Orbital Debris Mitigation Plan for "Telstar 12" Satellite at 15°WL

§25.114(d)(14): Description of the design and operational strategies that will be used to mitigate orbital debris

§25.114(d)(14)(i), Debris Release Assessment. The T12 satellite has been designed so that in the normal operation of the satellite no debris will be released by the spacecraft. The spacecraft hardware of T12 has been designed so that individual faults will not cause the loss of the entire spacecraft. All critical components (e.g., computers and control devices) have been built within the structure and shielded from external influences. Items that could not be built within the spacecraft nor shielded (e.g., antennas) are able to withstand impact. The 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 open waveguides that point towards the earth (There is one set on each side of the spacecraft and either set could be used to successfully de-orbit the spacecraft.). These wide angle antennas would continue to operate even if struck and bent.

§25.114(d)(14)(ii), Accidental Explosion Assessment. Skynet 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, Skynet takes specific precautions. All batteries and fuel tanks are monitored for pressure or temperature variations. Alarms in the Satellite Control Center inform controllers of any variations. Additionally, long-term trending analysis is performed to monitor for any unexpected trends.

The batteries are operated utilizing the manufacturer's automatic recharging scheme. Doing so ensures 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 ensure that the spacecraft has no explosive risk after it has been successfully de-orbited, stored energy sources onboard the spacecraft will be removed by venting excess propellant, and all propulsion lines and latch valves will be vented and left open. This includes all fuel and helium pressurant contained within the propulsion system. Once de-orbit maneuvers have been completed, 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.

§25.114(d)(14)(iii), Assessment Regarding Collision with Larger Debris and Other Space Stations. The Telstar 12 satellite has been operating at this orbital location since 1999 and Skynet has continuously monitored and minimized the probability of the space station becoming a source of debris by collisions with large debris or other space stations.

In order to protect against collision with other orbiting objects, Telesat Canada, a company related to Skynet, has a contract with MIT/Lincoln Labs to provide notification and high-precision orbits for drifter objects when close approaches with our operational satellites are projected. Processing of the notifications is fully automated to ensure efficient response should avoidance maneuver(s) be required to eliminate any threat of collision with the drifter object. For nearby operational satellites Skynet coordinates with operators directly and/or by providing ephemerides to the Space Data Center and the Joint Space Operations Center (JSpOC). The JSpOC also provides notifications to Skynet for any object they see approaching a Skynet satellite.

To further limit future potential for collision, Skynet will continue to monitor new satellite launches to ensure that future satellites do not present a danger to T12. If a new satellite is located in the vicinity of T12, Skynet will coordinate station keeping activities with the satellite operator to avoid any risk of collision.

Combined, these systems constitute a best practice approach to collision avoidance.

§25.114(d)(14)(iv), Post-Mission Disposal Plans. At end-of-life, the T12 satellite will be removed from its geostationary orbit at 15° WL to an altitude with a perigee no less than 290.4 km above the standard geostationary orbit of 35786 km. This altitude is determined by using the FCC-recommended equation in section 25.283(a)[1] regarding end-of-life satellite disposal. The corresponding calculations for the T12 satellite are presented below:

Minimum De-orbit Altitude= 36021 km + (1000×CR×A/m) (Eq.1)
CR = solar pressure radiation coefficient of the spacecraft = 1.16
A/m = area to mass ratio, in square meters per kilogram, of the spacecraft = 0.04776
Result: (Eq.1) Minimum Deorbit Altitude = 36021 km + (1000×1.16×0.04776) = 36076.4 km which is 290.4 km above the geostationary orbit of 35786 km.

The propellant needed to achieve the minimum de-orbit altitude is based on the delta-V required. Based on an estimated end-of-life mass of 1600 kg, and the delta-V required, approximately 8.6kg of propellant will be reserved to ensure that the 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.

1

47 C.F.R. §25.283(a)

Propellant tracking is accomplished using a bookkeeping method consistent with industry standards. Using this method, 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.

Propellant Gauging System (PGS) tests can be performed throughout the operational life. 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 decreases, the accuracy of the test results increases. Therefore, operationally, the PGS tests will be performed as the satellite approaches its end of propellant life in order to verify bookkeeping results.