Raytheon
CAGE CODE 15090
09/15/14

Orbital Debris Assessment Report
for the
SeeMe Satellite

25 February 2016

Prepared by:
Raytheon Company
P.O. Box 11337
Tucson, AZ 85734-1337

The Orbital Debris Assessment Report is prepared required by the Federal Communications Commission and is submitted to the FCC for operation approval of the SeeMe spacecraft as part of Raytheon's application for experimental license authorization to operate the satellite. The plan addresses aspects of the spacecraft mission, expected orbit life, and end-of-mission disposal relevant to orbital debris guidelines published by the U.S. Government and NASA.

Overview of Project:

The SeeMe satellite is a small imaging satellite with a 0.2 meter x 0.2 meter base unit to which a 0.6 meter x 0.309 meter telescope is attached. See Figure 1 below. The cross section of the satellite used for this assessment is the maximum cross section of the satellite. The cross section measurement of the satellite is the same for the maximum, minimum, and average cross sections of the satellite, because the satellite was designed to mimic a cube. The satellite has been compiled from commercial off the shelf components as part of a demonstration of how a small, quickly deployable satellite could be used to provide imaging and communications in an emergency.

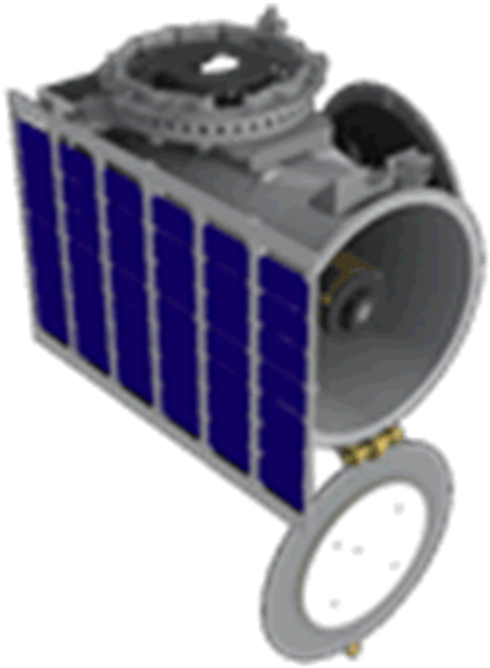

Figure 1. Image of demonstration satellite under development

During launch, the SeeMe satellite is attached to and property of the DARPA Phoenix/eXCITe satellite via a Lightband system from Planetary Systems Corporation (PSC). The separation system generates no debris during normal operation.

The SeeMe satellite will be fully contained in the Phoenix/eXCITe satellite during and after the satellite launch. No debris release is expected unless there is a catastrophic event during the rocket launch.

Approximately three weeks after deployment of the Phoenix/eXCITe satellite, the SeeMe satellite will be released into its orbit. The SeeMe satellite is expected to operate in an elliptical orbit with apogee at 720 km and perigee at 450 km. The inclination is 98°. No orbit maintenance is performed due to a lack of propulsion. Normal orbit perturbation and altitude degradation will occur over the course of the satellite orbit lifetime which is estimated to be approximately 7 years.

1. **Limitation of debris released during normal operations.**

   No planned release of debris.

2. **Accidental Explosions: limit probability of accidental explosion during mission operations and passivate to limit probability of accidental explosion after end of mission.**

   The satellite has no propulsion or pressurized devices mitigating the risk of accidental explosion generating unintended debris.

3. **Intentional Breakups: Limit number, size, and orbital lifetime of debris larger than 1 mm and 10 cm (includes tests involving collisions or explosions of flight systems and intentional breakup during space system reentry to reduce the amount of debris reaching the surface of the earth).**

   There are no tests involving collisions or explosions of the flight systems. Therefore, no debris is anticipated from intentional breakups.

4. **Collisions with large objects during orbital lifetime: Assess probability of collision with intact space systems or large debris (>10 cm).**

   The NASA DAS simulator indicates a 0.00000 probability (zero to within the evaluation capability of the DAS tool) of collision with large objects, meeting the applicable 4.5-1 requirement: Probability of Collision with Large Objects.

5. **Collisions with small debris during mission operations: Assess and limit the probability of damage to critical components as a result of impact with small debris.**

   The NASA DAS simulator indicates compliance with requirement 4.5-2: Probability of Damage from Small Objects. This indicates the resulting probability of accidental collision with debris or meteoroids is less than 0.01.

6. **Minimization of the potential for on-orbit break-ups.**

The body of the vehicle is made from one continuous piece of metal. The likelihood of the vehicle breaking up on its own is extremely low. Having the vehicle impact something on orbit would be the only opportunity for the vehicle to break up on orbit.

The system has a gyroscope, but no propulsion. The program will minimize cross-sectional area if warned by NORAD of a need to do so to avoid collision. Further, Raytheon will implement a procedure for notification to the Joint Space Operations Center "JSpOC" of upcoming orbits and other relevant data to allow better collision avoidance by all space vehicles. Raytheon's JSpOC point of contact is:

Further, Raytheon affirms its commitment to working with other US satellite operators to ensure the maximum operator-to-operator cooperation.

7. Post-mission disposal:

The post-mission disposal plan has been reviewed and approved by NOAA.