True Anomaly Demo-1 Orbital Debris Assessment Report (ODAR)

This report complies with NASA-STD-8719.14c, APPENDIX A

Report Version: Initial, 12/24/2022

Updated, 6/14/2023

DAS Software Version Used In Analysis: v3.2.3

This document's data are NOT restricted

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Signature Page

VERSION APPROVAL and/or **FINAL APPROVAL*:**

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RF Lead

*Approval signature indicates acceptance of the ODAR-defined risk

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Record of Revision

Rev	Date	Affected Pages	Description of Changes	Author
Initial	12/18/22	All	All	JK
Rev A	6/14/2023	5,11,13,15	Updated final deorbit altitude and plan	JK

Final/PDR/CDR Orbital Debris Assessment Report Evaluation: True Anomaly Demo-1 Mission

NASA-STD-8719.14C – 2019-04-25

Based upon ODAR version 3.2.3, dated 12,18,2022

Requirement	Compliant	N/A	Not Compliant	Incomplete	Comments
4.3-1.a 25 year limit	X				
4.3-1.b <100 object x year limit	X				
4.3-2 GEO +/- 200km		X			
4.4-1 <0.001 Explosion Risk	X				
4.4-2 Passivate Energy Source	X				
4.4-3 Limit BU Long term Risk		X			
4.4-4 Limit BU Short term Risk		X			
4.5-1 <001 10cm Impact Risk	X				
4.5-2 Post Mission Disposal Risk	X				
4.6-1a-c Disposal Method	X				
4.6-2 GEO Disposal		X			
4.6-3 MEO Disposal		X			
4.6-4 Disposal Reliability	X				
4.7-1 Ground	X				

Population Risk					
4.8-1 Tether Risk		X			

Comments:

Orbital Assessment Report Format:

This ODAR follows the recommended format in NASA-STD-8719.14C, Appendix A.1 and contains the indicated minimum in each section 2 through 8 below for the True Anomaly Demo-1 mission. Section 9 through 14 apply only to launch vehicle and are not covered here.

ODAR Section 1: Program Management and Mission Overview:

HQ Mission Directorate sponsoring the mission: **True Anomaly Inc.**

Program / Project Manager: **Sean Ozdemir**

Foreign government or space agency participation and NASA's responsibility: **N/A**

Upcoming mission milestones schedule

PDR: **Q4 2022**

CDR: **Q1 2023**

FRR: **Q3 2023**

Launch: **Q4 2023**

Mission description:

The Demo 1 mission will launch two Jackal spacecraft on a SpaceX Transporter mission. The two Jackal spacecraft will perform proximity operations with each other and come within 1 km to demonstrate the payload suite capability.

Launch and mission duration:

Launch Vehicle: **SpaceX Falcon 9**

Launch Site: **Vandenberg, CA**

Proposed launch date: **October 1, 2023**

Mission duration: **1-5 years**

Launch and deployment profile, including all parking, and operational orbits with apogee, perigee, and inclination:

The Jackal space vehicles will be launched into a sun synchronous orbit with an altitude between 505-545 km. The launch is the SpaceX Transporter 9 mission. The Jackal space vehicles will be deployed among other space vehicles on the same launch.

Description of spacecraft's maneuver capability both attitude and orbit control:

The Jackal spacecraft is capable of up to 500 m/s of delta V from a hydrazine thruster system. This propulsion system consists of twelve, 1 N thrusters. The SV also has four, 1N reaction wheels and three, 15 Am torque rods.

Reasons for selecting operational orbit(s):

The orbit was selected from the available launch vehicle options to meet the mission requirements.

Identification of any interaction or potential physical interference with other operational spacecraft (does not include radio frequency interaction):

There is no planned physical interference with other operational spacecraft. Proximity operations (500m - 1 km) will be performed with another Jackal SV.

ODAR Section 2: Spacecraft Description:

A. Physical description of the spacecraft, including spacecraft bus, payload instrumentation, and all appendages, such as solar arrays, antennas, and instrument or attitude control booms:

The spacecraft consists of two flat plates that sandwich a hydrazine propellant tank. All spacecraft electronics are mounted on one of those two plates. The payload suite consists of two star trackers, a narrow field of view camera, a short wave infrared (SWIR) camera, and a long wave infrared (LWIR) camera. There are two solar array wings which each consist of two panels. The panels are equal in size and fold during launch. There are two S-band antennas that are used for TT&C functions, up and downlink. There is one Ka-band phased array that will be used for mission data downlink. There are no deployable or fixed booms on the spacecraft. Cross section area of the Y/Z plane is 3.67 m^2 and of the X/Y plane is 0.56 m^2. Reference Figure 1, 2 and 3.

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

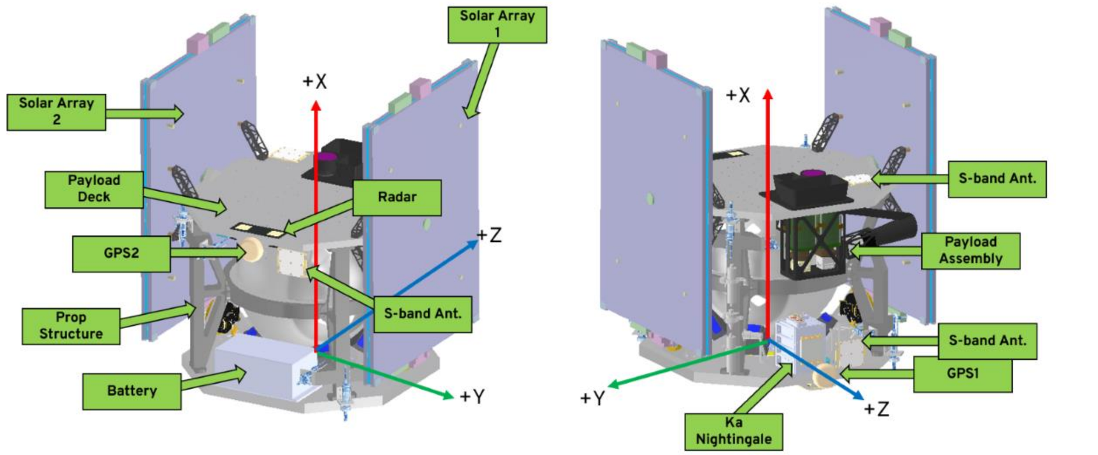


Figure 1: Jackal Overview

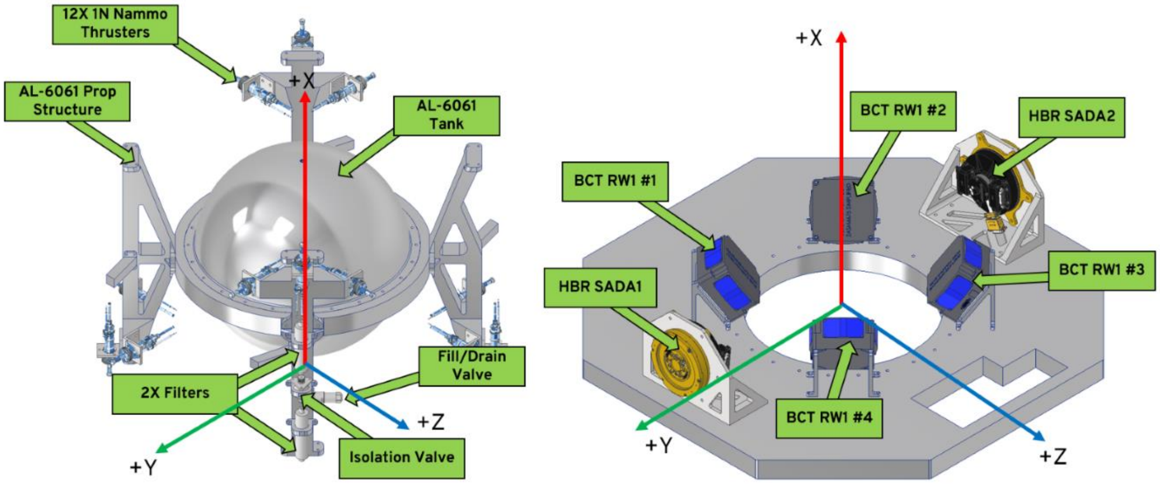


Figure 2: Jackal Overview

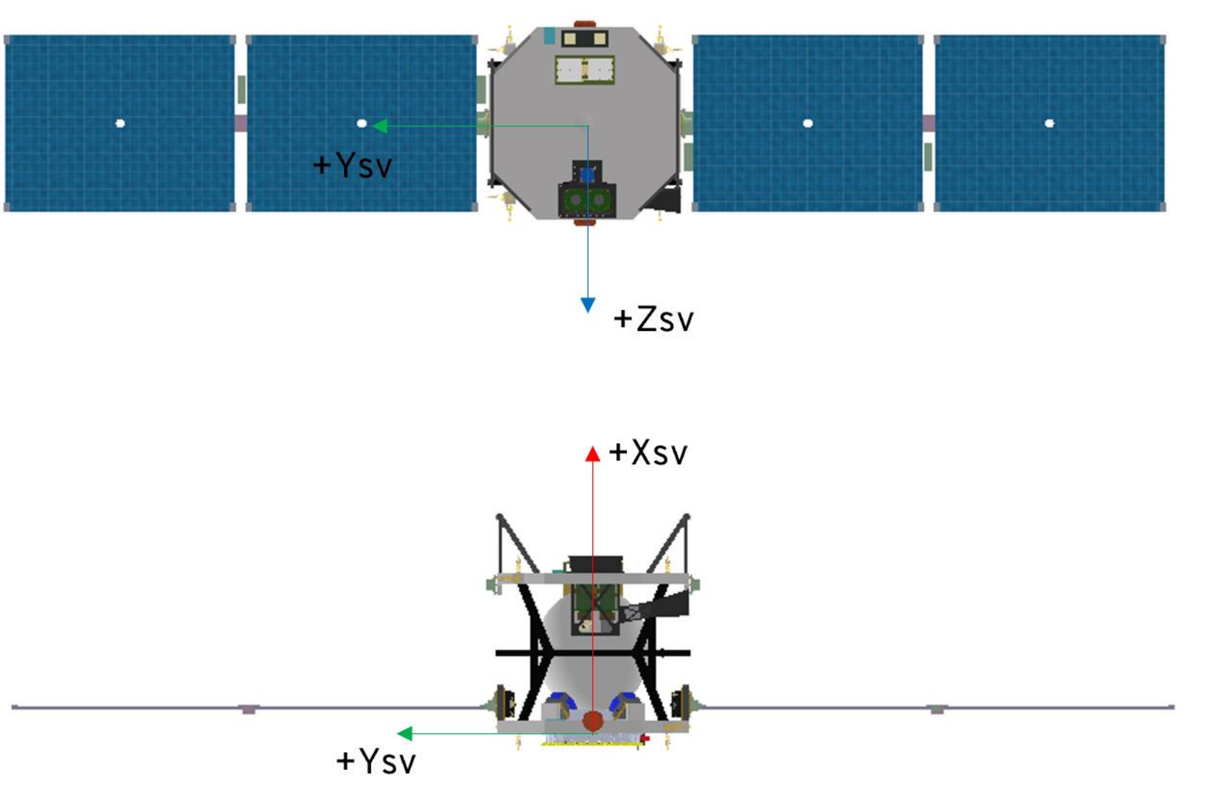


Figure 3: Jackal Coordinate Frame

C. Total spacecraft wet mass at launch:

265.58 kg

D. Dry mass of spacecraft at launch:

215.19 kg

E. Identification, including type, mass and pressure, of all fluids (liquids and gases) planned to be on board (including any planned future in-space transfers), 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:

Hydrazine at low pressure, < 100 psi

F. Description of all propulsions systems (e.g. cold gas, monopropellant, electric, nuclear):

The Jackal spacecraft is capable of up to 500 m/s of delta V from a hydrazine thruster system. This propulsion system consists of twelve 1 N thrusters. The hydrazine is kept at a low pressure and is fed to the thrusters through a pump. The SV also has four 1N reaction wheels and three 15 Am torque rods.

G. 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:

The SV has four, 1N reaction wheels and three, 15 Am torque rods. The satellite will nominally fly with the -X plate in the velocity direction.

H. Description of any range safety or other pyrotechnic devices:
No pyrotechnics.

I. Description of the electrical generation and storage system
The Jackal spacecraft generates power from 784W solar arrays. There are two wings that consist of two panels each. Each wing is mounted to a solar array drive which will be used to keep the arrays normal to the sun. Electrical power is stored in a 52 A/Hr battery with a voltage range of 22.4-33.6V.

J. Identification of any other sources of stored energy not noted above:
The solar arrays are stowed and released by a resettable device under a preload.

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

L. 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:
Proximity operations are planned to about 1 km between the two Jackal spacecraft.

ODAR Section 3: Assessment of Spacecraft Debris Released during Normal Operations

A. Identification of any object (>1 mm) expected to be released from the spacecraft any time after launch, including object dimensions, mass, and material:
No planned debris will be released.

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

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

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

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

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

G. Assessment of spacecraft compliance with Requirements 4.3-1 and 4.3-2 (per DAS v3.3.2)

Requirement 4.3-1, Mission Related Debris Passing Through LEO**:**

Requirement 4.3-1a: All debris released during the deployment, operation, and disposal phases shall be limited to a maximum orbital lifetime of 25 years from date of release.

Compliance Statement: **Compliant, no debris released**

Requirement 4.3-1b: The total object-time product shall be no larger than 100 object-years per mission. For the purpose of this standard, satellites smaller than a 1U standard CubeSat are treated as mission-related debris and thus are bound by this definition to collectively follow the same 100 object-years per mission deployment limit

Compliance Statement: **Compliant, no debris released**

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

For missions leaving debris in orbits with the potential of traversing GEO (GEO altitude +/- 200 km and +/- 15 degrees inclination), released debris with diameters of 5 mm or greater shall be left in orbits which will ensure that within 25 years after release the apogee will no longer exceed GEO - 200 km or the perigee will not be lower than GEO + 200 km , and also ensures that the debris is incapable of being perturbed to lie within that GEO +/- 200 km and +/- 15� zone for at least 100 years thereafter. For the purpose of this standard, satellites smaller than a 1U standard CubeSat are treated as mission-related debris and thus are bound by this definition to follow this requirement.

Compliance Statement: **N/A (no debris released)**

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

A. Identification of all potential causes of spacecraft breakup during deployment and mission operations:

No panned spacecraft breakup

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

Battery Short: a sustained short will stress the discharge FETs on the battery monitoring board and cause the internal temperature of the battery to rise. If the internal temperature of the battery rises too high it could cause thermal runaway and create an explosion.

Battery over-rate charge: If the battery is charged at too high of a rate or too high of a voltage the temperature may increase and lead to thermal runaway.

For both of these cases the battery monitoring board does have protection while on the ground to prevent both of those cases. So multiple failures would need to occur for this to happen. Battery charging rate is also limited during flight. Also during flight, any short circuits would trip an over current monitor and open the circuit.

C. Detailed plan for any designed spacecraft breakup, including explosions and intentional collisions:

No panned spacecraft breakup or collision

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

- Payload suite – Star Trackers, NFOV, SWIR, LWIR
- S-band Receive/Transmit and Ka-band Transmit
- GPS receivers
- SADA and SADE
- Battery pack

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

The prop system will perform a de-orbit burn and then be passivated.

F. Assessment of spacecraft compliance with Requirements 4.4-1 through 4.4-4 (per DAS v3.0.1)

<u>Requirement 4.4-1:</u> 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 (i.e., every individual free-flying structural object), the program or project shall demonstrate, via failure mode and effects analyses, probabilistic risk assessments, or other appropriate analyses, that the integrated probability of explosion for all credible failure modes of each spacecraft and launch vehicle does not exceed 0.001 (excluding small particle impacts).

> Compliance Statement: **Compliant, there are no volatile materials on board and the propellant is kept at below 100 psi.**

<u>Requirement 4.4-2</u>: 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 and a plan to either

1) 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

2) Control to a level which cannot cause an explosion or deflagration large enough to release orbital debris or break up the spacecraft.

Compliance Statement: **Compliant, Method 1**

Requirement 4.4.3: Limiting the long-term risk to other space systems from planned breakups:

Planned explosions or intentional collisions shall:

a) Be conducted at an altitude such that for orbital debris fragments larger than 10 cm the object-time product does not exceed 100 object-years. For example, if the debris fragments greater than 10cm decay in the maximum allowed 1 year, a maximum of 100 such fragments can be generated by the breakup.

b) Not generate debris larger than 1 mm that remains in Earth orbit longer than one year.

Compliance Statement: **N/A, there are no planned breakups.**

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

Immediately before a planned explosion or intentional collision, the probability of debris, orbital or ballistic, larger than 1 mm colliding with any operating spacecraft within 24 hours of the breakup shall be verified to not exceed 10-6.

Compliance Statement: **N/A, There are no planned breakups.**

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

A. Assessment of spacecraft compliance with requirements 4.5-1 and 4.5-2 (per DAS v3.2.3 and NASA-STD-8719.14C, section 4.5.4).

The collision risk was assessed for the full nominal duration of the mission at the planned operational altitude.

Requirement 4.5-1: Limiting debris generated by collisions with large objects when 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 does not exceed 0.001.

Probability of collision with larger objects: **Compliant**

Collision Probability: 5.624e-5 (5-year operation)

Aggregated probability: 1.125e-4 (5-year operation)

Requirement 4.5-2: Limiting debris generated by collisions with small objects when operating in Earth 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 post mission disposal maneuver requirements does not exceed 0.01.

Probability of collision with space objects:

Compliant, by following NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook and coordinating with the 18th space squadron. Maneuvers will be executed at 1e-4 probability to maintain the risk of a conjunction to 1e-4 or better.

B. Detailed description and assessment of the efficacy of any planned debris avoidance capability intended to help in meeting the requirements of requirement 4.5-1, including any plans to move to less congested altitudes, as well as any tracking enhancements

The spacecraft has full attitude and orbit control allowing it to perform collision avoidance maneuvers. In addition, at the end of life the spacecraft will perform a final burn to lower the orbit and increase the drag effect. There is compliance with requirement 4.5-1 regardless of the satellite's capabilities.

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

A. Description of spacecraft disposal option selected:

The spacecraft will reserve sufficient propellant to perform a final burn to lower its altitude to no higher than 515km. Due to the increased drag at that altitude the spacecraft will re-enter in ~21 years.

B. 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:

Propulsion system

C. Calculation of area-to-mass ratio after post mission disposal, if the controlled reentry option is not selected. Effective area-to-mass ratio may change based on changes in attitude control at end-of-mission and end-of-life:

Spacecraft Mass: **217 kg**

Minimum Cross-Section Area: **0.531 m^2**

Area to mass ratio; 3.76 / 222 = **0.0024 m^2/kg**

D. If appropriate, preliminary plan for spacecraft controlled reentry:

N/A

E. Assessment of spacecraft compliance with Requirements 4.6-1 through 4.6-4

Requirement 4.6-1: Disposal for space structures passing through LEO:

A spacecraft or orbital stage with a perigee altitude below 2,000 km shall be disposed of by one of the following three methods:

a. Atmospheric reentry option:

(1) Leave the space structure in an orbit in which natural forces will lead to atmospheric reentry within 25 years after the completion of mission or

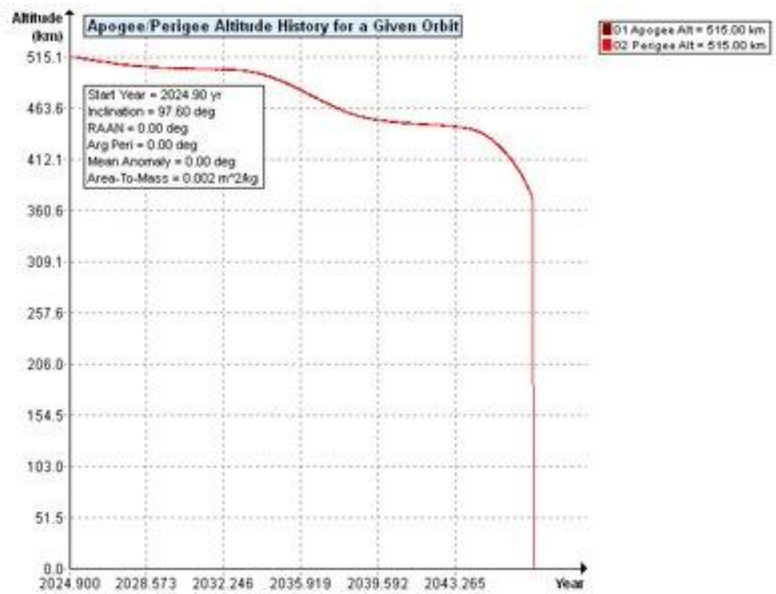
(2) Maneuver the space structure into a controlled de-orbit trajectory as soon as practical after completion of mission.

b. Storage orbit option: Maneuver the space structure into an orbit with perigee altitude above 2000 km and ensure its apogee altitude will be below 19,700 km, both for a minimum of 100 years.

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

Compliance Statement: **Compliant to method A, atmospheric reentry. The maximum altitude to deorbit within 25 years is 529 km, the planned orbit at time of passivation is 515km.**

Figure 4: Apogee/Perigee Timeline to reentry from 515km altitude



<u>Requirement 4.6-2</u>: Disposal for space structures near GEO:

A spacecraft or orbital stage in an orbit near GEO shall be maneuvered at EOM to a disposal orbit above GEO with a predicted minimum perigee of GEO +200 km (35,986 km) or below GEO with a predicted maximum apogee of GEO – 200 km (35,586 km) for a period of at least 100 years after disposal.

Compliance Statement: **N/A**

<u>Requirement 4.6-3:</u> Disposal for space structures between LEO and GEO**:**

Between LEO and Medium Earth Orbit (MEO): A spacecraft or orbital stage shall be left in an orbit with a perigee altitude greater than 2000 km and apogee altitude below 19,700 km for 100 years.

Between MEO and GEO: A spacecraft or orbital stage shall be left in an orbit with a perigee altitude greater than 20,700 km and apogee altitude below 35,300 km for 100 years.

Compliance Statement: **N/A**

Requirement 4.6-4: Reliability of Post mission Disposal Operations Analysis**:**

NASA space programs and projects shall ensure that all post mission disposal operations to meet Requirements 4.6-1, 4.6-2, and/or 4.6-3 are designed for a probability of success as follows:

a. Be no less than 0.90 at EOM, and

b. For controlled reentry, the probability of success at the time of reentry burn must be sufficiently high so as not to cause a violation of Requirement 4.7-1 pertaining to limiting the risk of human casualty.

Compliance Statement:

Compliant, In the event the satellite fails, it will passively re-enter in under 25 years.

ODAR Section 7: Assessment of Spacecraft Reentry Hazards

A. Detailed description of spacecraft components by size, mass, material, shape, and original location on the space vehicle, if the atmospheric reentry option is selected:

Component Table

Component Name	Quantity	Material	Object Shape	Mass (kg)	Diameter/ Width (m)	Length (m)	Height (m)
Bottom Plate -Z Deck (6061 Al)	1	Aluminum	Plate	47.9	0.813	0.813	-
Top Plate +Z Deck (6061 Al)	1	Aluminum	Plate	22.4	0.813	0.813	-
Battery -- SIL, 1456 Wh	1	Copper	Box	13.0	0.140	0.356	0.07
18" Propellant Tank	1	Ti	Sphere	9.0	0.457	-	-
Side Structure	4	Aluminum	Plate	7.9	0.247	0.559	-
Solar Array	4	Composite/ Aluminum	Plate	6.7	0.750	0.965	-
Payload Structure + Baffles +Lid	1	Aluminum	Box	5.4	0.216	0.254	0.136
Cesium Nightingale	1	Aluminum	Box	5.0	0.148	0.183	0.134
Feed Lines - Swagelok	1	Steel	Cylinder	4.6	0.006	0.228	-
Separation System -- Ruag PAS 381S (15")	1	Aluminum	Cylinder	3.4	0.381	0.013	-
SADA Honeybee Type II	2	Aluminum	Cylinder	3.1	0.152	0.076	-
Redwire Spectra CAM	1	Steel	Box	2.8	0.057	0.160	0.051
Raptor SWIR + Lens	1	Steel	Box	2.8	0.061	0.210	0.050
SADA Secondary Structure	2	Aluminum	Box	2.4	0.197	0.203	0.146

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).

Compliance Statement: **Compliant (risk of human casualty: 0)**

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.

Compliance Statement: **N/A**

c. For controlled reentries, the product of the probability of failure to execute the reentry burn and the risk of human casualty assuming uncontrolled reentry shall not exceed 0.0001 (1:10,000).

Compliance Statement: **N/A**

ODAR Section 7A: Assessment of Spacecraft Hazardous Material

Summary of the hazardous materials contained on the spacecraft using all columns and the format in paragraph 4.7.4.10:

None

ODAR Section 8: Assessment for Tether Missions

Requirement 4.8-1: Mitigate the collision hazards of space tethers in protected regions of space:

Intact and remnants of severed tether systems in Earth orbit shall limit the generation of orbital debris from on-orbit collisions with other operational spacecraft post mission. Tether systems should generally not remain deployed after the completion of their mission objectives. After mission objectives are met, such tethers should have provisions for disposal (full retraction/stowing and/or removal from Earth orbit) with a >0.90 probability of success, including an assessment of the reliability of the disposal system and accounting for the possibility of damage to or cutting of the tether prior to disposal.

Compliance Statement: **N/A**

Output of DAS v.3.2.3:

12 17 2022; 18:25:24PM Activity Log Started

12 17 2022; 18:29:16PM Processing Requirement 4.3-1: Return Status : Not Run

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

No Project Data Available

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=============== End of Requirement 4.3-1 ===============

12 17 2022; 18:29:19PM Processing Requirement 4.3-2: Return Status : Passed

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No Project Data Available

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=============== End of Requirement 4.3-2 ===============

06 15 2023; 19:45:24PM Processing Requirement 4.6 Return Status : Passed

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

INPUT

Space Structure Name = Jackal Block 1 Sat 1

Space Structure Type = Payload

Perigee Altitude = 545.000000 (km)

Apogee Altitude = 545.000000 (km)

Inclination = 97.575000 (deg)

RAAN = 0.000000 (deg)

Argument of Perigee = 0.000000 (deg)

Mean Anomaly = 0.000000 (deg)

Area-To-Mass Ratio = 0.002400 (m^2/kg)

Start Year = 2023.900000 (yr)

Initial Mass = 265.320000 (kg)

Final Mass = 217.692000 (kg)

Duration = 1.000000 (yr)

Station Kept = True

Abandoned = False

Long-Term Reentry = False

OUTPUT

Suggested Perigee Altitude = 515.000000 (km)

Suggested Apogee Altitude = 515.000000 (km)

Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2044 (yr)

Requirement = 61

Compliance Status = Pass

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

=============== End of Requirement 4.6 ===============

12 17 2022; 18:35:02PM *********Processing Requirement 4.7-1

Return Status : Passed

***********INPUT****

Item Number = 1

name = Jackal

quantity = 1

parent = 0

materialID = 5

type = Cylinder

Aero Mass = 221.740005

Thermal Mass = 221.740005

Diameter/Width = 0.750000

Length = 0.760000

name = Bottom Plate -Z Deck (6061 Al)

quantity = 1

parent = 1

materialID = 5

type = Flat Plate

Aero Mass = 47.900002

Thermal Mass = 47.900002

Diameter/Width = 0.813000

Length = 0.813000

name = Top Plate +Z Deck (6061 Al)

quantity = 1

parent = 1

materialID = 5

type = Flat Plate

Aero Mass = 22.400000

Thermal Mass = 22.400000

Diameter/Width = 0.813000

Length = 0.813000

name = Battery -- SIL, 1456 Wh

quantity = 1

parent = 1

materialID = 19

type = Box

Aero Mass = 13.000000

Thermal Mass = 13.000000

Diameter/Width = 0.140000

Length = 0.356000

Height = 0.070000

name = 18" Propellant Tank - Ariane

quantity = 1

parent = 1

materialID = 5

type = Sphere

Aero Mass = 9.000000

Thermal Mass = 9.000000

Diameter/Width = 0.457000

name = Side Structure

quantity = 4

parent = 1

materialID = 5

type = Flat Plate

Aero Mass = 7.900000

Thermal Mass = 7.900000

Diameter/Width = 0.247000

Length = 0.559000

name = Solar Array -- Sparkwing

quantity = 4

parent = 1

materialID = 23

type = Flat Plate

Aero Mass = 6.700000

Thermal Mass = 6.700000

Diameter/Width = 0.750000

Length = 0.965000

name = Payload Structure + Baffles +Lid

quantity = 1

parent = 1

materialID = 5

type = Box

Aero Mass = 5.400000

Thermal Mass = 5.400000

Diameter/Width = 0.216000

Length = 0.254000

Height = 0.136000

name = Cesium Nightingale

quantity = 1

parent = 1

materialID = 5

type = Box

Aero Mass = 5.000000

Thermal Mass = 5.000000

Diameter/Width = 0.148000

Length = 0.183000

Height = 0.134000

name = Feed Lines - Swagelok

quantity = 1

parent = 1

materialID = 54

type = Cylinder

Aero Mass = 4.600000

Thermal Mass = 4.600000

Diameter/Width = 0.060000

Length = 0.228000

name = Separation System -- Ruag PAS 381S (15") - STOWED

quantity = 1

parent = 1

materialID = 5

type = Flat Plate

Aero Mass = 3.400000

Thermal Mass = 3.400000

Diameter/Width = 0.381000

Length = 0.381000

name = SADA -- Honeybee Type II

quantity = 2

parent = 1

materialID = 5

type = Cylinder

Aero Mass = 3.100000

Thermal Mass = 3.100000

Diameter/Width = 0.152000

Length = 0.076000

name = Redwire SpectraCAM + Lens

quantity = 1

parent = 1

materialID = 54

type = Box

Aero Mass = 2.800000

Thermal Mass = 2.800000

Diameter/Width = 0.057000

Length = 0.160000

Height = 0.051000

name = Raptor SWIR + Lens

quantity = 1

parent = 1

materialID = 54

type = Box

Aero Mass = 2.800000

Thermal Mass = 2.800000

Diameter/Width = 0.061000

Length = 0.210000

Height = 0.050000

name = SADA Secondary Structure

quantity = 2

parent = 1

materialID = 5

type = Box

Aero Mass = 2.400000

Thermal Mass = 2.400000

Diameter/Width = 0.197000

Length = 0.203000

Height = 0.146000

**************OUTPUT****

Item Number = 1

name = Jackal

Demise Altitude = 77.998435

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Bottom Plate -Z Deck (6061 Al)

Demise Altitude = 54.053393

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Top Plate +Z Deck (6061 Al)

Demise Altitude = 67.485446

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Battery -- SIL, 1456 Wh

Demise Altitude = 68.034181

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = 18" Propellant Tank - Ariane

Demise Altitude = 72.670535

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Side Structure

Demise Altitude = 70.015953

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Solar Array -- Sparkwing

Demise Altitude = 75.647653

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Payload Structure + Baffles +Lid

Demise Altitude = 71.983320

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Cesium Nightingale

Demise Altitude = 70.501992

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Feed Lines - Swagelok

Demise Altitude = 61.041147

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Separation System -- Ruag PAS 381S (15") - STOWED

Demise Altitude = 74.052664

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = SADA -- Honeybee Type II

Demise Altitude = 67.478321

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Redwire SpectraCAM + Lens

Demise Altitude = 67.225416

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Raptor SWIR + Lens

Demise Altitude = 68.731496

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = SADA Secondary Structure

Demise Altitude = 74.749331

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

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

End of True Anomaly ODAR