ATTACHMENT D

YAM Orbital Debris Assessment Report (ODAR)

YAM-ODAR-1.0

This report is presented as compliance with NASA-STD-8719.14, APPENDIX A. Report Version: 1.2, 8/21/2017

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Debris Assessment Software (DAS) version used in analysis: v2.1.1

Revision Record				
Revision:	Date:	Affected Pages:	Changes:	Author(s):
1.0	5/3/2019	All –Initial	DAS Software Results Orbit Lifetime Analysis	D. Morse

Contents

Self-assessment of the ODAR using the format in Appendix A.2 of NASA-STD-8719.14:

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

Section	Status	Comments
4.3-1, Mission-Related Debris Passing Through LEO	COMPLIANT	
4.3-2, Mission-Related Debris Passing Near GEO	COMPLIANT	
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	N/A	
4.4-3, Limiting the long-term risk to other space systems from planned breakups	COMPLIANT	
4.4-4, Limiting the short-term risk to other space systems from planned breakups	COMPLIANT	
4.5-1, Probability of Collision with Large Objects	COMPLIANT	
4.5-2, Probability of Damage from Small Objects	COMPLIANT	System will passively deorbit; therefore, no components are 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	
4.6-3, Disposal for space structures between LEO and GEO	N/A	
4.6-4, Reliability of post-mission disposal operations	COMPLIANT	
4.8-1, Collision Hazards of Space Tethers	N/A	

Assessment Report Format:

ODAR Technical Sections Format Requirements:

Loft Orbital is a U.S. company. This ODAR follows the format in NASA-STD-8719.14, Appendix A.1 and includes the content indicated as a minimum in each of sections 2 through 8 below for the YAM constellation. Sections 9 through 14 apply to the launch vehicle ODAR and are not covered here.

ODAR Section 1: Program Management and Mission Overview

Program/project manager: Pieter van Duijn

Senior Management: Alexander B. Greenberg (Co-founder & Chief Operating Officer)

Launch and deployment profile, including all parking, transfer, and operational orbits with apogee, perigee, and inclination: The YAM constellation will consist of approximately 10 satellites launched into sun-synchronous circular orbits with orbit altitudes between 425 and 570 km. The first satellite in the constellation to be launch will be YAM-2 which is discussed in further detail below. The remaining orbital debris analysis assumes the worst-case orbit altitude of 570 km circular SSO. The orbital decay of the YAM constellation is provided for completeness.

Schedule of upcoming mission milestones: Loft Orbital has contracted Spaceflight Services to broker the YAM-2 launch. Spaceflight's most recent manifest indicates a launch window of February 1, 2020 – April 30, 2020.

Mission Overview: Each YAM satellite will be launched into a sun-synchronous, Low Earth Orbit (LEO). Each satellite bus will use reaction wheels, magnetic torque coils, a star tracker, magnetometers, sun sensors, and an inertial measurement unit to enable precision 3-axis pointing without the use of propellant.

Launch Vehicle and Launch Site: YAM-2: Polar Satellite Launch Vehicle, Operated by the Indian Space Research Organization. The launch site is the Satish Dhawan Space Centre in Srihrikota, India. The PSLV launch vehicle will transport multiple mission payloads to orbit.

YAM-2 will be deployed into an approximately sun synchronous circular low Earth orbit. Once the final stage has burned out, the primary payloads will be dispensed. After the primary payloads are clear, the secondary payload will separate. YAM-2 will deploy one solar panel once deployed from the MkII Motorized Light Band (MLB) deployer. The spacecraft is expected to be deployed with the following orbital parameters:[1]

Highest Apogee: 550 km

Highest Perigee: 550 km

Target Inclination: 97.5° ± 0.3°

YAM-2 has no on-board propulsion and therefore does not actively change its orbit. There is no parking or transfer orbit.

Mission Duration: The anticipated lifetime of the spacecraft is less than 6 years in LEO.

ODAR Section 2: Spacecraft Description:

Physical description of the constellation: At present, each YAM satellite is based on the Blue Canyon Technologies (BCT) MicroSat bus. Basic physical dimensions are 750 mm x 1300 mm x 600 mm with a mass of approximately 78.8 kg. The satellite is composed of the BCT bus, deployable solar panel, solar array drive assembly, and Payload Hub. The solar panel generates up to 200W of electric power which is stored in a 300Wh COTS Li-Ion unpressurized battery assembly. Solar array is deployed using a TiNi Aerospace, Inc. (TiNi) frangibolts. The bus is 3-axis stabilized, employing star trackers and sun sensor for attitude knowledge and reaction wheels and torque rods for attitude control. Loft Orbital will seek additional approval if it chooses to deploy a different bus.

The YAM-2 satellite will be separated from the PSLV launch vehicle using the MkII MLB, which provides debris free actuation.

Power is locked away from all spacecraft platform and payload components by means of redundant series separation switches on the MkII MLB. These switches cannot be activated until the spacecraft separates from the deployer structure.

The YAM spacecraft is depicted in Figure 1.

[1] The YAM-2 satellite will be deployed between 500 km and 550 km at the discretion of the launch service provider. Loft Orbital has assumed a 550 km deployment orbital altitude for purposes of this orbital debris analysis.

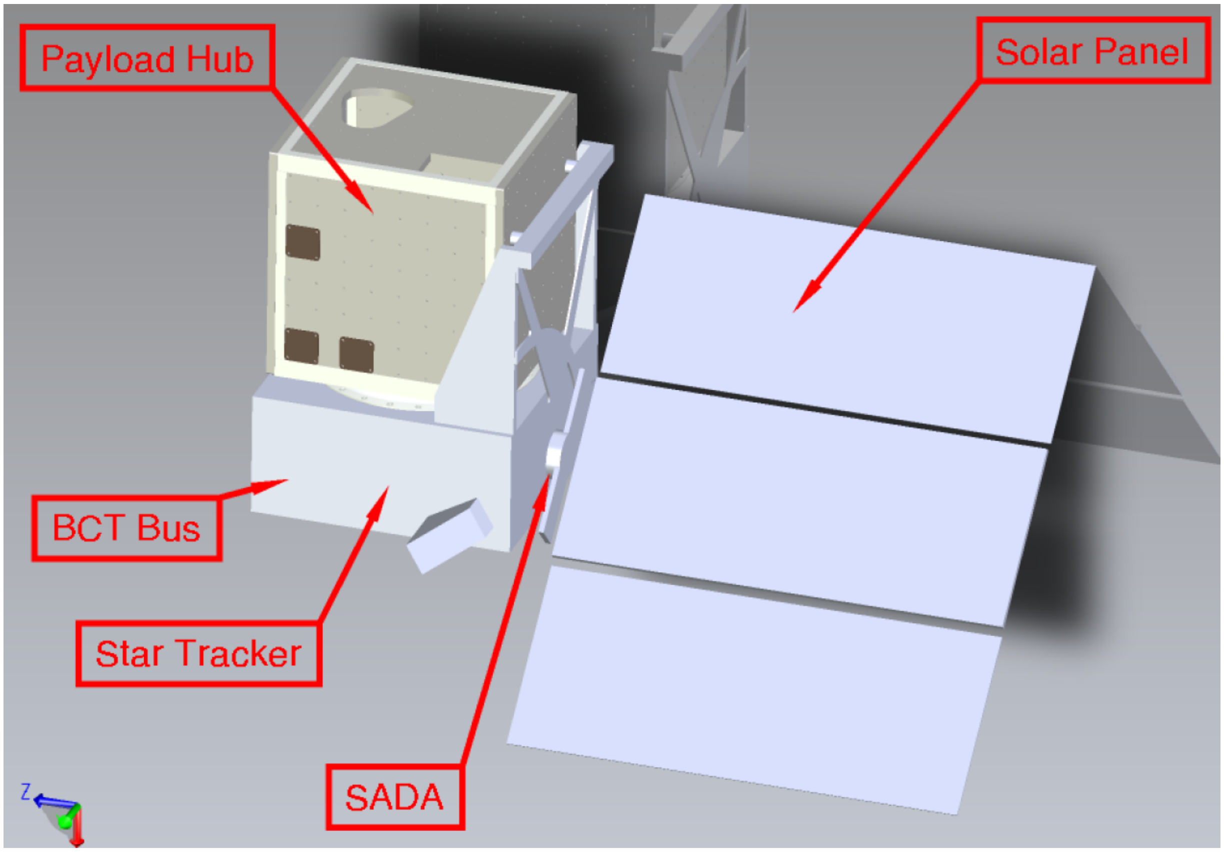

Figure 1 YAM Spacecraft Configuration

Total satellite mass at launch, including all propellants and fluids: 78.8 kg.

Dry mass of satellites at launch: 78.8 kg (no propellants on board)

Description of all propulsion systems (cold gas, mono-propellant, bi-propellant, electric, nuclear): None

Identification, including mass and pressure, of all fluids (liquids and gases) planned to be on board and a description of the fluid loading plan or strategies, excluding fluids in sealed heat pipes: None

Fluids in Pressurized Batteries: None

The YAM satellites use an 8-cell unpressurized standard COTS Lithium-Ion battery cells in each spacecraft. The total capacity energy capacity per spacecraft is 300 W-h.

Description of attitude control system and indication of the normal attitude of the spacecraft with respect to the velocity vector: The YAM spacecraft attitude will be controlled initially by 3 torque rods, which will allow the satellite to be aligned relative to the Earth's magnetic field. These will allow the satellite to detumble and align with the magnetic field.

- A *safe mode* is optimized for solar power generation from the satellite. The spacecraft's deployable panel will be oriented towards the sun. This mode will make use of magnetometers, sun sensors, reaction wheels, and magnetic torquers to orient the spacecraft correctly.
- A *targeted tracking mode* will allow the satellite Nadir panel to be directed at any location on the Earth's surface. This mode will make use of reaction wheels and a star tracker to orient the spacecraft.
- An *LVLH mode* keeps the Nadir panel pointed towards the Earth's surface. This mode will make use of reaction wheels and a star tracker to orient the spacecraft.

Description of any range safety or other pyrotechnic devices: None

The spacecraft deploys its solar panels using a frangibolt system (manufactured by TiNi), which does not release any debris.

The YAM-2 satellite will be released from the PSLV launch vehicle using the MkII MLB separation system which provides debris-free actuation.

The solar panel spring constant is very low.

Description of the electrical generation and storage system: Standard COTS Lithium-Ion battery cells are charged before payload integration and provide 300 W-h of electrical energy during the eclipse portion of the satellite's orbit. A series of Triple Junction Solar Cells generate a maximum on-orbit power of approximately 200 W at the end-of-life of the mission (5 years for calculation purposes). The charge/discharge cycle is managed by a power management system overseen by the Flight Computer.

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

Identification of any radioactive materials on board: None

ODAR Section 3: 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 Low Earth Orbit (LEO): N/A

Assessment of spacecraft compliance with Requirements 4.3-1 and 4.3-2 (per DAS v2.1.1)
4.3-1, Mission Related Debris Passing Through LEO: COMPLIANT
4.3-2, Mission Related Debris Passing Near GEO: COMPLIANT

ODAR Section 4: Assessment of Spacecraft Intentional Breakups and Potential for Explosions.

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: The in-orbit failure of a battery cell protection circuit could lead to a short circuit resulting in overheating and a very remote possibility of battery cell explosion.

Detailed plan for any designed spacecraft breakup, including explosions and intentional collisions: There are no planned breakups.

List of components which shall be passivated at End of Mission (EOM) including method of passivation and amount which cannot be passivated:

- Eight (8) Lithium Ion Battery Cells – configure spacecraft to keep solar array pointed away from sun and let batteries deplete
- Reaction wheels – remove power and configure spacecraft to keep solar array pointed away from sun
- Sealed heat pipe – no passivation is planned or required

Rationale for all items which are required to be passivated, but cannot be due to their design: None

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: *"For each spacecraft and launch vehicle orbital stage employed for a mission, the program or project shall demonstrate, via failure mode and effects analyses or equivalent analyses, that the integrated probability of explosion for all credible failure modes of each spacecraft and launch vehicle is less than 0.001 (excluding small particle impacts) (Requirement 56449)."*

Compliance statement:

Required Probability: 0.001

Expected probability: 0.000; COMPLIANT. Furthermore, the combined probability of the entire constellation of 10 YAM satellites is 0.000 which is also COMPLIANT.

Supporting Rationale and FMEA details:

Battery explosion:

On-orbit failure of a battery cell protection circuit could lead to a short circuit resulting in overheating and a very remote possibility of battery cell deflagration. Multiple independent failures must first occur for this effect. In the event of an unlikely explosion, the effect to the far-term LEO environment is considered negligible due to the following:

- YAM satellites have a short orbital life due to the low orbital altitude (<6 years)
- YAM satellites have relatively low mass
- YAM satellites have spacecraft structural aluminum covers, which will likely contain debris results from a battery rupturing, except for those that may be vented through small orifices

Requirement 4.4-2: **Design for passivation after completion of mission operations while in orbit about Earth or the Moon:**

'Design of all spacecraft and launch vehicle orbital stages shall include the ability to deplete all onboard sources of stored energy and disconnect all energy generation sources when they are no longer required for mission operations or post-mission disposal or control to a level which can not cause an explosion or deflagration large enough to release orbital debris or break up the spacecraft (Requirement 56450)."

Compliance statement: At EOM, the flight software will be updated to point the solar arrays away from the sun, momentum bias the satellite, turn off the reaction wheels, and shed power from all electronics. In the unlikely event that a battery cell does explosively rupture, the small size, mass, and potential energy of these small batteries is such that while the spacecraft could be expected to vent gases, most debris from the battery rupture should be contained within the spacecraft due to the lack of penetration energy to the multiple enclosures surrounding the batteries.

Requirement 4.4-3. Limiting the long-term risk to other space systems from planned breakups: Compliance statement: This requirement is not applicable. There are no planned breakups.

Requirement 4.4-4: Limiting the short-term risk to other space systems from planned breakups: Compliance statement: This requirement is not applicable. There are no planned breakups.

ODAR Section 5: Assessment of Spacecraft Potential for On-Orbit Collisions

Assessment of spacecraft compliance with Requirements 4.5-1 and 4.5-2 (per DAS v2.1.1, and calculation methods provided in NASA-STD-8719.14, section 4.5.4):

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

"For each spacecraft and launch vehicle orbital stage in or passing through LEO, the program or project shall demonstrate that, during the orbital lifetime of each spacecraft and orbital stage, the probability of accidental collision with space objects larger than 10 cm in diameter is less than 0.001 (Requirement 56506)."

Large Object Impact and Debris Generation Probability: 0.00001; COMPLIANT. Furthermore, the combined probability of the entire constellation of 10 YAM satellites is 0.0001, which is also COMPLIANT.

Requirement 4.5-2. Limiting debris generated by collisions with small objects when operating in Earth or lunar orbit:

"For each spacecraft, the program or project shall demonstrate that, during the mission of the spacecraft, the probability of accidental collision with orbital debris and meteoroids sufficient to prevent compliance with the applicable postmission disposal requirements is less than 0.01 (Requirement 56507)."

Small Object Impact and Debris Generation Probability: Not applicable; the spacecraft will be disposed of by atmospheric entry and does not require a specific spacecraft orientation and drag state to meet the disposal requirements. Therefore, no element or component of the spacecraft system is required to complete post-mission operations.

Identification of all systems or components required to accomplish any post-mission disposal operation, including passivation and maneuvering: None

ODAR Section 6: Assessment of Spacecraft Post-Mission Disposal Plans and Procedures

6.1 Description of spacecraft disposal option selected: The satellite will de-orbit naturally by atmospheric re-entry. There is no propulsion system.

6.2 Plan for any spacecraft maneuvers required to accomplish post-mission disposal: None

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

Spacecraft Mass: 78.8 kg

Cross-sectional Area: 0.883 m^2

(Calculated by DAS 2.1.1). Area to mass ratio: 0.88/78.8 = 0.0112 m^2/kg

6.4 Assessment of spacecraft compliance with Requirements 4.6-1 through 4.6-5 (per DAS v2.1.1 and NASA-STD-8719.14 section): Requirement 4.6-1. Disposal for space structures passing through LEO:

"A spacecraft or orbital stage with a perigee altitude below 2000 km shall be disposed of by one of three methods: (Requirement 56557)

a. Atmospheric reentry option: Leave the space structure in an orbit in which natural forces will lead to atmospheric reentry within 25 years after the completion of mission but no more than 30 years after launch; or Maneuver the space structure into a controlled de-orbit trajectory as soon as practical after completion of mission.

b. Storage orbit option: Maneuver the space structure into an orbit with perigee altitude greater than 2000 km and apogee less than GEO - 500 km.

c. Direct retrieval: Retrieve the space structure and remove it from orbit within 10 years after completion of mission."

Analysis: The YAM satellites' method of disposal is COMPLIANT using method "a." In the worst-case orbit altitude of 570 x 570 km near-circular orbit, the passive deorbit time is 5.3 years after launch with orbit history as shown in Figure 2. It should be noted that this is assuming a launch date of January 2021. Because de-orbit lifetime will vary depending on the launch date, Loft Orbital will select launch opportunities that ensure that each YAM satellite will meet the FCC's 6-year de-orbit requirement for satellites authorized under the FCC's new small satellite streamlined licensing rules.[2]

The first spacecraft, YAM-2, will be deployed in a 550 x 550 km near-circular orbit, reentering in approximately 4.375 years after launch with orbit history as shown in Figure 3 (analysis assumes a noon-midnight Sun synchronous orbit with solar array tracking).

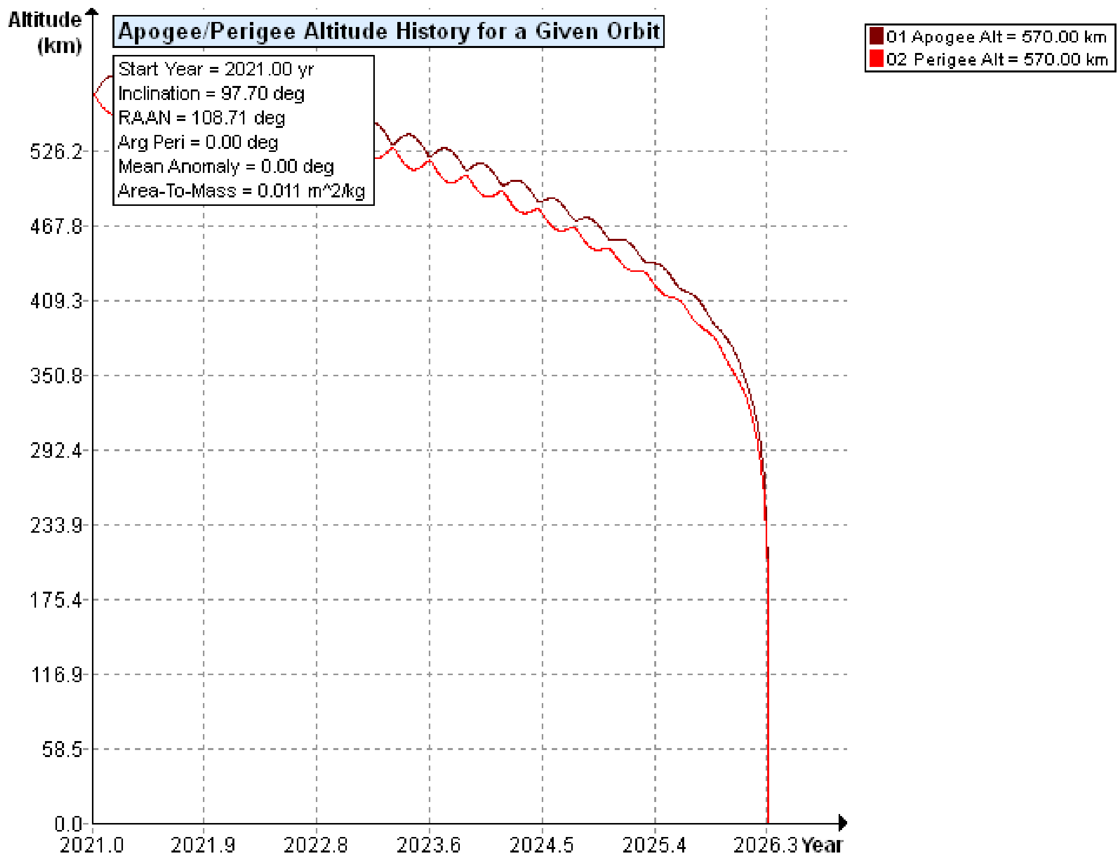

Figure 2 YAM Orbit History – at Maximum Orbit Altitude of 570 km x 570 km SSO

[2] *See Streamlining Licensing Procedures for Small Satellites*, Report and Order, IB Docket No. 18-86 (rel. Aug. 2, 2019) (new 47 C.F.R. § 25.122); *see also* Attachment A, Narrative § II(A).

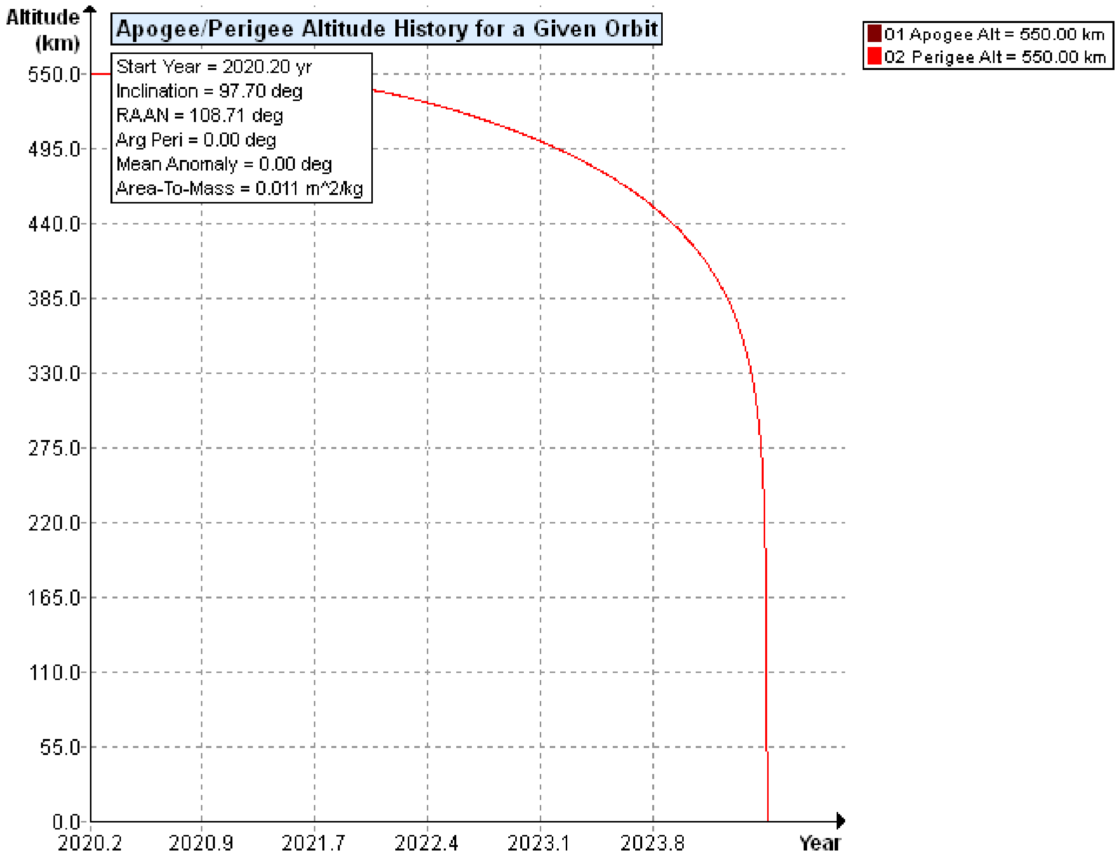

Figure 3 YAM-2 Orbit History

Requirement 4.6-2. Disposal for space structures near GEO:
Analysis is not applicable.

Requirement 4.6-3. Disposal for space structures between LEO and GEO: Analysis is not applicable.

Requirement 4.6-4. Reliability of Post-mission Disposal Operations:
Analysis is not applicable. The satellite will reenter passively without post-mission disposal operations within the allowable timeframe.

ODAR Section 7: Assessment of Spacecraft Reentry Hazards:

Assessment of spacecraft compliance with Requirement 4.7-1: Requirement 4.7-1. Limit the risk of human casualty:

"The potential for human casualty is assumed for any object with an impacting kinetic energy in excess of 15 joules:
a) For uncontrolled reentry, the risk of human casualty from surviving debris shall not exceed 0.0001 (1:10,000) (Requirement 56626)."

Summary Analysis Results: DAS reports that the YAM satellites are COMPLIANT with the requirement with a per satellite casualty risk of 1:100000000. Experimentation has demonstrated that 1:100000000 is the smallest human casualty risk that the DAS software will report. Since the analysis shows all components of the YAM satellites demising above an altitude of 60 km and both the Debris Casualty Area and the Impact Kinetic Energy are reported as 0.0 in all cases, this reflects 0 chance of human casualty. For the same reasons, the total constellation casualty risk is also 0%.

The DAS Output Summary Follows:

07 26 2019; 06:35:04AM Processing Requirement 4.3-2: Return Status : Passed

=====================
No Project Data Available
=====================

=============== End of Requirement 4.3-2 ===============
07 26 2019; 06:35:10AM Requirement 4.4-3: Compliant

=============== End of Requirement 4.4-3 ===============
07 26 2019; 06:44:16AM Processing Requirement 4.5-1: Return Status : Passed

==============
Run Data
==============

INPUT

Space Structure Name = YAM
Space Structure Type = Payload
Perigee Altitude = 570.000000 (km)
Apogee Altitude = 570.000000 (km)
Inclination = 97.700000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.011200 (m^2/kg)
Start Year = 2021.000000 (yr)
Initial Mass = 78.800000 (kg)
Final Mass = 78.800000 (kg)
Duration = 5.000000 (yr)
Station-Kept = False
Abandoned = True
PMD Perigee Altitude = -1.000000 (km)

PMD Apogee Altitude = -1.000000 (km)
PMD Inclination = 0.000000 (deg)
PMD RAAN = 0.000000 (deg)
PMD Argument of Perigee = 0.000000 (deg)
PMD Mean Anomaly = 0.000000 (deg)

OUTPUT

Collision Probability = 0.000011
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range
Status = Pass

==============

=============== End of Requirement 4.5-1 ===============
07 26 2019; 06:50:23AM Requirement 4.5-2: Compliant
07 26 2019; 06:50:39AM Processing Requirement 4.6 Return Status : Passed

==============
Project Data
==============

INPUT

Space Structure Name = YAM
Space Structure Type = Payload

Perigee Altitude = 570.000000 (km)
Apogee Altitude = 570.000000 (km)
Inclination = 97.700000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.011200 (m^2/kg)
Start Year = 2021.000000 (yr)
Initial Mass = 78.800000 (kg)
Final Mass = 78.800000 (kg)
Duration = 5.000000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 383.753632 (km)
PMD Apogee Altitude = 383.753632 (km)
PMD Inclination = 97.653241 (deg)
PMD RAAN = 57.516157 (deg)
PMD Argument of Perigee = 322.623706 (deg)
PMD Mean Anomaly = 0.000000 (deg)

OUTPUT

Suggested Perigee Altitude = 383.753632 (km)

Suggested Apogee Altitude = 383.753632 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2026 (yr)
Requirement = 61
Compliance Status = Pass

==============

=============== End of Requirement 4.6 ===============
07 26 2019; 06:50:50AM *********Processing Requirement 4.7-1
Return Status : Passed

***********INPUT****
Item Number = 1

name = YAM
quantity = 1
parent = 0
materialID = 8
type = Box
Aero Mass = 78.800003
Thermal Mass = 78.800003
Diameter/Width = 0.750000
Length = 1.300000
Height = 0.600000

name = Solar Array Support
quantity = 3
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.670000
Thermal Mass = 0.670000
Diameter/Width = 0.250000
Length = 0.800000

name = Solar Array Panel
quantity = 3
parent = 1
materialID = 27
type = Flat Plate
Aero Mass = 1.660000
Thermal Mass = 1.660000
Diameter/Width = 0.250000
Length = 0.800000

name = Solar Array Drive
quantity = 1
parent = 1
materialID = 8

type = Cylinder
Aero Mass = 1.650000
Thermal Mass = 1.650000
Diameter/Width = 0.093000
Length = 0.108000

name = Internal Bus Components
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 4.270000
Thermal Mass = 4.270000
Diameter/Width = 0.500000
Length = 0.500000
Height = 0.200000

name = Bus Structure - Outside Components
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 6.900000
Thermal Mass = 6.900000
Diameter/Width = 0.500000
Length = 0.500000
Height = 0.200000

name = Payload Wire Harness
quantity = 1
parent = 1
materialID = 19
type = Box
Aero Mass = 3.000000
Thermal Mass = 3.000000
Diameter/Width = 0.100000
Length = 0.300000
Height = 0.100000

name = Sep System
quantity = 1
parent = 1
materialID = 8
type = Cylinder
Aero Mass = 4.700000
Thermal Mass = 4.700000
Diameter/Width = 0.500000
Length = 0.200000

name = Payload Panels
quantity = 6

parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 2.600000
Thermal Mass = 2.600000
Diameter/Width = 0.500000
Length = 0.500000

name = Bus Panels 1
quantity = 4
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 1.500000
Thermal Mass = 1.500000
Diameter/Width = 0.200000
Length = 0.500000

name = Bus Panels 2
quantity = 2
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 3.000000
Thermal Mass = 3.000000
Diameter/Width = 0.500000
Length = 0.500000

name = Reaction Wheels
quantity = 4
parent = 1
materialID = 8
type = Box
Aero Mass = 0.828000
Thermal Mass = 0.828000
Diameter/Width = 0.112000
Length = 0.112000
Height = 0.038000

name = Battery
quantity = 3
parent = 1
materialID = 8
type = Box
Aero Mass = 0.770000
Thermal Mass = 0.770000
Diameter/Width = 0.100000
Length = 0.200000
Height = 0.100000

name = Torque Rod

quantity = 3
parent = 1
materialID = 60
type = Cylinder
Aero Mass = 0.550000
Thermal Mass = 0.550000
Diameter/Width = 0.038000
Length = 0.194000

name = Payload1
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 4.750000
Thermal Mass = 4.750000
Diameter/Width = 0.241000
Length = 0.257000
Height = 0.140000

name = Payload2_1
quantity = 2
parent = 1
materialID = 8
type = Box
Aero Mass = 1.310000
Thermal Mass = 1.310000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

name = Payload3
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.080000
Length = 0.100000
Height = 0.070000

name = Paylaod4
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 3.000000
Thermal Mass = 3.000000
Diameter/Width = 0.114000
Length = 0.191000

Height = 0.114000

name = Payload5
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 1.000000
Thermal Mass = 1.000000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

name = Paylaod2_2
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 2.010000
Thermal Mass = 1.010000
Diameter/Width = 0.401000
Length = 0.401000

name = Paylaod6
quantity = 1
parent = 20
materialID = 8
type = Box
Aero Mass = 1.000000
Thermal Mass = 1.000000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

name = PCU
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.850000
Thermal Mass = 0.850000
Diameter/Width = 0.114000
Length = 0.114000
Height = 0.114000

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Item Number = 1

name = YAM
Demise Altitude = 77.993408
Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****
name = Solar Array Support
Demise Altitude = 76.314751
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Solar Array Panel
Demise Altitude = 77.228142
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Solar Array Drive
Demise Altitude = 63.911160
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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name = Internal Bus Components
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Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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name = Bus Structure - Outside Components
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Impact Kinetic Energy = 0.000000

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Impact Kinetic Energy = 0.000000

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Impact Kinetic Energy = 0.000000

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name = Payload Panels
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Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

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Demise Altitude = 72.244080
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Bus Panels 2
Demise Altitude = 68.915451
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Reaction Wheels
Demise Altitude = 67.996529
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Battery
Demise Altitude = 73.965691
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
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Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
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Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Payload2_1
Demise Altitude = 66.981331
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Payload3
Demise Altitude = 72.790085
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Paylaod4
Demise Altitude = 65.330566
Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****
name = Payload5
Demise Altitude = 69.199936
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Paylaod2_2
Demise Altitude = 75.120552
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Paylaod6
Demise Altitude = 62.046406
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = PCU
Demise Altitude = 71.542015
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

=============== End of Requirement 4.7-1 ===============

Requirements 4.7-1b, and 4.7-1c:
These requirements are non-applicable requirements because the YAM constellation does not use controlled reentry.

4.7-1, b): *"For controlled reentry, the selected trajectory shall ensure that no surviving debris impact with a kinetic energy greater than 15 joules is closer than 370 km from foreign landmasses, or is within 50 km from the continental U.S., territories of the U.S., and the permanent ice pack of Antarctica (Requirement 56627)."*

Not applicable to YAM. The spacecraft does not use controlled reentry and no debris is expected to survive.

4.7-1 c): *"For controlled reentries, the product of the probability of failure of the reentry burn (from Requirement 4.6-4.b) and the risk of human casualty assuming uncontrolled reentry shall not exceed 0.0001 (1:10,000) (Requirement 56628)."*

Not applicable to YAM. It does not use controlled reentry and no debris is expected to survive.

ODAR Section 8: Assessment for Tether Missions

Not applicable. There are no tethers used in the YAM mission.

END of ODAR for YAM

Appendix A: Acronyms

Arg peri	Argument of Perigee
CDR	Critical Design Review
cm	centimeter
COTS	Commercial Off-The-Shelf (items)
DAS	Debris Assessment Software
EOM	End Of Mission
FRR	Flight Readiness Review
GEO	Geosynchronous Earth Orbit
ITAR	International Traffic In Arms Regulations
kg	kilogram
km	kilometer
LEO	Low Earth Orbit
Li-Ion	Lithium Ion
m^2	Meters squared
ml	milliliter
mm	millimeter
N/A	Not Applicable.
NET	Not Earlier Than
ODAR	Orbital Debris Assessment Report
OSMA	Office of Safety and Mission Assurance
PDR	Preliminary Design Review
PL	Payload
ISIPOD	ISIS CubeSat Deployer
PSIa	Pounds Per Square Inch, absolute
RAAN	Right Ascension of the Ascending Node
SMA	Safety and Mission Assurance
Ti	Titanium
Yr	year