

Sherpa-FX3 Orbital Debris Assessment Report (ODAR)

This report is presented in compliance with NASA-STD-8719.14B, APPENDIX A.

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This document contains no proprietary, ITAR, or export-controlled information.

**DAS Software Version Used In Analysis: v3.1.0
Report prepared by Mike Coletti, Mission Manager
Analysis prepared by Eric Lund, Lead Systems Engineer**

VERSION APPROVAL and/or FINAL APPROVAL*:

Mike Coletti
Mission Manager
Spaceflight, Inc.

*Approval signatures indicate acceptance of the ODAR-defined risk.

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Self-assessment of the ODAR using the format in Appendix A.2 of NASA-STD- 8719.14:

A self-assessment is provided below in accordance with the assessment format provided in Appendix A.2 of NASA-STD-8719.14B.

Orbital Debris Self-Assessment Report Evaluation: Sherpa-FX3 on December 2021-January 2022 SpaceX Falcon 9 Rideshare Mission

Requirement #	Launch Vehicle				Spacecraft			Comments
	Compliant	Not Compliant	Incomplete	Standard Non-Compliant	Compliant or N/A	Not Compliant	Incomplete	
4.3-1.a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No Debris Released in LEO.
4.3-1.b	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No Debris Released in LEO.
4.3-2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No Debris Released in GEO.
4.4-1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.4-2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.4-3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No planned breakups.
4.4-4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No planned breakups.
4.5-1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.5-2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.6-1(a)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.6-1(b)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.6-1(c)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.6-2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Spacecraft does not go to GEO.
4.6-3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Spacecraft does not go beyond LEO.
4.6-4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.7-1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.8-1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No tethers used.

Assessment Report Format:

ODAR Technical Sections Format Requirements:

As Spaceflight, Inc. is based in the United States (US), and governed by the laws, rules, and regulation of the US; this ODAR follows the format recommended in NASA-STD-8719.14b, Appendix A.1 and includes the content indicated at a minimum in each section 2 through 8 below for the December 2021-January 2022 SpaceX Rideshare Mission. Sections 9 through 14 which apply to the launch vehicle ODAR and are not covered here.

ODAR Section 1: Program Management and Mission Overview

Project Manager: Mike Coletti

Foreign government or space agency participation: No foreign government or space agency participation.

Schedule of upcoming mission milestones:

Launch: December 2021-January 2022

Mission Overview:

The December 2021-January 2022 SpaceX Rideshare Mission (“Transporter-3”) is a commercial rideshare mission, for which the primary objective of Spaceflight Inc., is deploying 8 customer spacecraft into a planned sun-synchronous circular orbit of 525 km with a tolerance of ± 25 km. The launch vehicle will deploy a free flyer spacecraft, called “Sherpa-FX3”, which will deploy additional customer spacecraft within several hours of launch and separation and will carry one hosted payload through de-orbit. (*Each of these satellite customers are responsible for obtaining an FCC or other agency or administration authorization as appropriate and do not constitute debris*). This represents a worst-case scenario and ensures that any changes to the Sherpa-FX3 manifest will be bounded by this ODAR analysis.

Sherpa-FX3 is physically and functionally identical to the Sherpa-FX1 and Sherpa-FX2 vehicles Spaceflight has flown previously.

ODAR Configuration:

ODAR analysis was run for two potential scenarios (Nominal Mission and Failed Mission). The results presented here for the Failed Mission envelope the worst-case scenario and our final mission analyses shall be no worse than these initial baselined numbers. Since the physical architecture layout of the Sherpa vehicle is often not finalized until around Launch – 3months, due to customer remanifest, vehicle optimization, etc., Spaceflight seeks to initially present these worst-case, generalized results for the Sherpa FX-3 vehicle now. Once the physical architecture has been finalized, Spaceflight shall rerun our ODAR analysis and provide an updated ODAR report to the Commission demonstrating that the finalized ODAR shows equal or improved results compared to those baselined in this submission.

The terms *Nominal Mission* and *Failed Mission* are defined as follows:

- *Nominal Mission:* All customer deployments successful.
- *Failed Mission:* All spacecraft deployments unsuccessful, which represents a worst-case scenario.¹

¹ In addition to assuming the highest possible mass, Spaceflight has also assumed the highest target orbit and highest ballistic coefficient throughout the orbit lifetime of the vehicles.

In order to most accurately perform analysis within the constraints of the DAS tool, ODAR analyses contained in this report were run for the scenarios in the following table, showing comparison to the intended mission.

Scenario	DAS Analysis	Mission	Delta between DAS and Mission
Sherpa-FX3 Nominal Mission	525 km operational orbit, no PMD	525 km operational orbit, No PMD	None
Sherpa-FX3 Failed Mission	550 km (highest possible), no PMD	550 km (highest possible), no PMD	None

ODAR Summary:

- No debris released in normal operations;
- No credible scenario for breakups;
- The collision probability with other objects is compliant with NASA standards; and
- The estimated worst-case decay lifetime due to atmospheric drag is under 25 years, through the possible range altitudes and mission cases presented herein, as predicted by DAS 3.1.0.

	Nominal Mission	Failed Mission
Sherpa-FX3	12.9 years	16.0 years

Launch vehicle and launch site: SpaceX Falcon 9, Cape Canaveral Air Force Station, Florida

Proposed launch date: December 2021-January 2022

Mission duration:

Maximum Sherpa-FX3 Nominal Transmitting Operations:

- < 36 hours

Post-Mission Orbit lifetime:

- For a Nominal Mission at 525 km, Sherpa-FX3 has a predicted post-mission orbit lifetime 12.9 years.

Launch and deployment profile, including all parking, transfer, and operational orbits with apogee, perigee, and inclination:

Sherpa-FX3				
	Apogee Altitude	Perigee Altitude	Inclination	Duration
Mission Orbit	525 ± 25 km	525 ± 25 km	97.384 ± 0.1 deg	<1 day
End-of-Life Orbit	525 ± 25 km	525 ± 25 km	97.384 ± 0.1 deg	12.9 years (nominal) 16.0 years (failed, 550 km mission)

ODAR Section 2: Spacecraft Description**Physical description of the spacecraft:**

Sherpa-FX3 is a non-propulsive, free flying spacecraft that is designed to deploy auxiliary spacecraft. Sherpa-FX3 will also carry one (1) hosted payload that will remain on the spacecraft through deorbit.² It is structurally alike, to the previously licensed Sherpa-FX1³ and Sherpa-FX2⁴. The separation system and customer payload layout on Sherpa-FX3 can be variable, depending on the number of microsattellites and CubeSats manifested to the mission. CubeSat and Microsatellite separation systems are interchangeable and can be affixed radially on the body of the Sherpa-FX3 vehicle. A microsatellite, CubeSat dispenser, or other adapter for separation system mounting can be affixed on the outboard end of Sherpa-FX3. Thus, Sherpa-FX3 will deploy customers in the same fashion as the previously licensed Sherpa-FX1 and Sherpa-FX2. For this Mission, the planned configuration has a microsatellite on the outboard end of Sherpa-FX3, with three microsattellites, a 3U dispenser containing 4 sub-3U cubesats, and a hosted payload attached radially on the body of Sherpa-FX3.⁵ The Sherpa-FX3 Mission configuration also includes an S-band receive antenna and an L-band transmitter as part of its avionics.

Sherpa-FX3 will be attached to a single port on a SpaceX-provided payload ring. The SpaceX Falcon 9 will have multiple rings with SpaceX's other customers stacked above and/or below the ring to which Spaceflight's Sherpa-FX3 is attached. Once a separation signal is received by Sherpa-FX3's separation system from SpaceX's Falcon 9 avionics, the Sherpa-FX3 will separate.

Sherpa-FX3 utilizes the R2A-Core system for its primary mission to command the deployment of approximately 8 customer spacecraft into SSO. After Sherpa-FX3's separation from SpaceX's Falcon 9 launch vehicle and a subsequent delay in accordance with SpaceX requirements, once activated, the R2A-Core executes an onboard mission sequence to deploy customer spacecraft. The internal volume of Sherpa-FX3 will contain R2A-Core sequencer and batteries.

The R2A-Core also activates the EyeStar S3 Black Box Radio (provided by NearSpace Launch) and, specifically, the L-band transmitter which sends deployment confirmation telemetry to the Globalstar constellation for relay by commercial Globalstar and NearSpace Launch data services to Spaceflight.

In a case where any combination of spacecraft are unable to make the mission, a non-separating mass model will be either inserted into a locked dispenser door or affixed directly to the Sherpa structure, depending on the missing spacecraft's form factor. These mass models are materially and physically the same as those evaluated in Spaceflight's Sherpa-FX1 submission and therefore have not been included in this new risk analysis. In the Sherpa-FX12STA, examples for a microsat mass model, entire 12U and 6U dispenser mass models, or a single CubeSat mass model within a flight dispenser were all shown to fully demise and not contribute to any human casualty risk. Some customers are responsible for providing their own mass model. If a case arises that a customer mass model will need to be integrated for flight, Spaceflight will re-run DAS analysis incorporating that specific mass model and its corresponding material properties to ensure demise and no worse risk of casualty than what is presented here, before integration onto the Sherpa-FX3 structure.

² There may also be a passively modulated radar reflector to help identify Sherpa sooner among the cluster of objects separated by the launch vehicle. This radar reflector does not transmit or receive any radio frequencies and is simply a component to assist identification and tracking.

³ [SAT-STA-20200728-00089](#) Spaceflight, Inc. Sherpa-FX1 STA.

⁴ [SAT-STA-20210205-00017](#) Spaceflight, Inc. Sherpa-FX2 and Sherpa-LTE1 STA.

⁵ None of the spacecraft to be deployed will themselves deploy additional spacecraft.

Total satellite mass at launch, including all propellants and fluids, potential mass growth and uncertainties:

Sherpa-FX3	280 kg
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Dry mass of satellites at launch, excluding solid rocket motor propellants, but including potential mass growth and uncertainties:

Sherpa-FX3	280 kg
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Dry mass of satellites at end of mission, excluding solid rocket motor propellants:

Sherpa-FX3	130.4 kg
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Description of all propulsion systems (cold gas, mono-propellant, bi-propellant, electric, nuclear):

Sherpa-FX3 has no propulsion.

Identification, including mass and pressure, of all fluids (liquids and gases) planned to be on board and a description of the fluid loading plan or strategies, excluding fluids in sealed heat pipes: N/A

Fluids in Pressurized Batteries: None.

Power System #1: Sherpa-FX3 uses two of the same NiMH battery packs previously used on the Sherpa-FX1 mission.

Description of attitude control system and indication of the normal attitude of the spacecraft with respect to the velocity vector: Sherpa-FX3 does not have attitude control.

Description of any range safety or other pyrotechnic devices: None.

Description of the electrical generation and storage system:

Power System #1: Standard Commercial Off The Shelf (COTS) lithium iron disulfide and nickel-metal hydride battery cells are charged prior to payload integration and provide electrical energy during the primary phase of the mission to separate customer spacecraft. Total energy capacity is ~228 W·hr and the maximum voltage is 36 VDC. These batteries have no ability to recharge once Sherpa-FX3 is in orbit. The electrical load on this circuit has a low-voltage cut-off at ~23 VDC, below which the batteries have <1% energy capacity remaining. These batteries are at the very center of the structure. In the event of an unlikely battery explosion, the structure would contain any fragments or debris.

Identification of any other sources of stored energy not noted above: None.

Identification of any radioactive materials on board: None.

ODAR Section 3: Assessment of Spacecraft Debris Released during Normal Operations

Identification of any object (>1 mm) expected to be released from the spacecraft any time after launch, including object dimensions, mass, and material: There are no intentional releases other than customer spacecraft deployments (see Mission Overview).

Rationale/necessity for release of each object: N/A.

Time of release of each object, relative to launch time: N/A.

Release velocity of each object with respect to spacecraft: N/A.

Expected orbital parameters (apogee, perigee, and inclination) of each object after release:
N/A.

Calculated orbital lifetime of each object, including time spent in Low Earth Orbit (LEO):
N/A.

Assessment of spacecraft compliance with Requirements 4.3-1 and 4.3-2 (per DAS v3.1.0) 4.3-1,

Mission Related Debris Passing Through LEO: COMPLIANT

4.3-2, Mission Related Debris Passing Near GEO: COMPLIANT

ODAR Section 4: Assessment of Spacecraft Intentional Breakups and Potential for Explosions.**Potential causes of spacecraft breakup during deployment and mission operations:**

There is no credible scenario that would result in spacecraft breakup during normal deployment and operations.

Summary of failure modes and effects analyses of all credible failure modes which may lead to an accidental explosion:

An in-mission failure of a battery protection circuit could lead to a short circuit resulting in overheating and a very remote possibility of battery cell explosion. The battery safety systems discussed in the FMEA (see requirement 4.4-1 below) describe the combined faults that must occur for any of seven (7) independent, mutually exclusive failure modes to lead to explosion.

Detailed plan for any designed spacecraft breakup, including explosions and intentional collisions:

There are no planned breakups.

List of components which shall be passivated at End of Mission (EOM) including method of passivation and amount which cannot be passivated:

No components require passivation at EOM.

Rationale for all items which are required to be passivated, but cannot be due to their design:

N/A

Assessment of spacecraft compliance with Requirements 4.4-1 through 4.4-4:

Requirement 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:

For each spacecraft and launch vehicle orbital stage employed for a mission, the program or project shall demonstrate, via failure mode and effects analyses or equivalent analyses, that the integrated probability of explosion for all credible failure modes of each spacecraft and launch vehicle is less than 0.001 (excluding small particle impacts) (Requirement 56449).

Compliance statement:

Required Probability: 0.001.

Expected probability: 0.000.

Supporting Rationale and FMEA details:**Battery explosion:**

Effect: For Sherpa-FX3 all failure modes below might theoretically result in battery explosion with the possibility of orbital debris generation. However, in the unlikely event that a battery cell does explosively rupture, the small size, mass, and potential energy, of the selected space-rated COTS battery cells is such that while the spacecraft could be expected to vent gases, most debris from the battery rupture should be contained within the battery housing / containment device due to the lack of penetration energy.

Probability: Extremely Low. It is believed to be a much less than 0.1% probability that multiple independent (not common mode) faults must occur for each failure mode to cause the ultimate effect (explosion).

Failure mode 1: Internal short circuit.

Mitigation 1: Qualification and acceptance 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.

Combined faults required for realized failure: 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 2: Cells were tested in lab for high load discharge rates in a variety of flight-like configurations to determine like likelihood and impact of an out of control thermal rise in the cell. Cells were also tested in a hot environment to test the upper limit of the cells capability. No failures were seen.

Combined faults required for realized failure: Spacecraft thermal design must be incorrect and external over-current detection and disconnect function must fail to enable this failure mode.

Failure Mode 3: 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 3: This failure mode is negated by a) qualification-tested short 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 proto-qualification and acceptance environmental tests (shock, vibration, thermal cycling, and thermal-vacuum tests).

Combined faults required for realized failure: An external load must fail/short-circuit and external over-current detection and disconnect function failure must all occur to enable this failure mode.

Failure Mode 4: Inoperable vents.

Mitigation 4: Battery vents are not inhibited by the battery holder design or the spacecraft.

Combined effects required for realized failure: The final assembler fails to install proper venting.

Failure Mode 5: Crushing.

Mitigation 5: This mode is negated by spacecraft design. There are no moving parts in the proximity of the batteries.

Combined faults required for realized failure: 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 6: These modes are negated by a) battery holder/case design made of non-conductive plastic, and b) operation in vacuum such that no moisture can affect insulators.

Combined faults required for realized failure: 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 failure modes 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 7: The spacecraft thermal design will negate this possibility. Thermal rise has been analyzed in combination with space environment temperatures showing that batteries do not exceed normal allowable operating temperatures, which are well below temperatures of concern for explosions.

Combined faults required for realized failure: Thermal analysis and thermal design and mission simulations in thermal-vacuum chamber testing and over-current monitoring and control must all fail for this failure mode to occur.

Requirement 4.4-2: Design for passivation after completion of mission operations while in orbit about Earth or the Moon:

Design of all spacecraft and launch vehicle orbital stages shall include the ability to deplete all onboard sources of stored energy and disconnect all energy generation sources when they are no longer required for mission operations or post-mission disposal or control to a level which cannot cause an explosion or deflagration large enough to release orbital debris or break up the spacecraft (Requirement 56450).

Compliance statement:

Sherpa-FX3 is designed such that when mission operations begin, all energy from the secondary batteries will dissipate within 36 hours. The primary batteries will dissipate all energy within 36 hours. Additionally, Sherpa-FX3 battery charge circuits include overcharge protection and active thermal monitoring to limit the risk of battery failure. However, in the unlikely event that a battery cell does explosively rupture, the small size, mass, and potential energy, of these small batteries is such that while the spacecraft could be expected to vent gases, most debris from the battery rupture should be contained within the vessel due to the lack of penetration energy.

Requirement 4.4-3. Limiting the long-term risk to other space systems from planned breakups:

Compliance statement:

This requirement is not applicable. There are no planned breakups.

Requirement 4.4-4: Limiting the short-term risk to other space systems from planned breakups:

Compliance statement:

This requirement is not applicable. There are no planned breakups for Sherpa-FX3.

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

Assessment of spacecraft compliance with Requirements 4.5-1 and 4.5-2 (per DAS v3.1.0, and calculation methods provided in NASA-STD-8719.14b, section 4.5.4):

Requirement 4.5-1:

Assess probability of collision with intact space systems or large debris (>10cm)

Large Object Impact and Debris Generation Probability:

Spacecraft	Nominal Mission	Failed Mission	Status
Sherpa-FX3	0.00001728	0.00005305	PASS

Requirement 4.5-2:

Assess and limit the probability of damage to critical components as a result of impact with small debris.

Spacecraft	Status
Sherpa-FX3	COMPLIANT

Probability of Damage from Small Debris

Sherpa-FX3 does not have the ability to perform a post mission disposal maneuver and is compliant with all orbit lifetime requirements.

Identification of all systems or components required to accomplish any post-mission disposal operation, including passivation and maneuvering:

Sherpa-FX3 batteries will deplete within 36 hours after separation. Sherpa-FX3 will deorbit naturally and rely on atmospheric drag. Sherpa-FX3 does not have propellants or pressure vessels.

Recontact Analysis. Although beyond the scope of a standard orbital debris analysis, Spaceflight has conducted extensive testing and modeling to limit the risk that individual spacecraft that will be deployed on this mission will re-contact with each other after release. That analysis is presented as attachment titled *Sherpa-FX3 Long-Term Recontact Probability* to Spaceflight’s STA application.

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

6.1 Description of spacecraft disposal option selected: Sherpa-FX3 will deorbit naturally by atmospheric re-entry.

6.2 Plan for any spacecraft maneuvers required to accomplish post-mission disposal:

Sherpa-FX3 does not have propulsion or attitude control. There is no plan for post-mission disposal maneuvers.

6.3 Calculation of area-to-mass ratio after post-mission disposal if the controlled reentry option is not selected:**Spacecraft Mass:**

	Nominal Mission	Failed Mission
Sherpa-FX3	130.4 kg	280 kg

Cross-sectional Area: (arithmetic mean for random tumbling attitude)

	Nominal Mission	Failed Mission
Sherpa-FX3	0.6920 m ²	1.3252 m ²

Area to mass ratio: (arithmetic mean for random tumbling attitude)

	Nominal Mission	Failed Mission
Sherpa-FX3	0.005307 m ² /kg	0.004733 m ² /kg

6.4 Assessment of spacecraft compliance with Requirements 4.6-1 through 4.6-5 (per DAS v 3.1.0 and NASA-STD-8719.14 section):

Requirement 4.6-1: Disposal for space structures passing through LEO:

A spacecraft or orbital stage with a perigee altitude below 2000 km shall be disposed of by one of three methods:

(Requirement 56557)

a. Atmospheric reentry option:

- *Leave the space structure in an orbit in which natural forces will lead to atmospheric reentry within 25 years after the completion of mission but no more than 30 years after launch; or*
- *Maneuver the space structure into a controlled de-orbit trajectory as soon as practical after completion of mission.*

b. Storage orbit option: Maneuver the space structure into an orbit with perigee altitude greater than 2000 km and apogee less than GEO - 500 km.

c. Direct retrieval: Retrieve the space structure and remove it from orbit within 10 years after completion of mission.

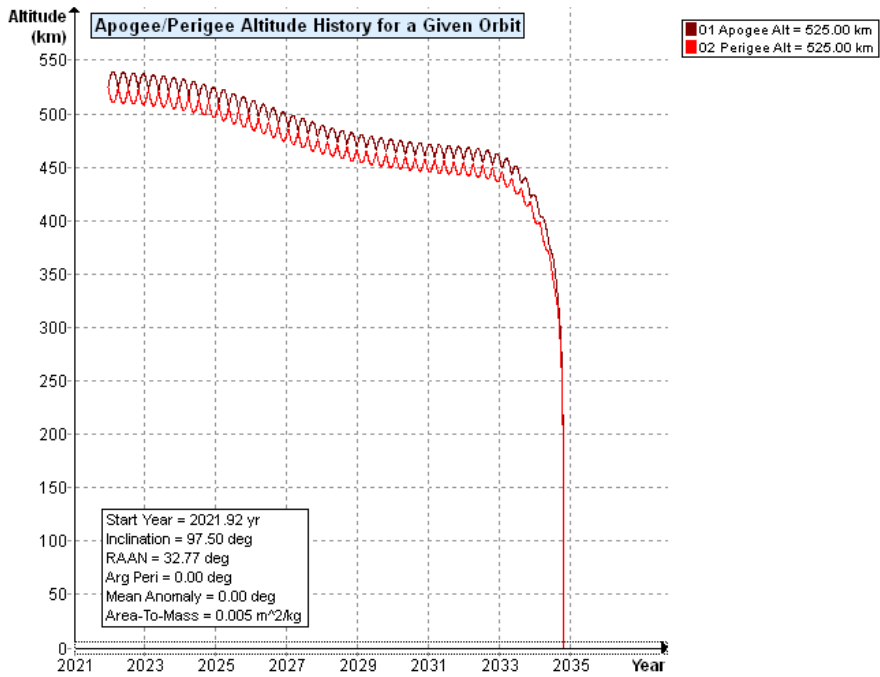


Figure 1 - Sherpa-FX3 (Nominal Mission at 525 km) orbit history

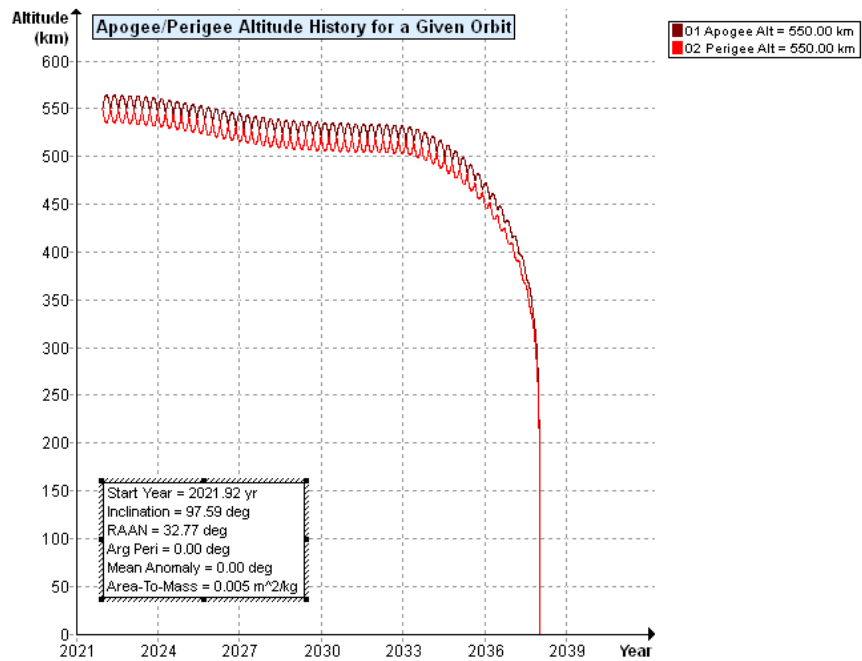


Figure 2 - Sherpa-FX3 (Failed Mission at 550 km) orbit history.

Analysis: Sherpa-FX3 reentry is COMPLIANT using method “a”.

Satellite Name	Sherpa-FX3
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BOL Orbit (Drop off)	550 x 550 km
Operational Orbit	550 x 550 km
EOM Orbit	550 x 550 km
Total Lifetime for Nominal Mission	12.9 years
Total Lifetime if Mission Failure	16 years

Requirement 4.6-2. Disposal for space structures near GEO.

Analysis: Not applicable.

Requirement 4.6-3. Disposal for space structures between LEO and GEO. Analysis: Not applicable.

Requirement 4.6-4. Reliability of Post-mission Disposal Operations

Reliability: Sherpa-FX3 will rely on atmospheric drag to fully de-orbit. Spaceflight shows DAS analysis cases here for: (i) its planned or Nominal Mission (successful deployment of all spacecraft planned to be deployed); and (ii) an off-nominal Mission Failure case, where no spacecraft are deployed. In both cases, DAS returns a total mission lifetime less than 25 years.

Spaceflight shows DAS analysis cases here for: (i) its planned or Nominal Mission (successful deployment of all spacecraft planned to be deployed and successful orbit reduction); (ii) an off-nominal Mission Failure case where no spacecraft are deployed and the electric propulsion system is not commissioned and altitude decays naturally via atmospheric drag. In each case DAS returns a total on-orbit lifetime of 25 years or less.

As with SSO-A, Sherpa-FX1, Sherpa-FX2 and Sherpa-LTE1, Spaceflight has a team of highly qualified engineers, and a well-established process for rideshare missions such as this. Spaceflight finds that an avionics failure in the middle of the separation sequence is highly unlikely and has previously demonstrated flight heritage on the Sherpa-FX1, Sherpa-FX2, and Sherpa-LTE1 missions. If the primary avionics systems were to fail, it will most likely succumb to the launch environment, which occurs prior to any deployments from the Sherpa vehicles resulting in the Mission Failure cases.

Finally, Spaceflight believes a successful mission, “Nominal Mission” case, is most probable. The analysis contained above shows compliance with the applicable FCC regulations and guidelines.

ODAR Section 7: Assessment of Spacecraft Reentry Hazards

Assessment of spacecraft compliance with Requirement 4.7-1:

Requirement 4.7-1: Limit the risk of human casualty:

The potential for human casualty is assumed for any object with an impacting kinetic energy in excess of 15 joules:

a) For uncontrolled reentry, the risk of human casualty from surviving debris shall not exceed 0.0001 (1:10,000) (Requirement 56626).

Summary Analysis Results:

DAS calculates Sherpa-FX3 and its separation systems and subcomponents (listed in further detail in the full DAS results appended to this report) have a 1:100,000,000 risk of human casualty and thus that the Sherpa FX-3 meets the requirement. No components of the Sherpa FX-3 are expected to survive reentry.

For the “Mission Failed” case, as the Sherpa vehicle begins to demise, customer payloads will break free and should demise as described in the ODAR assessments they would have provided during their own licensing efforts. Consistent with Spaceflight’s prior missions, Spaceflight relies upon its customers’ own authorizations for reentry hazards each for their own spacecraft.

Requirements 4.7-1b, and 4.7-1c below are non-applicable requirements because the Sherpa-FX3 Mission does not use controlled reentry.

4.7-1, b) **NOT APPLICABLE.** For controlled reentry, the selected trajectory shall ensure that no surviving debris impact with a kinetic energy greater than 15 joules is closer than 370 km from foreign landmasses, or is within 50 km from the continental U.S., territories of the U.S., and the permanent ice pack of Antarctica (Requirement 56627).

4.7-1 c) **NOT APPLICABLE.** For controlled reentries, the product of the probability of failure of the reentry burn (from Requirement 4.6-4.b) and the risk of human casualty assuming uncontrolled reentry shall not exceed 0.0001 (1:10,000) (Requirement 56628).

ODAR Section 8: Assessment for Tether Missions

Not applicable. There are no tethers in the mission.

Raw DAS Output – Nominal Mission

08 08 2021; 16:35:53PM Activity Log Started
08 08 2021; 16:35:54PM Opened Project C:\Users\elund\Box\Eric Lund\Missions and Programs\SXRS-6\DAS ODAR Rev B Nominal\
08 08 2021; 16:36:09PM Processing Requirement 4.3-1: Return Status : Not Run

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No Project Data Available
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End of Requirement 4.3-1
08 08 2021; 16:36:11PM Processing Requirement 4.3-2: Return Status : Passed

=====
No Project Data Available
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End of Requirement 4.3-2
08 08 2021; 17:24:14PM Processing Requirement 4.5-1: Return Status : Passed

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

****INPUT****

Space Structure Name = Sherpa-FX3
Space Structure Type = Payload
Perigee Altitude = 525.000 (km)
Apogee Altitude = 525.000 (km)
Inclination = 97.498 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass Ratio = 0.0053 (m²/kg)
Start Year = 2021.918 (yr)
Initial Mass = 280.000 (kg)
Final Mass = 130.600 (kg)
Duration = 0.010 (yr)
Station-Kept = False
Abandoned = True

****OUTPUT****

Collision Probability = 1.7282E-05
Returned Message: Normal Processing
Date Range Message: Normal Date Range
Status = Pass

=====

=====
End of Requirement 4.5-1

08 08 2021; 17:24:17PM Project Data Saved To File
08 08 2021; 17:24:23PM Requirement 4.5-2: Compliant

=====
End of Requirement 4.5-2

08 08 2021; 17:24:25PM Processing Requirement 4.6 Return Status : Passed

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

****INPUT****

Space Structure Name = Sherpa-FX3
Space Structure Type = Payload

Perigee Altitude = 525.000000 (km)
Apogee Altitude = 525.000000 (km)
Inclination = 97.498000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.005307 (m^2/kg)
Start Year = 2021.918000 (yr)
Initial Mass = 280.000000 (kg)
Final Mass = 130.600000 (kg)
Duration = 0.010000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 523.377211 (km)
PMD Apogee Altitude = 526.612841 (km)
PMD Inclination = 97.496581 (deg)
PMD RAAN = 3.586296 (deg)
PMD Argument of Perigee = 166.918252 (deg)
PMD Mean Anomaly = 0.000000 (deg)

****OUTPUT****

Suggested Perigee Altitude = 523.377211 (km)
Suggested Apogee Altitude = 526.612841 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2034 (yr)
Requirement = 61
Compliance Status = Pass

=====

=====
End of Requirement 4.6
08 08 2021; 17:24:29PM *****Processing Requirement 4.7-1
Return Status : Passed

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

Item Number = 1

name = Sherpa-FX3
quantity = 1
parent = 0
materialID = 5
type = Cylinder
Aero Mass = 130.600006
Thermal Mass = 130.600006

Diameter/Width = 0.813000

name = FX upper 24-in separation sytem

quantity = 1

parent = 1

materialID = 5

type = Box

Aero Mass = 1.800000

Thermal Mass = 1.800000

Diameter/Width = 0.610000

Length = 0.610000

Height = 0.031000

name = FX Hex Plate

quantity = 2

parent = 1

materialID = 8

type = Box

Aero Mass = 10.000000

Thermal Mass = 10.000000

Diameter/Width = 0.822000

Length = 0.822000

Height = 0.070000

name = FX Interior Wall

quantity = 6

parent = 1

materialID = 8

type = Flat Plate

Aero Mass = 0.830000

Thermal Mass = 0.830000

Diameter/Width = 0.118000

Length = 0.318000

name = FX Corner Brace

quantity = 6

parent = 1

materialID = 8

type = Box

Aero Mass = 1.100000

Thermal Mass = 1.100000

Diameter/Width = 0.151000

Length = 0.178000

Height = 0.151000

name = FX QuadPack adapter plate

quantity = 4

parent = 1

materialID = 8

type = Flat Plate

Aero Mass = 1.727000

Thermal Mass = 1.727000

Diameter/Width = 0.297000

Length = 0.311000

name = MLB adapter plate w spacer

quantity = 3

parent = 1
materialID = 8
type = Box
Aero Mass = 2.840000
Thermal Mass = 2.840000
Diameter/Width = 0.283660
Length = 0.311150
Height = 0.059030

name = FX antenna bracket w antennas
quantity = 2
parent = 1
materialID = 8
type = Box
Aero Mass = 1.428000
Thermal Mass = 1.428000
Diameter/Width = 0.300000
Length = 0.400000
Height = 0.150000

name = FX avionics deck plate
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 3.800000
Thermal Mass = 3.800000
Diameter/Width = 0.544000
Length = 0.544000
Height = 0.022000

name = FX R2A-Core
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 3.100000
Thermal Mass = 3.100000
Diameter/Width = 0.285000
Length = 0.285000
Height = 0.090000

name = FX battery module
quantity = 2
parent = 1
materialID = 5
type = Box
Aero Mass = 2.650000
Thermal Mass = 2.650000
Diameter/Width = 0.100000
Length = 0.139000
Height = 0.100000

name = FX NSL Black Box Std
quantity = 1
parent = 1
materialID = 5

type = Box
Aero Mass = 0.290000
Thermal Mass = 0.290000
Diameter/Width = 0.054000
Length = 0.089000
Height = 0.047000

name = empty 3U CSD
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 3.254000
Thermal Mass = 3.254000
Diameter/Width = 0.157000
Length = 0.402000
Height = 0.134000

name = empty QuadPack
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 7.500000
Thermal Mass = 7.500000
Diameter/Width = 0.250000
Length = 0.440000
Height = 0.250000

name = FX QuadPack Mass Model
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 26.299999
Thermal Mass = 26.299999
Diameter/Width = 0.250000
Length = 0.528000
Height = 0.250000

name = FX PRA
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 8.573400
Thermal Mass = 8.573400
Diameter/Width = 0.626000
Length = 0.626000
Height = 0.070000

name = FX 15-3 Spacer Ring
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 6.663090

Thermal Mass = 6.663090
Diameter/Width = 0.198000
Length = 0.198000
Height = 0.076200

name = FX lower 8-in separation system
quantity = 3
parent = 1
materialID = 5
type = Box
Aero Mass = 1.191000
Thermal Mass = 1.191000
Diameter/Width = 0.117508
Length = 0.117508
Height = 0.045466

name = lower 15-in separation system
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 2.137868
Thermal Mass = 2.137868
Diameter/Width = 0.206154
Length = 0.206154
Height = 0.045466

name = TagSat-3
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 1.920000
Thermal Mass = 1.920000
Diameter/Width = 0.168000
Length = 0.226000
Height = 0.098800

*****OUTPUT*****

Item Number = 1

name = Sherpa-FX3
Demise Altitude = 77.998985
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX upper 24-in separation sytem
Demise Altitude = 75.561157
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX Hex Plate
Demise Altitude = 65.440125
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX Interior Wall
Demise Altitude = 74.333366
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX Corner Brace
Demise Altitude = 75.097557
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX QuadPack adapter plate
Demise Altitude = 73.018227
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = MLB adapter plate w spacer
Demise Altitude = 71.655098
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX antenna bracket w antennas
Demise Altitude = 76.225677
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX avionics deck plate
Demise Altitude = 72.360001
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX R2A-Core
Demise Altitude = 70.643524
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX battery module
Demise Altitude = 67.245712
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX NSL Black Box Std
Demise Altitude = 74.793434
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = empty 3U CSD

Demise Altitude = 72.961761
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = empty QuadPack
Demise Altitude = 70.788521
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX QuadPack Mass Model
Demise Altitude = 58.213013
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX PRA
Demise Altitude = 67.274368
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX 15-3 Spacer Ring
Demise Altitude = 58.463749
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX lower 8-in separation system
Demise Altitude = 69.385178
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = lower 15-in separation system
Demise Altitude = 69.392578
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = TagSat-3
Demise Altitude = 72.550003
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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

08 08 2021; 17:24:29PM Project Data Saved To File

Raw DAS Output – Failed Mission

08 08 2021; 17:26:21PM Activity Log Started
08 08 2021; 17:26:22PM Opened Project C:\Users\elund\Box\Eric Lund\Missions and Programs\SXRS-6\DAS ODAR Rev B DoA\
08 08 2021; 17:26:32PM Processing Requirement 4.3-1: Return Status : Not Run

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

=====
End of Requirement 4.3-1
08 08 2021; 17:26:34PM Processing Requirement 4.3-2: Return Status : Passed

=====
No Project Data Available
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=====
End of Requirement 4.3-2
08 08 2021; 20:34:43PM Processing Requirement 4.5-1: Return Status : Passed

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

****INPUT****

Space Structure Name = Sherpa-FX3_DoA
Space Structure Type = Payload
Perigee Altitude = 550.000 (km)
Apogee Altitude = 550.000 (km)
Inclination = 97.594 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass Ratio = 0.0047 (m²/kg)
Start Year = 2021.918 (yr)
Initial Mass = 280.200 (kg)
Final Mass = 280.200 (kg)
Duration = 0.010 (yr)
Station-Kept = False
Abandoned = True

****OUTPUT****

Collision Probability = 5.3054E-05
Returned Message: Normal Processing
Date Range Message: Normal Date Range
Status = Pass

=====

=====
End of Requirement 4.5-1

08 08 2021; 20:34:46PM Project Data Saved To File
08 08 2021; 20:34:57PM Requirement 4.5-2: Compliant

=====
End of Requirement 4.5-2

08 08 2021; 20:35:00PM Processing Requirement 4.6 Return Status : Passed

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

****INPUT****

Space Structure Name = Sherpa-FX3_DoA
Space Structure Type = Payload

Perigee Altitude = 550.000000 (km)
Apogee Altitude = 550.000000 (km)
Inclination = 97.594000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.004733 (m^2/kg)
Start Year = 2021.918000 (yr)
Initial Mass = 280.200000 (kg)
Final Mass = 280.200000 (kg)
Duration = 0.010000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 548.418795 (km)
PMD Apogee Altitude = 551.568986 (km)
PMD Inclination = 97.592575 (deg)
PMD RAAN = 3.586401 (deg)
PMD Argument of Perigee = 163.426735 (deg)
PMD Mean Anomaly = 0.000000 (deg)

****OUTPUT****

Suggested Perigee Altitude = 548.418795 (km)
Suggested Apogee Altitude = 551.568986 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2037 (yr)
Requirement = 61
Compliance Status = Pass

=====

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08 08 2021; 20:35:06PM *****Processing Requirement 4.7-1
Return Status : Passed

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

Item Number = 1

name = Sherpa-FX3_DoA
quantity = 1
parent = 0
materialID = 5
type = Cylinder
Aero Mass = 280.200012
Thermal Mass = 280.200012

Diameter/Width = 0.813000

name = FX upper 24-in separation sytem
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 1.800000
Thermal Mass = 1.800000
Diameter/Width = 0.610000
Length = 0.610000
Height = 0.031000

name = FX Hex Plate
quantity = 2
parent = 1
materialID = 8
type = Box
Aero Mass = 10.000000
Thermal Mass = 10.000000
Diameter/Width = 0.822000
Length = 0.822000
Height = 0.070000

name = FX Interior Wall
quantity = 6
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.830000
Thermal Mass = 0.830000
Diameter/Width = 0.118000
Length = 0.318000

name = FX Corner Brace
quantity = 6
parent = 1
materialID = 8
type = Box
Aero Mass = 1.100000
Thermal Mass = 1.100000
Diameter/Width = 0.151000
Length = 0.178000
Height = 0.151000

name = FX QuadPack adapter plate
quantity = 4
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 1.727000
Thermal Mass = 1.727000
Diameter/Width = 0.297000
Length = 0.311000

name = MLB adapter plate w spacer
quantity = 3

parent = 1
materialID = 8
type = Box
Aero Mass = 2.840000
Thermal Mass = 2.840000
Diameter/Width = 0.283660
Length = 0.311150
Height = 0.059030

name = FX antenna bracket w antennas
quantity = 2
parent = 1
materialID = 8
type = Box
Aero Mass = 1.428000
Thermal Mass = 1.428000
Diameter/Width = 0.300000
Length = 0.400000
Height = 0.150000

name = FX avionics deck plate
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 3.800000
Thermal Mass = 3.800000
Diameter/Width = 0.544000
Length = 0.544000
Height = 0.022000

name = FX R2A-Core
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 3.100000
Thermal Mass = 3.100000
Diameter/Width = 0.285000
Length = 0.285000
Height = 0.090000

name = FX battery module
quantity = 2
parent = 1
materialID = 5
type = Box
Aero Mass = 2.650000
Thermal Mass = 2.650000
Diameter/Width = 0.100000
Length = 0.139000
Height = 0.100000

name = FX NSL Black Box Std
quantity = 1
parent = 1
materialID = 5

type = Box
Aero Mass = 0.290000
Thermal Mass = 0.290000
Diameter/Width = 0.054000
Length = 0.089000
Height = 0.047000

name = empty 3U CSD
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 3.254000
Thermal Mass = 3.254000
Diameter/Width = 0.157000
Length = 0.402000
Height = 0.134000

name = empty QuadPack
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 7.500000
Thermal Mass = 7.500000
Diameter/Width = 0.250000
Length = 0.440000
Height = 0.250000

name = FX QuadPack Mass Model
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 26.299999
Thermal Mass = 26.299999
Diameter/Width = 0.250000
Length = 0.528000
Height = 0.250000

name = FX PRA
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 8.573400
Thermal Mass = 8.573400
Diameter/Width = 0.626000
Length = 0.626000
Height = 0.070000

name = FX 15-3 Spacer Ring
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 6.663090

Thermal Mass = 6.663090
Diameter/Width = 0.198000
Length = 0.198000
Height = 0.076200

name = FX lower 8-in separation system
quantity = 3
parent = 1
materialID = 5
type = Box
Aero Mass = 1.191000
Thermal Mass = 1.191000
Diameter/Width = 0.117508
Length = 0.117508
Height = 0.045466

name = lower 15-in separation system
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 2.137868
Thermal Mass = 2.137868
Diameter/Width = 0.206154
Length = 0.206154
Height = 0.045466

name = TagSat-3
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 1.920000
Thermal Mass = 1.920000
Diameter/Width = 0.168000
Length = 0.226000
Height = 0.098800

*****OUTPUT*****

Item Number = 1

name = Sherpa-FX3_DoA
Demise Altitude = 77.998436
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX upper 24-in separation sytem
Demise Altitude = 76.194603
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX Hex Plate
Demise Altitude = 69.036789
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX Interior Wall
Demise Altitude = 75.214851
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX Corner Brace
Demise Altitude = 75.815979
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX QuadPack adapter plate
Demise Altitude = 74.178185
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = MLB adapter plate w spacer
Demise Altitude = 73.050003
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX antenna bracket w antennas
Demise Altitude = 76.674156
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX avionics deck plate
Demise Altitude = 73.698349
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX R2A-Core
Demise Altitude = 72.215454
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX battery module
Demise Altitude = 69.358665
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX NSL Black Box Std
Demise Altitude = 75.568245
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = empty 3U CSD

Demise Altitude = 74.131493
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = empty QuadPack
Demise Altitude = 72.353012
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX QuadPack Mass Model
Demise Altitude = 61.644234
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX PRA
Demise Altitude = 69.627716
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX 15-3 Spacer Ring
Demise Altitude = 61.798462
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = FX lower 8-in separation system
Demise Altitude = 71.143936
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = lower 15-in separation system
Demise Altitude = 71.156197
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

name = TagSat-3
Demise Altitude = 73.773125
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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

08 08 2021; 20:35:06PM Project Data Saved To File

END of Sherpa-FX3 Orbital Debris Assessment Report (ODAR)