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Assessments on Conformity of APSTAR-VI Satellite with FCC rules Regarding Orbital Debris Mitigation

APT Satellite Company Limited issues the letter about the result of the titled assessments based on the §25.114(d)(14)(i)-(iv) of the Federal Communications Commission's rules.

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

APT has conducted the assessment of the whole mission of APSTAR-VI and determined that no debris has been released by the spacecraft. All separation and deployment mechanisms are fully controlled by the Thales Alenia Space and the launching service provider, there is no debris leaving the spacecraft after the commission of service.

The structure of APSTAR-VI satellite has a shape of a parallelepipedic box organized around a Central Tube which interfaces with the launch vehicle. 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 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-VI 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 is destroyed, the other redundant unit is also 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 0.79 at 15 years and 0.83 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. The redundancy scheme could ensure the control and de-orbit capability of the satellite after a collision happens.

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

APT has conducted the assessment the possibility of an accidental explosion onboard the spacecraft via reviewing failure modes for all equipment. In order to ensure that the spacecraft does not explode on orbit, the design of the spacecraft has 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, the over charge protection if over charge for the batteries will be triggered to prevent over heat of the batteries.

APSTAR VI satellite use bipropellant system. In order to protect the propulsion system, fuel tank will all be operated in a blow down mode. At the completion of orbit raising, the pressurant will be isolated from the fuel system. This will cause the pressure in the tanks to decrease over the life of the spacecraft. This will also protect from a pressure valve failure causing the fuel tanks to become over pressurized. 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. 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 in the years 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 the space station becoming a source of debris by collisions with large debris or other operational space stations. The probability of the collision between APSTAR VI and other Space stations is negligible because our Orbital Analyst regularly is determined APSTAR VI orbit trends based on ranging result and orbital parameters (Eccentricity and Inclination). APT will maintain APSTAR-VI within 0.05° of the assigned orbital position (134E) in both the longitude and latitude planes, 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 VI 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-VI spacecraft.

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

APSTAR-VI will be removed from its geostationary orbit at 134° E.L. in accordance with a guideline issued by OFTA(Office of Telecommunications Authority) of Hong Kong in July 2007, regarding end-of-life satellite disposal. (ref. http://www.ofta.gov.hk/en/report-paper-guide/guidance-notes/gn_200706.pdf)

The following equations are used to calculate the minimum orbit raise needed for de-orbit operation. They are totally consistent with the FCC-recommended equation in the new §25.283 rule regarding end-of-life satellite disposal.

Minimum Deorbit Altitude raise = 235 km + (1000•CR•A/m)
CR = solar pressure radiation coefficient of the spacecraft = 1
A/m (87 m2 / 1915 kg) = area to mass ratio, in square meters per kilogram, of the spacecraft = 0.045

Result:
Minimum Deorbit Altitude raise for APSTAR-VI = 235 km + (1000•1•0.045) = 280 km
Required Delta V: 10.2 m/s
Required fuel (reserved): 7.5 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. Any remaining propellant will be consumed by further raising the orbit until combustion is no longer possible. Propellant tracking is accomplished using a bookkeeping method, this method is provided by the satellite manufacture with a good accuracy.

Yours truly,
APT Satellite Company Limited

Rolland Fung