All propulsion subsystem pressure vessels, which have high margins of safety at launch, have even higher margins in orbit, since use of propellants and pressurants during launch decreases the propulsion system pressure. Burst tests are performed on all pressure vessels during qualification testing to demonstrate a margin of safety against burst.

Bipropellant mixing is prevented by the use of valves that prevent backwards flow in propellant and pressurization lines. All pressures, including those of the batteries, are monitored by telemetry.

At the end of operational life, after the satellite has reached its final disposal orbit, onboard sources of stored energy will be depleted or secured, and the batteries will be discharged. However, at the end of NSS-6's operational life, there will be oxidizer remaining in the tanks that cannot be vented. Following insertion of the spacecraft into orbit, the spacecraft manufacturer permanently sealed the oxidizer tanks by firing pyrotechnic valves. This is a design feature of the Lockheed A2100 series spacecraft that cannot now be changed or remedied. Information regarding the residual oxidizer in the tanks is as follows:

Tank	Volume [l]	Pressure [bar]	Temp. [deg C]	Oxidizer mass [kg]
Ox 1	327.5	18.25	22.0	12.75
Ox 2	327.5	18.25	22.0	12.75

The oxidizer tanks are well shielded, and the residual pressure in the tanks will be well below their maximum rating.

§25.114(d)(14)(iii): 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 95° E.L. 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 stationkeeping limits, collision with another controlled object (excluding where the satellite is collocated with another object) is the direct result of that object entering the allocated space.

Besides SES-operated SES-8 satellite, SES is not aware of any other spacecraft that are operational or planned to be deployed at or near 95.0° E.L. such that there would be an overlap with the stationkeeping volume of NSS-6. SES is aware that the LUCH-5V satellite was launched on 28 April 2014 and is intended to be operated in the vicinity of 95° E.L. SES expects to coordinate stationkeeping with the operator of that spacecraft. 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.

§25.114(d)(14)(iv): Post-mission disposal of the satellite from operational orbit will be accomplished by carrying out maneuvers to raise the satellite 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 NSS-6 to a disposal orbit at end of life and has selected a target minimum perigee of 300 km above the normal operational altitude. SES intends to reserve 5.8 kg of fuel in order to account for post-mission disposal of NSS-6. SES has assessed fuel gauging uncertainty and has provided an adequate margin of fuel reserve to address the assessed uncertainty. This is consistent with the minimum perigee altitude requirement under Section 25.283(a) of the Commission's Rules. The Minimum Disposal Orbit Perigee Altitude as calculated under the Section 25.283(a) formula is as follows:

36,021 km + (1000 x CR x A/m) = 36,071 km

(or 285 km above the GSO arc (35,786 km)

Where:

Area of the satellite (average aspect area): 93.6 m^2

Mass of the spacecraft: 2278 kg

CR (solar radiation pressure coefficient): 1.22

ANNEX B:
PROPOSED SATELLITE POINTS OF COMMUNICATION FOR MELCO ESAA TERMINALS

ANNEX B-1: Galaxy 16

A. Galaxy 16 Coverage Map

Figure 2: Galaxy 16 at North America Beam

B. Galaxy 16 Link Budget

Forward Link Budget

eXConnect Terminal		
Antenna Type	MELCO	
Lat	26.4	deg
Lon	-82.3	deg
EIRP max	47.2	dBW
G/T	9.3	dB/K
Satellite		
Name	G-16	
Longitude	-99.0	deg
Hub Earth Station		
Site	Brewster	
Lat	33.663	deg
Lon	-84.226	deg
EIRP max	80.1	dBW
G/T	33.4	dB/K
Signal		
Waveform	DVB-S2	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.60	
Overhead Rate	0.94	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	1.13	bps/Hz
Data Rate	3.38E+07	bps
Information Rate (Data + Overhead)	3.60E+07	bps
Symbol Rate	3.00E+07	Hz
Chip Rate (Noise Bandwidth)	3.00E+07	Hz
Occupied Bandwidth	3.60E+07	Hz
Power Equivelent Bandwidth	3.60E+07	Hz
C/N Threshold	2.7	dB
Uplink		
Frequency	14.380	GHz
Back off	3.6	dB
EIRP Spectral Density	37.7	dBW/4kHz
Slant Range	37229	km
Space Loss, Ls	207.0	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	4.0	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	4.9	dB/K
Thermal Noise, C/No	99.0	dBHz
C/(No+Io)	98.5	dBHz
Satellite		
Flux Density	-89.9	dBW/m2
SFD @ Hub	-86.9	dBW/m2
Small Signal Gain (IBO/OBO)	2.0	dB
OBO	1.0	dB
Downlink		
Frequency	12.080	GHz
Transponder Sat. EIRP @ Beam Peak	52.3	dBW
Transponder Sat. EIRP @ Terminal	51.3	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	12.5	dBW/4kHz
Carrier EIRP @ Beam Peak	51.3	dBW
Carrier EIRP @ Terminal	50.3	dBW
Slant Range	36845	km
Space Loss, Ls	205.4	dB
Pointing Loss, Lpnt	0.3	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	82.5	dBHz
C/(No+Io)	79.3	dBHz
End to End		
End to End C/(No+Io)	79.2	dBHz
Implementation Loss	1.0	dB
End to End C/N w/ Imp Loss	3.5	dB
Link Margin	0.8	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	MELCO	
Lat	26.4	deg
Lon	-82.3	deg
EIRP max	47.2	dBW
G/T	9.3	dB/K
Satellite		
Name	G-16	
Longitude	-99.0	deg
Hub Earth Station		
Site	Brewster	
Lat	33.663	deg
Lon	-84.226	deg
EIRP max	80.1	dBW
G/T	33.4	dB/K
Signal		
Waveform	iDirect	
Modulation	BPSK	
Bits per symbol	1	
Spread Factor	4	
Coding Rate	0.67	
Overhead Rate	0.72	
Channel Spacing	1.20	
Spectral Efficiency (Rate/Noise BW)	0.12	bps/Hz
Data Rate	8.05E+05	bps
Information Rate (Data + Overhead)	1.11E+06	bps
Symbol Rate	1.67E+06	Hz
Chip Rate (Noise Bandwidth)	6.67E+06	Hz
Occupied Bandwidth	8.00E+06	Hz
Power Equivelent Bandwidth	6.56E+04	Hz
C/N Threshold	-4.2	dB
Uplink		
Frequency	14.340	GHz
Back off	6.9	dB
EIRP Spectral Density	8.1	dBW/4kHz
Slant Range	36845	km
Space Loss, Ls	206.9	dB
Pointing Loss, Lpnt	0.4	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.0	dB
Transponder G/T @ Terminal	4.9	dB/K
Thermal Noise, C/No	66.5	dBHz
C/(No+Io)	66.0	dBHz
Satellite		
Flux Density	-122.4	dBW/m2
SFD @ Terminal	-89.0	dBW/m2
Small Signal Gain (IBO/OBO)	2.5	dB
OBO	30.9	dB
Downlink		
Frequency	12.040	GHz
Transponder Sat. EIRP @ Beam Peak	52.3	dBW
Transponder Sat. EIRP @ Hub	51.3	dBW
DL PSD Limit	13.0	dBW/4kHz
DL PSD @ Beam Peak	-10.8	dBW/4kHz
Carrier EIRP @ Beam Peak	21.4	dBW
Carrier EIRP @ Hub	20.4	dBW
Slant Range	37229	km
Space Loss, Ls	205.5	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	4.3	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	72.6	dBHz
C/(No+Io)	72.1071	dBHz
End to End		
End to End C/(No+Io)	65.1	dBHz
Implementation Loss	0.0	dB
End to End C/N w/ Imp Loss	-3.2	dB
Link Margin	1.0	dB

C. Galaxy 16 Coordination Letter

27th March 2015

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

Re: Engineering Certification of Intelsat

To Whom It May Concern:

This letter certifies that Intelsat is aware that Panasonic Avionics Corporation ("Panasonic") is planning to seek a modification to its blanket authorization from the Federal Communications Commission ("FCC") to operate technically identical Ku-band transmit/receive earth stations aboard aircraft ("ESAAs"), Call Sign E100089, with the Galaxy 16 satellite at 99°W. Intelsat understands that Panasonic will file the modification pursuant to the FCC rules governing ESAA operations, including Section 25.227.

Intelsat certifies that the proposed operation of the ESAA transmit/receive terminals at the power density levels proposed is consistent with existing operator-to-operator coordination agreements with all adjacent satellite operators within +/- 6 degrees of orbital separation from Galaxy 16. Intelsat also acknowledges that the proposed operation of the Panasonic ESAA terminal has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable. If the FCC authorizes the operations proposed by Panasonic, Intelsat will include the power density levels specified by Panasonic in all future satellite network coordinations with other adjacent satellite operators.

Sincerely,

Alan Yates
Senior Technical Advisor, Spectrum Strategy
Intelsat

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