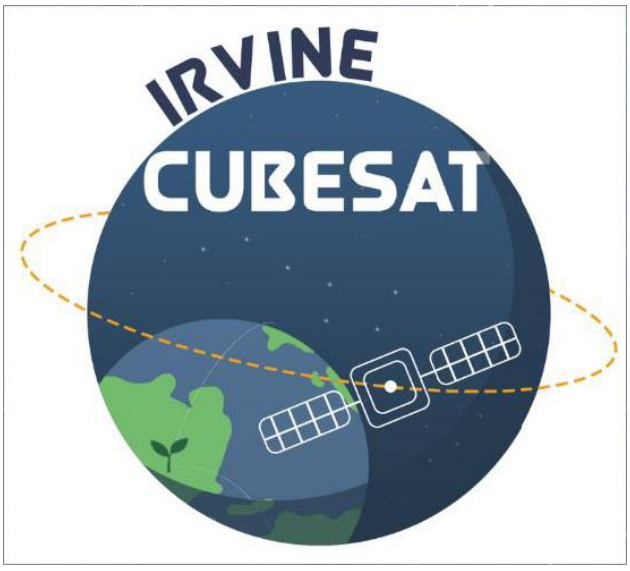
Rev 1
1/16/2018

Orbital Debris Assessment for the IRVINE02 CubeSat per NASA-STD 8719.14A



Signature Page

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REFERENCES:

A. *NASA Procedural Requirements for Limiting Orbital Debris Generation*, NPR 8715.6A, 5 February 2008
B. *Process for Limiting Orbital Debris*, NASA-STD-8719.14A, 25 May 2012
C. McKissock, Barbara, Patricia Loyselle, and Elisa Vogel. *Guidelines on Lithium-ion Battery Use in Space Applications*. Tech. no. RP-08-75. NASA Glenn Research Center Cleveland, Ohio
D. *UL Standard for Safety for Lithium Batteries, UL 1642*. UL Standard. 4th ed. Northbrook, IL, Underwriters Laboratories, 2007
E. Kwas, Robert. Thermal Analysis of ELaNa-4 CubeSat Batteries, ELVL-2012-0043254; Nov 2012
F. Range Safety User Requirements Manual Volume 3- Launch Vehicles, Payloads, and Ground Support Systems Requirements, AFSCM 91-710 V3.
G. *UL Standard for Safety for Household and Commercial Batteries, UL 2054*. UL Standard. 2nd ed. Northbrook, IL, Underwriters Laboratories, 2005
H. HQ OSMA Policy Memo/Email to 8719.14: CubeSat Battery Non-Passivation, Suzanne Aleman to Justin Treptow, 10, July 2014

Table 1: Orbital Debris Requirement Compliance Matrix

Requirement	Compliance Assessment	Comments
4.3-1a	Not applicable	No planned debris release
4.3-1b	Not applicable	No planned debris release
4.3-2	Not applicable	No planned debris release
4.4-1	Compliant	On board energy source (batteries) incapable of debris-producing failure
4.4-2	Compliant	On board energy source (batteries) incapable of debris-producing failure
4.4-3	Not applicable	No planned breakups
4.4-4	Not applicable	No planned breakups
4.5-1	Compliant	
4.5-2	Compliant	
4.6-1(a)	Compliant	Worst case lifetime 4.923 yrs
4.6-1(b)	Not applicable	
4.6-1(c)	Not applicable	
4.6-2	Not applicable	
4.6-3	Not applicable	
4.6-4	Not applicable	Passive disposal
4.6-5	Compliant	
4.7-1	Compliant	Non-credible risk of human casualty
4.8-1	Compliant	No planned tether release under IRVINE02 mission

ODAR Table of Contents

ODAR Section 1: Program Management and Mission Overview

Project Manager: Tinh Tran

Foreign Government or Space Agency Participation: The Ecuadorian Space Agency (EXA) will provide many of the necessary parts for the CubeSat, including the batteries and the solar panels. NASA will control the launch vehicle, which will be launched from the western coast of the United States (location TBD).

Schedule of Upcoming Mission Milestones:
Mission kickoff date: September 6, 2017
Design review date: October 13, 2017
Delivery date: August 1, 2018
Tentative Launch Date: August 31, 2018

Mission Overview:
IRVINE02 will be dispensed from a PPOD 3U CubeSat dispenser into an estimated orbit of 500 km Apogee and 500 km Perigee with an inclination of 97 degrees. The mission is expected to remain in orbit for a maximum of up to 4.923 years. During this time, the main payload will communicate using laser diodes. IRVINE02 will also continue taking pictures of celestial objects, as well as collecting other data using our sun sensors, GPS, and other equipment.

ODAR Summary:
No debris released in normal operations; no credible scenario for breakups; the collision probability with other objects is compliant with NASA standards; and the estimated nominal decay lifetime due to atmospheric drag is under 25 years following operations.

Launch Vehicle and Launch Site:
TBD; Western coast of the United States (location is TBD)

Proposed Launch Date:

August 30, 2018

Mission Duration:

Normal mission operations will take place until contact is lost, or some other mission detrimental factor causes a failure of essential systems. The natural decay time of the CubeSat is under 4.923 years.

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

The launch vehicle will be dispensing various payloads into a nearly circular 500 km polar orbit near sun-synchronous orbit.

IRVINE02 will decay from an orbit defined as follows:

Perigee: 500 km

Apogee: 500 km

Orbital Inclination: 97 degrees

ODAR Section 2: Spacecraft Description

Mission description: IRVINE02 will be dispensed from a PPOD 3U CubeSat dispenser into an estimated orbit of 500 km Apogee and 500 km Perigee with an inclination of 97 degrees. The mission is expected to remain in orbit for a maximum of up to 4.923 years. During this time, the main payload will communicate using laser diodes. IRVINE02 will also continue taking pictures of celestial objects (focusing primarily on Venus) where they will be sent to the ground station, where they will be used for educational purposes. Other data will be collected using sun sensors, GPS, and other necessary equipment. In addition, magnetorquers will be used for attitude control, and solar panels will be used for power.

Physical description of the spacecraft: IRVINE02 conforms to the 1U CubeSat specification, with a launch mass of 1.3 kg. Basic physical dimensions are 100mm x 100mm x 106mm, with two solar panels with 170mm x 85mm x 2mm extended dimensions. The IRVINE02 solar panel structure is comprised of two 100mm x 100mm plates that are extended. The solar arrays are spring-loaded and burn-wire deployed. Power storage is provided by Lithium-Ion cells. The batteries will be recharged by solar cells mounted on the body of the satellite and on the two deployable solar panels. IRVINE02 altitude is approximately determined using the magnetic field vector, measured by onboard magnetometers. The IRVINE02's altitude will be controlled by a 3-axis magnetorquer controller.

Total satellite mass at launch, including all propellants and fluids: 1.3 kg

Dry mass of satellites at launch, excluding solid rocket motor propellants: 1.3 kg

Description of all propulsion systems (cold gas, monopropellant, bipropellant, electric, nuclear): There is an electric thruster (one Accion Systems TILE-50) and there will be 3 magnetorquers on board, to adjust the orientation and heading of the cubesat.

Identification, including mass and pressure, of all fluids (liquids and gases) planned to be on board and a description of the fluid loading plan or strategies, excluding fluids in sealed heat pipes: The cubesat will contain 4.6 grams of ionic liquid propellant. Ionic liquids are salts comprising organic cations (imidazolium, ammonium, pyrrolidinium) associated with inorganic anions (Cl-, AlCl4-, PF6-, BF4-, NTf2-, DCA-) or organic anions (CH3COO-, CH3SO3-), which are liquid around room temperature. It is non-volatile, non-flammable and stable at high temperatures (up to 200^{o} C), a very good conductor and very stable with water and oxygen. The propellant will be unpressurized and already loaded into the propulsion system by the manufacturer.

Fluids in Pressurized Batteries: None

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

Identification of any object (>1 mm) expected to be released from the spacecraft any time after launch, including object dimensions, mass, and material: There are no intentional releases.

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

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

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

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

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

Assessment of spacecraft compliance with Requirements 4.3-1 and 4.3-2 (per DAS v2.0.1)
4.3-1, Mission Related Debris Passing Through LEO: NOT APPLICABLE
4.3-2, Mission Related Debris Passing Near GEO: NOT APPLICABLE

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

There are NO plans for designed spacecraft breakups, explosions, or intentional collisions on the IRVINE02 mission.

The probability of battery explosion is very low, and, due to the very small mass of the satellite and its short orbital lifetime, the effect of an explosion on the far-term LEO environment is negligible (ref (H)).

The CubeSats batteries still meet Req. 56450 (4.4-2) by virtue of the HQ OSMA policy regarding CubeSat battery disconnect stating;

“CubeSats as a satellite class need not disconnect their batteries if flown in LEO with orbital lifetimes less than 25 years.” (ref. (H)).

Assessment of spacecraft compliance with Requirements 4.4-1 through 4.4-4 shows that with a maximum possible lifetime of 4.923 years the IRVINE02 CubeSat is compliant.

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

Assessment of spacecraft compliance with Requirements 4.5-1 and 4.5-2 (per DAS v2.0.1, and calculation methods provided in NASA-STD-8719.14, section 4.5.4):

Requirement 4.5-1: Limiting debris generated by collisions with large objects when operating in Earth orbit:
For each spacecraft and launch vehicle orbital stage in or passing through LEO, the program or project shall demonstrate that, during the orbital lifetime of each spacecraft and orbital stage, the probability of accidental collision with space objects larger than 10 cm in diameter is less than 0.001 (Requirement 56506).

Large Object Impact and Debris Generation Probability: (DAS 2.1.1)
IRVINE02; Collision Probability: 0.00000; COMPLIANT.

The above analysis results are a product of the DAS 2.1.1 software. We then assume hard spheres of diameter 1 m for IRVINE02.

Requirement 4.5-2: **Limiting debris generated by collisions with small objects when operating in Earth or lunar orbit:**
For each spacecraft, the program or project shall demonstrate that, during the mission of the spacecraft, the probability of accidental collision with orbital debris and meteoroids sufficient to prevent compliance with the applicable post-mission disposal requirements is less than 0.01 (Requirement 56507).

Small Object Impact and Debris Generation Probability:
IRVINE02; Collision Probability: 0.00000 COMPLIANT.

Identification of all systems or components required to accomplish any post-mission disposal operation, including passivation and maneuvering:
No post-mission disposal procedures are necessary, since the satellite's orbit will naturally decay within 4.923 years.

ODAR Section 6: Assessment of Spacecraft Post-mission Disposal Plans and Procedure

6.1: Description of Spacecraft Disposal Option Selected:

IRVINE02 will de-orbit naturally by atmospheric re-entry within 4.923 years. All components will burn up during re-entry.

6.2: Plan for Any Spacecraft Maneuvers Required to Accomplish Post-Mission Disposal:

No maneuvers are required.

6.3: Calculation of Area-to-Mass Ratio After Post-Mission Disposal, if the Controlled Re-entry Option is Not Selected:

Spacecraft Mass: 1.3 kg

Cross-Sectional Area: 0.01 m^2

6.4: Assessment of Spacecraft Compliance with Requirements 4.6-1 Through 4.6-5 (per DAS v. 2.0.1 and NASA-STD-8719.14 Section):

Requirement 4.6-1: Disposal for Space Structures Passing Through LEO:

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

a. *Atmospheric Re-Entry Option:*
    - *Leave the space structure in an orbit in which natural forces will lead to atmospheric reentry within 25 years after the completion of mission by no more than 30 years after launch.*
    - *Maneuver the space structure into a controlled de-orbit trajectory as soon as practical after completion of mission.*
b. *Storage Orbit Option:*
    - *Maneuver the space structure into an orbit with perigee altitude greater than 2000 km and apogee less than GEO - 500 km.*
c. *Direct Retrieval:*
    - *Retrieve the space structure and remove it from orbit within 10 years after completion of mission.*

Analysis: The IRVINE02 satellite re-entry is COMPLIANT using method “a”.

Requirement 4.6-2: Disposal for Space Structures Near GEO:

Analysis: Not Applicable.

Requirement 4.6-3: Disposal for Space Structures Between LEO and GEO:
Analysis: Not Applicable.

Requirement 4.6-4: Reliability of Post-Mission Disposal Operations:

Analysis: The maximum drag configuration is the aerodynamically stable state, meaning that even under massive subsystem failure we would eventually assume this orientation.

ODAR Section 7: Assessment of Spacecraft Reentry Hazards

Assessment of spacecraft compliance with Requirement 4.7-1:

Requirement 4.7-1: Limit the risk of human casualty:
The potential for human casualty is assumed for any object with an impacting kinetic energy in excess of 15 joules:
a) For uncontrolled reentry, the risk of human casualty from surviving debris shall not exceed 0.0001 (1:10,000) (Requirement 56626).

Summary Analysis Results: DAS v2.1.1 reports that IRVINE02 is compliant with the requirement. There will be no risk of human casualty during reentry because it will completely burn up in the atmosphere.

```
01 08 2018; 12:38:19PM Activity Log Started
01 08 2018; 12:38:19PM New Project Files Created
01 08 2018; 12:42:00PM Activity Log Started
01 08 2018; 12:42:01PM Opened Project
C:\Users\JenniferBlackie\AppData\Local\NASA\DAS2.1.1\
01 08 2018; 12:42:11PM Activity Log Started
01 08 2018; 12:42:11PM Opened Project
C:\Users\JenniferBlackie\AppData\Local\NASA\DAS2.1.1\
01 08 2018; 12:44:26PM Activity Log Started
01 08 2018; 12:44:26PM Opened Project
C:\Users\JenniferBlackie\AppData\Local\NASA\DAS2.1.1\
01 08 2018; 17:19:28PM Project Data Saved To File
01 08 2018; 17:19:30PM Project Data Saved To File
01 08 2018; 17:19:31PM Project Data Saved To File
01 08 2018; 17:19:54PM Project Data Saved To File
01 08 2018; 17:19:54PM Saved Project As
C:\Users\JenniferBlackie\AppData\Local\NASA\DAS2.1.1\IRVINE02\
01 08 2018; 17:24:21PM Maneuver to Storage Orbit

**INPUT**

      Perigee Altitude = 500.000000 (km)
      Apogee Altitude = 500.000000 (km)
      Area-To-Mass Ratio = -
18854146343910883000000000000000000000000000000000000000000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000.000000 (m^2/kg)

**OUTPUT**
```

```
Storage Orbit
      Perigee Altitude = 2001.000000 (km)
      Apogee Altitude = 2002.000000 (km)
      Transfer Orbit Perigee = 500.000000 (km)
      Transfer Orbit Apogee = 2002.000000 (km)
      Delta-V: First Burn = 365.893368 (m/s)
      Delta-V: Second Burn = 348.038015 (m/s)
      Delta-V: Total = 713.931383 (m/s)
      Return Message: Initial Perigee is Low Enough that User Should
Consider Disposal by Atmospheric Reentry
01 08 2018; 17:29:53PM Activity Log Started
01 08 2018; 17:29:53PM Opened Project
C:\Users\JenniferBlackie\AppData\Local\NASA\DAS2.1.1\
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01 08 2018; 18:12:54PM Opened Project
C:\Users\JenniferBlackie\AppData\Local\NASA\DAS2.1.1\
01 08 2018; 18:13:18PM Processing Requirement 4.3-1:     Return Status :
Not Run

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No Project Data Available
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============== End of Requirement 4.3-1 ===============
01 08 2018; 18:13:22PM Processing Requirement 4.3-2: Return Status :
Passed

=====================
No Project Data Available
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============== End of Requirement 4.3-2 ===============
01 08 2018; 18:13:26PM Requirement 4.4-3:  Compliant

============== End of Requirement 4.4-3 ===============
01 08 2018; 18:16:04PM Mission Editor Changes Applied
01 08 2018; 18:16:14PM Processing Requirement 4.3-1:     Return Status :
Not Run

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

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

```
01 08 2018; 18:16:16PM Processing Requirement 4.3-2: Return Status :
Passed

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

============== End of Requirement 4.3-2 ===============
01 08 2018; 18:16:19PM Requirement 4.4-3:  Compliant

============== End of Requirement 4.4-3 ===============
01 08 2018; 18:16:59PM Activity Log Started
01 08 2018; 18:16:59PM Opened Project
C:\Users\JenniferBlackie\AppData\Local\NASA\DAS2.1.1\
01 08 2018; 18:17:49PM Mission Editor Changes Applied
01 08 2018; 18:17:55PM Processing Requirement 4.3-1:     Return Status :
Not Run

=====================
No Project Data Available
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============== End of Requirement 4.3-1 ===============
01 08 2018; 18:17:57PM 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 ===============
01 08 2018; 18:18:04PM Processing Requirement 4.3-2: Return Status :
Passed

=====================
No Project Data Available
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============== End of Requirement 4.3-2 ===============
01 08 2018; 18:18:07PM Requirement 4.4-3:  Compliant

============== End of Requirement 4.4-3 ===============
01 08 2018; 18:19:05PM Requirement 4.4-3:  Compliant

============== End of Requirement 4.4-3 ===============
```

```
01 08 2018; 18:26:14PM Processing Requirement 4.5-1:     Return Status :
Passed

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

**INPUT**

      Space Structure Name = IRVINE02
      Space Structure Type = Payload
      Perigee Altitude = 500.000000 (km)
      Apogee Altitude = 500.000000 (km)
      Inclination = 97.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Final Area-To-Mass Ratio = 0.008000 (m^2/kg)
      Start Year = 2018.670000 (yr)
      Initial Mass = 1.300000 (kg)
      Final Mass = 1.300000 (kg)
      Duration = 4.923000 (yr)
      Station-Kept = False
      Abandoned = True
      PMD Perigee Altitude = -1.000000 (km)
      PMD Apogee Altitude = -1.000000 (km)
      PMD Inclination = 0.000000 (deg)
      PMD RAAN = 0.000000 (deg)
      PMD Argument of Perigee = 0.000000 (deg)
      PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

      Collision Probability = 0.000000
      Returned Error Message: Normal Processing
      Date Range Error Message: Normal Date Range
      Status = Pass

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

=============== End of Requirement 4.5-1 ===============
01 08 2018; 18:26:24PM Project Data Saved To File
01 08 2018; 18:26:34PM Activity Log Started
01 08 2018; 18:26:34PM Opened Project
C:\Users\JenniferBlackie\AppData\Local\NASA\DAS2.1.1\
```

```
01 10 2018; 16:43:52PM Activity Log Started
01 10 2018; 16:43:52PM Opened Project
C:\Users\JenniferBlackie\AppData\Local\NASA\DAS2.1.1\
01 10 2018; 17:11:36PM Processing Requirement 4.3-1:     Return Status :
Not Run

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

=============== End of Requirement 4.3-1 ===============
01 10 2018; 17:11:38PM Processing Requirement 4.3-2: Return Status :
Passed

=====================
No Project Data Available
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=============== End of Requirement 4.3-2 ===============
01 10 2018; 17:11:40PM Requirement 4.4-3:  Compliant

=============== End of Requirement 4.4-3 ===============
01 10 2018; 17:15:00PM Activity Log Started
01 10 2018; 17:15:00PM Opened Project
C:\Users\JenniferBlackie\AppData\Local\NASA\DAS2.1.1\
01 10 2018; 17:18:41PM Mission Editor Changes Applied
01 10 2018; 17:20:15PM Mission Editor Changes Applied
01 10 2018; 17:20:22PM Processing Requirement 4.3-1:     Return Status :
Passed

==============
Project Data
==============
      Objects Passing Through LEO = True
      Number of Objects = 1

**INPUT**
      Quantity = 1
      Final Area-To-Mass Ratio = 0.008000 (m^2/kg)
      Perigee Altitude = 500.000000 (km)
      Apogee Altitude = 500.000000 (km)
      Inclination = 97.000000 (deg)
      RAAN = -1.000000 (deg)
      Argument of Perigee = -1.000000 (deg)
      Mean Anomaly = -1.000000 (deg)
```

```
      Released Year = 2018.670000 (yr)

**OUTPUT**
      Perigee Altitude = -6378.136000 (km)
      Apogee Altitude = -6378.136000 (km)
      Inclination = 0.000000 (deg)
      Lifetime = 4.697603 (yr)
      Object Reentered within 25 years of Release = True
      Object-Time = 4.681725 (obj-yrs)
      Total Object-Time = 4.681725 (obj-yrs)
      Status = Pass
       Returned Error Message - Normal Processing

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

=============== End of Requirement 4.3-1 ===============
01 10 2018; 17:20:32PM Processing Requirement 4.3-2: Return Status :
Passed

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

=============== End of Requirement 4.3-2 ===============
01 10 2018; 17:20:36PM Requirement 4.4-3:  Compliant

=============== End of Requirement 4.4-3 ===============
01 10 2018; 17:24:07PM Activity Log Started
01 10 2018; 17:24:07PM Opened Project
C:\Users\JenniferBlackie\AppData\Local\NASA\DAS2.1.1\
01 10 2018; 17:25:59PM Processing Requirement 4.3-1:     Return Status :
Not Run

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

=============== End of Requirement 4.3-1 ===============
01 10 2018; 17:26:05PM Processing Requirement 4.3-2: Return Status :
Passed

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

```
=============== End of Requirement 4.3-2 ===============
01 10 2018; 17:26:15PM Requirement 4.4-3:  Compliant

=============== End of Requirement 4.4-3 ===============
01 10 2018; 17:26:56PM Requirement 4.5-2:  Compliant
01 10 2018; 17:27:04PM Processing Requirement 4.6   Return Status :
Passed

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

**INPUT**

      Space Structure Name = IRVINE02
      Space Structure Type = Payload

      Perigee Altitude = 500.000000 (km)
      Apogee Altitude = 500.000000 (km)
      Inclination = 97.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Area-To-Mass Ratio = 0.008000 (m^2/kg)
      Start Year = 2018.670000 (yr)
      Initial Mass = 1.300000 (kg)
      Final Mass = 1.300000 (kg)
      Duration = 4.923000 (yr)
      Station Kept = False
      Abandoned = True
      PMD Perigee Altitude = -1.000000 (km)
      PMD Apogee Altitude = -1.000000 (km)
      PMD Inclination = 0.000000 (deg)
      PMD RAAN = 0.000000 (deg)
      PMD Argument of Perigee = 0.000000 (deg)
      PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

      Suggested Perigee Altitude = 500.000000 (km)
      Suggested Apogee Altitude = 500.000000 (km)
      Returned Error Message = Reentry during mission (no PMD req.).

      Released Year = 2023 (yr)
      Requirement = 61
```

```
      Compliance Status = Pass

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

=============== End of Requirement 4.6 ===============
01 10 2018; 17:34:27PM Processing Requirement 4.5-1:     Return Status :
Passed

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

**INPUT**

      Space Structure Name = IRVINE02
      Space Structure Type = Payload
      Perigee Altitude = 500.000000 (km)
      Apogee Altitude = 500.000000 (km)
      Inclination = 97.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Final Area-To-Mass Ratio = 0.008000 (m^2/kg)
      Start Year = 2018.670000 (yr)
      Initial Mass = 1.300000 (kg)
      Final Mass = 1.300000 (kg)
      Duration = 4.923000 (yr)
      Station-Kept = False
      Abandoned = True
      PMD Perigee Altitude = -1.000000 (km)
      PMD Apogee Altitude = -1.000000 (km)
      PMD Inclination = 0.000000 (deg)
      PMD RAAN = 0.000000 (deg)
      PMD Argument of Perigee = 0.000000 (deg)
      PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

      Collision Probability = 0.000000
      Returned Error Message: Normal Processing
      Date Range Error Message: Normal Date Range
      Status = Pass

==============
```

```
=============== End of Requirement 4.5-1 ===============
01 10 2018; 17:40:06PM Project Data Saved To File
01 10 2018; 17:40:09PM Project Data Saved To File
01 10 2018; 17:45:12PM Project Data Saved To File
01 10 2018; 17:45:13PM Project Data Saved To File
01 10 2018; 17:45:24PM Project Data Saved To File
01 10 2018; 17:45:25PM Project Data Saved To File
```

Requirements 4.7-1b, and 4.7-1c below are non-applicable requirements because IRVINE02 does not use controlled reentry.

4.7-1, b) **NOT APPLICABLE.** For controlled re-entry, 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 land masses, or is within 50 km from the continental U.S., territories of the U.S., and the permanent ice pack of Antarctica (Requirement 56627).

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

ODAR Section 8: Assessment for Tether Missions

Not applicable. There are no tethers in the IRVINE02 mission.