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

SWARM Orbital Debris Assessment Report

SWARM TECHNOLOGIES MISSION PROFILE
PREPARED BY: SWARM TECHNOLOGIES INC
REVISION 1, May 21, 2018

ODAR Signature Approval

Program/ Project Manager	Sara Spangelo
Signature	
Date	May 21, 2018

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, and data relay.
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 of the SpaceX SSO-A mission.
Proposed Launch Date:	September 1, 2018
Proposed Launch Vehicles	Electron Number of Satellites: 3 Altitude: 575 km SSO Period: 95 min
Proposed Launch Sites	Vandenberg Air Force Base, CA, United States

Launch Vehicle Operator:	SpaceX
Mission Duration:	The operational lifetime of the hardware and electronics for each satellite is designed to be up to 10 years following deployment from the launch vehicle. The orbital lifetime for the satellites is expected to be between 5.3 to 9.3 years, depending on the vehicle's orbit and solar influence of the Earth's atmosphere, as described in Section 6.
Launch / Deployment Profile:	**Launch** The Swarm satellites will be injected directly into the target orbits outlined in the table 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 satellite and its payloads, and prepare it 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 satellite passively decays until the satellite reenters the atmosphere and disintegrates. The satellite is nominally expected to reenter the atmosphere 5.3 years following deployment from the launch vehicle, as detailed in Appendix B: Swarm Satellites 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. 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	1.9801 kg (all three satellites), [0.3971 kg, 0.660 kg, 0.923kg] (individual

	satellite masses)
Dry Mass at Launch	1.9801 kg (all three satellites), [0.3971 kg, 0.660 kg, 0.923kg] (individual satellite masses)
Form Factor	1U satellites, Qty 3
COG	<X1,Y1,Z1> = <0, 4.3, 8.3>, <X2,Y2,Z2> = <0, 2.3, 18.5>, <X3,Y3,Z3> = <0, 1.6, 4.8> [mm] relative to geometric center (all three satellites)
Envelope (stowed)	100mm x 100mm x 113.5mm (each of the three satellites)
Envelope (deployed)	100mm x 100mm x 113.5mm (each of the three satellites) Deployed dipole antenna tip to tip is 892 mm
Propulsion Systems	None
Fluid Systems	None
AOCS	Stabilization, GPS navigation
Range Safety/ 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 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 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 satellites 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 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 ● Satellite maintains position around Z axis as planned for	0.025183* (max) 0.010838* (min)

	mission operations	*Assumes 100% maximum area
ADCS Nonfunctional	• Satellite tumbles randomly	0.025183* (max) 0.010838* (min) * Assumes 100% maximum area

Table 2 shows the simulated orbital dwell time for a Swarm 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 Satellite in Each Planned Orbit and Mission Scenario

		Orbital Lifetime (years)
Case		**Nominal**
Launch		**September 2018 SSO-A (3 Satellites)**
Orbit		**575 km x 575 km SSO**
Scenario	**Effective Area-to-Mass (m^2/kg)**	
Operational, Nominal	0.010838 (min)	9.248460
	0.025183 (max)	5.311431
ADCS Nonfunctional	0.010838 (min)	9.248460
	0.025183 (max)	5.311431

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:

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	48	Box	98 x 98 x 1.6
Primary Structure	Al 6061	1	128	Box	100 x 100 x 100
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

Each of the satellites is a standard 1U CubeSat in size (10 cm x 10 cm x 10 cm), and can be tracked by normal means with the Space Surveillance network.

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

05 12 2018; 21:12:24PM Activity Log Started
05 12 2018; 21:14:56PM Mission Editor Changes Applied
05 12 2018; 21:19:21PM Processing Requirement 4.3-1: Return Status : Passed

==========
Project Data
==========
Objects Passing Through LEO = True
Number of Objects = 4

INPUT
Quantity = 1
Final Area-To-Mass Ratio = 0.025183 (m^2/kg)
Perigee Altitude = 575.000000 (km)
Apogee Altitude = 575.000000 (km)
Inclination = 97.000000 (deg)
RAAN = -1.000000 (deg)

Argument of Perigee = -1.000000 (deg)
Mean Anomaly = -1.000000 (deg)
Released Year = 2018.000000 (yr)

OUTPUT
Perigee Altitude = -6378.136000 (km)
Apogee Altitude = -6378.136000 (km)
Inclination = 0.000000 (deg)
Lifetime = 5.293493 (yr)
Object Reentered within 25 years of Release = True
Object-Time = 5.256674 (obj-yrs)
Total Object-Time = 26.940452 (obj-yrs)
Status = Pass
Returned Error Message - Normal Processing

==========

INPUT
Quantity = 1
Final Area-To-Mass Ratio = 0.015154 (m^2/kg)
Perigee Altitude = 575.000000 (km)
Apogee Altitude = 575.000000 (km)
Inclination = 97.000000 (deg)
RAAN = -1.000000 (deg)
Argument of Perigee = -1.000000 (deg)
Mean Anomaly = -1.000000 (deg)
Released Year = 2018.000000 (yr)

OUTPUT
Perigee Altitude = -6378.136000 (km)
Apogee Altitude = -6378.136000 (km)
Inclination = 0.000000 (deg)
Lifetime = 6.565915 (yr)
Object Reentered within 25 years of Release = True
Object-Time = 6.529774 (obj-yrs)
Total Object-Time = 26.940452 (obj-yrs)
Status = Pass
Returned Error Message - Normal Processing

==========

INPUT
Quantity = 1
Final Area-To-Mass Ratio = 0.010838 (m^2/kg)
Perigee Altitude = 575.000000 (km)
Apogee Altitude = 575.000000 (km)
Inclination = 97.000000 (deg)
RAAN = -1.000000 (deg)
Argument of Perigee = -1.000000 (deg)
Mean Anomaly = -1.000000 (deg)

Released Year = 2018.000000 (yr)

OUTPUT
Perigee Altitude = -6378.136000 (km)
Apogee Altitude = -6378.136000 (km)
Inclination = 0.000000 (deg)
Lifetime = 9.318151 (yr)
Object Reentered within 25 years of Release = True
Object-Time = 9.281314 (obj-yrs)
Total Object-Time = 26.940452 (obj-yrs)
Status = Pass
Returned Error Message - Normal Processing

==========

INPUT
Quantity = 1
Final Area-To-Mass Ratio = 0.018921 (m^2/kg)
Perigee Altitude = 575.000000 (km)
Apogee Altitude = 575.000000 (km)
Inclination = 97.000000 (deg)
RAAN = -1.000000 (deg)
Argument of Perigee = -1.000000 (deg)
Mean Anomaly = -1.000000 (deg)
Released Year = 2018.000000 (yr)

OUTPUT
Perigee Altitude = -6378.136000 (km)
Apogee Altitude = -6378.136000 (km)
Inclination = 0.000000 (deg)
Lifetime = 5.899658 (yr)
Object Reentered within 25 years of Release = True
Object-Time = 5.872690 (obj-yrs)
Total Object-Time = 26.940452 (obj-yrs)
Status = Pass
Returned Error Message - Normal Processing

==========

========== End of Requirement 4.3-1 ==========
05 12 2018; 21:19:24PM Processing Requirement 4.3-2: Return Status : Passed

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

========== End of Requirement 4.3-2 ==========
05 12 2018; 21:19:26PM Requirement 4.4-3: Compliant

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

05 12 2018; 21:59:43PM Processing Requirement 4.5-1: Return Status : Passed

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

INPUT

Space Structure Name = spaceBEE-9
Space Structure Type = Payload
Perigee Altitude = 575.000000 (km)
Apogee Altitude = 575.000000 (km)
Inclination = 97.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.025183 (m^2/kg)
Start Year = 2018.000000 (yr)
Initial Mass = 0.397100 (kg)
Final Mass = 0.397100 (kg)
Duration = 10.000000 (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 = spaceBEE-10
Space Structure Type = Payload
Perigee Altitude = 575.000000 (km)
Apogee Altitude = 575.000000 (km)
Inclination = 97.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.015154 (m^2/kg)

Start Year = 2018.000000 (yr)
Initial Mass = 0.660000 (kg)
Final Mass = 0.660000 (kg)
Duration = 10.000000 (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 = spaceBEE-11
Space Structure Type = Payload
Perigee Altitude = 575.000000 (km)
Apogee Altitude = 575.000000 (km)
Inclination = 97.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.010838 (m^2/kg)
Start Year = 2018.000000 (yr)
Initial Mass = 0.923000 (kg)
Final Mass = 0.923000 (kg)
Duration = 10.000000 (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 ==========

05 12 2018; 22:01:29PM Requirement 4.5-2: Compliant
05 12 2018; 22:01:30PM Processing Requirement 4.6 Return Status : Passed

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

INPUT

Space Structure Name = spaceBEE-9
Space Structure Type = Payload

Perigee Altitude = 575.000000 (km)
Apogee Altitude = 575.000000 (km)
Inclination = 97.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.025183 (m^2/kg)
Start Year = 2018.000000 (yr)
Initial Mass = 0.397100 (kg)
Final Mass = 0.397100 (kg)
Duration = 10.000000 (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

Suggested Perigee Altitude = 575.000000 (km)
Suggested Apogee Altitude = 575.000000 (km)
Returned Error Message = Reentry during mission (no PMD req.).

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

==========

INPUT

Space Structure Name = spaceBEE-10
Space Structure Type = Payload

Perigee Altitude = 575.000000 (km)
Apogee Altitude = 575.000000 (km)
Inclination = 97.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.015154 (m^2/kg)
Start Year = 2018.000000 (yr)
Initial Mass = 0.660000 (kg)
Final Mass = 0.660000 (kg)
Duration = 10.000000 (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

Suggested Perigee Altitude = 575.000000 (km)
Suggested Apogee Altitude = 575.000000 (km)
Returned Error Message = Reentry during mission (no PMD req.).

Released Year = 2024 (yr)
Requirement = 61
Compliance Status = Pass

==========

INPUT

Space Structure Name = spaceBEE-11
Space Structure Type = Payload

Perigee Altitude = 575.000000 (km)
Apogee Altitude = 575.000000 (km)
Inclination = 97.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.010838 (m^2/kg)

Start Year = 2018.000000 (yr)
Initial Mass = 0.923000 (kg)
Final Mass = 0.923000 (kg)
Duration = 10.000000 (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

Suggested Perigee Altitude = 575.000000 (km)
Suggested Apogee Altitude = 575.000000 (km)
Returned Error Message = Reentry during mission (no PMD req.).

Released Year = 2027 (yr)
Requirement = 61
Compliance Status = Pass

==========

========== End of Requirement 4.6 ==========
05 12 2018; 22:03:37PM *********Processing Requirement 4.7-1
Return Status : Passed

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

name = spaceBEE-9
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.397100
Thermal Mass = 0.397100
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

name = Battery Pack
quantity = 1
parent = 1
materialID = 5
type = Cylinder
Aero Mass = 0.380760
Thermal Mass = 0.048500

Diameter/Width = 0.039000
Length = 0.670000

name = Primary Structure
quantity = 1
parent = 2
materialID = 5
type = Box
Aero Mass = 0.332260
Thermal Mass = 0.320000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

name = Subsystem PCB
quantity = 2
parent = 3
materialID = 76
type = Box
Aero Mass = 0.006130
Thermal Mass = 0.005130
Diameter/Width = 0.980000
Length = 0.980000
Height = 0.001600

name = Solar Panels
quantity = 2
parent = 4
materialID = 23
type = Box
Aero Mass = 0.001000
Thermal Mass = 0.001000
Diameter/Width = 0.050000
Length = 0.079000
Height = 0.000300

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

name = spaceBEE-9
Demise Altitude = 77.998184
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Battery Pack
Demise Altitude = 77.483612
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Primary Structure
Demise Altitude = 69.740013
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Subsystem PCB
Demise Altitude = 69.740013
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Solar Panels
Demise Altitude = 69.639374
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

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

name = spaceBEE-10
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.660000
Thermal Mass = 0.660000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

name = s
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.660000
Thermal Mass = 0.660000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

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

name = spaceBEE-10
Demise Altitude = 77.997765

Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = s
Demise Altitude = 68.818443
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

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

name = spaceBEE-11
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.923000
Thermal Mass = 0.923000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

name = s
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.923000
Thermal Mass = 0.923000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

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

name = spaceBEE-11
Demise Altitude = 77.998993
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = s
Demise Altitude = 67.556015
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

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

name = spaceBEE-9-debris
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.397100
Thermal Mass = 0.397100
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

name = s
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.397100
Thermal Mass = 0.397100
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

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

name = spaceBEE-9-debris
Demise Altitude = 77.990471
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = s
Demise Altitude = 70.143852
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

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

name = spaceBEE-10-debris
quantity = 1
parent = 0
materialID = 5

type = Box
Aero Mass = 0.660000
Thermal Mass = 0.660000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

name = s
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.660000
Thermal Mass = 0.660000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

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

name = spaceBEE-10-debris
Demise Altitude = 77.997765
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = s
Demise Altitude = 68.818443
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

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

name = spaceBEE-11-debris
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 0.923000
Thermal Mass = 0.923000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

name = s
quantity = 1

parent = 1
materialID = 5
type = Box
Aero Mass = 0.923000
Thermal Mass = 0.923000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

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

name = spaceBEE-11-debris
Demise Altitude = 77.998993
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = s
Demise Altitude = 67.556015
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

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

Appendix B: Swarm Satellites Orbit Lifetime

05 12 2018; 22:23:45PM Science and Engineering - Orbit Lifetime/Dwell Time

INPUT

Start Year = 2018.000000 (yr)
Perigee Altitude = 575.000000 (km)
Apogee Altitude = 575.000000 (km)
Inclination = 0.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.025183 (m^2/kg)

OUTPUT

Orbital Lifetime from Startyr = 5.311431 (yr)
Time Spent in LEO during Lifetime = 5.311431 (yr)
Last year of Propagation = 2023 (yr)
Returned Error Message: Object reentered
05 12 2018; 22:24:09PM Science and Engineering - Orbit Lifetime/Dwell Time

INPUT

Start Year = 2018.000000 (yr)
Perigee Altitude = 575.000000 (km)
Apogee Altitude = 575.000000 (km)
Inclination = 0.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.010838 (m^2/kg)

OUTPUT

Orbital Lifetime from Startyr = 9.248460 (yr)
Time Spent in LEO during Lifetime = 9.248460 (yr)
Last year of Propagation = 2027 (yr)
Returned Error Message: Object reentered