**Exhibit B – Orbital Debris Assessment Report ("ODAR")**

# SWARM Orbital Debris Assessment Report

SWARM TECHNOLOGIES MISSION PROFILE
PREPARED BY: SWARM TECHNOLOGIES INC
REVISION 1, April 23, 2017

## ODAR Signature Approval

| | |
|---|---|
| Program/ Project Manager | Sara Spangelo |
| Signature |  |
| Date | June 7, 2017 |

## ODAR Section 1: Program Management and Mission Overview

| | |
|---|---|
| Program/ Project Manager | Sara Spangelo |
| Mission Description | This mission is a technology demo for two-way communications satellites, data relay, and a new attitude control system. |
| Foreign Government Involvement | None |
| Project Milestones | The project milestones for the Swarm satellites align with the launch of the vehicles into orbit, including a delivery of the spacecraft one month prior to launch to Spaceflight services. |
| Proposed Launch Date: | Sept 15, 2017 |
| Proposed Launch Vehicles | PSLV<br>Number of Satellites: 4<br>Altitude: 580 km<br>Inclination:97.7 degrees (SSO)<br>LTDN 9:30AM |
| Proposed Launch Sites | SHAR, India |

| | |
|---|---|
| Launch Vehicle Operator: | Astrix/ ISRO |
| Mission Duration: | The operational lifetime of the hardware for each satellite is designed to be up to 10 years following deployment from the launch vehicle. The orbital lifetime for the satellites is nominally expected to be between 4.4 to 9.9 years, depending on the vehicle's orbit, and solar influence of the Earth's atmosphere, as described in Section 6. |
| Launch / Deployment Profile: | **Launch**<br>The Swarm satellites will be injected directly into the target orbits outlined in the table above.<br><br>**Checkout**<br>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 satellite and its payloads, and prepare it for the operational phase.<br><br>**Operations**<br>The operational phase of the satellite begins following the successful deployment of the Swarm satellites from the launch vehicle, and successful checkout. The operational phase continues until the end of the market study.<br><br>**Post-mission Disposal**<br>Following the end of the operational phase, the satellites will remain on orbit in a non-transmitting mode while the orbit of the satellite passively decays until the satellite reenters the atmosphere and disintegrates. The satellite is nominally expected to reenter the atmosphere 7.7 years following deployment from the launch vehicle, as detailed in Appendix B: Swarm BEEs Orbit Lifetime. |
| Selection of Orbit: | The selection of the chosen orbit was made due to available launch opportunities. |
| Potential Physical Interference with Other Orbiting Object: | As the satellite does not have any propulsion systems, its orbit will naturally decay following deployment from the launch vehicle.<br><br>As detailed in Section 5, the probability of physical interference between the satellites and other space objects is sufficiently unlikely that the satellite complies with Requirement 4.5. |

# ODAR Section 2: Spacecraft Description

**Physical Description:**

| **Property** | **Value** |
|---|---|

| | |
|---|---|
| Total Mass at Launch | 0.732 kg (all four satellites), 0.182 kg (each individual satellite) |
| Dry Mass at Launch | 0.732 kg (all four satellites), 0.182 kg (each individual satellite) |
| Form Factor | 1/4U satellites, Qty 4 stacked into form-factor of a 1U CubeSat |
| COG | < 0.170 cm in vertical direction from geometric center |
| Envelope (stowed) | 100mm x 100mm x 113.5mm (all four satellites) |
| Envelope (deployed) | 100mm x 100mm x 113.5mm (all four satellites)<br>Deployed dipole antenna tip to tip is 892 mm |
| Propulsion Systems | None |
| Fluid Systems | None |
| AOCS | Passive stabilization about two axis, GPS navigation |
| Range Safety/<br>Pyrotechnic Devices | None |
| Electrical Generation | Solar cells |
| Electrical Storage | Rechargeable lithium-ion battery. Qty 1: 18650B Panasonic 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 2.1.2 log demonstrating the compliance to the above requirements is available in Appendix A – “DAS 2.1.2 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 12.5 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 BEE 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 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 | **COMPLIANT** |

| | |
|---|---|
| about Earth or the Moon | |
| 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 satellites with an orbiting object larger than 10cm in diameter was sufficiently small that the simulation performed using DAS 2.1.2 software returned a probability value of 0.

| **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** |

A DAS 2.1.2 log demonstrating the compliance to the above requirements is available in Appendix A – "DAS 2.1.2 Log".

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

**Description of Disposal Option Selected:**
Following its deployment, the satellite's orbit will naturally decay until it reenters the atmosphere. Table 1 describes the mission scenarios for which lifetime analysis of Swarm BEEs was considered, and the effective area-to-mass ratio of the satellite in each scenario. The ratio was calculated using the external dimensions of the satellite and deployed arrays. The satellites will be deployed from the P-POD with a spring and will separate from one another with separation springs in the 1/4U feet.

Drag area from deployed antennas (2x 446mm whip antennas) was neglected; as such, the effective area-to-mass calculated below is a conservative case.

*Table 1 - 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 | 0.0154 |

| | | |
|---|---|---|
| | • Satellite maintains position around Z axis as planned for mission operations | |
| ADCS Nonfunctional | • Satellite tumbles randomly | 0.0350 |

Table 2 shows the simulated orbital dwell time for a Swarm BEE satellite for the 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 2.1.2 software to be less than 10 years.

*Table 2 – Orbit Dwell Time for Swarm BEE Satellite in Each Planned Orbit and Mission Scenario*

| | | **Orbital Lifetime (years)** | | |
|---|---|---|---|---|
| **Case** | | **Nominal** | **Lowest Altitude** | **Highest Altitude** |
| **Launch** | | **Q3 2017 PSLV (4 Satellites)** | **Q3 2017 PSLV (4 Satellites)** | **Q3 2017 PSLV (4 Satellites)** |
| **Orbit (Launch Sept. 17, 2017, 9:30 LTDN)** | | **580 km x 580 km SSO (97.7 deg)** | **500 km x 500 km SSO (97.4 deg)** | **600 km x 600 km SSO (97.8 deg)** |
| **Scenario** | **Effective Area-to-Mass ($m^2$/kg)** | | | |
| Operational, Nominal | 0.0154 | 7.68 | 5.23 | 9.87 |
| ADCS Nonfunctional | 0.0350 | 5.80 | 4.38 | 6.27 |

**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<br>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:

| Subsystem | Materials | Quantity | Mass (grams) | Shape | Size (cm) |
|---|---|---|---|---|---|
| **Solar Panels** | Copper, Glass | 2 | 1 | Box | 79 x 50 x 0.3 |
| **Main Board PCB** | FR4 | 2 | 48 | Box | 98 x 98 x 1.6 |
| **Primary Structure** | Al 6061 | 1 | 32 | Box | 100 x 100 x 27 |
| **Battery** | Li-Ion | 1 | 48.5 | Cylinder | 18 (r) x 67 (l) |

**Summary of objects expected to survive an uncontrolled reentry (using DAS 2.1.2 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 2.1.2 log demonstrating the compliance to Requirement 4.7-1 is available in Appendix A – “DAS 2.1.2 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** |

# ODAR Section 9: Orbital Tracking Methodology

In consideration of the small satellite form factor, the satellites employ a radar return enhancement technology to ensure passive ground tracking capability by third party tracking services. Each of our satellites is a ¼-U size, or 100 mm x 100 mm x 28 mm, and is composed of an aluminum frame, and 6 PCBs on each face. Each 100 mm x 100 mm face PCB has a built-in ground plane and solar cells, which provide the same radar return as a 1U satellite, or a 3U satellite end-on. Each 100 mm x 28 mm face is composed of a passive Ku-band radar reflector, specifically designed to be used to passively increase the radar cross section of small satellites for enhanced tracking. Each 100 mm x 28 mm face has an equivalent radar return signature of a 100 mm x 280 mm area (or 10x larger than it's actual area), in effect providing a radar signature equivalent of a 3U satellite, side-on. The passive radar retroreflector was designed for the Haystack Auxiliary RADAR (HAX) operated by MIT Lincoln Labs, which has the following capabilities:

| | |
|---|---|
| Peak Power: | 50 Kilowatts |
| Center frequency: | 16.7 GHz (Ku Band) |
| Bandwidth: | 2 GHz |
| Antenna Diameter: | 12.2 meters |
| Antenna Gain (at 16.7 GHz): | 63.6 dB |
| Antenna Beamwidth: | 0.10 degrees |
| Polarization: | Right Hand Circular |
| Pulse Length: | 1.64 milliseconds |
| Pulse Repetition Frequency: | 60 Hz |

The radar retroreflectors were developed by Terry Albert at SPAWAR. Albert, Terry R CIV SPAWARSYSCEN-PACIFIC, 56290 <terry.albert@navy.mil>

The HAX Radar, which is part of the NORAD system, operated by the Joint Space Operations Center (JSpOC), will track our satellites. The radar reflectors will improve the RADAR return from the smallsat, and thereby improve the ability to detect and track it. HAX can track the satellite any time the smallsat flies over it, and JSpOC calculates the TLEs from the RADAR returns. Any other radar unit in the Ku-band (14.7 GHz to 18.7 GHz) would similarly be able to track our satellites, and would see a signature that is the equivalent to a 3U satellite.

Further, each of our satellites has an onboard GPS receiver, and the GPS location of each of our satellites is transmitted every time that the satellite is interrogated from the ground. We will have the ability to silence all RF transmission of the satellite by command from the ground. Our GPS data, and computed TLEs, will be provided to JSpOC, and any other entity that wishes to receive the live telemetry.

The GPS device will provide telemetry for the hardware lifetime of the satellite, which exceeds the anticipated orbital lifetime of the satellite.

# Appendix A: DAS 2.1.2 Log

Below is the log of the DAS 2.1.2 simulation performed to demonstrate compliance to the above requirements.

```
04 20 2017; 15:03:17PM Activity Log Started
04 20 2017; 15:03:17PM New Project Files Created
04 20 2017; 15:04:46PM Mission Editor Changes Applied
04 20 2017; 15:04:50PM Project Data Saved To File


04 21 2017; 22:16:49PM Science and Engineering - Orbit Lifetime/Dwell Time

**INPUT**

      Start Year = 2017.000000 (yr)
      Perigee Altitude = 600.000000 (km)
      Apogee Altitude = 600.000000 (km)
      Inclination = 97.792400 (deg)
      RAAN = 316.647000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Area-To-Mass Ratio = 0.035000 (m^2/kg)

**OUTPUT**

      Orbital Lifetime from Startyr = 6.269678 (yr)
      Time Spent in LEO during Lifetime  = 6.269678 (yr)
      Last year of Propagation = 2023 (yr)
      Returned Error Message: Object reentered
04 21 2017; 22:17:01PM Science and Engineering - Orbit Lifetime/Dwell Time

**INPUT**

      Start Year = 2017.000000 (yr)
      Perigee Altitude = 600.000000 (km)
      Apogee Altitude = 600.000000 (km)
      Inclination = 97.792400 (deg)
      RAAN = 316.647000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Area-To-Mass Ratio = 0.015400 (m^2/kg)

**OUTPUT**

      Orbital Lifetime from Startyr = 9.872690 (yr)
      Time Spent in LEO during Lifetime  = 9.872690 (yr)
      Last year of Propagation = 2026 (yr)
      Returned Error Message: Object reentered
04 21 2017; 22:23:05PM Science and Engineering - Orbit Lifetime/Dwell Time
```

**INPUT**

Start Year = 2017.000000 (yr)
Perigee Altitude = 600.000000 (km)
Apogee Altitude = 600.000000 (km)
Inclination = 97.792400 (deg)
RAAN = 316.647000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.015400 (m^2/kg)

**OUTPUT**

Orbital Lifetime from Startyr = 9.872690 (yr)
Time Spent in LEO during Lifetime = 9.872690 (yr)
Last year of Propagation = 2026 (yr)
Returned Error Message: Object reentered
04 21 2017; 22:23:21PM Science and Engineering - Orbit Lifetime/Dwell Time

**INPUT**

Start Year = 2017.000000 (yr)
Perigee Altitude = 600.000000 (km)
Apogee Altitude = 600.000000 (km)
Inclination = 97.792400 (deg)
RAAN = 316.647000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.035000 (m^2/kg)

**OUTPUT**

Orbital Lifetime from Startyr = 6.269678 (yr)
Time Spent in LEO during Lifetime = 6.269678 (yr)
Last year of Propagation = 2023 (yr)
Returned Error Message: Object reentered
04 21 2017; 22:23:48PM Science and Engineering - Orbit Lifetime/Dwell Time

**INPUT**

Start Year = 2017.000000 (yr)
Perigee Altitude = 580.000000 (km)
Apogee Altitude = 580.000000 (km)
Inclination = 97.700000 (deg)
RAAN = 316.647000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.035000 (m^2/kg)

**OUTPUT**

Orbital Lifetime from Startyr = 5.798768 (yr)

Time Spent in LEO during Lifetime  = 5.798768 (yr)
Last year of Propagation = 2022 (yr)
Returned Error Message: Object reentered
04 21 2017; 22:24:08PM Science and Engineering - Orbit Lifetime/Dwell Time

**INPUT**

Start Year = 2017.000000 (yr)
Perigee Altitude = 580.000000 (km)
Apogee Altitude = 580.000000 (km)
Inclination = 97.700000 (deg)
RAAN = 316.647000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.015400 (m^2/kg)

**OUTPUT**

Orbital Lifetime from Startyr = 7.676934 (yr)
Time Spent in LEO during Lifetime  = 7.676934 (yr)
Last year of Propagation = 2024 (yr)
Returned Error Message: Object reentered
04 21 2017; 22:24:41PM Science and Engineering - Orbit Lifetime/Dwell Time

**INPUT**

Start Year = 2017.000000 (yr)
Perigee Altitude = 500.000000 (km)
Apogee Altitude = 500.000000 (km)
Inclination = 97.400000 (deg)
RAAN = 316.647000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.015400 (m^2/kg)

**OUTPUT**

Orbital Lifetime from Startyr = 5.229295 (yr)
Time Spent in LEO during Lifetime  = 5.229295 (yr)
Last year of Propagation = 2022 (yr)
Returned Error Message: Object reentered
04 21 2017; 22:24:54PM Science and Engineering - Orbit Lifetime/Dwell Time

**INPUT**

Start Year = 2017.000000 (yr)
Perigee Altitude = 500.000000 (km)
Apogee Altitude = 500.000000 (km)
Inclination = 97.400000 (deg)
RAAN = 316.647000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.035000 (m^2/kg)

```
**OUTPUT**

      Orbital Lifetime from Startyr = 4.380561 (yr)
      Time Spent in LEO during Lifetime  = 4.380561 (yr)
      Last year of Propagation = 2021 (yr)
      Returned Error Message: Object reentered



04 24 2017; 14:19:28PM Processing Requirement 4.3-1:   Return Status :  Passed

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

**INPUT**
      Quantity = 4
      Final Area-To-Mass Ratio = 0.035000 (m^2/kg)
      Perigee Altitude = 580.000000 (km)
      Apogee Altitude = 580.000000 (km)
      Inclination = 97.600000 (deg)
      RAAN = -1.000000 (deg)
      Argument of Perigee = -1.000000 (deg)
      Mean Anomaly = -1.000000 (deg)
      Released Year = 2017.000000 (yr)

**OUTPUT**
      Perigee Altitude = -6378.136000 (km)
      Apogee Altitude = -6378.136000 (km)
      Inclination = 0.000000 (deg)
      Lifetime = 5.807192 (yr)
      Object Reentered within 25 years of Release = True
      Object-Time = 23.162218 (obj-yrs)
      Total Object-Time = 23.162218 (obj-yrs)
      Status = Pass
       Returned Error Message - Normal Processing

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

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



04 24 2017; 11:28:14AM Processing Requirement 4.3-2: Return Status : Passed

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

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

========== End of Requirement 4.3-2 ==========
04 24 2017; 11:28:22AM Requirement 4.4-3:  Compliant

========== End of Requirement 4.4-3 ==========
04 24 2017; 11:28:23AM Requirement 4.4-3:  Compliant

========== End of Requirement 4.4-3 ==========
04 24 2017; 11:40:35AM Processing Requirement 4.5-1:   Return Status :  Passed

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

**INPUT**

Space Structure Name = SwarmBEE
Space Structure Type = Payload
Perigee Altitude = 580.000000 (km)
Apogee Altitude = 580.000000 (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 = 0.035000 (m^2/kg)
Start Year = 2017.000000 (yr)
Initial Mass = 0.183100 (kg)
Final Mass = 0.183100 (kg)
Duration = 5.000000 (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

==========

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

04 21 2017; 15:50:26PM Requirement 4.5-2:  Compliant
04 21 2017; 15:53:04PM Processing Requirement 4.6   Return Status :  Passed

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

**INPUT**

      Space Structure Name = SwarmBEE
      Space Structure Type = Payload

      Perigee Altitude = 580.000000 (km)
      Apogee Altitude = 580.000000 (km)
      Inclination = 97.600000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Area-To-Mass Ratio = 0.004150 (m^2/kg)
      Start Year = 2017.000000 (yr)
      Initial Mass = 0.156400 (kg)
      Final Mass = 0.156400 (kg)
      Duration = 5.000000 (yr)
      Station Kept = False
      Abandoned = True
      PMD Perigee Altitude = 576.060384 (km)
      PMD Apogee Altitude = 576.060384 (km)
      PMD Inclination = 97.748927 (deg)
      PMD RAAN = 344.718056 (deg)
      PMD Argument of Perigee = 8.342328 (deg)
      PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

      Suggested Perigee Altitude = 576.060384 (km)
      Suggested Apogee Altitude = 576.060384 (km)
      Returned Error Message = Passes LEO reentry orbit criteria.

      Released Year = 2045 (yr)
      Requirement = 61
      Compliance Status = Pass

==========

========== End of Requirement 4.6 ==========
04 25 2017; 12:32:07PM *********Processing Requirement 4.7-1
      Return Status :  Passed

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

Item Number = 1

name = SwarmBEE
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.183100
Thermal Mass = 0.183100
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.028300

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 = Subsystem PCB
quantity = 2
parent = 1
materialID = 5
type = Box
Aero Mass = 0.041300
Thermal Mass = 0.041300
Diameter/Width = 0.098000
Length = 0.098000
Height = 0.001600

name = Primary Structure
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.032000
Thermal Mass = 0.032000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.002700

name = Battery Pack
quantity = 1
parent = 1
materialID = 5

```
type = Cylinder
Aero Mass = 0.048500
Thermal Mass = 0.048500
Diameter/Width = 0.039000
Length = 0.067000

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

name = SwarmBEE
Demise Altitude = 77.988602
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

************************************
name = Solar Panels
Demise Altitude = 77.964577
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

************************************
name = Subsystem PCB
Demise Altitude = 75.182190
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

************************************
name = Primary Structure
Demise Altitude = 76.035942
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

************************************
name = Battery Pack
Demise Altitude = 73.450478
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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

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

name = SwarmBEE2
quantity = 4
parent = 0
materialID = 5
type = Box
Aero Mass = 0.183100
Thermal Mass = 0.183100
```

```
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.028300

name = S
quantity = 4
parent = 1
materialID = 5
type = Box
Aero Mass = 0.183100
Thermal Mass = 0.183100
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.028300

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

name = SwarmBEE2
Demise Altitude = 77.988602
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

************************************
name = S
Demise Altitude = 69.932800
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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

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