APRIZE SATELLITE
Smart Data for the Long Haul

3554 Chain Bridge Road
Suite 103
Fairfax, Virginia
22030

V. 703-352-9728
F. 703-273-7011

www.aprizesat.com

**TO:** Federal Communications Commission

**ATTN:** Mr. Anthony Serafini

**DATE:** November 12, 2010

**REF:** FCC File # 0084-EX-ML-2010

**SUBJ**: EduSat Debris Mitigation

## Background:

Aprize Satellite Inc. ("Aprize") is a small business concern, which is independently owned and financed by its two founders, Dr. Dino A. Lorenzini and Mr. Mark Kanawati. The overall goal of Aprize is to develop, deploy, and operate a constellation of low-Earth orbit satellites to provide fixed and mobile data services at affordable prices to satisfy critical remote monitoring requirements for homeland security and in-transit visibility. Experimental work to date has shown significant promise that an affordable space network can be built and operated with a modest investment of capital and expanded as necessary to meet customer demand for satellite services. Aprize holds an experimental license to use and operate the radio transmitting facilities of six AprizeSat satellites and is now seeking authorization to add to its license an Aprize hosted payload on the EduSat satellite.

SpaceQuest, Ltd., the technology provider of Aprize, provided the components to the University of Rome for construction EduSat. In return for special pricing, the University offered to host an Aprize payload aboard EduSat. The Aprize hosted payload is totally separate from the Italian program. Operation of the payload is completely under U.S. control and uses different frequencies. The Aprize payload aboard EduSat will use the same frequencies previously approved by the FCC for the AprizeSat 1-6 satellites, namely 400.505-400.645 MHz and 2200-2310 MHz. The purpose of these satellites is to validate its spacecraft technology and to develop, evaluate and advance satellite data communications applications such as space-based Automatic Identification System (AIS) services, which will greatly expand the visibility of vessel traffic throughout the world's waterways beyond the typical 50 nautical mile limit of ground-based AIS receivers. With access to space-based AIS global data, national governments will be able to achieve a level of maritime domain awareness that could significantly impact their security, safety, economy, or environment, including identifying threats as early and as far from their shores as possible. The experimental tests and demonstrations of this and other applications will be conducted by SpaceQuest, Ltd. on behalf of Aprize using SpaceQuest's experimental ground station licenses. SpaceQuest has submitted a modification to its FCC license (0086-EX-ML-2010) to access the Aprize payload on EduSat.

After considering the possibility of orbital debris and contamination, the following information is provided by Aprize with respect to the EduSat satellite.

## Technical Information:

The Italian EduSat spacecraft will be disposed of by uncontrolled atmospheric re-entry. The time needed for the spacecraft to reenter the atmosphere and burn up will be shortened significantly by the deployment of an experimental drag chute, which will increase the effective cross section area of the satellite. The drag chute was developed by the University of Rome as a compact, low-cost, minimally invasive technique to reduce the orbital duration of small satelites. The deployment of the sail is completely passive as it is obtained by the corrosion of an 'L-shaped' string. When the string is fully corroded the bindings return to their original shape stretching the sail.

1. Due to the small size of EduSat (32-cm cube) and soft metal structure (Aluminum), the entire satellite will burn up and be consumed due to atmospheric heating. No large or small pieces of the spacecraft will survive to the Earth's surface.

2. There is 0% probability of human casualty resulting from surviving fragments of the satellites due to the fact that all pieces will disintegrate during atmospheric re-entry.

3. These conclusions are based on the formulas and calculations in NSS 1740.14, *NASA Guidelines and Assessment Procedures for Limiting Orbital Debris*, dated August 1995.

4. The assumptions and parameters used in developing the estimates are:
   a. Apogee 700 km
   b. Perigee 643 km
   c. Inclination 98.25 degees
   d. Mass 10 kg
   e. Area 0.202 $m^2$
   f. Appendages 4 fixed antenna elements.
   g. Area/Mass 0.02 $m^2$/kg

5. Analytical results from the NASA Debris Assessment Software (See Figure 1) confirm that EduSat satisfies all of the FCC Requirements for Limiting Orbital Debris including:
   a. Mission-Related Debris Passing Through LEO
   b. Mission-Related Debris Passing Near GEO
   c. Long-Term Risk from Planned Breakups
   d. Probability of Collision With Large Objects
   e. Probability of Damage from Small Objects
   f. Postmission Disposal
   g. Casualty Risk from Reentry Debris

6. The NASA Debris Assessment Software results show that without the use of a deorbiting mechanism EduSat will reenter the atmosphere and burn up in 19 years (See Figure 2.)

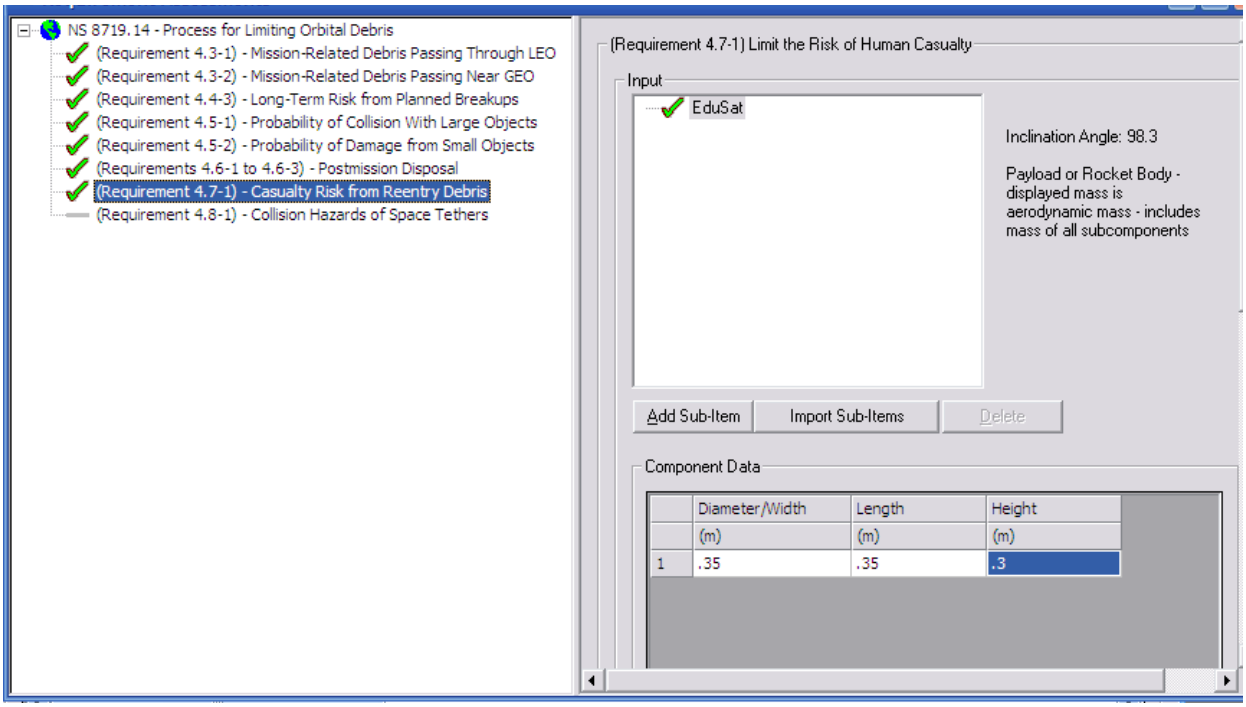



***Figure 1. EduSat Meets All of the NASA Debris Assessment Requirements***

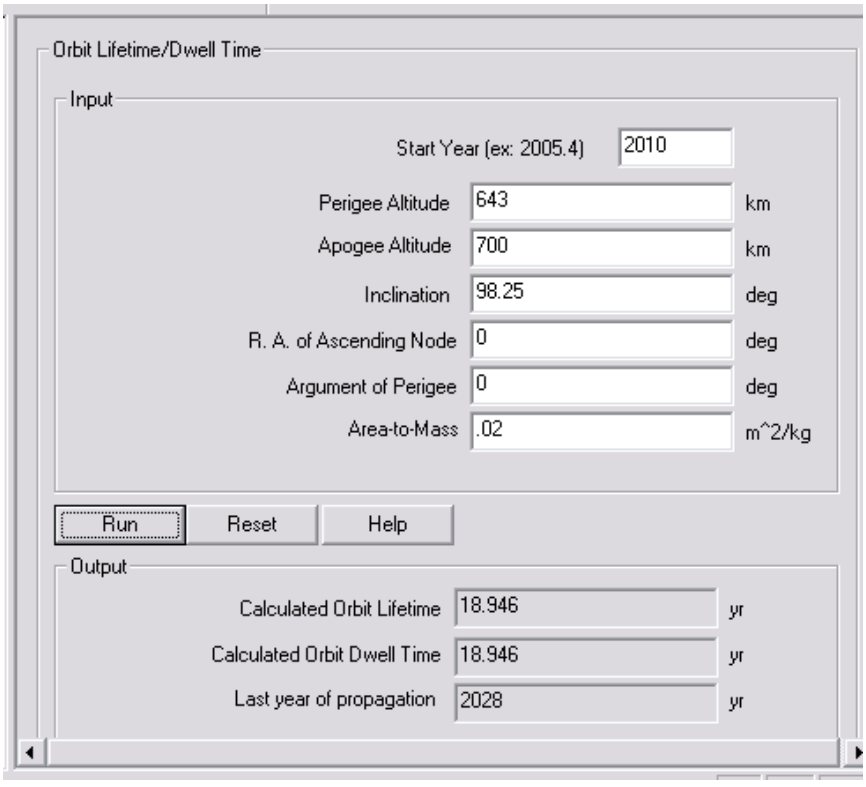



***Figure 2. EduSat will have a Total Orbit Lifetime of 19 years.***

## Orbital Debris Mitigation Requirement Analysis Results

In accordance with the ***U.S. Goverment Orbital Debris Mitigation Standard Practice***s, the following information regarding the operation of EduSat is hereby submitted:

**Requirement 1. Control of Debris Released During Normal Operations.**

1-1. *For all operational orbit regimes:* EduSat is designed to eliminate the release of any debris larger than 5 mm in any dimension during its orbital lifetime.

**Requirement 2. Minimizing Debris Generated by Accidental Explosions.**

2.1. *Limiting the risk to other space systems from accidental explosions during mission operatons:* EduSat has no on-board fuels, no explosives, or pressure vessels. The only stored energy on board the satellites is contained in the six nickel-cadmium batteries, which are non-explosive and will be fully discharged at end-of-life. Similar nickel-cadmium cells have been used successfully on many small satellite programs without incident. Thus, EduSat will not generate additional sources of debris.

2.2. *Limiting the risk to other space systems from accidental explosions after completion of mission operations:* After completion of its mission operations, EduSat will remain dormant until it re-enters the atmosphere and disintegrates during its return to Earth.

**Requirement 3. Selection of Safe Flight Profile and Operational Configuration.**

3.1 *Collision with large objects during orbital lifetime:* The probability of EduSat colliding with an object larger than 1 meter is less than 0.001% as shown in Figure 3.

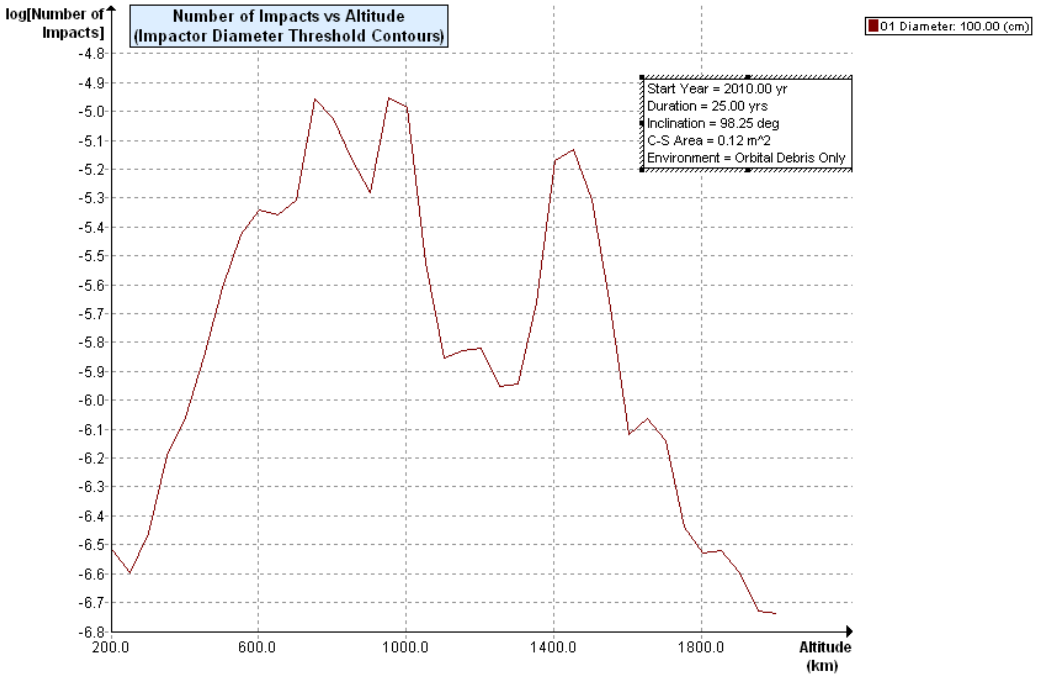



***Figure 3. Log Number of Impacts of 1 Meter Objects Vs. Altitude***

3.2 *Collision with small debris during mission operations*: Collision with debris smaller than 1 cm diameter will not prevent post-mission disposal as EduSat will reenter the atmosphere without any action taken by the spacecraft itself. Figures 4, 5 and 6 show the probability of impact with space debris.

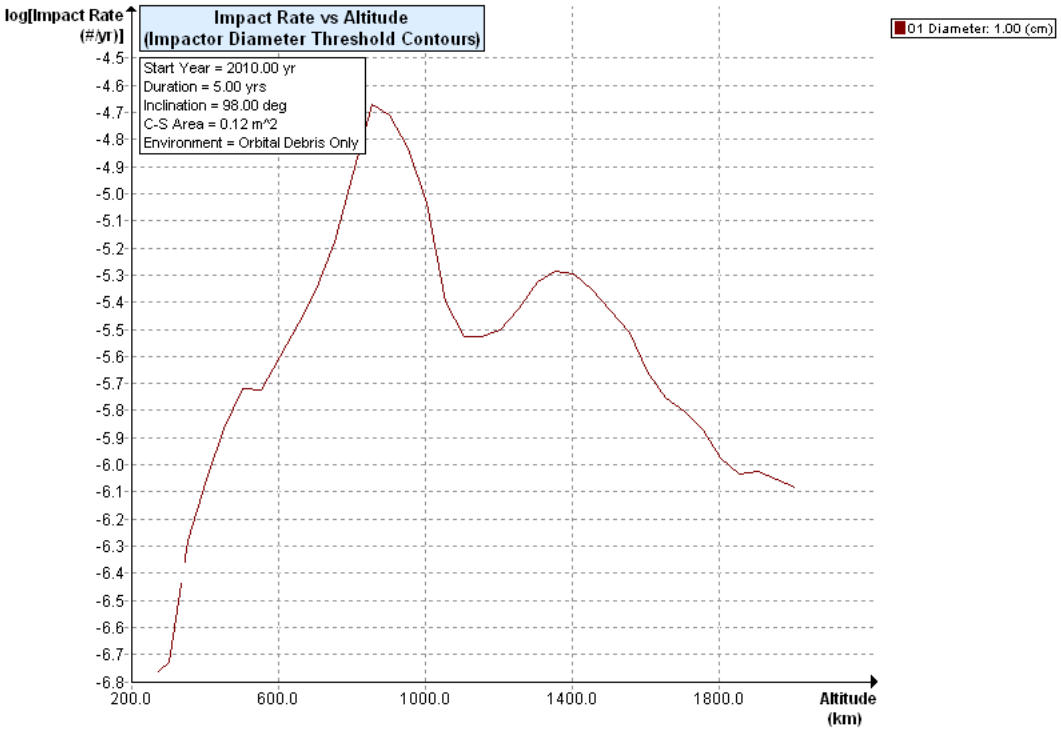



***Figure 4. Log Impact Rate (#/yr) of 1 cm Particles vs. Satellite Altitude***

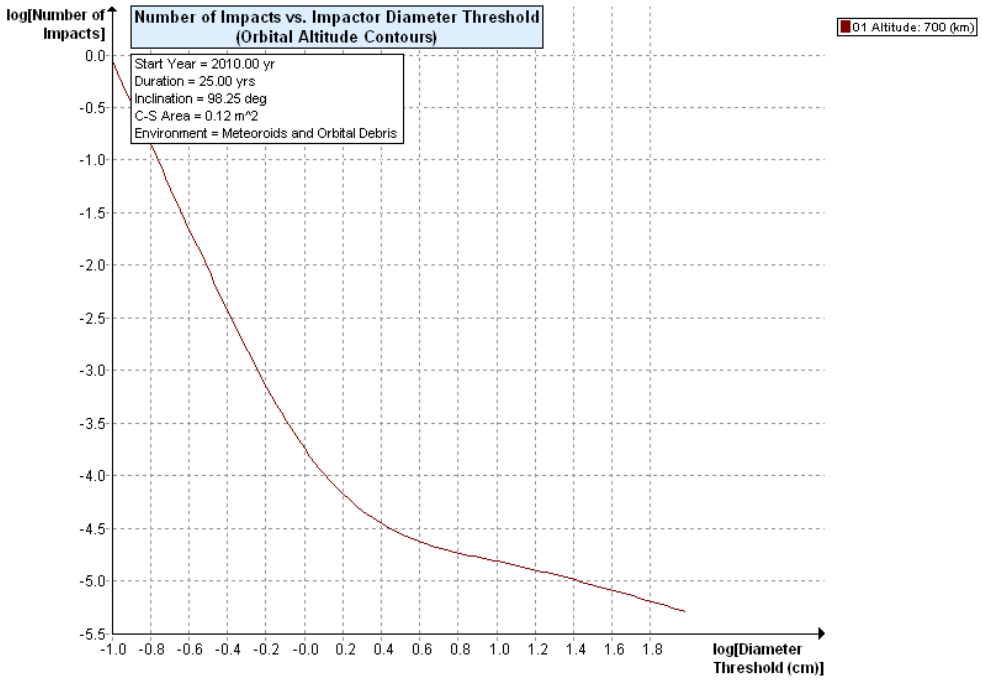



***Figure 5. Log Number of Impacts vs. Log Diameter of Particles***

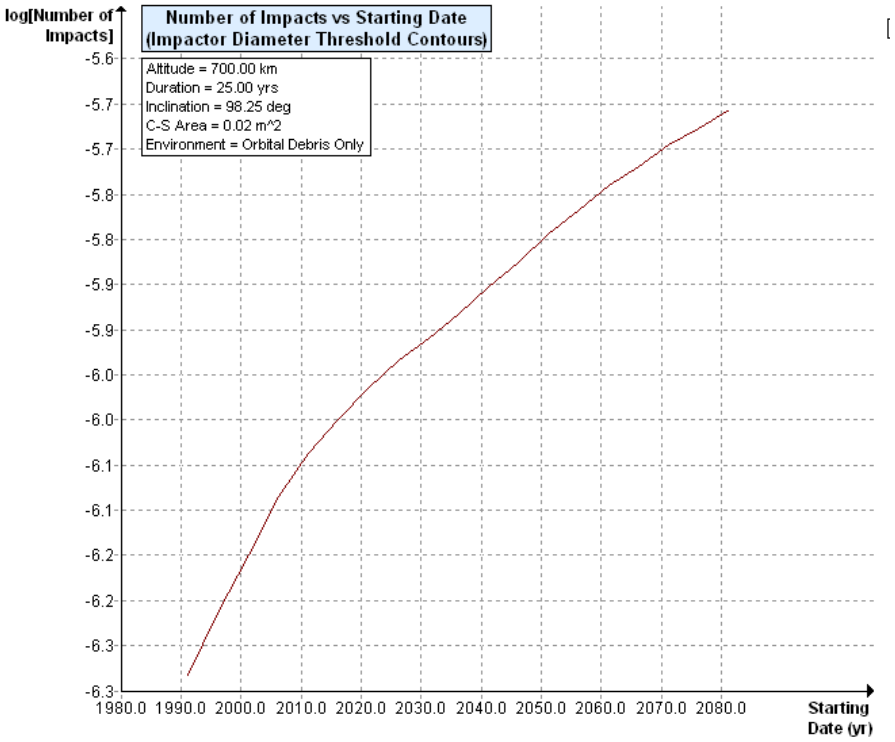



***Figure 6. Log Number of Impacts vs. Time***

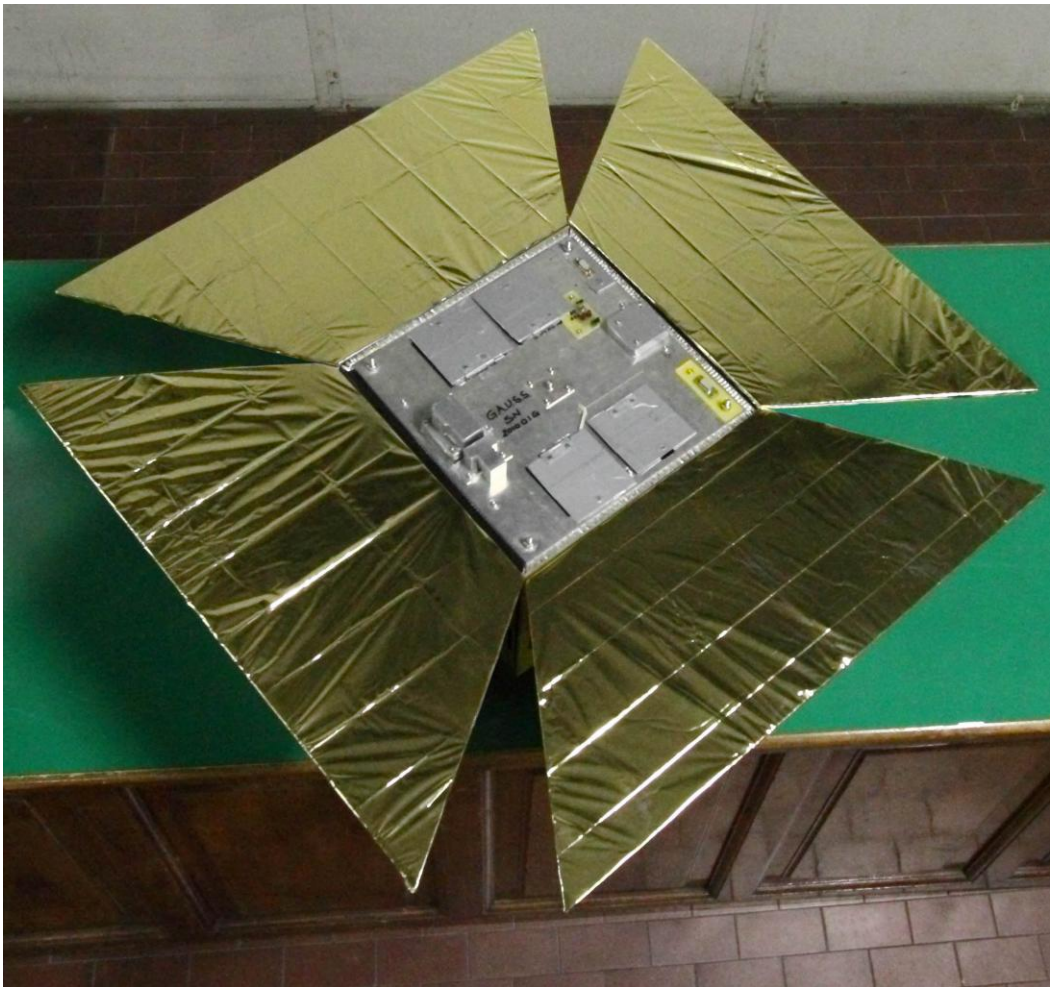
3.3 *Tether systems:* Edusat has a deployable deorbit mechanism, but does not deploy a tether.

**Requirement 4. Postmission Disposal of Space Structures.**

4.1 *Disposal for final mission orbits:*

a. Atmospheric reentry option: The requirement is to "Leave the structure in an orbit in which, using conservative projections for solar activity, atmospheric drag will limit the lifetime to no longer than 25 years after completion of mission." Using conservative projections for solar activity and atmospheric drag, the total orbital lifetime of EduSat will be about 19 years without the aid of the deorbiting drag chute. (See Figure 7)

EduSat is equipped with a deorbiting device that will be deployed by natural means within 5 years following orbital insertion. A photo of the device is shown below. The drag device will increase the overall satelite surface area by 0.36 square meters. If the experimental deorbit mechanism works as planned, EduSat will deorbit and burn up in less than 9 years following deployment. (See Figure 8)



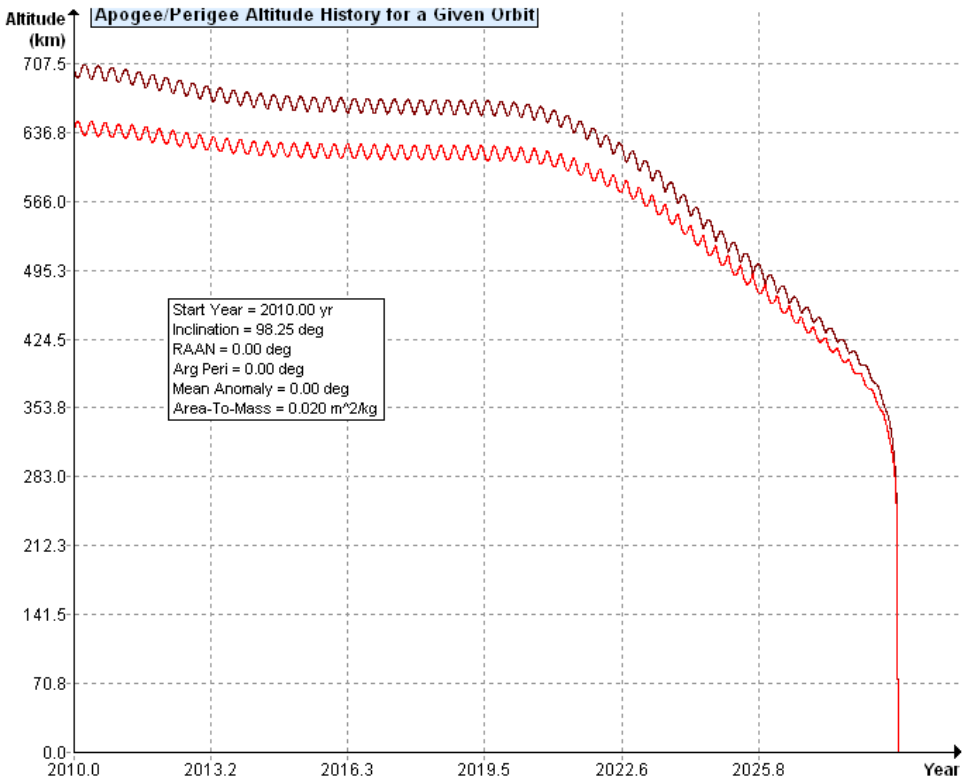



***Figure 7. NASA DAS Predicts EduSat Will Decay in About 19 years.***

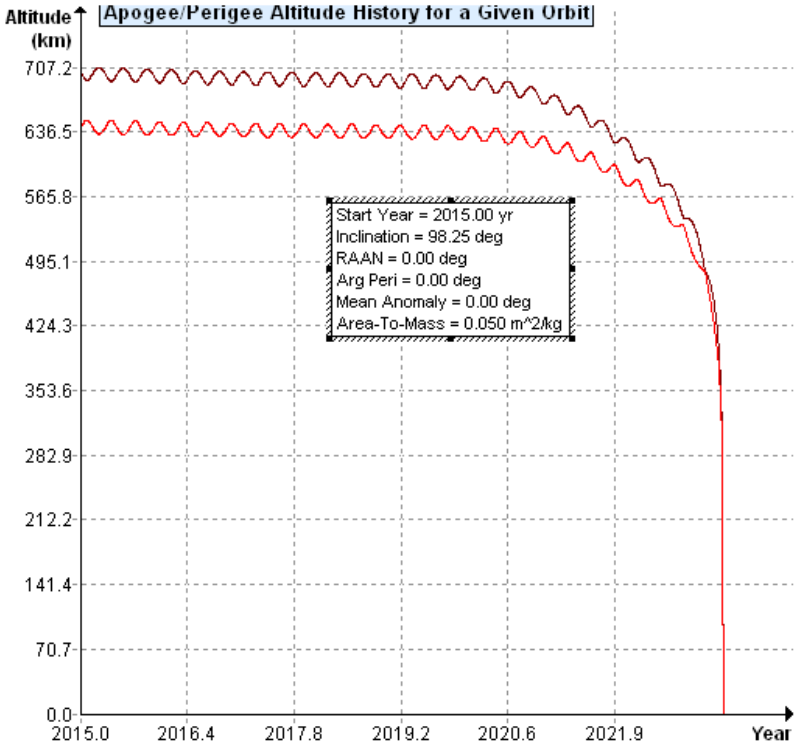



***Figure 8. Orbital Lifetime of EduSat following deorbit device deployment is less than 9 Years.***

Atmospheric reentry option: The requirement is that "If a space structure is to be disposed of by reentry into the Earth's atmosphere, the risk of human casualty will be less than 1 in 10,000." According to the calculations made with the NASA Debris Assessment Software there will be no risk of human casuality as the small spacecraft will completely disintegrate at an altitude of 58.8 km during reentry. The results of these calculations are shown in Figure 9.

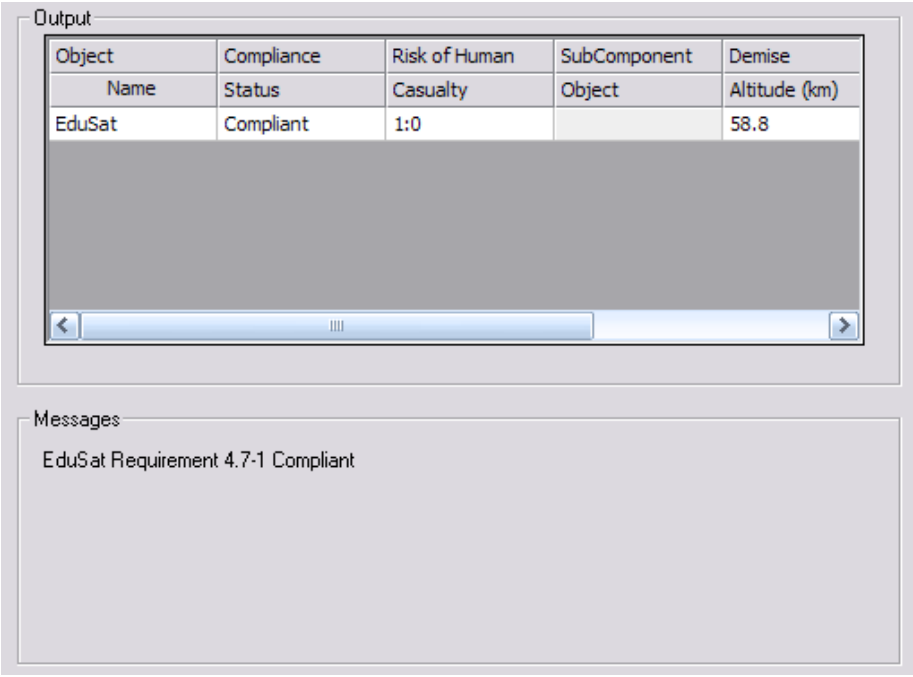



***Figure 9. EduSat Will Burn Up and Disintegrate at an Altitude of 58.8 km***

b. Maneuvering to a storage orbit: Not Applicable

c. Direct retrieval: Not Applicable

4.2 *Tether systems*: Not Applicable

Sincerely,

Dino A. Lorenzini
President, Aprize Satellite Inc.