Swarm Orbital Debris Assessment Report

SWARM TECHNOLOGIES MISSION PROFILE
PREPARED BY: SWARM TECHNOLOGIES INC
REVISION 1: October 5, 2018

ODAR Signature Approval

Program/ Project Manager	Sara Spangelo
Signature	*Sara Spangelo*
Date	October 5, 2018

ODAR Section 1: Program Management and Mission Overview

Program/Project Manager	Sara Spangelo
Mission Description	The purpose of the Swarm 1 satellite constellation is to provide low-cost, global two-way communication services. Swarm proposes to provide these services by deploying a constellation consisting of 150 ¼U satellites.
Foreign Government Involvement	None
Project Milestones Proposed Launch Date: Proposed Launch Vehicles: Proposed Launch Sites: Launch Vehicle Operator:	The Swarm satellites will typically be launched 12 to 20 at a time, dependent on launch availability and the orbital characteristics required to optimize system coverage. Swarm will deploy its constellation by launching its satellites as secondary payloads. Swarm is able to start orbital deployment as soon as March 1, 2019, but proposes June 1, 2019 as a nominal deployment start date to provide sufficient time for the FCC to process Swarm's commercial license application. Launches will be booked as they become available and are subject to schedule and orbital parameter changes. As a result, Swarm's finalized list of launch dates and orbital parameters is not yet available. Swarm therefore requests authorization to deploy and subsequently replenish its constellation on launches with parameters within the following bounds: ● Inclination: equatorial (0 degrees) to polar sun-synchronous (98 degrees)

	● Apogee: 400-550 km ● Perigee: 400-550 km The table below includes a list of the desired altitudes and orbital planes for Swarm's 150-satellite constellation and is representative of available launch opportunities in the desired timeframe. _table below_ This ODAR analyzes a range of representative orbits. For the purposes of debris assessment, an analysis was conducted with the "worst-case" altitude and lifetime in order to assess the maximum collision probability in the worst-case scenario. The aggregate collision probability for all Swarm satellites launched over the 15-year period of the requested grant is also calculated.

# Satellites	Altitude [km]	Inclination [°]
20	450	45
20	500	10
62	500	SSO (97.4)
48	550	SSO (97.6)
Lower and upper bound	400-550	0-98

Mission Duration:	The operational lifetime of the hardware for each satellite is designed to be up to 20 years following deployment from the launch vehicle. The orbital lifetime for the satellites is expected to range from 2.5 to 12.2 years, depending on the vehicle's orbit and the solar influence of the Earth's atmosphere, as described in Section 6. The hardware design allows for a margin of 1.6x to 8x the orbital lifetime.
Launch / Deployment Profile:	**Launch** The Swarm satellites will be injected directly into the target orbits outlined in the tables above. **Checkout** For up to 1 month following deployment into orbit, the Swarm satellites will remain in checkout phase. During this phase, ground operators will verify correct operation of the satellites and their payloads, and prepare them for the operational phase. **Operations** The operational phase of the satellite begins following the successful deployment of the Swarm satellites from the launch vehicle and successful checkout. **Post-mission Disposal** Following the end of the operational phase, the satellites will remain on orbit in a non-transmitting mode while the orbit of the satellites passively decays until the satellites reenter the atmosphere and disintegrate. The satellites are nominally expected to reenter the atmosphere 2.5 to 12.2 years following deployment from

	the launch vehicle.
Selection of Orbit:	The selection of the chosen orbits was made based on available launch opportunities, orbital lifetime considerations, and system requirements.
Potential Physical Interference with Other Orbiting Object:	As the satellites do not have any propulsion systems, their orbits will naturally decay following deployment from the launch vehicle. As detailed in Section 5, the probability of physical interference between the satellites and other space objects is sufficiently unlikely that the satellites comply with Requirement 4.5.

ODAR Section 2: Spacecraft Description

Physical Description:

Property	Value
Total Mass at Launch	0.31 kg to 0.45 kg (range depends on weights used)
Dry Mass at Launch	0.31 kg to 0.45 kg
Form Factor	¼U satellite
COG	0.31 kg satellite: $<X1,Y1,Z1> = <0, 16.5, -1.5>$ [mm] relative to center 0.45 kg satellite: $<X1,Y1,Z1> = <0, 26.2, -1.8>$ [mm] relative to center
Envelope (stowed)	113mm x 113mm x 26mm
Envelope (deployed)	113mm x 113mm x 26mm Deployed antennas are 1,142 mm tip to tip
Propulsion Systems	None
Fluid Systems	None
ADCS	GPS, 9 DOF IMU, magnetometer, passive stabilization for coarse pointing, magnetorquer system for fine pointing
Range Safety/ Pyrotechnic Devices	None
Electrical Generation	Solar cells
Electrical Storage	Rechargeable lithium-ion battery. Qty 1: 18650 cell.
Radioactive Materials	None

ODAR Section 3: Assessment of Debris Released During Normal Operations

Objects larger than 1mm expected to be released during orbit:	None
Rationale for release of each object:	N/A
Time of release of each object:	N/A
Release velocity of each object:	N/A
Expected orbital parameters of each object:	N/A
Calculated orbital lifetime of each object:	N/A

Assessment of spacecraft compliance with Requirements 4.3-1 and 4.3-2:	
4.3-1, Mission-Related Debris Passing Through LEO:	COMPLIANT
4.3-2, Mission-Related Debris Passing Near GEO:	COMPLIANT

A DAS 2.1.1 log demonstrating the compliance to the above requirements is available in Appendix A – "DAS 2.1.1 Log".

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

Potential causes for spacecraft breakup (there is only one plausible causes for breakup of the satellites):
- Energy released from onboard Lithium-ion battery from the unlikely event of overcharging or shorts

Summary of failure modes and effects analysis of all credible failure modes which may lead to an accidental explosion:
The battery aboard the satellite is a 11 Whr Lithium-Ion battery, which represents the only credible failure mode during which stored energy is released. The main failure modes associated with Lithium Ion batteries result from overcharging, over-discharging, internal shorts, and external shorts.

The battery onboard Swarm satellites complies with all controls / process requirements identified in JSC-20793 Section 5.4.3 to mitigate chance of any accidental venting / explosion caused by the above failure modes.

Detailed Plan for any designed spacecraft breakup, including explosions and intentional collisions:
There is no planned breakup of the satellites on-orbit.

List of components passivated at EOM:
At end of mission, all radio transmissions and beacons will be disabled. Spacecraft transmissions are only initiated by ground command and self terminate. All RF transmissions from the satellite can be disabled via command from the ground.

Rationale for all items required to be passivated that cannot be due to design:
N/A

Assessment of spacecraft compliance with Requirements 4.4-1 through 4.4-4:	
4.4-1, Limiting the risk to other space systems from accidental explosions during deployment and mission operations while in orbit about Earth or the Moon	**COMPLIANT**
4.4-2, Design for passivation after completion of mission operations while in orbit about Earth or the Moon	**COMPLIANT**
4.4-3, Limiting the long-term risk to other space systems from planned breakups: There are no planned breakups of any of the satellites.	**COMPLIANT**
4.4-4, Limiting the short-term risk to other space systems from planned breakups There are no planned breakups of any of the satellites.	**COMPLIANT**

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

Probability for Collision with Objects >10cm:

The probability of a collision of any of the Swarm satellites with an orbiting object larger than 10 cm in diameter was calculated using DAS 2.1.1 software. Tables 1 and 2 below show the risk of collision for a satellite deployed in a range of possible orbits, including the upper bound of 550 km in altitude, in each of the identified mission scenarios. Calculations were performed for both the minimum and maximum effective area-to-mass ratio of the satellite in each scenario.

In every scenario evaluated, including the worst-case (longest-lifetime) scenario, the probability of collision was sufficiently small that the simulation performed using DAS 2.1.1 software returned a probability value of 0. More specifically, the DAS 2.1.1 software interface displays a collision probability in each case of 0.00000, and the DAS 2.1.1 activity log (see Appendix A, DAS 2.1.1 Log) states that the collision probability in each case is 0.000000.

Table 1 - Collision Risk for Swarm Satellite in Each Planned Orbit in the Operational, Nominal Mission Scenario

Altitude [km]	Inclination [°]	Satellite Mass [kg]	Scenario	Area to mass ratio [m²/kg]	Lifetime [yrs]	Collision risk per DAS analysis
450	45	0.31	Operational, Nominal	0.0095	2.5	**0**
450	45	0.45	Operational, Nominal	0.0065	2.9	**0**
500	10	0.31	Operational, Nominal	0.0095	3.5	**0**
500	10	0.45	Operational, Nominal	0.0065	4.3	**0**
500	97.4 (SSO)	0.31	Operational, Nominal	0.0095	3.5	**0**
500	97.4 (SSO)	0.45	Operational, Nominal	0.0065	4.3	**0**
550	97.6 (SSO)	0.31	Operational, Nominal	0.0095	5.6	**0**
550	97.6 (SSO)	0.45	Operational, Nominal	0.0065	12.2	**0**

Table 2 - Collision Risk for Swarm Satellite in Each Planned Orbit in the ADCS Nonfunctional Mission Scenario

Altitude [km]	Inclination [°]	Satellite Mass [kg]	Scenario	Area to mass ratio [m²/kg]	Lifetime [yrs]	Collision risk per DAS analysis
450	45	0.31	ADCS Nonfunctional	0.025	1.8	**0**
450	45	0.45	ADCS Nonfunctional	0.017	2.0	**0**
500	10	0.31	ADCS Nonfunctional	0.025	2.4	**0**
500	10	0.45	ADCS Nonfunctional	0.017	2.7	**0**
500	97.4 (SSO)	0.31	ADCS Nonfunctional	0.025	2.4	**0**
500	97.4 (SSO)	0.45	ADCS Nonfunctional	0.017	2.8	**0**
550	97.6 (SSO)	0.31	ADCS Nonfunctional	0.025	3.2	**0**
550	97.6 (SSO)	0.45	ADCS Nonfunctional	0.017	3.8	**0**

Table 3 - Collision Risk for Swarm Satellite in Each Planned Orbit in the Intentional De-Orbit Mission Scenario

Altitude [km]	Inclination [°]	Satellite Mass [kg]	Scenario	Area to mass ratio [m²/kg]	Lifetime [yrs]	Collision risk per DAS analysis
450	45	0.31	Intentional De-Orbit	0.041	1.5	0
450	45	0.45	Intentional De-Orbit	0.028	1.7	0
500	10	0.31	Intentional De-Orbit	0.041	2.1	0
500	10	0.45	Intentional De-Orbit	0.028	2.3	0

500	97.4 (SSO)	0.31	Intentional De-Orbit	0.041	2.1	0
500	97.4 (SSO)	0.45	Intentional De-Orbit	0.028	2.3	0
550	97.6 (SSO)	0.31	Intentional De-Orbit	0.041	2.7	0
550	97.6 (SSO)	0.45	Intentional De-Orbit	0.028	3.1	0

The aggregate probability of collision for the constellation was also evaluated. Swarn anticipates deploying approximately 506 satellites over the 15-year license term to maintain a constellation of 150 operational satellites (see Table 4). The NASA DAS 2.1.1 log provides a collision probability of 0.000000 for all of the planned orbits and mission scenarios evaluated (see Appendix A), suggesting that the maximum potential collision probability for any individual satellite is 4×10^{-7}. Therefore, for the 15-year lifetime of the constellation, the worst-case probability of collision is $506\times4\times10^{-7} = 0.0002$.[1] This value complies with Requirement 4.5-1 that the probability of collision be less than 0.001.

Table 4 - Anticipated Satellite Deployments Over 15-Year License Term

# Satellites in Operational Constellation	Altitude [km]	Inclination [°]	Average lifetime [yrs][2]	Number of satellites deployed in given orbit over 15-year term
20	450	45	2.7	110
20	500	10	3.9	77
62	500	SSO (97.4)	3.9	238
48	550	SSO (97.6)	8.9	81
			Total	**506**

Probability of Damage from Small Objects

Compliance with Requirement 4.5-2 requires an assessment of the probability that post-mission disposal will be impeded by damage from space objects, including small orbital debris and meteoroids, of sufficient size to prevent post-mission disposal. Because post-mission disposal is accomplished via natural atmospheric drag, none of the satellite subsystems are vital to completing post-mission disposal. The satellites therefore comply with Requirement 4.5-2.

Assessment of spacecraft compliance with Requirement 4.5-1 and 4.5-2:	
4.5-1, Probability of Collision with Large Objects:	**COMPLIANT**
4.5-2, Probability of Damage from Small Objects:	**COMPLIANT**

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[1] The maximum collision probability value per satellite of 4×10^{-7} is derived solely from the limited precision of the NASA DAS tool. The aggregate probability of collision over the lifetime of the constellation is likely to be significantly lower than 0.0002.

[2] The average lifetime was calculated by averaging the minimum and maximum lifetimes for a satellite in the specified orbit in the operational, nominal mission scenario (see Table 1).

A DAS 2.1.1 log demonstrating the compliance to the above requirements is available in Appendix A – "DAS 2.1.1 Log".

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

Description of Disposal Option Selected:

The satellites will be deployed from the P-POD with a spring and will separate from one another with separation springs in the feet. Following their deployment, the satellites' orbits will naturally decay until they reenter the atmosphere. Table 5 describes the mission scenarios for which lifetime analysis of Swarm satellites was considered, and the effective area-to-mass ratio of the satellite in each scenario. As shown in Figure 1A, the satellites assume a low-drag flight configuration in the operational, nominal scenario. The satellites can also be commanded to assume a high-drag flight configuration if accelerated de-orbiting is required (see Figure 1B). The effective area-to-mass ratios were calculated for both the minimum and maximum satellite mass using the external dimensions of the satellite.

Drag area from deployed antennas (4 antennas, 521mm long turnstile antennas) was neglected; as such, the effective area-to-mass calculated below is a conservative case.

Table 5 - Area-to-Mass Ratio of Swarm Satellites in Various Mission Scenarios

Scenario	Description	Effective Area-to-Mass (m^2/kg)
Operational, Nominal	• Satellite maintains +Z axis nadir • Satellite maintains position around Z axis as planned for mission operations	0.0095 (for minimum satellite mass of 0.31 kg) 0.0069 (for maximum satellite mass of 0.45 kg)
ADCS Nonfunctional	• Satellite tumbles randomly	0.025 (for minimum satellite mass of 0.31 kg) 0.017 (for maximum satellite mass of 0.45 kg)
Intentional De-orbit	• Satellite maintains high-drag configuration	0.041 (for minimum satellite mass of 0.31 kg) 0.028 (for maximum satellite mass of 0.45 kg)

Flight Configurations:
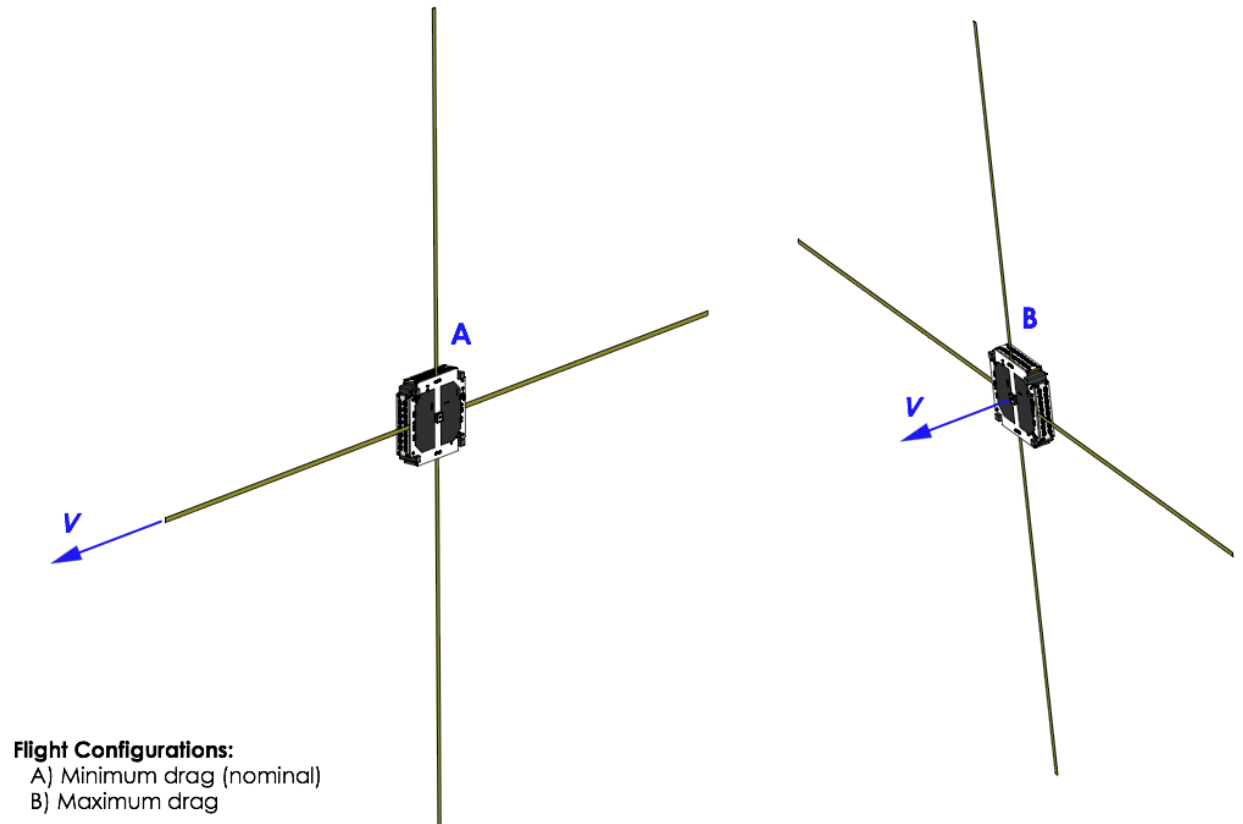 A) Minimum drag (nominal)
 B) Maximum drag

Figure 1. (A) A Swarm satellite in the low-drag nominal flight configuration. **(B)** A Swarm satellite in high-drag mode to accelerate de-orbiting.

Tables 6 and 7 show the simulated orbital dwell time for a Swarm satellite in a range of possible orbits in each of the identified mission scenarios. In all mission scenarios and orbits, the dwell time of the satellite was simulated using DAS 2.1.1 software to be 12.2 years or less.

Table 6 – Orbit Dwell Time for Swarm Satellite in Each Planned Orbit in the Operational, Nominal Mission Scenario

Altitude [km]	Inclination [°]	Satellite Mass [kg]	Scenario	Area to mass ratio [m²/kg]	Lifetime [yrs]
450	45	0.31	Operational, Nominal	0.0095	2.5
450	45	0.45	Operational, Nominal	0.0065	2.9
500	10	0.31	Operational, Nominal	0.0095	3.5
500	10	0.45	Operational, Nominal	0.0065	4.3
500	97.4 (SSO)	0.31	Operational, Nominal	0.0095	3.5
500	97.4 (SSO)	0.45	Operational, Nominal	0.0065	4.3
550	97.6 (SSO)	0.31	Operational, Nominal	0.0095	5.6
550	97.6 (SSO)	0.45	Operational, Nominal	0.0065	12.2

Table 7 – Orbit Dwell Time for Swarm Satellite in Each Planned Orbit in the ADCS Nonfunctional Mission Scenario

Altitude [km]	Inclination [°]	Satellite Mass [kg]	Scenario	Area to mass ratio [m²/kg]	Lifetime [yrs]
450	45	0.31	ADCS Nonfunctional	0.025	1.8
450	45	0.45	ADCS Nonfunctional	0.017	2.0
500	10	0.31	ADCS Nonfunctional	0.025	2.4
500	10	0.45	ADCS Nonfunctional	0.017	2.7
500	97.4 (SSO)	0.31	ADCS Nonfunctional	0.025	2.4
500	97.4 (SSO)	0.45	ADCS Nonfunctional	0.017	2.8
550	97.6 (SSO)	0.31	ADCS Nonfunctional	0.025	3.2
550	97.6 (SSO)	0.45	ADCS Nonfunctional	0.017	3.8

Table 8 – Orbit Dwell Time for Swarm Satellite in Each Planned Orbit in the Intentional Accelerated De-Orbit Mission Scenario

Altitude [km]	Inclination [°]	Satellite Mass [kg]	Scenario	Area to mass ratio [m²/kg]	Lifetime [yrs]
450	45	0.31	Intentional De-Orbit	0.041	1.5
450	45	0.45	Intentional De-Orbit	0.028	1.7
500	10	0.31	Intentional De-Orbit	0.041	2.1
500	10	0.45	Intentional De-Orbit	0.028	2.3
500	97.4 (SSO)	0.31	Intentional De-Orbit	0.041	2.1
500	97.4 (SSO)	0.45	Intentional De-Orbit	0.028	2.3
550	97.6 (SSO)	0.31	Intentional De-Orbit	0.041	2.7
550	97.6 (SSO)	0.45	Intentional De-Orbit	0.028	3.1

Identification of Systems Required for Post-mission Disposal: None

Plan for Spacecraft Maneuvers required for Post-mission Disposal: N/A

Calculation of final Area-to-Mass Ratio if Atmospheric Reentry Not Selected: N/A

Assessment of Spacecraft Compliance with Requirements 4.6-1 through 4.6-4:	
4.6-1, Disposal for space structures passing through LEO All of the satellites will reenter the atmosphere within 25 years of mission completion and 30 years of launch.	**COMPLIANT**
4.6-2, Disposal for space structures passing through GEO:	**N/A**

4.6-3, Disposal for space structures between LEO and GEO:	**N/A**
4.6-4, Reliability of post-mission disposal operations:	**COMPLIANT**

ODAR Section 7: Assessment of Spacecraft Reentry Hazards

Detailed description of spacecraft components by size, mass, material, shape, and original location on the space vehicle:
A system-level mass breakdown and primary materials list included in the generic satellite bus is available in the table below:

Table 9 - Subsystem Components Evaluated as Reentry Hazards

Subsystem	Materials	Quantity	Mass (grams)	Shape	Size (mm)
Solar Panels	Copper, Glass	2	1	Box	79 x 50 x 0.3
Main Board PCB	FR4	2	28	Box	98 x 98 x 1.6
Primary Structure	Al 6061	1	203 (for 310 g satellite) 342 (for 449 g satellite)	Box	113 x 113 x 28
Battery	Li-Ion	1	49	Cylinder	18 (r) x 67 (l)

Summary of objects expected to survive an uncontrolled reentry (using DAS 2.1.1 software): None
Calculation of probability of human casualty for expected reentry year and inclination: 0%

Assessment of spacecraft compliance with Requirement 4.7-1:	
4.7-1, Casualty Risk from Reentry Debris:	**COMPLIANT**

A DAS 2.1.1 log demonstrating the compliance to Requirement 4.7-1 is available in Appendix A – "DAS 2.1.1 Log".

ODAR Section 7A: Assessment of Spacecraft Hazardous Materials

Summary of Hazardous Materials Contained on Spacecraft: None

ODAR Section 8: Assessment for Tether Missions

Type of tether: N/A
Description of tether system: N/A
Determination of minimum size of object that will cause the tether to be severed: N/A
Tether mission plan, including duration and post-mission disposal: N/A
Probability of tether colliding with large space objects: N/A
Probability of tether being severed during mission or after post-mission disposal: N/A
Maximum orbital lifetime of a severed tether fragment: N/A

Assessment of compliance with Requirement 4.8-1:	
4.8-1, Collision Hazards of Space Tethers:	**N/A**

Appendix A: DAS 2.1.1 Log

```
10 05 2018; 13:19:12PM  Activity Log Started
10 05 2018; 13:19:12PM  Opened Project C:\Users\Swarm
STK\AppData\Local\NASA\DAS2.1.1\Commercial 1\
10 05 2018; 13:19:43PM  Science and Engineering - Orbit Lifetime/Dwell Time

**INPUT**

     Start Year = 2019.600000 (yr)
     Perigee Altitude = 450.000000 (km)
     Apogee Altitude = 450.000000 (km)
     Inclination = 45.000000 (deg)
     RAAN = 0.000000 (deg)
     Argument of Perigee = 0.000000 (deg)
     Area-To-Mass Ratio = 0.009500 (m^2/kg)

**OUTPUT**

     Orbital Lifetime from Startyr = 2.513347 (yr)
     Time Spent in LEO during Lifetime  = 2.513347 (yr)
     Last year of Propagation = 2022 (yr)
     Returned Error Message: Object reentered
10 05 2018; 13:19:50PM  Science and Engineering - Orbit Lifetime/Dwell Time

**INPUT**

     Start Year = 2019.600000 (yr)
     Perigee Altitude = 450.000000 (km)
```

```
Apogee Altitude = 450.000000 (km)
Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.006500 (m^2/kg)
```

OUTPUT

```
Orbital Lifetime from Startyr = 2.918549 (yr)
Time Spent in LEO during Lifetime  = 2.918549 (yr)
Last year of Propagation = 2022 (yr)
Returned Error Message: Object reentered
```
10 05 2018; 13:20:02PM Science and Engineering - Orbit Lifetime/Dwell Time

INPUT

```
Start Year = 2019.600000 (yr)
Perigee Altitude = 500.000000 (km)
Apogee Altitude = 500.000000 (km)
Inclination = 10.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.009500 (m^2/kg)
```

OUTPUT

```
Orbital Lifetime from Startyr = 3.498973 (yr)
Time Spent in LEO during Lifetime  = 3.498973 (yr)
Last year of Propagation = 2023 (yr)
Returned Error Message: Object reentered
```
10 05 2018; 13:20:07PM Science and Engineering - Orbit Lifetime/Dwell Time

INPUT

```
Start Year = 2019.600000 (yr)
Perigee Altitude = 500.000000 (km)
Apogee Altitude = 500.000000 (km)
Inclination = 10.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.006500 (m^2/kg)
```

OUTPUT

```
Orbital Lifetime from Startyr = 4.265572 (yr)
Time Spent in LEO during Lifetime  = 4.265572 (yr)
Last year of Propagation = 2023 (yr)
Returned Error Message: Object reentered
```

```
10 05 2018; 13:20:16PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

      Start Year = 2019.600000 (yr)
      Perigee Altitude = 500.000000 (km)
      Apogee Altitude = 500.000000 (km)
      Inclination = 97.400000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Area-To-Mass Ratio = 0.009500 (m^2/kg)


**OUTPUT**

      Orbital Lifetime from Startyr = 3.515400 (yr)
      Time Spent in LEO during Lifetime  = 3.515400 (yr)
      Last year of Propagation = 2023 (yr)
      Returned Error Message: Object reentered
10 05 2018; 13:20:22PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

      Start Year = 2019.600000 (yr)
      Perigee Altitude = 500.000000 (km)
      Apogee Altitude = 500.000000 (km)
      Inclination = 97.400000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Area-To-Mass Ratio = 0.006500 (m^2/kg)


**OUTPUT**

      Orbital Lifetime from Startyr = 4.287474 (yr)
      Time Spent in LEO during Lifetime  = 4.287474 (yr)
      Last year of Propagation = 2023 (yr)
      Returned Error Message: Object reentered
10 05 2018; 13:20:38PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

      Start Year = 2019.600000 (yr)
      Perigee Altitude = 550.000000 (km)
      Apogee Altitude = 550.000000 (km)
      Inclination = 97.600000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Area-To-Mass Ratio = 0.009500 (m^2/kg)
```

```
**OUTPUT**

      Orbital Lifetime from Startyr = 5.585216 (yr)
      Time Spent in LEO during Lifetime  = 5.585216 (yr)
      Last year of Propagation = 2025 (yr)
      Returned Error Message: Object reentered
10 05 2018; 13:20:42PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

      Start Year = 2019.600000 (yr)
      Perigee Altitude = 550.000000 (km)
      Apogee Altitude = 550.000000 (km)
      Inclination = 97.600000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Area-To-Mass Ratio = 0.006500 (m^2/kg)


**OUTPUT**

      Orbital Lifetime from Startyr = 12.150582 (yr)
      Time Spent in LEO during Lifetime  = 12.150582 (yr)
      Last year of Propagation = 2031 (yr)
      Returned Error Message: Object reentered
10 05 2018; 13:21:47PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

      Start Year = 2019.600000 (yr)
      Perigee Altitude = 450.000000 (km)
      Apogee Altitude = 450.000000 (km)
      Inclination = 45.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Area-To-Mass Ratio = 0.025000 (m^2/kg)


**OUTPUT**

      Orbital Lifetime from Startyr = 1.801506 (yr)
      Time Spent in LEO during Lifetime  = 1.801506 (yr)
      Last year of Propagation = 2021 (yr)
      Returned Error Message: Object reentered
10 05 2018; 13:21:54PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

      Start Year = 2019.600000 (yr)
      Perigee Altitude = 450.000000 (km)
```

```
        Apogee Altitude = 450.000000 (km)
        Inclination = 45.000000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Area-To-Mass Ratio = 0.017000 (m^2/kg)


**OUTPUT**

        Orbital Lifetime from Startyr = 2.047912 (yr)
        Time Spent in LEO during Lifetime  = 2.047912 (yr)
        Last year of Propagation = 2021 (yr)
        Returned Error Message: Object reentered
10 05 2018; 13:22:03PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

        Start Year = 2019.600000 (yr)
        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
        Inclination = 10.000000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Area-To-Mass Ratio = 0.025000 (m^2/kg)


**OUTPUT**

        Orbital Lifetime from Startyr = 2.409309 (yr)
        Time Spent in LEO during Lifetime  = 2.409309 (yr)
        Last year of Propagation = 2022 (yr)
        Returned Error Message: Object reentered
10 05 2018; 13:22:06PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

        Start Year = 2019.600000 (yr)
        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
        Inclination = 10.000000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Area-To-Mass Ratio = 0.017000 (m^2/kg)


**OUTPUT**

        Orbital Lifetime from Startyr = 2.748802 (yr)
        Time Spent in LEO during Lifetime  = 2.748802 (yr)
        Last year of Propagation = 2022 (yr)
        Returned Error Message: Object reentered
```

```
10 05 2018; 13:22:18PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

      Start Year = 2019.600000 (yr)
      Perigee Altitude = 500.000000 (km)
      Apogee Altitude = 500.000000 (km)
      Inclination = 97.400000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Area-To-Mass Ratio = 0.025000 (m^2/kg)


**OUTPUT**

      Orbital Lifetime from Startyr = 2.414784 (yr)
      Time Spent in LEO during Lifetime  = 2.414784 (yr)
      Last year of Propagation = 2022 (yr)
      Returned Error Message: Object reentered
10 05 2018; 13:22:22PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

      Start Year = 2019.600000 (yr)
      Perigee Altitude = 500.000000 (km)
      Apogee Altitude = 500.000000 (km)
      Inclination = 97.400000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Area-To-Mass Ratio = 0.017000 (m^2/kg)


**OUTPUT**

      Orbital Lifetime from Startyr = 2.754278 (yr)
      Time Spent in LEO during Lifetime  = 2.754278 (yr)
      Last year of Propagation = 2022 (yr)
      Returned Error Message: Object reentered
10 05 2018; 13:22:32PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

      Start Year = 2019.600000 (yr)
      Perigee Altitude = 550.000000 (km)
      Apogee Altitude = 550.000000 (km)
      Inclination = 97.600000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Area-To-Mass Ratio = 0.025000 (m^2/kg)
```

```
**OUTPUT**

     Orbital Lifetime from Startyr = 3.208761 (yr)
     Time Spent in LEO during Lifetime  = 3.208761 (yr)
     Last year of Propagation = 2022 (yr)
     Returned Error Message: Object reentered
10 05 2018; 13:22:36PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

     Start Year = 2019.600000 (yr)
     Perigee Altitude = 550.000000 (km)
     Apogee Altitude = 550.000000 (km)
     Inclination = 97.600000 (deg)
     RAAN = 0.000000 (deg)
     Argument of Perigee = 0.000000 (deg)
     Area-To-Mass Ratio = 0.017000 (m^2/kg)


**OUTPUT**

     Orbital Lifetime from Startyr = 3.822040 (yr)
     Time Spent in LEO during Lifetime  = 3.822040 (yr)
     Last year of Propagation = 2023 (yr)
     Returned Error Message: Object reentered
10 05 2018; 13:22:55PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

     Start Year = 2019.600000 (yr)
     Perigee Altitude = 450.000000 (km)
     Apogee Altitude = 450.000000 (km)
     Inclination = 45.000000 (deg)
     RAAN = 0.000000 (deg)
     Argument of Perigee = 0.000000 (deg)
     Area-To-Mass Ratio = 0.041000 (m^2/kg)


**OUTPUT**

     Orbital Lifetime from Startyr = 1.522245 (yr)
     Time Spent in LEO during Lifetime  = 1.522245 (yr)
     Last year of Propagation = 2021 (yr)
     Returned Error Message: Object reentered
10 05 2018; 13:23:02PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

     Start Year = 2019.600000 (yr)
     Perigee Altitude = 450.000000 (km)
```

```
        Apogee Altitude = 450.000000 (km)
        Inclination = 45.000000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Area-To-Mass Ratio = 0.028000 (m^2/kg)


**OUTPUT**

        Orbital Lifetime from Startyr = 1.735797 (yr)
        Time Spent in LEO during Lifetime  = 1.735797 (yr)
        Last year of Propagation = 2021 (yr)
        Returned Error Message: Object reentered
10 05 2018; 13:23:12PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

        Start Year = 2019.600000 (yr)
        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
        Inclination = 10.000000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Area-To-Mass Ratio = 0.041000 (m^2/kg)


**OUTPUT**

        Orbital Lifetime from Startyr = 2.058864 (yr)
        Time Spent in LEO during Lifetime  = 2.058864 (yr)
        Last year of Propagation = 2021 (yr)
        Returned Error Message: Object reentered
10 05 2018; 13:23:18PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

        Start Year = 2019.600000 (yr)
        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
        Inclination = 10.000000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Area-To-Mass Ratio = 0.028000 (m^2/kg)


**OUTPUT**

        Orbital Lifetime from Startyr = 2.321697 (yr)
        Time Spent in LEO during Lifetime  = 2.321697 (yr)
        Last year of Propagation = 2021 (yr)
        Returned Error Message: Object reentered
```

```
10 05 2018; 13:23:28PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

     Start Year = 2019.600000 (yr)
     Perigee Altitude = 500.000000 (km)
     Apogee Altitude = 500.000000 (km)
     Inclination = 97.400000 (deg)
     RAAN = 0.000000 (deg)
     Argument of Perigee = 0.000000 (deg)
     Area-To-Mass Ratio = 0.041000 (m^2/kg)


**OUTPUT**

     Orbital Lifetime from Startyr = 2.064339 (yr)
     Time Spent in LEO during Lifetime  = 2.064339 (yr)
     Last year of Propagation = 2021 (yr)
     Returned Error Message: Object reentered
10 05 2018; 13:23:36PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

     Start Year = 2019.600000 (yr)
     Perigee Altitude = 500.000000 (km)
     Apogee Altitude = 500.000000 (km)
     Inclination = 97.400000 (deg)
     RAAN = 0.000000 (deg)
     Argument of Perigee = 0.000000 (deg)
     Area-To-Mass Ratio = 0.028000 (m^2/kg)


**OUTPUT**

     Orbital Lifetime from Startyr = 2.327173 (yr)
     Time Spent in LEO during Lifetime  = 2.327173 (yr)
     Last year of Propagation = 2021 (yr)
     Returned Error Message: Object reentered
10 05 2018; 13:23:52PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

     Start Year = 2019.600000 (yr)
     Perigee Altitude = 550.000000 (km)
     Apogee Altitude = 550.000000 (km)
     Inclination = 97.600000 (deg)
     RAAN = 0.000000 (deg)
     Argument of Perigee = 0.000000 (deg)
     Area-To-Mass Ratio = 0.041000 (m^2/kg)
```

```
**OUTPUT**

     Orbital Lifetime from Startyr = 2.677618 (yr)
     Time Spent in LEO during Lifetime  = 2.677618 (yr)
     Last year of Propagation = 2022 (yr)
     Returned Error Message: Object reentered
10 05 2018; 13:23:56PM  Science and Engineering - Orbit Lifetime/Dwell Time


**INPUT**

     Start Year = 2019.600000 (yr)
     Perigee Altitude = 550.000000 (km)
     Apogee Altitude = 550.000000 (km)
     Inclination = 97.600000 (deg)
     RAAN = 0.000000 (deg)
     Argument of Perigee = 0.000000 (deg)
     Area-To-Mass Ratio = 0.028000 (m^2/kg)


**OUTPUT**

     Orbital Lifetime from Startyr = 3.066393 (yr)
     Time Spent in LEO during Lifetime  = 3.066393 (yr)
     Last year of Propagation = 2022 (yr)
     Returned Error Message: Object reentered




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

10 05 2018; 13:24:09PM  Activity Log Started
10 05 2018; 13:26:06PM  Mission Editor Changes Applied
10 05 2018; 13:26:22PM  Processing Requirement 4.3-1: Return Status :  Not Run

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


============== End of Requirement 4.3-1 ==============
10 05 2018; 13:26:26PM  Processing Requirement 4.3-2: Return Status : Passed

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

```
=============== End of Requirement 4.3-2 ===============
10 05 2018; 13:26:29PM  Requirement 4.4-3:  Compliant


=============== End of Requirement 4.4-3 ===============
10 05 2018; 15:11:19PM  Processing Requirement 4.5-1: Return Status :  Passed


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


**INPUT**


      Space Structure Name = 450 km 45 deg operational 0.31 kg
      Space Structure Type = Payload
      Perigee Altitude = 450.000000 (km)
      Apogee Altitude = 450.000000 (km)
      Inclination = 45.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Final Area-To-Mass Ratio = 0.009500 (m^2/kg)
      Start Year = 2019.600000 (yr)
      Initial Mass = 0.310000 (kg)
      Final Mass = 0.310000 (kg)
      Duration = 2.500000 (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


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


**INPUT**


      Space Structure Name = 450 km 45 deg operational 0.45 kg
      Space Structure Type = Payload
```

```
Perigee Altitude = 450.000000 (km)
Apogee Altitude = 450.000000 (km)
Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.006500 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.450000 (kg)
Final Mass = 0.450000 (kg)
Duration = 2.900000 (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
```

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

INPUT

```
Space Structure Name = 500 km 10 deg operational 0.31 kg
Space Structure Type = Payload
Perigee Altitude = 500.000000 (km)
Apogee Altitude = 500.000000 (km)
Inclination = 10.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.009500 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.310000 (kg)
Final Mass = 0.310000 (kg)
Duration = 3.500000 (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


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

**INPUT**

      Space Structure Name = 500 km 10 deg operational 0.45 kg
      Space Structure Type = Payload
      Perigee Altitude = 500.000000 (km)
      Apogee Altitude = 500.000000 (km)
      Inclination = 10.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Final Area-To-Mass Ratio = 0.006500 (m^2/kg)
      Start Year = 2019.600000 (yr)
      Initial Mass = 0.450000 (kg)
      Final Mass = 0.450000 (kg)
      Duration = 4.300000 (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


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

**INPUT**
```

```
Space Structure Name = 500 km 97.4 deg (SSO) operational 0.31 kg
Space Structure Type = Payload
Perigee Altitude = 500.000000 (km)
Apogee Altitude = 500.000000 (km)
Inclination = 97.400000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.009500 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.310000 (kg)
Final Mass = 0.310000 (kg)
Duration = 3.500000 (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
```

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

INPUT

```
Space Structure Name = 500 km 97.4 deg (SSO) operational 0.45 kg
Space Structure Type = Payload
Perigee Altitude = 500.000000 (km)
Apogee Altitude = 500.000000 (km)
Inclination = 97.400000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.006500 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.450000 (kg)
Final Mass = 0.450000 (kg)
Duration = 4.300000 (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
```

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

INPUT

```
Space Structure Name = 550 km 97.6 deg (SSO) operational 0.31 kg
Space Structure Type = Payload
Perigee Altitude = 550.000000 (km)
Apogee Altitude = 550.000000 (km)
Inclination = 97.600000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.009500 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.310000 (kg)
Final Mass = 0.310000 (kg)
Duration = 5.600000 (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
```

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

**INPUT**

      Space Structure Name = 550 km 97.6 deg (SSO) operational 0.45 kg
      Space Structure Type = Payload
      Perigee Altitude = 550.000000 (km)
      Apogee Altitude = 550.000000 (km)
      Inclination = 97.600000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Final Area-To-Mass Ratio = 0.006500 (m^2/kg)
      Start Year = 2019.600000 (yr)
      Initial Mass = 0.450000 (kg)
      Final Mass = 0.450000 (kg)
      Duration = 12.200000 (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


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

**INPUT**

      Space Structure Name = 450 km 45 deg ADCS nonfunctional 0.31 kg
      Space Structure Type = Payload
      Perigee Altitude = 450.000000 (km)
      Apogee Altitude = 450.000000 (km)
      Inclination = 45.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Final Area-To-Mass Ratio = 0.025000 (m^2/kg)
      Start Year = 2019.600000 (yr)
      Initial Mass = 0.310000 (kg)
```

```
Final Mass = 0.310000 (kg)
Duration = 1.800000 (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
```

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

INPUT

```
Space Structure Name = 450 km 45 deg ADCS nonfunctional 0.45 kg
Space Structure Type = Payload
Perigee Altitude = 450.000000 (km)
Apogee Altitude = 450.000000 (km)
Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.017000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.450000 (kg)
Final Mass = 0.450000 (kg)
Duration = 2.000000 (yr)
Station-Kept = False
Abandoned = True
PMD Perigee Altitude = -1.000000 (km)
PMD Apogee Altitude = -1.000000 (km)
PMD Inclination = 0.000000 (deg)
PMD RAAN = 0.000000 (deg)
PMD Argument of Perigee = 0.000000 (deg)
PMD Mean Anomaly = 0.000000 (deg)
```

OUTPUT

```
Collision Probability = 0.000000
Returned Error Message: Normal Processing
```

```
Date Range Error Message: Normal Date Range
Status = Pass


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

**INPUT**

        Space Structure Name = 500 km 10 deg ADCS nonfunctional 0.31 kg
        Space Structure Type = Payload
        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
        Inclination = 10.000000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Mean Anomaly = 0.000000 (deg)
        Final Area-To-Mass Ratio = 0.025000 (m^2/kg)
        Start Year = 2019.600000 (yr)
        Initial Mass = 0.310000 (kg)
        Final Mass = 0.310000 (kg)
        Duration = 2.400000 (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


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

**INPUT**

        Space Structure Name = 500 km 10 deg ADCS nonfunctional 0.45 kg
        Space Structure Type = Payload
        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
        Inclination = 10.000000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Mean Anomaly = 0.000000 (deg)
```

```
Final Area-To-Mass Ratio = 0.017000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.450000 (kg)
Final Mass = 0.450000 (kg)
Duration = 2.700000 (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
```

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

INPUT

```
Space Structure Name = 500 km 97.4 deg (SSO) ADCS nonfunctional 0.31 kg
Space Structure Type = Payload
Perigee Altitude = 500.000000 (km)
Apogee Altitude = 500.000000 (km)
Inclination = 97.400000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.025000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.310000 (kg)
Final Mass = 0.310000 (kg)
Duration = 2.400000 (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


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

**INPUT**

        Space Structure Name = 500 km 97.4 deg (SSO) ADCS nonfunctional 0.45 kg
        Space Structure Type = Payload
        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
        Inclination = 97.400000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Mean Anomaly = 0.000000 (deg)
        Final Area-To-Mass Ratio = 0.017000 (m^2/kg)
        Start Year = 2019.600000 (yr)
        Initial Mass = 0.450000 (kg)
        Final Mass = 0.450000 (kg)
        Duration = 2.800000 (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


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

**INPUT**

        Space Structure Name = 550 km 97.6 deg (SSO) ADCS nonfunctional 0.31 kg
        Space Structure Type = Payload
        Perigee Altitude = 550.000000 (km)
        Apogee Altitude = 550.000000 (km)
        Inclination = 97.600000 (deg)
```

```
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.025000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.310000 (kg)
Final Mass = 0.310000 (kg)
Duration = 3.200000 (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
```

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

INPUT

```
Space Structure Name = 550 km 97.6 deg (SSO) ADCS nonfunctional 0.45 kg
Space Structure Type = Payload
Perigee Altitude = 550.000000 (km)
Apogee Altitude = 550.000000 (km)
Inclination = 97.600000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.017000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.450000 (kg)
Final Mass = 0.450000 (kg)
Duration = 3.800000 (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


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

**INPUT**

      Space Structure Name = 450 km 45 deg intentional de-orbit 0.31 kg
      Space Structure Type = Payload
      Perigee Altitude = 450.000000 (km)
      Apogee Altitude = 450.000000 (km)
      Inclination = 45.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Final Area-To-Mass Ratio = 0.041000 (m^2/kg)
      Start Year = 2019.600000 (yr)
      Initial Mass = 0.310000 (kg)
      Final Mass = 0.310000 (kg)
      Duration = 1.500000 (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


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

**INPUT**

      Space Structure Name = 450 km 45 deg intentional de-orbit 0.45 kg
      Space Structure Type = Payload
```

```
Perigee Altitude = 450.000000 (km)
Apogee Altitude = 450.000000 (km)
Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.028000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.450000 (kg)
Final Mass = 0.450000 (kg)
Duration = 1.700000 (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
```

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

INPUT

```
Space Structure Name = 500 km 10 deg intentional de-orbit 0.31 kg
Space Structure Type = Payload
Perigee Altitude = 500.000000 (km)
Apogee Altitude = 500.000000 (km)
Inclination = 10.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.041000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.310000 (kg)
Final Mass = 0.310000 (kg)
Duration = 2.100000 (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


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

**INPUT**

      Space Structure Name = 500 km 10 deg intentional de-orbit 0.45 kg
      Space Structure Type = Payload
      Perigee Altitude = 500.000000 (km)
      Apogee Altitude = 500.000000 (km)
      Inclination = 10.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Final Area-To-Mass Ratio = 0.028000 (m^2/kg)
      Start Year = 2019.600000 (yr)
      Initial Mass = 0.450000 (kg)
      Final Mass = 0.450000 (kg)
      Duration = 2.300000 (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


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

**INPUT**
```

```
        Space Structure Name = 500 km 97.4 deg (SSO) intentional de-orbit 0.31
kg
        Space Structure Type = Payload
        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
        Inclination = 97.400000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Mean Anomaly = 0.000000 (deg)
        Final Area-To-Mass Ratio = 0.041000 (m^2/kg)
        Start Year = 2019.600000 (yr)
        Initial Mass = 0.310000 (kg)
        Final Mass = 0.310000 (kg)
        Duration = 2.100000 (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


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

**INPUT**

        Space Structure Name = 500 km 97.4 deg (SSO) intentional de-orbit 0.45
kg
        Space Structure Type = Payload
        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
        Inclination = 97.400000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Mean Anomaly = 0.000000 (deg)
        Final Area-To-Mass Ratio = 0.028000 (m^2/kg)
        Start Year = 2019.600000 (yr)
        Initial Mass = 0.450000 (kg)
        Final Mass = 0.450000 (kg)
```

```
Duration = 2.300000 (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
```

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

INPUT

```
Space Structure Name = 550 km 97.6 deg (SSO) intentional de-orbit 0.31
kg
Space Structure Type = Payload
Perigee Altitude = 550.000000 (km)
Apogee Altitude = 550.000000 (km)
Inclination = 97.600000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.041000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.310000 (kg)
Final Mass = 0.310000 (kg)
Duration = 2.700000 (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


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

**INPUT**

        Space Structure Name = 550 km 97.6 deg (SSO) intentional de-orbit 0.45
kg
        Space Structure Type = Payload
        Perigee Altitude = 550.000000 (km)
        Apogee Altitude = 550.000000 (km)
        Inclination = 97.600000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Mean Anomaly = 0.000000 (deg)
        Final Area-To-Mass Ratio = 0.028000 (m^2/kg)
        Start Year = 2019.600000 (yr)
        Initial Mass = 0.450000 (kg)
        Final Mass = 0.450000 (kg)
        Duration = 3.100000 (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 ==============
10 05 2018; 15:11:38PM  Requirement 4.5-2:  Compliant
10 05 2018; 15:11:40PM  Processing Requirement 4.6    Return Status :  Passed


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


**INPUT**
```

```
Space Structure Name = 450 km 45 deg operational 0.31 kg
Space Structure Type = Payload

Perigee Altitude = 450.000000 (km)
Apogee Altitude = 450.000000 (km)
Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.009500 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.310000 (kg)
Final Mass = 0.310000 (kg)
Duration = 2.500000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 229.633877 (km)
PMD Apogee Altitude = 237.508511 (km)
PMD Inclination = 44.975467 (deg)
PMD RAAN = 257.156807 (deg)
PMD Argument of Perigee = 67.288848 (deg)
PMD Mean Anomaly = 0.000000 (deg)
```

OUTPUT

```
Suggested Perigee Altitude = 229.633877 (km)
Suggested Apogee Altitude = 237.508511 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2022 (yr)
Requirement = 61
Compliance Status = Pass
```

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

INPUT

```
Space Structure Name = 450 km 45 deg operational 0.45 kg
Space Structure Type = Payload

Perigee Altitude = 450.000000 (km)
Apogee Altitude = 450.000000 (km)
Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.006500 (m^2/kg)
```

```
Start Year = 2019.600000 (yr)
Initial Mass = 0.450000 (kg)
Final Mass = 0.450000 (kg)
Duration = 2.900000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 238.642987 (km)
PMD Apogee Altitude = 238.642987 (km)
PMD Inclination = 44.975761 (deg)
PMD RAAN = 149.045778 (deg)
PMD Argument of Perigee = 175.348179 (deg)
PMD Mean Anomaly = 0.000000 (deg)
```

OUTPUT

```
Suggested Perigee Altitude = 238.642987 (km)
Suggested Apogee Altitude = 238.642987 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2022 (yr)
Requirement = 61
Compliance Status = Pass
```

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

INPUT

```
Space Structure Name = 500 km 10 deg operational 0.31 kg
Space Structure Type = Payload

Perigee Altitude = 500.000000 (km)
Apogee Altitude = 500.000000 (km)
Inclination = 10.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.009500 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.310000 (kg)
Final Mass = 0.310000 (kg)
Duration = 3.500000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 167.936135 (km)
PMD Apogee Altitude = 169.141377 (km)
PMD Inclination = 9.990380 (deg)
PMD RAAN = 213.697191 (deg)
PMD Argument of Perigee = 78.256351 (deg)
```

```
        PMD Mean Anomaly = 0.000000 (deg)


**OUTPUT**


        Suggested Perigee Altitude = 167.936135 (km)
        Suggested Apogee Altitude = 169.141377 (km)
        Returned Error Message = Passes LEO reentry orbit criteria.


        Released Year = 2023 (yr)
        Requirement = 61
        Compliance Status = Pass


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

**INPUT**


        Space Structure Name = 500 km 10 deg operational 0.45 kg
        Space Structure Type = Payload


        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
        Inclination = 10.000000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Mean Anomaly = 0.000000 (deg)
        Area-To-Mass Ratio = 0.006500 (m^2/kg)
        Start Year = 2019.600000 (yr)
        Initial Mass = 0.450000 (kg)
        Final Mass = 0.450000 (kg)
        Duration = 4.300000 (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
```

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

**INPUT**

        Space Structure Name = 500 km 97.4 deg (SSO) operational 0.31 kg
        Space Structure Type = Payload

        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
        Inclination = 97.400000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Mean Anomaly = 0.000000 (deg)
        Area-To-Mass Ratio = 0.009500 (m^2/kg)
        Start Year = 2019.600000 (yr)
        Initial Mass = 0.310000 (kg)
        Final Mass = 0.310000 (kg)
        Duration = 3.500000 (yr)
        Station Kept = False
        Abandoned = True
        PMD Perigee Altitude = 239.023740 (km)
        PMD Apogee Altitude = 239.023740 (km)
        PMD Inclination = 97.501056 (deg)
        PMD RAAN = 206.856447 (deg)
        PMD Argument of Perigee = 336.624670 (deg)
        PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

        Suggested Perigee Altitude = 239.023740 (km)
        Suggested Apogee Altitude = 239.023740 (km)
        Returned Error Message = Passes LEO reentry orbit criteria.

        Released Year = 2023 (yr)
        Requirement = 61
        Compliance Status = Pass


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

**INPUT**

        Space Structure Name = 500 km 97.4 deg (SSO) operational 0.45 kg
        Space Structure Type = Payload

        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
        Inclination = 97.400000 (deg)
```

```
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.006500 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.450000 (kg)
Final Mass = 0.450000 (kg)
Duration = 4.300000 (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
```

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

INPUT

```
Space Structure Name = 550 km 97.6 deg (SSO) operational 0.31 kg
Space Structure Type = Payload

Perigee Altitude = 550.000000 (km)
Apogee Altitude = 550.000000 (km)
Inclination = 97.600000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.009500 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.310000 (kg)
Final Mass = 0.310000 (kg)
Duration = 5.600000 (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 = 550.000000 (km)
        Suggested Apogee Altitude = 550.000000 (km)
        Returned Error Message = Reentry during mission (no PMD req.).


        Released Year = 2025 (yr)
        Requirement = 61
        Compliance Status = Pass


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

**INPUT**

        Space Structure Name = 550 km 97.6 deg (SSO) operational 0.45 kg
        Space Structure Type = Payload

        Perigee Altitude = 550.000000 (km)
        Apogee Altitude = 550.000000 (km)
        Inclination = 97.600000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Mean Anomaly = 0.000000 (deg)
        Area-To-Mass Ratio = 0.006500 (m^2/kg)
        Start Year = 2019.600000 (yr)
        Initial Mass = 0.450000 (kg)
        Final Mass = 0.450000 (kg)
        Duration = 12.200000 (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 = 550.000000 (km)
        Suggested Apogee Altitude = 550.000000 (km)
        Returned Error Message = Reentry during mission (no PMD req.).
```

```
        Released Year = 2031 (yr)
        Requirement = 61
        Compliance Status = Pass


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

**INPUT**

        Space Structure Name = 450 km 45 deg ADCS nonfunctional 0.31 kg
        Space Structure Type = Payload

        Perigee Altitude = 450.000000 (km)
        Apogee Altitude = 450.000000 (km)
        Inclination = 45.000000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Mean Anomaly = 0.000000 (deg)
        Area-To-Mass Ratio = 0.025000 (m^2/kg)
        Start Year = 2019.600000 (yr)
        Initial Mass = 0.310000 (kg)
        Final Mass = 0.310000 (kg)
        Duration = 1.800000 (yr)
        Station Kept = False
        Abandoned = True
        PMD Perigee Altitude = 206.400887 (km)
        PMD Apogee Altitude = 210.199490 (km)
        PMD Inclination = 44.974085 (deg)
        PMD RAAN = 258.441881 (deg)
        PMD Argument of Perigee = 76.945658 (deg)
        PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

        Suggested Perigee Altitude = 206.400887 (km)
        Suggested Apogee Altitude = 210.199490 (km)
        Returned Error Message = Passes LEO reentry orbit criteria.

        Released Year = 2021 (yr)
        Requirement = 61
        Compliance Status = Pass


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

**INPUT**

        Space Structure Name = 450 km 45 deg ADCS nonfunctional 0.45 kg
        Space Structure Type = Payload
```

```
Perigee Altitude = 450.000000 (km)
Apogee Altitude = 450.000000 (km)
Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.017000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.450000 (kg)
Final Mass = 0.450000 (kg)
Duration = 2.000000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 307.713069 (km)
PMD Apogee Altitude = 314.497747 (km)
PMD Inclination = 44.982815 (deg)
PMD RAAN = 214.882644 (deg)
PMD Argument of Perigee = 63.759059 (deg)
PMD Mean Anomaly = 0.000000 (deg)
```

OUTPUT

```
Suggested Perigee Altitude = 307.713069 (km)
Suggested Apogee Altitude = 314.497747 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2021 (yr)
Requirement = 61
Compliance Status = Pass
```

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

INPUT

```
Space Structure Name = 500 km 10 deg ADCS nonfunctional 0.31 kg
Space Structure Type = Payload

Perigee Altitude = 500.000000 (km)
Apogee Altitude = 500.000000 (km)
Inclination = 10.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.025000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.310000 (kg)
Final Mass = 0.310000 (kg)
```

```
Duration = 2.400000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 244.018916 (km)
PMD Apogee Altitude = 246.238744 (km)
PMD Inclination = 9.992735 (deg)
PMD RAAN = 100.715868 (deg)
PMD Argument of Perigee = 79.699634 (deg)
PMD Mean Anomaly = 0.000000 (deg)
```

OUTPUT

```
Suggested Perigee Altitude = 244.018916 (km)
Suggested Apogee Altitude = 246.238744 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2022 (yr)
Requirement = 61
Compliance Status = Pass
```

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

INPUT

```
Space Structure Name = 500 km 10 deg ADCS nonfunctional 0.45 kg
Space Structure Type = Payload

Perigee Altitude = 500.000000 (km)
Apogee Altitude = 500.000000 (km)
Inclination = 10.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.017000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.450000 (kg)
Final Mass = 0.450000 (kg)
Duration = 2.700000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 323.266220 (km)
PMD Apogee Altitude = 326.677590 (km)
PMD Inclination = 9.996339 (deg)
PMD RAAN = 343.028829 (deg)
PMD Argument of Perigee = 106.646861 (deg)
PMD Mean Anomaly = 0.000000 (deg)
```

OUTPUT

```
Suggested Perigee Altitude = 323.266220 (km)
Suggested Apogee Altitude = 326.677590 (km)
Returned Error Message = Passes LEO reentry orbit criteria.


Released Year = 2022 (yr)
Requirement = 61
Compliance Status = Pass


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

**INPUT**

      Space Structure Name = 500 km 97.4 deg (SSO) ADCS nonfunctional 0.31 kg
      Space Structure Type = Payload

      Perigee Altitude = 500.000000 (km)
      Apogee Altitude = 500.000000 (km)
      Inclination = 97.400000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Area-To-Mass Ratio = 0.025000 (m^2/kg)
      Start Year = 2019.600000 (yr)
      Initial Mass = 0.310000 (kg)
      Final Mass = 0.310000 (kg)
      Duration = 2.400000 (yr)
      Station Kept = False
      Abandoned = True
      PMD Perigee Altitude = 262.601160 (km)
      PMD Apogee Altitude = 273.569202 (km)
      PMD Inclination = 97.455787 (deg)
      PMD RAAN = 156.041808 (deg)
      PMD Argument of Perigee = 98.151501 (deg)
      PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

      Suggested Perigee Altitude = 262.601160 (km)
      Suggested Apogee Altitude = 273.569202 (km)
      Returned Error Message = Passes LEO reentry orbit criteria.

      Released Year = 2022 (yr)
      Requirement = 61
      Compliance Status = Pass


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

```
**INPUT**

     Space Structure Name = 500 km 97.4 deg (SSO) ADCS nonfunctional 0.45 kg
     Space Structure Type = Payload

     Perigee Altitude = 500.000000 (km)
     Apogee Altitude = 500.000000 (km)
     Inclination = 97.400000 (deg)
     RAAN = 0.000000 (deg)
     Argument of Perigee = 0.000000 (deg)
     Mean Anomaly = 0.000000 (deg)
     Area-To-Mass Ratio = 0.017000 (m^2/kg)
     Start Year = 2019.600000 (yr)
     Initial Mass = 0.450000 (kg)
     Final Mass = 0.450000 (kg)
     Duration = 2.800000 (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 = 2022 (yr)
     Requirement = 61
     Compliance Status = Pass

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

**INPUT**

     Space Structure Name = 550 km 97.6 deg (SSO) ADCS nonfunctional 0.31 kg
     Space Structure Type = Payload

     Perigee Altitude = 550.000000 (km)
     Apogee Altitude = 550.000000 (km)
     Inclination = 97.600000 (deg)
     RAAN = 0.000000 (deg)
     Argument of Perigee = 0.000000 (deg)
     Mean Anomaly = 0.000000 (deg)
```

```
Area-To-Mass Ratio = 0.025000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.310000 (kg)
Final Mass = 0.310000 (kg)
Duration = 3.200000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 254.105585 (km)
PMD Apogee Altitude = 262.658859 (km)
PMD Inclination = 97.679539 (deg)
PMD RAAN = 95.066826 (deg)
PMD Argument of Perigee = 117.789173 (deg)
PMD Mean Anomaly = 0.000000 (deg)
```

OUTPUT

```
Suggested Perigee Altitude = 254.105585 (km)
Suggested Apogee Altitude = 262.658859 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2022 (yr)
Requirement = 61
Compliance Status = Pass
```

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

INPUT

```
Space Structure Name = 550 km 97.6 deg (SSO) ADCS nonfunctional 0.45 kg
Space Structure Type = Payload

Perigee Altitude = 550.000000 (km)
Apogee Altitude = 550.000000 (km)
Inclination = 97.600000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.017000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.450000 (kg)
Final Mass = 0.450000 (kg)
Duration = 3.800000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 272.942475 (km)
PMD Apogee Altitude = 283.183236 (km)
PMD Inclination = 97.708149 (deg)
PMD RAAN = 320.789627 (deg)
```

```
     PMD Argument of Perigee = 95.590376 (deg)
     PMD Mean Anomaly = 0.000000 (deg)


**OUTPUT**


     Suggested Perigee Altitude = 272.942475 (km)
     Suggested Apogee Altitude = 283.183236 (km)
     Returned Error Message = Passes LEO reentry orbit criteria.


     Released Year = 2023 (yr)
     Requirement = 61
     Compliance Status = Pass


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

**INPUT**


     Space Structure Name = 450 km 45 deg intentional de-orbit 0.31 kg
     Space Structure Type = Payload


     Perigee Altitude = 450.000000 (km)
     Apogee Altitude = 450.000000 (km)
     Inclination = 45.000000 (deg)
     RAAN = 0.000000 (deg)
     Argument of Perigee = 0.000000 (deg)
     Mean Anomaly = 0.000000 (deg)
     Area-To-Mass Ratio = 0.041000 (m^2/kg)
     Start Year = 2019.600000 (yr)
     Initial Mass = 0.310000 (kg)
     Final Mass = 0.310000 (kg)
     Duration = 1.500000 (yr)
     Station Kept = False
     Abandoned = True
     PMD Perigee Altitude = 294.479374 (km)
     PMD Apogee Altitude = 301.337149 (km)
     PMD Inclination = 44.982129 (deg)
     PMD RAAN = 156.984769 (deg)
     PMD Argument of Perigee = 79.949068 (deg)
     PMD Mean Anomaly = 0.000000 (deg)


**OUTPUT**


     Suggested Perigee Altitude = 294.479374 (km)
     Suggested Apogee Altitude = 301.337149 (km)
     Returned Error Message = Passes LEO reentry orbit criteria.


     Released Year = 2021 (yr)
     Requirement = 61
```

```
        Compliance Status = Pass


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

**INPUT**

        Space Structure Name = 450 km 45 deg intentional de-orbit 0.45 kg
        Space Structure Type = Payload

        Perigee Altitude = 450.000000 (km)
        Apogee Altitude = 450.000000 (km)
        Inclination = 45.000000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Mean Anomaly = 0.000000 (deg)
        Area-To-Mass Ratio = 0.028000 (m^2/kg)
        Start Year = 2019.600000 (yr)
        Initial Mass = 0.450000 (kg)
        Final Mass = 0.450000 (kg)
        Duration = 1.700000 (yr)
        Station Kept = False
        Abandoned = True
        PMD Perigee Altitude = 301.934953 (km)
        PMD Apogee Altitude = 311.975767 (km)
        PMD Inclination = 44.983474 (deg)
        PMD RAAN = 109.060950 (deg)
        PMD Argument of Perigee = 63.730411 (deg)
        PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

        Suggested Perigee Altitude = 301.934953 (km)
        Suggested Apogee Altitude = 311.975767 (km)
        Returned Error Message = Passes LEO reentry orbit criteria.

        Released Year = 2021 (yr)
        Requirement = 61
        Compliance Status = Pass


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

**INPUT**

        Space Structure Name = 500 km 10 deg intentional de-orbit 0.31 kg
        Space Structure Type = Payload

        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
```

```
Inclination = 10.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.041000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.310000 (kg)
Final Mass = 0.310000 (kg)
Duration = 2.100000 (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 = 2021 (yr)
Requirement = 61
Compliance Status = Pass
```

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

INPUT

```
Space Structure Name = 500 km 10 deg intentional de-orbit 0.45 kg
Space Structure Type = Payload

Perigee Altitude = 500.000000 (km)
Apogee Altitude = 500.000000 (km)
Inclination = 10.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.028000 (m^2/kg)
Start Year = 2019.600000 (yr)
Initial Mass = 0.450000 (kg)
Final Mass = 0.450000 (kg)
Duration = 2.300000 (yr)
Station Kept = False
Abandoned = True
```

```
        PMD Perigee Altitude = 291.609283 (km)
        PMD Apogee Altitude = 294.516220 (km)
        PMD Inclination = 9.995498 (deg)
        PMD RAAN = 26.568505 (deg)
        PMD Argument of Perigee = 109.472226 (deg)
        PMD Mean Anomaly = 0.000000 (deg)


**OUTPUT**


        Suggested Perigee Altitude = 291.609283 (km)
        Suggested Apogee Altitude = 294.516220 (km)
        Returned Error Message = Passes LEO reentry orbit criteria.

        Released Year = 2021 (yr)
        Requirement = 61
        Compliance Status = Pass


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

**INPUT**


        Space Structure Name = 500 km 97.4 deg (SSO) intentional de-orbit 0.31
kg
        Space Structure Type = Payload

        Perigee Altitude = 500.000000 (km)
        Apogee Altitude = 500.000000 (km)
        Inclination = 97.400000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Mean Anomaly = 0.000000 (deg)
        Area-To-Mass Ratio = 0.041000 (m^2/kg)
        Start Year = 2019.600000 (yr)
        Initial Mass = 0.310000 (kg)
        Final Mass = 0.310000 (kg)
        Duration = 2.100000 (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 = 2021 (yr)
     Requirement = 61
     Compliance Status = Pass


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

**INPUT**

     Space Structure Name = 500 km 97.4 deg (SSO) intentional de-orbit 0.45
kg
     Space Structure Type = Payload

     Perigee Altitude = 500.000000 (km)
     Apogee Altitude = 500.000000 (km)
     Inclination = 97.400000 (deg)
     RAAN = 0.000000 (deg)
     Argument of Perigee = 0.000000 (deg)
     Mean Anomaly = 0.000000 (deg)
     Area-To-Mass Ratio = 0.028000 (m^2/kg)
     Start Year = 2019.600000 (yr)
     Initial Mass = 0.450000 (kg)
     Final Mass = 0.450000 (kg)
     Duration = 2.300000 (yr)
     Station Kept = False
     Abandoned = True
     PMD Perigee Altitude = 299.650065 (km)
     PMD Apogee Altitude = 311.387653 (km)
     PMD Inclination = 97.458690 (deg)
     PMD RAAN = 118.618122 (deg)
     PMD Argument of Perigee = 117.991624 (deg)
     PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

     Suggested Perigee Altitude = 299.650065 (km)
     Suggested Apogee Altitude = 311.387653 (km)
     Returned Error Message = Passes LEO reentry orbit criteria.

     Released Year = 2021 (yr)
     Requirement = 61
     Compliance Status = Pass


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

**INPUT**
```

Space Structure Name = 550 km 97.6 deg (SSO) intentional de-orbit 0.31
kg
        Space Structure Type = Payload

        Perigee Altitude = 550.000000 (km)
        Apogee Altitude = 550.000000 (km)
        Inclination = 97.600000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)
        Mean Anomaly = 0.000000 (deg)
        Area-To-Mass Ratio = 0.041000 (m^2/kg)
        Start Year = 2019.600000 (yr)
        Initial Mass = 0.310000 (kg)
        Final Mass = 0.310000 (kg)
        Duration = 2.700000 (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 = 550.000000 (km)
        Suggested Apogee Altitude = 550.000000 (km)
        Returned Error Message = Reentry during mission (no PMD req.).

        Released Year = 2022 (yr)
        Requirement = 61
        Compliance Status = Pass

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

INPUT

        Space Structure Name = 550 km 97.6 deg (SSO) intentional de-orbit 0.45
kg
        Space Structure Type = Payload

        Perigee Altitude = 550.000000 (km)
        Apogee Altitude = 550.000000 (km)
        Inclination = 97.600000 (deg)
        RAAN = 0.000000 (deg)
        Argument of Perigee = 0.000000 (deg)

Mean Anomaly = 0.000000 (deg)
        Area-To-Mass Ratio = 0.028000 (m^2/kg)
        Start Year = 2019.600000 (yr)
        Initial Mass = 0.450000 (kg)
        Final Mass = 0.450000 (kg)
        Duration = 3.100000 (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 = 550.000000 (km)
        Suggested Apogee Altitude = 550.000000 (km)
        Returned Error Message = Reentry during mission (no PMD req.).

        Released Year = 2022 (yr)
        Requirement = 61
        Compliance Status = Pass

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

============== End of Requirement 4.6 ==============
10 05 2018; 15:14:12PM ********Processing Requirement 4.7-1
        Return Status : Passed

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

name = 450 km 45 deg operational 0.31 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

name = Solar Panels
quantity = 2
parent = 1

```
materialID = 24
type = Box
Aero Mass = 0.001000
Thermal Mass = 0.001000
Diameter/Width = 0.050000
Length = 0.079000
Height = 0.000300

name = Main Board PCB
quantity = 2
parent = 1
materialID = 23
type = Box
Aero Mass = 0.028000
Thermal Mass = 0.028000
Diameter/Width = 0.098000
Length = 0.098000
Height = 0.001600

name = Primary Structure
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.203000
Thermal Mass = 0.203000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

name = Battery Pack
quantity = 1
parent = 1
materialID = 5
type = Cylinder
Aero Mass = 0.049000
Thermal Mass = 0.049000
Diameter/Width = 0.036000
Length = 0.067000

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

name = 450 km 45 deg operational 0.31 kg
Demise Altitude = 77.997574
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
```

```
************************************
name = Solar Panels
Demise Altitude = 77.976097
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


************************************
name = Main Board PCB
Demise Altitude = 76.848984
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


************************************
name = Primary Structure
Demise Altitude = 70.511620
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


************************************
name = Battery Pack
Demise Altitude = 73.459892
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


************************************

***********INPUT****
 Item Number = 2

name = 450 km 45 deg operational 0.45 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

name = 4
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
```

```
Length = 0.113000
Height = 0.028000


**************OUTPUT****
Item Number = 2


name = 450 km 45 deg operational 0.45 kg
Demise Altitude = 77.992897
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************
name = 4
Demise Altitude = 65.963036
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************

***********INPUT****
 Item Number = 3


name = 500 km 10 deg operational 0.31 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


**************OUTPUT****
Item Number = 3


name = 500 km 10 deg operational 0.31 kg
```

```
Demise Altitude = 77.989960
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


**********************************
name = 5
Demise Altitude = 66.509857
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


**********************************

***********INPUT****
 Item Number = 4

name = 500 km 10 deg operational 0.45 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

**************OUTPUT****
Item Number = 4

name = 500 km 10 deg operational 0.45 kg
Demise Altitude = 77.995621
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


**********************************
name = 5
Demise Altitude = 65.277229
```

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


***********************************

***********INPUT****
 Item Number = 5

name = 500 km 97.4 deg (SSO) operational 0.31 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

**************OUTPUT****
Item Number = 5

name = 500 km 97.4 deg (SSO) operational 0.31 kg
Demise Altitude = 77.994484
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************
name = 5
Demise Altitude = 68.840744
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************

***********INPUT****
 Item Number = 6
```

```
name = 500 km 97.4 deg (SSO) operational 0.45 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


**************OUTPUT****
Item Number = 6


name = 500 km 97.4 deg (SSO) operational 0.45 kg
Demise Altitude = 77.989998
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************
name = 5
Demise Altitude = 67.775116
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************

***********INPUT****
 Item Number = 7


name = 550 km 97.6 deg (SSO) operational 0.31 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.310000
```

```
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


**************OUTPUT****
Item Number = 7


name = 550 km 97.6 deg (SSO) operational 0.31 kg
Demise Altitude = 77.992767
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


**********************************
name = 5
Demise Altitude = 68.822350
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


**********************************

***********INPUT****
 Item Number = 8


name = 550 km 97.6 deg (SSO) operational 0.45 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


name = 5
quantity = 1
```

parent = 1
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

**************OUTPUT****
Item Number = 8

name = 550 km 97.6 deg (SSO) operational 0.45 kg
Demise Altitude = 77.991013
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = 5
Demise Altitude = 67.775414
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

***********INPUT****
 Item Number = 9

name = 450 km 45 deg ADCS nonfunctional 0.31 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

name = 4
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000

```
Height = 0.028000

**************OUTPUT****
Item Number = 9

name = 450 km 45 deg ADCS nonfunctional 0.31 kg
Demise Altitude = 77.997574
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

***********************************
name = 4
Demise Altitude = 67.160706
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

***********************************

***********INPUT****
 Item Number = 10

name = 450 km 45 deg ADCS nonfunctional 0.45 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

name = 4
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

**************OUTPUT****
Item Number = 10

name = 450 km 45 deg ADCS nonfunctional 0.45 kg
Demise Altitude = 77.992897
```

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


************************************
name = 4
Demise Altitude = 65.963036
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


************************************

***********INPUT****
 Item Number = 11

name = 500 km 10 deg ADCS nonfunctional 0.31 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

**************OUTPUT****
Item Number = 11

name = 500 km 10 deg ADCS nonfunctional 0.31 kg
Demise Altitude = 77.989960
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

************************************
name = 5
Demise Altitude = 66.509857
Debris Casualty Area = 0.000000
```

Impact Kinetic Energy = 0.000000

****

***********INPUT****
 Item Number = 12

name = 500 km 10 deg ADCS nonfunctional 0.45 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

**************OUTPUT****
Item Number = 12

name = 500 km 10 deg ADCS nonfunctional 0.45 kg
Demise Altitude = 77.995621
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = 5
Demise Altitude = 65.277229
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

***********INPUT****
 Item Number = 13

name = 500 km 97.4 deg (SSO) ADCS nonfunctional 0.31 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

**************OUTPUT****
Item Number = 13

name = 500 km 97.4 deg (SSO) ADCS nonfunctional 0.31 kg
Demise Altitude = 77.994484
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = 5
Demise Altitude = 68.840744
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

***********INPUT****
 Item Number = 14

name = 500 km 97.4 deg (SSO) ADCS nonfunctional 0.45 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000

```
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


**************OUTPUT****
Item Number = 14


name = 500 km 97.4 deg (SSO) ADCS nonfunctional 0.45 kg
Demise Altitude = 77.989998
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************
name = 5
Demise Altitude = 67.775116
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************

***********INPUT****
 Item Number = 15


name = 550 km 97.6 deg (SSO) ADCS nonfunctional 0.31 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


name = 5
quantity = 1
parent = 1
```

```
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


**************OUTPUT****
Item Number = 15


name = 550 km 97.6 deg (SSO) ADCS nonfunctional 0.31 kg
Demise Altitude = 77.992767
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************
name = 5
Demise Altitude = 68.822350
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************

***********INPUT****
 Item Number = 16

name = 550 km 97.6 deg (SSO) ADCS nonfunctional 0.45 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000
```

```
***************OUTPUT****
Item Number = 16


name = 550 km 97.6 deg (SSO) ADCS nonfunctional 0.45 kg
Demise Altitude = 77.991013
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************
name = 5
Demise Altitude = 67.775414
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************

***********INPUT****
 Item Number = 17


name = 450 km 45 deg intentional de-orbit 0.31 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


name = 4
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


***************OUTPUT****
Item Number = 17


name = 450 km 45 deg intentional de-orbit 0.31 kg
Demise Altitude = 77.997574
Debris Casualty Area = 0.000000
```

Impact Kinetic Energy = 0.000000

****
name = 4
Demise Altitude = 67.160706
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

***********INPUT****
 Item Number = 18

name = 450 km 45 deg intentional de-orbit 0.45 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

name = 4
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

**************OUTPUT****
Item Number = 18

name = 450 km 45 deg intentional de-orbit 0.45 kg
Demise Altitude = 77.992897
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = 4
Demise Altitude = 65.963036
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

```
**********************************

***********INPUT****
 Item Number = 19

name = 500 km 10 deg intentional de-orbit 0.31 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


**************OUTPUT****
Item Number = 19

name = 500 km 10 deg intentional de-orbit 0.31 kg
Demise Altitude = 77.989960
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


**********************************
name = 5
Demise Altitude = 66.509857
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


**********************************

***********INPUT****
 Item Number = 20


name = 500 km 10 deg intentional de-orbit 0.45 kg
```

```
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


**************OUTPUT****
Item Number = 20


name = 500 km 10 deg intentional de-orbit 0.45 kg
Demise Altitude = 77.995621
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************
name = 5
Demise Altitude = 65.277229
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************

***********INPUT****
 Item Number = 21


name = 500 km 97.4 deg (SSO) intentional de-orbit 0.31 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
```

```
Length = 0.113000
Height = 0.028000


name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


**************OUTPUT****
Item Number = 21


name = 500 km 97.4 deg (SSO) intentional de-orbit 0.31 kg
Demise Altitude = 77.994484
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************
name = 5
Demise Altitude = 68.840744
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************

***********INPUT****
 Item Number = 22


name = 500 km 97.4 deg (SSO) intentional de-orbit 0.45 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


name = 5
quantity = 1
parent = 1
materialID = 5
```

```
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


**************OUTPUT****
Item Number = 22


name = 500 km 97.4 deg (SSO) intentional de-orbit 0.45 kg
Demise Altitude = 77.989998
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************
name = 5
Demise Altitude = 67.775116
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


***********************************

***********INPUT****
 Item Number = 23


name = 550 km 97.6 deg (SSO) intentional de-orbit 0.31 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000

name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.310000
Thermal Mass = 0.310000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000
```

```
***************OUTPUT****
Item Number = 23


name = 550 km 97.6 deg (SSO) intentional de-orbit 0.31 kg
Demise Altitude = 77.992767
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


**********************************
name = 5
Demise Altitude = 68.822350
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


**********************************

***********INPUT****
 Item Number = 24


name = 550 km 97.6 deg (SSO) intentional de-orbit 0.45 kg
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


name = 5
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.450000
Thermal Mass = 0.450000
Diameter/Width = 0.113000
Length = 0.113000
Height = 0.028000


***************OUTPUT****
Item Number = 24


name = 550 km 97.6 deg (SSO) intentional de-orbit 0.45 kg
Demise Altitude = 77.991013
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000
```

```
************************************
name = 5
Demise Altitude = 67.775414
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000


************************************

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