SpinLaunch

AlphaSat Spacecraft
Orbital Debris Assessment Report (ODAR)

Initial Release

Date: July 22nd, 2022

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CEO

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ORBITAL DEBRIS ASSESSMENT REPORT

This document contains the orbital debris assessment report (ODAR) for the SpinLaunch (SL) spacecraft AlphaSat.

Table 1 includes a summary of the results in the following sections.

Table 1: AlphaSat ODAR Summary Information

ODAR Requirement for AlphaSat	Compliant or N/A	Not Compliant	Incomplete
4.3.1-a	x		
4.3.1-b	x		
4.3.2	x		
4.4-1	x		
4.4-2	x		
4.4-3	x		
4.4-4	x		
4.5-1	x		
4.5-2	x		
4.6-1(a)	x		
4.6-2	x		
4.6-3	x		
4.6-4	x		
4.7-1	x		
4.8-1	x		

ODAR SECTION 1: PROGRAM MANAGEMENT AND MISSION OVERVIEW

Project Manager: Severiano Sandomirsky

Foreign Government / Space Agency Participation: None

Schedule of Upcoming Mission Milestones: Launch scheduled for December 1st, 2022 – February 28th, 2023

Mission Overview:

The AlphaSat spacecraft is scheduled for launch December 1st, 2022 – February 28th, 2023 aboard a Arianespace Vega-C rocket. The spacecraft is expected to be inserted into SSO orbit with a target perigee and apogee of 564 km, with a +6/-14 km orbital variance (i.e. between 550-570 km).

The mission will demonstrate custom satellite avionics components developed to survive the launch environment of the SpinLaunch system. The mission will also demonstrate an experimental water-based propulsion system developed by Miles Space. The AlphaSat satellite employs 2-axis stabilization[1] for operational attitude control.

ODAR Summary:

1. No orbital debris to be released as part of normal operations
2. No credible scenarios for spacecraft breakup
3. Collision probability is compliant with NASA ODAR requirements 4.5-1 and 4.5-2 as calculated by DAS v3.2.1
4. Orbit decay lifetime due to atmospheric drag is less than 25 years and therefore compliant with ODAR requirement 4.6
5. Reentry debris casualty risk is compliant with NASA ODAR 4.7-1 as calculated by DAS v3.2.1

Launch Vehicle and Launch Site: Vega-C VV-23; Kourou, French Guiana Space Port

Projected Launch Date: December 1st, 2022 – February 28th, 2023

Mission Duration:

1. Nominal operations: 3 years
2. Post-operations orbital lifetime: 16.099 years (stowed configuration), 10.924 years (fully deployed) from the worst-case insertion orbit of 570 x 570 km

Launch and Deployment Profile:

[1] AlphaSat will be testing some 3-axis stabilization modes, but most operational control will rely on 2-axis stabilization using a single magnetorquer.

The launch and deployment profile consists of launch and insertion into orbit. The AlphaSat launch, insertion, and deployment information is provided in Table 1.1.

Table 1.1: Summary of AlphaSat Launch and Insertion, Operational Orbit Information

Target Launch Date	December 1st, 2022 – February 28th, 2023
Launch Vehicle	Vega-C
Secondary Payload Aggregator	SpaceFlight Services
AlphaSat Launch Configuration	Smallsat measuring 34 cm x 23 cm x 23 cm
Perigee Altitude	564 km +6/-14 km
Apogee Altitude	564 km +6/-14km
Inclination	SSO, LTDN 10:30

Launch and Insertion:
The AlphaSat spacecraft, as scheduled, will launch on an Arianespace Vega-C rocket, flight VV-23, between December 1st, 2022 – February 28th, 2023. SpaceFlight services will integrate AlphaSat as a secondary payload. The launch and insertion orbit details are provided in Table 1.1. For the provided insertion orbit range of 550 km to 570 km, SSO.

Spacecraft maneuver capability, including attitude, orbit control, and time period during which capabilities will be exercised:

The spacecraft has an experimental water-based onboard propulsion system with an ISP of ~1300s and a max thrust of 2.8 mN. The AlphaSat spacecraft employs 2-axis stabilization which will be activated shortly after release & solar array deployment and employed throughout the operational life for antenna pointing, solar array pointing, and other mission options. At end of life, any remaining propellant may[2] be employed

[2] If testing of both the experimental propulsion system and the 3-axis stabilization algorithms are both successful and the systems remain operational at end of life, remaining propellant would be employed at end of life to lower the spacecraft altitude.

to lower the orbital altitude or it will be vented before the AlphaSat satellite is passivated and left to naturally deorbit and reenter the atmosphere.

Reason for selection of operational orbit(s) (such as ground track, SSO, GEO sync, instrument resolution, or co-locate with other spacecraft):

Rideshare opportunity.

Identification of any interaction or potential physical interference with other operational spacecraft: No intentional interactions with other spacecraft.

ODAR SECTION 2: SPACECRAFT DESCRIPTION

Clear overall spacecraft dimensions:
The physical dimensions of the AlphaSat spacecraft bus are: ~34 cm x 24 cm x 23 cm. Once the solar arrays have been deployed, the AlphaSat spacecraft dimensions increase to ~100 cm x 34 cm x 24 cm.

Total spacecraft mass at launch, including all propellants and fluids:
~16.7 kg for the AlphaSat spacecraft, this includes 0.25kg of water propellant for the experimental propulsion system.

Dry mass of spacecraft at launch, minus consumables and propellants:
~16.45 kg for the AlphaSat spacecraft.

Identification, including type, mass, and pressure, of all fluids (liquids and gases) planned to be on board, excluding fluids in sealed heat pipes. Description of all fluid systems, including size, type, and qualifications of fluid containers such as propellant and pressurization tanks, including pressurized batteries:

Propellant consists of 0.25kg of degassed water. No fluid in pressurized batteries. The AlphaSat spacecraft uses unpressurized COTS Panasonic NCR18650B, lithium cobalt battery cells.

Description of all propulsion systems (e.g., cold gas, mono-propellant, bi-propellant, solid propellant, electric, nuclear):
Experimental water-based M1.4 Plasma Thruster by Miles Space.

Description of all active and/or passive attitude control systems with an indication of the normal attitude of the spacecraft with respect to the velocity vector:

Attitude/position is sensed with a star tracker, GPS, 3DOF accelerometers (set of 2), 3DOF gyroscopes (set of 4), and 3DOF magnetometers (set of 2).

Attitude is controlled with reaction wheels (set of 3) and magnetorquers (set of 3).

Normal attitude of the AlphaSat spacecraft will be 2-axis stabilized with the normal vector of the solar array aligned with the local magnetic field by use of a single magnetorquer whose axis is along that vector. Additional (experimental) attitude control modes would adjust the spacecraft to maximize solar energy collection (as necessary) and to steer antenna beam peaks towards GW ES during contacts.

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

Space vehicle separation will be accomplished using spring-loaded debris-free low-shock release system.

Solar array deployment will also be achieved using a heating element to cut a short length of Ultra-High Molecular Weight Polyethylene (UHMWPE) string that is held in place with space-rated epoxy to ensure that all cut portions remain positively affixed to the spacecraft. Thus assuring no release of any debris.

Description of the electrical generation and storage system:

The AlphaSat spacecraft generates a peak of 80 W of electrical power from a combination of four deployed double-sided and one fixed single-sided solar array panels.

The AlphaSat spacecraft uses sixteen (16) Lithium Ion 12Wh Panasonic 18650B batteries providing a total capacity theoretical capacity of 192 Wh (regulated to no higher than 90% end-of-charge capacity).

Battery assembly will be charged at the time of integration and four deployable solar array panels, plus one body-fixed panel, will recharge the assembly on-orbit. Power management and distribution electronics onboard the spacecraft control the charge of the battery and flow of power to other spacecraft elements.

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

Identification of any radioactive material on board: None

Address the trackability of the spacecraft. Spacecraft operating in low-Earth orbit will be presumed trackable if each individual spacecraft is 10 cm or larger in its smallest dimension, excluding deployable components: The spacecraft is in low-Earth orbit and has a smallest dimension measuring at least 10 cm. Thus, it is trackable.

The statement shall also disclose the following:

How the operator plans to identify the spacecraft following deployment and whether spacecraft tracking will be active or passive:

Spacecraft tracking will be active. Prior to deployment, an initial ephemeris is produced by the launch service that will be used to schedule a contact time window with the ground station. The accuracy of the ephemeris will depend on the launch vehicle's performance, delays, and deployment times. A more accurate ephemeris will be made available shortly after deployment. After deployment, when the satellite establishes contact with the nearest available SpinLaunch-contracted ground station, active satellite tracking will be employed to enhance and maintain satellite ephemeris data. The collected data will be used to identify the spacecraft from TLE once they become available from the 18th Space Control Squadron.

Whether, prior to deployment, the spacecraft will be registered with the 18th Space Control Squadron or successor entity: Prior to deployment, the spacecraft will be registered with the 18th Space Control Squadron via their Satellite Registration Form and Space Situational Awareness (SSA) Sharing Agreement.

The extent to which the spacecraft operator plans to share information regarding initial deployment, ephemeris, and/or planned maneuvers with the 18th Space Control Squadron or successor entity, other entities that engage in space situational awareness or space traffic management functions, and/or other operators:

SL intends to provide the 18th Space Control Squadron with information regarding initial deployment, owner/operator (O/O) ephemeris, and planned maneuvers. This is intended to provide better space situational awareness and improve the accuracy of conjunction analysis (CA). The higher accuracy O/O ephemeris will improve the quality of the CA and reduce the frequency of Conjunction Data Messages (CDMs). SL intends to share ephemeris with other operators on an as-needed basis.

Description of any planned proximity operations or docking with other spacecraft in LEO or GEO, including the controls that will be used to mitigate the risk of a collision that could generate debris or prevent planned later passivation or disposal activities for either spacecraft:

None.

ODAR SECTION 3: ASSESSMENT OF SPACECRAFT DEBRIS RELEASED DURING NOMINAL OPERATIONS

Identification of any object > 1mm expected to be released from spacecraft after launch: 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 of each object after release: N/A

Calculated orbital lifetime of each object, including time spent in Low Earth Orbit: N/A

Assessment of spacecraft compliance with ODAR Requirements 4.3-1 and 4.3-2 (per DAS v3.2.1):

- 4.3-1, Mission Related Debris Passing Through LEO: COMPLIANT
- 4.3-2, Mission Related Debris Passing Through GEO: COMPLIANT

ODAR SECTION 4: ASSESSMENT OF SPACECRAFT INTENTIONAL BREAKUPS AND POTENTIAL FOR EXPLOSION

Potential causes of spacecraft breakup during deployment and mission operations:

There are no credible causes of spacecraft breakup during nominal deployment and mission operations.

Summary of failure modes and effects analyses of all credible failure modes that may lead to an accidental explosion:

The spacecraft has no chemical propellants or pressurized vessels[3]. The battery safety systems are discussed in the assessment of spacecraft compliance with ODAR requirement 4.4-1 and describe combined faults required for the mutually exclusive failures that lead to battery venting. The batteries are Panasonic NCR18650B[4] Li-Ion COTS batteries equipped with a safety vent feature that vents excessive pressure build-up, precluding explosions. The batteries include over-current limiting "PTC" devices in every cell.

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[3] Propellant tank is filled at sea level ~1 atmosphere and sealed before launch. Therefore, it is theoretically a pressure vessel but the maximum operating pressure is extremely low and would not result in a catastrophic failure that generates debris.

[4] These are some of the most common space-qualified batteries for CubeSats thus offering extensive flight heritage.

Detailed plan for any designed spacecraft breakup: None

List of components which are passivated at End of Mission (EOM). List includes method of passivation and amount which cannot be passivated:

The following components will be passivated at EOM:
- Batteries - method of passivation: power to most subsystems will be commanded off. However, all thermostat heaters (except for the battery heater) will be latched at full duty to drain the batteries at or below a known, safe C-rate and shunt any power generated by the solar arrays.
- Reaction wheels – method of passivation: command reaction wheels off at end of mission and let them spin down passively.
- Propulsion System – Excess propellant will be expended to reduce the orbit altitude as much as possible or vented.

Items which are required to be passivated, but cannot be due to their design:

The batteries cannot be passivated. However, once solar array power is disconnected from the bus, the operations of the spacecraft will mostly drain the batteries with any additional power collected by the solar array, immediately being transferred to heat in the satellite.

Assessment of spacecraft compliance with ODAR requirements 4.4-1 - 4.4-4:

4.4-1: Limited the risk to other space systems from accidental explosions during deployment and mission operations while in orbit around Earth or the Moon:
- Required Probability: 0.001 – COMPLIANT; expected probability of 0.000

Battery explosion:
- Effect: All failure modes below might result in battery explosion with the possibility of orbital debris generation. However, 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 due to the multiple enclosures surrounding the batteries.
- Probability: Extremely Low. It is believed to be less than 0.01% given that multiple independent (not common mode) faults must occur for each failure mode to cause the ultimate effect (explosion). Each battery cell is UL certified with individual over-voltage and over-current protection.

Supporting Rationale:

- Failure Mode 1: Internal cell short circuit
    - Mitigation 1: Qualification and acceptance shock, vibration, thermal cycling, and vacuum tests followed by maximum system rate-limited charge and discharge to prove that no internal short circuit sensitivity exists. Combined faults required for realized failure: Environmental testing AND functional charge/discharge tests must both be ineffective in discovery of the failure mode.
- Failure Mode 2: Internal thermal rise due to high load discharge rate.
    - Mitigation 2: Battery cells were UL tested in lab for high load discharge rates by short circuiting the terminal with a 1.3mm^2 Cu wire to determine the feasibility of an out-of-control thermal rise in the cell. No failures were observed or identified via satellite telemetry or via external monitoring circuitry.
    - Combined faults required for realized failure: Spacecraft thermal design must be incorrect AND external over-current detection and disconnect function must fail to enable this failure mode.
- Failure Mode 3: Excessive discharge rate or short-circuit due to external device failure or terminal contact with conductors not at battery voltage levels (due to abrasion or inadequate proximity separation).
    - Mitigation 3: This failure mode is negated by:
        a) Qualification tested short circuit protection on each external circuit,
        b) Design of battery packs and insulators such that no contact with nearby board traces is possible without being caused by some other mechanical failure,
    - Combined faults required for realized failure: An external load must fail/short-circuit AND external over-current detection and disconnect function must all occur to enable this failure mode.
- Failure Mode 4: Inoperable vents
    - Mitigation 4: Battery venting is not inhibited by the battery holder design or the spacecraft design. The battery can vent gases to the external environment. Dual vents per battery cell provide redundancy against a single fault.
    - Combined faults required for realized failure: The cell manufacturer OR the satellite integrator fails to install proper venting.
- Failure Mode 5: Crushing
    - Mitigation 5: Failure mode prevented by design. No moving parts near the battery assembly. Battery cells UL tested for crush to 13kN pressure. Battery cells UL tested for impact using 9.1kg at 61cm.
    - Combined faults required for realized failure: A catastrophic failure must occur in an external system AND the failure must cause a collision sufficient to crush the batteries leading to an internal short

circuit AND the satellite must be in a naturally sustained orbit at the time the crushing occurs.

- Failure Mode 6: Low-level current leakage or short-circuit through battery pack case or due to moisture-based degradation of insulators.
  - Mitigation 6: These modes are negated by a) battery holder/case design made of non-conductive plastic, and b) operation in a vacuum, such that no moisture can affect insulators.
  - Combined faults required for realized failure: Abrasion or piercing failure of circuit board coating or wire insulators AND dislocation of battery packs AND failure of battery terminal insulators AND failure to detect such failure modes in environmental tests must occur to result in this failure mode.
- Failure Mode 7: Excess battery cell temperature due to orbital environment and high discharge combined.
  - Mitigation 7: The spacecraft thermal design will negate this possibility. Thermal rise has been analyzed in combination with space environment temperatures showing that batteries do not exceed normal allowable operating temperatures under a variety of modeled cases, including worst case orbital scenarios. Analysis shows these temperatures to be well below temperatures of concern for explosions. Battery cells UL tested to 150C for 10 minutes without fire or explosion.
  - Combined faults required for realized failure: incorrect thermal analysis AND thermal design AND mission simulations in thermal-vacuum chamber testing AND over-current monitoring and control must all fail for this failure mode to occur.

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

- Compliance Statement: After all other passivation activities have been completed, the power system will disconnect all loads except the thermostat heaters. All thermostat heaters, except the battery heater, will be turned on full duty. The power draw in this configuration exceeds the maximum power supply provided by the solar arrays. Therefore, the batteries will draw down and stay mostly (>99%) discharged. This approach has been verified, through thermal analysis, not to exceed any thermal safety limits. Once in EOM mode with low battery voltage cutoff, the satellite cannot be recovered.

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

- Compliance Statement: Requirement not applicable, no planned breakups

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

- Compliance Statement: Requirement not applicable, no planned breakups

ODAR SECTION 5: ASSESSMENT OF SPACECRAFT POTENTIAL FOR ON-ORBIT COLLISIONS

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

Per DAS v3.2.1, the probability of collision with large space objects is:
AlphaSat: 4.5052E-06

Assessment of spacecraft compliance with ODAR requirements 4.5-1 and 4.5-2:

- 4.5-1: Limiting debris generated by collisions with large objects when operating in Earth Orbit (per DAS v3.2.1):
  - COMPLIANT; Collision Probability < 0.001
- 4.5-2: Limiting debris generated by collisions with small objects when operating in Earth or Lunar Orbit:
  - COMPLIANT; Not applicable as the planned disposal method is via atmospheric reentry that does not require a specific orientation or drag state.

Detailed description and assessment of the efficacy of any planned debris avoidance capability intended to help in meeting requirement 4.5-1:

Not applicable. While the AlphaSat spacecraft is equipped with an experimental propulsion system, it should not be counted on to support debris/collision avoidance. Furthermore, operational employment of the propulsion system would also require successful demonstration of 3-axis spacecraft control. If both of these experiments prove successful, the AlphaSat operator will re-engage with the 18th Space Control Squadron to update them on these enhanced operational capabilities.

If at any time during the spacecraft's mission or de-orbit phase the spacecraft will operate in or transit through the orbits used by any planned or inhabitable spacecraft, including the International Space Station, describe the design and operational strategies, such as coordination, that will be used to minimize the risk of collision and avoid posing any operational constraints to the spacecraft:

AlphaSat will not be placed in or otherwise operate within a 10 km sphere centered around the ISS. Additionally, when the AlphaSat perigee drops below the orbit of the ISS, SpinLaunch will contact the NASA JSC Flight Operations Director (FOD) Human Space Flight Conjunction Assessment Operations to ensure that the ISS has a point of contact for the SpinLaunch spacecraft.

After the end of its operational life, the AlphaSat spacecraft will passively deorbit. This passive deorbit stage will pass through the orbital altitude of the ISS. As can be seen in Figure 6.1 and Figure 6.2 below, the orbit stays nearly circular, thus limiting the period of time when conjunctions with the ISS may occur.

Certify that upon receipt of a space situational awareness conjunction warning, the operator will review and take all possible steps to assess the collision risk, and will mitigate the collision risk if necessary:

Upon receipt of a space situational awareness conjunction warning, the operator certifies that it will attempt to contact the operator of any active spacecraft involved in such a warning, share ephemeris data and other appropriate operational information with any such operator in order to avoid a collision. The AlphaSat spacecraft does not have an operational maneuvering capabilities and therefore cannot adjust its orbit to address potential conjunctions.

ODAR SECTION 6: ASSESSMENT OF SPACECRAFT POST-MISSION DISPOSAL PLANS AND PROCEDURES

Description of spacecraft disposal option selected:

Per NASA-STD 8719.4, AlphaSat will be disposed of via atmospheric reentry. The operational altitude lends to natural forces that will quickly lead to atmospheric reentry once the operations, including station keeping with maneuvers, are ceased.

Identification of all systems or components required to accomplish any post-mission disposal maneuvers. Plan for any spacecraft maneuvers required to accomplish post-mission disposal:

No systems, components, special maneuvers, or operations are required for post-mission disposal to meet the 25-year requirement. The spacecraft can deorbit naturally and meet this requirement. However, the AlphaSat spacecraft does have a propulsion system that will be employed to the extent possible at the end of life to reduce orbit altitude to the extent possible and minimize the post-mission lifetime of the spacecraft.

Calculation of area-to-mass ratio after post-mission disposal:

The final area-to-mass ratio is calculated using the dry mass of the vehicle and the average cross-sectional area. Average cross-sectional area is calculated using the equation for estimated average cross-sectional area for non-convex shapes from NASA-STD-8179.14C: $A_{avg} = (A_{max} + A_1 + A_2)/2$, where A_{max} is the maximum cross-sectional area and A_1 and A_2 are the cross-sectional areas for the two viewing directions orthogonal to the maximum cross-sectional area viewing direction.

AlphaSat Final (Deployed-configuration) area-to-mass ratio calculation:

- Spacecraft mass: 16.7 kg (wet mass)
- Cross-sectional area: 0.230793 m^2 (average)
- Area-to-mass ratio: 0.01382 m^2/kg (final)

Calculation of area-to-mass ratio for worst-case deorbit scenarios:

Additional analysis is provided for the two worst-case deorbit scenarios in the following section on ODAR requirement 4.6-1, those for deorbit time with the vehicle at the maximum altitude launch deployment with undeployed solar panels and for the vehicle at maximum altitude during the approach maneuver with deployed solar panels. The average cross-sectional area for these two cases is calculated using the same equation from NASA-STD-8179.14C as previously provided.

AlphaSat Initial (Undeployed) area-to-mass ratio calculation:

- Spacecraft mass: 16.7 kg (wet mass)
- Cross-sectional area: 0.101416 m^2 (average)
- Area-to-mass ratio: 0.0060703 m^2/kg (final)

Assessment of spacecraft compliance with ODAR requirements 4.6-1 to 4.6-4:

- 4.6-1(a): Disposal for space structures in or passing through LEO:
    - COMPLIANT - The DAS prediction for orbit lifetime following a nominal three-year mission lifetime is approximately eleven (11) years. Accordingly, the spacecraft complies with the 25-year re-entry requirement.
    - For the AlphaSat spacecraft a worst-case deorbit time is considered for if the spacecraft were deployed at the worst-case altitude of 570 km and completed solar panel deployment. In this situation, the satellite would re-enter the Earth's atmosphere in approximately 11.324 years as shown in Figure 6.1.
    - For the AlphaSat spacecraft an alternative worst-case deorbit time is considered for if the spacecraft were deployed at the worst-case altitude of 570 km and failed prior to solar panel deployment. In this situation, the satellite would re-enter the Earth's atmosphere in approximately 19.225 years as shown in Figure 6.2.

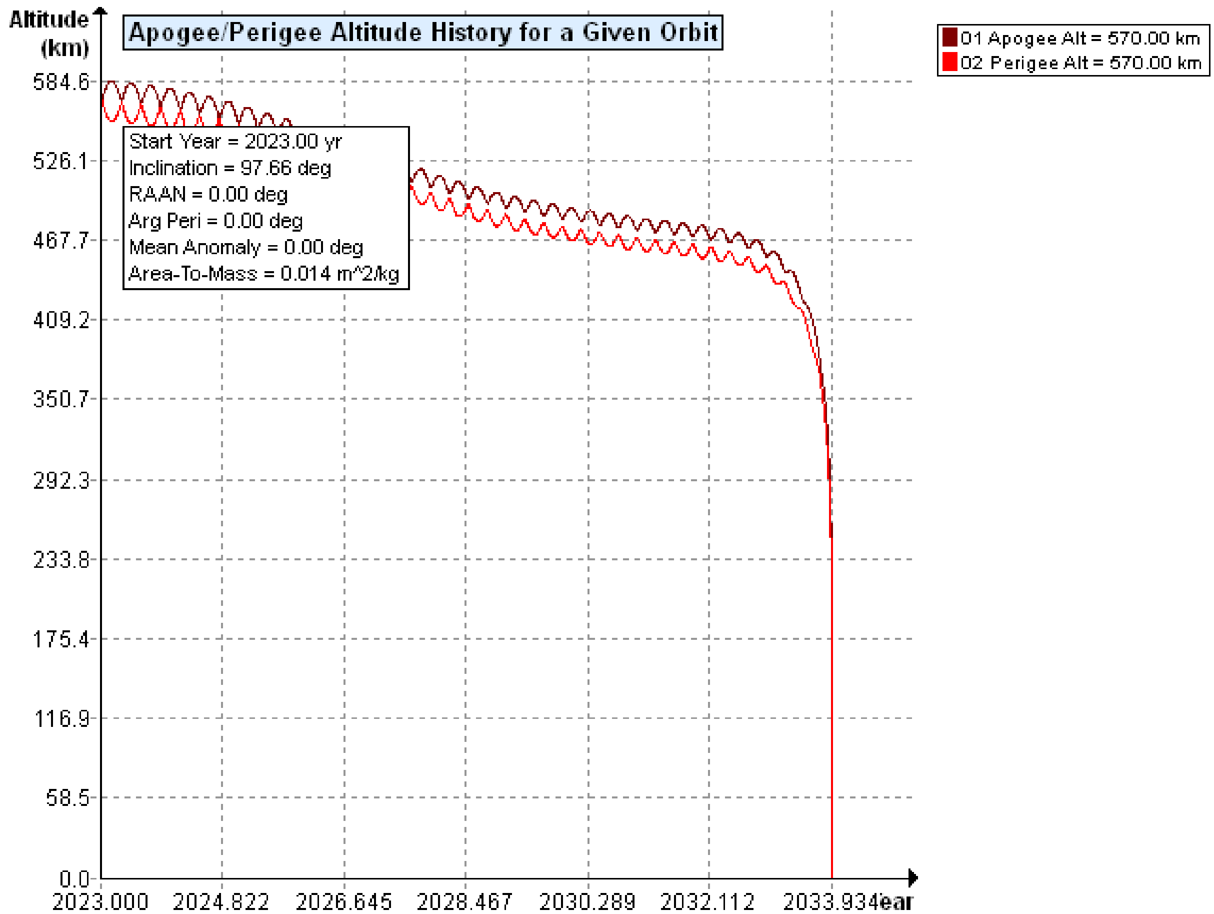

Figure 6.1. AlphaSat De-orbit Altitude Profile from Max Operational Altitude

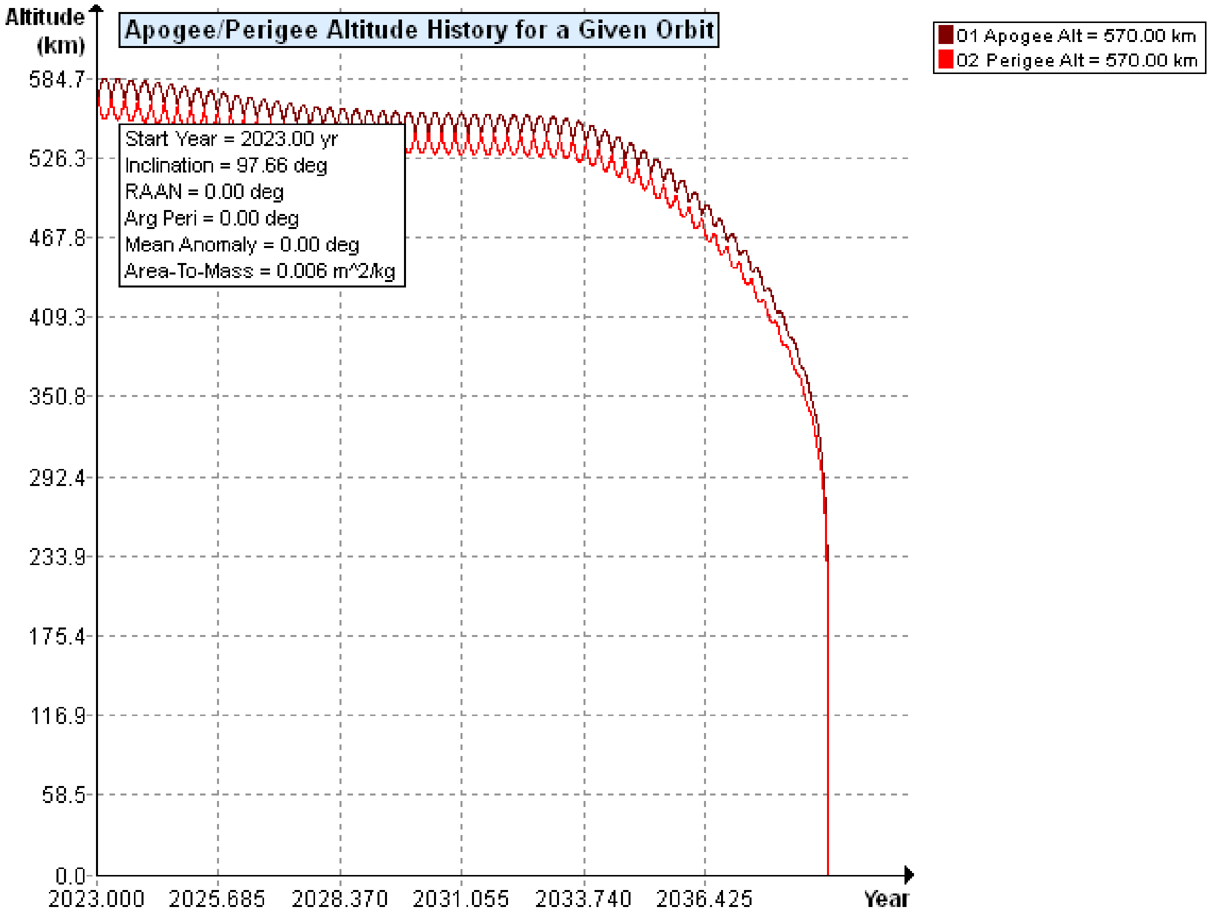

Figure 6.2. AlphaSat De-orbit Altitude Profile from Max Operational Altitude – Assuming Solar Arrays Never Deploy

- 4.6-2: Disposal for space structure near GEO
  - Not applicable
- 4.6-3: Disposal for space structures between LEO and GEO
  - Not applicable
- 4.6-4: Reliability of post-mission disposal operations
  - The spacecraft will reenter passively without post-mission disposal operations within the required timeframe

ODAR SECTION 7: ASSESSMENT OF SPACECRAFT REENTRY HAZARDS

Summary of objects expected to survive uncontrolled reentry:

For AlphaSat, portions of the hysteresis dampener and the EPS stack bracket are expected to survive uncontrolled reentry per the DAS v3.2.1 Casualty Risk from Reentry Debris requirement assessment. This corresponds to a 1:43,500 risk of human casualty and a total debris casualty area of 1.1 m^2.

Assessment of spacecraft compliance with ODAR requirement 4.7-1:

- 4.7-1(a): Limit the risk of human casualty from surviving debris for an uncontrolled reentry to no greater than 1 in 10,000
  - COMPLIANT per DAS v3.2.1;
  - AlphaSat risk is 1 in 43,500
- 4.7-1(b): Not applicable, only for controlled reentry
- 4.7-1(c): Not applicable, only for controlled reentry

ODAR SECTION 8: ASSESSMENT FOR SPECIAL CLASSES OF SPACE MISSIONS

None of the special classes in this Section are applicable.

DAS v3.2.1 OUTPUT FILE

07 13 2022; 08:59:27AM Processing Requirement 4.3-1: Return Status : Not Run

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

=============== End of Requirement 4.3-1 ===============
07 13 2022; 08:59:30AM Processing Requirement 4.3-2: Return Status : Passed

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

=============== End of Requirement 4.3-2 ===============
07 13 2022; 09:17:24AM Processing Requirement 4.5-1: Return Status : Passed

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

INPUT

Space Structure Name = AlphaSat
Space Structure Type = Payload
Perigee Altitude = 570.000 (km)
Apogee Altitude = 570.000 (km)
Inclination = 97.656 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass Ratio = 0.0061 (m^2/kg)
Start Year = 2023.000 (yr)
Initial Mass = 16.700 (kg)
Final Mass = 16.450 (kg)
Duration = 5.000 (yr)
Station-Kept = False
Abandoned = True
Long-Term Reentry = False

OUTPUT

Collision Probability = 4.5052E-06
Returned Message: Normal Processing
Date Range Message: Normal Date Range
Status = Pass

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

=============== End of Requirement 4.5-1 ===============

07 13 2022; 09:18:12AM Project Data Saved To File
07 13 2022; 09:18:19AM Requirement 4.5-2: Compliant

=============== End of Requirement 4.5-2 ===============

07 13 2022; 09:18:20AM Processing Requirement 4.6 Return Status : Passed

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

INPUT

Space Structure Name = AlphaSat
Space Structure Type = Payload

Perigee Altitude = 570.000000 (km)
Apogee Altitude = 570.000000 (km)
Inclination = 97.655800 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.006073 (m^2/kg)
Start Year = 2023.000000 (yr)
Initial Mass = 16.700000 (kg)
Final Mass = 16.450000 (kg)
Duration = 5.000000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 545.296140 (km)
PMD Apogee Altitude = 552.367667 (km)
PMD Inclination = 97.724211 (deg)
PMD RAAN = 8.269627 (deg)
PMD Argument of Perigee = 163.084769 (deg)
PMD Mean Anomaly = 0.000000 (deg)

Long-Term Reentry = False

OUTPUT

Suggested Perigee Altitude = 545.296140 (km)
Suggested Apogee Altitude = 552.367667 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2039 (yr)
Requirement = 61
Compliance Status = Pass

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

=============== End of Requirement 4.6 ===============
07 13 2022; 09:18:25AM *********Processing Requirement 4.7-1
Return Status : Passed

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

name = AlphaSat
quantity = 1
parent = 0
materialID = 8
type = Box
Aero Mass = 16.450001
Thermal Mass = 16.450001
Diameter/Width = 0.239700
Length = 0.340000
Height = 0.227400

name = Structure +Y
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.781000
Thermal Mass = 0.781000
Diameter/Width = 0.209000
Length = 0.340000

name = Structure -Y
quantity = 1

parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.706000
Thermal Mass = 0.706000
Diameter/Width = 0.209000
Length = 0.340000

name = Structure +X
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.696000
Thermal Mass = 0.696000
Diameter/Width = 0.226000
Length = 0.340000

name = Structure -X
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.747000
Thermal Mass = 0.747000
Diameter/Width = 0.226000
Length = 0.340000

name = Structure +Z
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.239000
Thermal Mass = 0.239000
Diameter/Width = 0.183000
Length = 0.209000

name = Structure -Z
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.313000

Thermal Mass = 0.313000
Diameter/Width = 0.183000
Length = 0.209000

name = Reaction Wheels
quantity = 3
parent = 1
materialID = 8
type = Box
Aero Mass = 0.700000
Thermal Mass = 0.700000
Diameter/Width = 0.090000
Length = 0.112000
Height = 0.084000

name = Payload Antenna
quantity = 1
parent = 1
materialID = 23
type = Flat Plate
Aero Mass = 0.948000
Thermal Mass = 0.948000
Diameter/Width = 0.220000
Length = 0.300000

name = Transceiver
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.253000
Thermal Mass = 0.253000
Diameter/Width = 0.087000
Length = 0.093000
Height = 0.018000

name = TT&C Antenna
quantity = 2
parent = 1
materialID = 8
type = Box
Aero Mass = 0.100000
Thermal Mass = 0.100000
Diameter/Width = 0.083000

Length = 0.101000
Height = 0.009000

name = Diplexer
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.794000
Thermal Mass = 0.794000
Diameter/Width = 0.076000
Length = 0.099000
Height = 0.070000

name = Cables
quantity = 5
parent = 1
materialID = 19
type = Cylinder
Aero Mass = 0.005000
Thermal Mass = 0.005000
Diameter/Width = 0.010000
Length = 0.100000

name = Flight Computer
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.130000
Thermal Mass = 0.130000
Diameter/Width = 0.089000
Length = 0.094000
Height = 0.020000

name = Magetorquers
quantity = 3
parent = 1
materialID = 19
type = Box
Aero Mass = 0.200000
Thermal Mass = 0.200000
Diameter/Width = 0.040000
Length = 0.100000

Height = 0.025000

name = Backup Reaction Wheel
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.180000
Thermal Mass = 0.180000
Diameter/Width = 0.044000
Length = 0.044000
Height = 0.044000

name = Star Tracker
quantity = 1
parent = 1
materialID = 23
type = Box
Aero Mass = 0.055000
Thermal Mass = 0.055000
Diameter/Width = 0.050000
Length = 0.053000
Height = 0.035000

name = Camera
quantity = 3
parent = 1
materialID = 8
type = Box
Aero Mass = 0.083000
Thermal Mass = 0.083000
Diameter/Width = 0.042000
Length = 0.147000
Height = 0.017000

name = Battery cells
quantity = 16
parent = 1
materialID = 58
type = Cylinder
Aero Mass = 0.049000
Thermal Mass = 0.049000
Diameter/Width = 0.019000
Length = 0.065000

name = Battery enclosure
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.975000
Thermal Mass = 0.975000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.080000

name = PMB/LSB
quantity = 1
parent = 1
materialID = 23
type = Box
Aero Mass = 0.220000
Thermal Mass = 0.220000
Diameter/Width = 0.089000
Length = 0.093000
Height = 0.015000

name = Blue Board
quantity = 1
parent = 1
materialID = 23
type = Box
Aero Mass = 0.150000
Thermal Mass = 0.150000
Diameter/Width = 0.089000
Length = 0.093000
Height = 0.010000

name = EPS stack bracket
quantity = 1
parent = 1
materialID = 58
type = Box
Aero Mass = 0.112000
Thermal Mass = 0.112000
Diameter/Width = 0.053000
Length = 0.110000
Height = 0.025000

name = Front connector panel
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.044000
Thermal Mass = 0.044000
Diameter/Width = 0.060000
Length = 0.120000

name = Body-fixed array
quantity = 1
parent = 1
materialID = 23
type = Flat Plate
Aero Mass = 0.410000
Thermal Mass = 0.410000
Diameter/Width = 0.240000
Length = 0.338000

name = deployable arrays
quantity = 4
parent = 1
materialID = 27
type = Flat Plate
Aero Mass = 0.182000
Thermal Mass = 0.182000
Diameter/Width = 0.188000
Length = 0.338000

name = Panel hinges
quantity = 4
parent = 1
materialID = 8
type = Box
Aero Mass = 0.053500
Thermal Mass = 0.053500
Diameter/Width = 0.030000
Length = 0.050000
Height = 0.020000

name = Solar cells
quantity = 52

parent = 1
materialID = -1
type = Flat Plate
Aero Mass = 0.003600
Thermal Mass = 0.003600
Diameter/Width = 0.040000
Length = 0.070000

name = Release mechanism
quantity = 2
parent = 1
materialID = 8
type = Box
Aero Mass = 0.300000
Thermal Mass = 0.300000
Diameter/Width = 0.080000
Length = 0.080000
Height = 0.040000

name = Thermal Harness
quantity = 30
parent = 1
materialID = 20
type = Cylinder
Aero Mass = 0.050000
Thermal Mass = 0.050000
Diameter/Width = 0.020000
Length = 0.200000

name = Thruster
quantity = 1
parent = 1
materialID = 23
type = Box
Aero Mass = 0.535000
Thermal Mass = 0.535000
Diameter/Width = 0.090000
Length = 0.095000
Height = 0.090000

name = Propellant
quantity = 1
parent = 1
materialID = 75

type = Box
Aero Mass = 0.250000
Thermal Mass = 0.250000
Diameter/Width = 0.050000
Length = 0.100000
Height = 0.050000

name = Hysteresis Dampener
quantity = 1
parent = 1
materialID = 46
type = Flat Plate
Aero Mass = 0.800000
Thermal Mass = 0.800000
Diameter/Width = 0.150000
Length = 0.300000

**************OUTPUT****
Item Number = 1

name = AlphaSat
Demise Altitude = 77.996124
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Structure +Y
Demise Altitude = 74.173523
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Structure -Y
Demise Altitude = 74.542168
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Structure +X
Demise Altitude = 74.707062
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

name = Structure -X
Demise Altitude = 74.465279
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Structure +Z
Demise Altitude = 76.064743
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Structure -Z
Demise Altitude = 75.451324
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Reaction Wheels
Demise Altitude = 71.921440
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Payload Antenna
Demise Altitude = 74.663445
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Transceiver
Demise Altitude = 73.092369
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = TT&C Antenna
Demise Altitude = 75.887115
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Diplexer
Demise Altitude = 69.763054

Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Cables
Demise Altitude = 77.754562
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Flight Computer
Demise Altitude = 75.522812
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Magetorquers
Demise Altitude = 74.693092
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Backup Reaction Wheel
Demise Altitude = 72.324249
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Star Tracker
Demise Altitude = 76.798676
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Camera
Demise Altitude = 76.408997
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Battery cells
Demise Altitude = 70.205246
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Battery enclosure
Demise Altitude = 68.745018
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = PMB/LSB
Demise Altitude = 75.015915
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Blue Board
Demise Altitude = 75.801353
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = EPS stack bracket
Demise Altitude = 0.000000
Debris Casualty Area = 0.442888
Impact Kinetic Energy = 34.324928

****
name = Front connector panel
Demise Altitude = 76.895378
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Body-fixed array
Demise Altitude = 76.727455
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = deployable arrays
Demise Altitude = 0.000000
Debris Casualty Area = 2.904157
Impact Kinetic Energy = 8.511274

****

name = Panel hinges
Demise Altitude = 75.379936
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Solar cells
Demise Altitude = 0.000000
Debris Casualty Area = 22.167500
Impact Kinetic Energy = 0.075562

****
name = Release mechanism
Demise Altitude = 72.722321
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Thermal Harness
Demise Altitude = 77.190193
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Thruster
Demise Altitude = 74.373466
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Propellant
Demise Altitude = 77.309700
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Hysteresis Dampener
Demise Altitude = 0.000000
Debris Casualty Area = 0.659558
Impact Kinetic Energy = 232.617096

****

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

07 13 2022; 09:18:25AM Project Data Saved To File