

This document contains the questions and responses posed in Correspondence Reference Number 31517, File Number 0053-EX-ML-2016.

**1. What is the anticipated orbital lifetime of the satellite in the event perigee lowering does not occur, i.e., decay from the initial circular orbit?**

The orbital lifetime is dependent on the area-to-mass ratio of the satellite, and thus is it dependent on the attitude of the satellite in orbit as well as its mass. For attitude in orbital lifetime predictions, we assume a random tumbling attitude of the satellite. With the propulsion tank filled (fully fueled), the resulting predicted orbital lifetime from the initial orbit would be 36.84 years (predicted by NASA DAS software). In the case of random tumbling but the propulsion fuel has been depleted, the predicted orbital lifetime would be 30.29 years.

**2. Please address the reliability of the perigee lowering maneuver(s).**

A propulsion maneuver is planned to lower the perigee of the orbit from 670 km to 485 km. The maneuver is accomplished by utilizing the on-board propulsion system, which is manufactured by Spaceflight Systems, Inc. (formerly Andrews Space Inc.) Although the Pathfinder satellites will be the first demonstration and utilization of the propulsion system in space, the propulsion system is a Technology Readiness Level (TRL) 6 system that has demonstrated flight worthiness throughout a series of qualification tests that concluded in 2015. The test approach for the development and qualification of the propulsion system included qualification testing to verify both the expected performance and environmental suitability. These tests included vibration testing; thermal vacuum testing, which included performance characterization under thermal vacuum conditions; pressure proof testing; and pressure burst testing. The qualification testing was successfully completed in the summer of 2015.

Additionally, pre-flight verification testing is to be conducted for each flight unit to verify performance of the as built configuration. The flight article verification is currently in progress for the Pathfinder-1 satellite. No test anomalies have been encountered to date with the flight articles. Flight article verification testing for the Pathfinder-1 satellite is scheduled to be completed during April 2016 and Spaceflight will notify the Commission at that time of any test anomalies that may be experienced.

Propulsion system testing has demonstrated that the system is expected to provide a total of 52 m/s  $\Delta V$ . A perigee lowering maneuver from 670 to 485 km will utilize 50 m/s  $\Delta V$ , thus we assumed utilization of nearly the full capacity of the propulsion system. The 670 x 485 km orbit is desired for operations. To meet a 25-year deorbit requirement, the perigee would need to be lowered only to 620 km. Lowering the perigee to 620 km, as opposed to the planned 485 km, requires only 13 m/s of  $\Delta V$ . Accordingly, since only 13 m/s is required and the system is expected to provide 52 m/s total, the system could dramatically underperform and still meet the 25-year standard.