ORBITAL DEBRIS ASSESSMENT REPORT FOR MILES CUBESAT

September 21, 2016

Orbital Debris Assessment Report for Miles CubeSat

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Approved By: ________________________________ Date: _________
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Approved By: ________________________________ Date: _________
Mission Directorate Associate Administrator

Approved By: ________________________________ Date: _________
NASA Chief, Safety and Mission Assurance.

TEAM MILES ORBITAL DEBRIS ASSESSMENT REPORT LOG

Document Revision	Person Responsible	Effective Date	Description
Initial	D. Smith	09/21/2016	Orbital Debris Assessment Report released

DAS not used, planned mission is outside of DAS's parameters. GMAT used to calculate Orbit.

No information in this document is proprietary.

Table of Contents

1.0 Project Management and Mission Overview

1.1 Identification of Mission Directorate

Team Miles plans to launch the Miles CubeSat as part of the secondary payload on the NASA SLS-EM1 mission with the goal of completing the Farthest Communication Distance from Earth prize as part of the Deep Space Derby of the NASA CubeSat Challenge. The planned deployment from SLS is “Bus Stop 5”, beyond the Moon, 411,900 km from Earth.

1.2 Identification of Project Manager and Personnel

Wesley Faler, Team Lead

Don Smith, Safety Engineer

1.3 Identification of any foreign government or space agency

No foreign government or Space Agency

1.4 Schedule of Mission Milestones from launch through EOM

Day	Time	Activity
1	00:00:00	Deployment (assumed time), Separation switches close to apply power.
	00:00:01	Power is supplied to 555 timers that act as a 30 second time delay inhibit.
	00:00:30	CPU is switched on. Internal checks performed on gyros, accelerometers, solar panels, batteries, and star tracker cameras
	00:10:00	Solar panels are deployed
	00:20:00	Power is supplied to RF system and transmission begins
	00:30:00	Activate ACS System, Star Trackers, Sun Sensors, Tank heaters and Temperature Sensors
	00:40:00	Start propulsion system and begin Attitude Stabilization
3	00:00:00	Calculate burn plan for deep space
	00:40:00	Execute Burn Plan for deep space
4-199		Spend 20 hours in 25-minute burn, 5-minute Attitude Stabilization
4-199		Spend 4 hours in communication mode – ¾ transmitting data, ¼ receiving data
200	00:00:00	Execute Storage Orbit Insertion Burn Plan. Actual time determined by flight computer.
200+	00:00:00	Storage Orbit attained in deep space. Initiates End of Mission Sequence and depowers. Actual time determined by flight computer.

1.5 Brief Description of Mission

Team Miles plans to launch a CubeSat as part of the secondary payload on the NASA SLS-EM1 mission with the goal of completing the Farthest Communication Distance from Earth prize as part of the Deep Space Derby of the NASA CubeSat Challenge. Using the innovative Constant-Q™ thrusters, the craft will autonomously calculate and execute a burn plan from booster deployment to deep space. A safe disposal orbit in deep space will be established.

1.6 Identification of the anticipated launch vehicle and launch site

SLS at Launch Pad 39A, Kennedy Space Center

1.7 Identification of the proposed launch date and mission duration

Launch date 7/31/18, 200 days

1.8 Description of the launch and deployment profile

N/A Transfer to SLS ODAR

1.9 Reason for selection of operational orbit(s)

N/A Transfer to SLS ODAR

1.10 Identification of any interaction or potential physical interference with other operational spacecraft

N/A Transfer to SLS ODAR

2.0 Spacecraft Description

2.1 Physical description of the spacecraft

14 kg, 6U CubeSat. Total of 6 2x3U Solar panels will deploy, 3 each attached to the top and base plate of the craft, in a forward-facing attitude.

2.2 Detailed illustration of the entire spacecraft in the mission operation configuration with clear overall dimensional markings and marked internal component locations

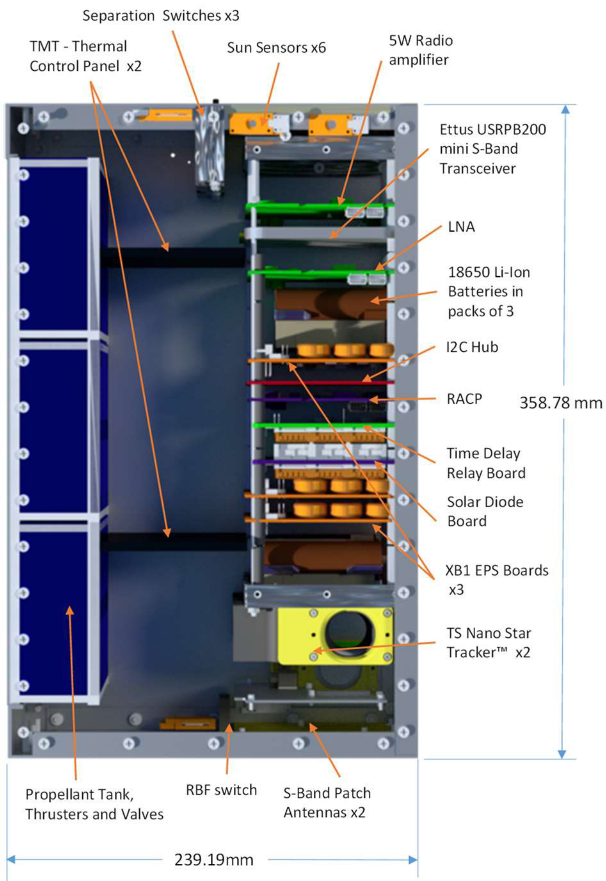

Figure 2-1 Notated Internal Craft

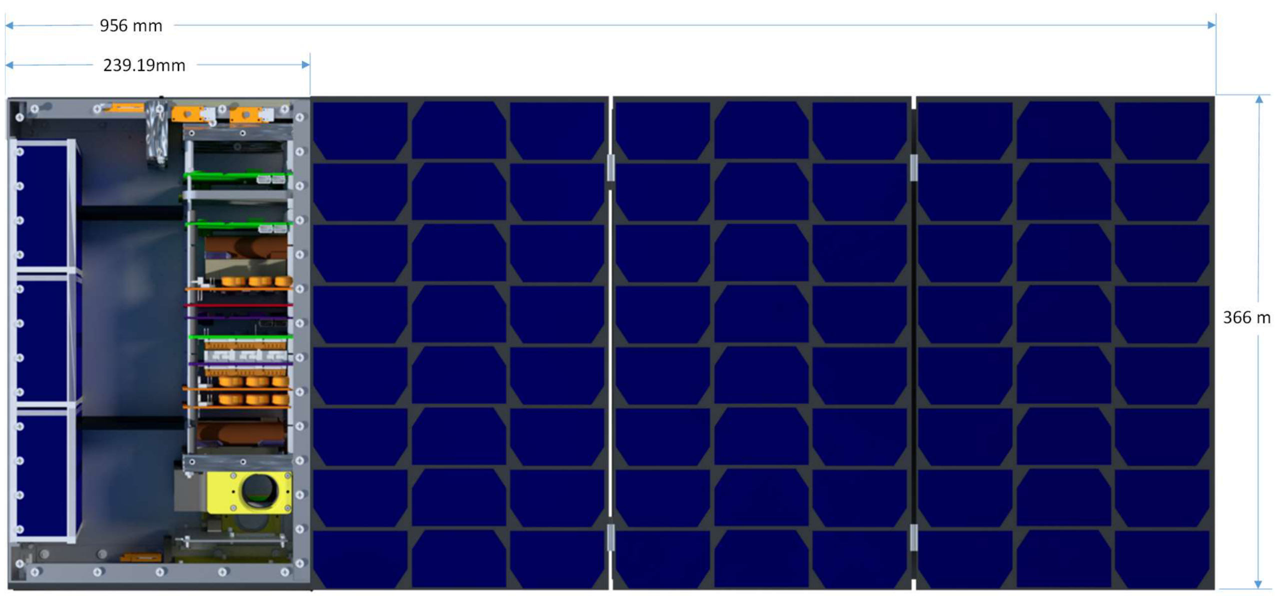

Figure 2-2 Dimensions of Craft w/Solar Panels

2.3 Total spacecraft mass at launch

Wet Mass 14 kg.

2.4 Dry mass of spacecraft at launch

Dry Mass 10 kg.

2.5 Description of all propulsion systems

Iodine crystals, sublimated into vapor using heat.

2.6 Identification, including mass and pressure, of all fluids (liquids and gases) planned to be on board

4kg iodine crystals contained in a pressurized system consisting of propellant tank and valves. No plumbing. **Iodine tank shall be designed to an FoS 2.0 nominal pressure. The valves shall be designed to an FoS of 2.5 nominal pressure (line item d. Other components and their internal parts) per table 6-1 SLS-RQMT-216.**

2.7 Description of all active and/or passive attitude control system

Propulsion system includes 12 ConstantQ™ thrusters, arranged as 6 vertical pairs. Controlled by the ADCS software, they can be used in pairs, or singly to affect pitch, roll and yaw.

2.8 Description of any range safety or other pyrotechnic devices

None

2.9 Description of the electrical generation and storage system

6 2x3U deployed Solar Panels, 9 18650 Li-Ion batteries.

2.10 Identification of any other sources of stored energy not noted above

None

2.11 Identification of any radioactive materials on board or make a positive statement that there are no radioactive materials onboard

N/A – No radioactive materials on board.

3.0 Assessment of Spacecraft Debris Released During Normal Operations

3.1 Identification of any solid object (>1mm) expected to be released from the spacecraft

N/A

3.2 Rationale/necessity for release of each object

N/A

3.3 Time of release of each object, relative to launch time

N/A

3.4 Release velocity of each object with respect to spacecraft

N/A

3.5 Expected orbital parameters (apogee, perigee, and inclination) of each object after release

N/A

3.6 Calculated orbital lifetime of each object, including time spent in Low Earth Orbit (LEO)

N/A

3.7 Assessment of spacecraft compliance with Requirements 4.3-1 and 4.3-2

N/A

4.0 Assessment of Spacecraft Intentional Breakups and Potential for Explosions

4.1 Identification of all potential causes of spacecraft breakup during deployment and mission operations

N/A because of distance of deployment

4.2 Summary of failure modes and effects analyses of all credible failure modes which may lead to an accidental explosion

N/A because of distance of deployment

4.3 Detailed plan for any designed spacecraft breakup, including explosions and intentional collisions

N/A because of distance of deployment

4.4 List of components which are passivated at EOM. List includes method of passivation and amount which cannot be passivated.

Power charging from Solar panels is cut off, propulsion is cut off. The 9 Li-Ion batteries will be fully drained transmitting data.

4.5 Rationale for all items which are required to be passivated, but cannot be due to their design.

N/A

4.6 Assessment of craft compliance with Requirements 4.4-1 through 4.4-4

N/A because of distance of deployment

5.0 Assessment of Spacecraft Potential for On-orbit Collisions

5.1 Calculation of spacecraft probability of collision with space objects larger than 10 cm in diameter during the orbital lifetime of the spacecraft

N/A because of distance of deployment and planned orbit.

5.2 Calculation of spacecraft probability of collision with space objects

N/A because of distance of deployment and planned orbit.

5.3 Assessment of spacecraft compliance with Requirements 4.5-1 and 4.5-2

N/A because of distance of deployment and planned orbit.

6.0 Assessment of Spacecraft Post Mission Disposal Plans and Procedures

6.1 Description of spacecraft disposal option selected

At the end of the mission, scheduled for 200 days, the craft will enter a disposal orbit and prevent all power from flowing in the system. The end of mission command will be executed either by a special coded message from the ground station or as the final mission objective. All potential energy must be prevented from flowing in the craft and prevent the ability to collect and store any energy. A circuit on the diode board will be triggered, cutting solar cells off from the craft. As the craft will keep transmitting, batteries will drain until craft is dead.

6.2 Identification of all systems or components required to accomplish any post mission disposal operation, including passivation and maneuvering

CPU, Switch circuit on I2C Hub circuit board

6.3 Plan for any spacecraft maneuvers required to accomplish post mission disposal

N/A

6.4 Calculation of area-to-mass ratio after post mission disposal, if the controlled reentry option is not selected

$$Area = 0.35878m * 0.22344m + 3 * 0.35878m * 0.22344m = 0.32066m^2$$

$$Area - to - mass\ ratio = \frac{0.32066\ m^2}{11.5\ kg} = 0.02788\ {m^2}/{kg}$$

6.5 If appropriate, preliminary plan for spacecraft controlled reentry

N/A

6.6 Assessment of craft compliance with Requirements 4.6-1 through 4.6-4

N/A

7.0 Assessment of Spacecraft Reentry Hazards

7.1 Detailed description of spacecraft components if the atmospheric reentry option is selected

No re-entry planned.

7A Assessment of Spacecraft Hazardous Materials

7A.1 Summary of the hazardous materials contained on the spacecraft

6kg of iodine crystals

8.0 Tethers – Not Applicable

9.0 Launch Vehicle Description

Transfer to SLS ODAR

10.0 Assessment of Launch Vehicle Debris Released During Normal Operations

Transfer to SLS ODAR

11.0 Assessment of Launch Vehicle Potential for Explosions and Intentional Breakups

Transfer to SLS ODAR

12.0 Assessment of Launch Vehicle Potential for On-orbit Collisions

Transfer to SLS ODAR

13.0 Assessment of Launch Vehicle Post Mission Disposal Plans and Procedures

Transfer to SLS ODAR

14.0 Assessment of Launch Vehicle Reentry Hazards

Transfer to SLS ODAR

14A: Assessment of Launch Vehicle Hazardous Materials

Transfer to SLS ODAR

A.2 Review of ODARs
In accordance with NPR 8715.6, Section 2.2, each delivered ODAR will be reviewed by the OSMA and by the Space Operations Mission Directorate with technical assistance from the NASA ODPO.

After the OSMA review, the check sheet in Figure A.2-1 will be returned to the Headquarters Sponsoring Mission Directorate Program Executive for distribution back to the program. OSMA will also provide a copy to the orbital debris lead at the Center supporting the program for assisting with corrective actions.

Orbital Debris Assessment Report Evaluation: Miles CubeSat Mission Based on ODAR ________ Version, dated September 21, 2016								
Reqm't #	Launch Vehicle				Spacecraft			Comments
	Compliant	Not Compliant	Incomplete	Standard Non-Compliant	Compliant or N/A	Not Compliant	Incomplete	
4.3-1.a					N/A			Outside of LEO and GEO
4.3-1.b					N/A			Outside of LEO and GEO
4.3-2					N/A			EOM in deep space
4.4-1					N/A			Transfers to SLS
4.4-2					N/A			Transfers to SLS
4.4-3					N/A			Transfers to SLS
4.4-4					N/A			Transfers to SLS
4.5-1					N/A			Outside of LEO and GEO
4.5-2					N/A			Outside of LEO and GEO
4.6-1(a)					N/A			EOM in deep space
4.6-1(b)					N/A			No reentry
4.6-1(c)					N/A			Outside of LEO and GEO
4.6-2					N/A			Transfers to SLS
4.6-3					N/A			Outside of LEO and GEO
4.6-4					N/A			EOM in deep space
4.7-1					N/A			Transfers to SLS
4.8-1					N/A			No tethers

Additional Comments:

Reviewed by: ______________________ on: ____________