From: Robbie Shanholtz

To: Behnam Ghaffari
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Subject: FCC File No. 0464-EX-PL-2008

Message:

(1) A statement that the space station operator has assessed and limited the amount of debris released in a planned manner during normal operations, and has assessed and limited the probability of the space station becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal;

Telesat has assessed the launch, orbit raising, deployment and normal operations portions of the mission and determined that no debris will be released by the spacecraft. The only portion of the mission in which portions of the spacecraft are separated from the main spacecraft body is during deployment. However, all separation and deployment mechanisms are designed to contain all debris generated when activated (so no debris ends up leaving the spacecraft). The assessment found no other sources for debris throughout the mission.
Spacecraft Hardware Design: To protect from small body collisions, the design of the XTAR spacecraft allows for individual faults without losing the entire spacecraft. All critical components (i.e. computers and control devices) are built within the structure and shielded from external influences. Items that can not be built within the spacecraft nor shielded (like antennas) are redundant, and able to withstand impact. The XTAR spacecraft can be controlled through both the normal payload antennas and wide angle antennas. The likelihood of both being damaged during a small body collision is minimal. The wide angle antennas on this spacecraft are basically open waveguide that point towards the earth (there is one set on each side of the spacecraft ? either set could be used to successfully de-orbit the spacecraft). These wide angle antennas would continue to operate even if struck and bent.

(2) A statement that the space station operator has assessed and limited the probability of accidental explosions during and after completion of mission operations. This statement must include a demonstration that debris generation will not result from the conversion of energy sources on board the spacecraft into energy that fragments the spacecraft. Energy sources include chemical, pressure, and kinetic energy. This demonstration should address whether stored energy will be removed at the spacecraft?s end of life, by depleting residual fuel and leaving all fuel line valves open, venting any pressurized system, leaving all batteries in a permanent discharge state, and removing any remaining source of stored energy, or through other equivalent procedures specifically disclosed in the application;

Telesat has reviewed failure modes for all equipment to assess the possibility of an accidental explosion onboard the spacecraft. In order to ensure that the spacecraft does not explode on orbit Telesat will take 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. Doing so will ensure that charging terminates normally without building up additional heat and pressure. As this process occurs wholly within the spacecraft, it also affords protection from command link failures (on the ground).
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 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, 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.

(3) A statement that the space station operator 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. Where a space station will be launched into a low-Earth orbit that is identical, or very similar, to an orbit used by other space stations, the statement must include an analysis of the potential risk of collision and a description of what measures the space station operator plans to take to avoid in-orbit collisions. If the space station operator is relying on coordination with another system, the statement must indicate what steps have been taken to contact, and ascertain the likelihood of successful coordination of physical operations with, the other system. The statement must disclose the accuracy?if any?with which orbital parameters of non-geostationary satellite orbit space stations will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s). In the event that a system is not able to maintain orbital tolerances, /i.e./, it lacks a propulsion system for orbital maintenance, that fact should be included in the debris mitigation disclosure. Such systems must also indicate the anticipated evolution over time of the orbit of the proposed satellite or satellites.

Where a space station requests the assignment of a geostationary-Earth orbit location, it must assess whether there are any known satellites located at, or reasonably expected to be located at, the requested orbital location, or assigned in the vicinity of that location, such that the station keeping volumes of the respective satellites might overlap. If so, the statement must include a statement as to the identities of those parties and the measures that will be taken to prevent collisions;

Telesat has also assessed and limited the probability of the space station becoming a source of debris by collisions with large debris or other operational space stations.
In order to minimize the possibility of a large body impact collision, Telesat has assessed the proximity of other known Space Stations. No other objects are stationed close enough to the XTAR spacecraft to require transfer of elements and coordination of maneuvers. The closest neighboring spacecraft allow for .5 degrees of separation.
Additionally Telesat has entered into the CRDA with MIT/LL. As part of this service, MIT/LL monitors the XTAR spacecraft and bodies approaching it (i.e. uncontrolled spacecraft Telesat can not track). If an approach is predicted that is under 5 km (MIT/LL guard band), Telesat is notified, and a maneuver plan to increase the separation. This plan is reviewed with MIT/LL to ensure safe separation is achieved.

(4) A statement detailing the postmission disposal plans for the space station at end of life, including the quantity of fuel?if any?that will be reserved for post-mission disposal maneuvers.

For geostationary-Earth orbit space stations, the statement must disclose the altitude selected for a postmission disposal orbit and the calculations that are used in deriving the disposal altitude. The statement must also include a casualty risk assessment if planned post-mission disposal involves atmospheric re-entry of the space station. In general, an assessment should include an estimate as to whether portions of the spacecraft will survive re-entry and reach the surface of the Earth, as well as an estimate of the resulting probability of human casualty.

XTAR-EUR, a Space Systems/Loral built FS-1300 bus, will be removed from its geostationary orbit at 331° W.L. at a perigee altitude no less than ~300 km above the standard geostationary orbit of 35786 km. This altitude was arrived at by using the FCC-recommended equation in the new §25.283 rule regarding end-of-life satellite disposal.
Minimum Deorbit Altitude= 36,021 km + (1000?CR?A/m) (Eq.1)
CR = solar pressure radiation coefficient of the spacecraft = 1.6
A/m = area to mass ratio, in square meters per kilogram, of the spacecraft = 0.032

Result:
(Eq.1) Minimum Deorbit Altitude = 36,021 km + (1000.1.6?.032) = 292.6 km
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 1410.9 kg, and the delta-V required, approximately 6.2 kg of propellant will be reserved to ensure minimum de-orbit altitude is obtained. Any remaining propellant will be consumed by further raising the orbit until combustion is no longer possible. The remaining species of propellant, either Oxidizer (N204) or Fuel (MMH), will be vented, placing the propulsion system on the spacecraft in ?safe? mode.

Propellant tracking is accomplished using a bookkeeping method. Using this method, the ground control station tracks the number of jet seconds utilized for station keeping, momentum control and other attitude control events. From jet seconds, amount of fuel used is determined. 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.

One year from the end of life of the spacecraft, a PGS test is to be performed. This test uses heaters and heat transfer curves to determine the actual fuel still aboard the spacecraft. As the amount of fuel in the tanks decrease, the accuracy of the test results increases. Operationally, the test is scheduled to be performed one year before end of life as it provides more than adequate margin to compensate for any bookkeeping uncertainty as well as maximum accuracy for fuel remaining.

The PGS test is also conducted periodically while the satellite is on-orbit to confirm the amount of fuel used and verify the results of the bookkeeping method. Only at the final year mark is it used as the mechanism to determine the amount of remaining fuel.