ORBITAL DEBRIS PLAN

Below is an orbital debris plan for the exactEarth "EV1" satellite ("Satellite") submitted in support of the Kongsberg Satellite Services ("KSAT") non-common carrier earth station application of February 18, 2016 (IBFS File No. SES-REG-20160218-00154). The statement is prepared by KSAT in conjunction with its customer, exactEarth, the satellite owner and operator, in accordance with requirements of 47 C.F.R. §§ 25.137(d); 25.114(d)(14).

The Satellite was launched in 2012. It uses an off-the-shelf platform from Surrey Satellite Technology Ltd. (SSTL-100), designed to prevent the release of debris during the mission and having the robustness to withstand the impact of small debris. The SSTL-100 platform contains a low-power propulsion system intended to be used for minor orbital corrections and the avoidance of orbital debris.

The Satellite is part of the exactEarth AIS satellite constellation.[1] While the orbital perigees of the satellites in the exactEarth constellation are generally below 625 km (an altitude suitable for AIS signal collection), the Satellite was launched in a ride share arrangement to a significantly higher orbit. Unique among the satellites operated by exactEarth, all of which will reenter within 25 years post-mission, the Satellite will not. From this higher orbit, reentry within that time frame would be possible only with a substantially larger propulsion system; such a system could not be accommodated on the SSTL-100 platform.

exactEarth's current policy, consistent with space industry standards and best practices, calls for 25-year post-mission reentry of its satellites. Taking advantage of the increased options for launches of secondary payloads, exactEarth plans to add two satellites to its constellation this year, both of which will reenter within 25 years post-mission. As a satellite operator, exactEarth recognizes the importance of debris mitigation and the collective responsibility of all space actors to take measures to minimize the threat of debris to other operational spacecraft and to ensure that the usable orbits remain accessible for future missions.

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1 Most of the satellites in the exactEarth constellation were authorized by the Commission's Office of Engineering and Technology as "AprizeSats," all with approved orbital debris plans. See letter from D. Lorenzini, AprizeSat, to A. Serafini, FCC, OET (Sept. 9, 2010) (supplementing their experimental license application, FCC File No. 0084-EX-ML-2010, with debris plans for AprizeSats 3-6); letter from D. Lorenzini, AprizeSat, to A. Serafini, FCC, OET (June 12, 2012) (supplementing their experimental license application, FCC File No. 0023-EX-ML-2012, with debris plans for AprizeSats 7-10).

KSAT applauds the Commission's Satellite Division for its policy foresight and efforts to mitigate debris, and respectfully requests lenient treatment of this isolated case. Despite the Satellite operator's current policy of compliance with the 25-year reentry guideline, the Satellite's low-power propulsion system is unable to compensate for the high perigee at end of mission. No action short of physical retrieval of the Satellite, which is not an available commercial option, could change the orbit of the Satellite so as to conform to the 25-year reentry guideline.

KSAT also requests a waiver of Section 25.283(c) of the Commission's rules,[2] to the extent applicable, concerning discharge of batteries at end of mission. Good cause exists for this treatment as the underlying purpose of the Commission's policy—to mitigate debris—is effectively achieved here even though the battery's charging circuits are not severed at the end of the mission. As explained below, the battery contains many of the safety features highlighted in NASA's Guidelines on Lithium-ion Battery Use in Space Applications, NASA/TM-2009-215751.

The Satellite uses a Lithium-ion battery. The Li-ion cells used in the battery are Sony 18650 Hard Carbon commercial cylindrical cells. The battery is shielded within the Satellite structure and is designed to prevent breakups; it contains self-protection circuits to avoid over charging (that could result in an explosion). The battery is located in an area where an explosion or rupture would not break the spacecraft's outer shell.

The battery is protected from overcharge by dump resistors in the power system that shunt the charging current when a voltage clamps above an upper level. Once the battery returns to nominal voltage, the clamp is taken off and the dump resistors become inactive again. The cells within the battery are also individually protected against overcharge (for example, if a cell in a string becomes mismatched as it ages). In such case, the pressure increase in the cell will activate a Current Interrupt Device that will permanently open circuit the cell (and hence string) in the battery.

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2 Several precedents exist for waiver of strict compliance with Section 25.283(c). *See, e.g.*, Dish Operating L.L.C. License Modification Application Grant, IBFS File No. SES-MFS-20080926-01242, Condition 487 (Jan. 30, 2009) (granting a waiver of sec. 25.283(c) for Ciel-2 in part because of "the limited probability that [residual stored energy sources] would result in . . . an explosion or deflagration large enough to release orbital debris"); Panasonic Avionics Corp. License Modification Application Grant, IBFS File No. SES-MFS-20130930-00845, Condition 90168 (Sept. 24, 2014) (granting a waiver of sec. 25.283(c) for Apstar 7, a Thales Alenia Space Spacebus-4000C2 model spacecraft that was launched on March 31, 2012, which was unable to deplete all residual stored energy).

The Sony cell also has a Positive Temperature Coefficient (PTC) switch which will heat up when a large current (charge or discharge) occurs in the cell, and limit the current by increasing the resistance. In the case of over pressure caused by excessive temperature (due to external heat for example), there is an external disc that will puncture and vent the cell safely.

ATTACHMENT

ORBITAL DEBRIS STATEMENT FOR THE EXACTEARTH EV1 SATELLITE

1. Basic Satellite Design and Orbital Parameters

No.	System Description	Comment
1.	Satellite Bus Design	Microsatellite with dimensions of 60 x 60 x 80 cm, a box-shape, and a launch mass of 98 kg. The Satellite uses the off-the-shelf SSTL-100 platform/bus from Surrey Satellite Technology Ltd. (SSTL), adapted for the Satellite mission with by COM DEV designed AIS receiver payload.
2.	Satellite Payload	Payload: AIS receiver.
3.	Satellite Orbit	Apogee of 830.7 km; perigee of 805.9 km; inclination of 98.955 degrees. Launch Date: July 22, 2012.
4.	Propulsion System	The spacecraft has a low power propulsion system – the "SSTL Low Power Resistojet" – for minor orbital corrections. It is rated for thrust only up to 100 mN. The fuel is butane and is stored within pressurized tanks in a liquid/vapor mixture.
5.	Power Subsystem	Solar Arrays: Body mounted solar arrays with single junction GaAs cells, total area 1.08 m^2. One deployable solar array with triple Junction GaAs cells, total area 0.36m^2. Approximately 65

		W orbital average DC power at BOL. Battery: Li-ion cells providing 15 Ah capacity. Main Bus Voltage Range: 28V-33V range
6.	Attitude Control	Three-axis stabilized nadir pointing bus platform, using reaction wheels and magnetic torque rods. Command and data handling: Dual-redundant Controller Area Network (CAN) bus

2. Orbital Debris Mitigation

No.	47 C.F.R. § 25.114	Required Statements	Comment
1.	(d)(14)(i)	*Planned Release of Debris* A statement that the space station operator has assessed and limited the amount of debris released in a planned manner during normal operations	No objects will be intentionally released during the mission. The spacecraft is designed such that it does not release any debris. There are no deployable devices other than solar panels and no debris will result from their deployment. The solar panel deployment is achieved using a Frangibolt system (non-explosive actuator) with an enclosure around the assembly to capture of any loose pieces. All mechanisms, such as reaction wheels and torque rods, are enclosed and the batteries are contained within the stack assembly.

2.	(d)(14)(i)	*Collisions with Small Debris and Loss of Control* A statement that the space station operator . . . has assessed and limited the probability of the space station becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal	The spacecraft has an outer structure of honeycomb panels which will mitigate the impact of a strike from another object. The propulsion system is used to avoid space debris when a notification of a close encounter is received. The satellite bus is designed so that there are no credible single point failures. All units either have full hot, cold or functional redundancy or where this is not possible or practical to do so, graceful degradation (such as loss of single string on the battery/solar cells).
3.	(d)(14)(ii)	*Mitigating Risk of Accidental Explosion* A statement that the space station operator has assessed and limited the probability of accidental explosions during and after completion of mission operations. ▪ This statement must include a demonstration that debris generation will not result from the conversion of energy sources on board the spacecraft into energy that fragments the spacecraft. Energy sources include chemical, pressure, and kinetic energy. ▪ This demonstration should address whether stored energy will be removed at the spacecraft's end of	Breakup due to accidental explosion during or after the mission is unlikely because of the measures taken to mitigate potential failure modes that can lead to break up, as explained below: *Propulsion System and Pressure Vessels* – The Satellite has a low power propulsion system (the "SSTL Low Power Resistojet") for minor orbital corrections. The fuel is butane and is stored within pressurized tanks in a liquid/vapor mixture. The pressure of the mixture is 4 bar and baffles are employed to reduce slosh within the tank. The tank has been designed so that it leaks before bursting to avoid a break-up of the spacecraft. (The burst to working pressure ratio is 25:1.) At the end of the mission, a command set will be created to provide a depletion burn. *Battery Failure* – The batteries are shielded within the Satellite structure and are designed to prevent breakups; they contain self-protection circuits to avoid over charging (that would result in an explosion). The batteries are located in areas where

		life, by depleting residual fuel and leaving all fuel line valves open, venting any pressurized system, leaving all batteries in a permanent discharge state, and removing any remaining source of stored energy, or through other equivalent procedures specifically disclosed in the application;	explosions or ruptures would not break the spacecraft outer shell. While the batteries' charging circuits are not severed at the end of the mission, the risk of debris generation is effectively mitigated by the measures described above. The Li-ion cells used in the battery are Sony 18650 Hard Carbon commercial cylindrical cells. Both the battery and its individual cells are protected from overcharge by dump resistors in the power system, which shunt the charging current when a voltage clamps above an upper level. Moreover, in the case of over pressure caused by excessive temperature (due to external heat for example) there is an external disc that will puncture and vent the cell safely. See pages 2-3 for more detail. *Catastrophic Reaction Wheel Failure* – Reaction wheels are enclosed within a mechanical structure designed to contain debris. At the end of the mission, power to the reaction wheels will be terminated by command, allowing them to spin down. *Pyrotechnics or Self-destruct Systems* – The spacecraft does not employ pyrotechnics or self-destruct systems.
4.	(d)(14)(iii)	*Collision with Large Debris or Other Objects* A statement that the space station operator has assessed and limited the probability of the space station becoming a source of debris by collisions with large debris or other operational space stations. . . .	An analysis of the Satellite's orbital parameters has been performed using NASA's Debris Assessment Software, version 2.0.2 to simulate the probability of the Satellite colliding with an orbiting object larger than 10 cm in diameter; the collision probability value was 0.000045, a passing result. See section 3.1, Probability of Collision with Large Objects (below), containing the log of the DAS analysis. To work around limitations in

		▪ Where a space station will be launched into a low-Earth orbit that is identical, or very similar, to an orbit used by other space stations, the statement must include an analysis of the potential risk of collision and a description of what measures the space station operator plans to take to avoid in-orbit collisions. ▪ If the space station operator is relying on coordination with another system, the statement must indicate what steps have been taken to contact, and ascertain the likelihood of successful coordination of physical operations with, the other system. . . .	NASA's Debris Assessment Software, which can cause erroneous results when the satellite will not reenter before the year 2050, a fictional post-mission disposal maneuver lowering the Satellite perigee to altitude of 450 km was assumed in order to generate a result for this item.
5.	(d)(14)(iii)	*Orbital Maintenance and Evolution* The statement must disclose the accuracy—if any—with which orbital parameters of non-geostationary satellite orbit space stations will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s).	The Satellite has a design life of 5 years. The Satellite will maintain orbital tolerances during its mission life using its low-power propulsion system. Post-mission, from a perigee of approximately 800 km with an inclination of 98.955 degrees, the satellite will perform a depletion burn with any remaining propellant, after which the orbit will decay naturally. The Satellite's RAM area and solar radiation pressure area exceed 60

		▪ In the event that a system is not able to maintain orbital tolerances, i.e., it lacks a propulsion system for orbital maintenance, that fact should be included in the debris mitigation disclosure. Such systems must also indicate the anticipated evolution over time of the orbit of the proposed satellite or satellites	cm x 60 cm with the deployed solar panel. Given its high orbit and very limited propulsion system, the Satellite will not be able to reenter within 25 years post-mission. The off-the-shelf SSTL-100 satellite platform could not accommodate a propulsion system capable of lowering the Satellite's orbit to effect reentry within that time frame from such a high orbit. See section 3.2, Orbit Evolution (below), for a plot of the orbital evolution within the time frame NASA's Debris Assessment Software, version 2.0.2, is able to calculate.
6.	(d)(14)(iv)	*Post-Mission Disposal Plan* A statement detailing the post-mission disposal plans for the space station at end of life, including the quantity of fuel—if any—that will be reserved for post-mission disposal maneuvers	The post-mission disposal plan is to allow the orbit to decay naturally after a propulsion system depletion burn. A command set will be uploaded to instruct the Satellite to perform the depletion burn with any remaining propellant in order to lower the perigee. The Satellite has insufficient energy to perform a re-entry maneuver. The Satellite's time to deorbit post-mission will exceed 25 years. See section 3.3, Post-Mission Disposal (below), using NASA's Debris Assessment Software, version 2.0.2.
7.	(d)(14)(iv)	*Casualty Risk Assessment for Atmospheric Reentry* The statement must also include a casualty risk assessment if planned post-mission disposal involves atmospheric re-entry of the space station. In general, an assessment should include an estimate as to whether	We simulated the Satellite's uncontrolled atmospheric reentry and the risk of human casualty resulting from reentry debris using NASA's Debris Assessment Software, version 2.0.2, testing compliance with NASA-STD 8719.14 Revision A, Requirement 4.7-1 ("For uncontrolled reentry, the risk of human casualty from surviving debris shall not exceed 0.0001 (1:10,000) . . . ."). The Satellite complies with Requirement 4.7-1: The DAS analysis

		portions of the spacecraft will survive re-entry and reach the surface of the Earth, as well as an estimate of the resulting probability of human casualty	has estimated that the risk of human casualty presented by EV1's reentry is 1:64200, a passing result by a substantial margin. See the component list table and the DAS log of the casualty risk analysis in section 3.4, Casualty Risk Analysis (below).

3. Inputs to and Results from NASA Debris Assessment Software, v2.0.2, for the Satellite (EV1)

3.1. Probability of Collision with Large Objects – § 25.114(d)(14)(iii)

07 18 2016; 15:00:28PM Processing Requirement 4.5-1: Return Status : Passed

==============
Run Data
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INPUT

Space Structure Name = EV1
Space Structure Type = Payload
Perigee Altitude = 805.900000 (km)
Apogee Altitude = 830.700000 (km)
Inclination = 98.955000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.004091 (m^2/kg)[3]
Start Year = 2012.000000 (yr)
Initial Mass = 98.000000 (kg)
Final Mass = 88.000000 (kg)
Duration = 5.000000 (yr)
Station-Kept = True
Abandoned = False
PMD Perigee Altitude = 450.000000 (km)
PMD Apogee Altitude = 830.000000 (km)
PMD Inclination = 98.955000 (deg)
PMD RAAN = 0.000000 (deg)
PMD Argument of Perigee = 0.000000 (deg)
PMD Mean Anomaly = 0.000000 (deg)

OUTPUT

Collision Probability = 0.000045
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range
Status = Pass

[3] Calculated as follows: 0.6 m * 0.6 m / 88 kg = 0.0040909090909091 m^2/kg.

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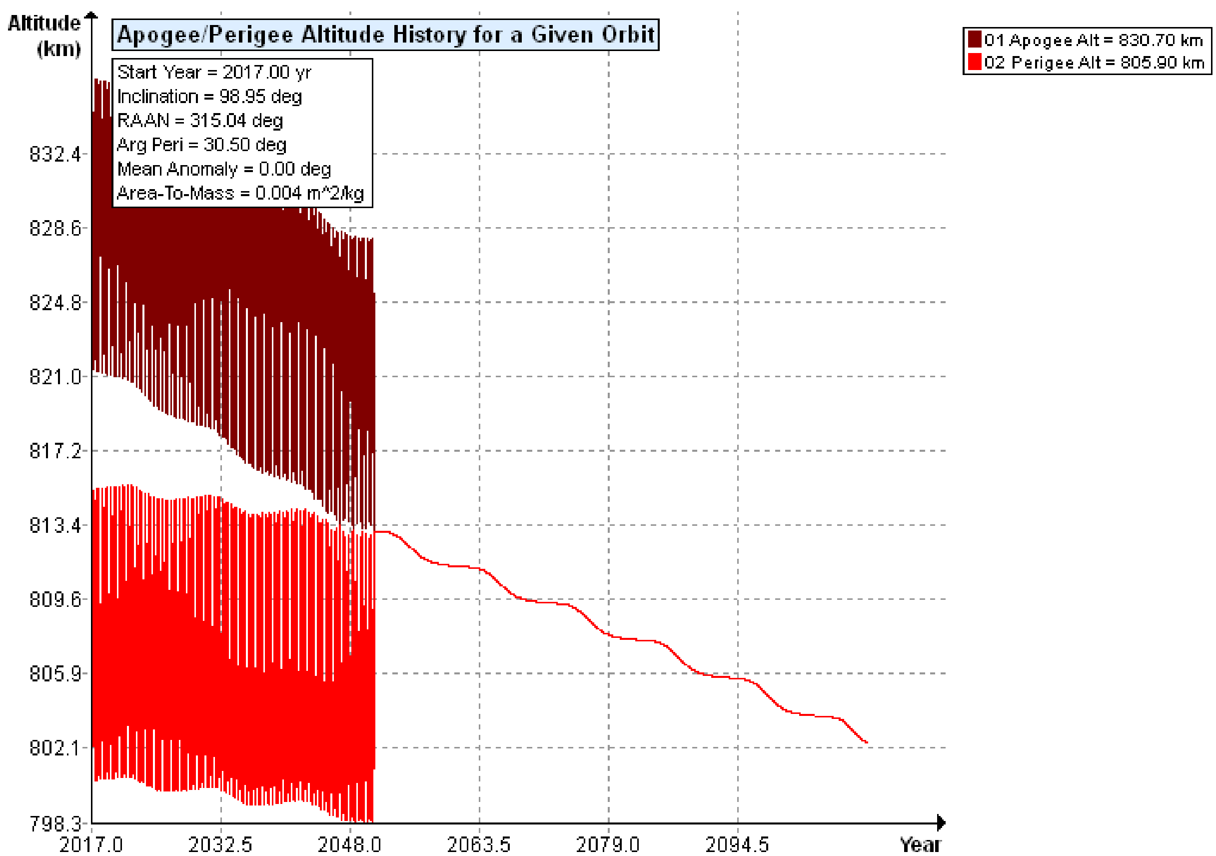
=============== End of Requirement 4.5-1 ===============

3.2. Orbit Evolution – § 25.114(d)(14)(iii)

Plot of Orbital Evolution assuming no post-mission disposal maneuver is performed (a worst case scenario):



07 13 2016; 19:15:32PM Science and Engineering - Apogee/Perigee History for a Given Orbit

INPUT

Perigee Altitude = 805.900000 (km)
Apogee Altitude = 830.700000 (km)
Inclination = 98.955000 (deg)
RAAN = 315.039000 (deg)

Argument of Perigee = 30.500000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.004091 (m^2/kg)
Start Year = 2017.000000 (yr)
Integration Time = 93.000000 (yr)

OUTPUT

Plot

07 13 2016; 19:17:42PM Science and Engineering - Orbit Lifetime/Dwell Time

INPUT

Start Year = 2017.000000 (yr)
Perigee Altitude = 805.900000 (km)
Apogee Altitude = 830.700000 (km)
Inclination = 98.955000 (deg)
RAAN = 315.039000 (deg)
Argument of Perigee = 30.500000 (deg)
Area-To-Mass Ratio = 0.004091 (m^2/kg)

OUTPUT

Orbital Lifetime from Startyr = 100.002738 (yr)
Time Spent in LEO during Lifetime = 100.002738 (yr)
Last year of Propagation = 2117 (yr)
Returned Error Message: Object did not reenter within MAXPROPYRS

3.3. Post-Mission Disposal – Atmospheric Reentry – § 25.114(d)(14)(iv)

07 13 2016; 19:18:30PM Processing Requirement 4.6 Return Status : Failed

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Project Data
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INPUT

Space Structure Name = EV1
Space Structure Type = Payload

Perigee Altitude = 805.900000 (km)
Apogee Altitude = 830.700000 (km)
Inclination = 98.955000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.004091 (m^2/kg)
Start Year = 2012.000000 (yr)
Initial Mass = 98.000000 (kg)
Final Mass = 88.000000 (kg)
Duration = 5.000000 (yr)
Station Kept = True
Abandoned = True
PMD Perigee Altitude = 805.900000 (km)
PMD Apogee Altitude = 830.700000 (km)
PMD Inclination = 98.955000 (deg)
PMD RAAN = 0.000000 (deg)
PMD Argument of Perigee = 0.000000 (deg)
PMD Mean Anomaly = 0.000000 (deg)

OUTPUT

Suggested Perigee Altitude = 425.900000 (km)
Suggested Apogee Altitude = 830.700000 (km)
Returned Error Message = LEO reentry PMD exceeds lifetime limit.

Released Year = 2042 (yr)
Requirement = 61
Compliance Status = Fail

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

3.4. Casualty Risk Analysis – § 25.114(d)(14)(iv)

We simulated the Satellite's (EV1) uncontrolled atmospheric reentry and the resulting risk of human casualty from reentry debris using DAS 2.0.2, testing compliance with Requirement 4.7-1. Three components may survive reentry. While one component is estimated to have an impact energy that exceeds 15 Joules, the analysis indicates a passing result for EV1. Below is a table listing the components used in the simulation and, following that, we have inserted the DAS log indicating compliance with Requirement 4.7-1:

Component Name	Quantity	Material Type	Object Shape	Mass (kg)	Diameter/ Width (m)	Length (m)	Height (m)
EV1	1	Aluminum (generic)	Box	88.000	0.600	0.800	0.600
Solar Arrays (closure panels)	3	Aluminum (generic)	Flat Plate	3.000	0.600	0.617	
Battery	1	Aluminum (generic)	Box	4.915	0.159	0.221	0.068
Battery support bracket	1	Aluminum (generic)	Box	0.849	0.202	0.335	0.048
Reaction Wheel	3	Aluminum (generic)	Cylinder	0.900	0.104	0.100	
Torque Rod	3	Aluminum (generic)	Cylinder	0.470	0.250	0.256	
Bus Electronics (Micro Trays inc. PCBs)	9	Aluminum (generic)	Box	3.000	0.322	0.322	0.033
Bus Electronics (Nano Trays inc. PCBs)	6	Aluminum (generic)	Box	0.430	0.135	0.190	0.029
Tie Bars 305.0	8	Titanium (6 Al-4 V)	Cylinder	0.043	0.063	0.305	
Tie Bars 102.0	6	Titanium (6 Al-4 V)	Cylinder	0.010	0.050	0.102	
Thruster	1	Aluminum (generic)	Cylinder	0.240	0.021	0.650	
Propellant Tank	2	Stainless Steel (generic)	Cylinder	1.400	0.11	0.325	
Hinge	2	Aluminum (generic)	Cylinder	0.250	0.260	0.090	
HDRS	1	Aluminum (generic)	Cylinder	1.007	0.120	0.980	
Structural HDRS Panel	1	Aluminum (generic)	Flat Plate	3.300	0.600	0.600	
Exterior Bottom Panel	1	Aluminum (generic)	Box	4.600	0.600	0.600	0.025
Exterior Top	1	Aluminum (generic)	Box	2.300	0.600	0.600	0.020

Component Name	Quantity	Material Type	Object Shape	Mass (kg)	Diameter/ Width (m)	Length (m)	Height (m)
Deployable Panel (fully populated)	1	Aluminum (generic)	Box	2.467	0.617	0.640	0.012

08 26 2016; 16:30:43PM *********Processing Requirement 4.7-1
Return Status : Passed

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

name = EV1
quantity = 1
parent = 0
materialID = 5
type = Box
Aero Mass = 88.000000
Thermal Mass = 88.000000
Diameter/Width = 0.600000
Length = 0.800000
Height = 0.600000

name = Solar Arrays (closure panels)
quantity = 3
parent = 1
materialID = 5
type = Flat Plate
Aero Mass = 3.000000
Thermal Mass = 3.000000
Diameter/Width = 0.600000
Length = 0.617000

name = Battery
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 4.915000
Thermal Mass = 4.915000
Diameter/Width = 0.159000
Length = 0.221000
Height = 0.068000

name = Battery suport bracket
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 0.849000
Thermal Mass = 0.849000
Diameter/Width = 0.202000
Length = 0.335000
Height = 0.048000

name = Reaction Wheel
quantity = 3
parent = 1
materialID = 5
type = Cylinder
Aero Mass = 0.900000
Thermal Mass = 0.900000
Diameter/Width = 0.104000
Length = 0.100000

name = Torque Rod
quantity = 3
parent = 1
materialID = 5
type = Cylinder
Aero Mass = 0.470000
Thermal Mass = 0.470000
Diameter/Width = 0.250000
Length = 0.256000

name = Bus Electronics (Micro Trays inc. PCBs)
quantity = 9
parent = 1
materialID = 5
type = Box
Aero Mass = 3.000000
Thermal Mass = 3.000000
Diameter/Width = 0.322000
Length = 0.322000
Height = 0.033000

name = Bus Electronics (Nano Trays inc. PCBs)
quantity = 6

parent = 1
materialID = 5
type = Box
Aero Mass = 0.430000
Thermal Mass = 0.430000
Diameter/Width = 0.135000
Length = 0.190000
Height = 0.029000

name = Tie Bars 305.0
quantity = 8
parent = 1
materialID = 65
type = Cylinder
Aero Mass = 0.043000
Thermal Mass = 0.043000
Diameter/Width = 0.063000
Length = 0.305000

name = Tie Bars 102.0
quantity = 6
parent = 1
materialID = 65
type = Cylinder
Aero Mass = 0.010000
Thermal Mass = 0.010000
Diameter/Width = 0.050000
Length = 0.102000

name = Thruster
quantity = 1
parent = 1
materialID = 5
type = Cylinder
Aero Mass = 0.240000
Thermal Mass = 0.240000
Diameter/Width = 0.021000
Length = 0.650000

name = Propellant Tank
quantity = 2
parent = 1
materialID = 54
type = Cylinder

Aero Mass = 1.400000
Thermal Mass = 1.400000
Diameter/Width = 0.110000
Length = 0.325000

name = Hinge
quantity = 2
parent = 1
materialID = 5
type = Cylinder
Aero Mass = 0.250000
Thermal Mass = 0.250000
Diameter/Width = 0.260000
Length = 0.090000

name = HDRS
quantity = 1
parent = 1
materialID = 5
type = Cylinder
Aero Mass = 1.007000
Thermal Mass = 1.007000
Diameter/Width = 0.120000
Length = 0.980000

name = Structural HDRS Panel
quantity = 1
parent = 1
materialID = 5
type = Flat Plate
Aero Mass = 3.300000
Thermal Mass = 3.300000
Diameter/Width = 0.600000
Length = 0.600000

name = Exterior Bottom Panel
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 4.600000
Thermal Mass = 4.600000
Diameter/Width = 0.600000
Length = 0.600000

Height = 0.025000

name = Exterior Top
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 2.300000
Thermal Mass = 2.300000
Diameter/Width = 0.600000
Length = 0.600000
Height = 0.020000

name = Deployable Panel (fully populated)
quantity = 1
parent = 1
materialID = 5
type = Box
Aero Mass = 2.467000
Thermal Mass = 2.467000
Diameter/Width = 0.617000
Length = 0.640000
Height = 0.012000

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

name = EV1
Demise Altitude = 77.997933
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Solar Arrays (closure panels)
Demise Altitude = 71.378480
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Battery
Demise Altitude = 58.961182
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Battery suport bracket
Demise Altitude = 75.081019
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Reaction Wheel
Demise Altitude = 69.767761
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Torque Rod
Demise Altitude = 76.775980
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Bus Electronics (Micro Trays inc. PCBs)
Demise Altitude = 67.551261
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Bus Electronics (Nano Trays inc. PCBs)
Demise Altitude = 74.917410
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Tie Bars 305.0
Demise Altitude = 0.000000
Debris Casualty Area = 4.364455
Impact Kinetic Energy = 1.026582

****
name = Tie Bars 102.0
Demise Altitude = 0.000000
Debris Casualty Area = 2.704783
Impact Kinetic Energy = 0.197254

****
name = Thruster

Demise Altitude = 76.567402
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Propellant Tank
Demise Altitude = 0.000000
Debris Casualty Area = 1.245284
Impact Kinetic Energy = 569.692993

****
name = Hinge
Demise Altitude = 76.930355
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = HDRS
Demise Altitude = 76.578011
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Structural HDRS Panel
Demise Altitude = 70.396956
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Exterior Bottom Panel
Demise Altitude = 67.733402
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Exterior Top
Demise Altitude = 73.198636
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Deployable Panel (fully populated)
Demise Altitude = 72.984472
Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

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