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

In the Matter of	)	
	)	
BlackSky Global LLC	)	File No. SAT-MOD-_____
	)	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 submits this application ("Application") to modify its license for the construction, deployment and operation of a non-geostationary satellite orbit ("NGSO")-like Earth Exploration Satellite Service constellation.

BlackSky is currently licensed to operate a four-satellite earth imaging service (Global-1 through Global-4). Three of those satellites are currently in operation. The fourth, Global-4, is currently scheduled for launch in August of 2019. This application requests authority for BlackSky to expand its constellation to sixteen satellites (the next twelve satellites being referred to herein as Global-5 through Global-16). Further, to allow BlackSky greater flexibility in the operation of its constellation over the fifteen

years of its license, BlackSky requests authority to construct, launch, and operate replacement satellites for Global-1 through Global-16 throughout its license term (collectively, with Global 5-16, the "Additional Satellites") within the orbital parameters set forth herein and as previously authorized for Global-1 through Global-4, provided that BlackSky would not have in service more than sixteen satellites in operation at any one time.[1]

This application represents the second phase of operations in requesting license to raise the number of satellites that BlackSky has in operation to sixteen. The Additional Satellites represent an iteration on BlackSky's satellite architecture that uses the technical baseline BlackSky's Global-4 satellite but includes incremental changes to accommodate both the needs of the production supply chain and address learning from the on-orbit performance of the initial phase of satellite operations.

BlackSky is not seeking any change to Global-1 through Global-4 as previously authorized.

[1] BlackSky notes that its current license, while fifteen years in length, contains a restriction (Condition 16) that limits its authorization to those satellites deployed no later than October 31, 2020. BlackSky understands that the genesis of this restriction lies with coordination concerns that have been raised by the ("NOAA") as to BlackSky's operations in the 401-402 MHz band, concerns also reflected in Condition 4 to BlackSky's current authorization. As discussed later in this Application, BlackSky has initiated coordination discussions with NOAA with respect to the proposed expansion of BlackSky's constellation. As part of those coordination activities, BlackSky will be discussing with NOAA and hereby seeks a relaxation of this restriction.

II. Public Interest

BlackSky has built and operates an analytics infrastructure that allows its customers to observe and understand in real time events and activities occurring around the world. BlackSky's multi-sensor global intelligence platform effectively creates for its customers a source for all relevant information fully integrated into one affordable package. The platform employs BlackSky's advanced analytics to integrate data derived from multiple third party geospatial sources (*e.g.*, visible imagery, radar imagery, and tracking data—including both on-demand imaging and persistent surveillance) coupled with BlackSky's activity monitoring (*e.g.*, the monitoring of social media, news feeds, and other data sources). The integrated and user-directed product allows BlackSky's customers to monitor and derive insights into relevant world events. Such insights include, for example, greater awareness and understanding of activity at a refugee camp, a pipeline or other key element in a supply chain, a border crossing or other sensitive locations, all in real time.

Through the development of BlackSky's Constellation, BlackSky plans to improve the services that it provides to its users in two ways: (i) allowing BlackSky more immediately to direct and coordinate the focus of its observations on a particular area, not just once, but several times a day; and (ii) making the provision of such data far more affordable to its customers. This expansion is fundamental to continue to serve BlackSky's customers and achieve BlackSky's objective of helping them to understand their environment in a world where the rate of change continues to increase.

III. Technical Description

A. Design of the New Satellites

The Additional Satellites will be identical to the already authorized Global-4 design with the exception of the items that are listed below. BlackSky is changing suppliers for the telescope and S/X-band antennas which are now produced by alternate vendors to the existing performance specifications. This change is driven by the need to maintain a production cadence of the satellite assembly. Additionally, as a result of findings from BlackSky's latest satellites, BlackSky will be making changes to the reaction wheel orientations and onboard avionics units to improve the agility and efficiency of the spacecraft. These changes are limited to incremental improvements in the performance characteristics of the design and do not represent significant changes in the satellite components, performance or concept of operations.

B. Frequency and Spectrum

The overall frequency and spectrum on which the Additional Satellites would operate is substantially unchanged from Global-1 to Global-4. For convenience, that spectrum is summarized in Table 1 below. The one adjustment relative to frequency that BlackSky is requesting from its current license is to allow it to operate its telemetry beacon and secondary downlink in the 401-402 MHz band on one or more of seven separate channels (401.500, 401.4375, 401.375, 401.225, 401.155, 401.085, 401.015) and/or, on an eighth channel in an adjacent band, at 400.875 MHz, with exact channels of operation limited to the channels to be coordinated with NOAA and other federal agencies. The beacons will be used to aid in the initial acquisition of the satellite and

will be disabled during normal operations. BlackSky hopes that by adding this greater flexibility to its operation in this band it will facilitate coordination with NOAA.

Table 1 Showing Overall Frequencies Employed

Primary Payload Downlink:	(X-band)	8025-8400 MHz
Secondary TT&C Downlink:	(UHF)	401-402 MHz
Secondary TT&C Downlink (alt):	(UHF)	400-401 MHz
Primary TT&C Uplink	(S-band)	2025-2100 MHz
Secondary TT&C Uplink:	(UHF)	449.75–450.25 MHz
GPS Receiver (receive-only):	(L-band)	1575.42 MHz

C. Orbit Information:

The BlackSky satellites need to operate in a range of orbits in order to achieve a high revisit rate. The exact orbits into which the satellites will be injected and later operated is also a function of the launch missions that will be available for the satellites. Each satellite has a predicted mission life of approximately three years. As a secondary customer on many launch missions, it is not practical long in advance for BlackSky to know exactly the exact parameters at which its satellites can be deployed. To allow BlackSky sufficient flexibility to accommodate these missions, BlackSky requests authorization for its Additional Satellites to be deployed anywhere from 385 to 600[2] kilometers in altitude and at inclinations anywhere from 35 degrees to 60 degrees.

[2]BlackSky notes that the operational altitude of the ISS is approximately 400 km. If BlackSky plans an orbital injection or will operate within the proximity of ISS, it will coordinate with NASA to assure protection of the ISS.

While greater flexibility is requested to accommodate potential changes in launch missions, Global-5 through Global-8 are currently scheduled to be launched in November 2019 on a Small Satellite Launch Vehicle (SSLV) by the Indian Space Research Organization from its Satish Dhawan Space Center. The planned altitude and inclination of these satellites is below:

Mission	Satellite	Nominal Orbital Parameters
SSLV	Global-5	475 OR 550 km (+/- 10 km), 50˚
SSLV	Global-6	475 OR 550 km (+/- 10 km), 50˚
SSLV	Global-7	410 OR 485 km (+/- 10 km), 50˚
SSLV	Global-8	410 OR 485 km (+/- 10 km), 50˚

Launch arrangements for Additional Satellites after Global-8 are still to be made.

D. Earth Stations

Earth stations currently planned for use with the constellation are as follows:

Name of Station	Address	Coordinates….	Frequency Bands
Guam (E190037)	Birandan Anakko 168 Dededo, Guam, GU, 96929	13° 30' 49" N 144° 49' 31" E	UHF Uplink UHF downlink S Uplink X Downlink
Fairbanks (WJ2XHL)	1625 Richardson Highway, North Pole, AK 99705, USA	64° 47' 37" N 147° 32' 10" W	UHF Uplink UHF downlink S Uplink X Downlink

Svalbard	Svalbard Satellite Services, SvalSat Platåberget, PB 458 9171 Longyearbyen, NORWAY	78° 13′ 45″ N 015° 23′ 42″ E	S Uplink X Downlink
Usingen	Erdfunkstelle 1 61250 Usingen, GERMANY	50° 19' 51" N 008° 28' 16" E	UHF Uplink UHF downlink S Uplink X Downlink
Invercargill	781 Colyer Road, Awarua Plains 9877, NEW ZEALAND	46° 31' 43" S 168° 22' 52" E	UHF Uplink UHF downlink S Uplink X Downlink
Chitose	066 - 0051 Hokkaido Chitose-shi Izumizawa 1007-199, JAPAN	42° 46' 28" N 141° 37' 28" E	UHF Uplink UHF downlink S Uplink X Downlink

BlackSky's service is still developing and it anticipates adding earth stations in the future, subject to such conditions as the Commission may specify as to the addition of earth station locations. While no specific locations for these earth stations have been established, BlackSky contemplates additional earth stations in, among other places, Chile, South Africa, Western Australia, Greece, Northeast United States, and potentially Qatar .

IV Frequency Considerations

A. Coordination with Federal Systems.

BlackSky has initiated coordination with various federal agencies. BlackSky is committed to supporting coordination with all federal agencies with operations in the bands for which the modified license is sought to avoid interference and has taken steps to initiate coordination ahead of this application. Additional particulars regarding what

BlackSky understands may be the biggest challenges with regard to such coordination are addressed in the discussion below as it relates to particular frequency bands.

B. **The 8025-8400 MHz Band**

The 8025-8400 MHz band is allocated to a number of services, including EESS (space to Earth). BlackSky's proposed use of the frequencies in this band is consistent with this allocation. The likelihood of interference is low due to the typically short transmissions and the required condition of one or more satellites belonging to different systems would have to travel through the antenna beam of the receiving earth station and transmit at the same time as the desired satellite. BlackSky will coordinate its operations with other satellite operators to avoid such occurrence.

With respect to any potential interference with the Fixed Service, BlackSky demonstrates below that its satellite transmissions will meet the PFD limits specified by the ITU for the protection of the Fixed Service in this band.

With regard to any concerns regarding any potential interference to NASA's operations, BlackSky will coordinate its expanded operations with NASA as it has done with its existing operations, reducing power from its satellites when directed toward particular earth stations, as may be necessitated by such coordination.[3]

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[3] To date, BlackSky has coordinated the operation of five earth stations with NASA. *See Appendix A to Letter* dated May 31, 2019 from Kristina Hloptsidis, Director of Regulatory and Compliance, BlackSky Global LLC, to Marlene H. Dortch, Secretary, Federal Communications Commission, re BlackSky Global, LLC, Earth Exploration Satellite Service License, FCC Call Sign S3032; File No. SAT-LOA-20190314-00015. A sixth earth station to be located at Chitose, Japan, is in the process of being coordinated with NASA. Coordination with NASA to increase the number of satellites in BlackSky's constellation that would be directing signals to these earth stations has been initiated.

C. 2025-2110 MHz Band

Non-federal EESS (space to Earth) may operate in the 2025-2100 MHz band, subject to such conditions as may be applied on a case-by-case basis. Transmission to satellites operating in this band shall not cause harmful interference to federal and non-federal stations operating in accordance with the U.S. Table of Frequency Allocations.[4] BlackSky will coordinate with federal and non-federal operators in this band to ensure compliance with this requirement.

D. 401-402 MHz Band

The 401-402 MHz band is allocated to several services, including Space Operation (space to Earth). BlackSky's proposed use of the frequencies in this band is consistent with this allocation.

BlackSky is committed to coordinating with federal and non-federal operators in this band as needed to avoid harmful interference. To increase BlackSky's flexibility in coordination, BlackSky has remapped the channels available in its UHF transceiver to provide more frequency options. A total of seven channels with transmission between 401.000 and 401.515 MHz may be used, with the particular channels to be employed to be determined through coordination.

E. 400-401 MHz Band

The 400-401MHz band is allocated to several services, including Space

[4] *See* 47 C.F.R. § 2.106, note US 347.

Operation (space to Earth) as secondary allocation , subject to compatibility analysis and coordination requirements.[5] BlackSky's proposed use of the frequencies in this band is consistent with this allocation. BlackSky understands that any grant permitting operation on this frequency would be subject to such requirements, but has added the capability to operate on this frequency to allow maximum flexibility in efforts to coordinate the operation of these beacons.

F. **449.75–450.25 MHz Band**

The 449.75-450.25 MHz may be used by federal and non-federal stations for space telecommand (Earth-to-space) at specific locations, subject to such conditions as may be applied on a case-by-case basis. [6] BlackSky's proposed use of the frequencies in this band is consistent with the guidance in US Table note 87 and has designed the carrier frequency close to 450 MHz (450.2 MHz). Internationally, BlackSky will comply with the requirements for such use that are stated in International Table footnote 5.286.[7]

G. Power Flux Density

Table 21-4 of the ITU Radio Regulations states that the power flux density (PFD) at the Earth's surface produced by emissions from an EESS space station in the 8025-8400 MHz band, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the following values:

- -150 dB(W/m) in any 4 kHz band for angles of arrival between 0 and 5 degrees above the horizontal plane;

[5] *See* 47 C.F.R. § 2.106, note US 324.
[6] *See* 47 C.F.R. § 2.106, note US 87.
[7] *See* 47 C.F.R. § 2.106, note 5.286.

- -150 + 0.5(d-5) dB(W/m) in any 4 kHz band for angles of arrival d (in degrees) between 5 and 25 degrees above the horizontal plane; and
- -140 dB(W/m) in any 4 kHz band for angles of arrival between 25 and 90 degrees above the horizontal plane.

The PFD is calculated as follows:

- PFD [dB(W/m / 4 kHz] = EIRP (dBW) – 71 – 20log10(D) – 10log10(BW) – 24
  Where EIRP is the Maximum EIRP of the transmission;
  D is the distance between the satellite and affected surface area in km; and
  BW is the bandwidth of the transmission in MHz.

As the PFD calculation averages the power over the entire bandwidth of the transmission, the calculation was compared to the measured output power of the transmitter in a 4kHz band, and the greater of the two was used in order to ensure a conservative PFD is used. The figure below (Figure 1) illustrates the calculated PFD for the maximum and worst case minimum altitudes for the Additional Satellites and demonstrates compliance with the requirement. The upper altitude shown is 600 km. Although BlackSky does not intend to operate at an altitude that is lower than 400km, 385 km is used as the lower bound as, in the event of a lower-altitude launch or if the altitude of a BlackSky satellite were to lower over time. 385 km is the lowest possible operating altitude of the satellite. While neither planned nor anticipated, as this would be the worst case, the PFD values reported in the Schedule S are also shown at an altitude of 385 km.

Figure 1: The Global Satellite's Power Flux Density

ITU Radio Regulations No. 22.5 specifies that in the 8025-8400 MHz band, which is shared by EESS, fixed-satellite service (Earth-to-space), and the METS (Earth-to-space), the maximum PFD produced at the geostationary satellite orbit ("GSO") by any EESS space station shall not exceed -174 db (W/m) in any 4 kHz band. The calculation below shows that the PFD produced by the transmission from a Global satellite would not exceed that limit, even in the worst hypothetical case.

Using the worst case (i.e., highest altitude) orbit of the Global intended constellation (600 km), the distance to the geostationary orbit would be 35,186 km. At

this orbital distance, for an antenna pointed towards the geostationary orbit having a maximum EIRP density of -19.7 dBW/4kHz, the PFD at the geostationary orbit would be approximately -181.6 dBW/m^2 in a 4kHz band.

V. Schedule S

As the launch and thus the orbital parameters for the Additional Satellites are still to be determined, BlackSky is able only to provide representative information as to some parts of Schedule S to this modification application. If and to the extent required, BlackSky requests a waiver of Section 25.114(c) of the Commission's rules to the extent that to accommodate such launch flexibility its Schedule S submission does not fully conform to that rules requirements.

Additionally, BlackSky offers the following clarifying points to the data provided. Receiving Beams URC and URX and Transmitting Beams UTC, UTX, UTC2 and URX2 in the Schedule S describe a UHF omni directional whip antenna. The signal is described as having linear polarization and it is intended to close the link in almost any spacecraft orientation. With the spacecraft telescope oriented to nadir and the spacecraft in a high elevation pass over a ground station, the polarization will be predominately horizontal so 0 deg has been selected for the polarization angle in the Schedule S. Similar to the X/S patterns, no specific control in z axis rotation is assumed, so the provided patterns can rotate 0-360 deg, still assuming nadir pointing of the telescope.

Similarly, the ground station antennas for this beam use circularly polarized antennas to be able to close the link regardless of spacecraft orientation, so only RHCP patterns were developed for the spacecraft. The UHF co-polar patterns submitted reflect a linear co-polar by adding 3dB to these circular patterns, while the cross-polar patterns are simply the original RHCP.

Transmitting Beams UTC and UTX in the schedule S have been widened in frequency to incorporate additional frequency channels and UTC2 and UTX2 have been added to incorporate the available channel in the 400-401 band. Each spacecraft can only operate on a single channel at a time, the eight potential receive channels have been included for licensing in the schedule S.

With regard to the gain patterns and contour plots, the X/S fixed beam is directed at ground station location by orienting spacecraft. There is no specific control in z axis rotation, so schedule S patterns may be rotated in any direction 0-360.

With regard to service areas identified in transmitting and receiving beams, the areas listed are consistent with the identified ground stations Section III Part D, Earth Stations, with the addition of areas contemplated for future operations, but for which BlackSky does not yet have an established earth station location (Chile, South Africa, Western Australia, Greece, Northeast USA and potentially Qatar). Antenna Gain Contours have been provided over actual locations for established earth station locations and over notional locations for service areas contemplated for future operations. As the operational altitude may vary, these diagrams have been provided at minimum and maximum altitudes as shown in Section III.C.

With regard to the Orbital Planes defined in the Schedule S, the listed Orbital planes are representative of the current intent at the time of filing. The Global 5 and later satellites are generally intended to be launched in pairs to a given Orbital Plane, with 90deg offsets in Right Ascension of the Ascending Node (RAAN) to manage day/night phasing. The actual orbital parameters may vary from the values currently represented in Schedule S depending on launch opportunities, but operation will remain within the ranges shown in /section III.C above; *i.e.,* from 385 to 600 kilometers in altitude and at inclinations anywhere from 35 degrees to 60 degrees.

Specifically, with respect to the values shown in Schedule S, all current and propagated into a Jan 1, 2020 epoch for commonality:

- Orbital Planes 1, 2, and 3 have been updated with current orbital parameters as propagated to a Jan 1, 2020 epoch.
- Orbital Plane 4 launch is imminent, and the target orbit is set.
- Orbital Planes 5 and 6 have a launch vehicle set, however, target orbital parameters are still being finalized, so orbital parameters shown are within anticipated range, but are still to be determined.
- Orbital Planes 7, 8, 9, and 10 do not yet have launch providers identified, so orbital parameters shown are representative, but are still to be determined.

VI. Orbital Debris Mitigation

BlackSky has conducted an orbital debris assessment for all Global satellites. Details of this assessment are shown in Exhibit A to this Narrative. This assessment demonstrates that all systems are compliant with applicable policies.

VII. Other Matters

A. Modified Processing Round Rules

BlackSky requests waiver of Sections 25.156 and 25.157 of the Commission's rules, which provide for the processing of "NGSO-like satellite systems" under a modified processing round framework. BlackSky requests instead that this Application be processed pursuant to the first-come, first-served procedure adopted for "GSO-like satellite systems" under Section 25.158 of the Commission's rules.

The Commission has waived the modified processing round requirement and allowed EESS NGSO satellite systems to be processed on a first-come, first-served basis on multiple occasions. In *Space Imaging, LLC*, the Commission concluded that authorizing Space Imaging to operate in its requested EESS frequency bands would not preclude other NGSO operators from operating in those bands because EESS NGSO operators are generally capable of sharing spectrum in the same frequency.[8]

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[8] *See Space Imaging, LLC, Declaratory Order and Order and Authorization,* 20 FCC Rcd 11694, 11968 (2005) ("*Space Imaging Order*").

Subsequent waivers have been granted to other EESS operators, each premised on a showing that such operators would be capable of sharing with current and future NGSO systems operating in the same frequency bands.[9] As demonstrated in Section III.A.4 (ii) above, BlackSky is equally capable of such sharing.

As the Commission stated in its space imaging Order, "[t]he purpose of the modified processing round rule is to preserve opportunities for competitive market entry in frequency bands where licensing the first applicant to operate throughout the band would prevent subsequent applicants from using the spectrum."[10] Because, as with EESS NGSO applications previously granted, grant of BlackSky's application would not prevent subsequent applications from using the spectrum, grant of the waiver would not undermine the policy objectives of the rule and, as shown herein, would otherwise serve the public interest. Accordingly, good cause exists to waive the modified processing round rules.[11]

B. Default Service Rules

BlackSky requests a waiver of the default service rules under Section 25.217(b) of the Commission's rules. Although the Commission has not adopted band-specific rules for EESS NGSO operations in the 8025-8400 MHz band, the Commission has granted to

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[9] *See e.g., Spire Global, Inc.* SAT-LOA-20151123-00078 (granted Oct. 14, 2016); *Planet Labs, Inc.*, SAT-LOA-20130626-00087 (granted Dec. 3, 2013); *Skybox Imaging, Inc.*, SAT-LOA-20120322-00058 (granted Sep. 20, 2012).

[10] *Space Imaging Order*, 20 FCC Rcd at ¶ 10.

[11] *See WAIT Radio v. FCC*, 418 F.2d 1153, 1157 (D.C. Cir 1969).

NGSO EESS system licensees on multiple occasions waivers of the default service rules contained in Section 25.217(b), based on the fact that EESS operators in the 8025-8400 MHz band are required to comply with technical requirements in Part 2 of the Commission's rules and applicable ITU rules.[12] In these cases, the Commission concluded that because the cited requirements had been sufficient to prevent harmful interference in the 8025-8400 MHz band, there was no need to impose additional technical requests.[13] For these same reasons, the Commission should grant BlackSky a waiver of the default service rules contained in Section 25.217(b).

C. Posting of Bond

BlackSky has already met the milestone and bond requirements of its current license. As noted above, three of the four authorized satellites have already been launched and placed into service and the fourth has been constructed and is awaiting launch in August 2019. Accordingly, BlackSky's license is no longer subject to a bond requirement. Given this record of performance, BlackSky urges that no new bond should be required for the expansion of its system, consistent with treatment of other similarly situated NGSO systems seeking to expand their constellations.[14]

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[12] *See Space Imaging Order*, 20 FCC Rcd at 11973-74 ¶¶ 26-31; *DigitalGlobe, Inc.*, Order and Authorization, 20 FCC Rcd 15696 ¶¶ 1, 15 (2005); *see also* Planet Labs, Inc., SAT-MOD-20150802-00053 (granted Sept. 15, 2016), SAT-LOA-20130626-00087 (granted Dec. 3, 2013); Skybox Imaging, Inc., SAT-LOA-20120322-00058 (granted Sep. 20, 2012).

[13] *Id.*

[14] *See e.g. Stamp Grant*, Planet Labs, Inc, FCC Call Sign S2912, IBFS File No. SAT-MOD-20171106-00151, condition 15 (May 24, 2018); *Stamp Grant*, Astro Digital U.S., Inc., FCC Call Sign S3014, IBFS File No. SAT-LOA-20170508-00071, condition 16 (Aug 1, 2018); *Stamp Grant*, Spire Global, Inc., FCC Call Sign S2946, IBFS File No. SAT-AMD-20180102-00001, condition 23 (Nov 29, 2018).

D. ITU Advance Publication Materials and Cost Recovery

BlackSky is preparing ITU filing information as required under Section 25.111(d) of the Commission's rules and will provide this information along with a signed declaration of unconditional acceptance of all consequent ITU cost-recovery responsibility under separate cover.

E. Notification of Intent to Commence Space Station Construction

Pursuant to Section 25.113(f) of the Commission's rules, BlackSky hereby notifies the Commission of its intent to commence construction at its own risk of the Additional Satellites that are the subject of this Application.

F. NOAA Authorization

BlackSky is submitting concurrently with this Application a request to NOAA to amend BlackSky's NOAA license to reflect the changes that are presented in this Application. BlackSky will notify the Commission when this amendment is granted and will submit a copy of the updated NOAA public summary reflecting this amendment when it becomes available.

VI. CONCLUSION

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

Respectfully submitted,

/s/

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August 2, 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

BlackSky Global
Global-5 through Global-16 Satellites
Orbital Debris Assessment Report (ODAR)

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

Report Version: A June 2019

Revision history:

Version	Date	Author	Description
A	June 2019	Melissa Briggs, Katie Todd, John DiPalma	Initial Release

Document Data is Not Restricted.

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

Table of Contents

Table of Tables

Table of Figures

1. 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-5 through Global-8 Satellite

Requirement #	Launch Vehicle				Spacecraft			Comments
	Compliant	Not Compliant	Incomplete	Standard Non-Compliant	Compliant or N/A	Not Compliant	Incomplete	
4.3-1.a 25 yr limit	☐	☐	☐	☐	☒	☐	☐	Compliant / Not Applicable; no intentional debris released in LEO. See Section 5.2.
4.3-1.b <100 object x yr limit	☐	☐	☐	☐	☒	☐	☐	Compliant / Not Applicable; no intentional debris released in LEO. See Section 5.2.
4.3-2 GEO +/- 200km	☐	☐	☐	☐	☒	☐	☐	Compliant / Not Applicable; no intentional debris released in GEO. See Section 5.2.
4.4-1 <0.001 Explosion Risk	☐	☐	☐	☐	☒	☐	☐	Compliant per FMEA. See Section 6.3.
4.4-2 Passivate Energy Sources	☐	☐	☐	☐	☒	☐	☐	Compliant; propulsion tank containing water will be depleted during operations. See Section 6.3.
4.4-3 Limit BU Long term Risk	☐	☐	☐	☐	☒	☐	☐	Not applicable; no planned breakups. See Section 6.3.
4.4-4 Limit BU short term Risk	☐	☐	☐	☐	☒	☐	☐	Not applicable; no planned breakups. See Section 6.3.
4.5-1 Collision with Large Objects	☐	☐	☐	☐	☒	☐	☐	Compliant per DAS. See Section 7.2.
4.5-2 Collision with Small Objects	☐	☐	☐	☐	☒	☐	☐	Compliant per DAS. See Section 0.
4.6-1(a) Disposal, Atmo. Reentry	☐	☐	☐	☐	☒	☐	☐	Compliant per DAS. Natural forces cause atmospheric reentry. See Section 0.
4.6-1(b) Disposal, Storage Orbit	☐	☐	☐	☐	☒	☐	☐	Not applicable; disposal will be atmospheric reentry. See Section 0.
4.6-1(c) Disposal, Direct Retrieval	☐	☐	☐	☐	☒	☐	☐	Not applicable; disposal will be atmospheric reentry. See Section 0.
4.6-2 GEO Disposal	☐	☐	☐	☐	☒	☐	☐	Not applicable; spacecraft does not go beyond LEO. See Section 0.
4.6-3 MEO Disposal	☐	☐	☐	☐	☒	☐	☐	Not applicable; spacecraft does not go beyond LEO. See Section 0.
4.6-4 Disposal Reliability	☐	☐	☐	☐	☒	☐	☐	Not applicable; applicable only to NASA space programs and projects. See Section 0.
4.7-1 Ground Population Risk	☐	☐	☐	☐	☒	☐	☐	Compliant per DAS. Section 0.
4.8-1 Tether Risk					☒	☐	☐	Not applicable. No tethers used. See Section 10.

2. Assessment Report Format

2.1. NASA-STD-8719.14 Rev B, Appendix A.1 Applicability

ODAR Technical Sections Format Requirements:

BlackSky Global LLC ("BlackSky") is a U.S. company. This ODAR, for BlackSky's Global-5 through Global-16 satellites, follows the format recommended in NASA- STD-8719.14 revision B, Appendix A.1, ODAR Section 1 through 8.

ODAR sections 9 through 14 apply to the launch vehicles ODAR and are not covered here.

2.2. Structure of this Report

2.2.1. Main Body, Sections 3 through 9

Each section of this report that references an applicable ODAR Section outlined in NASA-STD-8719.14 Rev B, Appendix A.1 (i.e., Sections 3 through 9 of this report) is formatted such that:

1. The first subsection outlines the criteria from the NASA Standard and either replies to it directly or points to another area of this report for that information.
2. The second subsection, where necessary, provides supporting data.
3. The final subsection(s) explicitly cover requirement compliance as required by the first subsection.

2.2.2. Appendix A

Appendix A includes the following:

1. Screenshot of the DAS software version in "About DAS".
2. Screenshot of the header of the DAS solar flux file to demonstrate version.
3. Requirement run information from DAS for Global-5 for the following requirements *(note that Global-5 is provided as an example as all of the satellites represent the same configuration*):
    a. Requirement 4.5-1
    b. Requirement 4.5-2
    c. Requirement 4.6-1
    d. Requirement 4.7-1

2.3. Overview of Mission Dependency of Requirement Compliance

This report is optimized to cover Global-5 through Global-16, as they are intended to be the same configuration as it applies to this report. In many cases, complying to the ODAR requirements in NASA-STD-8719.14 is based solely on high-level concept of operations and the design of the satellite, but not otherwise mission-dependent.

However, some requirements and portions of this report *are* dependent on orbital parameters, launch dates, launch vehicles, launch sites and other mission-specific parameters. The table below differentiates which sections of this report depend on these mission-specific parameters.

Table 1: Overview of Mission Dependency of Requirement Compliance

Section of This Report	Mission Dependent?
Section 3 (ODAR Section 1)	Yes; this is a mission overview.
Section 4 (ODAR Section 2)	No
Section 5 (ODAR Section 3)	No
Section 6 (ODAR Section 4)	No
Section 7 (ODAR Section 5)	Yes; requires DAS run per mission.
Section 8 (ODAR Section 6)	Yes; requires DAS run per mission.
Section 9 (ODAR Section 7)	Yes; requires DAS run per mission.
Section 10 (ODAR Sections 8 – 14)	No

2.4. Supporting Data Storage (Internal Reference)

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

Windchill Link (This is a BlackSky internal reference) :
https://spaceflightindustries.app.box.com/folder/78511918271

3. ODAR Section 1: Program Management and Mission Overview

3.1. NASA-STD-8719.14B Criteria for ODAR Section 1

Table 2: NASA-STD-8719.14B Criteria for ODAR Section 1

	NASA-STD-8719.14B Item	Response
a	Identification of the HQ Mission Directorate sponsoring the mission and the Program Executive	Not applicable.
b	Identification of the responsible program/project manager and senior scientific and management personnel	John DiPalma and Seth Burke
c	Identification of any foreign government or space agency participation in the mission and a summary of NASA's responsibility under the governing agreement(s)	None.
d	Clear schedule of mission design and development milestones from NASA mission selection through proposed launch date, including spacecraft PDR and CDR (or equivalent) dates	See Section 3.2.2, High-Level Milestone and Launch Overview.
e	Brief description of the mission	See Section 3.2, Mission Overview.
f	Identification of the anticipated launch vehicle and launch site	See Section 3.2.2, High-Level Milestone and Launch Overview.

	NASA-STD-8719.14B Item	Response
g	Identification of the proposed launch date and mission duration	See Section 3.2.2, High-Level Milestone and Launch Overview.
h	Description of the launch and deployment profile, including all parking, transfer, and operational orbits with apogee, perigee, and inclination	See Section
i	Description of the spacecraft's maneuver capability, including both attitude and orbit control. Give the time period during which the capabilities will be exercised.	Global-5 through Global-16, like their predecessors, have been developed with propulsion systems that are sized for both attitude and orbit control. That system is described in Section 3.2.4, Global-5 through Global-16 Propulsion System.
j	Reason for selection of operational orbit(s) (such as ground track, SSO, GEO sync, instrument resolution, co-locate with other spacecraft, …)	Orbits are selected to meet ground track and instrument resolution mission requirements.
k	Identification of any interaction or potential physical interference with other operational spacecraft. Note: This does not include potential for radio frequency interaction unless it affects the risk of generating orbital debris.	Purposeful interaction/interference is not part of the nominal concept of operations.

3.2. Mission Overview

Global-5 through Global-16 are part of BlackSky's constellation of commercial Earth observation satellites. These are the among the many satellites planned for BlackSky's earth-observing constellation, following on 3 previous Global missions, Global-1, Global-2 and Global-3.

Global-5 through Global-16 are expected to be in a single configuration. They will, however, have different orbital parameters. These differences are made explicit throughout this report.

3.2.1. Configuration Changes from Global-4 ODAR

This ODAR covers the Global-5 through Global-16 satellite architecture. These satellites represent the following changes from the previously submitted Global-4 ODAR May 15, 2019:

a) New payload telescope vendor and part number.
b) S-Band and X-Band Antenna parts have been swapped for different versions.
c) Upgrades of two on-board avionics units, the power control unit and a portion of the flight computer.

In every case, the above changes do not affect overall spacecraft dimensions used in the previous version of this report, but they do change mass properties of the listed components. Battery architecture, propulsion architecture and the FMEA shown in Section 6.2 remain unchanged.
Note, the launch vehicle and parameters for Globals 5-8 reflect current mission plans, but may be

changed to other qualified launch vehicles and within the broader mission parameters shown for Globals 9-16 should unanticipated events require a change in launch plans. While changes in parameters could result in minor variances in the calculations that are shown, the range of sample parameters that are shown are designed to demonstrate compliance within the overall envelope of orbital parameters that are presented regardless of individual variations that may occur as long as within this range.

3.2.2. High-Level Milestone and Launch Overview

Table 3: Mission Milestones

Satellite	Anticipated Launch Date	Anticipated Launch Vehicle	Anticipated Launch Site	Mission Duration
Global-5	November 2019	Small Satellite Launch Vehicle (SSLV)- Indian Space Research Organization	Satish Dhawan Space Center	3 years
Global-6	November 2019	Small Satellite Launch Vehicle (SSLV)- Indian Space Research Organization	Satish Dhawan Space Center	3 years
Global-7	November 2019	Small Satellite Launch Vehicle (SSLV)- Indian Space Research Organization	Satish Dhawan Space Center	3 years
Global-8	November 2019	Small Satellite Launch Vehicle (SSLV)- Indian Space Research Organization	Satish Dhawan Space Center	3 years
Global-9	Q1 2020	TBD	TBD	3 years
Global-10	Q1 2020	TBD	TBD	3 years
Global-11	Q1 2020	TBD	TBD	3 years
Global-12	Q1 2020	TBD	TBD	3 years
Global-13	Q3 2020	TBD	TBD	3 years
Global-14	Q3 2020	TBD	TBD	3 years
Global-15	Q3 2020	TBD	TBD	3 years
Global-16	Q3 2020	TBD	TBD	3 years

3.2.3. Constellation Launch and Deployment Profile

Table 4: Orbit Profiles

Project	Orbit (km)	Inclination (deg)	Comments
Global-5	385-550 km	50 deg (or 45-55 deg)	TBD L-3 from launch
Global-6	385-550 km	50 deg (or 45-55 deg)	TBD L-3 from launch
Global-7	385-550 km	50 deg (or 45-55 deg)	TBD L-3 from launch
Global-8	385-550 km	50 deg (or 45-55 deg)	TBD L-3 from launch
Global-9	385-600 km.	35 – 60 deg	
Global-10	385-600 km.	35 – 60 deg	
Global-11	385-600 km.	35 – 60 deg	
Global-12	385-600 km.	35 – 60 deg	

Project	Orbit (km)	Inclination (deg)	Comments
Global-13	385-600 km.	35 – 60 deg	
Global-14	385-600 km.	35 – 60 deg	
Global-15	385-600 km.	35 – 60 deg	
Global-16	385-600 km.	35 – 60 deg	

3.2.4. Global-5 through Global-16 Propulsion System

The Global-5 through Global-16 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-5 through -16 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. 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.

3.2.5. Operational Orbit and Lifetime

Maximum nominal operations will occur over 36 months (3 years).

4. ODAR Section 2: Spacecraft Description

4.1. NASA-STD-8719.14B Criteria for ODAR Section 2

Table 5: NASA-STD-8719.14B Criteria for ODAR Section 2

	NASA-STD-8719.14B Item	Response
a	Physical description of the spacecraft, including spacecraft bus, payload instrumentation, and all appendages, such as solar arrays, antennas, and instrument or attitude control booms	See Section 4.2, Physical Description of the Spacecraft.

	NASA-STD-8719.14B Item	**Response**
b	Detailed illustration of the entire spacecraft in the mission operation configuration with clear overall dimensional markings and marked internal component locations	See Section 4.2, Physical Description of the Spacecraft.
c	Total spacecraft mass at launch, including all propellants and fluids.	55.1 kg
d	Dry mass of spacecraft at launch (minus all consumables and propellants).	50.6 kg
e	Identification, including type, mass and pressure, of all fluids (liquids and gases) planned to be on board (including any planned future in-space transfers), excluding fluids in sealed heat pipes. Description of all fluid systems, including size, type, and qualifications of fluid containers such as propellant and pressurization tanks, including pressurized batteries	Standard propellant fill is 4.4 kg of water and146g of FE-36 at maximum expected operating pressure (MEOP) of 63.5 psia. Fluid is loaded through independent, electrically actuated fill and drain valves. Global-5 through Global-16 use 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.
f	Description of all propulsion systems (e.g.: cold gas, mono-propellant, bi-propellant, solid propellant, electric, nuclear)	Global-5 through Global-16 contains a single propulsion system with a single thruster. This system uses electrically-heated 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. Global-5 through Global-16 will have an uncontrolled reentry. Though the propellant system will be used for orbit maintenance, orbit phasing and minor orbit adjustments, it is not intended to be used for deorbit.

	NASA-STD-8719.14B Item	Response
g	Description of all active and/or passive attitude control systems with an 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 average cross-sectional area is used, meaning that an average cross-sectional area of all possible orientations is used. This results in a cross-section area of 0.385 m^2.
h	Description of any range safety or other pyrotechnic devices	No pyrotechnic devices are used.
i	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.
j	Identification of any other sources of stored energy not noted above	None.
k	Identification of any radioactive materials on board or make an explicit statement that there are no radioactive materials onboard	None.
l	Description of any planned proximity operations or docking with other spacecraft in LEO or GEO, including the controls that will be used to mitigate the risk of a collision that could generate debris or prevent planned later passivation or disposal activities for either spacecraft.	None.

4.2. Physical Description of the Spacecraft

Basic physical dimensions of the Global-5 through -16 satellites are 55 cm x 67 cm x 86 cm. A CAD model of the spacecraft is shown in Figure 1.

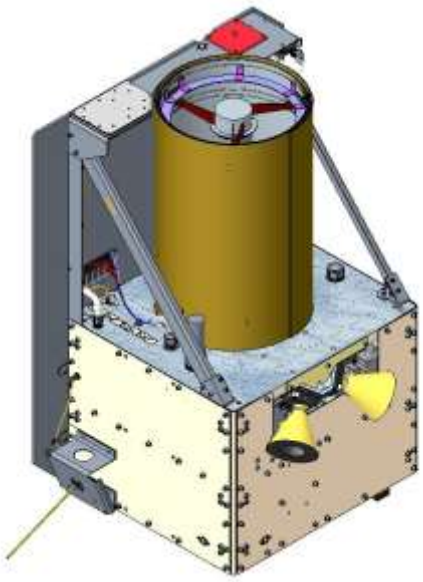

Figure 1. CAD model of the Global-5 through Global-16 spacecraft.

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.

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

5.1. NASA-STD-8719.14B Criteria for ODAR Section 3

Table 6: NASA-STD-8719.14B Criteria for ODAR Section 3

	NASA-STD-8719.14B Item	**Response**
a	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.
b	Rationale/necessity for release of each object	N/A.
c	Time of release of each object, relative to launch time	N/A.
d	Release velocity of each object with respect to spacecraft	N/A.
e	Expected orbital parameters (apogee, perigee, and inclination) of each object after release	N/A.
f	Calculated orbital lifetime of each object,	N/A.

	including time spent in LEO	
g	Assessment of spacecraft compliance with Requirements 4.3-1 and 4.3-2	See Section 5.2, Compliance to Requirements 4.3-1 and 4.3-2

5.2. Compliance to Requirements 4.3-1 and 4.3-2

Table 7: Compliance to Requirements 4.3-1 and 4.3-2

Requirement from NASA-STD-8719.14B	Compliance Assessment
Requirement 4.3-1a: All debris released during the deployment, operation, and disposal phases shall be limited to a maximum orbital lifetime of 25 years from date of release.	Compliant / Not Applicable. There are no intentional releases.
Requirement 4.3-1b: The total object-time product shall be no larger than 100 object years per mission… (Note: there is more requirement text than shown here; for the sake of space, it is not reproduced in its totality here.)	Compliant / Not Applicable. There are no intentional releases.
Requirement 4.3-2: Debris passing near GEO: For missions leaving debris in orbits with the potential of traversing GEO (GEO altitude +/- 200 km and +/- 15 degrees inclination), released debris with diameters of 5 mm or greater shall be left in orbits which will ensure that within 25 years after release the apogee will no longer exceed GEO - 200 km or the perigee will not be lower than GEO + 200 km , and also ensures that the debris is incapable of being perturbed to lie within that GEO +/- 200 km and +/- 15° zone for at least 100 years thereafter…	Compliant / Not Applicable. There are no intentional releases.

6. ODAR Section 4: Assessment of Spacecraft Intentional Breakups and Potential for Explosions.

6.1. NASA-STD-8719.14B Criteria for ODAR Section 4

Table 8: NASA-STD-8719.14B Criteria for ODAR Section 4

	NASA-STD-8719.14B Item	Response
a	Identification of all 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.

	NASA-STD-8719.14B Item	Response
b	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, the Global-5 through Global-16 battery unit features two temperature sensors which monitor battery cells for high temperatures.
c	Detailed plan for any designed spacecraft breakup, including explosions and intentional collisions	There are no planned breakups.
d	List of components which are passivated at EOM. List includes 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 the propellant is not totally consumed by EOM, 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.
e	Rationale for all items which are required to be passivated, but cannot be due to their design.	Global-5 through Global-16'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.
f	Assessment of spacecraft compliance with Requirements 4.4-1 through 4.4-4	See Section 6.3, Compliance to Requirements 4.4-1 through 4.4-4.

6.2. FMEA Details for Battery Explosion

6.2.1. Probability and Effect

6.2.1.1. 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.

6.2.1.2. 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).

6.2.2. Failure Modes

6.2.2.1. 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.

6.2.2.2. 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.

6.2.2.3. 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.

6.2.2.4. 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.

6.2.2.5. 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.

6.2.2.6. 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.

6.2.2.7. 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.

6.3. Compliance to Requirements 4.4-1 through 4.4-4

Table 9: Compliance to Requirements 4.4-1 through 4.4-4

Requirement	Compliance Statement
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 (i.e., every individual free-flying structural object), the program or project shall demonstrate, via failure mode and effects analyses, probabilistic risk assessments, or other appropriate analyses, that the integrated probability of explosion for all credible failure modes of each spacecraft and launch vehicle does not exceed 0.001 (excluding small particle impacts.).	Compliant. Expected probability is 0.000 per FMEA.
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 and a plan to either 1) deplete all onboard sources of stored energy and disconnect all energy generation sources when they are no longer required for mission operations or postmission disposal or 2) control to a level which cannot cause an explosion or deflagration large enough to release orbital debris or break up the spacecraft. The design of depletion burns and ventings should minimize the probability of accidental collision with tracked objects in space.	Compliant; all onboard sources of stored energy will be depleted prior to disposal. See Section 6.1, NASA-STD-8719.14B Criteria for ODAR Section 4 item D for passivation information.
Requirement 4.4-3. Limiting the long-term risk to other space systems from planned breakups for Earth and lunar missions: Planned explosions or intentional collisions shall: a. be conducted at an altitude such that for orbital debris fragments larger than 10 cm the object-time product does not exceed 100 object-years. For example, if the debris fragments greater than 10cm decay in the maximum allowed 1 year, a maximum of 100 such fragments can be generated by the breakup. b. Not generate debris larger than 1 mm that remains in Earth orbit longer than one year	Not applicable. There are no planned explosions or intentional collisions.
Requirement 4.4-4: Limiting the short-term risk to other space systems from planned breakups for Earth orbital missions: Immediately before a planned explosion or intentional collision, the probability of debris, orbital or ballistic, larger than 1 mm colliding with any operating spacecraft within 24 hours of the breakup shall be verified to not exceed 10-6 .	Not applicable. There are no planned explosions or intentional collisions.

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

7.1. NASA-STD-8719.14B Criteria for ODAR Section 5

Table 10: NASA-STD-8719.14B Criteria for ODAR Section 5

<table>
<tr><th></th><th>NASA-STD-8719.14B Item</th><th>Response</th></tr>
<tr><td>a</td><td>Calculation of spacecraft probability of collision with space objects larger than 10 cm in diameter during the orbital lifetime of the spacecraft.</td><td>DAS was used to calculate this probability.

See Section 7.2, Compliance to Requirement 4.5-1: DAS Probability of Collision with Large Objects.</td></tr>
<tr><td>b</td><td>Calculation of spacecraft probability of collision with space objects, including orbital debris and meteoroids, of sufficient size to prevent postmission disposal.</td><td>DAS was used to calculate this probability.

See DAS Output in Section 0,

<table>
<tr><th>Satellite</th><th>Large Object Collision Probability</th><th>Compliance Status per DAS</th><th>Altitude</th><th>Inc.</th><th>Launch</th></tr>
<tr><td rowspan="4">Global -5 -6 -7 -8</td><td>0.000008</td><td>COMPLIANT</td><td>550</td><td>45</td><td>2020.0</td></tr>
<tr><td>0.000008</td><td>COMPLIANT</td><td>550</td><td>55</td><td>2020.0</td></tr>
<tr><td>0.000000</td><td>COMPLIANT</td><td>385</td><td>45</td><td>2020.0</td></tr>
<tr><td>0.000000</td><td>COMPLIANT</td><td>385</td><td>55</td><td>2020.0</td></tr>
<tr><td rowspan="4">Global 9 -10 -11 -12</td><td>0.000018</td><td>COMPLIANT</td><td>600</td><td>35</td><td>2020.25</td></tr>
<tr><td>0.000021</td><td>COMPLIANT</td><td>600</td><td>60</td><td>2020.25</td></tr>
<tr><td>0.000000</td><td>COMPLIANT</td><td>385</td><td>35</td><td>2020.25</td></tr>
<tr><td>0.000000</td><td>COMPLIANT</td><td>385</td><td>60</td><td>2020.25</td></tr>
<tr><td rowspan="4">Global 13 -14 -15 -16</td><td>0.000017</td><td>COMPLIANT</td><td>600</td><td>35</td><td>2020.75</td></tr>
<tr><td>0.000020</td><td>COMPLIANT</td><td>600</td><td>60</td><td>2020.75</td></tr>
<tr><td>0.000000</td><td>COMPLIANT</td><td>385</td><td>35</td><td>2020.75</td></tr>
<tr><td>0.000000</td><td>COMPLIANT</td><td>385</td><td>60</td><td>2020.75</td></tr>
</table>

Compliance to Requirement 4.5-2: DAS Probability of Damage from Small Objects.</td></tr>
</table>

<table>
<tr><th></th><th>NASA-STD-8719.14B Item</th><th>Response</th></tr>
<tr><td>c</td><td>Assessment of spacecraft compliance with Requirements 4.5-1 and 4.5-2</td><td>
See Section 7.2,

Compliance to Requirement 4.5-1: DAS Probability of Collision with Large Object and Section 0,
<table>
<tr><th>Satellite</th><th>Large Object Collision Probability</th><th>Compliance Status per DAS</th><th>Altitude</th><th>Inc.</th><th>Launch</th></tr>
<tr><td rowspan="4">Global -5 -6 -7 -8</td><td>0.000008</td><td>COMPLIANT</td><td>550</td><td>45</td><td>2020.0</td></tr>
<tr><td>0.000008</td><td>COMPLIANT</td><td>550</td><td>55</td><td>2020.0</td></tr>
<tr><td>0.000000</td><td>COMPLIANT</td><td>385</td><td>45</td><td>2020.0</td></tr>
<tr><td>0.000000</td><td>COMPLIANT</td><td>385</td><td>55</td><td>2020.0</td></tr>
<tr><td rowspan="4">Global 9 -10 -11 -12</td><td>0.000018</td><td>COMPLIANT</td><td>600</td><td>35</td><td>2020.25</td></tr>
<tr><td>0.000021</td><td>COMPLIANT</td><td>600</td><td>60</td><td>2020.25</td></tr>
<tr><td>0.000000</td><td>COMPLIANT</td><td>385</td><td>35</td><td>2020.25</td></tr>
<tr><td>0.000000</td><td>COMPLIANT</td><td>385</td><td>60</td><td>2020.25</td></tr>
<tr><td rowspan="4">Global 13 -14 -15 -16</td><td>0.000017</td><td>COMPLIANT</td><td>600</td><td>35</td><td>2020.75</td></tr>
<tr><td>0.000020</td><td>COMPLIANT</td><td>600</td><td>60</td><td>2020.75</td></tr>
<tr><td>0.000000</td><td>COMPLIANT</td><td>385</td><td>35</td><td>2020.75</td></tr>
<tr><td>0.000000</td><td>COMPLIANT</td><td>385</td><td>60</td><td>2020.75</td></tr>
</table>
Compliance to Requirement 4.5-2: DAS Probability of Damage from Small Objects.
</td></tr>
</table>

d	Detailed description and assessment of the efficacy of any planned debris avoidance capability intended to help in meeting the requirements of requirement 4.5-1, including any plans to move to less congested altitudes, as well as any tracking enhancements (GPS, laser retroreflector, e.g.) that may assist in reducing the covariance of collision estimates. Note that significant risk remains for impact with debris objects less than 10 cm and/or that are otherwise	No systems or components are required. The orbit for Global-5 through Global-16 naturally decays with no maneuvering required. 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.

	NASA-STD-8719.14B Item	**Response**
	untrackable from the Earth, so such measures are only expected to slightly influence the statistical probability of collision with dangerous objects.	

7.2. Compliance to Requirement 4.5-1: DAS Probability of Collision with Large Objects

Large Object Collision Probability is calculated using DAS's Requirement Assessment for Requirement 4.5-1. For each block of anticipated satellite launch dates, a range of cases were run in DAS to envelope the worst-case altitudes and orbit inclinations. The results of the maximum and minimum altitudes and inclinations are shown in the results tables. The worst-case DAS output logs are reproduced in the Appendix.

Requirement per NASA-STD-8719.14B:

> ***Requirement 4.5-1. Limiting debris generated by collisions with large objects when 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 does not exceed 0.001. For spacecraft and orbital stages passing through the protected region +/- 200 km and +/-15 degrees of geostationary orbit, the probability of accidental collision with space objects larger than 10 cm in diameter shall not exceed 0.001 when integrated over 100 years from time of launch*

Table 11: Compliance to Requirement 4.5-1

Satellite	Large Object Collision Probability	Compliance Status per DAS	Altitude	Inc.	Launch
Global -5 -6 -7 -8	0.000008	COMPLIANT	550	45	2020.0
	0.000008	COMPLIANT	550	55	2020.0
	0.000000	COMPLIANT	385	45	2020.0
	0.000000	COMPLIANT	385	55	2020.0
Global -9 -10 -11 -12	0.000018	COMPLIANT	600	35	2020.25
	0.000021	COMPLIANT	600	60	2020.25
	0.000000	COMPLIANT	385	35	2020.25
	0.000000	COMPLIANT	385	60	2020.25
Global -13 -14 -15 -16	0.000017	COMPLIANT	600	35	2020.75
	0.000020	COMPLIANT	600	60	2020.75
	0.000000	COMPLIANT	385	35	2020.75
	0.000000	COMPLIANT	385	60	2020.75

7.3. Compliance to Requirement 4.5-2: DAS Probability of Damage from Small Objects

Small Object Collision Probability of PMD Failure is calculated using DAS's Requirement Assessment for Requirement 4.5-2. For each block of anticipated satellite launch dates, a range of cases were run in DAS to envelope the worst-case altitudes and orbit inclinations. The results of the maximum and minimum altitudes and inclinations are shown in the results tables. The worst-case DAS output logs are reproduced in the Appendix.

Requirement per NASA-STD-8719.14B:

> ***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).*

Table 12: Compliance to Requirement 4.5-2

Satellite	Probability of PMD Failure due	Compliance Status per DAS	Altitude	Inc.	Launch

	to Small Object Collision				
Global -5 -6 -7 -8	0.003826	COMPLIANT	550	45	2020.0
	0.004589	COMPLIANT	550	55	2020.0
	0.000402	COMPLIANT	385	45	2020.0
	0.000499	COMPLIANT	385	55	2020.0
Global -9 -10 -11 -12	0.004298	COMPLIANT	600	35	2020.25
	0.006735	COMPLIANT	600	60	2020.25
	0.000335	COMPLIANT	385	35	2020.25
	0.000570	COMPLIANT	385	60	2020.25
Global -13 -14 -15 -16	0.003876	COMPLIANT	600	35	2020.75
	0.006058	COMPLIANT	600	60	2020.75
	0.000334	COMPLIANT	385	35	2020.75
	0.000569	COMPLIANT	385	60	2020.75

8. ODAR Section 6: Assessment of Spacecraft Post-Mission Disposal Plans and Procedures

8.1. NASA-STD-8719.14B Criteria for ODAR Section 6

Table 13: NASA-STD-8719.14B Criteria for ODAR Section 6

	NASA-STD-8719.14B Item	Response
a	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. The average cross-sectional area was determined in accordance with NASA-STD-8719.14B by "determining the view, V, that yields the maximum cross-sectional area and denote the cross-sectional area as Amax. Let A1 and A2 be the cross-sectional areas for the two viewing directions orthogonal to V. Then define the average cross-sectional area as (Amax + A1 + A2) / 2."

	NASA-STD-8719.14B Item	**Response**
b	Identification of all systems or components required to accomplish any postmission disposal maneuvers. Plan for any spacecraft maneuvers required to accomplish postmission disposal	No maneuvers are required following normal operations.
c	Calculation of area-to-mass ratio after postmission disposal, if the controlled reentry option is not selected.	Spacecraft Mass at EOL: 51.0 kg Cross-sectional Area: 0.385 m^2 Area to mass ratio: 0.00755 m^2/kg
d	If appropriate, preliminary plan for spacecraft controlled reentry	Not applicable.

	NASA-STD-8719.14B Item	Response
e	Assessment of spacecraft compliance with Requirements 4.6-1 through 4.6-4	See Section 0,

ite Name	Launch Year	Operational Life	Post-Ops Life	Total Lifetime	Compliant?	Altitude
lobal -6 -7 -8	2020.0	3 yrs	10.2 yrs	13.2 yrs	Yes	550
	2020.0	3 yrs	10.2 yrs	13.2 yrs	Yes	550
	2020.0	3 yrs	0.3 yrs	3.3 yrs	Yes	385
	2020.0	3 yrs	0.3 yrs	3.3 yrs	Yes	385
lobal 0 -11 -12	2020.25	3 yrs	20.7 yrs	23.7 yrs	Yes	600
	2020.25	3 yrs	20.8 yrs	23.8 yrs	Yes	600
	2020.25	3 yrs	0.3 yrs	3.3 yrs	Yes	385
	2020.25	3 yrs	0.3 yrs	3.3 yrs	Yes	385
lobal 4 -15 -16	2020.75	3 yrs	20.8 yrs	23.8 yrs	Yes	600
	2020.75	3 yrs	20.9 yrs	23.9 yrs	Yes	600
	2020.75	3 yrs	0.3 yrs	3.3 yrs	Yes	385
	2020.75	3 yrs	0.4 yrs	3.4 yrs	Yes	385

Compliance to Requirements 4.6-1 through -4.

8.2. Operational Orbit and Lifetime

The orbit lifetime/dwell time is calculated below using DAS's Orbit Lifetime/Dwell time calculator under Science and Engineering. The compliance column is determined from DAS's requirement assessment for Requirement 4.6-1. For each block of anticipated satellite launch dates, a range of cases were run in DAS to envelope the worst-case altitudes and orbit inclinations. The results of the maximum and minimum altitudes and inclinations are shown in the results tables. The worst-case DAS output logs are reproduced in the Appendix.

Table 14: Operational Orbit and Lifetime

Satellite Name	Launch Year	Operational Life	Post-Ops Life	Total Lifetime	Compliant?	Altitude	Inc.

Global -5 -6 -7 -8	2020.0	3 yrs	10.2 yrs	13.2 yrs	Yes	550	45
	2020.0	3 yrs	10.2 yrs	13.2 yrs	Yes	550	55
	2020.0	3 yrs	0.3 yrs	3.3 yrs	Yes	385	45
	2020.0	3 yrs	0.3 yrs	3.3 yrs	Yes	385	55
Global -9 -10 -11 -12	2020.25	3 yrs	20.7 yrs	23.7 yrs	Yes	600	35
	2020.25	3 yrs	20.8 yrs	23.8 yrs	Yes	600	60
	2020.25	3 yrs	0.3 yrs	3.3 yrs	Yes	385	35
	2020.25	3 yrs	0.3 yrs	3.3 yrs	Yes	385	60
Global -13 -14 -15 -16	2020.75	3 yrs	20.8 yrs	23.8 yrs	Yes	600	35
	2020.75	3 yrs	20.9 yrs	23.9 yrs	Yes	600	60
	2020.75	3 yrs	0.3 yrs	3.3 yrs	Yes	385	35
	2020.75	3 yrs	0.4 yrs	3.4 yrs	Yes	385	60

8.3. Compliance to Requirements 4.6-1 through 4.6-4

Table 15: Compliance to Requirements 4.6-1 through 4.6-4

Requirement	Compliance Statement
Requirement 4.6-1: Disposal for space structures in or passing through LEO: A spacecraft or orbital stage with a perigee altitude below 2,000 km shall be disposed of by one of the following three methods:	See following three rows.
a. **Atmospheric reentry option:** (1) Leave the space structure in an orbit in which natural forces will lead to atmospheric reentry within 25 years after the completion of mission or NASA-STD-8719.14B – 2019-04-25 (2) Maneuver the space structure into a controlled de-orbit trajectory as soon as practical after completion of mission.	Compliant with Option (1) per DAS results shown in Section 8.2, Operational Orbit and Lifetime.
b. **Storage orbit option:** Maneuver the space structure into an orbit with perigee altitude above 2000 km and ensure its apogee altitude will be below 19,700 km, both for a minimum of 100 years.	Not applicable. Disposal will be atmospheric reentry.
c. **Direct retrieval:** Retrieve the space structure and remove it from orbit within 10 years after completion of mission.	Not applicable. Disposal will be atmospheric reentry.

Requirement	Compliance Statement
Requirement 4.6-2: Disposal for space structures near GEO: A spacecraft or orbital stage in an orbit near GEO shall be maneuvered at EOM to a disposal orbit above GEO with a predicted minimum perigee of GEO +200 km (35,986 km) or below GEO with a predicted maximum apogee of GEO – 200 km (35,586 km) for a period of at least 100 years after disposal.	Not applicable. Spacecraft does not go beyond LEO.
Requirement 4.6-3: Disposal for space structures between LEO and GEO: a. Between LEO and Medium Earth Orbit (MEO): A spacecraft or orbital stage shall be left in an orbit with a perigee altitude greater than 2000 km and apogee altitude below 19,700 km for 100 years. b. Between MEO and GEO: A spacecraft or orbital stage shall be left in an orbit with a perigee altitude greater than 20,700 km and apogee altitude below 35,300 km for 100 years.	Not applicable. Spacecraft does not go beyond LEO.
Requirement 4.6-4: Reliability of postmission disposal maneuver operations in Earth orbit: NASA space programs and projects shall ensure that all postmission disposal operations to meet Requirements 4.6-1, 4.6-2, and/or 4.6-3 are designed for a probability of success as follows: a. Be no less than 0.90 at EOM, and b. For controlled reentry, the probability of success at the time of reentry burn must be sufficiently high so as not to cause a violation of Requirement 4.7-1 pertaining to limiting the risk of human casualty.	Not applicable. This is not a part of a NASA space program or project.

9. ODAR Section 7: Assessment of Spacecraft Reentry Hazards

9.1. NASA-STD-8719.14B Criteria for ODAR Section 7

Table 16: NASA-STD-8719.14B Criteria for ODAR Section 7

	NASA-STD-8719.14B Item	Response
a	a. Detailed description of spacecraft components by size, mass, material, shape, and original location on the space vehicle, if the atmospheric reentry option is selected	See Section 9.2.1 and Appendix A.
b	b. Summary of objects expected to survive an uncontrolled reentry, using NASA DAS, NASA Object Reentry Survival Analysis Tool (ORSAT), or comparable software	See Section 9.2.2.
c	Calculation of probability of human casualty for the expected year of uncontrolled reentry and the spacecraft orbital inclination	See Section 9.2.2.
d	Assessment of spacecraft compliance with Requirement 4.7-1	See Section 0.

9.2. DAS Reentry Debris Analysis

9.2.1. Component by Size, Mass, Material, Shape and Location

See input information for DAS software's evaluation of Requirement 4.7-1 in Appendix A.

9.2.2. DAS Analysis Results

Compliance to this requirement is determined from DAS's requirement assessment for Requirement 4.7-1. For each block of anticipated satellite launch dates, a range of cases were run in DAS to envelope the worst-case altitudes and orbit inclinations. The results of the maximum and minimum altitudes and inclinations are shown in the results tables. The worst-case DAS output logs are reproduced in the Appendix. According to DAS calculations, there is a low risk of Human Casualty for Global-5 through Global-16; see DAS run data in Appendix A.

Note that 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.

Table 17: DAS Results for Casualty Risk due to Reentry Debris

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Satellite	Risk of Human Casualty	Compliance Status	Altitude	Inc.	Launch
Global -5 -6 -7 -8	1:30300	COMPLIANT	550	45	2020.0
	1:35300	COMPLIANT	550	55	2020.0
	1:32400	COMPLIANT	385	45	2020.0
	1:37500	COMPLIANT	385	55	2020.0
Global -9 -10 -11 -12	1:23000	COMPLIANT	600	35	2020.25
	1:37300	COMPLIANT	600	60	2020.25
	1:26300	COMPLIANT	385	35	2020.25
	1:41900	COMPLIANT	385	60	2020.25
Global -13 -14 -15 -16	1:22800	COMPLIANT	600	35	2020.75
	1:37300	COMPLIANT	600	60	2020.75
	1:26100	COMPLIANT	385	35	2020.75
	1:41600	COMPLIANT	385	60	2020.75

9.3. Compliance to Requirement 4.7-1

Table 18: Compliance to Requirement 4.7-1

Requirement	Compliance Statement
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:	See following three rows.
a. For uncontrolled reentry, the risk of human casualty from surviving debris shall not exceed 0.0001 (1:10,000).	Compliant per Section 9.2.2.
b. 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.	Not applicable. Satellite will have uncontrolled reentry.
c. For controlled reentries, the product of the probability of failure to execute the reentry burn and the risk of human casualty assuming uncontrolled reentry shall not exceed 0.0001 (1:10,000).	Not applicable. Satellite will have uncontrolled reentry.

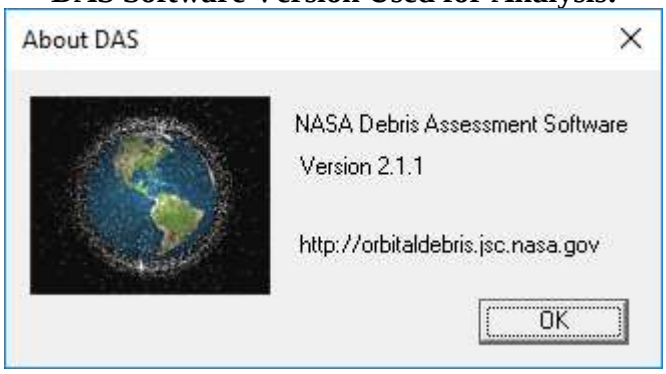
10. ODAR Sections 8 – 14 Applicability Overview

Table 19: ODAR Sections 8-14 Applicability Overview

ODAR Section(s)	Response
Section 8: Assessment for Tether Missions	Not applicable. There are no tethers on the Global satellites.
Sections 9 -14: Launch Vehicle	Only applicable to launch vehicles.

Appendix A: Supporting DAS Run Data

DAS Software Version Used for Analysis:



Header of DAS Solar Flux file used:

```
JD, Solar f10.7 flux (noontime), yyyy mm dd
No missing Days (interpolated)

Executed by A. Manis on 09/04/2019
```

Start of DAS Run Output for Global-5 through Global-8

Requirement 4.5-1

```
06 14 2019; 12:28:03PM  Processing Requirement 4.5-1: Return Status :  Passed

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

**INPUT**

      Space Structure Name = Global-5
      Space Structure Type = Payload
      Perigee Altitude = 550.000000 (km)
      Apogee Altitude = 550.000000 (km)
      Inclination = 55.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Final Area-To-Mass Ratio = 0.007550 (m^2/kg)
      Start Year = 2020.000000 (yr)
      Initial Mass = 55.400000 (kg)
      Final Mass = 51.000000 (kg)
      Duration = 3.000000 (yr)
      Station-Kept = True
      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 = 0.000008
      Returned Error Message: Normal Processing
      Date Range Error Message: Normal Date Range
      Status = Pass

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

=============== End of Requirement 4.5-1 ===============
```

Requirement 4.5-2

06 14 2019; 11:46:38AM Requirement 4.5-2: Compliant

==========

Spacecraft = Global-5
Critical Surface = FC+X

==========

INPUT

Apogee Altitude = 550.000000 (km)
Perigee Altitude = 550.000000 (km)
Orbital Inclination = 55.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.000000 (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 Penetration = 0.000000 (0.000000)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========

Spacecraft = Global-5
Critical Surface = FC+Y

==========

INPUT

Apogee Altitude = 550.000000 (km)
Perigee Altitude = 550.000000 (km)
Orbital Inclination = 55.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.000000 (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 Penetration = 0.000000 (0.000000)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========

Spacecraft = Global-5

Critical Surface = Battery+X
==========
==========

INPUT

Apogee Altitude = 550.000000 (km)
Perigee Altitude = 550.000000 (km)
Orbital Inclination = 55.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.000000 (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

Probabilty of Penetration = 0.000002 (0.000002)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
==========
Spacecraft = Global-5
Critical Surface = Battery+Y
==========
==========

INPUT

Apogee Altitude = 550.000000 (km)
Perigee Altitude = 550.000000 (km)
Orbital Inclination = 55.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.000000 (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

Probabilty of Penetration = 0.000000 (0.000000)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
==========
Spacecraft = Global-5
Critical Surface = Tank+Y
==========
==========

INPUT

Apogee Altitude = 550.000000 (km)
Perigee Altitude = 550.000000 (km)
Orbital Inclination = 55.000000 (deg)
RAAN = 0.000000 (deg)

Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.000000 (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

Probabilty of Penetration = 0.000196 (0.000196)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
==========
Spacecraft = Global-5
Critical Surface = Tank+X
==========
==========

INPUT

Apogee Altitude = 550.000000 (km)
Perigee Altitude = 550.000000 (km)
Orbital Inclination = 55.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.000000 (yr)
Duration = 3.000000 (yr)
Orientation = Random Tumbling
CS Areal Density = 3.091093 (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

Probabilty of Penetration = 0.004391 (0.004400)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

Requirement 4.6-1

```
 06 14 2019; 11:42:20AM Processing Requirement 4.6    Return Status :  Passed

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

 **INPUT**

      Space Structure Name = Global-5
      Space Structure Type = Payload

      Perigee Altitude = 550.000000 (km)
      Apogee Altitude = 550.000000 (km)
      Inclination = 55.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Area-To-Mass Ratio = 0.007550 (m^2/kg)
      Start Year = 2020.000000 (yr)
      Initial Mass = 55.400000 (kg)
      Final Mass = 51.000000 (kg)
      Duration = 3.000000 (yr)
      Station Kept = True
      Abandoned = True
      PMD Perigee Altitude = 550.000000 (km)
      PMD Apogee Altitude = 550.000000 (km)
      PMD Inclination = 55.000000 (deg)
      PMD RAAN = 0.000000 (deg)
      PMD Argument of Perigee = 0.000000 (deg)
      PMD Mean Anomaly = 0.000000 (deg)

 **OUTPUT**

      Suggested Perigee Altitude = 550.000000 (km)
      Suggested Apogee Altitude = 550.000000 (km)
      Returned Error Message = Passes LEO reentry orbit criteria.

      Released Year = 2033 (yr)
      Requirement = 61
      Compliance Status = Pass

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

=============== End of Requirement 4.6 ===============
```

Requirement 4.7-1

06 15 2019; 22:01:57PM
**********Processing Requirement 4.7-1
Return Status : Passed

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

name = Global-5
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 = Box
Aero Mass = 5.400000
Thermal Mass = 5.400000
Diameter/Width = 0.450000
Length = 0.500000
Height = 0.018000

name = Star Tracker
quantity = 2
parent = 1
materialID = 5
type = Cylinder
Aero Mass = 0.158000
Thermal Mass = 0.158000
Diameter/Width = 0.100000
Length = 0.120000

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

name = Telescope
quantity = 1
parent = 1
materialID = 5
type = Cylinder
Aero Mass = 8.319000
Thermal Mass = 3.400000
Diameter/Width = 0.330000
Length = 0.490000

name = Baffle
quantity = 1
parent = 7
materialID = 27
type = Cylinder
Aero Mass = 1.000000
Thermal Mass = 1.000000
Diameter/Width = 0.330000
Length = 0.490000

name = Bulkhead
quantity = 1
parent = 7
materialID = 27
type = Flat Plate
Aero Mass = 1.000000
Thermal Mass = 1.000000
Diameter/Width = 0.260000
Length = 0.260000

name = M1 Mirror
quantity = 1
parent = 7
materialID = 71
type = Flat Plate
Aero Mass = 1.300000
Thermal Mass = 1.300000
Diameter/Width = 0.260000
Length = 0.260000

name = Spider
quantity = 1
parent = 7
materialID = 72
type = Cylinder
Aero Mass = 1.300000
Thermal Mass = 1.300000
Diameter/Width = 0.260000
Length = 0.490000

name = Camera
quantity = 1
parent = 7
materialID = -2
type = Box
Aero Mass = 0.319000
Thermal Mass = 0.319000
Diameter/Width = 0.045000
Length = 0.045000
Height = 0.039000

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

name = X-Band Antenna
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.140000
Thermal Mass = 0.140000
Diameter/Width = 0.102000
Length = 0.114000

name = S-Band Antenna
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.055000
Thermal Mass = 0.055000
Diameter/Width = 0.076000
Length = 0.076000

name = Magnetometer 2
quantity = 1
parent = 1
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 = 1
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 = Box
Aero Mass = 5.400000
Thermal Mass = 5.400000
Diameter/Width = 0.450000
Length = 0.500000
Height = 0.018000

name = Tank 1
quantity = 1
parent = 1
materialID = 8
type = Cylinder
Aero Mass = 0.720000
Thermal Mass = 0.720000
Diameter/Width = 0.146800
Length = 0.265900

name = Tank 2
quantity = 1
parent = 1
materialID = 8
type = Cylinder
Aero Mass = 0.720000
Thermal Mass = 0.720000
Diameter/Width = 0.146800
Length = 0.265900

name = Thruster Head Assembly
quantity = 1
parent = 1
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 = 1
materialID = 8
type = Cylinder
Aero Mass = 0.005000
Thermal Mass = 0.005000
Diameter/Width = 0.015300
Length = 0.064000

name = UHF Whip Antenna
quantity = 1
parent = 1
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 = 1
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 = 1
materialID = 65
type = Box
Aero Mass = 0.053000
Thermal Mass = 0.053000
Diameter/Width = 0.055920
Length = 0.121500
Height = 0.045730

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

name = MLB Upper Half
quantity = 1
parent = 1
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 = Box
Aero Mass = 5.400000
Thermal Mass = 5.400000
Diameter/Width = 0.450000
Length = 0.500000
Height = 0.018000

name = PCU
quantity = 1
parent = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
materialID = 8
type = Box
Aero Mass = 0.137000
Thermal Mass = 0.137000
Diameter/Width = 0.077500
Length = 0.083000
Height = 0.018230

name = SA Substrate
quantity = 1
parent = 1
materialID = 5
type = Flat Plate
Aero Mass = 3.876000
Thermal Mass = 3.300000
Diameter/Width = 0.665000
Length = 0.845000

name = GaAs Cells
quantity = 72
parent = 40
materialID = 24
type = Flat Plate
Aero Mass = 0.008000
Thermal Mass = 0.008000
Diameter/Width = 0.078000
Length = 0.078000

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-5
Demise Altitude = 77.995354
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Payload Deck
Demise Altitude = 60.014431
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Star Tracker
Demise Altitude = 76.151749
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = IMU
Demise Altitude = 75.110825
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Magnetometer 1
Demise Altitude = 75.801071
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = DC-DC Converter 1
Demise Altitude = 74.642799
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Telescope
Demise Altitude = 73.937492
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Baffle
Demise Altitude = 73.622856
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Bulkhead
Demise Altitude = 72.649635
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = M1 Mirror
Demise Altitude = 0.000000
Debris Casualty Area = 0.739600
Impact Kinetic Energy = 408.651794

****
name = Spider
Demise Altitude = 0.000000
Debris Casualty Area = 0.915718
Impact Kinetic Energy = 132.431351

****
name = Camera
Demise Altitude = 73.937492
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Antenna Deck
Demise Altitude = 76.930244
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = X-Band Antenna
Demise Altitude = 75.142517
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = S-Band Antenna
Demise Altitude = 76.026260
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Magnetometer 2
Demise Altitude = 75.840294
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Coarse Sun Sensor
Demise Altitude = 77.615707
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Propulsion Deck
Demise Altitude = 60.014431
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Tank 1
Demise Altitude = 74.855232

Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Tank 2
Demise Altitude = 74.855232
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Thruster Head Assembly
Demise Altitude = 74.780220
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Coarse Sun Sensor
Demise Altitude = 77.615707
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Whip Antenna
Demise Altitude = 77.838249
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Whip Cover
Demise Altitude = 77.674576
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 = 5.603590

****
name = Fine Sun Sensor
Demise Altitude = 75.232819
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = MLB Upper Half
Demise Altitude = 76.181831
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Avionics Deck
Demise Altitude = 60.014431
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = PCU
Demise Altitude = 71.008041
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Battery
Demise Altitude = 77.995354
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = DC-DC Converter 2
Demise Altitude = 74.642799
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = X-Band Radio
Demise Altitude = 69.667610
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = S-Band Radio
Demise Altitude = 74.575531
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Radio
Demise Altitude = 74.045509
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = FC
Demise Altitude = 63.451412
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Reaction Wheels
Demise Altitude = 75.666351
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Torque Rods
Demise Altitude = 65.992989
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = GPS Receiver
Demise Altitude = 73.263237
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = DC-DC Converter 3
Demise Altitude = 74.642799
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = SA Substrate
Demise Altitude = 71.044975
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = GaAs Cells
Demise Altitude = 0.000000
Debris Casualty Area = 33.097252
Impact Kinetic Energy = 0.171585

****
name = Radiating Side Panel
Demise Altitude = 75.511124
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Support Strut
Demise Altitude = 77.447731
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Front Side Panel
Demise Altitude = 75.784134
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

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

End of DAS Run Output for Global-5 through Global-8

Start of DAS Run Output for Global-9 through Global-12

Requirement 4.5-1

```
06 14 2019; 14:15:45PM  Processing Requirement 4.5-1: Return Status :  Passed

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

**INPUT**

      Space Structure Name = Global-9
      Space Structure Type = Payload
      Perigee Altitude = 600.000000 (km)
      Apogee Altitude = 600.000000 (km)
      Inclination = 60.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Final Area-To-Mass Ratio = 0.007550 (m^2/kg)
      Start Year = 2020.250000 (yr)
      Initial Mass = 55.400000 (kg)
      Final Mass = 51.000000 (kg)
      Duration = 3.000000 (yr)
      Station-Kept = True
      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 = 0.000021
      Returned Error Message: Normal Processing
      Date Range Error Message: Normal Date Range
      Status = Pass

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

=============== End of Requirement 4.5-1 ===============
```

Requirement 4.5-2

06 14 2019; 15:17:58PM Requirement 4.5-2: Compliant

==========
==========
Spacecraft = Global-9
Critical Surface = FC+X
==========
==========

INPUT

Apogee Altitude = 600.000000 (km)
Perigee Altitude = 600.000000 (km)
Orbital Inclination = 60.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.250000 (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 Penetration = 0.000001 (0.000001)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
==========
Spacecraft = Global-9
Critical Surface = FC+Y
==========
==========

INPUT

Apogee Altitude = 600.000000 (km)
Perigee Altitude = 600.000000 (km)
Orbital Inclination = 60.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.250000 (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 Penetration = 0.000000 (0.000000)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
==========
Spacecraft = Global-9

Critical Surface = Battery+X
==========
==========

INPUT

Apogee Altitude = 600.000000 (km)
Perigee Altitude = 600.000000 (km)
Orbital Inclination = 60.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.250000 (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

Probabilty of Penetration = 0.000003 (0.000003)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
==========
Spacecraft = Global-9
Critical Surface = Battery+Y
==========
==========

INPUT

Apogee Altitude = 600.000000 (km)
Perigee Altitude = 600.000000 (km)
Orbital Inclination = 60.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.250000 (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

Probabilty of Penetration = 0.000000 (0.000000)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
==========
Spacecraft = Global-9
Critical Surface = Tank+Y
==========
==========

INPUT

Apogee Altitude = 600.000000 (km)
Perigee Altitude = 600.000000 (km)
Orbital Inclination = 60.000000 (deg)
RAAN = 0.000000 (deg)

Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.250000 (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

Probabilty of Penetration = 0.000300 (0.000300)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
==========
Spacecraft = Global-9
Critical Surface = Tank+X
==========
==========

INPUT

Apogee Altitude = 600.000000 (km)
Perigee Altitude = 600.000000 (km)
Orbital Inclination = 60.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.250000 (yr)
Duration = 3.000000 (yr)
Orientation = Random Tumbling
CS Areal Density = 3.091093 (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

Probabilty of Penetration = 0.006432 (0.006453)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

Requirement 4.6-1

```
06 14 2019; 13:50:29PM  Processing Requirement 4.6    Return Status :  Passed

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

**INPUT**

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

      Perigee Altitude = 600.000000 (km)
      Apogee Altitude = 600.000000 (km)
      Inclination = 60.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Area-To-Mass Ratio = 0.007550 (m^2/kg)
      Start Year = 2020.250000 (yr)
      Initial Mass = 55.400000 (kg)
      Final Mass = 51.000000 (kg)
      Duration = 3.000000 (yr)
      Station Kept = True
      Abandoned = True
      PMD Perigee Altitude = 600.000000 (km)
      PMD Apogee Altitude = 600.000000 (km)
      PMD Inclination = 60.000000 (deg)
      PMD RAAN = 0.000000 (deg)
      PMD Argument of Perigee = 0.000000 (deg)
      PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

      Suggested Perigee Altitude = 600.000000 (km)
      Suggested Apogee Altitude = 600.000000 (km)
      Returned Error Message = Passes LEO reentry orbit criteria.

      Released Year = 2044 (yr)
      Requirement = 61
      Compliance Status = Pass

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

=============== End of Requirement 4.6 ===============
```

Requirement 4.7-1

06 15 2019; 22:04:32PM
**********Processing
Requirement 4.7-1
Return Status : Passed

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

name = Global-5
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 = Box
Aero Mass = 5.400000
Thermal Mass = 5.400000
Diameter/Width = 0.450000
Length = 0.500000
Height = 0.018000

name = Star Tracker
quantity = 2
parent = 1
materialID = 5
type = Cylinder
Aero Mass = 0.158000
Thermal Mass = 0.158000
Diameter/Width = 0.100000
Length = 0.120000

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

name = Telescope
quantity = 1
parent = 1
materialID = 5
type = Cylinder
Aero Mass = 8.319000
Thermal Mass = 3.400000
Diameter/Width = 0.330000
Length = 0.490000

name = Baffle
quantity = 1
parent = 7
materialID = 27
type = Cylinder
Aero Mass = 1.000000
Thermal Mass = 1.000000
Diameter/Width = 0.330000
Length = 0.490000

name = Bulkhead
quantity = 1
parent = 7
materialID = 27
type = Flat Plate
Aero Mass = 1.000000
Thermal Mass = 1.000000
Diameter/Width = 0.260000
Length = 0.260000

name = M1 Mirror
quantity = 1
parent = 7
materialID = 71
type = Flat Plate
Aero Mass = 1.300000
Thermal Mass = 1.300000
Diameter/Width = 0.260000
Length = 0.260000

name = Spider
quantity = 1
parent = 7
materialID = 72
type = Cylinder
Aero Mass = 1.300000
Thermal Mass = 1.300000
Diameter/Width = 0.260000
Length = 0.490000

name = Camera
quantity = 1
parent = 7
materialID = -2
type = Box
Aero Mass = 0.319000
Thermal Mass = 0.319000
Diameter/Width = 0.045000
Length = 0.045000
Height = 0.039000

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

name = X-Band Antenna
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.140000
Thermal Mass = 0.140000
Diameter/Width = 0.102000
Length = 0.114000

name = S-Band Antenna
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.055000
Thermal Mass = 0.055000
Diameter/Width = 0.076000
Length = 0.076000

name = Magnetometer 2
quantity = 1
parent = 1
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 = 1
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 = Box
Aero Mass = 5.400000
Thermal Mass = 5.400000
Diameter/Width = 0.450000
Length = 0.500000
Height = 0.018000

name = Tank 1
quantity = 1
parent = 1
materialID = 8
type = Cylinder
Aero Mass = 0.720000
Thermal Mass = 0.720000
Diameter/Width = 0.146800
Length = 0.265900

name = Tank 2
quantity = 1
parent = 1
materialID = 8
type = Cylinder
Aero Mass = 0.720000
Thermal Mass = 0.720000
Diameter/Width = 0.146800
Length = 0.265900

name = Thruster Head Assembly
quantity = 1
parent = 1
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 = 1
materialID = 8
type = Cylinder
Aero Mass = 0.005000
Thermal Mass = 0.005000
Diameter/Width = 0.015300
Length = 0.064000

name = UHF Whip Antenna
quantity = 1
parent = 1
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 = 1
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 = 1
materialID = 65
type = Box
Aero Mass = 0.053000
Thermal Mass = 0.053000
Diameter/Width = 0.055920
Length = 0.121500
Height = 0.045730

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

name = MLB Upper Half
quantity = 1
parent = 1
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 = Box
Aero Mass = 5.400000
Thermal Mass = 5.400000
Diameter/Width = 0.450000
Length = 0.500000
Height = 0.018000

name = PCU
quantity = 1
parent = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
materialID = 8
type = Box
Aero Mass = 0.137000
Thermal Mass = 0.137000
Diameter/Width = 0.077500
Length = 0.083000
Height = 0.018230

name = SA Substrate
quantity = 1
parent = 1
materialID = 5
type = Flat Plate
Aero Mass = 3.876000
Thermal Mass = 3.300000
Diameter/Width = 0.665000
Length = 0.845000

name = GaAs Cells
quantity = 72
parent = 40
materialID = 24
type = Flat Plate
Aero Mass = 0.008000
Thermal Mass = 0.008000
Diameter/Width = 0.078000
Length = 0.078000

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-5
Demise Altitude = 77.994339
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Payload Deck
Demise Altitude = 60.896149
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Star Tracker
Demise Altitude = 76.180412
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = IMU
Demise Altitude = 75.149445
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Magnetometer 1
Demise Altitude = 75.830544
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = DC-DC Converter 1
Demise Altitude = 74.698616
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Telescope
Demise Altitude = 73.986740
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Baffle
Demise Altitude = 73.672806
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Bulkhead
Demise Altitude = 72.719086
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = M1 Mirror
Demise Altitude = 0.000000
Debris Casualty Area = 0.739600
Impact Kinetic Energy = 408.636993

****
name = Spider
Demise Altitude = 0.000000
Debris Casualty Area = 0.915718
Impact Kinetic Energy = 132.427155

****
name = Camera
Demise Altitude = 73.986740
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Antenna Deck
Demise Altitude = 76.954674
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = X-Band Antenna
Demise Altitude = 75.188805
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = S-Band Antenna
Demise Altitude = 76.055138
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Magnetometer 2
Demise Altitude = 75.877213
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Coarse Sun Sensor
Demise Altitude = 77.621475
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Propulsion Deck
Demise Altitude = 60.896149
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Tank 1
Demise Altitude = 74.910347

Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Tank 2
Demise Altitude = 74.910347
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Thruster Head Assembly
Demise Altitude = 74.835556
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Coarse Sun Sensor
Demise Altitude = 77.621475
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Whip Antenna
Demise Altitude = 77.844025
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Whip Cover
Demise Altitude = 77.673653
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 = 5.603589

****
name = Fine Sun Sensor
Demise Altitude = 75.278969
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = MLB Upper Half
Demise Altitude = 76.223755
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Avionics Deck
Demise Altitude = 60.896149
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = PCU
Demise Altitude = 71.134094
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Battery
Demise Altitude = 77.994339
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = DC-DC Converter 2
Demise Altitude = 74.698616
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = X-Band Radio
Demise Altitude = 69.798393
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = S-Band Radio
Demise Altitude = 74.631538
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Radio
Demise Altitude = 74.103111
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = FC
Demise Altitude = 63.665905
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Reaction Wheels
Demise Altitude = 75.718399
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Torque Rods
Demise Altitude = 66.210014
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = GPS Receiver
Demise Altitude = 73.340645
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = DC-DC Converter 3
Demise Altitude = 74.698616
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = SA Substrate
Demise Altitude = 71.368172
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = GaAs Cells
Demise Altitude = 0.000000
Debris Casualty Area = 33.097252
Impact Kinetic Energy = 0.171583

****
name = Radiating Side Panel
Demise Altitude = 75.585350
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Support Strut
Demise Altitude = 77.459450
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Front Side Panel
Demise Altitude = 75.841820
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

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

End of DAS Run Output for Global-9 through Global-12

Start of DAS Run Output for Global-13 through Global-16

Requirement 4.5-1

```
06 14 2019; 15:55:10PM  Processing Requirement 4.5-1: Return Status :  Passed

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

**INPUT**

      Space Structure Name = Global-13
      Space Structure Type = Payload
      Perigee Altitude = 600.000000 (km)
      Apogee Altitude = 600.000000 (km)
      Inclination = 60.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Final Area-To-Mass Ratio = 0.007550 (m^2/kg)
      Start Year = 2020.750000 (yr)
      Initial Mass = 55.400000 (kg)
      Final Mass = 51.000000 (kg)
      Duration = 3.000000 (yr)
      Station-Kept = True
      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 = 0.000020
      Returned Error Message: Normal Processing
      Date Range Error Message: Normal Date Range
      Status = Pass

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

=============== End of Requirement 4.5-1 ===============
```

Requirement 4.5-2

06 14 2019; 15:29:57PM Requirement 4.5-2: Compliant

==========
Spacecraft = Global-13
Critical Surface = FC+X
==========

INPUT

Apogee Altitude = 600.000000 (km)
Perigee Altitude = 600.000000 (km)
Orbital Inclination = 60.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.750000 (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 Penetration = 0.000001 (0.000001)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
Spacecraft = Global-13
Critical Surface = FC+Y
==========

INPUT

Apogee Altitude = 600.000000 (km)
Perigee Altitude = 600.000000 (km)
Orbital Inclination = 60.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.750000 (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 Penetration = 0.000000 (0.000000)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
Spacecraft = Global-13

Critical Surface = Battery+X
==========
==========

INPUT

Apogee Altitude = 600.000000 (km)
Perigee Altitude = 600.000000 (km)
Orbital Inclination = 60.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.750000 (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

Probabilty of Penetration = 0.000003 (0.000003)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
==========
Spacecraft = Global-13
Critical Surface = Battery+Y
==========
==========

INPUT

Apogee Altitude = 600.000000 (km)
Perigee Altitude = 600.000000 (km)
Orbital Inclination = 60.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.750000 (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

Probabilty of Penetration = 0.000000 (0.000000)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
==========
Spacecraft = Global-13
Critical Surface = Tank+Y
==========
==========

INPUT

Apogee Altitude = 600.000000 (km)
Perigee Altitude = 600.000000 (km)
Orbital Inclination = 60.000000 (deg)
RAAN = 0.000000 (deg)

Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.750000 (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

Probabilty of Penetration = 0.000273 (0.000273)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
==========
Spacecraft = Global-13
Critical Surface = Tank+X
==========
==========

INPUT

Apogee Altitude = 600.000000 (km)
Perigee Altitude = 600.000000 (km)
Orbital Inclination = 60.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass = 0.007550 (m^2/kg)
Initial Mass = 51.000000 (kg)
Final Mass = 51.000000 (kg)
Station Kept = Yes
Start Year = 2020.750000 (yr)
Duration = 3.000000 (yr)
Orientation = Random Tumbling
CS Areal Density = 3.091093 (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

Probabilty of Penetration = 0.005782 (0.005799)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

Requirement 4.6-1

```
06 14 2019; 15:23:46PM  Processing Requirement 4.6    Return Status :  Passed

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

**INPUT**

      Space Structure Name = Global-13
      Space Structure Type = Payload

      Perigee Altitude = 600.000000 (km)
      Apogee Altitude = 600.000000 (km)
      Inclination = 60.000000 (deg)
      RAAN = 0.000000 (deg)
      Argument of Perigee = 0.000000 (deg)
      Mean Anomaly = 0.000000 (deg)
      Area-To-Mass Ratio = 0.007550 (m^2/kg)
      Start Year = 2020.750000 (yr)
      Initial Mass = 55.400000 (kg)
      Final Mass = 51.000000 (kg)
      Duration = 3.000000 (yr)
      Station Kept = True
      Abandoned = True
      PMD Perigee Altitude = 600.000000 (km)
      PMD Apogee Altitude = 600.000000 (km)
      PMD Inclination = 60.000000 (deg)
      PMD RAAN = 0.000000 (deg)
      PMD Argument of Perigee = 0.000000 (deg)
      PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

      Suggested Perigee Altitude = 600.000000 (km)
      Suggested Apogee Altitude = 600.000000 (km)
      Returned Error Message = Passes LEO reentry orbit criteria.

      Released Year = 2044 (yr)
      Requirement = 61
      Compliance Status = Pass

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

=============== End of Requirement 4.6 ===============
```

Requirement 4.7-1

06 15 2019; 22:07:16PM
**********Processing
Requirement 4.7-1
Return Status : Passed

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

name = Global-5
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 = Box
Aero Mass = 5.400000
Thermal Mass = 5.400000
Diameter/Width = 0.450000
Length = 0.500000
Height = 0.018000

name = Star Tracker
quantity = 2
parent = 1
materialID = 5
type = Cylinder
Aero Mass = 0.158000
Thermal Mass = 0.158000
Diameter/Width = 0.100000
Length = 0.120000

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

name = Telescope
quantity = 1
parent = 1
materialID = 5
type = Cylinder
Aero Mass = 8.319000
Thermal Mass = 3.400000
Diameter/Width = 0.330000
Length = 0.490000

name = Baffle
quantity = 1
parent = 7
materialID = 27
type = Cylinder
Aero Mass = 1.000000
Thermal Mass = 1.000000
Diameter/Width = 0.330000
Length = 0.490000

name = Bulkhead
quantity = 1
parent = 7
materialID = 27
type = Flat Plate
Aero Mass = 1.000000
Thermal Mass = 1.000000
Diameter/Width = 0.260000
Length = 0.260000

name = M1 Mirror
quantity = 1
parent = 7
materialID = 71
type = Flat Plate
Aero Mass = 1.300000
Thermal Mass = 1.300000
Diameter/Width = 0.260000
Length = 0.260000

name = Spider
quantity = 1
parent = 7
materialID = 72
type = Cylinder
Aero Mass = 1.300000
Thermal Mass = 1.300000
Diameter/Width = 0.260000
Length = 0.490000

name = Camera
quantity = 1
parent = 7
materialID = -2
type = Box
Aero Mass = 0.319000
Thermal Mass = 0.319000
Diameter/Width = 0.045000
Length = 0.045000
Height = 0.039000

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

name = X-Band Antenna
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.140000
Thermal Mass = 0.140000
Diameter/Width = 0.102000
Length = 0.114000

name = S-Band Antenna
quantity = 1
parent = 1
materialID = 8
type = Flat Plate
Aero Mass = 0.055000
Thermal Mass = 0.055000
Diameter/Width = 0.076000
Length = 0.076000

name = Magnetometer 2
quantity = 1
parent = 1
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 = 1
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 = Box
Aero Mass = 5.400000
Thermal Mass = 5.400000
Diameter/Width = 0.450000
Length = 0.500000
Height = 0.018000

name = Tank 1
quantity = 1
parent = 1
materialID = 8
type = Cylinder
Aero Mass = 0.720000
Thermal Mass = 0.720000
Diameter/Width = 0.146800
Length = 0.265900

name = Tank 2
quantity = 1
parent = 1
materialID = 8
type = Cylinder
Aero Mass = 0.720000
Thermal Mass = 0.720000
Diameter/Width = 0.146800
Length = 0.265900

name = Thruster Head Assembly
quantity = 1
parent = 1
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 = 1
materialID = 8
type = Cylinder
Aero Mass = 0.005000
Thermal Mass = 0.005000
Diameter/Width = 0.015300
Length = 0.064000

name = UHF Whip Antenna
quantity = 1
parent = 1
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 = 1
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 = 1
materialID = 65
type = Box
Aero Mass = 0.053000
Thermal Mass = 0.053000
Diameter/Width = 0.055920
Length = 0.121500
Height = 0.045730

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

name = MLB Upper Half
quantity = 1
parent = 1
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 = Box
Aero Mass = 5.400000
Thermal Mass = 5.400000
Diameter/Width = 0.450000
Length = 0.500000
Height = 0.018000

name = PCU
quantity = 1
parent = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
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 = 1
materialID = 8
type = Box
Aero Mass = 0.137000
Thermal Mass = 0.137000
Diameter/Width = 0.077500
Length = 0.083000
Height = 0.018230

name = SA Substrate
quantity = 1
parent = 1
materialID = 5
type = Flat Plate
Aero Mass = 3.876000
Thermal Mass = 3.300000
Diameter/Width = 0.665000
Length = 0.845000

name = GaAs Cells
quantity = 72
parent = 40
materialID = 24
type = Flat Plate
Aero Mass = 0.008000
Thermal Mass = 0.008000
Diameter/Width = 0.078000
Length = 0.078000

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-5
Demise Altitude = 77.997704
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Payload Deck
Demise Altitude = 52.697868
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Star Tracker
Demise Altitude = 76.062614
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = IMU
Demise Altitude = 74.983971
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Magnetometer 1
Demise Altitude = 75.689598
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = DC-DC Converter 1
Demise Altitude = 74.482880
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Telescope
Demise Altitude = 73.778419
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Baffle
Demise Altitude = 73.446945
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Bulkhead
Demise Altitude = 72.418465
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = M1 Mirror
Demise Altitude = 0.000000
Debris Casualty Area = 0.739600
Impact Kinetic Energy = 408.651459

****
name = Spider
Demise Altitude = 0.000000
Debris Casualty Area = 0.915718
Impact Kinetic Energy = 132.424347

****
name = Camera
Demise Altitude = 73.778419
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Antenna Deck
Demise Altitude = 76.817810
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = X-Band Antenna
Demise Altitude = 74.991966
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = S-Band Antenna
Demise Altitude = 75.930031
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Magnetometer 2
Demise Altitude = 75.743881
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Coarse Sun Sensor
Demise Altitude = 77.595535
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Propulsion Deck
Demise Altitude = 52.697868
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Tank 1
Demise Altitude = 74.704063

Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Tank 2
Demise Altitude = 74.704063
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Thruster Head Assembly
Demise Altitude = 74.604378
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Coarse Sun Sensor
Demise Altitude = 77.595535
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Whip Antenna
Demise Altitude = 77.835571
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Whip Cover
Demise Altitude = 77.660217
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 = 5.603791

****
name = Fine Sun Sensor
Demise Altitude = 75.105980
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = MLB Upper Half
Demise Altitude = 76.052422
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Avionics Deck
Demise Altitude = 52.697868
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = PCU
Demise Altitude = 70.615112
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Battery
Demise Altitude = 77.997704
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = DC-DC Converter 2
Demise Altitude = 74.482880
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = X-Band Radio
Demise Altitude = 69.235970
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = S-Band Radio
Demise Altitude = 74.416008
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = UHF Radio
Demise Altitude = 73.859322
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = FC
Demise Altitude = 62.755486
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Reaction Wheels
Demise Altitude = 75.540581
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Torque Rods
Demise Altitude = 65.219513
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = GPS Receiver
Demise Altitude = 73.029572
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = DC-DC Converter 3
Demise Altitude = 74.482880
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = SA Substrate
Demise Altitude = 69.131935
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = GaAs Cells
Demise Altitude = 0.000000
Debris Casualty Area = 33.097252
Impact Kinetic Energy = 0.171585

****
name = Radiating Side Panel
Demise Altitude = 75.302673
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Support Strut
Demise Altitude = 77.412048
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Front Side Panel
Demise Altitude = 75.587051
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

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

End of DAS Run Output for Global-13 through Global-16