0501-EX-PL-2008
CORRESPONDENCE RESPONSE
REFERENCE NUMBER: 8566

MOPS.510.03

Revision	Date	Authored by	Description
MOPS.510.01	05/21/2009	David A. Ferguson	Initial Release
MOPS.510.02A	05/28/2009	David A. Ferguson	Additional Questions Rev 2A
MOPS.510.02B	05/28/2009	David A. Ferguson	Question Order, Formatting and Notes for Cal Poly Telecon
MOPS.510.03	06/15/2009	David A. Ferguson	Drawings and Final Edits

Approvals:

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Mission Operations Date

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Subsystem Team Lead Date

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Project Manager/Systems Engineer Date

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1 Document Overview

The following document serves as a response to correspondence received from the FCC in reference to the experimental license 0501-EX-PL-2008. The correspondence lists detailed questions that require a detailed response. The questions are as follows:

1.1 *Correspondance Questions*

Our International would like to have answers to the following questions:

1) In calculating the satellite orbital dwell time, the application indicates that two different values were used for the area of the satellite. In one case, a value 0.02 m^2 was used while in another case a value of 0.2m^2 was used. Is this a typographical error? Which value was used for each calculation? What is the basis for the use of these particular values? 2) What is the maximum aspect area of the satellite? Minimum? 3) What measure(s) have been taken to avoid collision with other objects in space? Would the satellite have any propulsion capabilities? 4) What is the failure rate of satellites using this bus, i.e. how many have no mission life, or fail within a day or two after launch? How many operate successfully through their full design life? What steps, if any, have been taken to identify and address failure modes? 5) Is the 1 kg weight an estimate or a measured value ? If a measured value, please indicate the actual weight of the satellite, to three decimals of accuracy. 6) What is the reliability of the deployment mechanism of the antenna system? How does the deployment mechanism work? 7) Can you provide any more detail about the launch? What launcher? Are the altitudes specified in the application still accurate? What is the reliability/accuracy of the orbital insertion? 8) Has the University's submission been peer reviewed?

The items indicated above must be submitted before processing can continue on the above referenced application. Failure to provide the requested information within 30 days of 05/26/2009 may result in application dismissal pursuant to Section 5.67 and forfeiture of the filing fee pursuant to Section 1.1108.

1.2 *Referenced Documents*

[1] Hermes Cubesat Orbital Debris Mitigation Plan: 12/2008 original document submitted on behalf of 0501-EX-PL-2008.

[2] NASA Debris Assessment Software Version 2.0.1 (http://orbitaldebris.jsc.nasa.gov)

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1. Additional Orbital Debris Analysis

The cross sectional area defined in the original orbital debris analysis[1] submitted on December 2008 is an estimate for a tumbling Cubesat. Through the original analysis an estimate of 0.02 m^2 aspect area was used with a 1.000 kg mass. This provided a 13.17 year orbital lifetime for our preceding analysis. The new analysis is for a worst case constant aspect area orbit.

Worst case orbital debris analysis using a constant minimum cross section for Hermes with the NASA Debris Assessment Software Version 2.0.1[2] indicates a dwell time of 23.628 years, which is below the maximum allowable 25 years.

Table 1: Hermes Physical Parameters Used in Orbital Debris Analysis

Hermes Cubsat Mission Physical Parameter	Physical Parameter Value
Final Mass Estimate	0.990 [kg]
Current Mass Total	0.986 [kg]

Table 2: Hermes Orbital Parameters Used in Orbital Debris Analysis

Hermes Cubsat Mission Orbital Parameter	Orbital Parameter Value
Orbital Altitude	643 [km]
Orbital Inclination	97.9 [degrees]
Launch Date	2010.06 [January 22, 2010]
Area-to-Mass ***(worst case)***	0.0109 [m^2 / kg]
Orbital Lifetime ***(worst case)***	23.63 [years]

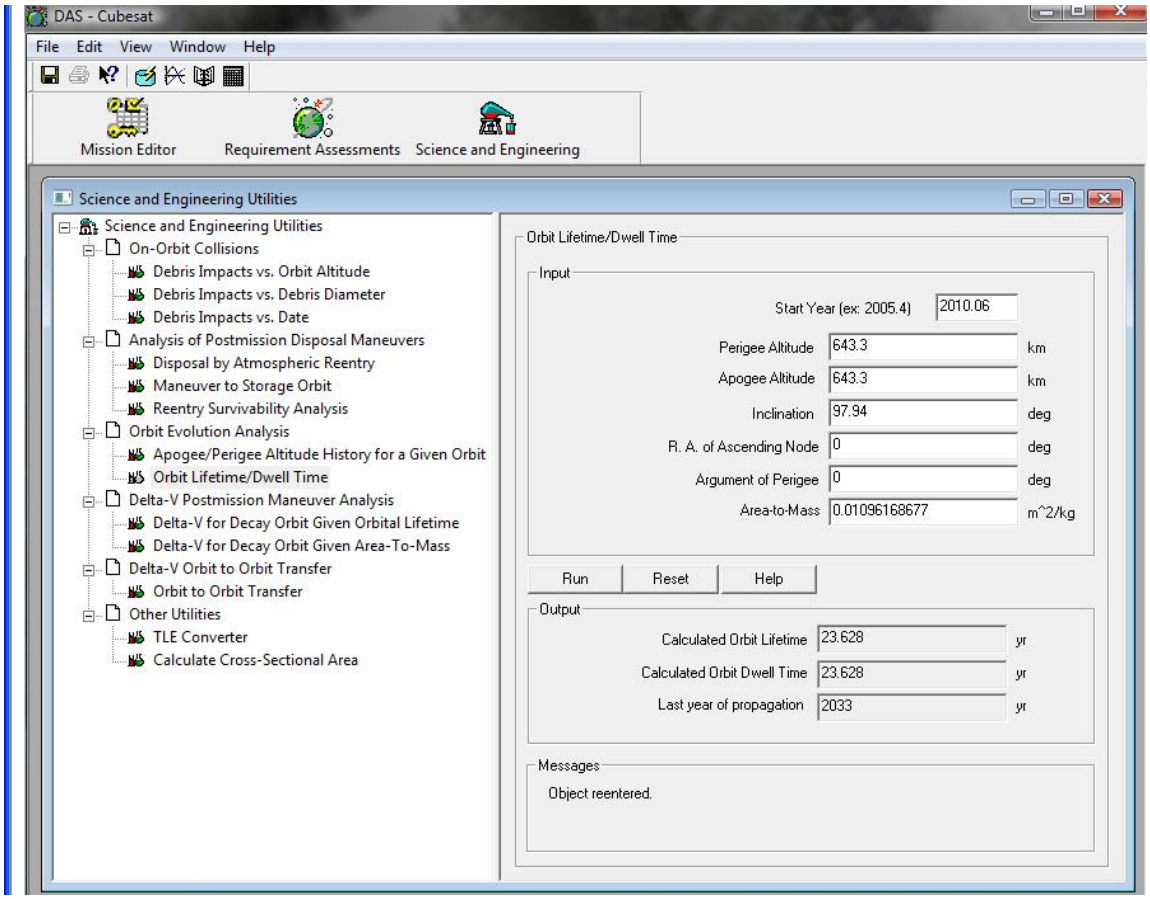

Figure 1: NASA Debris Analysis Software Worst Case Analysis

2. Hermes Area Measurements

The maximum aspect area of Hermes Cubesat is 0.0213 m^2, which requires a satellite orientation such that the diagonal corner of Hermes is fixed in the ram direction of the orbit.

The minimum aspect area of Hermes Cubesat is 0.0108 m^2, which requires a satellite orientation such that the smallest side panel faces directly into the ram direction of the orbit. Further analysis of this worst case configuration was complied using NASA Debris Assessment Software Version 2.0.1[2]. Since this software does not include random tumbling generation for a cube, the estimate of 0.02 m^2 was used in the original analysis[1].

Cross sectional area for Hermes is determined from measurements of the flight structure using digital calipers to an accuracy of 0.001mm. These measurements do not include the deployed antennas. However, the deployed antennas will assist in the orbital decay of Hermes.

3. Collision Avoidance

Hermes is a passively controlled satellite and is launching with two other Cubesats from other universities.

Hermes has absolutely no propulsion capabilities, and has passive alignment control with a magnetic system.

4. Mission Life Justification

The Hermes project's main purpose is to create a primary power and communications system for future Cubesat projects. The S-Band communications system is vital to the research and development of future Cubesat projects. The S-band communications system will streamline data acquisition enabling more complex science missions in the future. During this research and development timeline this project has touched hundreds of undergraduate and graduate engineering students of various disciplines. It is imperative that projects like Hermes are sustained.

The Hermes bus is the first of its kind designed entirely by graduate and undergraduate research with multiple peer revisions and industry review. There is currently no flight heritage for the Hermes bus. The Hermes bus will undergo a launch readiness review (LRR) where both faculty advisors and industry professionals will issue a flight readiness certification.

In addition to research opportunities and student access to space utilizing a LEO satellite, Hermes Cubesat is crucial to workforce development of engineering students in the university. Also, the Cubesat program is a nationally recognized NASA program. Furthermore success rate of the CalPoly Cubesat program has shown 90% of satellites chosen for a domestic launch succeed upon orbit.

5. Hermes Mass

The mass budget update as of 5/28/09 indicates Hermes has a mass total of 0.986 kg. An estimated 0.004 kg of staking materials is to be added in the final integration of the satellite bringing the final configuration mass total to 0.990 kg.

6. Antenna Deployment Mechanism

The Hermes antennas are secured directly to the structure. Dacron is tied to both the antenna and structure to secure each antenna in a stowed configuration for transport and launch. Nichrome wire is wrapped around a portion of the Dacron.

Following a delay after launch, Hermes CDH systems will initiate a burn sequence which will send an electrical current through the nichrome wire. This will heat the nichrome significantly and burn through the dacron holding the antenna in the stowed configuration. All parts of the dacron will remain attached to the Hermes structure following the burn sequence. This sequence will deploy the Hermes antennas. This method has been tested with 100% success in a vacuum chamber at six separate instances.

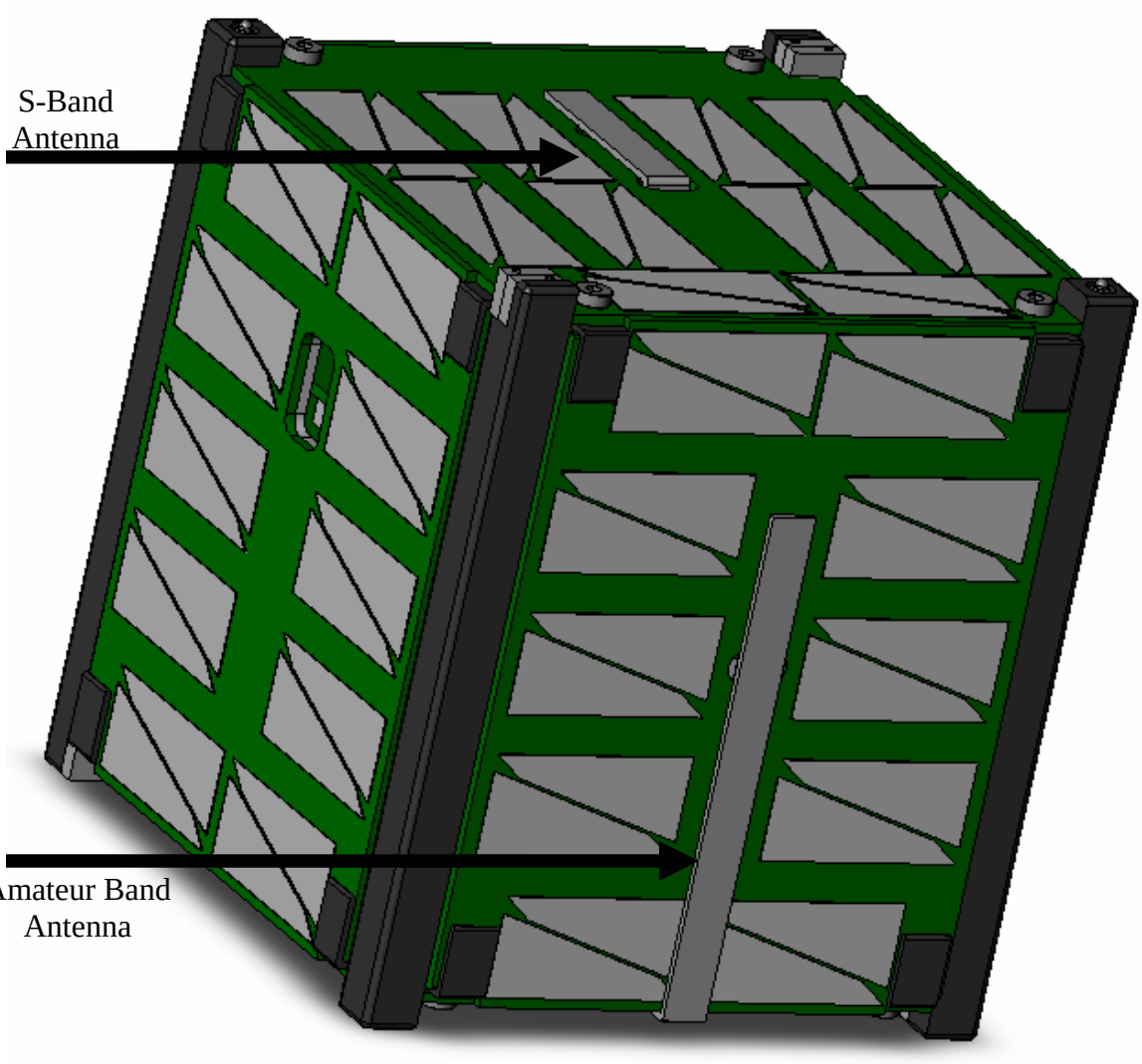

Figure 2: Stowed configuration of Amateur Band Antenna and S-Band Antenna

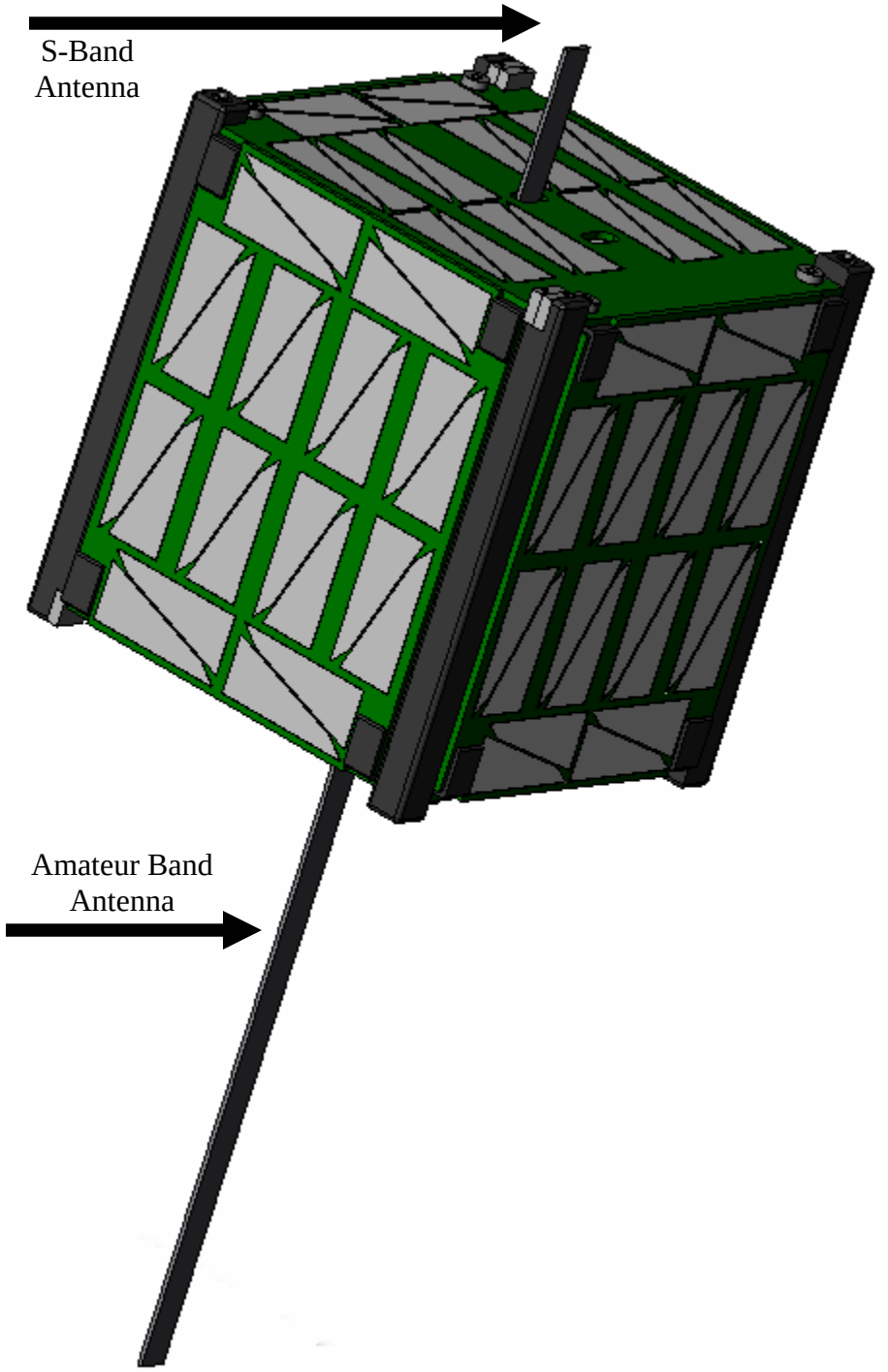

Figure 3: Deployed Configuration of Amateur Band Antenna and S-Band Antenna

7. Orbital Insertion

Other than the provided parameters, additional launch information is currently not made public.

The information provided in the original orbital debris analysis document is accurate.

The inclination provided from the domestic launch is 97.9 deg and the altitude is 643 km.

How accurate are we deployed? ASK ROLAND!

How much info can/should we supply to the FCC?!

8. Peer and Industry Review

The Hermes Cubesat project has undergone 3 years of R&D utilizing hundreds of undergraduate and graduate students at the University of Colorado through the Colorado Space Grant Consortium (COSGC). During these three years, the satellite has been designed from the ground up including failure mode analysis and extensive testing.

Upon competitive review of 6 university Cubesats, the Hermes mission was one of three selected following a NASA design review in June of 2008 to launch aboard a domestic launch provider in the first quarter 2010.