Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
BlackSky Global LLC	)	File No. ____________________
	)	Call Sign S3032
Application for Modification of License	)	
To Construct, Deploy and Operate an	)	
NGSO Earth Exploration	)	
Satellite Service Constellation System	)	

APPLICATION NARRATIVE

I. Introduction and Overview

BlackSky Global LLC ("BlackSky"), by its attorneys and pursuant to Section 25.117 of the Commission's rules, hereby files a modification of its license ("License") for the construction, deployment and operation of a non-geostationary satellite orbit ("NGSO")-like Earth Exploration Satellite Service constellation.

BlackSky's License covers four satellites. The first two of those satellites, Global-1 and Global-2 are already launched, deployed, and in operation. The modifications in the License parameters and conditions for which authority is herein sought involve the following: (i) a change in the propulsion system to be employed for Global-4 from a butane-based to water-based system;[1] (ii) a correction in the injection altitude for

[1] Other minor changes in equipment model parts (GPS and solar arrays), but not in its function or mode of operation, have also be made. The ODAR further reflects some changes in nomenclature and refined analyses of the mass and dimensions for some other individual components. If and to the extent that prior authorization is also required to make those changes, it is hereby requested.

Global-4-; and (iii) a change in the planned launch vehicle (new launch vehicle still to be determined) and associated initial deployment parameters for Global-3 satellite to a permitted orbital apogee range of 435-585 km with inclinations ranging from 40 degrees to polar sun-synchronous (nominal 98 degrees).

BlackSky respectfully requests expedition of this modification application to allow it to meet the Global-4 launch, currently scheduled to occur in May 2019.[2]

II. Change to Liquid-Based Propulsion System

BlackSky seeks authority to change the propulsion system for the Global-4 satellite from its currently employed butane-based system to a water-based system. The new water-based system offers better propulsion capability and easier range safety compliance than the previous system. As reflected in that Report, Global-4 remains compliant with all NASA DAS standards. As demonstrated in the attached ODAR, there would be no risk of hazardous persistent liquid droplets from the water-based system. With regard to heritage and testing, the water-based propulsion system to be employed is based on existing propulsion systems manufactured by the same vendor, Deep Space Industries, now Bradford Space, Inc., that have previously been authorized by the Commission and are on-orbit today. Of the three primary components of the

[2] BlackSky regrets not notifying the Commission, not filing this modification application sooner. While the need to change from the launch vehicle (PSLV) originally scheduled for Global-3 and BlackSky's realization of the discrepancy between the orbital injection altitude originally requested/licensed for the Rocket Lab launch and that now planned for Rocket Lab are very recent events, the decision to change the propulsion system for Global-4 was made on October 9, 2018 but was not brought to the Commission's attention until far more recently.

system, the thruster and electronics are unchanged from the existing systems on-orbit today, the only change from existing components is an increase in the capacity of the propulsion tanks. As described in greater detail in the ODAR, to ensure that the new tanks are suitable for use in space, the entire propulsion system underwent a rigorous qualification test campaign which subjected it to environments more extreme than will exist during launch or use in space.

III. Change in Injection Altitude for the Global-4 Launch

By this Application, BlackSky seeks to correct the injection altitude for its Global-4 launch from a previously stated 475 km to 450 km, allowing also for a tolerance of +/- 15 km, lowering the bottom end of the injection altitude stated in BlackSky's License from 460 to 435 km. BlackSky notes that in its original application, it calculated PFD for a worst case minimum altitude for the Global 1-4 satellites of 400 km in the event that the altitude of its satellites were to lower over time, noting that is the lowest possible operating altitude of the Global satellites.[3] That minimum worst case operating altitude has not changed, nor has the interference potential of the Global satellites, by reducing their injection range. In other respects, due to the limitations of the Schedule S form to a single altitude per satellite, the Schedule S for Global-4 is updated to show the planned insertion altitude of 450 km.

[3] *BlackSky Global LLC, Application for Authority to Deploy and Operate an NGSO Earth Exploration Satellite Service Constellation System*, FCC File No. SAT-LOA- 20180320-00023, Exhibit 1 Narrative at 9 (2018) ("Original Application").

IV. Flexibility to Allow for New Launch Vehicle/Parameters for Global-3.

BlackSky recently learned that the orbital parameters for the PSLV launch that had been planned for Global-3 have changed. Because the new parameters of that launch are not compatible with BlackSky's mission, BlackSky will need to secure a new launch vehicle for Global-3. To allow BlackSky somewhat greater flexibility in selecting such a launch, it requests a change in its range of initial deployment to a permitted orbital apogee range of 435-585 km with inclinations ranging from 40 degrees to polar sun-synchronous (nominal 98 degrees).

As the launch and thus the orbital parameters for the launch of Global-3 is still to be determined, BlackSky is unable to complete all of the detail normally required for the completion of Schedule S to this modification application. BlackSky urges that the Schedule S information provided in its original application[4] and that shown here for the revised parameters for Global-4 are sufficiently representative of the requested orbital range for which authority is requested for Global-3. If and to the extent required, BlackSky requests a waiver of Schedule S requirements for Global-3.

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[4] The data that is contained in the Schedule S that accompanies this Application reflects that which was previously submitted by BlackSky in its original application for Globals 1-4, other than the changes to Global-4 altitude and addition of a Guam earth station as described in this Narrative. Owing to the limitations of the Schedule S form, orbital plane information for Global-3 has been left unchanged as BlackSky was unable to enter range information or "TBD" for parameters for the orbit of that satellite that are still to be determined due to the cancellation of the PSLV mission which was intended to launch the satellite.

V. Earth Stations

BlackSky's original application identified two earth stations to be employed with its constellation at North Pole, Alaska, and Awarua Plains, New Zealand. BlackSky subsequently identified to the Commission to additional earth stations at Svalbard, Norway and Usingen, Germany.[5] There is currently a pending application by a BlackSky contractor, Atlas Space Operations, Inc., for an earth station, for which BlackSky plans to employ services from for its constellation.[6] While for completeness of this Application, BlackSky notes this Guam station, it understands that the station may not be put into operation by Atlas until authorized by the Commission and further that, even when authorized for operation, in accordance with condition 7 of BlackSky's License, BlackSky will not be permitted to transmit remote-sensing data in the 8025-8400 MHz frequency band until that station has been coordinated with NASA, a process that is still ongoing.

VI. Orbital Debris Assessment Report

A new ODAR for Global-4 is attached hereto as Exhibit A. For reference, a redlined version of that ODAR from the ODAR submitted with BlackSky's original

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[5] See *Update to Original Application Regarding Planned Earth Stations*, FCC File No. SAT-LOA-20180320-00023, filed June 7, 2018. *See also Letter from Henry Goldberg to Marlene H. Dortch re FCC File No. SAT-LOA-20180320-00023* providing a list of NASA coordinated earth stations (October 24, 2018).

[6] *See Public Notice, Satellite Radio Applications Accepted for Filing*, ATLAS Space Operations, Inc., Application for Authority to operate a Fixed Earth Station in the Earth Exploration Service, Call sign E190037, FCC File No. SES-LIC-20181224-03650, Report No. SES-02135 (released Feb 13, 2019).

application for its License is also provided as Exhibit B. Because the exact launch parameters for Global-3 are still to be determined, BlackSky is not in a position to update the ODAR from that launch from the parameters for Global 3 that were stated in its original application. Given that Global-3 is the same satellite design as Global-1 and Global-2, including the utilization of the same butane-based propulsion system that is operational on those two satellites, and will be injected into launch to an altitude that is within the range that is already reflected on the License or sought to be reduced herein for Global-4 with ODAR analyses presented at various orbital injection altitudes at the top, bottom, and with the 435-585 orbital range, BlackSky urges that this should be sufficient detail to allow the grant of this modification for Global-3. In any event, given the impending Global-4 launch, BlackSky urges that such part of this application as relates to the modification of Global-4 be processed, if determined to be necessary holding in abeyance that part of this application that relates to Global-3 until more exact launch parameters are known.

VII. Conclusion

In view of the foregoing, grant of BlackSky's Application for Modification of its License is in the public interest, and it is respectfully requested that the Commission grant the application expeditiously.

Respectfully submitted,

Henry Goldberg

Henry Goldberg
Jonathan L. Wiener
GOLDBERG, GODLES, WIENER
& WRIGHT, LLP
1025 Connecticut Ave, N.W., Suite 1000
Washington, DC 20036
(202) 429-4900

March 14, 2019

ATTACHMENT A

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application and associated attachments, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this Application and that it is complete and accurate to the best of my knowledge and belief.

/s/______________________
Nick Merski
VP, Space Operations

ATTACHMENT B

CERTIFICATION AS TO CHANGES FROM

Pursuant to Section 25.117(c) of the Commission's rules, I hereby certify that, except as stated in the attached application and associated Orbital Debris Assessment Report and Schedule S, there would be no changes in the operating parameters previously submitted to the Commission in connection with BlackSky's existing License and its licensed conditions.

/s/_______________________
Nick Merski
VP, Space Operations

EXHIBIT A

ORBITAL DEBRIS MITIGATION

BlackSky Global
Global-4 Satellite
Orbital Debris Assessment Report (ODAR) –

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

Report Version: B(R3) March 2019

Revision history:

Version	**Date**	**Author**	**Description**
B(R) – Annotated	02/08/2019	Miles Atherly, Katie Todd	Updated to reflect Global-4 propulsion system change. Highlighted additional updates in the document referencing the new propulsion system.
B(R1) Annotated	02/13/2019	Kevin Brown, Kristina Hloptsidis	Updated to add additional detail regarding propulsion system and heritage
B(R1) Annotated	3/5/19	Katie Todd	Updated for launch altitude change. Nominal 450 km.

Document Data is Not Restricted.

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

DAS Software Version Used In Analysis: v2.0.2

DAS Solar flux file Used: Released 18 December 2018

Table Contents

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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-8719.14.

Orbital Debris Self-Assessment Report Evaluation: Global-4 Satellite

Requirement #	Launch Vehicle				Spacecraft			Comments
	Compliant	Not Compliant	Incomplete	Standard Non-Compliant	Compliant or N/A	Not Compliant	Incomplete	
4.3-1.a	☐	☐	☐	☐	☒	☐	☐	No Debris Released in LEO.
4.3-1.b	☐	☐	☐	☐	☒	☐	☐	No Debris Released in LEO.
4.3-2	☐	☐	☐	☐	☒	☐	☐	No Debris Released in GEO.
4.4-1	☐	☐	☐	☐	☒	☐	☐	Not applicable.
4.4-2	☐	☐	☐	☐	☒	☐	☐	Propulsion tank containing water will be depleted during operations
4.4-3	☐	☐	☐	☐	☒	☐	☐	No planned breakups.
4.4-4	☐	☐	☐	☐	☒	☐	☐	No planned breakups.
4.5-1	☐	☐	☐	☐	☒	☐	☐	Collision probability 0.000091 - 0.000058
4.5-2	☐	☐	☐	☐	☒	☐	☐	Not applicable.
4.6-1(a)	☐	☐	☐	☐	☒	☐	☐	Natural forces cause atmospheric reentry
4.6-1(b)	☐	☐	☐	☐	☒	☐	☐	Not applicable.
4.6-1(c)	☐	☐	☐	☐	☒	☐	☐	Not applicable.
4.6-2	☐	☐	☐	☐	☒	☐	☐	Spacecraft does not go to GEO.
4.6-3	☐	☐	☐	☐	☒	☐	☐	Spacecraft does not go beyond LEO.
4.6-4	☐	☐	☐	☐	☒	☐	☐	Requirements 4.6-1 through 4.6-3 are met
4.7-1	☐	☐	☐	☐	☒	☐	☐	DAS reports human casualty probability < 1:10,000
4.8-1					☒	☐	☐	No tethers used.

Assessment Report Format:

ODAR Technical Sections Format Requirements:

BlackSky Global LLC ("BlackSky") is a U.S. company; this ODAR, for BlackSky's Global-4 satellite, follows the format recommended in NASA- STD-8719.14, Appendix A.1 and includes the content indicated at a minimum in each section 2 through 8 below. Sections 9 through 14 apply to the launch vehicles ODAR and are not covered here.

All files created from the DAS 2.0.2 software and calculation files are located on windchill.

Windchill Link (This is a BlackSky internal reference)

ODAR Section 1: Program Management and Mission Overview

Project Manager: Katie Todd

Foreign government or space agency participation: none

Schedule of upcoming mission milestones:

Satellite	Flight Readiness Review	Launch
Global-4	1 month prior to launch	May 2019

Table 1: Mission Milestones

Mission Overview:
Global-1, 2, 3, and 4 are commercial Earth observation satellites. These are the first of many satellites planned for BlackSky's earth-observing constellation. This ODAR covers the Global-4 satellite only as it has had a design change. The design change on Global-4 consists of the removal of the butane-based propulsion system and a replacement with a water-based propulsion system. The new water-based system offers better propulsion capability and easier range safety compliance than the previous system. The design files and DAS inputs were updated for the Global-4 design update, and the results of the DAS assessments are presented in this report.

The Global-4 propulsion system propellant is liquid water and the pressurant is two-phase (both liquid and vapor) FE-36. There would be no risk of hazardous persistent liquid droplets. The liquid water propellant has a low but non-zero vapor-pressure. When liquid water is exposed to vacuum it will immediately evaporate and form small ice crystals. Once the ice crystals are exposed to sunlight they will sublimate into vapor and disperse, therefore no droplets will remain. This is observed on the space station when they occasionally eject waste water. The FE-36 pressurant has a relatively high vapor-pressure (39.5 psia at 25degC) and a freezing point of -103degC. Therefore, it will evaporate rapidly when exposed to vacuum and it will not form droplets.

The Global-4 propulsion system is a derivative of existing propulsion systems manufactured by the same vendor, Deep Space Industries, now Bradford Space, that have been authorized by the Commission and are on-orbit today.[1] The propulsion system was modified from existing systems to increase the capacity of the propellant tanks. The thruster and electronics are unchanged from the existing systems on-orbit today. To ensure that the new tanks are suitable for use in space, the entire propulsion system underwent a rigorous qualification test campaign which subjected it to environments more extreme than it will see during launch or use in space. The testing included extreme vibration, quasi-static (g-loading), and thermal environments. In addition to these environments, the new tanks were also destructively burst-tested to demonstrate that they have much more strength than required to contain the propellant and pressurant. The propulsion system passed all of these tests and has been qualified for use in space.

Global-4 is launching in 2019 (see table 1 above). Global-4 will be launched into a 45-degree orbit, with more detail shown in Table 3 below. The planned insertion altitude is 450 km circular. The tolerance on the insertion is +/- 15 km, thus the insertion could be between 435 km and 465 km circular. The planned mission duration for Global-4 is 36 months (3 years). At the end of its mission, the satellite will release any remaining propellant (which is expected to be depleted during operations) and rely on atmospheric drag to fully deorbit the spacecraft.

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 nominal decay lifetime due to atmospheric drag is under 25 years following operations (a range of 5.8-6.5 years including 3 years of operations, as calculated by DAS 2.0.2).

Launch vehicles and launch sites:

Project	Launch Vehicle	Launch location
Global-4	**Rocket Lab Electron**	**Mahia Peninsula, New Zealand**

Table 2: Launch Vehicles and Launch Sites

Mission duration: Maximum Nominal Operations: 36 months (3 years)

Post-Operations Orbit lifetime: See table 5 in section 6.4

Constellation Launch and deployment profile:

Project	Altitude	Inclination	LTDN or LTAN	Comments
Global-4	450 km circular nominal, +/- 15 km	45°	Not applicable	RAAN will vary over time; precessing orbit

Table 3: Orbit profiles

[1] [placeholder to site to Hawkeye experimental grant ,application (description of propulsion system on page 5 of ODAR) and Exhibit 2 (Technical Information), pages 1 and 6]

ODAR Section 2: Spacecraft Description

Physical description of the spacecraft:

Global-4 has a launch mass of 55.6 kg (fly away mass). Basic physical dimensions are 55 cm x 67 cm x 86 cm. A CAD model of the spacecraft is shown in Figure 1

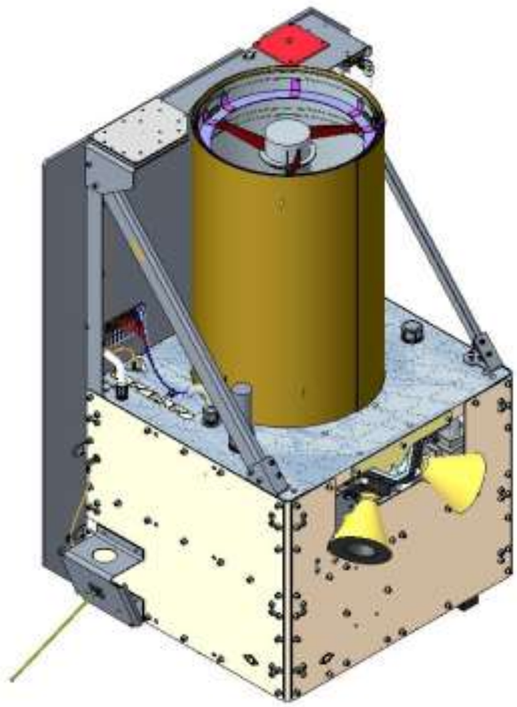

Figure 1. CAD model of the Global-4 spacecraft.

Each Global satellite's load bearing structure is comprised of three 45 cm x 50 cm skeleton deck plates, radiating side plates, and a vertical mounted 66.5cm x 86 cm side solar panel connected with struts. The Global satellites maintain 3-axis attitude control. Attitude knowledge is provided primarily by two orthogonally mounted star trackers. Attitude actuators include four reaction wheels and three orthogonal magnetorquers.

Total satellite mass at launch, including all propellants and fluids: 55.6 kg.

Dry mass of satellites at launch, excluding all propellant and pressurants: 51.1kg

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

Global-4 contains a single propulsion system with a single thruster.

This system uses electrically warmed distilled water as the working fluid and FE-36 as the pressurant. The water is warmed to several hundred degrees Celsius via an electrically heated superheater just before exiting the nozzle. Propulsion is not required to deorbit the satellite, but is part of the satellite to allow for orbit phasing and minor orbit adjustments.

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: 4.4 kg of water and 146g of FE-36 at maximum expected operating pressure (MEOP) of 63.5 psia. Fluid is loaded through independent, electrically actuated fill and drain valves.

Fluids in Pressurized Batteries: None. Global-4 uses two unpressurized standard COTS Lithium-Ion batteries. Each battery has a height of 98mm, a width of 96mm, a length of 176mm, and a mass of 1.6 kg.

Description of attitude control system and indication of the normal attitude of the spacecraft with respect to the velocity vector:

The long axis of the spacecraft can be oriented parallel to the nadir vector during imaging, but the satellite will typically be oriented in a sun-pointing attitude. For the purposes of orbital debris assessment, the smallest (worst-case for orbital lifetime) cross-sectional area is used, meaning that a face of 55 x 55 cm is in the velocity direction (the actual area of the deck plates are 45 x 50 cm, but there are some protrusions from the plates, such as the star trackers, so 55 x 55 cm is used). This results in a cross-section area of $0.3025 m^2$. The cross sectional area in a nadir-pointing configuration would be between $0.47\ m^2$ and $0.57\ m^2$.

Description of any range safety or other pyrotechnic devices: No pyrotechnic devices are used.

Description of the electrical generation and storage system: Standard COTS Lithium-Ion battery cells are charged before payload integration and provide electrical energy during the mission. The cells are recharged by solar cells mounted on the solar arrays. The battery cell protection circuit manages the charging cycle.

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.

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 v2.0.2)

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:

In-mission failure of a battery cell 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.

In addition to the battery protection mentioned about, the Global-4 battery unit features two temperature sensors which monitor battery cells for high temperatures.

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:

It is expected that all propellant (water) in the propulsion system will be consumed by EOM. In the event that it is not, it will be released (used to lower the orbit as much as possible) before EOM. After release of water at EOM, all pressurant will be exhausted through the fill/drain valve. In the event of a system failure that prevents release of all propellant, it has no detrimental impact; the orbital lifetime predictions assume the worst-case scenario that propulsion is not used to lower the orbit, and the water and pressurant do not pose a risk if not passivated.

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

Global-4's satellite battery charge circuits include overcharge protection and a parallel design 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.

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. (for the full range 435-465 km)

Supporting Rationale and FMEA details:

Battery explosion:

Effect: 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 COTS 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.
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.

*Combined faults required for realized failure: S*pacecraft 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:
Global-4's battery charge circuits include overcharge protection and a parallel design 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.

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 v2.0.2,

and calculation methods provided in NASA-STD-8719.14, section 4.5.4):

Requirement 4.5-1: Limiting debris generated by collisions with large objects when operating in Earth orbit:
For each spacecraft and launch vehicle orbital stage in or passing through LEO, the program or project shall demonstrate that, during the orbital lifetime of each spacecraft and orbital stage, the probability of accidental collision with space objects larger than 10 cm in diameter is less than 0.001 (Requirement 56506).

Large Object Impact and Debris Generation Probability:

Satellite	Collision Probability	Compliance status
Global-4	0.000091 with 465 km insertion 0.000058 with 435 km insertion	COMPLIANT

Table 4: Large Debris Generation

Requirement 4.5-2: Limiting debris generated by collisions with small objects when operating in Earth or lunar orbit**:**
For each spacecraft, the program or project shall demonstrate that, during the mission of the spacecraft, the probability of accidental collision with orbital debris and meteoroids sufficient to prevent compliance with the applicable post mission disposal requirements is less than 0.01 (Requirement 56507).

Small Object Impact and Debris Generation Probability:
Collision Probability: not applicable; COMPLIANT.

The satellite orbits decay naturally; no propulsion is required for post-mission disposal. Thus there are no parts of the satellite that are critical to be in compliance with post-mission disposal requirements.

Identification of all systems or components required to accomplish any post mission disposal operation, including passivation and maneuvering:
No systems or components are required. The orbit for Global-4 naturally decays with no maneuvering required.

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

6.1 **Description of spacecraft disposal option selected:** After completing its planned operations, the satellites will deorbit naturally by atmospheric re-entry. At the end of each of the Global satellite's operational life (i.e. at EOM) the attitude control system will stop counteracting the aerodynamic disturbance torques. This will result in the satellite gradually assuming a dynamically stable configuration. For atmospheric drag / re-entry calculations in DAS, the minimum plausible cross-section drag area of 55 x 55 cm was assumed. This is conservative because it represents the minimum cross section possible and ignores the fact that the satellite may be in other orientations after the end of the mission.

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

No maneuvers are required following normal operations.

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

Spacecraft Mass (EOL): 51.0 kg

Cross-sectional Area: 0.3025 m^2

Area to mass ratio: 0.0059 m^2/kg

6.4 Assessment of spacecraft compliance with Requirements 4.6-1 through 4.6-5 (per DAS v 2.0.2 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.

The analysis of this requirement for each satellite is shown below.

Satellite Name	Operational Orbit	Post-ops Life	Total Lifetime
Global-4	450 km circular nominal, +/- 15 km	3.5 years from 465 km 2.8 years from 435 km	6.5 years from 465 km 5.8 years from 435km

Table 5: Lifetimes

Altitude history versus time was analyzed for Global-4 and is shown on the following page. Figure 2 shows the altitude of the satellite assuming no propulsion system is used to maintain the altitude, and the orbit decay begins immediate after launch in May 2019. Figure 3 shows the altitude of the satellite assuming propulsion is used to maintain the orbit at from 465 km for 3 years during the operating life of the satellite (worst-case insertion orbit). Following this, the satellite orbit is assumed to decay from drag, starting at an altitude of 450 km in May 2022.

Global-4 Altitude history over time – no propulsion:

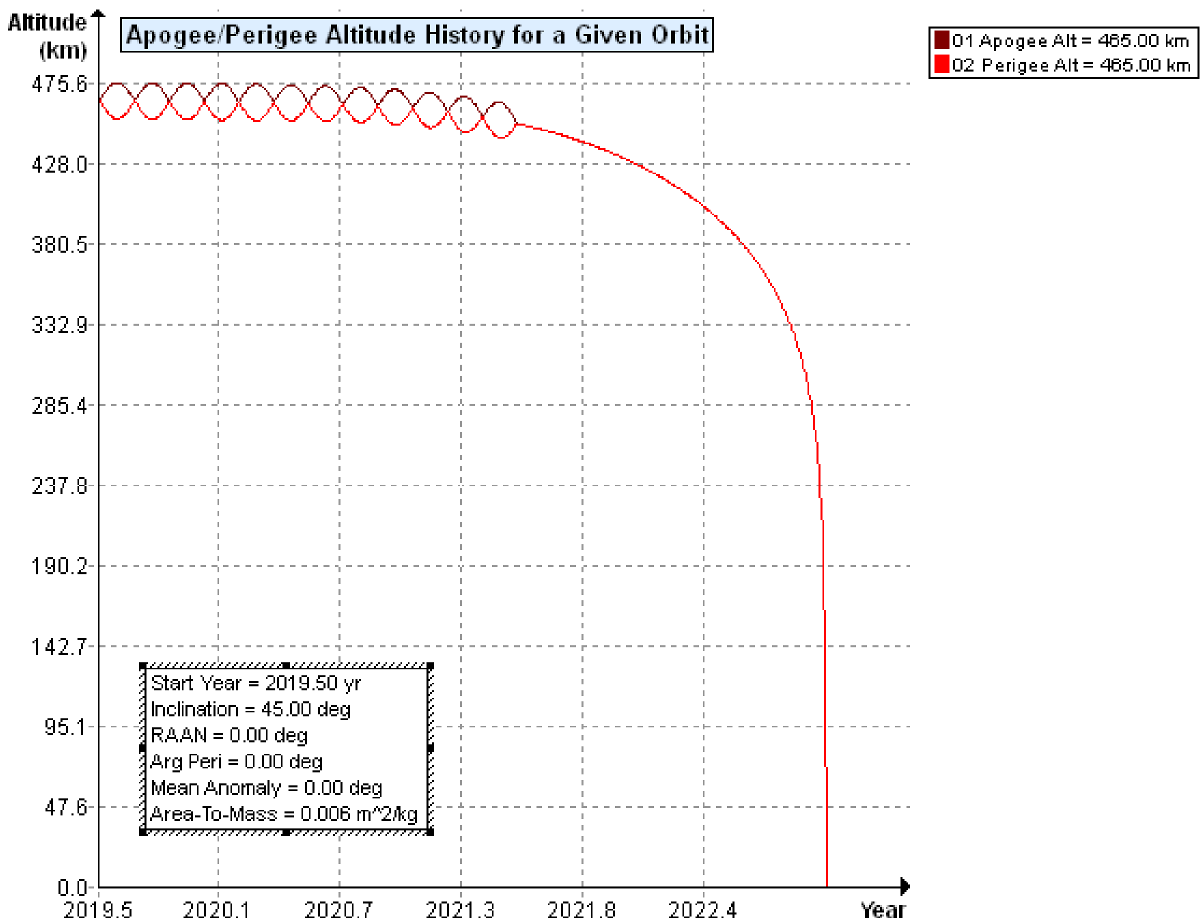

Figure 2: Global-4 Apogee/Perigee Altitude History for a Given Orbit – No propulsion

Analysis: The Global-4 satellite reentry is COMPLIANT using method "a: Atmospheric reentry option".

Global-4 Altitude history over time- propulsion used

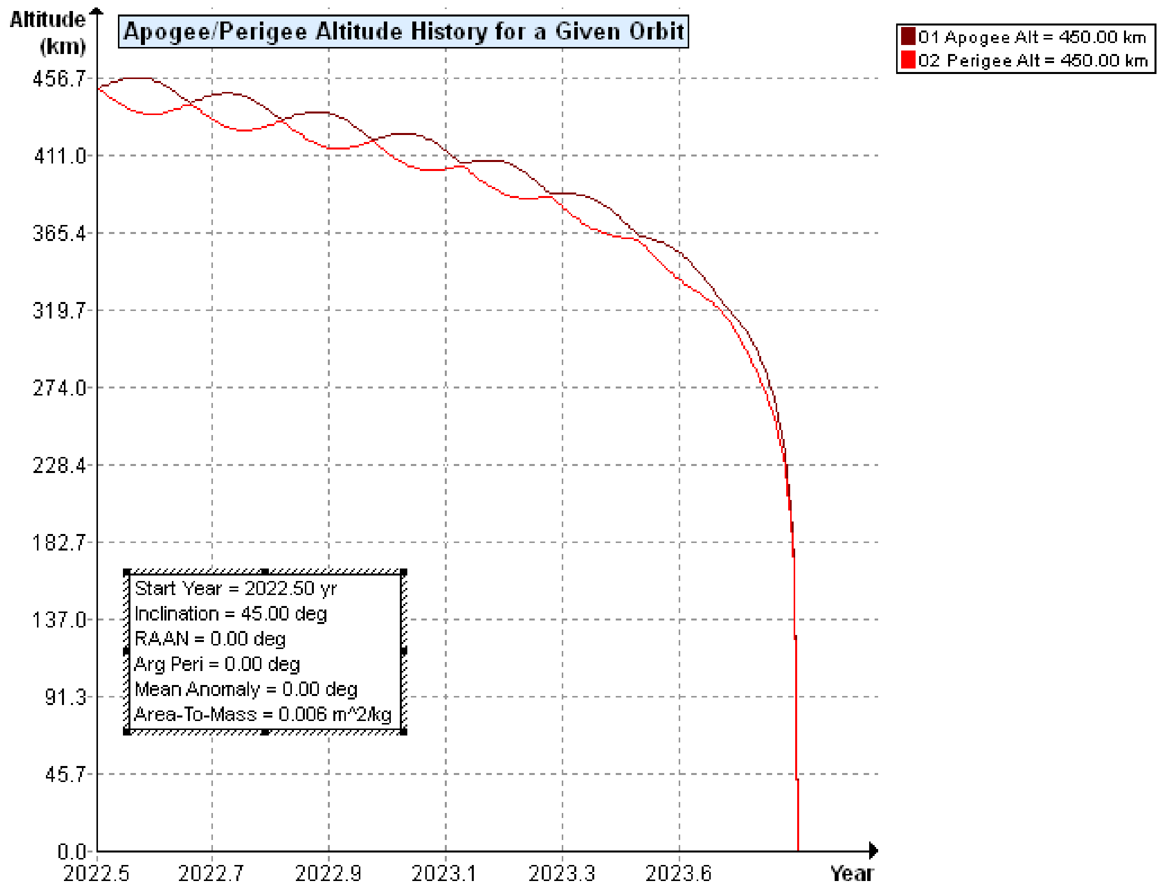

Figure 3: Global-4 Apogee/Perigee Altitude History for a Given Orbit – Propulsion used to maintain orbit at 450 km for 3 years

Analysis: The Global-4 satellite reentry is COMPLIANT using method "a: Atmospheric reentry option".

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

Analysis: The minimum drag configuration is the aerodynamically stable state, and provides the worst-case re-entry time. This minimum drag configuration was assumed for atmospheric re-entry analysis.

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 v2.0.2 reports that each Global satellite is compliant with the requirement. The total risk of human casualty for the spacecraft is given in the table below. According to DAS calculations, there is a low probability that some spacecraft components may reach the ground (see DAS input data below for input parameters). However, the DAS software does not currently allow explicit modeling of the specific geometries for these components, so these numbers are expected to be larger than anticipated due to conservatism in the inputs provided to DAS.

Satellite	Risk of Human Casualty	Compliance status
Global-4	1:13,200 from 465 km insertion. 1:13,300 from 435 km insertion	COMPLIANT

Table 6. Casualty risk from re-entry debris.

Below is a full output from the DAS software for Global-4

Analysis (per DAS v2.0.2):

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

INPUT

Space Structure Name = Global-4
Space Structure Type = Payload
Perigee Altitude = 465.000000 (km)
Apogee Altitude = 465.000000 (km)
Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.005900 (m^2/kg)
Start Year = 2019.500000 (yr)
Initial Mass = 55.400000 (kg)
Final Mass = 51.000000 (kg)
Duration = 3.000000 (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 ===============
03 05 2019; 21:02:29PM   Requirement 4.5-2: Compliant

==
Spacecraft = Global-4
Critical Surface = FC+X
==

INPUT

Apogee Altitude = 465.000000 (km)
Perigee Altitude = 465.000000 (km)
Orbital Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.005900 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = No
Start Year = 2019.500000 (yr)
Duration = 3.000000 (yr)
Orientation = Random Tumbling
CS Areal Density = 15.624019 (g/cm^2)
CS Surface Area = 0.025474 (m^2)
Vector = (0.000000 (u), 0.000000 (v), 0.000000 (w))
CS Pressurized = No
Outer Wall 1   Density: 0.427403 (g/cm^2) Separation: 6.990000 (cm)

OUTPUT

Probabilty of Penitration = 0.000000
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==

Spacecraft = Global-4
Critical Surface = FC+Y
==

INPUT

Apogee Altitude = 465.000000 (km)
Perigee Altitude = 465.000000 (km)
Orbital Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.005900 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = No
Start Year = 2019.500000 (yr)
Duration = 3.000000 (yr)
Orientation = Random Tumbling
CS Areal Density = 28.141687 (g/cm^2)
CS Surface Area = 0.014143 (m^2)
Vector = (0.000000 (u), 0.000000 (v), 0.000000 (w))
CS Pressurized = No
Outer Wall 1 Density: 0.383772 (g/cm^2) Separation: 5.080000 (cm)

OUTPUT

Probabilty of Penitration = 0.000000
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==
Spacecraft = Global-4
Critical Surface = Battery+X
==

INPUT

Apogee Altitude = 465.000000 (km)
Perigee Altitude = 465.000000 (km)
Orbital Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.005900 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = No
Start Year = 2019.500000 (yr)
Duration = 3.000000 (yr)
Orientation = Random Tumbling
CS Areal Density = 9.469697 (g/cm^2)

CS Surface Area = 0.016896 (m^2)
Vector = (0.000000 (u), 0.000000 (v), 0.000000 (w))
CS Pressurized = No
Outer Wall 1 Density: 0.427403 (g/cm^2) Separation: 1.790000 (cm)

OUTPUT

Probability of Penitration = 0.000000
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

===
Spacecraft = Global-4
Critical Surface = Battery+Y
===

INPUT

Apogee Altitude = 465.000000 (km)
Perigee Altitude = 465.000000 (km)
Orbital Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.005900 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = No
Start Year = 2019.500000 (yr)
Duration = 3.000000 (yr)
Orientation = Random Tumbling
CS Areal Density = 17.006803 (g/cm^2)
CS Surface Area = 0.009408 (m^2)
Vector = (0.000000 (u), 0.000000 (v), 0.000000 (w))
CS Pressurized = No
Outer Wall 1 Density: 0.383772 (g/cm^2) Separation: 2.800000 (cm)

OUTPUT

Probability of Penitration = 0.000000
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

===
Spacecraft = Global-4
Critical Surface = Tank+Y
===

INPUT

Apogee Altitude = 465.000000 (km)
Perigee Altitude = 465.000000 (km)

Orbital Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.005900 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = No
Start Year = 2019.500000 (yr)
Duration = 3.000000 (yr)
Orientation = Random Tumbling
CS Areal Density = 3.952611 (g/cm^2)
CS Surface Area = 0.016926 (m^2)
Vector = (0.000000 (u), 0.000000 (v), 0.000000 (w))
CS Pressurized = Yes
Outer Wall 1   Density: 0.676247 (g/cm^2) Separation: 9.320000 (cm)

OUTPUT

Probability of Penitration = 0.000001
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

===
Spacecraft = Global-4
Critical Surface = Tank+X
===

INPUT

Apogee Altitude = 465.000000 (km)
Perigee Altitude = 465.000000 (km)
Orbital Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.005900 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = No
Start Year = 2019.500000 (yr)
Duration = 3.000000 (yr)
Orientation = Random Tumbling
CS Areal Density = 1.091093 (g/cm^2)
CS Surface Area = 0.061315 (m^2)
Vector = (0.000000 (u), 0.000000 (v), 0.000000 (w))
CS Pressurized = Yes
Outer Wall 1   Density: 0.427403 (g/cm^2) Separation: 4.730000 (cm)

OUTPUT

Probability of Penitration = 0.000089

Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

03 05 2019; 21:03:12PM Processing Requirement 4.6 Return Status : Passed

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

INPUT

Space Structure Name = Global-4
Space Structure Type = Payload

Perigee Altitude = 465.000000 (km)
Apogee Altitude = 465.000000 (km)
Inclination = 45.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.005900 (m^2/kg)
Start Year = 2019.500000 (yr)
Initial Mass = 55.400000 (kg)
Final Mass = 51.000000 (kg)
Duration = 3.000000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 403.854540 (km)
PMD Apogee Altitude = 403.854540 (km)
PMD Inclination = 44.993730 (deg)
PMD RAAN = 33.977528 (deg)
PMD Argument of Perigee = 176.175982 (deg)
PMD Mean Anomaly = 0.000000 (deg)

OUTPUT

Suggested Perigee Altitude = 403.854540 (km)
Suggested Apogee Altitude = 403.854540 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

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

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

============== End of Requirement 4.6 ==============
03 05 2019; 21:03:14PM *********Processing Requirement 4.7-1
Return Status : Passed

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

Item Number = 1

name = Global-4
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 51.000000
Thermal Mass = 51.000000
Diameter/Width = 0.500000
Length = 0.845000
Height = 0.450000

name = Payload Deck
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 12.770090
Thermal Mass = 5.400000
Diameter/Width = 0.450000
Length = 0.500000

name = Telescope
quantity = 1
parent = 2
materialID = 5
type = Cylinder
Aero Mass = 5.860000
Thermal Mass = 5.860000
Diameter/Width = 0.300000
Length = 0.478000

name = Camera
quantity = 1
parent = 2
materialID = -2
type = Box
Aero Mass = 0.319000
Thermal Mass = 0.319000
Diameter/Width = 0.045000
Length = 0.045000
Height = 0.039000

name = Star Tracker
quantity = 2
parent = 2
materialID = 5
type = Cylinder
Aero Mass = 0.158000
Thermal Mass = 0.158000
Diameter/Width = 0.100000

Length = 0.120000

name = IMU
quantity = 2
parent = 2
materialID = 8
type = Box
Aero Mass = 0.055000
Thermal Mass = 0.055000
Diameter/Width = 0.038600
Length = 0.044800
Height = 0.021500

name = Magnetometer 1
quantity = 1
parent = 2
materialID = 8
type = Box
Aero Mass = 0.080090
Thermal Mass = 0.080090
Diameter/Width = 0.043000
Length = 0.099170
Height = 0.017000

name = DC-DC Converter 1
quantity = 5
parent = 2
materialID = 8
type = Box
Aero Mass = 0.137000
Thermal Mass = 0.137000
Diameter/Width = 0.077500
Length = 0.083000
Height = 0.018230

name = Antenna Deck
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.873090
Thermal Mass = 0.363000
Diameter/Width = 0.450000
Length = 0.500000

name = X-Band Antenna
quantity = 1
parent = 9
materialID = 8
type = Flat Plate
Aero Mass = 0.300000
Thermal Mass = 0.300000

Diameter/Width = 0.103403
Length = 0.149936

name = S-Band Antenna
quantity = 1
parent = 9
materialID = 8
type = Flat Plate
Aero Mass = 0.120000
Thermal Mass = 0.120000
Diameter/Width = 0.083820
Length = 0.083820

name = Magnetometer 2
quantity = 1
parent = 9
materialID = 8
type = Box
Aero Mass = 0.080090
Thermal Mass = 0.080090
Diameter/Width = 0.045000
Length = 0.099170
Height = 0.017000

name = Coarse Sun Sensor
quantity = 2
parent = 9
materialID = 8
type = Cylinder
Aero Mass = 0.005000
Thermal Mass = 0.005000
Diameter/Width = 0.015300
Length = 0.064000

name = Propulsion Deck
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 8.054537
Thermal Mass = 5.400000
Diameter/Width = 0.450000
Length = 0.500000

name = Tank 1
quantity = 1
parent = 14
materialID = 8
type = Cylinder
Aero Mass = 0.669000
Thermal Mass = 0.669000
Diameter/Width = 0.146800

Length = 0.265900

name = Tank 2
quantity = 1
parent = 14
materialID = 8
type = Cylinder
Aero Mass = 0.669000
Thermal Mass = 0.669000
Diameter/Width = 0.146800
Length = 0.265900

name = Thruster Head Assembly
quantity = 1
parent = 14
materialID = 8
type = Box
Aero Mass = 0.521000
Thermal Mass = 0.521000
Diameter/Width = 0.139130
Length = 0.164490
Height = 0.100140

name = Coarse Sun Sensor
quantity = 4
parent = 14
materialID = 8
type = Cylinder
Aero Mass = 0.005000
Thermal Mass = 0.005000
Diameter/Width = 0.015300
Length = 0.064000

name = Fine Sun Sensor
quantity = 1
parent = 14
materialID = 5
type = Box
Aero Mass = 0.035000
Thermal Mass = 0.035000
Diameter/Width = 0.032000
Length = 0.034000
Height = 0.021000

name = UHF Whip Antenna
quantity = 1
parent = 14
materialID = 19
type = Cylinder
Aero Mass = 0.000460
Thermal Mass = 0.000460
Diameter/Width = 0.000645

Length = 0.158750

name = UHF Whip Cover
quantity = 1
parent = 14
materialID = 23
type = Cylinder
Aero Mass = 0.006477
Thermal Mass = 0.006477
Diameter/Width = 0.004750
Length = 0.203200

name = Tank Bracket
quantity = 4
parent = 14
materialID = 65
type = Box
Aero Mass = 0.053000
Thermal Mass = 0.053000
Diameter/Width = 0.055920
Length = 0.121500
Height = 0.045730

name = MLB Upper Half
quantity = 1
parent = 14
materialID = 9
type = Box
Aero Mass = 0.521600
Thermal Mass = 0.521600
Diameter/Width = 0.344340
Length = 0.344340
Height = 0.026100

name = Avionics Deck
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 17.864399
Thermal Mass = 5.400000
Diameter/Width = 0.450000
Length = 0.500000

name = PCU
quantity = 1
parent = 24
materialID = 5
type = Box
Aero Mass = 0.990000
Thermal Mass = 0.990000
Diameter/Width = 0.147000

Length = 0.202000
Height = 0.050000

name = Battery
quantity = 2
parent = 24
materialID = -1
type = Box
Aero Mass = 1.600000
Thermal Mass = 1.600000
Diameter/Width = 0.098000
Length = 0.176000
Height = 0.096000

name = DC-DC Converter 2
quantity = 3
parent = 24
materialID = 8
type = Box
Aero Mass = 0.137000
Thermal Mass = 0.137000
Diameter/Width = 0.077500
Length = 0.083000
Height = 0.018230

name = X-Band Radio
quantity = 1
parent = 24
materialID = 8
type = Box
Aero Mass = 1.000000
Thermal Mass = 1.000000
Diameter/Width = 0.115000
Length = 0.160000
Height = 0.046000

name = S-Band Radio
quantity = 1
parent = 24
materialID = 8
type = Box
Aero Mass = 0.200000
Thermal Mass = 0.200000
Diameter/Width = 0.050000
Length = 0.135000
Height = 0.025000

name = UHF Radio
quantity = 1
parent = 24
materialID = 8
type = Box

Aero Mass = 0.141700
Thermal Mass = 0.141700
Diameter/Width = 0.057150
Length = 0.082550
Height = 0.015748

name = FC
quantity = 1
parent = 24
materialID = 8
type = Box
Aero Mass = 3.980000
Thermal Mass = 3.980000
Diameter/Width = 0.121920
Length = 0.219600
Height = 0.116000

name = Reaction Wheels
quantity = 4
parent = 24
materialID = 8
type = Box
Aero Mass = 0.226000
Thermal Mass = 0.226000
Diameter/Width = 0.140000
Length = 0.140000
Height = 0.041900

name = Torque Rods
quantity = 3
parent = 24
materialID = 54
type = Cylinder
Aero Mass = 0.420000
Thermal Mass = 0.420000
Diameter/Width = 0.022220
Length = 0.227000

name = GPS Receiver
quantity = 1
parent = 24
materialID = 8
type = Box
Aero Mass = 0.240700
Thermal Mass = 0.240700
Diameter/Width = 0.079400
Length = 0.092100
Height = 0.025100

name = DC-DC Converter 3
quantity = 1
parent = 24

materialID = 8
type = Box
Aero Mass = 0.137000
Thermal Mass = 0.137000
Diameter/Width = 0.077500
Length = 0.083000
Height = 0.018230

name = Solar Array
quantity = 1
parent = 1
materialID = 24
type = Flat Plate
Aero Mass = 2.855000
Thermal Mass = 2.855000
Diameter/Width = 0.665000
Length = 0.845000

name = Radiating Side Panel
quantity = 2
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.700000
Thermal Mass = 0.700000
Diameter/Width = 0.380000
Length = 0.431000

name = Support Strut
quantity = 2
parent = 1
materialID = 8
type = Box
Aero Mass = 0.144000
Thermal Mass = 0.144000
Diameter/Width = 0.150000
Length = 0.582000
Height = 0.020000

name = Front Side Panel
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.700000
Thermal Mass = 0.700000
Diameter/Width = 0.380000
Length = 0.480000

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

name = Global-4
Demise Altitude = 77.993824
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Payload Deck
Demise Altitude = 67.115456
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Telescope
Demise Altitude = 0.000000
Debris Casualty Area = 0.957818
Impact Kinetic Energy = 2348.565186

****
name = Camera
Demise Altitude = 67.115456
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Star Tracker
Demise Altitude = 65.363691
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = IMU
Demise Altitude = 63.755644
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Magnetometer 1
Demise Altitude = 64.400390
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = DC-DC Converter 1
Demise Altitude = 62.070245
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Antenna Deck
Demise Altitude = 77.186238
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = X-Band Antenna
Demise Altitude = 70.000488
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = S-Band Antenna
Demise Altitude = 71.607386
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Magnetometer 2
Demise Altitude = 74.098441
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Coarse Sun Sensor
Demise Altitude = 76.683043
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Propulsion Deck
Demise Altitude = 64.939163
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Tank 1
Demise Altitude = 58.162186
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Tank 2
Demise Altitude = 58.162186
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Thruster Head Assembly
Demise Altitude = 0.000000
Debris Casualty Area = 0.548016
Impact Kinetic Energy = 122.851974

****
name = Coarse Sun Sensor
Demise Altitude = 64.315616

Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Fine Sun Sensor
Demise Altitude = 58.694725
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Whip Antenna
Demise Altitude = 64.827491
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Whip Cover
Demise Altitude = 64.474280
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Tank Bracket
Demise Altitude = 0.000000
Debris Casualty Area = 1.841898
Impact Kinetic Energy = 5.603826

****
name = MLB Upper Half
Demise Altitude = 0.000000
Debris Casualty Area = 0.726832
Impact Kinetic Energy = 44.850822

****
name = Avionics Deck
Demise Altitude = 67.843011
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = PCU
Demise Altitude = 54.559678
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Battery
Demise Altitude = 67.843011
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

name = DC-DC Converter 2
Demise Altitude = 64.073003
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = X-Band Radio
Demise Altitude = 55.989608
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = S-Band Radio
Demise Altitude = 64.227691
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Radio
Demise Altitude = 63.593499
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = FC
Demise Altitude = 45.256295
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Reaction Wheels
Demise Altitude = 64.600612
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Torque Rods
Demise Altitude = 57.078577
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = GPS Receiver
Demise Altitude = 62.363499
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = DC-DC Converter 3
Demise Altitude = 64.073003
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Solar Array
Demise Altitude = 0.000000
Debris Casualty Area = 1.821465
Impact Kinetic Energy = 236.710159

****
name = Radiating Side Panel
Demise Altitude = 75.396285
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Support Strut
Demise Altitude = 77.429097
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Front Side Panel
Demise Altitude = 75.679121
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

=============== End of Requirement 4.7-1 ===============
03 05 2019; 21:03:29PM   Mission Editor Changes Applied
03 05 2019; 21:03:39PM   Processing Requirement 4.3-1:   Return Status : Not Run

=====================
No Project Data Available
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ODAR Section 8: Assessment for Tether Missions

Not applicable. There are no tethers on the Global satellites.

END of ODAR for Globa1-4