AST&Science LLC
File No. 1059-EX-CN-2020
SUBMITTED UNDER REQUEST FOR CONFIDENTIAL TREATMENT

Response of November 3, 2021

During AST's discussion with staff on November 1, 2021, questions were raised regarding the difference in the mass of the phased array between the declared mission mass and the sum of the phased array components in the demise analysis. AST was asked to go through all of the elements of the phased array to ensure that the DAS log was accurate regarding the component mass breakdown.

The difference of the mass of the phased array was due to a change in the mass of two items, the Micron Structure and the Micron Antennas. The Micron Structure mass increased to 1.82 kg because of structural modifications for stiffness. And each Micron Antenna element increased to 0.071 kg because the original estimate did not include the electronics board. This brings the total mass of the phased array to [redacted] kg in the demise analysis. The total mass listed in the DAS mission editor is [redacted] kg. This minor discrepancy is a result of items contained on the phased array that do not need to be captured in the DAS, such as adhesives, bondings, and fasteners.

AST has attached an updated DAS activity log.

AST has finalized the design for the phased array, and integration and manufacturing of the satellite has started. Therefore, AST does not anticipate any further changes.

11 02 2021; 14:23:02PM Activity Log Started
11 02 2021; 14:23:02PM Opened Project
[redacted]
11 02 2021; 14:23:10PM Processing Requirement 4.3-1:   Return Status : Passed

==========
Project Data
==========
        Objects Passing Through LEO = True
        Number of Objects = 2

INPUT
        Quantity = 4
        [redacted]
        Perigee Altitude = 400.000000 (km)
        Apogee Altitude = 400.000000 (km)
        Inclination = 53.000000 (deg)
        RAAN = -1.000000 (deg)
        Argument of Perigee = -1.000000 (deg)
        Mean Anomaly = -1.000000 (deg)
        Released Year = 2022.300000 (yr)

OUTPUT
        Perigee Altitude = -6378.136000 (km)
        Apogee Altitude = -6378.136000 (km)
        Inclination = 0.000000 (deg)
        Lifetime = 0.097603 (yr)
        Object Reentered within 25 years of Release = True
        Object-Time = 0.328542 (obj-yrs)
        Total Object-Time = 0.410678 (obj-yrs)
        Status = Pass
         Returned Error Message - Normal Processing

==========

INPUT
        Quantity = 1
        [redacted]
        Perigee Altitude = 400.000000 (km)
        Apogee Altitude = 400.000000 (km)
        Inclination = 53.000000 (deg)
        RAAN = -1.000000 (deg)
        Argument of Perigee = -1.000000 (deg)
        Mean Anomaly = -1.000000 (deg)
        Released Year = 2022.300000 (yr)

OUTPUT
        Perigee Altitude = -6378.136000 (km)
        Apogee Altitude = -6378.136000 (km)
        Inclination = 0.000000 (deg)

```
        Lifetime = 0.097603 (yr)
        Object Reentered within 25 years of Release = True
        Object-Time = 0.082136 (obj-yrs)
        Total Object-Time = 0.410678 (obj-yrs)
        Status = Pass
         Returned Error Message - Normal Processing

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

=============== End of Requirement 4.3-1 ===============
11 02 2021; 14:23:12PM  Processing Requirement 4.3-2: Return Status : Passed

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

=============== End of Requirement 4.3-2 ===============
11 02 2021; 14:26:58PM  Processing Requirement 4.5-1:   Return Status :  Passed

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

**INPUT**

        Space Structure Name = ControlSat
        Space Structure Type = Payload
        Perigee Altitude = 415.000 (km)
        Apogee Altitude = 415.000 (km)
        Inclination = 53.000 (deg)
        RAAN = 0.000 (deg)
        Argument of Perigee = 0.000 (deg)
        Mean Anomaly = 0.000 (deg)
        [redacted]
        Start Year = 2022.300 (yr)
        [redacted]
        Duration = 2.000 (yr)
        Station-Kept = True
        Abandoned = True

**OUTPUT**

        Collision Probability = 6.0294E-06
        Returned Message: Normal Processing
        Date Range Message: Normal Date Range
        Status = Pass

==============
```

INPUT

Space Structure Name = Phased Array [redacted]
Space Structure Type = Payload
Perigee Altitude = 415.000 (km)
Apogee Altitude = 415.000 (km)
Inclination = 53.000 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
[redacted]
Start Year = 2022.300 (yr)
[redacted]
Duration = 2.000 (yr)
Station-Kept = True
Abandoned = True

OUTPUT

Collision Probability = 8.2784E-05
Returned Message: Normal Processing
Date Range Message: Normal Date Range
Status = Pass

==========

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

11 02 2021; 14:27:13PM Project Data Saved To File
11 02 2021; 14:31:37PM Requirement 4.5-2: Compliant

==========
Spacecraft = ControlSat
Critical Surface = Propellant Tank
==========

INPUT

Apogee Altitude = 415.000 (km)
Perigee Altitude = 415.000 (km)
Orbital Inclination = 53.000 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
[redacted]
Station Kept = Yes
Start Year = 2022.300 (yr)

Duration = 2.000 (yr)
Orientation = Fixed Oriented
[redacted]
CS Pressurized = Yes
[redacted]

OUTPUT

Probability of Penetration = 8.9766E-06 (8.9766E-06)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
Spacecraft = ControlSat
Critical Surface = Avionics
==========

INPUT

Apogee Altitude = 415.000 (km)
Perigee Altitude = 415.000 (km)
Orbital Inclination = 53.000 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
[redacted]
Station Kept = Yes
Start Year = 2022.300 (yr)
Duration = 2.000 (yr)
Orientation = Fixed Oriented
[redacted]
CS Pressurized = No
[redacted]

OUTPUT

Probability of Penetration = 2.8600E-10 (2.8600E-10)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
Spacecraft = ControlSat

Critical Surface = [redacted]
==========

INPUT

Apogee Altitude = 415.000 (km)
Perigee Altitude = 415.000 (km)
Orbital Inclination = 53.000 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
[redacted]
Station Kept = Yes
Start Year = 2022.300 (yr)
Duration = 2.000 (yr)
Orientation = Fixed Oriented
[redacted]
CS Pressurized = No

OUTPUT

Probability of Penetration = 1.6000E-05 (1.6000E-05)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
Spacecraft = ControlSat
Critical Surface = [redacted]
==========

INPUT

Apogee Altitude = 415.000 (km)
Perigee Altitude = 415.000 (km)
Orbital Inclination = 53.000 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
[redacted]
Station Kept = Yes
Start Year = 2022.300 (yr)
Duration = 2.000 (yr)
Orientation = Fixed Oriented
[redacted]

[redacted]
CS Pressurized = No
[redacted]

OUTPUT

Probability of Penetration = 2.3926E-09 (2.3926E-09)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
Spacecraft = ControlSat
Critical Surface = [redacted]
==========

INPUT

Apogee Altitude = 415.000 (km)
Perigee Altitude = 415.000 (km)
Orbital Inclination = 53.000 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
[redacted]
Station Kept = Yes
Start Year = 2022.300 (yr)
Duration = 2.000 (yr)
Orientation = Fixed Oriented
[redacted]
CS Pressurized = No
[redacted]

OUTPUT

Probability of Penetration = 1.3131E-07 (1.3131E-07)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
Spacecraft = ControlSat
Critical Surface = [redacted]
==========

INPUT

Apogee Altitude = 415.000 (km)
Perigee Altitude = 415.000 (km)
Orbital Inclination = 53.000 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
[redacted]
Station Kept = Yes
Start Year = 2022.300 (yr)
Duration = 2.000 (yr)
Orientation = Fixed Oriented
[redacted]
CS Pressurized = No
[redacted]

OUTPUT

Probability of Penetration = 5.1789E-10 (5.1789E-10)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

==========
Spacecraft = Phased Array [redacted]
Critical Surface = Micron [redacted]
==========

INPUT

Apogee Altitude = 415.000 (km)
Perigee Altitude = 415.000 (km)
Orbital Inclination = 53.000 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
[redacted]
Station Kept = Yes
Start Year = 2022.300 (yr)
Duration = 2.000 (yr)
Orientation = Random Tumbling
[redacted]

[redacted]
CS Pressurized = No
[redacted]

OUTPUT

Probability of Penetration = 1.2723E-04 (1.2724E-04)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

=============== End of Requirement 4.5-2 ===============

11 02 2021; 14:31:38PM Processing Requirement 4.6 Return Status : Passed

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

INPUT

Space Structure Name = ControlSat
Space Structure Type = Payload

Perigee Altitude = 415.000000 (km)
Apogee Altitude = 415.000000 (km)
Inclination = 53.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
[redacted]
Start Year = 2022.300000 (yr)
[redacted]
Duration = 2.000000 (yr)
Station Kept = True
Abandoned = True
PMD Perigee Altitude = 415.000000 (km)
PMD Apogee Altitude = 415.000000 (km)
PMD Inclination = 53.000000 (deg)
PMD RAAN = 0.000000 (deg)
PMD Argument of Perigee = 0.000000 (deg)
PMD Mean Anomaly = 0.000000 (deg)

OUTPUT

Suggested Perigee Altitude = 415.000000 (km)
Suggested Apogee Altitude = 415.000000 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2024 (yr)

Requirement = 61
Compliance Status = Pass

==========

INPUT

Space Structure Name = Phased Array [redacted]
Space Structure Type = Payload

Perigee Altitude = 415.000000 (km)
Apogee Altitude = 415.000000 (km)
Inclination = 53.000000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
[redacted]
Start Year = 2022.300000 (yr)
[redacted]
Duration = 2.000000 (yr)
Station Kept = True
Abandoned = True
PMD Perigee Altitude = 415.000000 (km)
PMD Apogee Altitude = 415.000000 (km)
PMD Inclination = 53.000000 (deg)
PMD RAAN = 0.000000 (deg)
PMD Argument of Perigee = 0.000000 (deg)
PMD Mean Anomaly = 0.000000 (deg)

OUTPUT

Suggested Perigee Altitude = 415.000000 (km)
Suggested Apogee Altitude = 415.000000 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

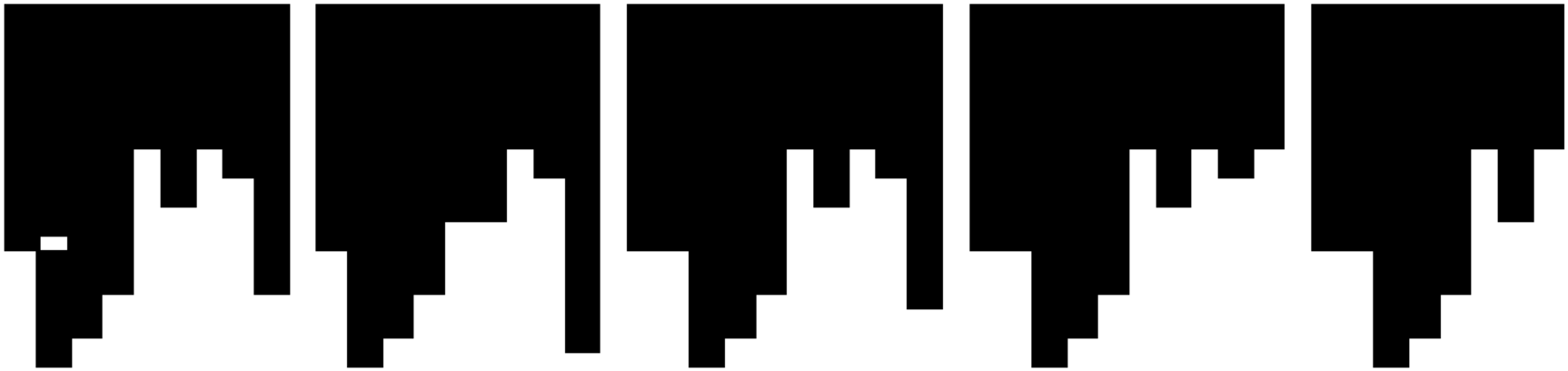
Released Year = 2024 (yr)
Requirement = 61
Compliance Status = Pass

==========

========== End of Requirement 4.6 ==========
11 02 2021; 14:31:45PM *********Processing Requirement 4.7-1
Return Status : Passed

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

[redacted]



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

name = ControlSat
Demise Altitude = 77.992874
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = ControlSat Structure
Demise Altitude = 0.000000
Debris Casualty Area = 2.667737
Impact Kinetic Energy = 154547.828125

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

****
Demise Altitude = 0.000000

Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000

Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

***********INPUT****
Item Number = 2

name = Phased Array [redacted]

**********OUTPUT****
Item Number = 2

name = Phased Array [redacted]
Demise Altitude = 77.990089
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 75.562752
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 75.073792
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 74.869576
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 0.000000
Debris Casualty Area = 33.478802
Impact Kinetic Energy = 12.651192

****
[redacted]
Demise Altitude = 66.942238
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 77.247917
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 76.724319
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 77.603447
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 77.585381
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
[redacted]
Demise Altitude = 77.077644
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

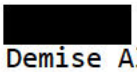
**********INPUT****
 Item Number = 3

name = LVA Panel - Debris
[redacted]

**********OUTPUT****
Item Number = 3

name = LVA Panel - Debris
Demise Altitude = 77.991196
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****



Demise Altitude = 68.612709
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

**********INPUT****
 Item Number = 4

name = LVA Base - Debris

**********OUTPUT****
Item Number = 4

name = LVA Base - Debris
Demise Altitude = 77.992432
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

[redacted]
Demise Altitude = 66.405739
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****

========== End of Requirement 4.7-1 ==========
11 02 2021; 14:31:45PM Project Data Saved To File
11 02 2021; 14:31:48PM Project Data Saved To File