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March 10, 2014

VIA ELECTRONIC FILING
Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: **Application of Panasonic Avionics Corporation, File No. SES-MFS-20130930-00845 (Call Sign E100089)**

Dear Ms. Dortch:

Pursuant to Section 1.65 of the Commission's Rules, 47 C.F.R. § 1.65, and in response to Commission correspondence dated February 12, 2014,[1] Panasonic Avionics Corporation ("Panasonic") hereby submits additional orbital debris/end of life information to supplement the information provided by satellite operators in connection with Panasonic's request to add the Superbird C2 and Apstar 7 satellites as authorized points of communication. Panasonic provides the following information to clarify and correct certain information included in Panasonic's modification application filed on September 30, 2013.[2]

I. Additional Information for Superbird C2

The International Bureau Letter requests clarification of certain issues associated with the End of Life Disposal and Debris Mitigation Plan submitted for the Superbird C2 satellite,[3] including confirmation of: (i) the volume of each helium tank; (ii) helium tank interconnection and volume of plumbing in liters; (iii) whether the stated mass of helium is end-of-life or launch

[1] *See* Letter from Jose Albuquerque, Chief, Satellite Division of the FCC International Bureau, to Carlos M. Nalda, Counsel for Panasonic Avionics Corporation, Squire Sanders (US) LLP, dated Feb. 12, 2014 ("International Bureau Letter").

[2] *See* Application of Panasonic Avionics Corporation; File No. SES-MFS-20130930-00845 (Call Sign E100089) ("Modification Application").

[3] *See id.*, Technical Appendix at 6-5.

volume; (iv) the temperature in kelvins for the pressure calculation; and (v) the estimated pressure calculation and calculated value.

After additional consultations with Sky Perfect JSAT (“SP-JSAT”), operator of the Superbird C2 satellite, Panasonic provides the following clarifying information in response to the Commission’s inquiry:

(i) the volume of each helium tank is approximately 81.39 liters, so the total volume of both tanks is 162.78 liters;

(ii) the two helium tanks are interconnected but there is insufficient information regarding the plumbing volume to provide specific volume information (see below regarding actual data on combined system pressure);

(iii) the stated mass of helium (6.4 kg) is end-of-life, as calculated using tank temperatures and the common pressure for the system (tanks and plumbing) received via telemetry data;

(iv) the range of temperature in kelvins used for the pressure calculation is from 279.6ºK to 289.5ºK; and

(v) the estimated pressure (2.07-2.40 megapascales) is correct and is based on telemetry data received almost six months after in-orbit testing; because this is an actual pressure value, no detailed explanation of an estimated pressure calculation is provided (but the calculation does approximate the helium mass reported above).

II. Additional Information for Apstar 7

The International Bureau Letter also requests clarification of certain issues associated with the Statement of Conformity submitted for the Apstar 7 satellite,[4] including confirmation of: (i) the correct number and volume of helium tanks; (ii) helium tank interconnection and volume of plumbing in liters; (iii) whether the stated mass of helium is end-of-life; (iv) the temperature in kelvins for the pressure calculation; and (v) a detailed explanation of the estimated pressure calculation and, if necessary, the correct pressure value.

After consultations between APT Satellite Company Limited (“APT”), operator of the Apstar 7 satellite, and Thales Alenia Space (“TAS”), manufacturer of the satellite, Panasonic confirms that certain information provided initially by APT was not accurate. Accordingly, Panasonic provides an updated Statement of Conformity from APT regarding the Apstar 7 satellite which should replace the previous Statement of Conformity, as well as the following clarifying information in response to the Commission’s inquiry:

[4] *See id.* at 3-5.

(i) there are two (2) helium tanks, each with a volume of 91 liters;

(ii) the helium tanks are interconnection but there is insufficient information regarding the plumbing volume to provide specific volume information (see below regarding actual data on combined system pressure);

(iii) the originally stated mass of helium was actually the mass at launch rather than end-of-life; the estimate end-of-life mass of helium is 2.1 kg in the tanks and tubing based on TAS software modeling (see below for confirmatory calculation);

(iv) the temperature in kelvins for the pressure calculation is 283ºK; and

(v) the residual pressure of the tanks and plumbing is 74 bars, as confirmed from telemetry data received from the satellite; using this pressure value, the calculation of remaining helium mass is:

$PV=nRT$ where

P is pressure in Pa
V is volume in m^3
n is the number of moles in mole
R is the universal gas constant
T is temperature in K

For Apstar 7 case:

$P = 74bar = 74 \times 10^5 Pa$;
$V = 2x\ 91L x 10^{-3} m^3$
$R = 8.3144621\ J \cdot K^{-1} \cdot mol^{-1}$
$T = 10C^\circ = 283K$

In addition, the known mass of a Helium atom per mole is 4.00260 $g.mol^{-1}$. So, the mass (M) of remaining helium in both helium tanks and tubing are roughly estimated as:

$$M = \frac{PV}{RT} \times 4.00260 = \frac{74 \times 10^5 \times 2 \times 91 \times 10^{-3} \times 4.00260}{8.3144621 \times 283}$$

$$\approx 2290g$$

$$= 2.29kg$$

This theoretical result approximates to 2.1 kg which was came out more precisely from the software model and declared by TAS.

III. Further Information and Waiver Request

Panasonic would be pleased to facilitate further discussions with SP-JSAT and APT with respect any additional information the Commission may require regarding the Superbird C2 and Apstar 7 satellites. In the meantime, Panasonic respectfully requests that the Commission accept the additional information provided by SP-JSAT and APT as sufficient for public notice of the subject application, and waive any rules or policies necessary to further consider and ultimately add the Superbird C2 and Apstar 7 satellites as authorized points of communication.

Any necessary waiver would serve the public interest because access to these in-orbit satellites would allow U.S.-registered aircraft to access the satellite like their foreign counterparts. In addition, because actual helium pressure in the interconnected system has been reported via telemetry data and is a small fraction of rated pressure of the system for each satellite, any uncertainty with respect to plumbing volume need not alter the conclusion that the Superbird C2 and Apstar 7 satellites satisfy the Commission's end-of-life and orbital debris mitigation policies.

* * * *

Please feel free to contact the undersigned with any questions you may have or if Panasonic can provide any additional information to facilitate expeditious action on its application.

Respectfully submitted,

Squire Sanders (US) LLP

Carlos M. Nalda

Counsel to Panasonic Avionics Corporation

Attachment

cc (w/ att.): Jose Albuquerque, Satellite Division, FCC International Bureau
Stephen Duall, Satellite Division, FCC International Bureau
Paul Blais, Satellite Division, FCC International Bureau

Statement on Conformity of APSTAR-7 Satellite with FCC Rules regarding Orbital Debris Mitigation

APT Satellite Company Limited ("APT") provides the following showing regarding compliance with 47 C.F.R. § 25.114(d)(14)(i)-(iv) and §25.283 of the Federal Communications Commission's ("FCC") rules regarding the orbital debris mitigation/end-of-life disposal of the APSTAR-7 satellite. In addition, APT acknowledges that the APSTAR-7 orbital debris mitigation/end-of-life disposal plan is consistent with guidelines issued by the Office of Telecommunications Authority ("OFTA") of Hong Kong in July 2007. (http://tel_archives.ofca.gov.hk/en/report-paper-guide/guidance-notes/gn_200706.pdf)

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

APT has assessed the operations of APSTAR-7 and has determined that no debris has been released by the spacecraft. All separation and deployment mechanisms were fully controlled by Thales Alenia Space and the launching service provider and no debris is planned to leave the spacecraft after the commission of service.

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

The APSTAR-7 spacecraft can be controlled through both the normal dish antennas and omni antennas. In the different FDIR (Failure, Discovery, Isolation and Recovery) mode (Normal Mode, Earth Pointing Mode, Inertial Attitude Acquisition Mode and Sun Acquisition Mode), the omni and dish antennas can be used functionally.

Furthermore, the spacecraft redundancy scheme protects against the failure of any one component by having spare components available. In case, if the primary component fails, the other redundant unit remains functional to maintain the satellites mission. The reliability has been assessed for each subsystem and for each phase of the mission, based on the analysis, the bus reliability is greater than 0.89 at 15 years and 0.92 at 13 years. According to the goal of the design, there is no item in the bus whose failure will cause loss of the satellite mission unless that item has a probability of success that is superior or equal to 0.99 for 15 years. This redundancy scheme should ensure the control and de-orbit capability of the satellite after a collision.

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

APT has conducted the assessment the possibility of an accidental explosion onboard APSTAR-7 via reviewing failure modes for all equipment. In order to ensure that the spacecraft does not explode on orbit, the designers of the spacecraft have taken specific precautions. All batteries and fuel tanks are monitored for pressure or temperature variations. Alarms in the SCC (Satellite Control Center) inform controllers of any variations. Additionally, long-term trending analysis will be performed to monitor for any unexpected trends. Operationally, batteries will be operated utilizing the manufacturer's automatic recharging scheme during eclipse season. This scheme will ensure that the batteries will not over-charge. Under the FDIR process, in the event that an overcharge condition is detected, overcharge protection will be triggered to prevent from overheated and do not raise its internal pressure for Li-Ion battery cells.

APSTAR-7 uses a bipropellant system. In order to protect the propulsion system, fuel tanks will all be operated in a blow down mode. At the completion of orbit-raising, the helium pressurant was isolated from the fuel system by the firing of pyrotechnic valves. This causes the pressure in the tanks to decrease over the life of the spacecraft. In order to ensure that the spacecraft has no explosive risk after it has been successfully de-orbited, all stored energy onboard the spacecraft will be removed except for a small amount of pressurant remaining when the valves were sealed after orbit raising, discussed below in Section (d).

Upon successful de-orbit of the spacecraft, based on the procedure, all propulsion lines and latch valves will be vented and left open. All battery chargers will be turned off and batteries will be left in a permanent discharge state. These steps will ensure that no buildup of energy can occur resulting in an explosion after the spacecraft is de-orbited.

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

APT has also conducted the assessment of the probability of APSTAR-7 becoming a source of debris by collisions with large debris or other operational space stations. The probability of the collision between APSTAR-7 and other Space stations is negligible since an Orbital Analyst regularly determines the satellite's orbit trends and assess the risk of collision based on ranging result. As a standard practice, in case of other satellite flyby or collocation with APSTAR-7, the orbital ephemeris data of both sides is exchanged prior to and during operations and the maneuver plan is adjusted accordingly. In addition, a collision precaution system is developed internally based on the data source on website of http://celestrak.com/NORAD/elements/ to track all GEO satellites and alert any satellite(s) getting closer to APT' fleet, facilitate APT to take appropriate measures to avoid collision. The below is list of adjacent satellites recorded recently according to our system:

127	COSMOS 2440	08	33108	2013-05-01 08:23:27	70.99 E	0.01	S	1.8995	0.02	in box
128 ☐	INTELSAT 5 (IS-5)	97	24916	2013-05-02 00:22:10	71.25 E	0.30	S	0.4911	0.65	move west
129	LEASAT 5	90	20410	2013-04-26 21:47:02	71.48 E	7.87	S	10.4841	0.01	in box
130	INTELSAT 22 (IS-22)	12	38098	2013-05-01 17:37:05	72.13 E	0.03	N	0.0345	0.00	in box
131	RADUGA 32	94	23448	2013-05-01 06:52:56	73.30 E	0.02	S	12.9487	0.04	in box
132	COSMOS 2133	91	21111	2013-04-29 23:25:51	73.50 E	13.24	S	13.6239	0.04	in box
133	KALPANA-1 (METSAT 1)	02	27525	2013-05-01 22:48:56	73.91 E	1.72	S	3.5542	0.00	in box
134	INSAT-3C	02	27298	2013-04-30 01:24:16	73.93 E	0.05	S	0.0603	0.01	in box
135	INSAT-4CR	07	32050	2013-05-01 13:11:10	74.05 E	0.07	N	0.0957	0.01	in box
136	ABS-1A	96	23768	2013-05-01 21:33:58	74.72 E	1.67	S	5.6015	0.00	in box
137	ABS-1	99	25924	2013-05-02 02:11:11	74.97 E	0.05	S	0.0595	0.00	in box
138	ELEKTRO-L 1 (GOMS 2)	11	37344	2013-05-02 00:41:10	76.15 E	0.02	N	0.023	0.01	in box
139 ☑	APSTAR 7	12	38107	2013-04-30 21:59:27	76.50 E	0.01	N	0.0368	0.01	in box
140	TIANLIAN I (CTDRS-1)	08	32779	2013-05-02 00:41:10	77.07 E	0.02	N	0.0517	0.00	in box
141	LUCH 1	95	23680	2013-05-01 07:13:19	77.45 E	0.01	S	11.9679	0.00	in box
142	THAICOM 5	06	29163	2013-05-01 22:45:11	78.49 E	0.00	N	0.0561	0.00	in box
143	COSMOS 2371	00	26394	2013-04-29 07:30:37	79.11 E	0.02	S	9.7061	0.03	in box
144	ESIAFI 1 (COMSTAR 4)	81	12309	2013-04-30 03:57:50	79.46 E	0.01	S	14.7018	0.03	in box
145	COSMOS 2085	90	20693	2013-04-28 05:39:41	79.79 E	0.01	S	14.2412	0.02	in box
146	COSMOS 2473	11	37806	2013-05-01 21:33:44	79.93 E	0.00	N	0.0747	0.01	in box

APT will maintain APSTAR-7 within 0.05° of the assigned orbital position (76.5 E.L.) in both the longitude and latitude, this orbit is mainly for geo-stationary satellite, all of the necessary coordination agreements have been successfully completed and signed to ensure the stable and interference-free operation of APSTAR-7 at this orbital slot, and all such notification information has been filed and registered with ITU. APT will continue to monitor launch details to verify that no new spacecraft takes residence in the vicinity of the APSTAR-7 spacecraft unless ongoing operational coordination is conducted with the nearby satellite(s).

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

At the completion of its mission, APSTAR-7 will be removed from its geostationary orbit at 76.5 E.L. to a perigee altitude no less than 274.5 km above the standard geostationary orbit of 35,786 km. This post-disposal perigee takes into account gravitational perturbations and solar radiation pressure that could alter the satellite orbit in the years after decommissioning. APT has planned the tracking telemetry and control transmissions required for end-of-life repositioning so as to avoid electrical interference to other space stations, and coordinated with any potentially affected satellite networks.

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

$$\mathbf{235\ km + (1000 \cdot CR \cdot A/M)}$$
$$\mathbf{= 235\ km + 1000 \times 79/2000}$$
$$\mathbf{= 274.5\ km}$$

Here:

CR =Solar radiation pressure coefficient;

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

Notes: **CR·A is a parameter derived by Orbital determination software** ≈79 m^2**;**

M= Satellite dry mass ≈2,000 kg (the satellite mass at de-orbit);

The amount of fuel reserved for the post-mission orbital raising is shown below:

Disposal altitude: GEO + 300 km (set 300 km as a target to instead 274.5 km to cover uncertainties);

Required Delta V: 10.94 m/s;

Required fuel (reserved): **9.56 kg**.

The propellant needed to achieve the minimum deorbit altitude is based on the delta-V required and specified by the spacecraft manufacturer, the required mass of propellant for de-orbit operation will be reserved in the tank before the end of life. Propellant tracking is accomplished using a bookkeeping method, this method is provided by the satellite manufacture with a good accuracy.

Any propellant in excess of expected bookkeeping values will be consumed by further raising the orbit until combustion is no longer possible.

Finally, all stored energy sources on board the satellite will be discharged by venting excess propellant, discharging batteries, relieving pressure vessels, and other appropriate measures. The table below provides further information regarding the amount of helium (pressure, container and volume) from the APSTAR-7 propulsion system remaining at end-of-life:

APSTAR-7 (SB4000C2)		
container		**status on end of life**
1	**fuel**	vent by leaving thruster valve open
2	**oxidizer**	vent by leaving thruster valve open
3	**helium**	sealed: 91litre,74bar,10°C
4	**helium**	sealed: 91litre,74bar,10°C

As noted above, propellant and oxidizer tanks will be vented at end-of-life by leaving the thruster valve open. The two (2) helium tanks, however, are isolated and sealed, cannot be reopened and will have a total estimated mass of 2.1 kg of helium remaining at the end-of-life including both tanks and tubing. The existence of residual helium is a result of the satellite design – isolating the helium tanks after orbit-raising reduces the risks associated with valves between these tanks and pressurized fuel/oxidizer tanks during the long operating life of the satellite and the remaining helium pressure is well below the design tolerance of the tanks as the proof pressure of tank is 442.5 bar. Accordingly, APT requests a waiver of §25.283 of the Commission’s rules with respect to the remaining helium because only direct retrieval of the spacecraft would allow APT to recover and discharge the sealed helium.

Yours truly,

APT Satellite Company Limited