EXHIBIT A – NARRATIVE EXHIBIT & TABLE OF CONTENTS

1.0 - Exhibit Table of Contents

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2.0 - Description of Application

Swarm Technologies ("Applicant" or "Swarm"), pursuant to Section 5.61 of the Federal Communications Commission's ("FCC's" or "Commission's") Rules, 47 C.F.R. § 5.61, hereby requests Special Temporary Authority ("STA") to downlink orbital data from four (4) SpaceBEE satellites presently in orbit. The STA is sought for a period of 180 days beginning not later than July 15, 2018.

Consistent with the standards set forth in Section 5.61, STA is needed for the discrete purpose of downlinking orbital data collected by Swarm satellites. Timely grant of this STA request will serve the public interest by allowing Swarm to downlink orbital data from Swarm SpaceBEE satellites in orbit. Such data, as discussed in Section 3.0 below, will reflect near-real time information and will be made available through a publicly accessible web portal to satellite operators and federal agencies to ensure that interested parties have access to current orbital parameters for Swarm SpaceBEEs.

3.0 – Swarm SpaceBEE Data

STA would allow Swarm to obtain and share telemetry packets containing essential orbital data. This data includes rotational and magnetometer data, as well as comprehensive GPS tracking information, such as latitude/longitude, altitude, course, speed, and satellite count.

All SpaceBEE satellite data, current within 0.5 seconds following downlink from a Swarm ground station, will be uploaded to a web portal located at www.swarm-technologies.com/gpsdata. Interested parties may obtain an ID and password to access the portal by emailing Sophie Arlow at sophie@swarm-technologies.com.

4.0 – RF Transmissions

Swarm seeks narrow authority to transmit data from the SpaceBEE satellites in order to access tracking information. The SpaceBEE satellites will only transmit to enable downlinking of GPS data, and will be muted at all other times. GPS data will be downlinked during passes over Los Altos, California and Buford, Georgia. These passes will occur approximately four times per day. Each transmission will require approximately two seconds.

Grant of the STA poses no concerns for interference. Space-to-ground transmissions under the proposed STA will be de minimis in nature and involve only the two ground stations identified above. Moreover, Orbcomm, the sole incumbent operator, previously approved Swarm's dismissed 0.25U STA request, File Number 0305-EX-CN-2017, and SpaceBEE satellites will not transmit co-channel with Orbcomm operations. Swarm appreciates that STA operations must occur on a sufferance-only, non-interference basis. Swarm will immediately mute transmissions in the unlikely event of interference.

5.0 – Orbital Parameters

All four SpaceBEE satellites currently orbit at approximately 500 km with 97.5 degrees of inclination. Due to launch vehicle operator adjustments these parameters deviate slightly from those submitted in File Number 0305-EX-CN-2017, which contemplated a 580 km altitude with 97.7 degrees of inclination.

Detailed information on the orbital parameters of the SpaceBEE satellites are provided below and in Exhibit B.

	SPACEBEE-1	*SPACEBEE-2*	*SPACEBEE-3*	*SPACEBEE-4*
NORAD ID	43142	43141	43140	43139
International Code	2018-004AH	2018-004AG	2018-004AF	2018-004AE
Perigee	494.8 km	495.0 km	495.1 km	495.6 km
Apogee	509.9 km	510.1 km	510.3 km	510.8 km
Inclination	97.5 °	97.5 °	97.5 °	97.5 °

.

EXHIBIT B
ORBITAL DEBRIS ASSESSMENT REPORT
STA File Number: 1140-EX-ST-2018

Exhibit B – Orbital Debris Assessment Report (“ODAR”)

SWARM Orbital Debris Assessment Report

SWARM TECHNOLOGIES MISSION PROFILE
PREPARED BY: SWARM TECHNOLOGIES INC
REVISION 2, June 25, 2018

ODAR Signature Approval

Program/ Project Manager	Sara Spangelo
Signature	Sara Spangelo
Date	June 25, 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, 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:	Jan 11, 2018
Proposed Launch Vehicles	SPACEBEE-1 NORAD ID: 43142 Int'l Code: 2018-004AH Perigee: 494.8 km Apogee: 509.9 km Inclination: 97.5 ° 1 43142U 18004AH 18175.61130205 +.00004341 +00000-0 +18456-3 0 9996 2 43142 097.5351 238.4555 0011014 080.8232 279.4251 15.23525976024841

	SPACEBEE-2 NORAD ID: 43141 Int'l Code: 2018-004AG Perigee: 495.0 km Apogee: 510.1 km Inclination: 97.5 ° 1 43141U 18004AG 18175.22091234 +.00004310 +00000-0 +18363-3 0 9993 2 43141 097.5347 238.0529 0011043 081.7858 278.4630 15.23459295024792 SPACEBEE-3 NORAD ID: 43140 Int'l Code: 2018-004AF Perigee: 495.1 km Apogee: 510.3 km Inclination: 97.5 ° 1 43140U 18004AF 18175.88084559 .00003903 00000-0 16682-3 0 9995 2 43140 97.5347 238.7066 0011036 79.5057 280.7422 15.23407071 24893 SPACEBEE-4: NORAD ID: 43139 Int'l Code: 2018-004AE Perigee: 495.6 km Apogee: 510.8 km Inclination: 97.5 ° 1 43139U 18004AE 18175.42967174 +.00003310 +00000-0 +14264-3 0 9992 2 43139 097.5343 238.2296 0011077 080.2811 279.9676 15.23240141024826
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 4.490 to 4.901 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. The operational phase continues until the end of the market study. **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 within 5 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. 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	1.2714 kg (all four satellites), (individually: 0.2835, 0.2977, 0.3131, 0.3771 kg)
Dry Mass at Launch	1.2714 kg (all four satellites)
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) 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/ 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 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 10 cm 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 • Satellite maintains position around Z axis as planned for mission operations	0.01411 (max) 0.01061 (min)
ADCS Nonfunctional	• Satellite tumbles randomly	0.01411 (max) 0.01061 (min)

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

Case		**Apogee Altitude (km)**	**Perigee Altitude (km)**	**Orbital Lifetime (years)**
Launch				
Orbit (Launch Jan. 11, 2018, 9:30 LTDN)				
Satellite	**Area-to-Mass (m^2/kg)**			
SPACEBEE-1	0.01411	509.9	494.8	4.490
SPACEBEE-2	0.01344	510.1	495.0	4.556
SPACEBEE-3	0.01278	510.3	495.1	4.621
SPACEBEE-4	0.01061	510.8	495.6	4.901

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 (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

[update: All four SPACEBEE satellite have been trackable by the Space Surveillance Network (SSN) by normal means. No gaps in tracking have occurred, and the satellites are currently being tracked, and the TLE orbital data is being posted publicly to the SSN database.]

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 ===============
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EXHIBIT C
NTIA SPACE RECORD DATA FORM
STA File Number: 1140-EX-ST-2018

NTIA Space record data form

NTIA requires the following data for space related experiments using government shared spectrum. For each transmit frequency, please provide the data for both ends of the transmit-receive link. Use Part A to describe the satellite to ground information. Part B is for all ground to space transmit links.

Part A: Space to Earth Downlink Data

Satellite Transmitter Data

Transmit Frequency: 137.950 MHz		
Satellite Name: SPACEBEE-1, SPACEBEE-2, SPACEBEE-3, SPACEBEE-4		
Data Field	**Data Answer**	**Description/Comments**
Polarization (XAP)	XAP = V	POLARIZATIONS INCLUDE : H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Orientation (XAZ)	XAZ = EC	NB= NARROWBEAM EC = EARTH COVERAGE
Antenna Dimension (XAD)	ANTENNA GAIN = 2.14 dBi BEAMWIDTH = Toroidal HPBW = 90 x 360 degrees. XAD = XAD01 02G090B	(NTIA format (XAD), EXAMPLE, XAD01 16G030B)
Type of satellite (State = SP) (City = geo or non)	Type = Nongeostationary State = SP City = non	Choose either: Geostationary or Nongeostationary
For Geostationary	Longitude =	IF ANY SATELLITES ARE GEOSTATIONARY, REPORT ITS LATITUDE AS 000000N (XLA AND/OR RLA) AND REPORT ITS LONGITUDE (XLG AND/OR RLG).
For Nongeostationary (Orbital Data)	INCLINATION ANGLE____97.5_______, APOGEE IN KILOMETERS____500_____, PERIGEE IN KILOMETERS_____500____, ORBITAL PERIOD IN HOURS __1__AND FRACTIONS OF HOURS IN DECIMAL___0.577___, THE NUMBER OF SATELLITES IN THE SYSTEM_____4______, ORB = ORB,097.7IN00580AP00580PE0001.6H04NNRT01	IF ANY SATELLITES ARE NONGEOSTATIONARY, REPORT ITS INCLINATION ANGLE, APOGEE IN KILOMETERS, PERIGEE IN KILOMETERS, ORBITAL PERIOD IN HOURS AND FRACTIONS OF HOURS IN DECIMAL, THE NUMBER OF SATELLITES IN THE SYSTEM, THEN T01, EXAMPLE, REM04 *ORB,98.0IN00510AP00510PE001.58H01NRT01, AND FOR SPACE-TO-SPACE COMMUNICATIONS WITH ANOTHER NONGEOSTATIONARY SATELLITE ADD AN ADDITIONAL *ORB FOR IT ENDING IN R01, EXAMPLE, REM05 *ORB,72.9IN03209AP00655PE013.46H01NRR01

Earth Station Data (Receiver) #1		
State (RSC)	RSC = CA	
City Name (RAL)	RAL = Los Altos	
Latitude (DDMMSS)	Lat = 37 21 53 N	
Longitude (DDDMMSS)	Lon = 122 06 39 W	
Antenna Polarization (RAP)	RAP = V	POLARIZATIONS INCLUDE : H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Antenna Azimuth (RAZ)	RAZ = 0-360 V00 to V90 (Azimuth = 0 to 360, Elevation 0 to 90)	THE EARTH STATION RECEIVER ANTENNA AZIMUTH (RAZ), THE MINIMUM ANGLE OF ELEVATION, V00 TO V90, EXAMPLE, RAZ01 V00
Antenna Dimensions (RAD)	ANTENNA GAIN______2.00_________, BEAMWIDTH_____180_________, AZIMUTHAL RANGE__0 to 360_______, THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS ___113_______ THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS ____3__________ RAD = RAD01 02G038B	EXAMPLE ASSUMING NONGEOSTATIONARY, RAD01 16G030B000-360A00357H006
FCC notes: 1. Use S-Note S945. 2. REM AGN, Cubesat, (insert name)		

Earth Station Data (Receiver) #2		
State (RSC)	RSC = GA	
City Name (RAL)	RAL = Buford	
Latitude (DDMMSS)	Lat = 34 05 05 N	
Longitude (DDDMMSS)	Lon = 083 56 51 W	
Antenna Polarization (RAP)	RAP = V	POLARIZATIONS INCLUDE : H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Antenna Azimuth (RAZ)	RAZ = 0-360 V00 to V90	THE EARTH STATION RECEIVER ANTENNA AZIMUTH (RAZ), THE MINIMUM ANGLE OF ELEVATION, V00 TO V90, EXAMPLE, RAZ01 V00

	(Azimuth = 0 to 360, Elevation 0 to 90)	
Antenna Dimensions (RAD)	ANTENNA GAIN______2.00_________, BEAMWIDTH_____180_________, AZIMUTHAL RANGE__0 to 360______, THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS ___366________ THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS ____3___________ RAD = RAD01 02G038B	EXAMPLE ASSUMING NONGEOSTATIONARY, RAD01 16G030B000-360A00357H006
FCC notes: 1. Use S-Note S945. 2. REM AGN, Cubesat, (insert name)		

Part B: Ground Stations, Earth to Space link data:

Earth Station Transmitter Data #1

Transmit Frequency: 137.950 MHz		
State (XSC)	XSC = CA	
City Name (XAL)	XAL = Los Altos	
Latitude (DDMMSS)	Lat = 37 21 53 N	
Longitude (DDDMMSS)	Lon = 122 06 39 W	
Antenna Polarization (XAP)	XAP = V	POLARIZATIONS INCLUDE : H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Antenna Azimuth (XAZ)	XAZ = 0-360 V00 to V90 (Azimuth = 0 to 360, Elevation 0 to 90)	THE EARTH STATION Transmitter ANTENNA AZIMUTH (XAZ), THE MINIMUM ANGLE OF ELEVATION, V00 TO V90, EXAMPLE, XAZ01 V00
Antenna Dimensions (RAD)	ANTENNA GAIN______2.00________, BEAMWIDTH_____180_________, AZIMUTHAL RANGE__0 to 360______, THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS ___113_______ THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS ____3__________ RAD = RAD01 02G038B	EXAMPLE ASSUMING NONGEOSTATIONARY, XAD01 16G030B000-360A00357H006
Satellite Receive Specifications		
Polarization (RAP)	RAP = V	POLARIZATIONS INCLUDE : H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Azimuth (RAZ)	RAZ = EC	STATION RECEIVER ANTENNA AZIMUTH (XAZ), THE MINIMUM ANGLE OF ELEVATION, V00 TO V90, EXAMPLE, RAZ01 V00
Dimension (XAD)	ANTENNA GAIN = 2.14 dBi BEAMWIDTH = Toroidal HPBW = 90 x 360 degrees. XAD = XAD01 02G090B	(NTIA format (RAD), EXAMPLE, RAD01 16G030B)
Type of satellite (State = SP)	Type = Nongeostationary State = SP	Choose either: Geostationary or Nongeostationary

City = G/No	City = non	
For Geostationary	Longitude =	IF ANY SATELLITES ARE GEOSTATIONARY, REPORT ITS LATITUDE AS 000000N (XLA AND/OR RLA) AND REPORT ITS LONGITUDE (XLG AND/OR RLG).
For Nongeostationary (Orbital Data)	INCLINATION ANGLE____97.5________, APOGEE IN KILOMETERS____500______, PERIGEE IN KILOMETERS_____500____, ORBITAL PERIOD IN HOURS __1__AND FRACTIONS OF HOURS IN DECIMAL___0.577___, THE NUMBER OF SATELLITES IN THE SYSTEM_____4_______, ORB = ORB,097.7IN00580AP00580PE0001.6H04 NNRR01	IF ANY SATELLITES ARE NONGEOSTATIONARY, REPORT ITS INCLINATION ANGLE, APOGEE IN KILOMETERS, PERIGEE IN KILOMETERS, ORBITAL PERIOD IN HOURS AND FRACTIONS OF HOURS IN DECIMAL, THE NUMBER OF SATELLITES IN THE SYSTEM, THEN T01, EXAMPLE, REM04 *ORB,98.0IN00510AP00510PE001.58H01NRT01, AND FOR SPACE-TO-SPACE COMMUNICATIONS WITH ANOTHER NONGEOSTATIONARY SATELLITE ADD AN ADDITIONAL *ORB FOR IT ENDING IN R01, EXAMPLE, REM05 *ORB,72.9IN03209AP00655PE013.46H01NRR01

Earth Station Transmitter Data #2

Transmit Frequency: 137.950 MHz		
State (XSC)	XSC = GA	
City Name (XAL)	XAL = Buford	
Latitude (DDMMSS)	Lat = 34 05 05 N	
Longitude (DDDMMSS)	Lon = 083 56 51 W	
Antenna Polarization (XAP)	XAP = V	POLARIZATIONS INCLUDE : H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Antenna Azimuth (XAZ)	XAZ = 0-360 V00 to V90 (Azimuth = 0 to 360, Elevation 0 to 90)	THE EARTH STATION Transmitter ANTENNA AZIMUTH (XAZ), THE MINIMUM ANGLE OF ELEVATION, V00 TO V90, EXAMPLE, XAZ01 V00
Antenna Dimensions (RAD)	ANTENNA GAIN______2.00_________, BEAMWIDTH_____35_________, AZIMUTHAL RANGE__0 to 360_______, THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS ___366________ THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS ____3___________ RAD = RAD01 02G038B	EXAMPLE ASSUMING NONGEOSTATIONARY, XAD01 16G030B000-360A00357H006
Satellite Receive Specifications		

Polarization (RAP)	RAP = V	POLARIZATIONS INCLUDE : H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Azimuth (RAZ)	RAZ = EC	STATION RECEIVER ANTENNA AZIMUTH (XAZ), THE MINIMUM ANGLE OF ELEVATION, V00 TO V90, EXAMPLE, RAZ01 V00
Dimension (XAD)	ANTENNA GAIN = 2.14 dBi BEAMWIDTH = Toroidal HPBW = 90 x 360 degrees. XAD = XAD01 02G090B	(NTIA format (RAD), EXAMPLE, RAD01 16G030B)
Type of satellite (State = SP) City = G/No	Type = Nongeostationary State = SP City = non	Choose either: Geostationary or Nongeostationary
For Geostationary	Longitude =	IF ANY SATELLITES ARE GEOSTATIONARY, REPORT ITS LATITUDE AS 000000N (XLA AND/OR RLA) AND REPORT ITS LONGITUDE (XLG AND/OR RLG).
For Nongeostationary (Orbital Data)	INCLINATION ANGLE____97.5________, APOGEE IN KILOMETERS____500______, PERIGEE IN KILOMETERS______500_____, ORBITAL PERIOD IN HOURS __1__AND FRACTIONS OF HOURS IN DECIMAL___0.577___, THE NUMBER OF SATELLITES IN THE SYSTEM______4_______, ORB = ORB,097.7IN00580AP00580PE0001.6H04NNRR01	IF ANY SATELLITES ARE NONGEOSTATIONARY, REPORT ITS INCLINATION ANGLE, APOGEE IN KILOMETERS, PERIGEE IN KILOMETERS, ORBITAL PERIOD IN HOURS AND FRACTIONS OF HOURS IN DECIMAL, THE NUMBER OF SATELLITES IN THE SYSTEM, THEN T01, EXAMPLE, REM04 *ORB,98.0IN00510AP00510PE001.58H01NRT01, AND FOR SPACE-TO-SPACE COMMUNICATIONS WITH ANOTHER NONGEOSTATIONARY SATELLITE ADD AN ADDITIONAL *ORB FOR IT ENDING IN R01, EXAMPLE, REM05 *ORB,72.9IN03209AP00655PE013.46H01NRR01