Panasonic Avionics Corporation
Amendment to ESAA Blanket License
Modification Application

Technical Appendix

NSS-12

1. Satellite Operator Certification Letter
2. Orbital Debris Management Report
3. Coverage Map
4. Link Budgets

1. **Satellite Operator Certification letter**

SES

Zachary Rosenbaum
VP, Spectrum Management and Development

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

9 February 2021

Subject: **Engineering Certification of SES**

To Whom It May Concern:

This letter certifies that SES is aware that Panasonic Avionics Corporation ("Panasonic") is planning to modify its earth stations aboard aircraft ("ESAA") blanket license from the Federal Communication Commission ("FCC"), Call Sign E100089, to add the NSS-12 (57°E.L.) satellite as an authorized point of communication for its PPA and SPA ESAA terminals. SES understands that Panasonic will file the modification application pursuant to the FCC rules governing ESAA operations, including Section 25.228.

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

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

Yours Sincerely,

Zach Rosenbaum
Zachary Rosenbaum

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2. Orbital Debris Management Report

3. Orbital Debris Mitigation Statement for NSS-12 (SSL1300 Bus)

Spacecraft Hardware Design

New Skies Satellites B.V. ("SES") has assessed and limited the amount of debris released in a planned manner during normal operations of NSS-12. No debris is generated during normal on-station operations, and the spacecraft will be in a stable configuration.

SES has also assessed and limited the probability of the space station becoming a source of orbital debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal. The design of SES's spacecraft locates all sources of stored energy within the body of the structure, which provides protection from small orbital debris. SES requires that spacecraft manufacturers assess the probability of micrometeorite damage that can cause any loss of functionality. This probability is then factored into the ultimate spacecraft probability of success. Any significant probability of damage would need to be mitigated in order for the spacecraft design to meet SES's required probability of success of the mission. SES has taken the following steps to limit the effects of such collisions: (1) critical spacecraft components are located inside the protective body of the spacecraft and properly shielded; and (2) all spacecraft subsystems have redundant components to ensure no single-point failures. The spacecraft will not use any subsystems for end-of-life disposal that are not used for normal operations.

Minimizing Accidental Explosions

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

The design of the NSS-12 spacecraft is such that the risk of explosion is minimized both during and after mission operations. In designing and building the spacecraft, the manufacturer took steps to ensure that debris generation will not result from the conversion of energy sources on board the satellite into energy that fragments the satellite. Burst tests are performed on all pressure vessels during qualification testing to demonstrate a margin of safety against burst. Bipropellant mixing is prevented by the use of valves that prevent backwards flow in propellant and pressurization lines. All pressures, including those of the batteries, are monitored by telemetry. At the end of operational life, after the satellite has reached its final disposal orbit, all on-board sources of stored energy will be depleted or secured, excess propellant remaining in the chemical propulsion tanks will be vented, excess pressurant remaining in the helium tanks will be vented, and the batteries will be discharged.

Safe Flight Profiles

SES has assessed and limited the probability of the space station becoming a source of debris by collisions with large debris or other operational space stations. Specifically, SES has assessed the possibility of collision with satellites located at, or reasonably expected to be located at, the requested orbital location or assigned in the vicinity of that location. Regarding avoidance of collisions with controlled objects, in general, if a geosynchronous satellite is controlled within its specified longitude and latitude station-keeping limits, collision with another controlled object (excluding where the satellite is collocated with another object) is the direct result of that object entering the allocated space.

In considering current and planned satellites that may have a station-keeping volume that overlaps that of the NSS-12 satellite, SES has reviewed the FCC databases for FCC licensed satellite networks and those that are currently under consideration by the FCC. In addition, networks for which a request for coordination has been published by the ITU near 57° E.L. have also been reviewed. Only those networks that either operate, or are planned to operate, and have an overlapping station-keeping volume with the NSS-12 satellite, have been taken into account in the analysis.

One other satellite is operating at the nominal 57° E.L. orbital location – ASTRA 1G operating at 57.2° E.L. ASTRA 1G is operated by SES, and SES has developed a colocation strategy to ensure the satellites can operate safely. The company is not aware of any other system with an overlapping station-keeping volume with NSS-12 that is the subject of an ITU filing and that is either in orbit or progressing towards launch. SES therefore concludes that physical coordination of NSS-12 with another operator is not required at the present time.

SES uses the Space Data Center ("SDC") system from the Space Data Association to monitor the risk of close approach of its satellites with other objects. Any close encounters (separation of less than 10 km) are flagged and investigated in more detail. If required, avoidance maneuvers are performed to eliminate the possibility of collisions. During any relocation, the moving spacecraft is maneuvered such that it is at least 30 km away from the synchronous radius at all times. In most cases, much larger deviation from the synchronous radius is used. In addition, the SDC system is used to ensure no close encounter occurs during the move. When de-orbit of a spacecraft is required, the initial phase is treated as a satellite move, and the same precautions are used to ensure collision avoidance.

Post-Mission Disposal

Post-mission disposal of the satellite from operational orbit will be accomplished by carrying out maneuvers to a higher orbit. The fuel budget for elevating the satellite to a disposal orbit is included in the satellite design. SES plans to maneuver NSS-12 to a disposal orbit with a minimum perigee of 283.5 km above the normal GSO operational orbit. This proposed disposal orbit altitude results from application of the IADC formula based on the following calculation:

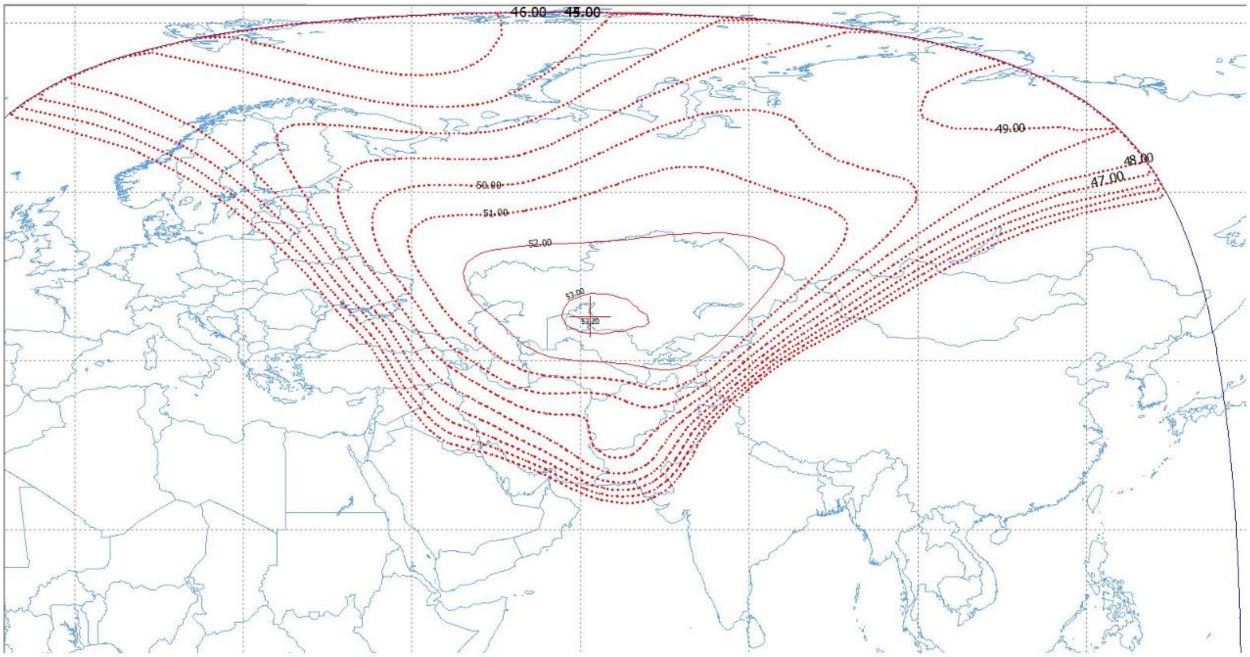
Total Solar Pressure Area "A" = 100.0 m2
"M" = Dry Mass of Satellite = 2476 kg
"CR" = Solar Pressure Radiation Coefficient = 1.2

Therefore the Minimum Disposal Orbit Perigee Altitude:

= 36,021 km + 1000 x CR x A/m
= 36,021 km + 1000 x 1.2 x 100.0/2476
= 36,069.5 km
= 283.5 km above GSO (35,786 km)

SES intends to reserve 10.84 kg of propellant in order to account for post-mission disposal of NSS-12. SES has assessed fuel-gauging uncertainty and has provided an adequate margin of fuel reserve to address the assessed uncertainty.

3. Coverage Map



4. Link Budgets

Forward Link Budget

eXConnect Terminal		
Antenna Type	PPA	
Lat	45.2	deg
Lon	61.1	deg
EIRP max	46.5	dBW
G/T	10.5	dB/K
Satellite		
Name	NSS-12	
Longitude	57.0	deg
Hub Earth Station		
Site	Moscow	
Lat	55.8	deg
Lon	37.6	deg
EIRP max	80.0	dBW
G/T	38.5	dB/K
Signal		
Waveform	DVB-S2X	
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	5.55E+07	bps
Information Rate (Data + Overhead)	6.17E+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	2.0	dB
Uplink		
Frequency	14.035	GHz
Back off	13.6	dB
EIRP Spectral Density	25.3	dBW/4kHz
Slant Range	39161	km
Space Loss, Ls	207.3	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.4	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	3.0	dB/K
Thermal Noise, C/No	88.3	dBHz
C/(No+Io)	87.8	dBHz
Satellite		
Flux Density	-98.9	dBW/m2
SFD @ Hub	-92.9	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	3.0	dB
Downlink		
Frequency	10.985	GHz
Transponder Sat. EIRP @ Beam Peak	53.2	dBW
Transponder Sat. EIRP @ Terminal	53.0	dBW
DL PSD Limit	12.2	dBW/4kHz
DL PSD @ Beam Peak	9.1	dBW/4kHz
Carrier EIRP @ Beam Peak	50.2	dBW
Carrier EIRP @ Terminal	50.0	dBW
Slant Range	37958	km
Space Loss, Ls	204.9	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	83.6	dBHz
C/(No+Io)	83.3	dBHz
End to End		
End to End C/(No+Io)	82.0	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	3.4	dB
Link Margin	1.4	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	PPA	
Lat	45.2	deg
Lon	61.1	deg
EIRP max	46.5	dBW
G/T	10.5	dB/K
Satellite		
Name	NSS-12	
Longitude	57.0	deg
Hub Earth Station		
Site	Moscow	
Lat	55.8	deg
Lon	37.6	deg
EIRP max	80.0	dBW
G/T	38.5	dB/K
Signal		
Waveform	MxDMA	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	2	
Coding Rate	0.50	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	0.45	bps/Hz
Data Rate	3.43E+06	bps
Information Rate (Data + Overhead)	3.81E+06	bps
Symbol Rate	3.81E+06	Hz
Chip Rate (Noise Bandwidth)	7.62E+06	Hz
Occupied Bandwidth	8.00E+06	Hz
Power Equivalent Bandwidth	1.15E+06	Hz
C/N Threshold	-1.7	dB
Uplink		
Frequency	14.035	GHz
Back off	0.0	dB
EIRP Spectral Density	13.7	dBW/4kHz
Slant Range	37958	km
Space Loss, Ls	207.0	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	6.0	dB/K
Thermal Noise, C/No	73.5	dBHz
C/(No+Io)	73.0	dBHz
Satellite		
Flux Density	-116.7	dBW/m2
SFD @ Terminal	-100.0	dBW/m2
Small Signal Gain (IBO/OBO)	0.0	dB
OBO	16.7	dB
Downlink		
Frequency	10.985	GHz
Transponder Sat. EIRP @ Beam Peak	53.2	dBW
Transponder Sat. EIRP @ Hub	50.0	dBW
DL PSD Limit	12.2	dBW/4kHz
DL PSD @ Beam Peak	3.7	dBW/4kHz
Carrier EIRP @ Beam Peak	36.5	dBW
Carrier EIRP @ Hub	33.3	dBW
Slant Range	39161	km
Space Loss, Ls	205.1	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.9	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	92.4	dBHz
C/(No+Io)	88.1866	dBHz
End to End		
End to End C/(No+Io)	72.9	dBHz
Implementation Loss	5.5	dB
End to End C/N w/ Imp Loss	-1.4	dB
Link Margin	0.3	dB

Forward Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	45.2	deg
Lon	61.1	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	NSS-12	
Longitude	57.0	deg
Hub Earth Station		
Site	Moscow	
Lat	55.8	deg
Lon	37.6	deg
EIRP max	80.0	dBW
G/T	38.5	dB/K
Signal		
Waveform	DVB-S2X	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	1	
Coding Rate	0.75	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	1.35	bps/Hz
Data Rate	6.94E+07	bps
Information Rate (Data + Overhead)	7.71E+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	3.8	dB
Uplink		
Frequency	14.035	GHz
Back off	13.6	dB
EIRP Spectral Density	25.3	dBW/4kHz
Slant Range	39161	km
Space Loss, Ls	207.3	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.4	dB
Radome, Lr	0.0	dB
Transponder G/T @ Hub	3.0	dB/K
Thermal Noise, C/No	88.3	dBHz
C/(No+Io)	87.8	dBHz
Satellite		
Flux Density	-98.9	dBW/m2
SFD @ Hub	-92.9	dBW/m2
Small Signal Gain (IBO/OBO)	3.0	dB
OBO	3.0	dB
Downlink		
Frequency	10.985	GHz
Transponder Sat. EIRP @ Beam Peak	53.2	dBW
Transponder Sat. EIRP @ Terminal	53.0	dBW
DL PSD Limit	12.2	dBW/4kHz
DL PSD @ Beam Peak	9.1	dBW/4kHz
Carrier EIRP @ Beam Peak	50.2	dBW
Carrier EIRP @ Terminal	50.0	dBW
Slant Range	37958	km
Space Loss, Ls	204.9	dB
Pointing Loss, Lpnt	0.1	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	84.6	dBHz
C/(No+Io)	84.4	dBHz
End to End		
End to End C/(No+Io)	82.7	dBHz
Implementation Loss	1.5	dB
End to End C/N w/ Imp Loss	4.1	dB
Link Margin	0.3	dB

Return Link Budget

eXConnect Terminal		
Antenna Type	SPA	
Lat	45.2	deg
Lon	61.1	deg
EIRP max	45.0	dBW
G/T	11.5	dB/K
Satellite		
Name	NSS-12	
Longitude	57.0	deg
Hub Earth Station		
Site	Moscow	
Lat	55.8	deg
Lon	37.6	deg
EIRP max	80.0	dBW
G/T	38.5	dB/K
Signal		
Waveform	MxDMA	
Modulation	QPSK	
Bits per symbol	2	
Spread Factor	2	
Coding Rate	0.50	
Overhead Rate	0.90	
Channel Spacing	1.05	
Spectral Efficiency (Rate/Noise BW)	0.45	bps/Hz
Data Rate	3.43E+06	bps
Information Rate (Data + Overhead)	3.81E+06	bps
Symbol Rate	3.81E+06	Hz
Chip Rate (Noise Bandwidth)	7.62E+06	Hz
Occupied Bandwidth	8.00E+06	Hz
Power Equivalent Bandwidth	8.07E+05	Hz
C/N Threshold	-1.7	dB
Uplink		
Frequency	14.035	GHz
Back off	0.0	dB
EIRP Spectral Density	12.2	dBW/4kHz
Slant Range	37958	km
Space Loss, Ls	207.0	dB
Pointing Loss, Lpnt	0.2	dB
Atmosphere / Weather Loss, La	0.0	dB
Radome, Lr	0.5	dB
Transponder G/T @ Terminal	6.0	dB/K
Thermal Noise, C/No	72.0	dBHz
C/(No+Io)	71.5	dBHz
Satellite		
Flux Density	-118.3	dBW/m2
SFD @ Terminal	-100.0	dBW/m2
Small Signal Gain (IBO/OBO)	0.0	dB
OBO	18.3	dB
Downlink		
Frequency	10.985	GHz
Transponder Sat. EIRP @ Beam Peak	53.2	dBW
Transponder Sat. EIRP @ Hub	50.0	dBW
DL PSD Limit	12.2	dBW/4kHz
DL PSD @ Beam Peak	2.1	dBW/4kHz
Carrier EIRP @ Beam Peak	34.9	dBW
Carrier EIRP @ Hub	31.7	dBW
Slant Range	39161	km
Space Loss, Ls	205.1	dB
Pointing Loss, Lpnt	0.0	dB
Atmosphere / Weather Loss, La	2.9	dB
Radome, Lr	0.0	dB
PCMA Loss	0.0	dB
Thermal Noise, C/No	90.8	dBHz
C/(No+Io)	86.6316	dBHz
End to End		
End to End C/(No+Io)	71.3	dBHz
Implementation Loss	3.5	dB
End to End C/N w/ Imp Loss	-1.0	dB
Link Margin	0.7	dB