<u>BASALT – SPIRIT EEL – ORBITAL DEBRIS MITIGATION PLAN</u>

I. Background

This orbital debris mitigation plan[1] is for Basalt's satellite system, Spirit-EEL (three 3U cubesats). Table 1 and Table 2 provide the input parameters for the various calculations in this document.

Table 1 captures the spacecraft mass and surface area information.

Table 1: Satellite Mass and Surface Area[2]

Mass (kg)[3]	4.49
Spacecraft Dimensions (m)	0.11 x 0.366 x 0.11
Deployed Surface Area (m^2)	0.0668
Stowed Surface Area (m^2)	0.0460
Deployed Area-to-Mass Ratio (m^2/kg)[4]	0.0149
Stowed Area-to-Mass Ratio (m^2/kg)[5]	0.0102

Table 2 summarizes the spacecraft altitude, inclination, plane, and timelines.

Table 2: Orbital Parameters

Launch Date	no earlier than October 2025
Launch Vehicle	SpaceX Falcon 9 – Transporter 15
Perigee Altitude (km)	510 ± 20
Apogee Altitude (km)	510 ± 20
Inclination (deg)	97.45 ± 1.5

[1] This orbital debris mitigation plan uses National Aeronautics and Space Administration debris assessment software ("NASA DAS") version 3.2.6.

[2] The satellites do not have propulsion.

[3] This worst-case calculation provides a small mass growth margin so that the results do not require updates unless the final design exceeds 4.49 kg.

[4] The final area-to-mass ratio is calculated using the total mass of the vehicle and the average cross-sectional area during operations. The cross-sectional area during nominal operations is composed using Basalt's initial guidance calculations that the spacecraft is pointed: 75% of the time prograde, 15% of the time pointing anti-radial, and 10% of the time tumbling.

[5] The stowed area to mass ratio is calculated using the total vehicle mass and the 6DOF-tumbling cross sectional area of the non-deployed spacecraft.

II. 47 C.F.R. § 25.114(d)(14) Compliance Showing

(14) A description of the design and operational strategies that will be used to mitigate orbital debris, including the following information:

(i) A statement that the space station operator has assessed and limited the amount of debris released in a planned manner during normal operations. Where applicable, this statement must include an orbital debris mitigation disclosure for any separate deployment devices, distinct from the space station launch vehicle, that may become a source of orbital debris;

Basalt has assessed and limited the amount of debris released in a planned manner during normal operations. Each satellite does not have any separate deployment devices, distinct from the space station launch vehicle, that may become an orbital debris source.

Space vehicle separation will be accomplished using a debris-free low-shock release system as designed by approved integrators for our launches. Basalt's integrator (EXOLaunch) will install the 3 Spirit-EEL spacecrafts into a CubeSat pod deployer. These use spring-loaded platforms and side rails to guide the spacecraft into orbit and are debris free.

The UHF antenna and solar panel deployment will also use mechanisms that do not release any debris. Both deployables will be restrained with a burn wire, and once released, these elements will deploy under spring tension.

(ii) A statement indicating whether the space station operator has assessed and limited the probability that the space station(s) will become a source of debris by collision with small debris or meteoroids that would cause loss of control and prevent disposal. The statement must indicate whether this probability for an individual space station is 0.01 (1 in 100) or less, as calculated using the NASA Debris Assessment Software or a higher fidelity assessment tool;

Basalt has assessed and limited the probability that each satellite will become a debris source by collision with small debris or meteoroids that would cause loss of control and prevent disposal. This requirement is not applicable because it concerns only space objects using subsystems to deorbit. Spirit-EEL satellites will deorbit passively via atmospheric reentry, which does not require a subsystem for specific orientation or drag state. Therefore, this requirement does not apply to the Spirit-EEL satellites.

(iii) A statement that the space station operator has assessed and limited the probability, during and after completion of mission operations, of accidental explosions or of release of liquids that will persist in droplet form. This statement must include a demonstration that debris generation will not result from the conversion of energy sources on board the spacecraft into energy that fragments the spacecraft. Energy sources include chemical, pressure, and kinetic energy. This demonstration should address whether stored energy will be removed at the spacecraft's end of life, by depleting residual fuel and leaving all fuel line valves open, venting any pressurized system, leaving all batteries in a permanent discharge state, and removing any remaining source of stored energy, or through other equivalent procedures specifically disclosed in the application;

Basalt has assessed and limited the probability, during and after completion of mission operations, of accidental explosions or of release of liquids that will persist in droplet form. There are no credible causes of spacecraft breakup during nominal deployment and mission operations.

The spacecraft has no chemical propellants or pressurized vessels. The battery safety systems are discussed in the assessment of spacecraft compliance with NASA Technical Standard 8719.14C Requirement 4.4-1. This standard describes the combined faults required for the mutually exclusive failures that lead to battery venting. The batteries are commercial-off-the-shelf batteries equipped with safety vent features on either side that releases excessive pressure build-up to preclude explosions.

A failure mode and effects analysis ("FMEA") was done to demonstrate the combined, mutually exclusive failures that must occur to result in the potential for accidental explosion of the batteries. The first foreseen risk of explosion would be battery overheating and the resulting low probability of cell explosion. Six independent scenarios were analyzed to consider the risk that battery explosion could occur (with an exceptionally low cumulative probability that explosion will occur).

Battery explosion:

- **Effect**: All failure modes below might result in battery explosion with the possibility of orbital debris generation. In the unlikely event that a battery cell does explosively rupture, the small size, mass, and potential energy of this small battery pack is such that the spacecraft could be expected to vent gases, but most debris should be contained within the vehicle chassis shell.

- **Probability**: Extremely Low. It is believed to be much less than the 0.0001% requirements given that multiple independent (not common mode) faults must occur for each failure mode to cause the ultimate effect (explosion). The Pumpkin Battery Module 2 is a commonly flown component which has had successful flight heritage on cubesats since 2019.

- **Failure Mode 1**: Battery internal short circuit.

    - *Mitigation:* Complete component and subsystem qualification and environmental acceptance tests of Pumpkin BM 2 ("BM 2"). The acceptance tests are shock, vibration, thermal cycling, and vacuum tests followed by maximum system rate-limited charge and discharge to prove that no internal short circuit sensitivity exists. BM 2 includes two independent system-level inhibits: Remove-Before-Flight inhibit and Separation Switch inhibit. Both system inhibits override all other battery protection and monitoring circuits. When either inhibit is active, the battery is isolated from all other circuitry and hence the BM 2's own active circuits are powered down.

    - *Combined Faults Required:* Environmental testing AND functional charge/discharge tests must both be ineffective in discovery of the failure mode.

- **Failure Mode 2**: Internal thermal rise due to high load discharge rate.

- *Mitigation:* BM 2 is mounted on a copper heat sink that provides a large thermal path to the rest of the vehicle chassis shell. This heat path from the batteries to the chassis mitigates the potential for thermal runaway of the cells. Additionally, the BM 2's V- terminal is connected to system ground, and its V+ terminal is connected such that it can sink charge currents and source discharge currents. The quiescent current draw of the BM 2 is small compared to the self-discharge rate of the batteries employed. The system's theoretical maximum discharge rated is limited by circuits on the Electrical Power System Module ("EPSM1" or "EPS") to not exceed cell limits. The integrated vehicles will be tested in high discharge states to mitigate this risk.

- *Combined Faults Required:* BM 2 over current detection AND independent EPS current limiting circuits must fail.

- **Failure Mode 3**: Overcharging and excessive charge rate.

  - *Mitigation:* The satellite bus battery charging circuit design reduces the possibility of the batteries being overcharged if circuits function nominally. This circuit has been qualified for survival in shock, vibration, and thermal-vacuum environments. The BM2 includes Intelligent Charge Override to permit battery charging with active Separation inhibit and a trickle charging mode. Additionally, primary battery protections include cell over/undervoltage, overcurrent, and overtemperature protection, which all inhibit charging and discharging when voltage, current, or temperature exceed a predefined limit. Secondary battery protections include fault in charge Field-Effect Transistor ("FET"), fault in zero-volt charge FET, fault in discharge FET, detection of cell imbalance, and independent cell overvoltage detection. The BM 2 also implements a robust cell balancing system to prevent inter-cell voltage imbalance.

  - *Combined Faults Required:*

    - For overcharging: The charge control circuit must fail to function AND all primary AND secondary battery protections must fail.

    - For excessive charge rate: The maximum charging rate from a single solar panel is 1200 mA. The maximum charge rate the battery can accept is 20 A. Due to solar panel current limits and their direction-facing arrangement on the satellite, there is no physical means of exceeding charging rate limits, even if only a single string from the battery was accepting charge. The solar panel arrays would need to generate more than 16 times their stated max output current for this failure.

- **Failure Mode 4**: Excessive discharge rate or short circuit due to external device failure or terminal contact with conductors not at battery voltage levels (due to abrasion or inadequate proximity separation).

- *Mitigation:* This failure mode is negated by a) circuit protection on each external circuit; b) design of battery packs and insulators such that no contact with nearby board traces is possible without being caused by some other mechanical failure; c) obviation of such other mechanical failures by qualification and acceptance environmental tests (shock, vibration, thermal cycling, and thermal-vacuum tests); and d) current limiters on the EPSM1 electrical power supply board, which has reduced current limits for each voltage channel to prevent excessive discharge rate.

- *Combined Faults Required:* The primary and secondary battery protections must fail AND an external load must fail/short-circuit AND external over-current detection and disconnect function must fail to enable the Separation Switch inhibit AND the EPSM1 overcurrent protection circuits must fail AND vibration qualification tests must fail.

● **Failure Mode 5**: Batteries are crushed during operation.

- *Mitigation:* This mode is negated by spacecraft design. There are no moving parts in the proximity of the batteries which could crush the cells or pack module.

- *Combined Faults Required:* A catastrophic failure must occur in an external system AND the failure must cause a collision sufficient to crush the batteries leading to an internal short circuit AND the satellite must be in a naturally sustained orbit at the time the crushing occurs.

● **Failure Mode 6**: Low-level current leakage or short-circuit through battery pack case or due to moisture-based degradation of insulators.

- *Mitigation:* These modes are negated by non-conductive inserts and covers concealing all the cell terminals and encased in a high temp polyimide case. Additionally, battery operation is in vacuum so that no moisture can affect insulators.

- *Combined Faults Required:* Abrasion or piercing failure of circuit board coating or wire insulators AND dislocation of battery packs AND failure of battery terminal insulators AND failure to detect such failures in environmental tests must occur to result in this failure mode.

● **Failure Mode 7**: Excess temperatures due to orbital environment and high discharge combined.

- *Mitigation*: The spacecraft thermal design will negate this possibility with strong thermal coupling between the heat-generating and heat-radiating parts of the system. In addition, thermal tests will be performed on the integrated system to prove battery stability and performance in all thermal regimes encountered during flight. Excessively high current discharge rates are limited via independent EPS and Battery pack current limiting circuitry.

    - *Combined Faults Required*: Thermal analysis AND thermal design AND mission simulations in thermal-vacuum chamber testing AND over-current monitoring and control in the EPS AND over-current limiting in the BM 2 must ALL fail for this failure mode to occur.

- **Failure Mode 8**: Polarity reversal due to over-discharge caused by continuous load during periods of negative power generation vs. consumption.

    - *Mitigation*: Power systems engineering for the spacecraft means that the spacecraft is incapable of entering such a power state, provided that the solar panels deploy, given that the solar panel output is greater than expected average power consumption. If such a state were to occur despite this mission design, flight software logic is designed to trigger a recharging state below 20% charge in the battery. In addition, BM 2 cell protection circuitry is designed to never allow polarity reversal to occur.

    - *Combined Faults Required*: The flight computer must stop executing code AND significant loads must be commanded/stuck "on" AND power margin mission analysis must be wrong AND the BM 2 cell protection circuit must fail for this failure mode to occur.

- **Failure Mode 9**: Excess battery temperatures due to post mission orbital environment and constant solar panel overcharge while satellite is powered off.

    - *Mitigation*: The solar panel arrays are managed by the Pumpkin Solar Interface Module, which provides dynamic control of the solar panel charging current to the batteries. These circuits are redundant to charge protection circuits on the BM 2 battery pack.

    - *Combined Faults Required*: Failure of the Solar Interface Module AND failure of the BM 2 charge protection circuits.

Reaction Wheel Explosion:

- **Effect**: All failure modes below might result in reaction wheel explosion with the possibility of orbital debris generation. However, in the unlikely event that a reaction wheel does explosively rupture, the small size, mass, and potential energy of these reaction wheels is such that most debris from the reaction wheel rupture should be contained within their computer numerical control-machined Aluminum enclosure due to the lack of penetration energy.

- **Probability**: Very Low. It is believed to be much less than the 0.0001% requirements given that multiple independent (not common mode) faults must occur for each failure mode to cause the ultimate effect (explosion). All reaction wheels are held in a thick, solid walled metal enclosure which would contain any explosion.

- **Failure Mode 1**: Malfunction of the Attitude Determination and Control System ("ADCS") computer and subsystem sensors causing overspeed and mechanical failure of the reaction wheel.

    - *Mitigation*: Each reaction wheel is held inside of its own solid-walled aluminum casing. These cased reaction wheels are in turn mounted inside of the main CubeADCS Aluminum solid-walled enclosure. Reaction wheel speeds are monitored by the ADCS computer, and should an overspeed limit be reached, reaction wheels will be halted by the system. In addition, the spacecraft chassis includes an outer aluminum shell wall to additionally contain debris.

    - *Combined Faults Required*: ADCS monitoring fails AND reaction wheel fragments breach their individual casings AND reaction wheel fragments breach the ADCS unit enclosure AND reaction wheel fragments breach the chassis wall.

(iv) A statement that the space station operator has assessed and limited the probability of the space station(s) becoming a source of debris by collisions with large debris or other operational space stations.

Basalt has assessed and limited the probability of each satellite becoming a source of debris by collisions with large debris or other operational space stations. See following responses.

(A) Where the application is for an NGSO space station or system, the following information must also be included:

(1) A demonstration that the space station operator has assessed and limited the probability of collision between any space station of the system and other large objects (10 cm or larger in diameter) during the total orbital lifetime of the space station, including any de-orbit phases, to less than 0.001 (1 in 1,000). The probability shall be calculated using the NASA Debris Assessment Software or a higher fidelity assessment tool. The collision risk may be assumed zero for a space station during any period in which the space station will be maneuvered effectively to avoid colliding with large objects.

For the single satellite collision scenario, the large object collision probability is 6.3369E-07 at the highest possible 530 km altitude, for each spacecraft.

For the aggregate satellite collision scenario, the associated probability is 1.9011E-06 and remains below the single satellite collision risk limit.[5]

(2) The statement must identify characteristics of the space station(s)' orbits that may present a collision risk, including any planned and/or operational space stations in those orbits, and indicate what steps, if any, have been taken to coordinate with the other spacecraft or system, or what other measures the operator plans to use to avoid collision.

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[5] The aggregate collision risk probability is calculated as Ptotal=1-i(1-Pi).

There is no significant risk of collision based on orbital parameters and small spacecraft size. Spirit-EEL spacecraft do not have a propulsion system and employ magnetorquers and reaction wheels for active attitude control. Furthermore, Basalt will register the Spirit-EEL satellites with the 18th Space Defense Squadron (or its successor), which provides monitoring in conjunction with the Combined Space Operations Center.

(3) If at any time during the space station(s)' mission or de-orbit phase the space station(s) will transit through the orbits used by any inhabitable spacecraft, including the International Space Station, the statement must describe the design and operational strategies, if any, that will be used to minimize the risk of collision and avoid posing any operational constraints to the inhabitable spacecraft.

During the de-orbit phase, the Spirit-EEL spacecraft will passively decay from an altitude greater than that of the International Space Station ("ISS") and Chinese space station to an altitude below that of the ISS and Chinese space station. Basalt will coordinate with the 18th Space Defense Squadron (or successor entity) and habitable space station operators, including by sharing ephemeris data, to minimize risk of collision.

(4) The statement must disclose the accuracy, if any, with which orbital parameters will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s). In the event that a system is not able to maintain orbital tolerances,* e.g.*, its propulsion system will not be used for orbital maintenance, that fact must be included in the debris mitigation disclosure. Such systems must also indicate the anticipated evolution over time of the orbit of the proposed satellite or satellites. All systems must describe the extent of satellite maneuverability, whether or not the space station design includes a propulsion system.

The satellites will not have a propulsion system and will naturally degrade orbits after deployment. Figure 1 shows each deployed satellite will deorbit within 5.57 years of its launch and satisfies the 6-year re-entry requirement. Figure 2 shows each stowed satellite will re-enter the Earth's atmosphere in about 8.49 years.

Figure 1: Deployed Satellite Orbital Lifetime

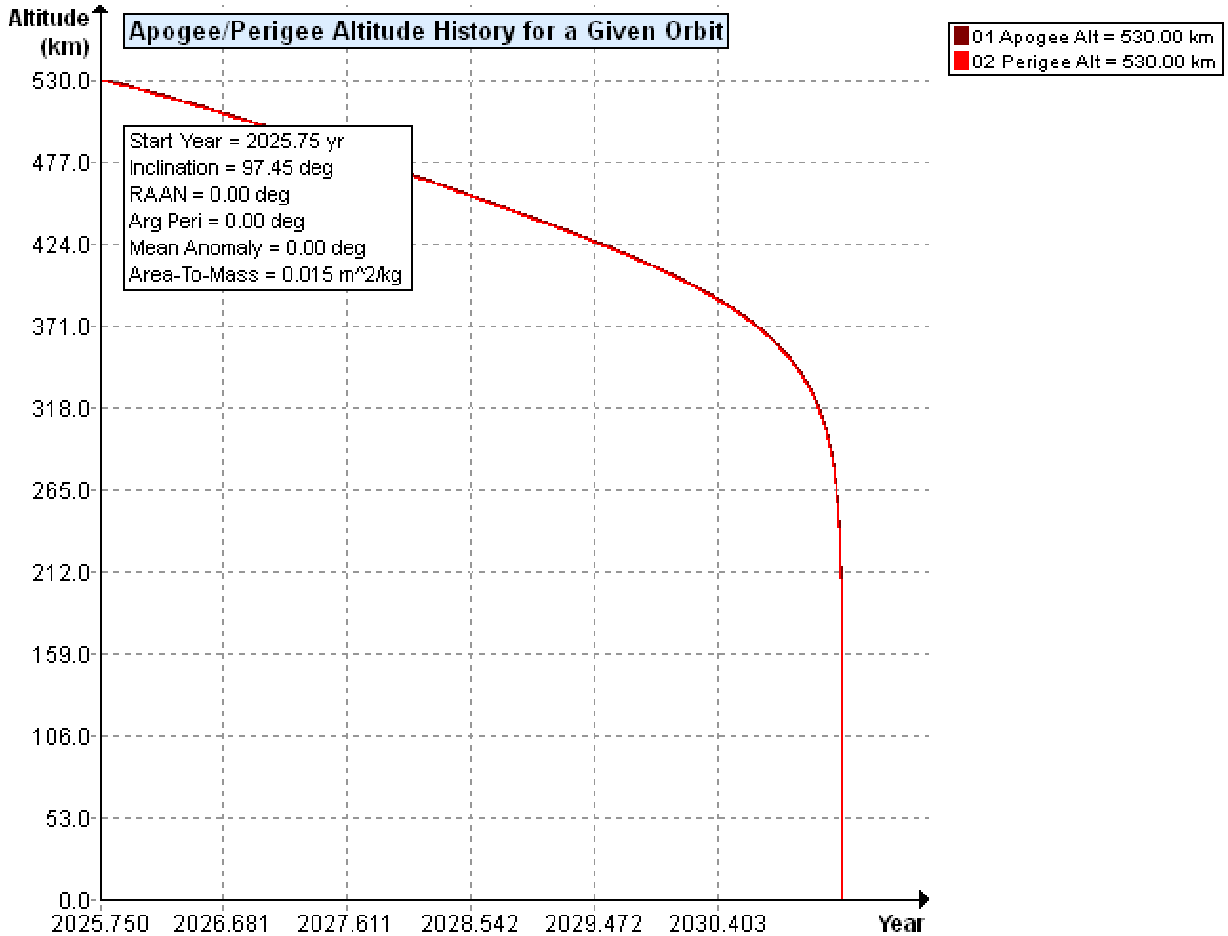
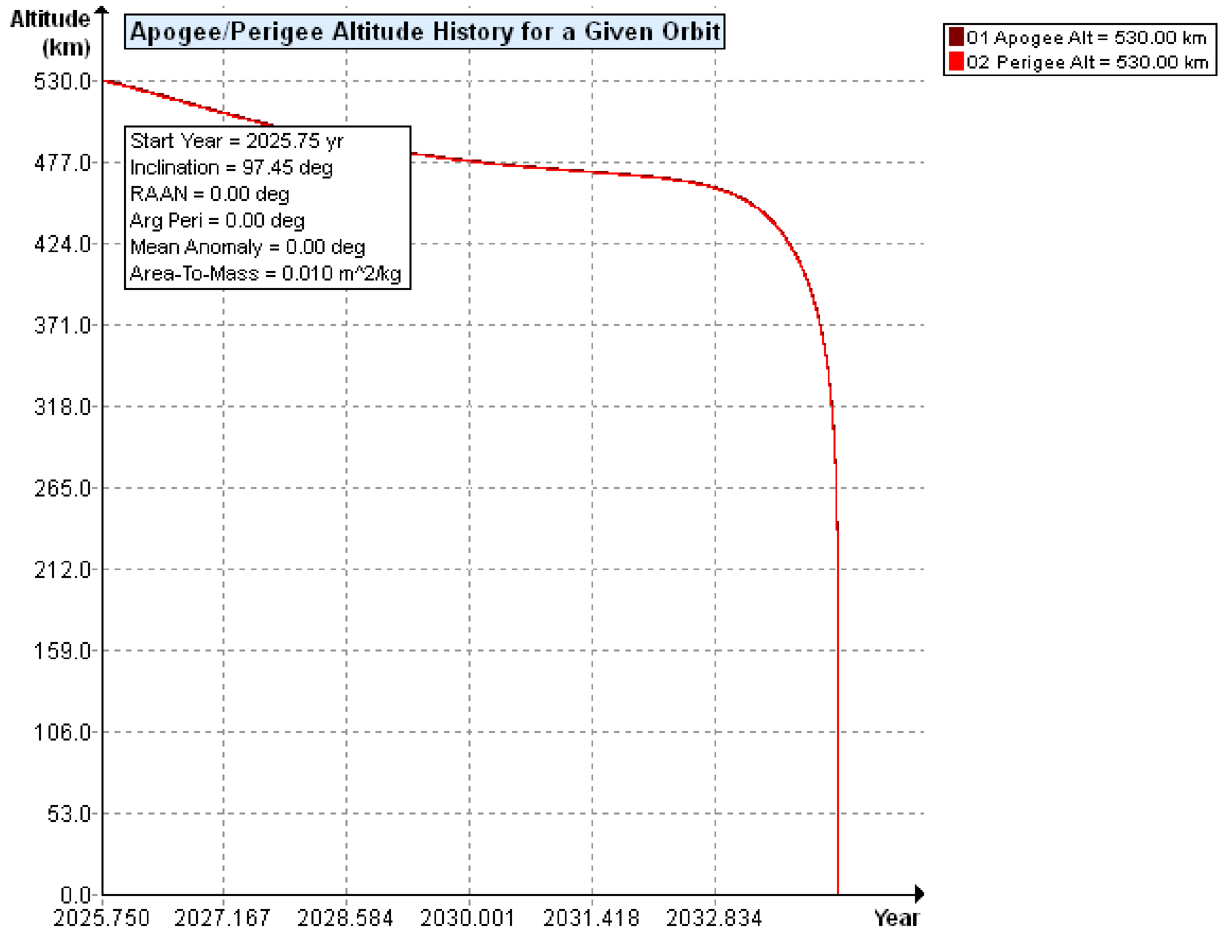


Figure 2: Stowed Satellite Orbital Lifetime



(5) The space station operator must certify that upon receipt of a space situational awareness conjunction warning, the operator will review and take all possible steps to assess the collision risk, and will mitigate the collision risk if necessary. As appropriate, steps to assess and mitigate the collision risk should include, but are not limited to: Contacting the operator of any active spacecraft involved in such a warning; sharing ephemeris data and other appropriate operational information with any such operator; and modifying space station attitude and/or operations.

Upon receipt of a space situational awareness conjunction warning, Basalt certifies that it will attempt to contact the operator of any active spacecraft involved in such a warning and share ephemeris data and other appropriate operational information with any such operator.

(B) Where a space station requests the assignment of a geostationary orbit location, it must assess whether there are any known satellites located at, or reasonably expected to be located at, the requested orbital location, or assigned in the vicinity of that location, such that the station keeping volumes of the respective satellites might overlap or touch. If so, the statement must include a statement as to the identities of those satellites and the measures that will be taken to prevent collisions;

Not applicable. The spacecraft will operate in low-Earth orbit.

(v) A statement addressing the trackability of the space station(s). Space station(s) operating in low-Earth orbit will be presumed trackable if each individual space station is 10 cm or larger in its smallest dimension, excluding deployable components.

Each satellite is presumed trackable given each is larger than 10 cm in its smallest dimension (excluding deployable components). See Table 1.

Where the application is for an NGSO space station or system, the statement shall also disclose the following:

(A) How the operator plans to identify the space station(s) following deployment and whether space station tracking will be active or passive;

The Spirit-EEL spacecraft will be passively tracked. For tracking, the following capabilities can be used: (1) unique keys; (2) GPS position/velocity collected by the satellites; and (3) calibration of two-line element ("TLE") ephemeris using Doppler shift of received transmissions (not routinely used).

Unique keys. Each satellite will be assigned a unique identifier prior to launch. This unique identifier will be included in all telemetry packets that are ever exchanged during a space-to-ground or ground-to-space interaction and will be logged and used to confirm and update tracking information for the Basalt network by the specific satellite. The format of the identifier used for the satellite will be unique to Basalt (and Basalt alone).

GPS. Following deployment, the redundant GPS receiver equipped to each satellite will telemeter the GPS position vector of the satellite on downlink TT&C channels. This telemetry can be received at Basalt's command and control center in San Francisco, CA. Additionally, the launch provider will provide inertial state vectors for satellite deployment.

Doppler shift. After commissioning, these TLEs can be verified or updated based on the data received by Basalt's telemetry downlink. Then, during ground station overpasses, Basalt can leverage Doppler and Ranging measurements to further refine orbit determination computations and to assist in more accurate satellite tracking telemetry.

(B) Whether, prior to deployment, the space station(s) will be registered with the 18th Space Control Squadron or successor entity; and

Prior to deployment, the spacecraft will be registered with the 18th Space Defense Squadron (or its successor) via its Satellite Registration Form and Space Situational Awareness Sharing Agreement.

(C) The extent to which the space station operator plans to share information regarding initial deployment, ephemeris, and/or planned maneuvers with the 18th Space Control Squadron or successor entity, other entities that engage in space situational awareness or space traffic management functions, and/or other operators.

The spacecraft will not engage in any planned maneuvers. Basalt will provide the 18th Space Defense Squadron (or its successor) information regarding initial deployment and owner/operator ("O/O") ephemeris to enable better space situational awareness and improve the accuracy of conjunction analysis ("CA"). The higher accuracy O/O ephemeris will improve the quality of the CA and reduce the frequency of Conjunction Data Messages. Basalt intends to share ephemeris with other operators on an as-needed basis.

(vi) A statement disclosing planned proximity operations, if any, and addressing debris generation that will or may result from the proposed operations, including any planned release of debris, the risk of accidental explosions, the risk of accidental collision, and measures taken to mitigate those risks.

Not applicable. No proximity operations are planned.

(vii) A statement detailing the disposal plans for the space station, including the quantity of fuel—if any—that will be reserved for disposal maneuvers.

Spirit-EEL satellites will be disposed of via uncontrolled atmospheric reentry. Low-Earth orbit's operational altitude lends to natural forces that will quickly prompt atmospheric reentry once the operations are ceased. No systems, components, special maneuvers, or operations are required for post-mission disposal.

The following components will be passivated at end of mission ("EOM"):

- Any <u>battery</u> energy left after EPS cut-off will be used by components onboard until depleted.

- <u>Reaction wheels</u> will be passivated.

The circuits are designed to allow for the disconnection of all solar panel power. In this EOM mode, the battery discharges to the low voltage cutoff within a few days. Once in EOM mode with low battery voltage cutoff, the satellite cannot be recovered.

In addition, the following specific provisions apply:

(A) For geostationary orbit space stations, the statement must disclose the altitude selected for a disposal orbit and the calculations that are used in deriving the disposal altitude.

Not applicable.

(B) For space stations terminating operations in an orbit in or passing through the low-Earth orbit region below 2,000 km altitude, the statement must disclose whether the spacecraft will be disposed of through atmospheric re-entry, specifying if direct retrieval of the spacecraft will be used. The statement must also disclose the expected time in orbit for the space station following the completion of the mission.

Not applicable.

(C) For space stations not covered by either [paragraph (d)(14)(vii)(A)]() or [(B)]() of this section, the statement must indicate whether disposal will involve use of a storage orbit or long-term atmospheric re-entry and rationale for the selected disposal plan.

Not applicable.

(D) For all space stations under [paragraph (d)(14)(vii)(B)]() or [(C)]() of this section, the following additional specific provisions apply:

(1) The statement must include a demonstration that the probability of success of the chosen disposal method will be 0.9 or greater for any individual space station. For space station systems consisting of multiple space stations, the demonstration should include additional information regarding efforts to achieve a higher probability of success, with a goal, for large systems, of a probability of success for any individual space station of 0.99 or better. For space stations under paragraph (d)(14)(vii)(B) of this section ending their mission in or passing through the low-Earth orbit region below 2000 km altitude, successful disposal is defined, for the purposes of this demonstration, as atmospheric re-entry of the spacecraft as soon as practicable, but no later than five years following completion of the mission. For all other space stations under paragraph (d)(14)(vii)(B) and paragraph (d)(14)(vii)(C) of this section, successful disposal will be assessed on a case-by-case basis.

The spacecraft will reenter passively without post-mission disposal operations.

(2) If planned disposal is by atmospheric re-entry, the statement must also include:

(i) A disclosure indicating whether the atmospheric re-entry will be an uncontrolled re-entry or a controlled targeted reentry.

Atmospheric reentry will be uncontrolled.

(ii) An assessment as to whether portions of any individual spacecraft will survive atmospheric re-entry and impact the surface of the Earth with a kinetic energy in excess of 15 joules, and demonstration that the calculated casualty risk for an individual spacecraft using the NASA Debris Assessment Software or a higher fidelity assessment tool is less than 0.0001 (1 in 10,000).

For Spirit-EEL, no spacecraft components are expected to survive uncontrolled reentry with energy of greater than 15J per the required assessment. As a result, the human casualty risk corresponds to 0 and a total debris casualty area of 0.00 m^2.

(E) Applicants for space stations to be used only for commercial remote sensing may, in lieu of submitting detailed post-mission disposal plans to the Commission, certify that they have submitted such plans to the National Oceanic and Atmospheric Administration for review.

Basalt submits this orbital debris mitigation plan for FCC consideration.

(viii) For non-U.S.-licensed space stations, the requirement to describe the design and operational strategies to minimize orbital debris risk can be satisfied by demonstrating that

debris mitigation plans for the space station(s) for which U.S. market access is requested are subject to direct and effective regulatory oversight by the national licensing authority.

Not applicable.

III. NASA Debris Assessment Software Activity Logs

A. Small Object Collision Risk

N/A

B. Large Object Collision Risk

INPUT

Space Structure Name = BSLT-1[6]
Space Structure Type = Payload
Perigee Altitude = 530.000 (km)
Apogee Altitude = 530.000 (km)
Inclination = 97.450 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass Ratio = 0.0149 (m^2/kg)
Start Year = 2025.750 (yr)
Initial Mass = 4.490 (kg)
Final Mass = 4.490 (kg)
Duration = 5.500 (yr)
Station-Kept = False
Abandoned = True
Long-Term Reentry = False

OUTPUT

Collision Probability = 6.3369E-07
Returned Message: Normal Processing
Date Range Message: Normal Date Range
Status = Pass

C. Orbital Lifetime

i. Deployed Configuration

INPUT

Start Year = 2025.750000 (yr)
Perigee Altitude = 530.000000 (km)
Apogee Altitude = 530.000000 (km)

[6] The same inputs apply to BSLT-2 and BSLT-3 given the three satellites are technically identical.

Inclination = 97.450000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.014900 (m^2/kg)

OUTPUT

Orbital Lifetime from Startyr = 5.577117 (yr)
Time Spent in LEO during Lifetime = 5.577117 (yr)
Last year of Propagation = 2031 (yr)
Returned Error Message: Object reentered

ii. Stowed Configuration

INPUT

Start Year = 2025.750000 (yr)
Perigee Altitude = 530.000000 (km)
Apogee Altitude = 530.000000 (km)
Inclination = 97.450000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Area-To-Mass Ratio = 0.010200 (m^2/kg)

OUTPUT

Orbital Lifetime from Startyr = 8.495725 (yr)
Time Spent in LEO during Lifetime = 8.495725 (yr)
Last year of Propagation = 2034 (yr)
Returned Error Message: Object reentered

D. Human Casualty Risk

Return Status : Passed

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

name = BSLT-1[7]
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 4.490000

[7] The same inputs apply to BSLT-2 and BSLT-3 given the three satellites are technically identical.

Thermal Mass = 4.490000
Diameter/Width = 0.110000
Length = 0.366000
Height = 0.110000

name = UHF Antenna
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.045000
Thermal Mass = 0.045000
Diameter/Width = 0.102000
Length = 0.102000
Height = 0.006000

name = Flight Computer
quantity = 1
parent = 1
materialID = 23
type = Box
Aero Mass = 0.094000
Thermal Mass = 0.094000
Diameter/Width = 0.096000
Length = 0.096000
Height = 0.010000

name = Antenna Interface Board
quantity = 1
parent = 1
materialID = 23
type = Box
Aero Mass = 0.094000
Thermal Mass = 0.094000
Diameter/Width = 0.096000
Length = 0.096000
Height = 0.010000

name = UHF Radio
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.100000
Thermal Mass = 0.100000
Diameter/Width = 0.096000

Length = 0.096000
Height = 0.023000

name = S Band Radio
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.200000
Thermal Mass = 0.200000
Diameter/Width = 0.065000
Length = 0.090000
Height = 0.025300

name = GNSS Unit
quantity = 1
parent = 1
materialID = 23
type = Box
Aero Mass = 0.109000
Thermal Mass = 0.109000
Diameter/Width = 0.096000
Length = 0.096000
Height = 0.020100

name = ADCS Unit
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.575000
Thermal Mass = 0.395000
Diameter/Width = 0.090000
Length = 0.090000
Height = 0.053000

name = Reaction Wheels
quantity = 3
parent = 8
materialID = 54
type = Sphere
Aero Mass = 0.060000
Thermal Mass = 0.060000
Diameter/Width = 0.028000

name = EPS

quantity = 1
parent = 1
materialID = 23
type = Box
Aero Mass = 0.230000
Thermal Mass = 0.230000
Diameter/Width = 0.090000
Length = 0.090000
Height = 0.015000

name = Battery
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.692000
Thermal Mass = 0.692000
Diameter/Width = 0.090000
Length = 0.090000
Height = 0.048000

name = Chassis
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 0.746000
Thermal Mass = 0.746000
Diameter/Width = 0.110000
Length = 0.366000
Height = 0.110000

name = Solar Panel
quantity = 1
parent = 1
materialID = 23
type = Box
Aero Mass = 0.360000
Thermal Mass = 0.360000
Diameter/Width = 0.200000
Length = 0.300000
Height = 0.005000

name = Heat Sink
quantity = 3
parent = 1

materialID = 19
type = Box
Aero Mass = 0.415000
Thermal Mass = 0.415000
Diameter/Width = 0.080000
Length = 0.080000
Height = 0.010000

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

name = BSLT-1
Demise Altitude = 77.997550
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Antenna
Demise Altitude = 77.422198
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Flight Computer
Demise Altitude = 76.762660
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Antenna Interface Board
Demise Altitude = 76.762660
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Radio
Demise Altitude = 77.552443
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = S Band Radio
Demise Altitude = 76.935341
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = GNSS Unit
Demise Altitude = 76.723723
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = ADCS Unit
Demise Altitude = 76.594442
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Reaction Wheels
Demise Altitude = 68.766863
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = EPS
Demise Altitude = 74.990549
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Battery
Demise Altitude = 75.483431
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Chassis
Demise Altitude = 77.417754
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Solar Panel
Demise Altitude = 76.819977
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Heat Sink
Demise Altitude = 72.994542
Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****