# Aethero

**TITAN**

Orbital Phobos Assessment Report[1]
(Compliant with U.S ITAR regulations)

Date: June 9th, 2026

_/s/ Amit Pinnamaneni_____
Amit Pinnamaneni
CTO

[1] Aethero used National Aeronautics and Space Administration (NASA) Debris Assessment Software v3.2.6 to evaluate compliance with NASA Standard 8719.14.C (Process for Limiting Orbital Debris) in this ODAR.

## DOCUMENT CHANGE LOG:

1. Initial Release: May 5, 2026

# ORBITAL DEBRIS ASSESSMENT REPORT

This document contains the orbital debris assessment report (ODAR) for the Aethero TITAN spacecraft described in the TITAN filing at the International Telecommunication Union.

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

Table 1: Titan ODAR Summary Table

| ODAR Requirement for Titan | 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:** Amit Pinnamaneni

**Foreign Government / Space Agency Participation:** None

**Schedule of Upcoming Mission Milestones:** Launch is scheduled for August 2026. Aethero will ensure the satellite deploys lower than 525 km orbital altitude. Adopting this limit will ensure the satellite poses minimal collision and human casualty risk and deorbits within 5 years after mission completion, in compliance with the 5-year FCC standard.

**Mission Overview:**

The Titan missions will demonstrate and test an edge computing platform and two Electro-Optical (EO) sensors onboard an Endurosat spacecraft. The Titan satellite has an Enpulsion EP propulsion system with ~234 m/s delta-V capability and will use magnetorquer and reaction wheel stabilization for active attitude control.

See table 1.1 and 1.2 below, for full orbit parameters of the Titan satellite.

**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 v3.2.6
4. Orbit decay lifetime due to atmospheric drag is less than 5 years, following a 5-year mission and therefore compliant with ODAR requirement 4.6. However, Aethero plans to conduct a PMD maneuver which reduces the post-mission deorbit time to less than 1 year.
5. Reentry debris casualty risk is compliant with NASA ODAR 4.7-1 as calculated by DAS v3.2.6

**Mission Durations:**

1. Nominal operations lifetime: 5 years
2. Post-operations orbital lifetime:
    a. TITAN: <1.0 year following PMD, <5.0 years w/o PMD
        i. From a maximum orbit altitude of 525 x 525 km

The Titan satellite would spend approximately 9.1 years on orbit following solar panel deployment. This deorbit period falls below the FCC 5-year deorbit requirement, following a 5-year mission. However, should the Titan satellite not deploy solar panels

then the orbital lifetime would be ~24.11 years (from the worst-case insertion orbit altitude) due to the reduced drag in the stowed configuration.

**Launch and Deployment Profile:**
The launch and deployment profile consists of launch and insertion into orbit. The Titan launch, insertion and deployment information is provided in Table 1.1.

Table 1.1: Summary of Titan Launches and Insertion, Operational Orbit Information

| | **Titan** |
|---|---|
| **Target Launch Date** | October 2026 |
| **Launch Vehicle** | SpaceX<br>Transporter 16<br>Falcon 9 |
| **Launch Site** | Vandenburg<br>California, USA |
| **Dimension (mm)** | 775 x 500 x 793 |
| **Perigee Altitude (km)** | 510 ± 15km |
| **Apogee Altitude (km)** | 510 ± 15km |
| **Inclination (degrees)** | 97.4 ± 0.5 |

Launch Parameter Rationale
**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 Titan spacecraft bus are: ~775 mm x 500 mm x 793 mm. The deployable solar panels will extend the overall dimensions to: 2900 mm x 775 mm x 793 mm.

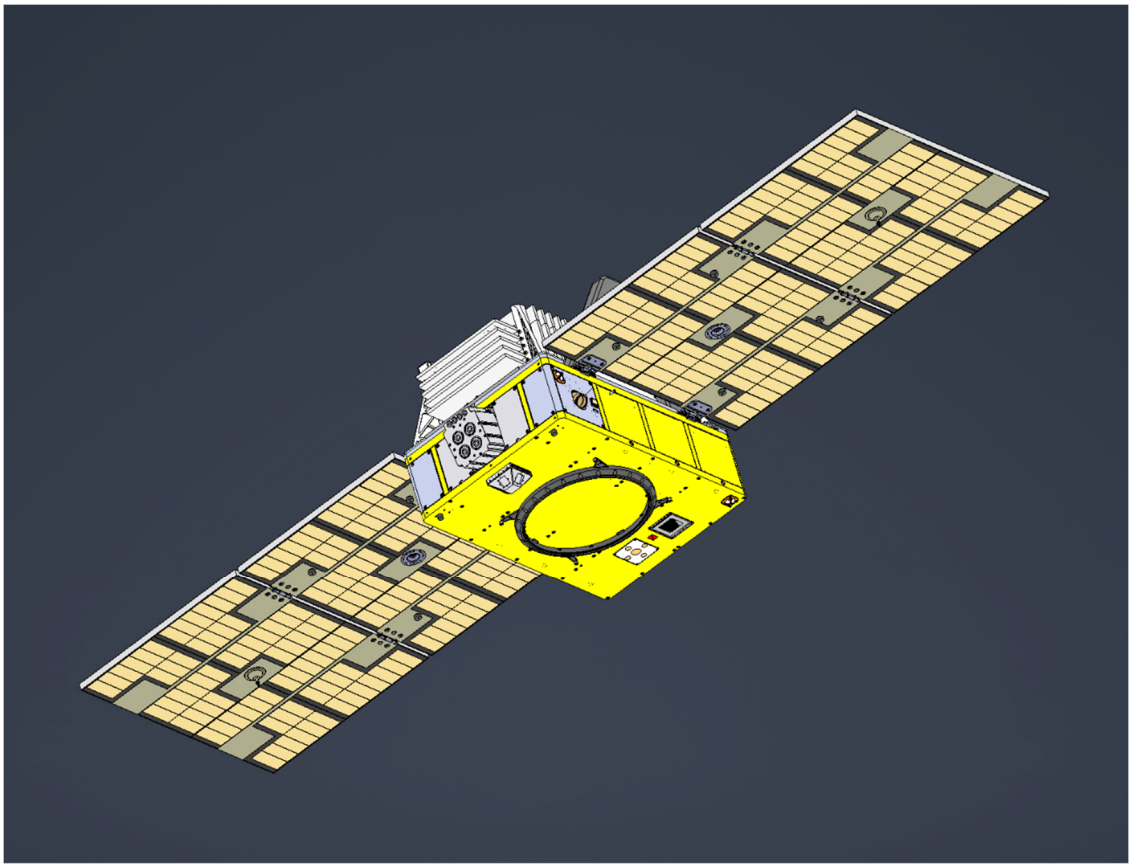

*Figure-1 Titan - Deployed Configuration*

**Total spacecraft mass at launch, including all propellants and fluids:**

~184.045 kg for the Titan

**Dry mass of spacecraft at launch, minus consumables and propellants:**

~182.745 kg for the Titan

**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:**

No fluid in pressurized batteries.

**Description of all propulsion systems (e.g., cold gas, mono-propellant, bi-propellant, solid propellant, electric, nuclear):**

- Enpulsion Micro Starling Electric Propulsion system:

- 300uN to 1mN thrust
- 1500-3500s ISP
- 50 kNs Total Impulse
- 1.3 kg Indium propellant

**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:**

Reaction wheel and magnetorquer stabilization for active attitude control.

**Description of any range safety or other pyrotechnic devices:**

None.

Space vehicle separation will be accomplished using a debris-free low-shock release system as designed by approved integrators for our launches. Integrators install the Titan spacecraft into a deployer. These use spring-loaded platforms and side rails to guide the spacecraft into orbit, without generating or releasing debris.

Solar panel deployment will also be achieved using mechanisms that do not release any debris.

**Description of the electrical generation and storage system:**

The Titan spacecraft uses an Endurosat EPS IV with a 4-cell battery pack, providing a maximum capacity of 1100 Wh. Electrical power is generated using body mounted and deployable triple junction solar cells.

Battery assembly will be charged prior to integration. 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:**

Reaction wheels store a small amount of kinetic energy.

**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 Aethero-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 two-line element sets once they become available by the 18th Space Defense 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 Defense 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:**

Aethero intends to provide the 18th Space Defense Squadron 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). Aethero intends to share ephemeris with other operators via Space-Track.org.

**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 v3.2.6):**

- 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. The battery safety systems are discussed in the assessment of spacecraft compliance with ODAR requirement 4.4-1, which describes the combined faults required for the mutually exclusive failures that lead to battery venting. The batteries are commercial-off-the-shelf batteries equipped with safety vent features on either side that releases excessive pressure build-up, precluding explosions.

**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:

- Solar panels - method of passivation: disconnected from the electrical power system (EPS) at EOM using an electronic switch.
- Batteries - method of passivation: will be passivated at EOM. Amount that cannot be passivated: the energy left in the batteries after the EPS cut-off is to be used up by components onboard until depleted.
- Momentum wheels – method of passivation: will be spun down at end of mission.

**Items which are required to be passivated, but cannot be due to their design:** None

**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, coupled with the multiple enclosures surrounding the batteries, will ensure most if not all debris from the battery rupture should be contained within the spacecraft due to the lack of penetration energy.
- 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: Protoflight level sine burst, sine and random vibration in three axes of the spacecraft, thermal vacuum cycling of the spacecraft and extensive functional testing followed by maximum system rate-limited charge and discharge cycles were performed to prove that no internal short circuit sensitivity exists. Additional environmental and functional testing of the batteries at the power subsystem vendor facilities were also conducted at the component level.

        - 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 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, and
            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 single fault.
        - Combined faults required for realized failure: The cell manufacturer and the satellite integrator must fail to install proper venting.
    - Failure Mode 5: Crushing
        - Mitigation 5: Failure mode prevented by design. No moving parts appear near the battery assembly. Battery cells are UL tested for crush and impact.
        - 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: Excess battery cell temperature due to orbital environment and high discharge combined.

- Mitigation 6: The spacecraft thermal design will negate this possibility. Thermal rise has been analyzed in combination with space environment temperatures showing that the 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 are UL tested 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: Circuits are designed to allow for the disconnection of all solar panel power. In this EOM mode, the battery discharges to the low voltage cutoff within a few days. 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 v3.2.6, the probability of collision for the worst-case scenario altitude (525km) with large space objects is:
Titan: 2.9407-05

Per DAS v3.2.6, the probability of collision for the worst-case scenario altitude (525km) with small objects is:
Titan: 0.0096384

**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 v3.2.6):

    - 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 necessarily applicable because the requirement concerns only space objects using subsystems to deorbit. Given Titan satellites can deorbit passively via atmospheric reentry, which does not require a subsystem for specific orientation or drag state, this requirement does not apply to the Titan satellites.

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

There is no significant risk of collision based on orbital parameters and small spacecraft size. Titan does have a propulsion system and employs reaction wheels and magnetorquer stabilization for active attitude control. Furthermore, we will register our satellites with the US Space Force's 18th Space Defense Squadron, which provides active monitoring in coordination with the Combined Space Operations Center.

Aethero will contact and work with any entity who owns a spacecraft that has the potential to collide with a Titan satellite to avoid collision.

**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:**

Following mission completion, Titan spacecraft will be actively lowered through the ISS orbit, under nominal operating conditions. With respect to the operational strategies to minimize risk to the ISS or any other inhabitable spacecraft in low Earth orbit, Aethero intends to monitor the location of its spacecraft and work closely with organizations, such as the 18th Space Defense Squadron, the NASA Flight Dynamics / Trajectory Operations and Planning Office (TOPO), and the China Manned Space Agency (CSMA). More generally, Aethero also works with the Space Data Association to coordinate physical operation of its constellation with other operators.

The Titan spacecraft will have a large enough inclination difference so that during the deorbit phase the probability of colliding with the ISS is negligible.

**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, Aethero 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.

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

**Description of spacecraft disposal option selected:**

Consistent with NASA-STD 8719.4C, Titan will be disposed of via atmospheric reentry. The operational altitude in low-Earth orbit lends to natural forces that will quickly lead to atmospheric reentry once the operations 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. The spacecraft will deorbit naturally. However, Aethero plans to lower the orbit altitude down to a circular orbit of ~350km or lower after the mission has completed, using remaining propellant. The maneuver will require:

- Enpulsion EP System
- EPS system
- AODC system
- OBC
- TT&C

**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.

Titan Final area-to-mass ratio calculation:

- Spacecraft mass: 184.045 kg (dry mass)
- Cross-sectional area: 1.33 $m^2$ (average)
- Area-to-mass ratio: 0.00726 $m^2/kg$ (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 5-year mission lifetime is approximately 4.1 years as shown in Figure 6.1, assuming no end of mission deorbit is conducted. Accordingly, the spacecraft complies with the 5-year re-entry requirement. However, the plan is to lower the orbit altitude to ~350km circular or lower following the end of mission. In this case, the post-mission deorbit time would be < 1 year, as shown in Figure 6.2.
  - For the Titan spacecraft a worst-case deorbit time is considered if the spacecraft were deployed at the worst-case altitude of 525 km in a non-operational state. In this situation, the satellite would re-enter the Earth's atmosphere in approximately 24.11 years.

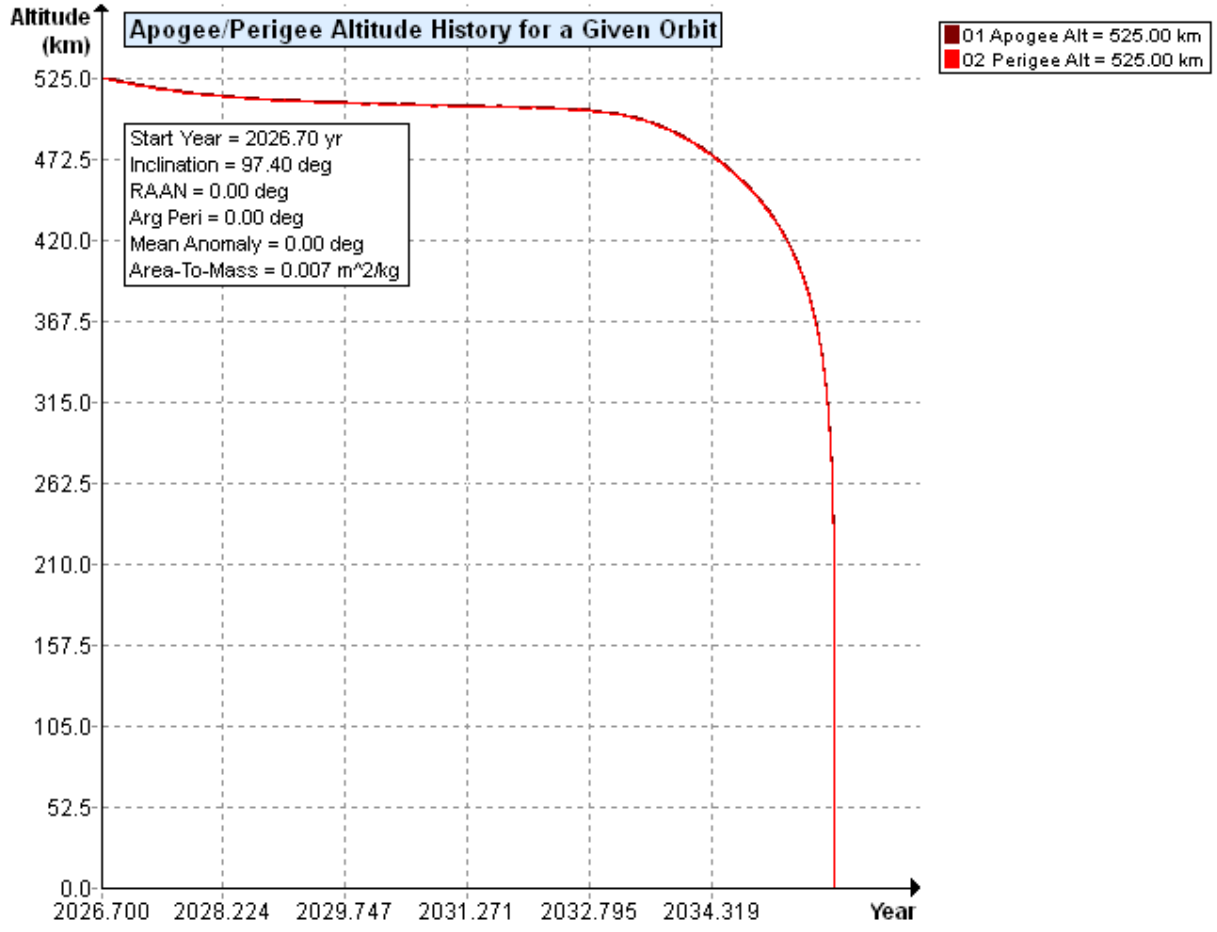


Figure 6.1. Titan De-orbit Altitude Profile from Operational Altitude

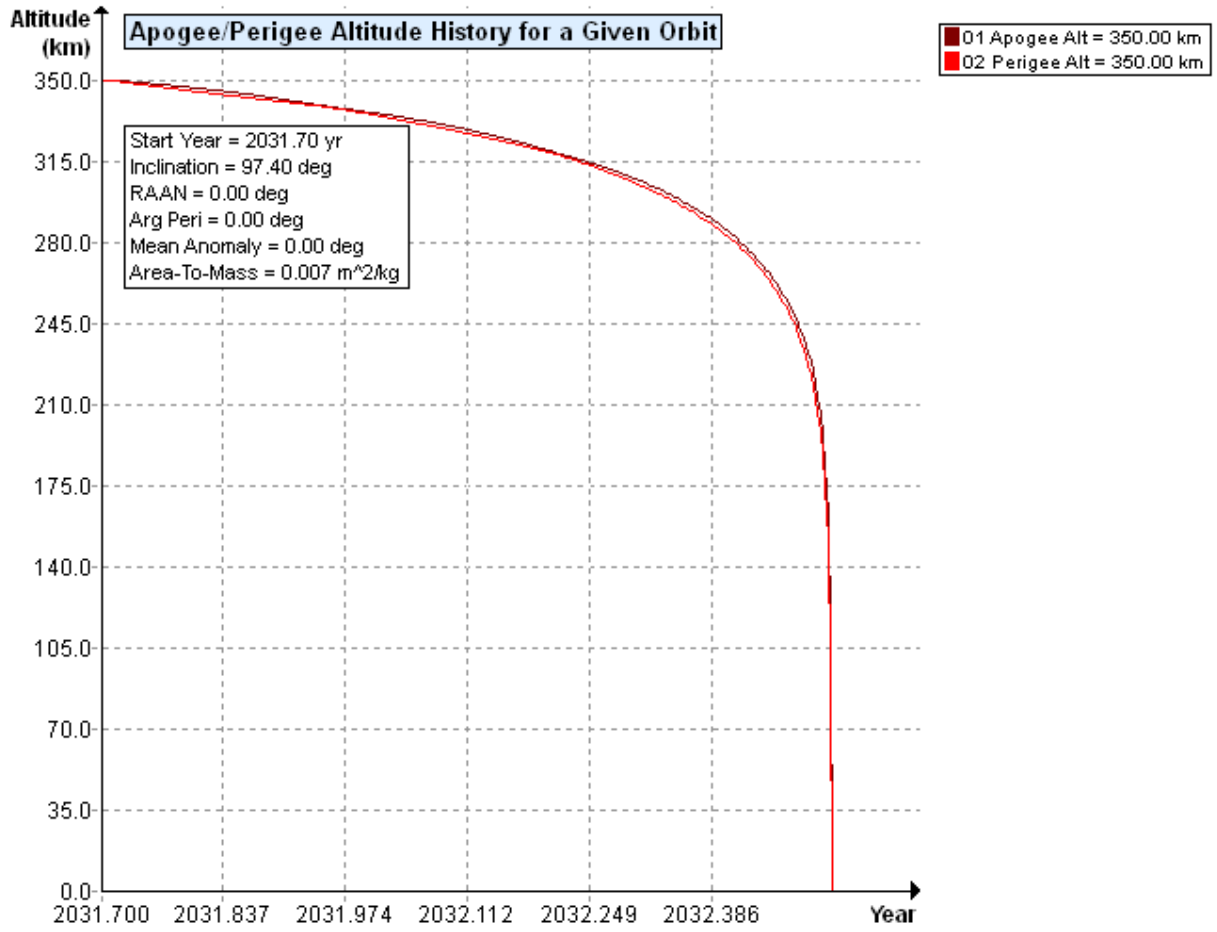


Figure 6.2. Titan De-orbit Altitude Profile Following End-of-Mission Deorbit

- 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 Titan, no spacecraft components are expected to survive uncontrolled reentry with energy of greater than 15J per the DAS v3.2.6 Casualty Risk from Reentry Debris requirement assessment. This corresponds to 0 risk of human casualty and a total debris

casualty area of 0.00 $m^2$ and falls within the 1:10,000 risk permitted by administrations, such as the United States.

**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 v3.2.6;
  - Titan risk is 0
- 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, except as discussed above with respect to formation flying.

## DAS v3.2.6 OUTPUT FILE

04 26 2026; 06:07:22AM Processing Requirement 4.3-1: Return Status : Not Run

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

========== End of Requirement 4.3-1 ==========
04 26 2026; 06:07:26AM Processing Requirement 4.3-2: Return Status : Passed

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

========== End of Requirement 4.3-2 ==========
04 26 2026; 06:30:12AM Processing Requirement 4.5-1: Return Status : Passed

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

**INPUT**

Space Structure Name = Titan
Space Structure Type = Payload
Perigee Altitude = 525.000 (km)
Apogee Altitude = 525.000 (km)
Inclination = 97.400 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass Ratio = 0.0073 (m^2/kg)
Start Year = 2026.700 (yr)
Initial Mass = 184.045 (kg)
Final Mass = 182.745 (kg)
Duration = 5.000 (yr)

Station-Kept = False
Abandoned = True
Long-Term Reentry = False

**OUTPUT**

Collision Probability = 2.9407E-05
Returned Message: Normal Processing
Date Range Message: Normal Date Range
Status = Pass

==========

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

04 26 2026; 06:30:35AM Project Data Saved To File
04 26 2026; 06:44:53AM Requirement 4.5-2: Compliant

==========
Spacecraft = Titan
Critical Surface = OBC
==========

**INPUT**

Apogee Altitude = 525.000 (km)
Perigee Altitude = 525.000 (km)
Orbital Inclination = 97.400 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass = 0.0073 (m^2/kg)
Initial Mass = 182.745 (kg)
Final Mass = 182.745 (kg)
Station Kept = No
Start Year = 2026.700 (yr)
Duration = 5.000 (yr)

Orientation = Random Tumbling
CS Areal Density = 0.270 (g/cm^2)
CS Surface Area = 0.0100 (m^2)
Vector = (0.000000 (u), 0.000000 (v), 0.000000 (w))
CS Pressurized = No
Outer Wall 1 Density: 0.540 (g/cm^2) Separation: 1.000 (cm)
Outer Wall 2 Density: 0.270 (g/cm^2) Separation: 10.000 (cm)

**OUTPUT**

Probability of Penetration = 1.3915E-03 (1.3924E-03)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
Spacecraft = Titan
Critical Surface = AODC Controller
==========

**INPUT**

Apogee Altitude = 525.000 (km)
Perigee Altitude = 525.000 (km)
Orbital Inclination = 97.400 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass = 0.0073 (m^2/kg)
Initial Mass = 182.745 (kg)
Final Mass = 182.745 (kg)
Station Kept = No
Start Year = 2026.700 (yr)
Duration = 5.000 (yr)
Orientation = Random Tumbling
CS Areal Density = 0.270 (g/cm^2)
CS Surface Area = 0.0100 (m^2)
Vector = (0.000000 (u), 0.000000 (v), 0.000000 (w))

CS Pressurized = No
Outer Wall 1 Density: 0.540 (g/cm^2) Separation: 1.000 (cm)
Outer Wall 2 Density: 0.270 (g/cm^2) Separation: 10.000 (cm)

**OUTPUT**

Probability of Penetration = 1.3915E-03 (1.3924E-03)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
Spacecraft = Titan
Critical Surface = EPS Controller
==========

**INPUT**

Apogee Altitude = 525.000 (km)
Perigee Altitude = 525.000 (km)
Orbital Inclination = 97.400 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass = 0.0073 (m^2/kg)
Initial Mass = 182.745 (kg)
Final Mass = 182.745 (kg)
Station Kept = No
Start Year = 2026.700 (yr)
Duration = 5.000 (yr)
Orientation = Random Tumbling
CS Areal Density = 0.270 (g/cm^2)
CS Surface Area = 0.0100 (m^2)
Vector = (0.000000 (u), 0.000000 (v), 0.000000 (w))
CS Pressurized = No
Outer Wall 1 Density: 0.540 (g/cm^2) Separation: 1.000 (cm)
Outer Wall 2 Density: 0.270 (g/cm^2) Separation: 10.000 (cm)

**OUTPUT**

Probability of Penetration = 1.3915E-03 (1.3924E-03)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========

Spacecraft = Titan
Critical Surface = Comms

==========

**INPUT**

Apogee Altitude = 525.000 (km)
Perigee Altitude = 525.000 (km)
Orbital Inclination = 97.400 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass = 0.0073 (m^2/kg)
Initial Mass = 182.745 (kg)
Final Mass = 182.745 (kg)
Station Kept = No
Start Year = 2026.700 (yr)
Duration = 5.000 (yr)
Orientation = Random Tumbling
CS Areal Density = 0.270 (g/cm^2)
CS Surface Area = 0.0100 (m^2)
Vector = (0.000000 (u), 0.000000 (v), 0.000000 (w))
CS Pressurized = No
Outer Wall 1 Density: 0.540 (g/cm^2) Separation: 1.000 (cm)
Outer Wall 2 Density: 0.270 (g/cm^2) Separation: 10.000 (cm)

**OUTPUT**

Probability of Penetration = 1.3915E-03 (1.3924E-03)
Returned Error Message: Normal Processing

Date Range Error Message: Normal Date Range

==========

Spacecraft = Titan
Critical Surface = Propulsion

==========

**INPUT**

Apogee Altitude = 525.000 (km)
Perigee Altitude = 525.000 (km)
Orbital Inclination = 97.400 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass = 0.0073 (m^2/kg)
Initial Mass = 182.745 (kg)
Final Mass = 182.745 (kg)
Station Kept = No
Start Year = 2026.700 (yr)
Duration = 5.000 (yr)
Orientation = Random Tumbling
CS Areal Density = 0.270 (g/cm^2)
CS Surface Area = 0.0100 (m^2)
Vector = (0.000000 (u), 0.000000 (v), 0.000000 (w))
CS Pressurized = No
Outer Wall 1  Density: 0.540 (g/cm^2)  Separation: 1.000 (cm)

**OUTPUT**

Probability of Penetration = 4.1070E-03 (4.1155E-03)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

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

04 26 2026; 06:45:05AM  Processing Requirement 4.6  Return Status :  Passed

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

**INPUT**

Space Structure Name = Titan
Space Structure Type = Payload

Perigee Altitude = 525.000000 (km)
Apogee Altitude = 525.000000 (km)
Inclination = 97.400000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.007260 (m^2/kg)
Start Year = 2026.700000 (yr)
Initial Mass = 184.045000 (kg)
Final Mass = 182.745000 (kg)
Duration = 5.000000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 505.821392 (km)
PMD Apogee Altitude = 506.763403 (km)
PMD Inclination = 97.384299 (deg)
PMD RAAN = 342.424296 (deg)
PMD Argument of Perigee = 151.519318 (deg)
PMD Mean Anomaly = 0.000000 (deg)
Long-Term Reentry = False

**OUTPUT**

Suggested Perigee Altitude = 505.821392 (km)
Suggested Apogee Altitude = 506.763403 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2035 (yr)
Requirement = 61
Compliance Status = Pass

==========

========== End of Requirement 4.6 ==========
04 26 2026; 06:45:08AM *********Processing Requirement 4.7-1
Return Status : Passed

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

name = Titan
quantity = 1
parent = 0
materialID = 8
type = Box
Aero Mass = 182.744995
Thermal Mass = 182.744995
Diameter/Width = 0.500000
Length = 0.775000
Height = 0.494000

name = BUS Structure
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 40.123000
Thermal Mass = 27.000000
Diameter/Width = 0.500000
Length = 0.775000
Height = 0.208000

name = OBC Module
quantity = 1

parent = 2
materialID = 8
type = Box
Aero Mass = 0.179000
Thermal Mass = 0.179000
Diameter/Width = 0.083000
Length = 0.093900
Height = 0.014400

name = Wiring
quantity = 300
parent = 2
materialID = 19
type = Box
Aero Mass = 0.019000
Thermal Mass = 0.019000
Diameter/Width = 0.006000
Length = 0.200000
Height = 0.006000

name = X-band Transmitter
quantity = 1
parent = 2
materialID = 8
type = Box
Aero Mass = 1.240000
Thermal Mass = 1.240000
Diameter/Width = 0.092000
Length = 0.100000
Height = 0.063300

name = S-band Transceiver
quantity = 1
parent = 2
materialID = 8
type = Box
Aero Mass = 0.380000

Thermal Mass = 0.380000
Diameter/Width = 0.089200
Length = 0.093700
Height = 0.032340

name = CubeADCS Core Stack
quantity = 1
parent = 2
materialID = 8
type = Box
Aero Mass = 0.215000
Thermal Mass = 0.215000
Diameter/Width = 0.088000
Length = 0.094000
Height = 0.053200

name = CubeWheel
quantity = 4
parent = 2
materialID = 8
type = Box
Aero Mass = 0.115000
Thermal Mass = 0.115000
Diameter/Width = 0.050000
Length = 0.050000
Height = 0.024000

name = CubeTorquer
quantity = 3
parent = 2
materialID = 8
type = Box
Aero Mass = 0.034000
Thermal Mass = 0.034000
Diameter/Width = 0.030000
Length = 0.040000
Height = 0.010000

name = CubeMag Compact
quantity = 1
parent = 2
materialID = 8
type = Box
Aero Mass = 0.008000
Thermal Mass = 0.008000
Diameter/Width = 0.020000
Length = 0.020000
Height = 0.010000

name = CubeMag Deployable
quantity = 1
parent = 2
materialID = 8
type = Box
Aero Mass = 0.016000
Thermal Mass = 0.016000
Diameter/Width = 0.066000
Length = 0.081900
Height = 0.017000

name = CubeSense Sun
quantity = 3
parent = 2
materialID = 8
type = Box
Aero Mass = 0.015000
Thermal Mass = 0.015000
Diameter/Width = 0.024000
Length = 0.035000
Height = 0.024000

name = CubeAuriga
quantity = 2
parent = 2

materialID = 8
type = Box
Aero Mass = 0.314000
Thermal Mass = 0.314000
Diameter/Width = 0.065000
Length = 0.094000
Height = 0.054000

name = X-band Antenna
quantity = 2
parent = 2
materialID = 23
type = Box
Aero Mass = 0.489000
Thermal Mass = 0.489000
Diameter/Width = 0.200000
Length = 0.300000
Height = 0.060000

name = Thermal Strap
quantity = 2
parent = 2
materialID = 8
type = Box
Aero Mass = 0.286000
Thermal Mass = 0.286000
Diameter/Width = 0.060000
Length = 0.400000
Height = 0.005000

name = Solar Array - Bumpers
quantity = 2
parent = 2
materialID = -1
type = Box
Aero Mass = 1.300000
Thermal Mass = 1.300000

Diameter/Width = 0.350000
Length = 0.500000
Height = 0.050000

name = X/Y Solar Panel Deployable
quantity = 4
parent = 1
materialID = 8
type = Box
Aero Mass = 1.800000
Thermal Mass = 1.800000
Diameter/Width = 0.596000
Length = 0.800000
Height = 0.020000

name = S-band Antenna - Wideband
quantity = 2
parent = 1
materialID = 8
type = Box
Aero Mass = 0.100000
Thermal Mass = 0.100000
Diameter/Width = 0.098000
Length = 0.112000
Height = 0.006400

name = TITAN-Enclosure
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 41.529999
Thermal Mass = 41.529999
Diameter/Width = 0.540000
Length = 0.775000
Height = 0.286000

name = ESTITAN
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 9.760000
Thermal Mass = 9.760000
Diameter/Width = 0.540000
Length = 0.775000
Height = 0.013000

name = Modular-Avionics-Box
quantity = 6
parent = 1
materialID = 8
type = Box
Aero Mass = 1.620000
Thermal Mass = 1.620000
Diameter/Width = 0.170000
Length = 0.255000
Height = 0.160000

name = Enpulsion
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 3.900000
Thermal Mass = 3.900000
Diameter/Width = 0.126000
Length = 0.135000
Height = 0.126000

name = SpaceForge
quantity = 4
parent = 1
materialID = 8

type = Box
Aero Mass = 0.020000
Thermal Mass = 0.020000
Diameter/Width = 0.040000
Length = 0.040000
Height = 0.020000

name = K97_IVAN
quantity = 4
parent = 1
materialID = 8
type = Box
Aero Mass = 1.200000
Thermal Mass = 1.200000
Diameter/Width = 0.163000
Length = 0.550000
Height = 0.020000

name = NxA-ECM
quantity = 2
parent = 1
materialID = 8
type = Box
Aero Mass = 5.420000
Thermal Mass = 5.420000
Diameter/Width = 0.100000
Length = 0.200000
Height = 0.100000

name = NxN 3x Stack
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 9.193000
Thermal Mass = 9.193000
Diameter/Width = 0.150000

Length = 0.350000
Height = 0.083000

name = UART Mux
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.104508
Thermal Mass = 0.104508
Diameter/Width = 0.082000
Length = 0.091300
Height = 0.014000

name = PDMDDM
quantity = 5
parent = 1
materialID = 8
type = Box
Aero Mass = 0.182998
Thermal Mass = 0.182998
Diameter/Width = 0.088400
Length = 0.093700
Height = 0.025000

name = PCDM
quantity = 2
parent = 1
materialID = 8
type = Box
Aero Mass = 6.131803
Thermal Mass = 6.131803
Diameter/Width = 0.150000
Length = 0.250000
Height = 0.090000

name = CSC MiniPix

quantity = 1
parent = 1
materialID = 58
type = Box
Aero Mass = 0.229781
Thermal Mass = 0.229781
Diameter/Width = 0.031000
Length = 0.082000
Height = 0.016000

name = Aluminum MiniPix
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.268213
Thermal Mass = 0.268213
Diameter/Width = 0.040000
Length = 0.100000
Height = 0.030000

name = MiniPix Space
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.064158
Thermal Mass = 0.064158
Diameter/Width = 0.035000
Length = 0.092000
Height = 0.025000

name = QuadMag
quantity = 1
parent = 1
materialID = 8
type = Box

Aero Mass = 0.187421
Thermal Mass = 0.187421
Diameter/Width = 0.050000
Length = 0.060000
Height = 0.030000

name = ESPER FLC
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 12.000000
Thermal Mass = 12.000000
Diameter/Width = 0.260000
Length = 0.370000
Height = 0.250000

name = PhaseOne Scanway Imager
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 1.324000
Thermal Mass = 1.324000
Diameter/Width = 0.090000
Length = 0.250000
Height = 0.090000

name = Hardware
quantity = 590
parent = 1
materialID = 58
type = Box
Aero Mass = 0.003000
Thermal Mass = 0.003000
Diameter/Width = 0.005000
Length = 0.020000

Height = 0.005000

name = Mini Assembly
quantity = 1
parent = 1
materialID = 54
type = Box
Aero Mass = 0.500000
Thermal Mass = 0.500000
Diameter/Width = 0.085000
Length = 0.085000
Height = 0.040000

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

name = Titan
Demise Altitude = 77.997934
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = BUS Structure
Demise Altitude = 75.097876
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = OBC Module
Demise Altitude = 74.578412
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = Wiring
Demise Altitude = 74.893895
Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

**********

name = X-band Transmitter
Demise Altitude = 73.059837
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = S-band Transceiver
Demise Altitude = 74.219215
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = CubeADCS Core Stack
Demise Altitude = 74.691679
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = CubeWheel
Demise Altitude = 74.468112
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = CubeTorquer
Demise Altitude = 74.723099
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = CubeMag Compact
Demise Altitude = 74.898941
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = CubeMag Deployable
Demise Altitude = 75.051613
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = CubeSense Sun
Demise Altitude = 74.956745
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = CubeAuriga
Demise Altitude = 74.467754
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = X-band Antenna
Demise Altitude = 74.429874
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = Thermal Strap
Demise Altitude = 74.735733
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = Solar Array - Bumpers
Demise Altitude = 74.702350
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = X/Y Solar Panel Deployable
Demise Altitude = 77.735327
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = S-band Antenna - Wideband
Demise Altitude = 77.753878
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = TITAN-Enclosure
Demise Altitude = 73.998202
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = ESTITAN
Demise Altitude = 76.420173
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = Modular-Avionics-Box
Demise Altitude = 77.361697
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********
name = Enpulsion
Demise Altitude = 74.938022
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = SpaceForge
Demise Altitude = 77.836813
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = K97_IVAN
Demise Altitude = 77.488981
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = NxA-ECM
Demise Altitude = 74.431539
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = NxN 3x Stack
Demise Altitude = 74.179036
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = UART Mux
Demise Altitude = 77.687590
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = PDMDDM
Demise Altitude = 77.549994
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = PCDM

Demise Altitude = 74.771000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = CSC MiniPix
Demise Altitude = 73.376896
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = Aluminum MiniPix
Demise Altitude = 77.197259
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = MiniPix Space
Demise Altitude = 77.761850
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = QuadMag
Demise Altitude = 77.197683
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = ESPER FLC
Demise Altitude = 75.487780
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = PhaseOne Scanway Imager
Demise Altitude = 77.151849

Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = Hardware
Demise Altitude = 77.184047
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

name = Mini Assembly
Demise Altitude = 73.863796
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

**********

========== End of Requirement 4.7-1 ==========
04 26 2026; 06:45:08AM Project Data Saved To File