TECHNICAL APPENDIX

Modification Application (Call Sign E100089)
Panasonic Avionics Corporation

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I. Express AM-5 Technical Supplement

1. Scope

This Attachment contains additional information regarding the EXPRESS-AM5 satellite required by Section 25.114 and other sections of the Part 25 rules that cannot be entered into the Schedule S online submission system.

2. General Description (Section 25.114(d)(1))

The EXPRESS-AM5 satellite is currently operating at the 140° E.L. orbital location. It was launched on December 26, 2013 and initiated commercial service on April 22, 2014. The EXPRESS-AM5 satellite provides a range of FSS services in the Ku-band over eastern Russian, Japan, and southeast Asia. The EXPRESS-AM5 satellite also operates in L, C and Ka-bands, but these additional bands are not the focus of this filing.

The EXPRESS-AM5 satellite employs 40 Ku-band transponders using both linear polarizations thereby providing dual-frequency reuse. The satellite employs two (2) fixed Ku-band beams and two (2) steerable Ku-band beams.

3. Spacecraft Overview

EXPRESS-AM5 was manufactured and supplied by JSC Information Satellite Systems ("ISS") together with Research Institute of Radio and Corporation MDA (Canada) and is based on the Express-2000 bus platform. The satellite is 3-axis stabilized and uses thermocatalytic engines for spacecraft orientation (hydrazine propellant) and plasma thrusters for correction of the spacecraft orbit (xenon propellant).

The EXPRESS-AM5 offers the following characteristics:

- 15-year operational life
- 3-axis stabilized
- 30 C-band transponders
- 40 Ku-band transponders
- 12 Ka-band transponders
- 2 L-band transponders
- 3400 kg satellite, 1030kg payload
- 14.2 kW total power, 12.7kW payload power

The spacecraft will operate in the Ku-band frequencies listed below:

Ku-band	Uplink	13.0 -13.25 GHz
		13.75 – 14.0 GHz
		14.0 – 14.5 GHz
	Downlink	10.95 – 11.20 GHz
		11.2 – 11.45 GHz
		11.45 – 11.7 GHz
		12.5 – 12.75 GHz

The Appendix 30B Ku-bands (13.0-13.25 GHz uplink and 11.2-11.45 GHz downlink) will not be employed for mobility services and are therefore not the focus of this filing.
The spacecraft provides the following Ku-band coverage (illustrations of the beam coverage areas is provided in Exhibit 2):

Ku-band	F1 (fixed 1)	Central/Eastern Russia, Mongolia, NE China, Japan
	F2 (fixed 2)	Eastern Russia, NE China, N. Japan
	S1 (steerable)	SE Asia, Eastern Russia

4. Telemetry, Tracking and Control (TT&C)

The EXPRESS-AM5 TT&C sub-system provides for communications during on-station operations, as well as during spacecraft emergencies. C-band telecommand transmissions are received and C-band telemetry communications are transmitted by the spacecraft through a horn antenna during on-station operations and through a near omni-directional antenna during both transfer orbit and emergency operations.

TT&C communication channels have been selected at the edge of the assigned C-band per Section 25.202(g). EXPRESS-AM5 utilizes one C-band telemetry channel and one C-band commanding channel. The C-band telemetry channel center frequency is 3405 MHz. The C-band commanding channel center frequency is 5746 MHz. TT&C operations will be conducted from the Zheleznogorsk and Khabarovsk Satellite Control Centers.

The TT&C beams used for orbital maneuvers and on-station emergencies have gain contours that vary by less than 8 dB across the surface of the Earth, and accordingly the gain at 8 dB below the peak falls beyond the edge of the Earth. Therefore, pursuant to Section 25.114(c)(4)(vi)(A) of the Commission's rules, contours for these beams are not required to be provided and the associated GXT files have not been included in Schedule S.

Contact details for the control stations are provided below:
EXPRESS-AM5 TT&C station 1:
Zheleznogorsk Satellite Control Centers
Krasnoyarskaya Ulitsa, 4a
Zheleznogorsk
Krasnoyarskiy kray, Russia, 662971
+7 391 973 35 14
56°14'59.81"N 93°30'55.16"E

EXPRESS-AM5 TT&C station 2:
Khabarovsk Satellite Control Centers
Doroga Na Rovnoye,
Khabarovskiy kray, Russia, 680517
+7 421 246 49 39
48°28'19.9"N 135°21'14.7"E

Satellite control center contacts and telephone numbers:

EXPRESS-AM5 Head of the Satellite Control Center: Sergey Fedonin
Phone: fixed: / mobile: +7 495 730 24 71
24/7 hours number(s): +7 495 730 24 68

EXPRESS-AM5 Head of the Satellite Communications Control Center: Mikhail Vaskovsky
Phone: +7 499 764 54 10

5. Uplink Power Control

EXPRESS-AM5 utilizes one Ku-band ULPC channel. The Ku-band ULPC channel center frequency is 11199.5 Mhz. The coverage patterns of the Ku-band ULPC beam has gain contours that vary by less than 8 dB across the surface of the Earth, and accordingly the gain at 8 dB below the peak falls beyond the edge of the Earth. Therefore, pursuant to Section 25.114(c)(4)(vi)(A) of the Rules, contours for these beams are not required to be provided and the associated GXT files have not been included in Schedule S. The Ku-band beacon has a bandwidth of 4 kHz

6. Frequency Plan

5.1 Ku-Band

The following tables list the uplink and downlink Ku-band channel planned for EXPRESS-AM5. This information is also provided in the accompanying Schedule S but is included here for completeness.

Table 1 Ku-Band Downlink Frequency Plan

Channel ID	Bandwidth (kHz)	Center Frequency (MHz)	Polarization
DA1	54000	12531.75	H
DA2	54000	12531.75	V
DA3	54000	12594.25	H
DA4	54000	12594.25	V
DA5	54000	12656.75	H
DA6	54000	12656.75	V
DA7	54000	12719.25	H
DA8	54000	12719.25	V
DB1	54000	10981.25	H
DB2	54000	10981.25	V
DB3	54000	11043.75	H
DB4	54000	11043.75	V
DB5	54000	11106.25	H
DB6	54000	11106.25	V
DB7	54000	11168.75	H
DB8	54000	11168.75	V
DD1	54000	11481.25	H
DD2	54000	11481.25	V
DD3	54000	11543.75	H
DD4	54000	11543.75	V
DD5	54000	11606.25	H
DD6	54000	11606.25	V
DD7	54000	11668.75	H
DD8	54000	11668.75	V
DF1	36000	11220.5	H
DF2	36000	11220.5	V
DF3	36000	11262.2	H
DF4	36000	11262.2	V
DF5	36000	11303.9	H
DF6	36000	11303.9	V
DF7	36000	11345.6	H
DF8	36000	11345.6	V
DF9	36000	11387.3	H
DF10	36000	11387.3	V
DF11	36000	11429	H
DF12	36000	11429	V
TT1	300	3405	R
B1	4	11199.5	R

Table 2 Ku-Band Uplink Frequency Plan

Channel ID	Bandwidth (kHz)	Center Frequency (MHz)	Polarization
UA1	54000	13781.25	V
UA2	54000	13781.25	H
UA3	54000	13843.75	V
UA4	54000	13843.75	H
UA5	54000	13906.25	V
UA6	54000	13906.25	H
UA7	54000	13968.75	V
UA8	54000	13968.75	H
UB1	54000	14281.25	V
UB2	54000	14281.25	H
UB3	54000	14343.75	V
UB4	54000	14343.75	H
UB5	54000	14406.25	V
UB6	54000	14406.25	H
UB7	54000	14468.75	V
UB8	54000	14468.75	H
UD1	54000	14031.25	V
UD2	54000	14031.25	H
UD3	54000	14093.75	V
UD4	54000	14093.75	H
UD5	54000	14156.25	V
UD6	54000	14156.25	H
UD7	54000	14218.75	V
UD8	54000	14218.75	H
UF1	36000	13020.5	V
UF2	36000	13020.5	H
UF3	36000	13062.2	V
UF4	36000	13062.2	H
UF5	36000	13103.9	V
UF6	36000	13103.9	H
UF7	36000	13145.6	V
UF8	36000	13145.6	H
UF9	36000	13187.3	V
UF10	36000	13187.3	H
UF11	36000	13229	V
UF12	36000	13229	H
TC1	1000	5746	L

7. Frequency Tolerance

The frequency tolerance requirements of Section 25.202(e) that the carrier frequency of each space station transmitter be maintained within 0.002% of the reference frequency will be met.

8. Out of Band Emissions

The out-of-band emission limits of Section 25.202(f)(1), (2) and (3) will be met.

9. Frequency Reuse

EXPRESS-AM5 employs full frequency reuse on the Ku-band uplink and downlink by employing dual orthogonal linear polarization and frequency reuse across multiple regional and spot beams.

10. Cessation of Emissions

All downlink transmissions can be turned on and off by ground telecommand, thereby causing cessation of emissions from the satellite, as required by Section 25.207 of the FCC's rules.

11. ITU Filings

The EXPRESS-AM5 satellite is operating in Ku-band based on the requirements for the EXPRESS-10 and EXPRESS-10B (140 E) ITU filings.
ITU Coordination of the EXPRESS-10 and EXPRESS-10B (140 E) networks with the satellite networks of the USA has been completed.

12. PFD Analysis

The power flux density ("PFD") limits for space stations operating in the 10950–11200 MHz and 11450–11700 MHz are specified in Section 25.208 of the Commission's rules. The Commission's rules do not specify a PFD limit in the 11200-11450 and 12500–12750 MHz band; however, there are PFD limits specified in rule No. 21.16 of the International Telecommunication Union ("ITU") Radio Regulations. The maximum PFD levels for the EXPRESS-AM5 transmissions were calculated for the bands 10950–11200 MHz, 11200-11450, 11450–11700 MHz and 12500-12750 MHz. The results are provided in Schedule S and show that the downlink power flux density levels of the EXPRESS-AM5 carriers do not exceed the limits specified in Sections 25.208 of the Commission's rules, and those in rule No. 21.16 of the ITU Radio Regulations, as applicable.

13. Link Budgets

Link analysis for EXPRESS-AM5 was conducted for representative carriers in the Ku-band F1 regional fixed beam, communicating with both the eXConnect SPA and DPA ESAA terminals. For each of these links, the operating parameters of neighboring satellites out to 10° off-axis (i.e.

four satellites on each side of the orbital slot) was considered. The results of the link analysis are shown in Exhibit 1.

14. Interference Analysis

The proposed operations of the ESAA transmit/receive terminals, represented by the link budgets in Exhibit 1, have been evaluated by RSCC and determined to be consistent with existing operator-to-operator coordination agreements with all adjacent satellite operators within ±6° of orbital separation from EXPRESS-AM5.

EXHIBIT 1: EXPRESS AM-5 LINK BUDGETS

SPA eXConnect Terminal

Forward Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	50.9	deg
Lon	134.0	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	AM5	
Longitude	140.0	deg
Hub Earth Station		
Site	Khabarovsk	
Lat	48.565	deg
Lon	135.065	deg
EIRP max	80.0	dBW
G/T	36.0	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	16APSK	
Bits per symbol	4	
Spread Factor	1	
Coding Rate	0.56	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	2.00	bps/Hz
Data Rate	1.03E+08	bps
Information Rate (Data + Overhead)	1.14E+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	6.6	dB
Uplink		
Frequency	14.380	GHz
Back off	7.0	dB
EIRP Spectral Density	31.9	dBW/4kHz
Slant Range	38265	km
Space Loss, Ls	207.3	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.8	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	7.9	dB/K
Thermal Noise, C/No	99.4	dBHz
C/(No+Io)	98.9	dBHz
Satellite		
Flux Density	-92.5	dBW/m2
SFD @ Hub	-89.9	dBW/m2
Small Signal Gain (IBO/OBO)	1.6	dB
OBO	1.0	dB
Downlink		
Frequency	11.106	GHz
Transponder Sat. EIRP @ Beam Peak	53.4	dBW
Transponder Sat. EIRP @ Terminal	52.4	dBW
DL PSD Limit	16.0	dBW/4kHz
DL PSD @ Beam Peak	11.3	dBW/4kHz
Carrier EIRP @ Beam Peak	52.4	dBW
Carrier EIRP @ Terminal	51.4	dBW
Slant Range	38494	km
Space Loss, Ls	205.1	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	85.8	dBHz
C/(No+Io)	85.5	dBHz
End to End		
End to End C/(No+Io)	85.3	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	6.7	dB
Link Margin	0.0	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	50.9	deg
Lon	134.0	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	AM5	
Longitude	140.0	deg
Hub Earth Station		
Site	Khabarovsk	
Lat	48.565	deg
Lon	135.065	deg
EIRP max	80.0	dBW
G/T	36.0	dB/K
Signal		
Waveform	MxDMA	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.55	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	0.99	bps/Hz
Data Rate	7.54E+06	bps
Information Rate (Data + Overhead)	8.38E+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	1.90E+06	Hz
C/N Threshold	2.2	dB
Uplink		
Frequency	14.406	GHz
Back off	0.0	dB
EIRP Spectral Density	12.2	dBW/4kHz
Slant Range	38494	km
Space Loss, Ls	207.3	dB
Pointing Loss, Lpnt	0.2	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	7.9	dB/K
Thermal Noise, C/No	73.5	dBHz
C/(No+Io)	73.0	dBHz
Satellite		
Flux Density	-118.4	dBW/m2
SFD @ Terminal	-97.9	dBW/m2
Small Signal Gain (IBO/OBO)	1.6	dB
OBO	18.9	dB
Downlink		
Frequency	11.660	GHz
Transponder Sat. EIRP @ Beam Peak	53.4	dBW
Transponder Sat. EIRP @ Hub	52.4	dBW
DL PSD Limit	16.0	dBW/4kHz
DL PSD @ Beam Peak	1.7	dBW/4kHz
Carrier EIRP @ Beam Peak	34.5	dBW
Carrier EIRP @ Hub	33.5	dBW
Slant Range	38265	km
Space Loss, Ls	205.4	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	3.8	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	88.8	dBHz
C/(No+Io)	85.5555	dBHz
End to End		
End to End C/(No+Io)	72.7	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	2.4	dB
Link Margin	0.2	dB

DPA eXConnect Terminal

Forward Link Budget

eXConnect Terminal		
Antenna Type	DPA	
Lat	50.9	deg
Lon	134.0	deg
EIRP max	46.2	dBW
G/T	10.2	dB/K
Satellite		
Name	AM5	
Longitude	140.0	deg
Hub Earth Station		
Site	Khabarovsk	
Lat	48.565	deg
Lon	135.065	deg
EIRP max	80.0	dBW
G/T	36.0	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	8PSK	
Bits per symbol	3	
Spread Factor	1	
Coding Rate	0.60	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	1.62	bps/Hz
Data Rate	8.33E+07	bps
Information Rate (Data + Overhead)	9.26E+07	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	5.3	dB
Uplink		
Frequency	14.380	GHz
Back off	7.0	dB
EIRP Spectral Density	31.9	dBW/4kHz
Slant Range	38265	km
Space Loss, Ls	207.3	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.8	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	7.9	dB/K
Thermal Noise, C/No	99.4	dBHz
C/(No+Io)	98.9	dBHz
Satellite		
Flux Density	-92.5	dBW/m2
SFD @ Hub	-89.9	dBW/m2
Small Signal Gain (IBO/OBO)	1.6	dB
OBO	1.0	dB
Downlink		
Frequency	11.106	GHz
Transponder Sat. EIRP @ Beam Peak	53.4	dBW
Transponder Sat. EIRP @ Terminal	52.4	dBW
DL PSD Limit	16.0	dBW/4kHz
DL PSD @ Beam Peak	11.3	dBW/4kHz
Carrier EIRP @ Beam Peak	52.4	dBW
Carrier EIRP @ Terminal	51.4	dBW
Slant Range	38494	km
Space Loss, Ls	205.1	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)	84.5	dBHz
End to End		
End to End C/(No+Io)	84.3	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	5.7	dB
Link Margin	0.4	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	DPA	
Lat	50.9	deg
Lon	134.0	deg
EIRP max	46.2	dBW
G/T	10.2	dB/K
Satellite		
Name	AM5	
Longitude	140.0	deg
Hub Earth Station		
Site	Khabarovsk	
Lat	48.565	deg
Lon	135.065	deg
EIRP max	80.0	dBW
G/T	36.0	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	8.91E+06	bps
Information Rate (Data + Overhead)	9.90E+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	2.54E+06	Hz
C/N Threshold	3.5	dB
Uplink		
Frequency	14.406	GHz
Back off	0.0	dB
EIRP Spectral Density	13.4	dBW/4kHz
Slant Range	38494	km
Space Loss, Ls	207.3	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	7.9	dB/K
Thermal Noise, C/No	74.7	dBHz
C/(No+Io)	74.2	dBHz
Satellite		
Flux Density	-117.1	dBW/m2
SFD @ Terminal	-97.9	dBW/m2
Small Signal Gain (IBO/OBO)	1.6	dB
OBO	17.6	dB
Downlink		
Frequency	11.660	GHz
Transponder Sat. EIRP @ Beam Peak	53.4	dBW
Transponder Sat. EIRP @ Hub	52.4	dBW
DL PSD Limit	16.0	dBW/4kHz
DL PSD @ Beam Peak	2.9	dBW/4kHz
Carrier EIRP @ Beam Peak	35.8	dBW
Carrier EIRP @ Hub	34.8	dBW
Slant Range	38265	km
Space Loss, Ls	205.4	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	3.8	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	90.1	dBHz
C/(No+Io)	86.8088	dBHz
End to End		
End to End C/(No+Io)	74.0	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	3.7	dB
Link Margin	0.2	dB

EXHIBIT 2: SERVICE AREAS

This document illustrates the service areas for the uplink and downlink beams in the accompanying Schedule S.

F1

The F1 service area includes the majority central and eastern Russia plus some east Asia and is illustrated in Figure 1.
It reflects the service area for:

Uplink beams: F1H3 and F1V3
Downlink beams: F1H5, F1H7, F1V5 and F1V7

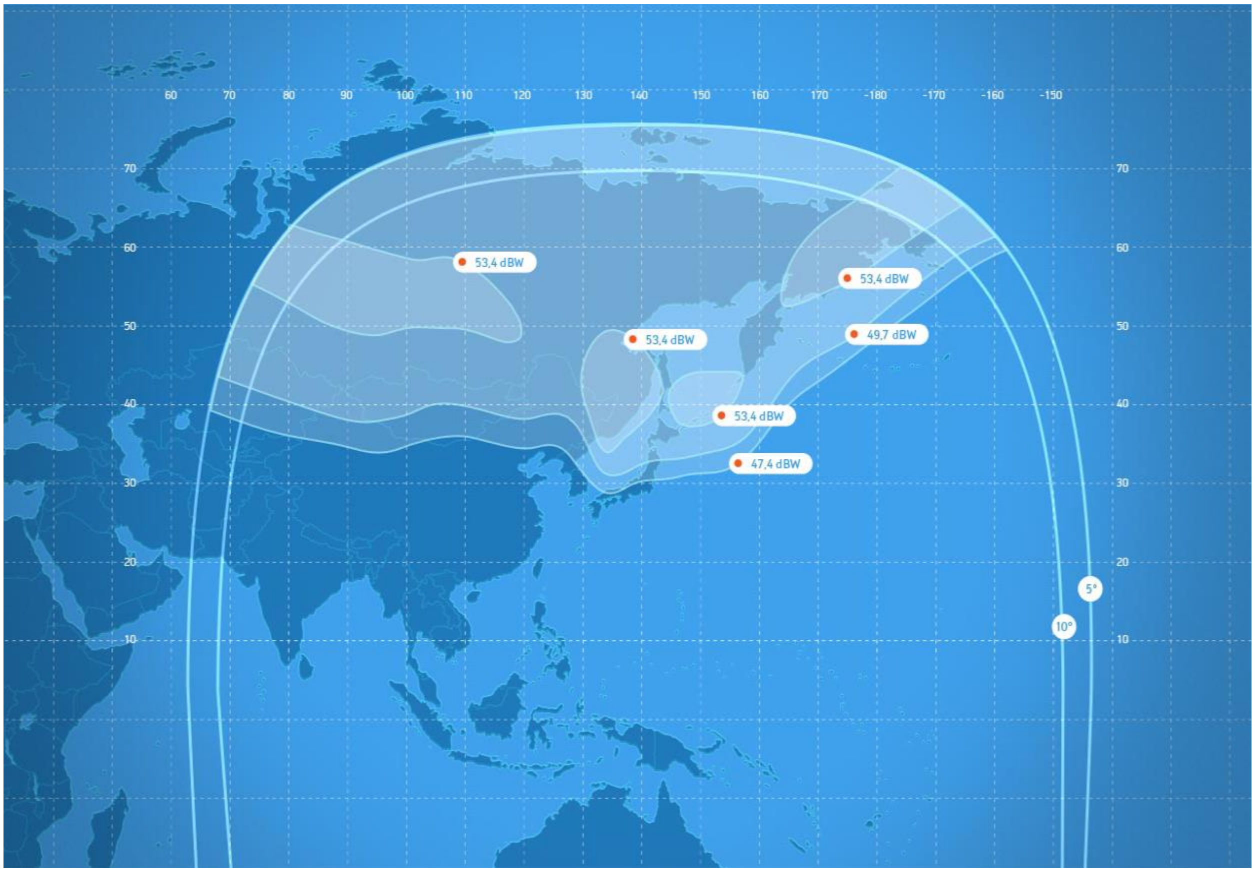

Figure 1 F1 Coverage of EXPRESS-AM5

F2

The F2 service area includes eastern Russia and northern Japan and is illustrated in Figure 2. It reflects the service area for:

> Uplink beams: F2H1, F2H2, F2V1 and F2V2
> Downlink beams: F2H6, F2H8, F2V6 and F2V8

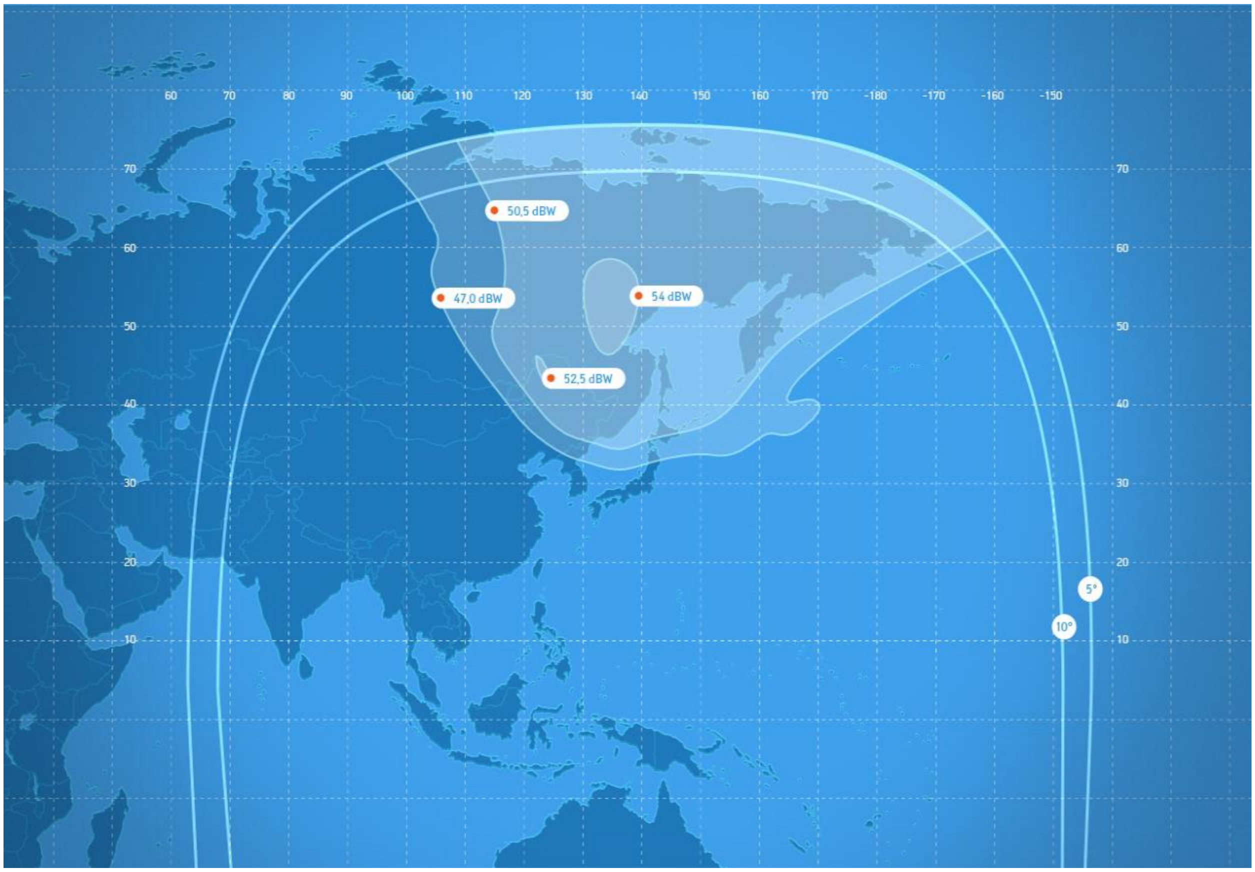

Figure 2 F2 Coverage of EXPRESS-AM5

S1

The S1 service area is a steerable spot beam. There are two spot beams which are currently directed towards southeast Asia and northern Siberia and are illustrated in Figure 3 and Figure 4Figure 2.

They reflect the service areas for:

Uplink beams: S1H2 and S1V2

Downlink beams: S1H8 and S1V8

Figure 3 S1 Coverage of EXPRESS-AM5 – Example #1

Figure 4 S1 Coverage of EXPRESS-AM5 – Example #2

EXHIBIT 3: OBRITAL DEBRIS MITIGATION PLAN

Russian Satellite Communications Company
Express AM 5 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 Express AM5 ("Express AM5") manufactured by JSC Information Satellite Systems ("ISS"), together with Research Institute of Radio and Corporation MDA (Canada) 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 Express AM5 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 Express AM5 in satisfaction of the Federal Communications Commission rules 47 C.F.R 25.114(d)(14) and 25.283(c).

2. General Information on Express AM5 Spacecraft

Express AM5 has been manufactured in compliance with applicable Russian standards and specifications and has a telecommunications payload manufactured by RSCC. 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). Express AM5 was launched in December 2014; the estimated active lifetime is 15 years.

3. Operation of Express AM5

All materials used on spacecraft Express AM5 are selected in compliance with GOST R 50109-92 and have minimum weight loss factors.

Operation of Express AM5 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 Express

AM5 Operations Control Center ("OCC"), which ensures security of the flight and prevents collisions with other spacecraft in orbit.

Express AM5 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

RSCC 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 Express AM5 is impossible.

RSCC 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

RSCC has reviewed failure modes for all equipment onboard Express AM5 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, RSCC 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

RSCC has assessed and limited the probability of the spacecraft becoming a source of debris by collisions with large debris or other operational spacecrafts. Express AM5 operates in a geostationary orbit at the orbital position 140° E in accordance with the filings to ITU and in accordance with all ITU legal standards. Express AM5 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 RSCC is minimized.

For the time being there is no other satellite working in this orbital position (140°).

RSCC will monitor scheduled launches to determine whether other satellites will be located in close proximity to Express AM5. If a new satellite is close to Express AM5, RSCC 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, Express AM5 will be removed from its geostationary orbit at 140° 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. Express AM5 De-Orbiting

RSCC 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 Express AM5 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.

4. After Express AM5 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.

APPENDIX

Express AM5 will be removed from its geostationary orbit at 140° 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 Express AM5 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 is based on delta-V and is defined by the Manufacturer.

II. Express AM-6 Technical Supplement

1. Scope

This Attachment contains additional information regarding the EXPRESS-AM6 satellite required by Section 25.114 and other sections of the Part 25 rules that cannot be entered into the Schedule S online submission system.

2. General Description (Section 25.114(d)(1))

The EXPRESS-AM6 satellite is currently operating at the 53° E.L. orbital location. It was launched on October 21, 2014 and initiated commercial service on April 22, 2015. The EXPRESS-AM6 satellite provides a range of FSS services in the Ku-band over eastern Russian, Japan, and southeast Asia. The EXPRESS-AM6 satellite also operates in L, C and Ka-bands, however, these additional bands are not the focus of this filing.

The EXPRESS-AM6 satellite employs 40 Ku-band transponders using both linear polarizations thereby providing dual-frequency reuse. The satellite employs two (2) fixed Ku-band beams and two (2) steerable Ku-band beams.

3. Spacecraft Overview

EXPRESS-AM6 was manufactured and supplied by JSC Information Satellite Systems (“ISS”) together with Research Institute of Radio and Corporation MDA (Canada) and is based on the Express-2000 bus platform. The satellite is 3-axis stabilized and uses thermocatalytic engines for spacecraft orientation (hydrazine propellant) and plasma thrusters for correction of the spacecraft orbit (xenon propellant).

The EXPRESS-AM6 offers the following characteristics:

- 15-year operational life
- 3-axis stabilized
- 14 C-band transponders
- 44 Ku-band transponders
- 12 Ka-band transponders
- 8 Ku/Ka-band transponders
- 2 L-band transponders
- 3358 kg satellite, 1100kg payload
- 14.0 kW total power, 12.1kW payload power

The spacecraft will operate in the Ku-band frequencies listed below:

Ku-band	Uplink	13.0 -13.25 GHz
		13.75 – 14.0 GHz
		14.0 – 14.5 GHz
	Downlink	10.95 – 11.20 GHz
		11.2 – 11.45 GHz
		11.45 – 11.7 GHz
		12.5 – 12.75 GHz

The Appendix 30B Ku-bands (13.0-13.25 GHz uplink and 11.2-11.45 GHz downlink) will not be employed for mobility services and are therefore not the focus of this filing.

The spacecraft provides the following Ku-band coverage (illustrations of the beam coverage areas is provided in Exhibit 2):

Ku-band	F1 (fixed 1)	Western Russia, Eastern Europe
	F2 (fixed 2)	Europe and Middle East
	S1 (steerable 1)	South Asia - Example
	S2 (steerable 2)	South Asia - Example

4. Telemetry, Tracking and Control (TT&C)

The EXPRESS-AM6 TT&C sub-system provides for communications during pre-launch, transfer orbit and on-station operations, as well as during spacecraft emergencies. C-band telecommand transmissions are received and C-band telemetry communications are transmitted by the spacecraft through a horn antenna during on-station operations and through a near omni-directional antenna during both transfer orbit and emergency operations.

TT&C communication channels have been selected at the edge of the assigned C-band per Section 25.202(g). EXPRESS-AM6 utilizes one C-band telemetry channel and one C-band commanding channel. The C-band telemetry channel center frequency is 3405 MHz. The C-band commanding channel center frequency is 5746 MHz. TT&C operations will be conducted from the Zheleznogorsk and Khabarovsk Satellite Control Centers.

The TT&C beams used for orbital maneuvers and on-station emergencies have gain contours that vary by less than 8 dB across the surface of the Earth, and accordingly the gain at 8 dB below the peak falls beyond the edge of the Earth. Therefore, pursuant to Section 25.114(c)(4)(vi)(A) of the Commission’s rules, contours for these beams are not required to be provided and the associated GXT files have not been included in Schedule S.

Contact details for the control stations are provided below:

EXPRESS-AM6 TT&C station 1:
Zheleznogorsk Satellite Control Centers
Krasnoyarskaya Ulitsa, 4a
Zheleznogorsk
Krasnoyarskiy kray, Russia, 662971
+7 391 973 35 14
56°14'59.81"N 93°30'55.16"E

EXPRESS-AM6 TT&C station 2:
Khabarovsk Satellite Control Centers
Doroga Na Rovnoye,
Khabarovskiy kray, Russia, 680517
+7 421 246 49 39
48°28'19.9"N 135°21'14.7"E

Satellite control center contacts and telephone numbers:

EXPRESS-AM6 Head of the Satellite Control Center: Sergey Fedonin
Phone: fixed: / mobile: +7 495 730 24 71
24/7 hours number(s): +7 495 730 24 68

EXPRESS-AM6 Head of the Satellite Communications Control Center: Mikhail Vaskovsky
Phone: +7 499 764 54 10

5. Uplink Power Control

EXPRESS-AM6 utilizes one Ku-band ULPC channel. The Ku-band ULPC channel center frequency is 11199.5 Mhz. The coverage patterns of the Ku-band ULPC beam has gain contours that vary by less than 8 dB across the surface of the Earth, and accordingly the gain at 8 dB below the peak falls beyond the edge of the Earth. Therefore, pursuant to Section 25.114(c)(4)(vi)(A) of the Rules, contours for these beams are not required to be provided and the associated GXT files have not been included in Schedule S. The Ku-band beacon has a bandwidth of 4 kHz

6. Frequency Plan

6.1 Ku-Band

The following tables list the uplink and downlink Ku-band channel planned for EXPRESS-AM6. This information is also provided in the accompanying Schedule S but is included here for completeness.

Table 3 Ku-Band Downlink Frequency Plan

Channel ID	Bandwidth (kHz)	Center Frequency (MHz)	Polarization
DA1	54000	12531.75	H
DA2	54000	12531.75	V
DA3	54000	12594.25	H
DA4	54000	12594.25	V
DA5	54000	12656.75	H
DA6	54000	12656.75	V
DA7	54000	12719.25	H
DA8	54000	12719.25	V
DB1	54000	10981.25	H
DB2	54000	10981.25	V
DB3	54000	11043.75	H
DB4	54000	11043.75	V
DB5	54000	11106.25	H
DB6	54000	11106.25	V
DB7	54000	11168.75	H
DB8	54000	11168.75	V
DD1	54000	11481.25	H
DD2	54000	11481.25	V
DD3	54000	11543.75	H
DD4	54000	11543.75	V
DD5	54000	11606.25	H
DD6	54000	11606.25	V
DD7	54000	11668.75	H
DD8	54000	11668.75	V
DF1	36000	11220.5	H
DF2	36000	11220.5	V
DF3	36000	11262.2	H
DF4	36000	11262.2	V
DF5	36000	11303.9	H
DF6	36000	11303.9	V
DF7	36000	11345.6	H
DF8	36000	11345.6	V
DF9	36000	11387.3	H
DF10	36000	11387.3	V
DF11	36000	11429	H
DF12	36000	11429	V
TT1	300	3405	R
B1	4	11199.5	R

Table 4 Ku-Band Uplink Frequency Plan

Channel ID	Bandwidth (kHz)	Center Frequency (MHz)	Polarization
UA1	54000	13781.25	V
UA2	54000	13781.25	H
UA3	54000	13843.75	V
UA4	54000	13843.75	H
UA5	54000	13906.25	V
UA6	54000	13906.25	H
UA7	54000	13968.75	V
UA8	54000	13968.75	H
UB1	54000	14281.25	V
UB2	54000	14281.25	H
UB3	54000	14343.75	V
UB4	54000	14343.75	H
UB5	54000	14406.25	V
UB6	54000	14406.25	H
UB7	54000	14468.75	V
UB8	54000	14468.75	H
UD1	54000	14031.25	V
UD2	54000	14031.25	H
UD3	54000	14093.75	V
UD4	54000	14093.75	H
UD5	54000	14156.25	V
UD6	54000	14156.25	H
UD7	54000	14218.75	V
UD8	54000	14218.75	H
UF1	36000	13020.5	V
UF2	36000	13020.5	H
UF3	36000	13062.2	V
UF4	36000	13062.2	H
UF5	36000	13103.9	V
UF6	36000	13103.9	H
UF7	36000	13145.6	V
UF8	36000	13145.6	H
UF9	36000	13187.3	V
UF10	36000	13187.3	H
UF11	36000	13229	V
UF12	36000	13229	H
TC1	1000	5746	L

7. Frequency Tolerance

The frequency tolerance requirements of Section 25.202(e) that the carrier frequency of each space station transmitter be maintained within 0.002% of the reference frequency will be met.

8. Out of Band Emissions

The out-of-band emission limits of Section 25.202(f)(1), (2) and (3) will be met.

9. Frequency Reuse

EXPRESS-AM6 employs full frequency reuse on the Ku-band uplink and downlink by employing dual orthogonal linear polarization and frequency reuse across multiple regional and spot beams.

10. Cessation of Emissions

All downlink transmissions can be turned on and off by ground telecommand, thereby causing cessation of emissions from the satellite, as required by Section 25.207 of the FCC's rules.

11. ITU Filings

The EXPRESS-AM6 satellite is operating in Ku-band based on the requirements for the EXPRESS-5 and EXPRESS-5B (53 E) ITU filings.

ITU Coordination of the EXPRESS-5 and EXPRESS-5B (53 E) networks with the satellite networks of the USA has been completed.

12. PFD Analysis

The power flux density ("PFD") limits for space stations operating in the 10950–11200 MHz and 11450–11700 MHz are specified in Section 25.208 of the Commission's rules. The Commission's rules do not specify a PFD limit in the 11200-11450 and 12500–12750 MHz band; however, there are PFD limits specified in rule No. 21.16 of the International Telecommunication Union ("ITU") Radio Regulations. The maximum PFD levels for the EXPRESS-AM6 transmissions were calculated for the bands 10950–11200 MHz, 11200-11450, 11450–11700 MHz and 12500-12750 MHz. The results are provided in Schedule S and show that the downlink power flux density levels of the EXPRESS-AM6 carriers do not exceed the limits specified in Sections 25.208 of the Commission's rules, and those in rule No. 21.16 of the ITU Radio Regulations, as applicable.

13. Link Budgets

Link analysis for EXPRESS-AM6 was conducted for representative carriers in the Ku-band F1 regional fixed beam, communicating with both the eXConnect SPA and DPA ESAA terminals. For each of these links, the operating parameters of neighboring satellites out to 10° off-axis (i.e. four satellites on each side of the orbital slot) was considered. The results of the link analysis are shown in Exhibit 1.

14. Interference Analysis

The proposed operations of the ESAA transmit/receive terminals, represented by the link budgets in Exhibit 1, have been evaluated by RSCC and determined to be consistent with existing operator-to-operator coordination agreements with all adjacent satellite operators within ±6° of orbital separation from EXPRESS-AM6.

EXHIBIT 1: EXPRESS-AM6 LINK BUDGETS

SPA eXConnect Terminal

Forward Link Budget

eXConnect Terminal		
Antenna Type	DPA	
Lat	49.9	deg
Lon	50.0	deg
EIRP max	46.3	dBW
G/T	10.2	dB/K
Satellite		
Name	AM6	
Longitude	53.0	deg
Hub Earth Station		
Site	Bear Lakes	
Lat	55.861	deg
Lon	37.961	deg
EIRP max	80.0	dBW
G/T	38.0	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	16APSK	
Bits per symbol	4	
Spread Factor	1	
Coding Rate	0.50	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	1.80	bps/Hz
Data Rate	9.26E+07	bps
Information Rate (Data + Overhead)	1.03E+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	5.7	dB
Uplink		
Frequency	14.380	GHz
Back off	4.9	dB
EIRP Spectral Density	34.0	dBW/4kHz
Slant Range	39080	km
Space Loss, Ls	207.4	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.4	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	9.3	dB/K
Thermal Noise, C/No	103.2	dBHz
C/(No+Io)	102.7	dBHz
Satellite		
Flux Density	-90.1	dBW/m2
SFD @ Hub	-87.3	dBW/m2
Small Signal Gain (IBO/OBO)	1.8	dB
OBO	1.0	dB
Downlink		
Frequency	11.106	GHz
Transponder Sat. EIRP @ Beam Peak	53.3	dBW
Transponder Sat. EIRP @ Terminal	52.3	dBW
DL PSD Limit	16.0	dBW/4kHz
DL PSD @ Beam Peak	11.2	dBW/4kHz
Carrier EIRP @ Beam Peak	52.3	dBW
Carrier EIRP @ Terminal	51.3	dBW
Slant Range	38381	km
Space Loss, Ls	205.0	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)	84.4	dBHz
End to End		
End to End C/(No+Io)	84.4	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	5.8	dB
Link Margin	0.0	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	DPA	
Lat	49.9	deg
Lon	50.0	deg
EIRP max	46.3	dBW
G/T	10.2	dB/K
Satellite		
Name	AM6	
Longitude	53.0	deg
Hub Earth Station		
Site	Bear Lakes	
Lat	55.861	deg
Lon	37.961	deg
EIRP max	80.0	dBW
G/T	38.0	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	9.60E+06	bps
Information Rate (Data + Overhead)	1.07E+07	bps
Symbol Rate	7.62E+06	Hz
Chip Rate (Noise Bandwidth)	7.62E+06	Hz
Occupied Bandwidth	8.00E+06	Hz
Power Equivalent Bandwidth	2.95E+06	Hz
C/N Threshold	4.1	dB
Uplink		
Frequency	14.406	GHz
Back off	0.0	dB
EIRP Spectral Density	13.5	dBW/4kHz
Slant Range	38381	km
Space Loss, Ls	207.3	dB
Pointing Loss, Lpnt	0.2	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	8.3	dB/K
Thermal Noise, C/No	75.3	dBHz
C/(No+Io)	74.8	dBHz
Satellite		
Flux Density	-117.1	dBW/m2
SFD @ Terminal	-98.3	dBW/m2
Small Signal Gain (IBO/OBO)	1.8	dB
OBO	16.9	dB
Downlink		
Frequency	11.106	GHz
Transponder Sat. EIRP @ Beam Peak	53.3	dBW
Transponder Sat. EIRP @ Hub	51.3	dBW
DL PSD Limit	16.0	dBW/4kHz
DL PSD @ Beam Peak	3.6	dBW/4kHz
Carrier EIRP @ Beam Peak	36.4	dBW
Carrier EIRP @ Hub	34.4	dBW
Slant Range	39080	km
Space Loss, Ls	205.2	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.8	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	93.0	dBHz
C/(No+Io)	88.5055	dBHz
End to End		
End to End C/(No+Io)	74.6	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	4.3	dB
Link Margin	0.1	dB

DPA eXConnect Terminal

Forward Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	49.9	deg
Lon	50.0	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	AM6	
Longitude	53.0	deg
Hub Earth Station		
Site	Bear Lakes	
Lat	55.861	deg
Lon	37.961	deg
EIRP max	80.0	dBW
G/T	38.0	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	16APSK	
Bits per symbol	4	
Spread Factor	1	
Coding Rate	0.56	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	2.00	bps/Hz
Data Rate	1.03E+08	bps
Information Rate (Data + Overhead)	1.14E+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	6.6	dB
Uplink		
Frequency	14.380	GHz
Back off	4.9	dB
EIRP Spectral Density	34.0	dBW/4kHz
Slant Range	39080	km
Space Loss, Ls	207.4	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.4	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	9.3	dB/K
Thermal Noise, C/No	103.2	dBHz
C/(No+Io)	102.7	dBHz
Satellite		
Flux Density	-90.1	dBW/m2
SFD @ Hub	-87.3	dBW/m2
Small Signal Gain (IBO/OBO)	1.8	dB
OBO	1.0	dB
Downlink		
Frequency	11.106	GHz
Transponder Sat. EIRP @ Beam Peak	53.3	dBW
Transponder Sat. EIRP @ Terminal	52.3	dBW
DL PSD Limit	16.0	dBW/4kHz
DL PSD @ Beam Peak	11.2	dBW/4kHz
Carrier EIRP @ Beam Peak	52.3	dBW
Carrier EIRP @ Terminal	51.3	dBW
Slant Range	38381	km
Space Loss, Ls	205.0	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	85.7	dBHz
C/(No+Io)	85.4	dBHz
End to End		
End to End C/(No+Io)	85.3	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	6.7	dB
Link Margin	0.1	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	49.9	deg
Lon	50.0	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	AM6	
Longitude	53.0	deg
Hub Earth Station		
Site	Bear Lakes	
Lat	55.861	deg
Lon	37.961	deg
EIRP max	80.0	dBW
G/T	38.0	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	8.23E+06	bps
Information Rate (Data + Overhead)	9.14E+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	2.19E+06	Hz
C/N Threshold	2.9	dB
Uplink		
Frequency	14.406	GHz
Back off	0.0	dB
EIRP Spectral Density	12.2	dBW/4kHz
Slant Range	38381	km
Space Loss, Ls	207.3	dB
Pointing Loss, Lpnt	0.2	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	8.3	dB/K
Thermal Noise, C/No	74.0	dBHz
C/(No+Io)	73.5	dBHz
Satellite		
Flux Density	-118.4	dBW/m2
SFD @ Terminal	-98.3	dBW/m2
Small Signal Gain (IBO/OBO)	1.8	dB
OBO	18.2	dB
Downlink		
Frequency	11.106	GHz
Transponder Sat. EIRP @ Beam Peak	53.3	dBW
Transponder Sat. EIRP @ Hub	51.3	dBW
DL PSD Limit	16.0	dBW/4kHz
DL PSD @ Beam Peak	2.3	dBW/4kHz
Carrier EIRP @ Beam Peak	35.1	dBW
Carrier EIRP @ Hub	33.1	dBW
Slant Range	39080	km
Space Loss, Ls	205.2	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.8	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	91.7	dBHz
C/(No+Io)	87.2083	dBHz
End to End		
End to End C/(No+Io)	73.3	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	3.0	dB
Link Margin	0.0	dB

EXHBIT 2: SERVICE AREAS

This document illustrates the service areas for the uplink and downlink beams in the accompanying Schedule S.

F1

The F1 service area includes eastern Europe and western/central Russia and is illustrated in Figure 1.
It reflects the service area for:

> Uplink beams: F1H2, F1H3, F1V2 and F1V3
> Downlink beams: F1H5, F1H7, F1H8, F1V5, F1V7 and F1V8

Figure 5 F1 Coverage of EXPRESS-AM6

F2

The F2 service area includes western Europe and the Middle East and is illustrated in Figure 2. It reflects the service area for:

Uplink beams: F2H1, F2H2, F2H3, F2V1, F2V2 and F2V3
Downlink beams: F2H5, F2H6, F2H7, F2H8, F2V5, F2V6, F2V7 and F2V8

Figure 6 F2 Coverage of EXPRESS-AM6

S1

The S1 service area is a steerable spot beam as illustrated in Figure 3Figure 2.
It reflects the service area for:

Uplink beams: S1H2, S1H3, S1V2 and S1V3
Downlink beams: S1H5, S1H7, S1H8, S1V5, S1V7 and S1V8

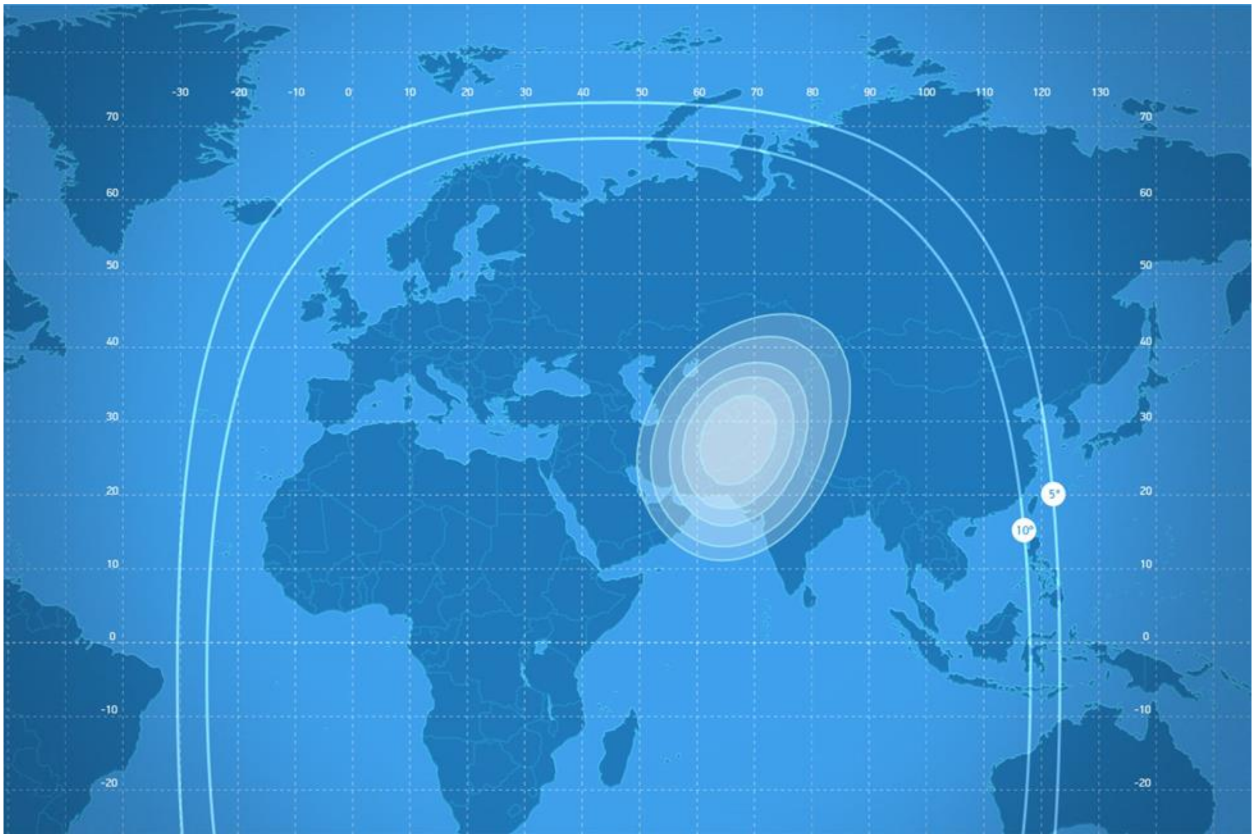

Figure 7 S1 Coverage of EXPRESS-AM6

S2

The S2 service area is a steerable spot beam as illustrated in Figure 4Figure 2.
It reflects the service area for:

Uplink beams: S2H2, S2H3, S2V2 and S2V3
Downlink beams: S2H5, S2H7, S2H8, S2V5, S2V7 and S2V8

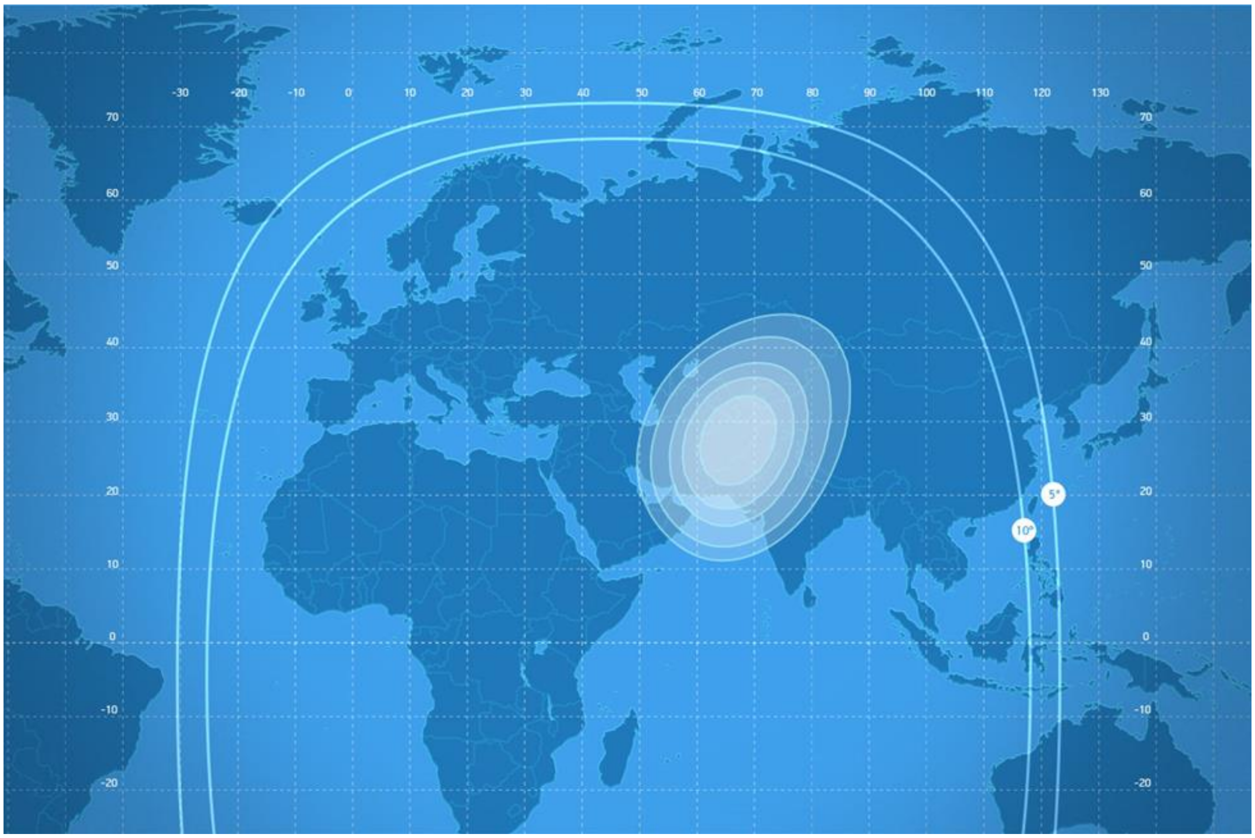

Figure 8 S2 Coverage of EXPRESS-AM6

EXHIBIT 3: OBRITAL DEBRIS MITIGATION PLAN

Russian Satellite Communications Company
Express AM 6 Spacecraft

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

5. Introduction

This Technical Reference and Orbital Debris Mitigation/End-of-Life Disposal Plan identifies the basic principles and operation of spacecraft Express AM6 ("Express AM6") manufactured by JSC Information Satellite Systems ("ISS"), together with Research Institute of Radio and Corporation MDA (Canada) 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 Express AM6 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 Express AM6 in satisfaction of the Federal Communications Commission rules 47 C.F.R 25.114(d)(14) and 25.283(c).

6. General Information on Express AM6 Spacecraft

Express AM6 has been manufactured in compliance with applicable Russian standards and specifications and has a telecommunications payload manufactured by RSCC. 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). Express AM6 was launched in December 2014; the estimated active lifetime is 15 years.

7. Operation of Express AM6

All materials used on spacecraft Express AM6 are selected in compliance with GOST R 50109-92 and have minimum weight loss factors.

Operation of Express AM6 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 Express

AM6 Operations Control Center ("OCC"), which ensures security of the flight and prevents collisions with other spacecraft in orbit.

Express AM6 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

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

RSCC 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 Express AM6 is impossible.

RSCC 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.

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

RSCC has reviewed failure modes for all equipment onboard Express AM6 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, RSCC 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.

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

RSCC has assessed and limited the probability of the spacecraft becoming a source of debris by collisions with large debris or other operational spacecrafts. Express AM6 operates in a geostationary orbit at the orbital position 53° E in accordance with the filings to ITU and in accordance with all ITU legal standards. Express AM6 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 RSCC is minimized.

For the time being there is no other satellite working in this orbital position (140°).

RSCC will monitor scheduled launches to determine whether other satellites will be located in close proximity to Express AM6. If a new satellite is close to Express AM6, RSCC will coordinate station keeping activities with the satellite operator to avoid any risk of collision.

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

At the scheduled completion of its mission, Express AM6 will be removed from its geostationary orbit at 53° 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.

8. Express AM6 De-Orbiting

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

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

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

8. 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 Express AM6 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.

9. After Express AM6 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.

10. 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.

APPENDIX

Express AM6 will be removed from its geostationary orbit at 140° 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 Express AM6 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 is based on delta-V and is defined by the Manufacturer.

III. Satellite Operator Certification Letters

Акционерное общество
«Газпром космические системы»
(АО «Газпром космические системы»)

а/я 1860, ОПС Щелково-12, Московская область,
Российская Федерация, 141112
тел.: +7 (495) 5042906, +7 (495) 5042907, факс: +7 (495) 5042911
e-mail: info@gazprom-spacesystems.ru, www.gazprom-spacesystems.ru

Joint stock company
«Gazprom Space Systems»
(Gazprom Space Systems JSC)

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

«16» 10 2017 г.

№ ИК-06/380/5213

Federal Communications Commission
International Bureau
445 12th Street, S.W.
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 located at 90° E.L.

GSS understands that Panasonic will file the modification application pursuant to the FCC rules governing ESAA operations to increase the maximum EIRP spectral density associated with ESAA emissions with the Yamal-401 satellite. GSS understands that this modification is related to a change in Panasonic's approach to ESAA uplink power limits that will enhance throughput and efficiency by considering ESAA skew angle and location in the beam to set maximum power levels for ESAA terminal uplink transmissions.

GSS understands the technical characteristics of the ESAA terminals, and GSS (i) recognizes that operation of these terminals at the power density levels provided to GSS is consistent with existing coordination agreements with all adjacent satellite operators within +/- 6 degrees of orbital separation from Yamal-401; (ii) acknowledges that the proposed operation of these terminals has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable; and (iii) if the FCC authorizes the operations proposed by Panasonic, GSS will take into consideration the power density levels associated such operations in all future satellite network coordinations with adjacent satellite operators.

Best regards,

Igor Kot,
Deputy Director General

ФЕДЕРАЛЬНОЕ АГЕНТСТВО СВЯЗИ
ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ УНИТАРНОЕ ПРЕДПРИЯТИЕ «КОСМИЧЕСКАЯ СВЯЗЬ» (ГП КС)
1-й Гончарный пер., д. 8, стр. 6, Москва, 115172
Тел. (495) 730 04 50, факс (495) 730 03 83
http://www.rscc.ru, e-mail: sco@rscc.ru
ОКПО 05472382, ОГРН 1027700418723
ИНН/КПП 7725027605 / 997750001

FEDERAL COMMUNICATIONS AGENCY
FEDERAL STATE UNITARY ENTERPRISE «RUSSIAN SATELLITE COMMUNICATIONS COMPANY» (RSCC)
8, bld. 6, 1st Goncharny per., Moscow, 115172, Russia
Tel. (495) 730 04 50, fax (495) 730 03 83
http://www.rscc.ru, e-mail: sco@rscc.ru

№ 16-04-15/190

January 17th, 2018

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20554

Re: Engineering Certification of Russian Satellite Communications Company

Dear Ms. Dortch:

Russian Satellite Communications Company ("RSCC") provides this letter in support of Panasonic Avionics Corporation's ("Panasonic") request for modification to its blanket authorization from the Federal Communications Commission ("FCC"), Call Sign E100089. Panasonic's planned license modification will seek to operate technically identical Ku-band transmit/receive earth stations aboard aircraft ("ESAA") with the Ekspress-AM5 satellite at 140.0° E.L. and Ekspress-AM6 satellite at 53.0° E.L. Panasonic seeks to operate its previously licensed ESAA terminals with these satellites for commercial purposes consistent with the FCC's Part 25 rules, including Section 25.227.

Specifically, Panasonic seeks to communicate with Ekspress-AM5 and Ekspress-AM6 pursuant with Section 25.227(a)(2) of the Commission's rules (i.e., at off-axis EIRP spectral density ("ESD") levels in excess of the Commission's ESD masks). The higher ESAA uplink power limits will enhance throughput and efficiency by considering ESAA skew angle and location in the beam to set maximum power levels for ESAA terminal uplink transmissions. Specifically, the ESAA terminals will transmit at a higher power at lower skew angles (resulting in narrower beam widths/greater off-axis discrimination) and at lower powers when at higher skew angles (resulting in wider beam widths/lower off-axis discrimination). Nonetheless, at all times Panasonic will operate consistent with the coordinated off-axis ESD levels of the serving satellites.

RSCC certifies that the proposed operation of the ESAA transmit/receive terminals at the power density levels provided by Panasonic to RSCC, adjusted as necessary to compensate for skew angles, is consistent with existing operator-to-operator coordination agreements with all adjacent satellite operators within+/- 6 degrees of orbital separation from the Ekspress-AM5 and Ekspress-AM6 satellites. RSCC also acknowledges that the proposed operation of the Panasonic ESAA terminals has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable. If the FCC authorizes the operations proposed by Panasonic, RSCC will include the power density levels specified by Panasonic and agreed by RSCC in all future satellite network co-ordinations with other adjacent satellite operators.

Sincerely,

Ksenia Drozdova

Deputy Director General
Business Development

№ 16-04-15/190 17.01.2018

17 января 2018 г.

Куда: Федеральная комиссия по связи

Касательно: техническая сертификация ГП КС

Уважаемый г-н Дорч!

Данным письмом ФГУП «Космическая связь» (ГП КС) сообщает, что знает о намерении компании Panasonic Avionics Corporation ("Panasonic") обратиться с запросом о внесении изменений в общее разрешение Федеральной комиссии связи («FCC") на работу с технически идентичными приемно-передаточными земными станциями Ku-диапазона на борту самолета ("ESAA") и КА «Экспресс-АМ5» (140 E) и «Экспресс-АМ6 (53 E). Panasonic намерен эксплуатировать терминалы ESAA, получившие лицензию согласно Части 25 FCC, включая Раздел 25.227.

В частности, Panasonic намерен использовать емкость КА «Экспресс-АМ5» (140 E) и «Экспресс-АМ6 (53 E) согласно Разделу 25.227 (a) (2) Правил FCC. ГП КС понимает, что Panasonic подает заявку на изменения согласно правилам FCC, которыми руководствуется при эксплуатации ESAA, в целях увеличения спектральной плотности ЭИИМ, связанной с излучениями ESAA и КА «Экспресс-АМ5» (140 E) и «Экспресс-АМ6 (53 E). ГП КС понимает, что данное изменение относится к изменившемуся подходу Panasonic к ограничениям мощности по линии вверх, что усилит производительность и эффективность с учетом угла и положения в луче для установки максимальных уровней мощности для передатчиков ESAA по линии вверх. При этом плотность ЭИИМ будет в пределах установленных ограничений по отношению к противоположной поляризации и соседним спутникам на геостационарной орбите.

На основе информации, полученной от Panasonic ГП КС знает технические характеристики терминалов ESAA и (i) понимает, что работа этих терминалов на уровнях плотности мощности согласуется с соглашением по координации со всеми соседними спутниками в пределах +/- 6 градусов от орбиты КА «Экспресс-АМ5» (140 E) и «Экспресс-АМ6 (53 E) и (ii) признает, что предлагаемая эксплуатация этих терминалов может пострадать от вредных помех от сетей соседних спутников, и (iii) если FCC разрешит операции, предлагаемые Panasonic, то ГП КС будет иметь ввиду уровни плотности мощности, связанные с такими операциями, в будущей координации с соседними операторами спутниковых сетей связи.

С уважением,

К.Ю. Дроздова

Зам. генерального директора

APSTAR
by APT Satellite

November 09, 2017

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

Re: Engineering Certification of APT Satellite Company Ltd.

To Whom It May Concern:

This letter certifies that APT Satellite Company Ltd. ("APT") 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 Apstar-6 satellite at 134° E.L and Apstar-7 satellite at 76.5° E.L.

APT understands that Panasonic will file the modification application pursuant to the FCC rules governing ESAA operations to increase the maximum EIRP spectral density associated with ESAA emissions with the Apstar-6 and Apstar-7 satellites. APT understands that this modification is related to a change in Panasonic's approach to ESAA uplink power limits that will enhance throughput and efficiency by considering ESAA skew angle and location in the beam to set maximum power levels for ESAA terminal uplink transmissions.

APT 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 the Apstar-6 and Apstar-7 satellites. APT also acknowledges that the proposed operation of the Panasonic ESAA terminals has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable. If the FCC authorizes the operations proposed by Panasonic, APT will include the power density levels specified by Panasonic in all future satellite network coordinations with other adjacent satellite operators.

Sincerely,

Zhang Shilin
Vice President
APT Satellite Company Limited

MD-A-17-017

October 23, 2017

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 Superbird-C2 satellite at 144° E.L.

JSAT understands that Panasonic will file the modification application pursuant to the FCC rules governing ESAA operations to increase the maximum EIRP spectral density associated with ESAA emissions with the Superbird-C2 satellite. JSAT understands that this modification is related to a change in Panasonic's approach to ESAA uplink power limits that will enhance throughput and efficiency by considering ESAA skew angle and location in the beam to set maximum power levels for ESAA terminal uplink transmissions.

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 coordination agreements with all adjacent satellite operators within +/- 6 degrees of orbital separation from the Superbird-C2 satellite. JSAT also acknowledges that the proposed operation of the Panasonic ESAA terminals 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 take into consideration the power density levels specified by Panasonic in all future satellite network coordinations with other adjacent satellite operators.

Sincerely,

Y. Moriai

Yutaka Moriai
General Manager
Mobile Business Division
SKY Perfect JSAT Corporation

1601 Telesat Court
Ottawa, ON, Canada K1B 5P4

10 October 2017

Federal Communications Commission
International Bureau, 445 12th Street SW
Washington, DC 20554

Re: Engineering Certification of Telesat

To Whom It May Concern:

This letter certifies that Telesat 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 ("ESAA"), Call Sign E100089, with Telstar 11N at 37.5° W.L., Telstar 12V at 15° W.L., Telstar 14R at 63° W.L., and Anik G1 at 107.3° W.L. Specifically, Telesat understands that in addition to the Panasonic Phased Array ("PPA") and Single Panel Antenna ("SPA") Ku-band antenna systems, Panasonic seeks to operate the previously licensed TECOM Ku-Stream 1000 ("TECOM") antenna system with these satellites for commercial purposes consistent with the FCC's Part 25 rules, including Section 25.227.

Telesat understands that Panasonic will file the modification application pursuant to the FCC rules governing ESAA operations to increase the maximum EIRP spectral density associated with ESAA emissions toward the Telstar 11N, Telstar 12V, Telstar 14R, and Anik G1 satellites. Telesat understands that this modification is related to a change in Panasonic's approach to ESAA uplink power levels that will enhance throughput and efficiency by considering ESAA skew angle and location in the beam to set maximum power levels for ESAA terminal uplink transmissions, while maintaining compliance with the FCC's Part 25 rules, including Section 25.227.

Telesat certifies that the proposed operation of the above-mentioned Panasonic transmit/receive ESAA terminals at the power density levels provided to Telesat is consistent with the existing operator-to-operator coordination agreements with all adjacent satellite operators within +/- 6 degrees of orbital separation from the Telstar 11N, Telstar 12V, Telstar 14R and Anik G1 satellites. Telesat also acknowledges that the proposed operation of the above-mentioned Panasonic ESAA terminals has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable. If the FCC authorizes the operations proposed by Panasonic, Telesat will include the power density levels specified by Panasonic in all future satellite network coordinations with other adjacent satellite operators.

Sincerely Yours,

BAHRAM BORNA
Senior Systems Engineer,
Telesat

eutelsat

December 13th, 2017

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

Re: Engineering Certification of Eutelsat Americas

To Whom It May Concern:

This letter certifies that Eutelsat Americas ("EAS") 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 Eutelsat 115WB (E115WB) satellite located at 114.9° W.L.

EAS understands that Panasonic will file the modification application pursuant to the FCC rules governing ESAA operations to increase the maximum EIRP spectral density associated with ESAA emissions with the E115WB satellite. EAS understands that this modification is related to a change in Panasonic's approach to ESAA uplink power limits that will enhance throughput and efficiency by considering ESAA skew angle and location in the beam to set maximum power levels for ESAA terminal uplink transmissions, while keeping EIRP Density within limits towards opposite polarization and towards neighbor satellites at geosynchronous arc.

Based on the information provided by Panasonic, EAS understands the technical characteristics of the ESAA terminals, and EAS (i) recognizes that operation of these terminals at the power density levels provided to EAS is consistent with existing coordination agreements with all adjacent satellite operators within +/- 6 degrees of orbital separation from E115WB; (ii) acknowledges that the proposed operation of these terminals has the potential to receive harmful interference from adjacent satellite networks that may be unacceptable; and (iii) if the FCC authorizes the operations proposed by Panasonic, EAS will take into consideration the power density levels associated such operations in all future satellite network coordinations with adjacent satellite operators.

Sincerely,

Hector Fortis
Eutelsat Americas
International and Regulatory Affairs

Eutelsat Americas |Av. Paseo de la Reforma No. 222 Pisos 20 y 21 | Col. Juárez CP 06600, Mexico, D.F. |

eutelsat

communications via satellite

September 25th, 2017

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

Re: Engineering Certification of Eutelsat S.A.

To Whom It May Concern:

This letter certifies that Eutelsat S.A. ("Eutelsat") 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 EUTELSAT 70B satellite at 70.5° E.L. and the EUTELSAT 172B satellite to be located at 172° E.L.

Eutelsat understands that Panasonic will file the modification application pursuant to FCC rules governing ESAA operations to increase the maximum EIRP spectral density associated with ESAA transmissions to the EUTELSAT 70B satellite, and to operate at higher maximum EIRP spectral density with the EUTELSAT 172B than with the existing EUTELSAT 172A satellite at 172° E.L. Eutelsat understands that this modification is related to a change in Panasonic's approach to ESAA uplink power limits that will enhance throughput and efficiency by considering ESAA skew angle and location in the beam to set maximum power levels for ESAA terminal uplink transmissions.

Eutelsat confirms and hereby certifies the following with respect to the terminal operations proposed by Panasonic:

a) The proposed Ku-band operation of Panasonic's ESAA terminal has the potential to create harmful interference to adjacent satellite networks that may be unacceptable;
b) The proposed operation of the transmit/receive terminals at the power density levels defined in the agreement between Panasonic and Eutelsat is consistent with existing satellite coordination agreements with all adjacent satellite operators within +/- 6 degrees of orbital separation from Eutelsat 70B and Eutelsat 172B satellites.

If the FCC authorizes the operation proposed by Panasonic, 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
Director of Resources Engineering

www.eutelsat.com

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INTELSAT.
Envision. Connect. Transform.

January 17, 2018

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20554

Re: Engineering Certification of Intelsat License LLC

Dear Ms. Dortch:

Intelsat License LLC ("Intelsat") provides this letter in support of Panasonic Avionics Corporation ("Panasonic") modification to its blanket authorization[1] from the Federal Communications Commission ("FCC"). Specifically, Panasonic's planned modification will seek to operate technically identical Ku-band transmit/receive earth stations aboard aircraft ("ESAA"), Call Sign E100089, with the Intelsat 14 satellite (Call Sign S2785) at 45.0° W.L., Intelsat 33e (Call Sign S2939) at 60.0° E.L, Intelsat 15 satellite (Call Sign S2789) at 85.15° E.L., and Intelsat 21 satellite (Call Sign S2863) at 58.0° W.L.

Intelsat understands that Panasonic will file the modification application pursuant to the FCC rules governing ESAA operations to increase the maximum EIRP spectral density associated with individual ESAA emissions with the Intelsat 14, Intelsat 33e, Intelsat 15 and Intelsat 21 satellites. Intelsat understands that this modification is related to a change in Panasonic's approach to ESAA uplink power limits that will enhance throughput and efficiency by considering ESAA skew angle and location in the beam to set maximum power levels for ESAA terminal uplink transmissions. Specifically, the ESAA terminals will transmit at a higher power at lower skew angles (resulting in narrower beamwidths/greater off-axis discrimination) and at lower powers when at higher skew angles (resulting in wider beamwidths/lower off-axis discrimination). Nonetheless, at all times Panasonic will operate consistent with the coordinated off-axis EIRP spectral density levels of the serving satellites.

Intelsat certifies that the proposed operation of the ESAA transmit/receive terminals at the power density levels provided by Panasonic to Intelsat, adjusted as necessary to compensate for skew angles, is consistent with existing operator-to-operator coordination agreements with all adjacent satellite operators within +/- 6 degrees of orbital separation from the Intelsat 14, Intelsat 33e, Intelsat 15, and Intelsat 21 satellites. Intelsat also acknowledges that the proposed operation of the Panasonic ESAA terminals 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 and agreed by Intelsat in all future satellite network coordinations with other adjacent satellite operators.

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[1] *See Policy Branch Information; Actions Taken*, Report No. SES-01979, File No. SES-MFS-20170312-00255 (Aug. 2, 2017) (Public Notice).

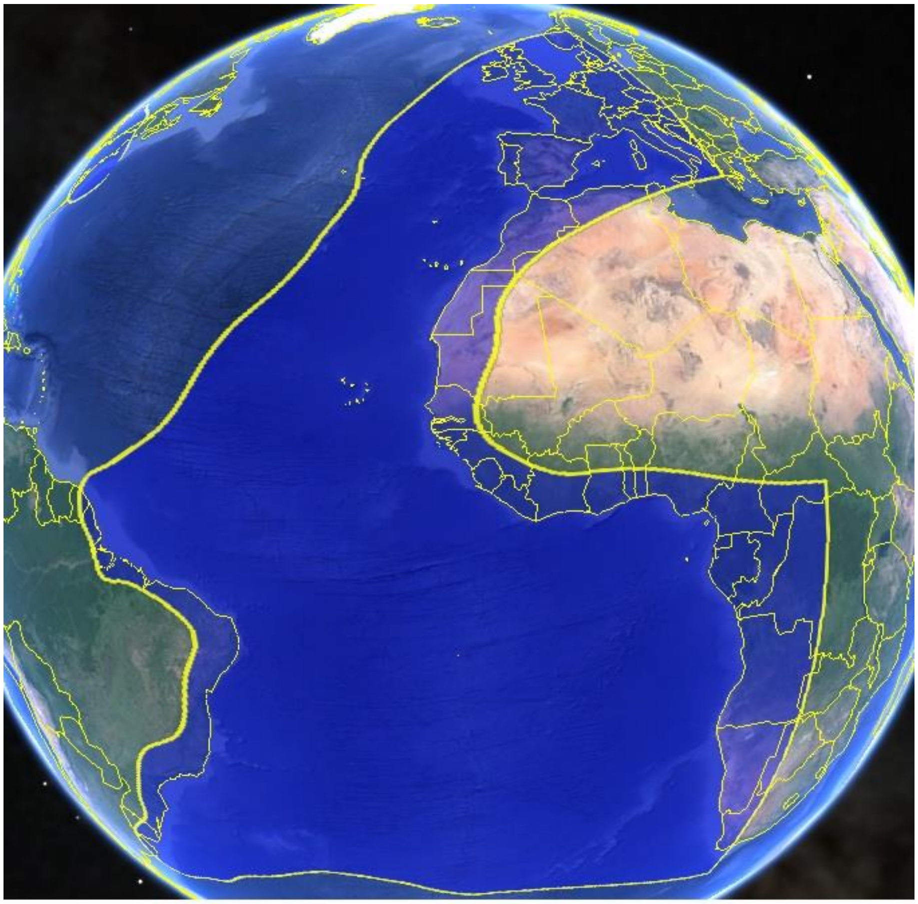
Intelsat Corporation
7900 Tysons One Place, McLean, VA 22102-5972 USA **www.intelsat.com** T +1 703-559-6800

Sincerely,

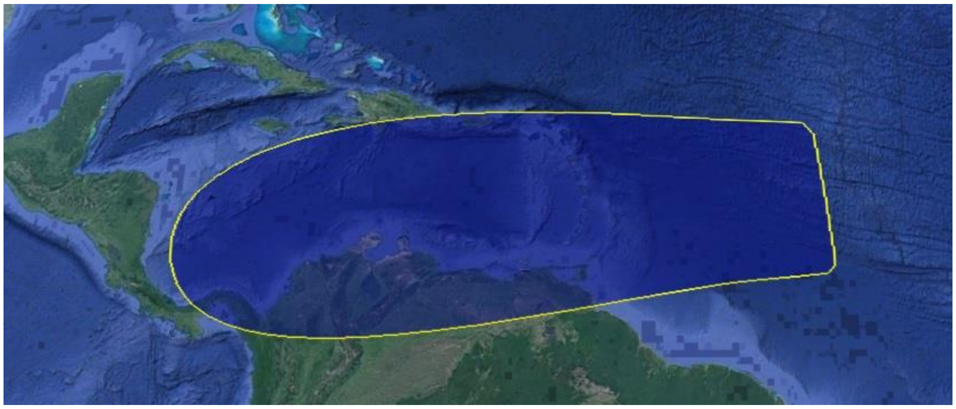
Alan Yates
Senior Manager, Spectrum Engineering

IV. Coverage Maps

a. IS-21

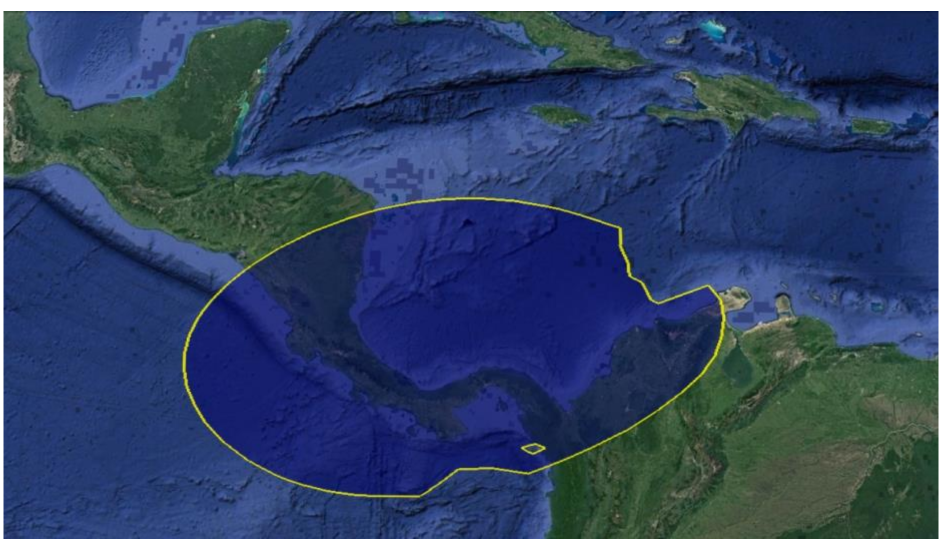


b. SES-15



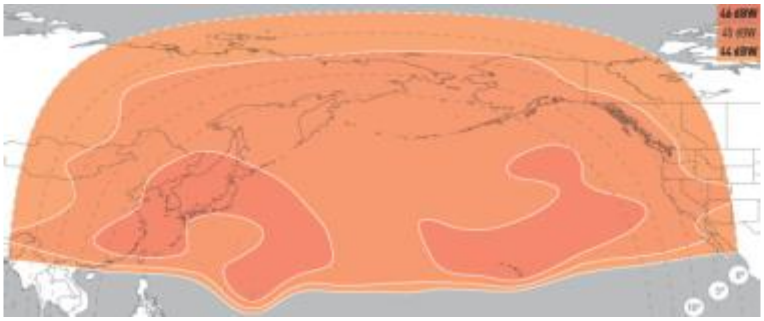
(Beam 48)

(Beam 51)

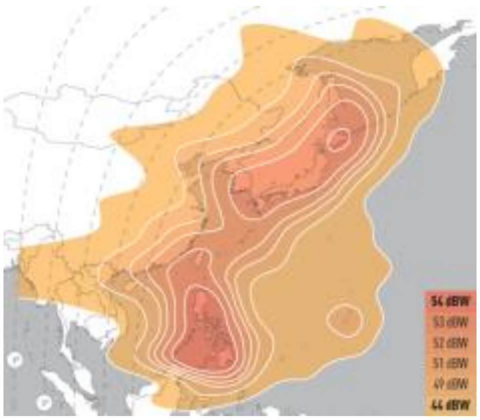


(Beam 52)

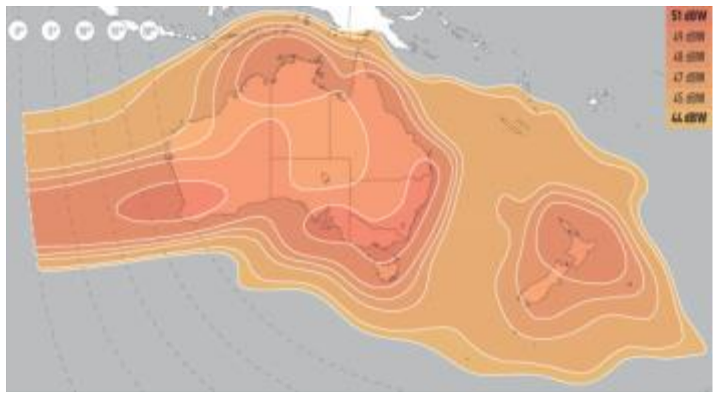
c. EUTELSAT 172B



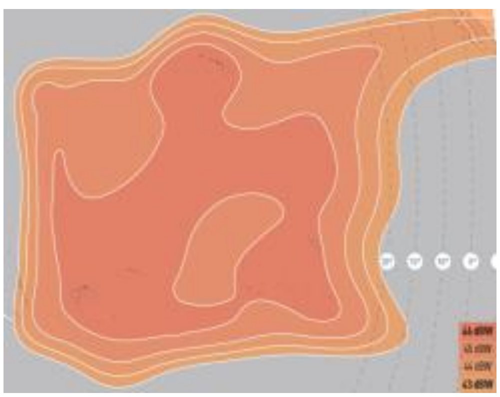
North Pacific (NP) Beam



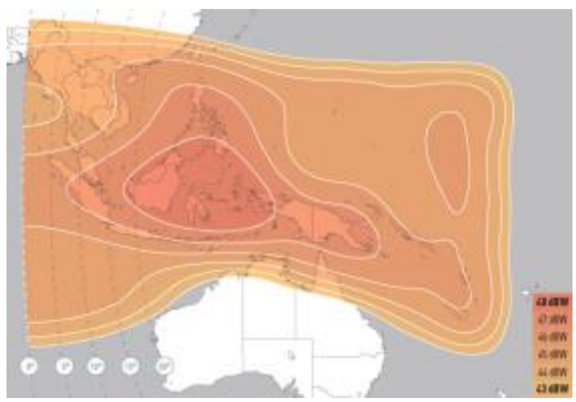
North East Asia (NEA) Beam



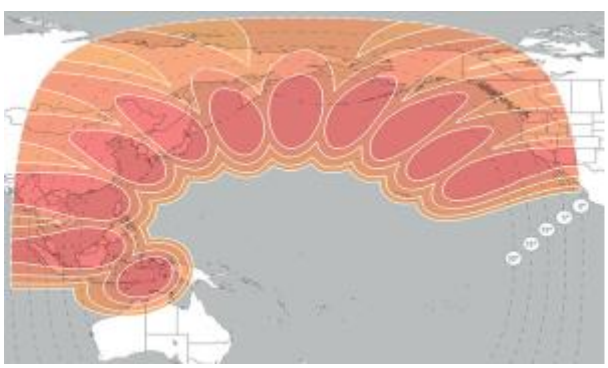
South Pacific (SP) Beam



South East Pacific (SEP) Beam



South West Pacific (SWP) Beam



High-throughput Satellite (HTS) Beams

V. eXConnect System Satellites and Gateways

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 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
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-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
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
Eutelsat 10A	Eutelsat	Cologne	Germany	Stellar	N/A

Satellite	**Satellite Operator**	**Gateway Earth Station Location**	**Country**	**Gateway Operator**	**FCC Call Sign**
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
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. Electrodyna mics	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-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

VI. <u>Section 25.227 Certifications</u>

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

Jan. 22, 2018

VII. CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

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

/s/

____

David C Morse, Ph.D.
Avaliant, LLC
Bellevue, WA USA
(425) 246-3080

Jan. 22, 2018