LIME

(Low-Latency Intelligence and Monitoring Experiment)

Orbital Debris Assessment Report (ODAR)

Revision: 1

February 21, 2024

Approved By:

Prepared By: Matthew McGovern

Document Data is Not Restricted. This document contains no proprietary, ITAR, or export-controlled information.

Prepared in compliance with NASA-STD-8719.14C by NOVI, LLC. NASA Debris Analysis Software (DAS) Version 3.2.5 was used in preparing this report.

Revisions

Rev	Change Description	Date	Approval
1	Initial Release	02/21/2024	2/22/2024

Approvers

All applicable Approvers for this document, and their responsibilities regarding this project are listed below:

Name	Title	Responsibilities
Amit Mehra	Principal Investigator	Program Management, Reviewer
Matthew McGovern	Senior Project Engineer	Project Manager, Author, Reviewer
Henry Leach	Systems Engineer	Author, Reviewer

Approval/s

X Matthew McGovern

Matthew McGovern
Senior Project Engineer

X Henry Leach

Henry Leach
LIME Systems Engineer

Table of Contents

Self-Assessment of the ODAR

A self-assessment is provided below in accordance with the format recommended in NASA-STD-8719.14C, Appendix A.2.

Table 1: Orbital Debris Self-Assessment Report Evaluation: LIME

Requirement	Status	Comments
4.3-1, Mission-Related Debris Passing Through LEO	COMPLIANT	
4.3-2, Mission-Related Debris Passing Near GEO	N/A	Mission entirely in LEO
4.4-1, Limiting the risk to other space systems from accidental explosions during deployment and mission operations while in orbit about Earth or the Moon	COMPLIANT	
4.4-2, Design for passivation after completion of mission operations while in orbit about Earth or the Moon	COMPLIANT	
4.4-3, Limiting the long-term risk to other space systems from planned breakups	N/A	No planned breakups
4.4-4, Limiting the short-term risk to other space systems from planned breakups	N/A	No planned breakups
4.5-1, Probability of Collision with Large Objects	COMPLIANT	
4.5-2, Probability of Damage from Small Objects	COMPLIANT	System will passively deorbit; no components critical to deorbit
4.6-1, Disposal for space structures passing through LEO	COMPLIANT	
4.6-2, Disposal for space structures passing through GEO	N/A	Mission entirely in LEO
4.6-3, Disposal for space structures between LEO and GEO	N/A	Mission entirely in LEO
4.6-4, Reliability of post-mission disposal operations	COMPLIANT	
4.7-1, Casualty risk from re-entry debris	COMPLIANT	
4.8-1, Collision Hazards of Space Tethers	N/A	No tethers on spacecraft

Program Management and Mission Overview

Project Manager: Matthew McGovern

Foreign Government or Space Agency Participation: None.

Mission Overview: LIME, a ~5.3kg 3U satellite, will launch NET October 2024 on a SpaceX Falcon 9 rocket from Cape Canaveral Space Force Station as a rideshare payload on the Transporter 12 mission. Once in orbit, LIME will be ejected from a Maverick CubeSat dispenser into a planned circular, sun-synchronous orbit (97.5 deg) at an average altitude of 520 km. LIME will then be operated for a

maximum duration of 24 months and will decay into the atmosphere a maximum of 4.71 years after deployment based on DAS v3.2.5's assessment of decay rate with no propulsion.

For this ODAR assessment, a worst-case altitude in terms of lifetime of 540 km is used (SpaceX dispersion around the 520km circular orbit target is +/- 20km).

ODAR Summary: No orbital debris will be produced by LIME, there are no credible scenarios for breakups, the collision probability with other objects is compliant with NASA standards, and the estimated nominal decay lifetime due to atmospheric drag is less than 5 years after the end of the mission (as calculated by DAS v3.2.5).

Launch: LIME is currently planned to be launched in a SpaceX Falcon-9 rocket from Cape Canaveral Space Force Base as part of the Transporter-12 mission, NET October 2024. SpaceX dictates the launch date, orbital inclination, and altitude for LIME.

Mission Duration: *Planned Mission Operations*: 12 months, *Extended Mission Operations*: 12 months, *Post-Operations Orbit lifetime*: 2.71 years until reentry via atmospheric orbital decay (worst case, 4.71 years in total).

Orbit Profile: LIME will be deployed from the launch vehicle into a near-circular SSO (near-polar) at an altitude of 520 +/- 20km. Assuming LIME is deployed at 520km the orbital period is approximately 95 minutes. There is no transfer or parking orbit. Since LIME has no propulsion, the orbit will naturally decay until LIME burns up in the atmosphere. NOVI can change the drag profile of LIME during nominal operations to slow or speed up orbit decay.

Spacecraft Maneuver Capability: LIME has a 3-axis attitude control that will be used throughout nominal operations to control where the antennas on the satellite are pointing. In post-operations the spacecraft will be commanded to maintain an attitude that increases its drag profile to expedite orbital decay for as long as the systems remain operational. LIME has no propulsion system for orbit control.

Interference With Other Operational Spacecraft: LIME should have no interactions or physical interference with other spacecraft

Spacecraft Description

Physical description of the spacecraft: Lime conforms to the 3U CubeSat specification, with a launch mass of ~5.3kg. Basic physical dimensions are 100mm x 100mm x 340mm, with one 320mm x 100 mm deployable solar array.

The load bearing structure of lime consist of two 340mm x 100mm plates that incorporate the CubeSat rails, with brackets between them for components to mount to. The deployable solar array, s-band antenna, and magnetometer are spring loaded, and burn-wire deployed.

Power storage is provided by Lithium-Ion cells. The batteries will be recharged by body and deployable panel mounted solar cells.

Lime's attitude is controlled with an off-the-shelf 3 axis integrated ADCS and will utilize 3 magnetorquers, 3 reaction wheels, a magnetometer, a nadir sensor, and sun sensors for attitude control.

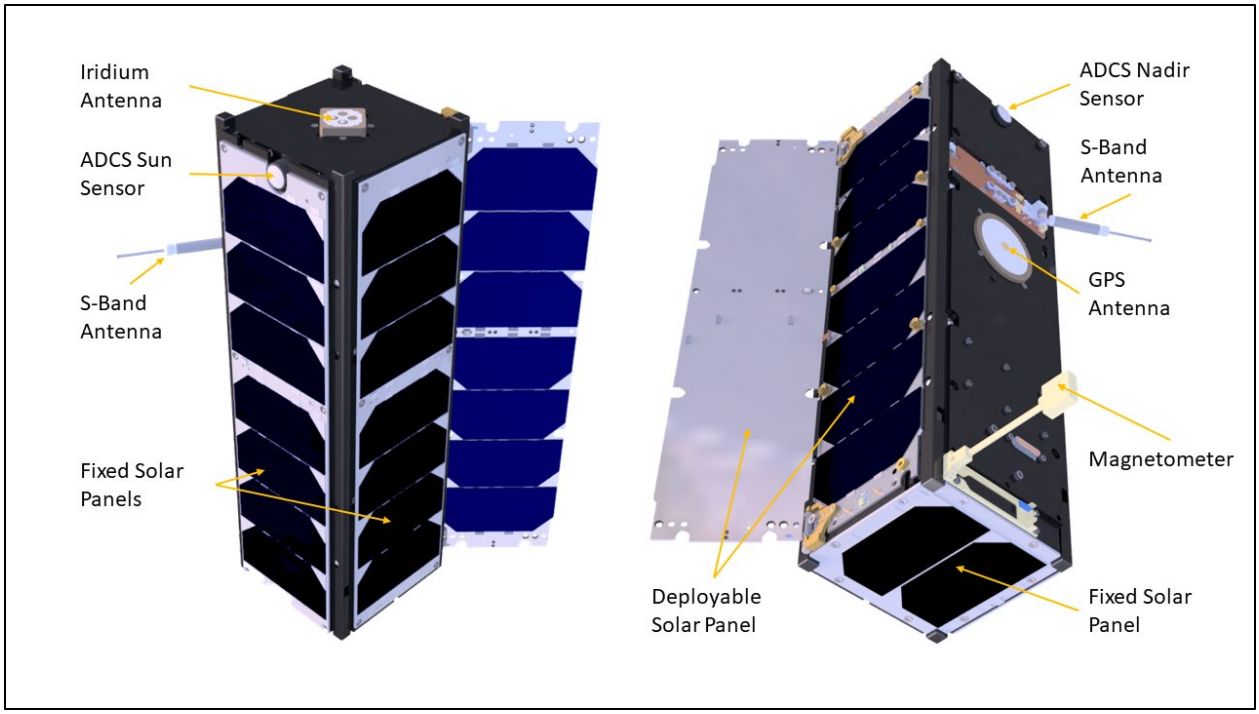

Figure 1: LIME Satellite, Deployed, Two Perspectives

Total spacecraft mass at launch (no propellant onboard): ~5.3kg

Identification, including type, mass and pressure, of all fluids (liquids and gases) planned to be on board (including any planned future in-space transfers): N/A - there will be no stored fluids or gasses on board.

Fluids in Pressurized batteries: None. LIME uses unpressurized standard Lithium-Ion battery cells.

Description of any range safety or other pyrotechnic devices: None.

Description of the electrical generation and storage system: The power will be generated using solar panels and stored in a lithium-ion battery pack. The batteries will be charged before payload integration. There are three stationary 3U panels, one stationary 1U panel, and one deployable 3U panel. There are two faces hosting antennas rather than solar panels. Lastly, there is a battery cell protection circuit that manages the charging cycle.

Identification of any other sources of stored energy not noted above: None.

Identification of any radioactive materials on board or an explicit statement that there are no radioactive materials onboard: There are no radioactive materials onboard LIME.

Description of any planned proximity operations or docking with other spacecraft: None.

Assessment of Spacecraft Debris Released during Normal Operations

Identification of any object (>1 mm) expected to be released from the spacecraft any time after launch, including object dimensions, mass, and material: None

Rationale/necessity for release of each object: N/A

Time of release of each object, relative to launch time: N/A

Release velocity of each object with respect to spacecraft: N/A

Expected orbital parameters (apogee, perigee, and inclination) of each object after release: N/A

Calculated orbital lifetime of each object, including time spent in LEO: N/A

Assessment of spacecraft compliance with Requirements 4.3-1 and 4.3-2 (per DAS v3.2.5):

Requirement 4.3-1, Mission Related Debris Passing Through LEO, released debris with diameters of 1mm or larger:

> No release of debris will occur during the lifetime of LIME. LIME solar panel, magnetometer, and antenna deployments use burn wires that will remain connected to the satellite. There is no probable scenario for unintentional debris generation.
>
> **Result for Requirement 4.3-1:** COMPLIANT

Requirement 4.3-2, Mission Related Debris Passing Near GEO:

> LIME's mission will be conducted entirely in low Earth orbit.
>
> **Result for Requirement 4.3-2:** N/A

Assessment of Spacecraft Intentional Breakups and Potential for Explosions

Identification of all potential causes of spacecraft breakup during deployment and mission operations: There is no credible scenario that would result in spacecraft breakup during normal deployment and operations.

Summary of failure modes and effects analyses of all credible failure modes which may lead to an accidental explosion: If the Lithium-Ion batteries fail, they are expected to vent gas rather than explode. The deployments of the solar array, magnetometer, and s-band antenna feature simple spring and stopper systems triggered by burn wire, there are no pyrotechnics. The probability of detachment during deployment is negligible.

Detailed plan for any designed spacecraft breakup, including explosions and intentional collisions: There are no planned intentional breakups by explosion, collision, nor by any other means.

List of components which are passivated at EOM. List includes method of passivation and amount which cannot be passivated: LIME contains no components which are passivated at EOM. The satellite will breakup in atmospheric reentry. There is no plan to passivate the batteries, however in the case of mechanical damage or short-circuit they will not explode.

Rationale for all items which are required to be passivated but cannot be due to their design: It was deemed unnecessary to passivate the lithium-ion batteries for EOM, as the satellite will break up on re-entry at the end of the mission. Additionally, limitations in space and mass prevent the inclusion of the necessary resources to disconnect the battery and solar cells at the end of the mission. If the battery has a failure it is expected to vent gasses through the satellites vent holes and will not cause the spacecraft to explode.

Assessment of spacecraft compliance with Requirements 4.4-1 through 4.4-4:

Requirement 4.4-1: Limiting the risk to other space systems from accidental explosions during deployment and mission operations while in orbit about Earth or the Moon:

The probability of battery explosion is very low. The battery cells are small and have low charges, which when combined with the safety systems built into the battery, such as over-current switches and temperature sensors, protect the system from catastrophic destruction. The battery also has extensive flight heritage with no known issues of this kind. If these protections fail, we expect that the battery cells would vent rather than explode. If there was venting from the batteries, the vent holes on the satellite would prevent pressure from building up. The effects of venting on the far-term LEO environment would be negligible.

Result for Requirement 4.4-1: COMPLIANT

Requirement 4.4-2: Design for passivation after mission operations complete while in Earth orbit:

Passivation will happen naturally at the end of mission by natural orbit decay and re-entry.

Result for Requirement 4.4-2: COMPLIANT

Requirement 4.4-3: Limiting the long-term risk to other space systems from planned breakups:

There are no planned breakups during the mission.

Result for Requirement 4.4-3: N/A

Requirement 4.4-4: Limiting the short-term risk to other space systems from planned breakups:

There are no planned breakups during the mission.

Result for Requirement 4.4-4: N/A

Assessment of Spacecraft Potential for On-Orbit Collisions

Since the orientation of the spacecraft during operations will vary, the probability of collision with other objects is computed in the worst-case scenario of the solar arrays being in the direction tangential to the velocity vector. NASA DAS v3.2.5 was used for orbit and collision analysis

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

Requirement 4.5-1: Limiting debris generated by collisions with large objects when operating in Earth orbit:

Calculation of the probability of spacecraft collision with space objects during the orbital lifetime of the spacecraft takes into account both the mean cross-sectional area and orbital lifetime. The mean cross-sectional area was calculated and input into DAS v3.2.5.

The largest mean cross-sectional area (CSA) is when LIME has its deployable solar panel deployed. Equation 1 is utilized to determine the mean CSA. Amax is identified as the view that yields the maximum cross-sectional area. A1 is the two cross-sectional areas orthogonal to Amax. The Mean CSA was calculated to be 0.0702m^2. Which makes the final area/mass ratio of the spacecraft to be 0.0132m^2/kg.

$$Mean\ CSA = \frac{(Amax+A1+A2)}{2}$$ Equation 1: Mean Cross Sectional Area for Complex Objects (LIME Deployed)

The computed probability of collision with large objects for LIME is 0.00000076074 This is below the maximum acceptable probability of 0.01.

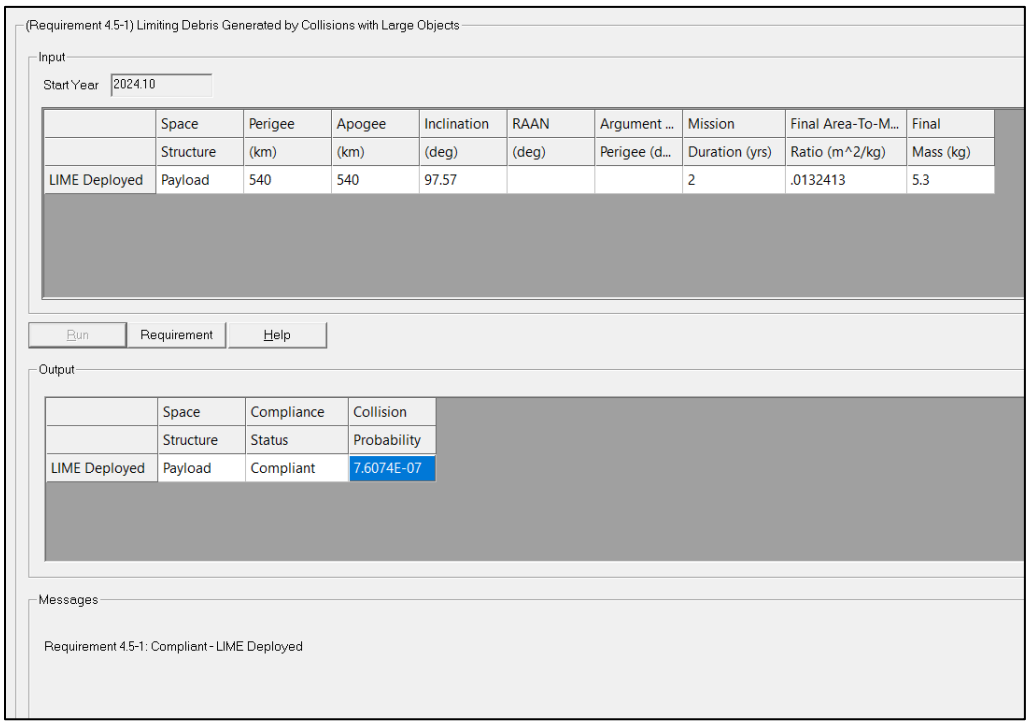

Figure 2: Requirement 4.5-1 DAS v3.2.5 Software Screenshot

Result for Requirement 4.5-1: COMPLIANT

Requirement 4.5-2: Limiting damage probability from small objects when operating in Earth or lunar orbit:

None of LIME's components are vital for post-mission disposal. LIME has no propellant and thus will not have a controlled reentry. At the end of mission operations, the CubeSat will be commanded to maintain its maximum drag attitude, if able, but this is not required for safe disposal.

Result for Requirement 4.5-2: COMPLIANT

Assessment of Spacecraft Post-Mission Disposal Plans and Procedures

Description of spacecraft disposal option selected: Lime will naturally decay from orbit within 5 years after the end of its mission, satisfying Requirement 4.6-1a.

Identification of all systems or components required to accomplish any post mission disposal maneuvers: The mission is designed to accomplish post-mission disposal via passive atmospheric reentry. If able, the spacecraft will be commanded at the end of the mission to maintain it maximum drag profile in order to expedite the disposal. To actively place the satellite in the maximum drag configuration requires the flight computer, ADCS, and power subsystems to be functional. Note that the orbit will

degrade within the 5-year post mission time limit regardless of the satellite's ability to maintain a maximum-drag attitude.

Calculation of area-to-mass ratio after post mission disposal, if the controlled reentry option is not selected: The area-to-mass ratio for LIME after post mission disposal is the same as the one calculated for Requirement 4.5-1. This is 0.0132m^2/kg.

If appropriate, preliminary plan for spacecraft-controlled reentry: N/A

Assessment of spacecraft compliance with Requirements 4.6-1 through 4.6-4:

Requirement 4.6-1: Disposal for space structures in or passing through Low Earth Orbit (LEO):

Max orbit lifetime for a 2-year mission is 7 years. LIME is projected to decay within 4.71 years in the worst case.

Result for Requirement 4.6-1: COMPLIANT

Requirement 4.6-2: Disposal for space structures near GEO:

There are no space structures near GEO involved in this mission.

Result for Requirement 4.6-2: N/A

Requirement 4.6-3: Disposal for space structures between LEO and GEO:

. There are no space structures between LEO and GEO involved in this mission.

Result for Requirement 4.6-3: N/A

Requirement 4.6-4: Reliability of post-mission disposal operations in Earth orbit:

The maximum orbital lifetime was calculated with the average area to mass ratio. Even in the case of a tumbling spacecraft, gravity and the Earth's atmosphere will cause the satellite to be disposed within the required 5-year timeframe after end of mission.

Result for Requirement 4.6-4: COMPLIANT

Assessment of Spacecraft Reentry Hazards

Requirement 4.7-1: Limit the risk of human casualty:

Using DAS v3.2.5, the risk of human casualty was calculated for an uncontrolled reentry to be 0 for the LIME satellite. There were no surviving components. See the appendix for a complete list of the inputs and outputs for the analysis. The result of 0 risk of human casualty is less than the 1:10,000 probability required in 4.7.1a.

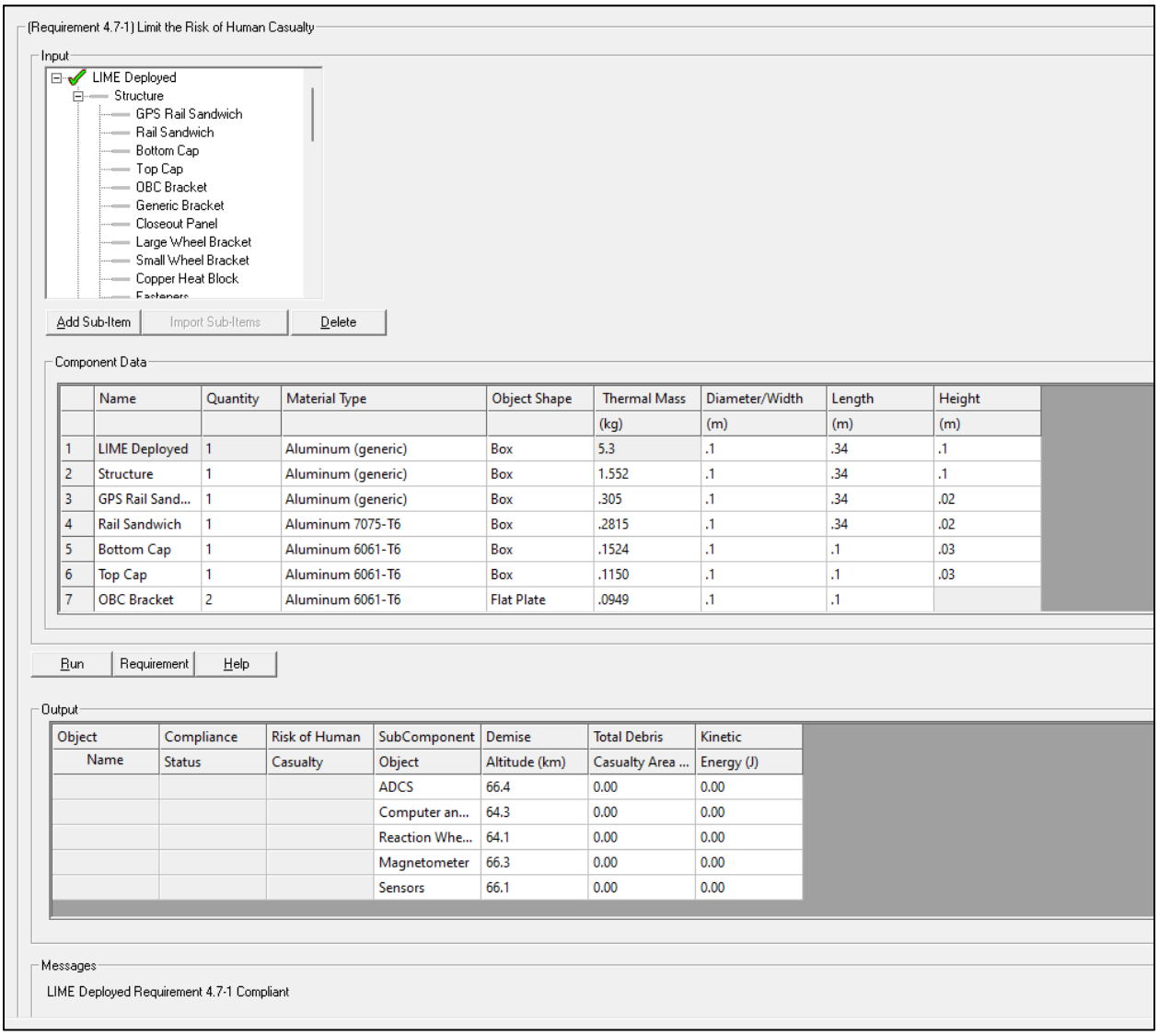

Figure 3: Requirement 4.7-1 DAS v3.2.5 Screenshot

Result for Requirement 4.7-1: COMPLIANT

Assessment for Tether Missions

Requirement 4.8-1. Mitigate the collision hazards of space tethers in Earth or Lunar orbits: There are no tethers used in the LIME mission.

Result for Requirement 4.8-1: N/A

END of ODAR for LIME.

Appendix

DAS Activity Log

02 21 2024; 15:12:20PM Activity Log Started
02 21 2024; 15:12:20PM Opened Project C:\Users\MattMcGovern\AppData\Local\NASA\DAS3.2.5\
02 21 2024; 15:12:37PM Project Data Saved To File
02 21 2024; 15:12:38PM Project Data Saved To File
02 21 2024; 15:12:42PM Mission Editor Changes Applied
02 21 2024; 15:12:42PM Project Data Saved To File
02 21 2024; 15:12:42PM Project Data Saved To File
02 21 2024; 15:12:45PM Mission Editor Changes Applied
02 21 2024; 15:12:45PM Project Data Saved To File
02 21 2024; 15:12:45PM Project Data Saved To File
02 21 2024; 15:12:59PM Science and Engineering - Orbit Lifetime/Dwell Time
INPUT
Start Year = 2024.100000 (yr)
Perigee Altitude = 540.000000 (km)
Apogee Altitude = 540.000000 (km)
Inclination = 98.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.013241 (m^2/kg)
OUTPUT
Orbital Lifetime from Startyr = 4.706366 (yr)
Time Spent in LEO during Lifetime = 4.706366 (yr)
Last year of Propagation = 2028 (yr)
Returned Error Message: Object reentered
02 21 2024; 15:15:24PM Science and Engineering - Orbit Lifetime/Dwell Time
INPUT
Start Year = 2024.100000 (yr)
Perigee Altitude = 545.000000 (km)
Apogee Altitude = 545.000000 (km)
Inclination = 98.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.013241 (m^2/kg)
OUTPUT
Orbital Lifetime from Startyr = 5.637235 (yr)
Time Spent in LEO during Lifetime = 5.637235 (yr)
Last year of Propagation = 2029 (yr)
Returned Error Message: Object reentered
02 21 2024; 15:15:30PM Science and Engineering - Orbit Lifetime/Dwell Time
INPUT
Start Year = 2024.100000 (yr)
Perigee Altitude = 540.000000 (km)
Apogee Altitude = 540.000000 (km)
Inclination = 98.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.013241 (m^2/kg)
OUTPUT
Page 1
DAS Activity Log
Orbital Lifetime from Startyr = 4.706366 (yr)
Time Spent in LEO during Lifetime = 4.706366 (yr)
Last year of Propagation = 2028 (yr)
Returned Error Message: Object reentered
02 21 2024; 15:23:39PM Processing Requirement 4.3-1: Return Status : Not Run
==========
No Project Data Available
==========
========== End of Requirement 4.3-1 ==========
02 21 2024; 15:23:41PM Processing Requirement 4.3-2: Return Status : Passed
==========

No Project Data Available
==========
========== End of Requirement 4.3-2 ==========
02 21 2024; 15:31:18PM Processing Requirement 4.5-1: Return Status : Passed
==========
Run Data
==========
INPUT
Space Structure Name = LIME Deployed
Space Structure Type = Payload
Perigee Altitude = 540.000 (km)
Apogee Altitude = 540.000 (km)
Inclination = 97.570 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass Ratio = 0.0132 (m^2/kg)
Start Year = 2024.100 (yr)
Initial Mass = 5.300 (kg)
Final Mass = 5.300 (kg)
Duration = 2.000 (yr)
Station-Kept = False
Abandoned = True
Long-Term Reentry = False
OUTPUT
Collision Probability = 7.6074E-07
Returned Message: Normal Processing
Date Range Message: Normal Date Range
Status = Pass
==========
========== End of Requirement 4.5-1 ==========
02 21 2024; 15:31:24PM Project Data Saved To File
02 21 2024; 15:31:29PM Requirement 4.5-2: Compliant
========== End of Requirement 4.5-2 ==========
02 21 2024; 15:31:30PM Processing Requirement 4.6 Return Status : Passed
==========
Project Data
==========
INPUT
Page 2
DAS Activity Log
Space Structure Name = LIME Deployed
Space Structure Type = Payload
Perigee Altitude = 540.000000 (km)
Apogee Altitude = 540.000000 (km)
Inclination = 97.570000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.013241 (m^2/kg)
Start Year = 2024.100000 (yr)
Initial Mass = 5.300000 (kg)
Final Mass = 5.300000 (kg)
Duration = 2.000000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 498.541702 (km)
PMD Apogee Altitude = 498.761481 (km)
PMD Inclination = 97.647618 (deg)
PMD RAAN = 9.028939 (deg)
PMD Argument of Perigee = 171.937007 (deg)

PMD Mean Anomaly = 0.000000 (deg)
Long-Term Reentry = False
OUTPUT
Suggested Perigee Altitude = 498.541702 (km)
Suggested Apogee Altitude = 498.761481 (km)
Returned Error Message = Passes LEO reentry orbit criteria.
Released Year = 2028 (yr)
Requirement = 61
Compliance Status = Pass
==========
========== End of Requirement 4.6 ==========
02 21 2024; 15:31:43PM *********Processing Requirement 4.7-1
Return Status : Passed
**********INPUT****
Item Number = 1
name = LIME Deployed
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 5.300000
Thermal Mass = 5.300000
Diameter/Width = 0.100000
Length = 0.340000
Height = 0.100000
name = Structure
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 3.102900
Thermal Mass = 1.552000
Diameter/Width = 0.100000
Length = 0.340000
Height = 0.100000
name = GPS Rail Sandwich
quantity = 1
parent = 2
materialID = 9
type = Box
Page 3
DAS Activity Log
Aero Mass = 0.305000
Thermal Mass = 0.305000
Diameter/Width = 0.100000
Length = 0.340000
Height = 0.020000
name = Rail Sandwich
quantity = 1
parent = 2
materialID = 9
type = Box
Aero Mass = 0.281500
Thermal Mass = 0.281500
Diameter/Width = 0.100000
Length = 0.340000
Height = 0.020000
name = Bottom Cap
quantity = 1
parent = 2
materialID = 8

type = Box
Aero Mass = 0.152400
Thermal Mass = 0.152400
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.030000
name = Top Cap
quantity = 1
parent = 2
materialID = 8
type = Box
Aero Mass = 0.115000
Thermal Mass = 0.115000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.030000
name = OBC Bracket
quantity = 2
parent = 2
materialID = 8
type = Flat Plate
Aero Mass = 0.094900
Thermal Mass = 0.094900
Diameter/Width = 0.100000
Length = 0.100000
name = Generic Bracket
quantity = 2
parent = 2
materialID = 8
type = Flat Plate
Aero Mass = 0.070600
Thermal Mass = 0.070600
Diameter/Width = 0.100000
Length = 0.100000
name = Closeout Panel
quantity = 1
parent = 2
materialID = 9
type = Flat Plate
Aero Mass = 0.126200
Thermal Mass = 0.126200
Diameter/Width = 0.100000
Length = 0.340000
name = Large Wheel Bracket
quantity = 1
parent = 2
Page 4
DAS Activity Log
materialID = 8
type = Box
Aero Mass = 0.012700
Thermal Mass = 0.012700
Diameter/Width = 0.050000
Length = 0.050000
Height = 0.020000
name = Small Wheel Bracket
quantity = 1
parent = 2
materialID = 8
type = Box
Aero Mass = 0.010500

Thermal Mass = 0.010500
Diameter/Width = 0.040000
Length = 0.040000
Height = 0.020000
name = Copper Heat Block
quantity = 2
parent = 2
materialID = 19
type = Flat Plate
Aero Mass = 0.054800
Thermal Mass = 0.054800
Diameter/Width = 0.040000
Length = 0.060000
name = Fasteners
quantity = 107
parent = 2
materialID = 54
type = Cylinder
Aero Mass = 0.001000
Thermal Mass = 0.001000
Diameter/Width = 0.003000
Length = 0.025000
name = Communications
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.413100
Thermal Mass = 0.210000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.020000
name = GPS Antenna
quantity = 1
parent = 14
materialID = 5
type = Flat Plate
Aero Mass = 0.035200
Thermal Mass = 0.035200
Diameter/Width = 0.050000
Length = 0.050000
name = S-Band Antenna
quantity = 1
parent = 14
materialID = 5
type = Box
Aero Mass = 0.024000
Thermal Mass = 0.024000
Diameter/Width = 0.010000
Length = 0.100000
Height = 0.010000
name = Radio Board

quantity = 1
parent = 14
materialID = 5
type = Flat Plate
Aero Mass = 0.091200
Thermal Mass = 0.091200
Diameter/Width = 0.100000

Length = 0.100000
name = Iridium Module
quantity = 1
parent = 14
materialID = 5
type = Box
Aero Mass = 0.031000
Thermal Mass = 0.031000
Diameter/Width = 0.040000
Length = 0.045000
Height = 0.010000
name = Iridium Antenna
quantity = 1
parent = 14
materialID = 5
type = Box
Aero Mass = 0.021700
Thermal Mass = 0.021700
Diameter/Width = 0.030000
Length = 0.030000
Height = 0.010000
name = Power
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 3.162000
Thermal Mass = 1.267000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.050000
name = Li-Ion Battery
quantity = 1
parent = 20
materialID = 5
type = Box
Aero Mass = 0.500000
Thermal Mass = 0.500000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.030000
name = EPS
quantity = 1
parent = 20
materialID = 5
type = Flat Plate
Aero Mass = 0.090000
Thermal Mass = 0.090000
Diameter/Width = 0.100000
Length = 0.100000
name = Shunt Resistor
quantity = 1
parent = 20
materialID = 5
type = Box
Aero Mass = 0.011900
Thermal Mass = 0.011900
Diameter/Width = 0.020000
Length = 0.040000

Height = 0.020000
name = Deployable Solar Panel
quantity = 1
parent = 20
materialID = 5
type = Flat Plate
Aero Mass = 0.577840
Thermal Mass = 0.288000
Diameter/Width = 0.100000
Length = 0.320000
name = Dep FR4
quantity = 1
parent = 24
materialID = 23
type = Flat Plate
Aero Mass = 0.240000
Thermal Mass = 0.240000
Diameter/Width = 0.100000
Length = 0.320000
name = Dep Solar Cells
quantity = 14
parent = 24
materialID = 24
type = Flat Plate
Aero Mass = 0.003560
Thermal Mass = 0.003560
Diameter/Width = 0.040000
Length = 0.080000
name = Fixed 3U Panel
quantity = 2
parent = 20
materialID = 5
type = Flat Plate
Aero Mass = 0.309920
Thermal Mass = 0.165000
Diameter/Width = 0.100000
Length = 0.320000
name = 3U FR4
quantity = 2
parent = 27
materialID = 23
type = Flat Plate
Aero Mass = 0.120000
Thermal Mass = 0.120000
Diameter/Width = 0.100000
Length = 0.320000
name = 3U Solar Cells
quantity = 14
parent = 27
materialID = 24
type = Flat Plate
Aero Mass = 0.003560
Thermal Mass = 0.003560
Diameter/Width = 0.040000
Length = 0.080000
name = Fixed 1U Panel
quantity = 1
parent = 20
materialID = 5
type = Flat Plate
Aero Mass = 0.095420

Thermal Mass = 0.044500
Diameter/Width = 0.100000
Length = 0.100000
Page 7
DAS Activity Log
name = 1U FR4
quantity = 1
parent = 30
materialID = 23
type = Flat Plate
Aero Mass = 0.043800
Thermal Mass = 0.043800
Diameter/Width = 0.100000
Length = 0.100000
name = 1U Solar Cells
quantity = 2
parent = 30
materialID = 24
type = Flat Plate
Aero Mass = 0.003560
Thermal Mass = 0.003560
Diameter/Width = 0.040000
Length = 0.080000
name = Avionics
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 5.116100
Thermal Mass = 1.912000
Diameter/Width = 0.100000
Length = 0.120000
Height = 0.100000
name = OBC
quantity = 1
parent = 33
materialID = 8
type = Box
Aero Mass = 0.620000
Thermal Mass = 0.620000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.040000
name = Payload
quantity = 1
parent = 33
materialID = 5
type = Box
Aero Mass = 0.980000
Thermal Mass = 0.490000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.040000
name = Payload Housing Top
quantity = 1
parent = 35
materialID = 8
type = Box
Aero Mass = 0.095200
Thermal Mass = 0.095200
Diameter/Width = 0.100000

Length = 0.100000
Height = 0.020000
name = Payload Board
quantity = 1
parent = 35
materialID = 5
type = Flat Plate
Aero Mass = 0.281800
Thermal Mass = 0.281800
Diameter/Width = 0.100000
Page 8
DAS Activity Log
Length = 0.100000
name = Payload Housing Bottom
quantity = 1
parent = 35
materialID = 8
type = Box
Aero Mass = 0.113000
Thermal Mass = 0.113000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.020000
name = ADCS
quantity = 1
parent = 33
materialID = 5
type = Box
Aero Mass = 1.604100
Thermal Mass = 0.802000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.040000
name = Computer and Coils
quantity = 1
parent = 39
materialID = 5
type = Box
Aero Mass = 0.301500
Thermal Mass = 0.301500
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.040000
name = Reaction Wheels
quantity = 3
parent = 39
materialID = 5
type = Box
Aero Mass = 0.150500
Thermal Mass = 0.150500
Diameter/Width = 0.046000
Length = 0.046000
Height = 0.035000
name = Magnetometer
quantity = 1
parent = 39
materialID = 5
type = Flat Plate
Aero Mass = 0.007700
Thermal Mass = 0.007700
Diameter/Width = 0.040000

Length = 0.100000
name = Sensors
quantity = 2
parent = 39
materialID = 5
type = Box
Aero Mass = 0.020700
Thermal Mass = 0.020700
Diameter/Width = 0.030000
Length = 0.060000
Height = 0.030000
**********OUTPUT****
Item Number = 1
name = LIME Deployed
Demise Altitude = 77.997943
Page 9
DAS Activity Log
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Structure
Demise Altitude = 75.181125
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = GPS Rail Sandwich
Demise Altitude = 74.226487
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Rail Sandwich
Demise Altitude = 74.302813
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Bottom Cap
Demise Altitude = 74.690627
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Top Cap
Demise Altitude = 74.810930
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = OBC Bracket
Demise Altitude = 74.751347
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Generic Bracket
Demise Altitude = 74.863598
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Closeout Panel
Demise Altitude = 74.689284
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Large Wheel Bracket

Demise Altitude = 75.070636
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Small Wheel Bracket
Demise Altitude = 75.063137
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Copper Heat Block
Demise Altitude = 73.854354
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Fasteners
Demise Altitude = 74.704092

Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Communications
Demise Altitude = 76.081349
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = GPS Antenna
Demise Altitude = 74.744266
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = S-Band Antenna
Demise Altitude = 75.267937
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Radio Board
Demise Altitude = 74.918176
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Iridium Module
Demise Altitude = 74.946367
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Iridium Antenna
Demise Altitude = 74.755292
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Power
Demise Altitude = 70.426625
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Li-Ion Battery
Demise Altitude = 66.949372
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****

name = EPS
Demise Altitude = 69.511416
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Shunt Resistor
Demise Altitude = 70.093003
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Deployable Solar Panel
Demise Altitude = 69.418286
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Dep FR4
Demise Altitude = 68.307234

Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Dep Solar Cells
Demise Altitude = 69.394340
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Fixed 3U Panel
Demise Altitude = 69.850276
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = 3U FR4
Demise Altitude = 69.375610
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = 3U Solar Cells
Demise Altitude = 69.825696
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Fixed 1U Panel
Demise Altitude = 70.005757
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = 1U FR4
Demise Altitude = 69.518357
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = 1U Solar Cells
Demise Altitude = 69.981311
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Avionics
Demise Altitude = 71.012049
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = OBC
Demise Altitude = 69.547346
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Payload
Demise Altitude = 68.138693
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Payload Housing Top
Demise Altitude = 67.848596
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Payload Board
Demise Altitude = 64.899248
Page 12
DAS Activity Log
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Payload Housing Bottom
Demise Altitude = 67.791889
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = ADCS
Demise Altitude = 66.428423
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Computer and Coils
Demise Altitude = 64.344209
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Reaction Wheels
Demise Altitude = 64.072585
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Magnetometer
Demise Altitude = 66.324848
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
name = Sensors
Demise Altitude = 66.130450
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
****
========== End of Requirement 4.7-1 ==========
02 21 2024; 15:31:43PM Project Data Saved To File
Page 13