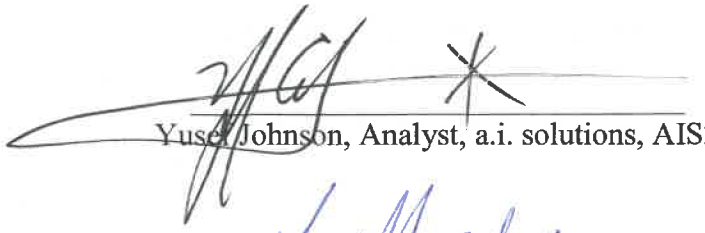
ELVL-2018-0045449
November 14, 2018

Orbital Debris Assessment for The Spectral Ocean Color (SPOC) CubeSat per NASA-STD 8719.14A

Signature Page



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ELVL-2018-0045449

Reply to Attn of: VA-H1

November 14, 2018

TO: Scott Higginbotham, LSP Mission Manager, NASA/KSC/VA-C

FROM: Yusef Johnson, a.i. solutions/KSC/AIS2

SUBJECT: Orbital Debris Assessment Report (ODAR) for the SPOC CubeSat (DRAFT)

REFERENCES:

A. *NASA Procedural Requirements for Limiting Orbital Debris Generation*, NPR 8715.6A, 5 February 2008
B. *Process for Limiting Orbital Debris*, NASA-STD-8719.14A, 25 May 2012
C. International Space Station Reference Trajectory, May 2017
D. McKissock, Barbara, Patricia Loyselle, and Elisa Vogel. *Guidelines on Lithium-ion Battery Use in Space Applications*. Tech. no. RP-08-75. NASA Glenn Research Center Cleveland, Ohio
E. *UL Standard for Safety for Lithium Batteries, UL 1642*. UL Standard. 4th ed. Northbrook, IL, Underwriters Laboratories, 2007
F. Kwas, Robert. Thermal Analysis of ELaNa-4 CubeSat Batteries, ELVL-2012-0043254; Nov 2012
G. Range Safety User Requirements Manual Volume 3- Launch Vehicles, Payloads, and Ground Support Systems Requirements, AFSCM 91-710 V3.
H. HQ OSMA Policy Memo/Email to 8719.14: CubeSat Battery Non-Passivation, Suzanne Aleman to Justin Treptow, 10, March 2014

The intent of this report is to satisfy the orbital debris requirements listed in ref. (a) for the SPOC CubeSat launching on a to-be-determined Commercial Resupply Service (CRS) vehicle. It serves as the final submittal in support of the spacecraft Safety and Mission Success Review (SMSR). Sections 1 through 8 of ref. (b) are addressed in this document; sections 9 through 14 fall under the requirements levied on the primary mission and are not presented here.

The following table summarizes the compliance status of the SPOC payload. The SPOC CubeSat is fully compliant with all applicable requirements.

Table 1: Orbital Debris Requirement Compliance Matrix

Requirement	Compliance Assessment	Comments
4.3-1a	Not applicable	No planned debris release
4.3-1b	Not applicable	No planned debris release
4.3-2	Not applicable	No planned debris release
4.4-1	Compliant	On board energy source (batteries) incapable of debris-producing failure
4.4-2	Compliant	On board energy source (batteries) incapable of debris-producing failure
4.4-3	Not applicable	No planned breakups
4.4-4	Not applicable	No planned breakups
4.5-1	Compliant	
4.5-2	Not applicable	
4.6-1(a)	Compliant	Worst case lifetime 2.4 years
4.6-1(b)	Not applicable	
4.6-1(c)	Not applicable	
4.6-2	Not applicable	
4.6-3	Not applicable	
4.6-4	Not applicable	Passive disposal
4.6-5	Compliant	
4.7-1	Compliant	Non-credible risk of human casualty
4.8-1	Compliant	SPOC has no planned tether release

Section 1: Program Management and Mission Overview

The Spectral Ocean Color (SPOC) mission is sponsored by the Human Exploration and Operations Mission Directorate at NASA Headquarters. The Program Executive is Jason Crusan. Responsible program/project manager and senior scientific and management personnel are as follows:

SPOC: David Cotton, Principal Investigator, University of Georgia

Program Milestone Schedule	
Task	Date
CubeSat Selection	December 18th, 2017
CubeSat Delivery to NanoRacks	August 1st, 2019
Launch	October 1st, 2019

Figure 1: Program Milestone Schedule

The SPOC mission will be launched on the NG-12 CRS launch vehicle to the International Space Station. SPOC will be deployed from the International Space Station using the NanoRacks CubeSat Deployer (NRCSD). The current launch date is no earlier than October 1st, 2019.

Section 2: Spacecraft Description

Table 2 outlines the generic attributes for the SPOC CubeSat

Table 2: SPOC CubeSat form description

CubeSat Names	CubeSat Quantity	CubeSat size	CubeSat Masses (kg)
SPOC	1	3U (34.4 x 10.9 x 10.6 cm^3)	3.6

SPOC – University of Georgia – 3U

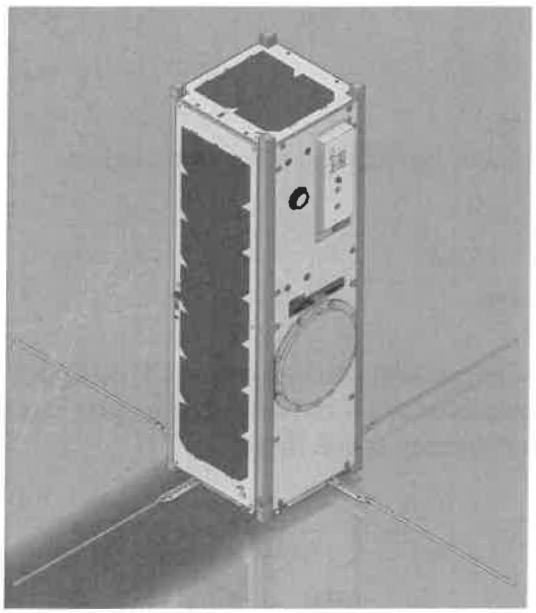

Figure 1: SPOC Cutaway View.

Overview

The SPectral and Ocean Color (SPOC) Satellite is an adjustable multi-spectral imaging satellite that shall acquire moderate resolution imagery across a wide range of spectral bands (433 nm to 866 nm) to monitor coastal ecosystems and ocean color. The SPOC mission will monitor coastal wetland status, estuarine water quality including biophysical characteristics and phytoplankton dynamics, and near-coastal ocean productivity while training students in STEM related fields. The diffraction grating spectrometer will allow the user to store and downlink 16 bands of their choice within the range of the sensor.

CONOPS

SPOC will be deployed from the International Space Station where it will wait 45 minutes to deploy a single UHF antenna and then go into a detumble sub-mode. Following this activity, SPOC will generate power and run health checks. Then it will start calibrating the sensor by taking scenes of semi-invariant targets on earth. SPOC will obtain data of targets via a push broom approach and downlink data to the University of Georgia (UGA) ground station. At the completion of SPOC's operational life, it will deorbit and burn up in Earth's atmosphere.

Materials

The CubeSat structure is made of Aluminum 6082-T6. It contains all standard commercial off the shelf (COTS) materials, electrical components, PCBs and solar cells.

Hazards

There are no pressure vessels, hazardous or exotic materials.

Power System/Batteries

The electrical power storage system consists of the Clyde Space 40 Whr CubeSat Lithium ion Battery. Clyde Space will provide certification that the batteries have met testing levels required for manned space flight.

Section 3: Assessment of Spacecraft Debris Released during Normal Operations

The assessment of spacecraft debris requires the identification of any object (>1 mm) expected to be released from the spacecraft any time after launch, including object dimensions, mass, and material.

The section 3 requires rationale/necessity for release of each object, time of release of each object, relative to launch time, release velocity of each object with respect to spacecraft, expected orbital parameters (apogee, perigee, and inclination) of each object after release, calculated orbital lifetime of each object, including time spent in Low Earth Orbit (LEO), and an assessment of spacecraft compliance with Requirements 4.3-1 and 4.3-2.

No releases are planned on the SPOC CubeSat mission therefore, this section is not applicable.

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

There are NO plans for designed spacecraft breakups, explosions, or intentional collisions on the SPOC mission.

The probability of battery explosion is very low, and, due to the very small mass of the satellites and their short orbital lifetimes, the effect of an explosion on the far-term LEO environment is negligible (ref (h)).

The CubeSats batteries still meet Req. 56450 (4.4-2) by virtue of the HQ OSMA policy regarding CubeSat battery disconnect stating;

> "CubeSats as a satellite class need not disconnect their batteries if flown in LEO with orbital lifetimes less than 25 years." (ref. (h))

SPOC is a 3U CubeSat. Therefore, it is covered by the rationale concerning CubeSat batteries contained by 3U or smaller CubeSats mentioned in ref. (h).

Limitations in space and mass prevent the inclusion of the necessary resources to disconnect the battery or the solar arrays at EOM. However, the low charges and small battery cells on the CubeSat's power system prevents a catastrophic failure, so that passivation at EOM is not necessary to prevent an explosion or deflagration large enough to release orbital debris.

Assessment of spacecraft compliance with Requirements 4.4-1 through 4.4-4 shows that with a maximum CubeSat lifetime of 2.4 years maximum, SPOC is compliant.

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

Calculation of spacecraft probability of collision with space objects larger than 10 cm in diameter during the orbital lifetime of the spacecraft takes into account both the mean cross sectional area and orbital lifetime.

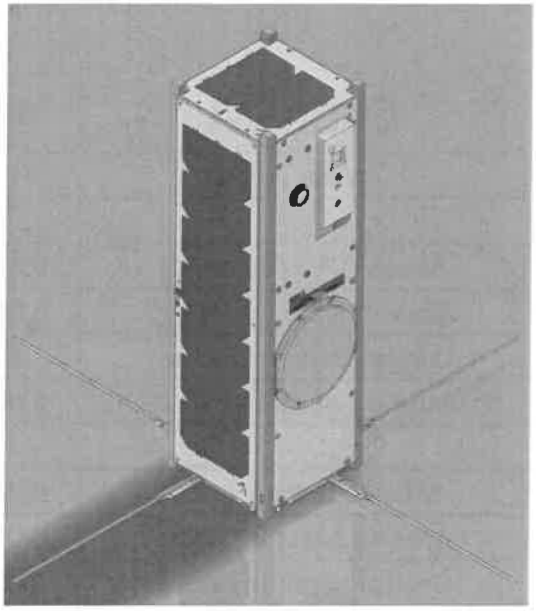

Figure 26: SPOC Cutaway View

$$Mean\ CSA = \frac{\sum Surface\ Area}{4} = \frac{[2 * (w * l) + 4 * (w * h)]}{4}$$

Equation 1: Mean Cross Sectional Area (CSA) for Convex Objects

$$Mean\ CSA = \frac{(A_{max} + A_1 + A_1)}{2}$$

Equation 2: Mean Cross Sectional Area for Complex Objects

All CubeSats evaluated for this ODAR are stowed in a convex configuration, indicating there are no elements of the CubeSats obscuring another element of the same CubeSats from view. Thus, mean CSA for all stowed CubeSats was calculated using Equation 1~~Equation 1~~. This configuration renders the longest orbital life times for all CubeSats.

Once a CubeSat has been ejected from the NanoRacks dispenser and deployables have been extended, Equation 2~~Equation 2~~ is utilized to determine the mean CSA. A_{max} is identified as the view that yields the maximum cross-sectional area. A_1 and A_2 are the two cross-sectional areas orthogonal to A_{max}. Refer to Appendix A for component dimensions used in these calculations

The SPOC (3.6 kg) orbit at deployment is projected to be 410 km apogee altitude by 397 km perigee altitude, with an inclination of 51.6 degrees. With an area to mass ratio of 0.0306 m^2/kg, DAS yields 2.4 years for orbit lifetime for its stowed state, which in turn is used to obtain the collision probability. SPOC shows a 0.0 probability of collision.

There will be no post-mission disposal operation. As such, the identification of all systems and components required to accomplish post-mission disposal operation, including passivation and maneuvering, is not applicable.

	CubeSat	SPOC
	Mass (kg)	3.6
Stowed	Mean C/S Area (m^2)	0.0306
Stowed	Area-to Mass (m^2/kg)	0.0085
Stowed	Orbital Lifetime (years)	2.4
Stowed	Probability of collision (10^X)	0.0000
Deployed **	Mean C/S Area (m^2)	0.0392
Deployed **	Area-to Mass (m^2/kg)	0.0108
Deployed **	Orbital Lifetime (years)	2.2
Deployed **	Probability of collision (10^X)	0.0000
	Solar Flux Table Dated 3/29/2018	

Table 3: CubeSat Orbital Lifetime & Collision Probability

The probability SPOC having a collision with debris and meteoroids greater than 10 cm in diameter and capable of preventing post-mission disposal is less than 0.00000, for any configuration. This satisfies the 0.001 maximum probability requirement 4.5-1.

Since the CubeSats have no capability or plan for end-of-mission disposal, requirement 4.5-2 is not applicable.

Assessment of spacecraft compliance with Requirements 4.5-1 shows SPOC be compliant. Requirement 4.5-2 is not applicable to this mission.

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

SPOC will naturally decay from orbit within 25 years after end of the mission, satisfying requirement 4.6-1a detailing the spacecraft disposal option.

Planning for spacecraft maneuvers to accomplish post-mission disposal is not applicable. Disposal is achieved via passive atmospheric reentry.

Calculating the area-to-mass ratio for the worst-case (smallest Area-to-Mass) post-mission disposal among the CubeSats finds SPOC in its stowed configuration as the worst case. The area-to-mass is calculated as follows:

$$\frac{Mean\ {}^{C}/_{S}\ Area\ (m^2)}{Mass\ (kg)} = Area - to - Mass\ (\frac{m^2}{kg})$$

Equation 3: Area to Mass

$$\frac{0.0306\ m^2}{3.6\ kg} = 0.0085 \frac{m^2}{kg}$$

The assessment of the spacecraft illustrates that it is compliant with Requirements 4.6-1 through 4.6-5.

DAS 2.1.1 Orbital Lifetime Calculations:

DAS inputs are: 410 km maximum apogee by 397 km maximum perigee altitudes with an inclination of 51.6° at deployment no earlier than October 2019. An area to mass ratio of 0.0085 m^2/kg for the SPOC CubeSat was used. DAS 2.1.1 yields a 2.4 years orbit lifetime for SPOC in its deployed state.

This meets requirement 4.6-1.

Section 7: Assessment of Spacecraft Reentry Hazards

A detailed assessment of the components of the SPOC CubeSat was performed. The assessment used DAS 2.1.1, a conservative tool used by the NASA Orbital Debris Office to verify Requirement 4.7-1. The analysis is intended to provide a bounding analysis for characterizing the survivability of a CubeSat's component during re-entry. For example, when DAS shows a component surviving reentry it is not taking into account the material ablating away or charring due to oxidative heating. Both physical effects are experienced upon reentry and will decrease the mass and size of the real-life components as the reenter the atmosphere, reducing the risk they pose still further.

The following steps are used to identify and evaluate a components potential reentry risk relative to the 4.7-1 requirement of having less than 15 J of kinetic energy and a 1:10,000 probability of a human casualty in the event the survive reentry.

1. Low melting temperature (less than 1000 °C) components are identified as materials that would never survive reentry and pose no risk to human casualty. This is confirmed through DAS analysis that showed materials with melting temperatures equal to or below that of copper (1080 °C) will always demise upon reentry for any size component up to the dimensions of a 1U CubeSat.

2. The remaining high temperature materials are shown to pose negligible risk to human casualty through a bounding DAS analysis of the highest temperature components, stainless steel (1500°C). If a component is of similar dimensions and has a melting temperature between 1000 °C and 1500°C, it can be expected to possess the same negligible risk as stainless steel components.

Table 4: SPOC High Melting Temperature Material Analysis

CubeSat	Name	Material	Mass (kg)	Demise Alt (km)	Kinetic Energy (J)
SPOC	Edmund Lens Housing #41137	Steel AISI 316	.049	69.3	-
SPOC	Mirror Mount 1	Steel AISI 316	.013	73.7	-
SPOC	Edmund Lens Housing #45103	Steel AISI 316	.046	69.8	-
SPOC	Mirror Mount 2	Steel AISI 316	.013	73.7	-
SPOC	Edmund Lens Housing #49934	Steel AISI 316	.027	69.8	-
SPOC	Diffraction Grating Holder	Steel AISI 316	.026	72.0	-
SPOC	Edmond Lens Housing #45349	Steel AISI 316	.066	70.4	-
SPOC	Custom Lens Housing	Steel AISI 316	.023	71.7	-
SPOC	Housing Clamping Bolts	18-8 Stainless Steel	.007	75.0	-
SPOC	Payload Housing Top	Aluminum 6061	.084	76.1	
SPOC	Payload Housing Bottom	Aluminum 6061	.080	72.1	
SPOC	Motherboard Heatsink 1	Steel AISI 316	.024	72.8	-
SPOC	Motherboard Heatsink 2	Steel AISI 316	.024	72.7	-
SPOC	Custom Standoff 1	Stainless Steel 316	.013	72.7	-

SPOC	Custom Standoff 2	Stainless Steel 316	.012	72.5	-
SPOC	Finderscope Mounting Bracket	Aluminum	.030	0.0	5
SPOC	Reaction Wheels	Stainless Steel 316	.028	0.0	1

The majority of components demise upon reentry. This CubeSat complies with the 1:10,000 probability of Human Casualty Requirement 4.7-1. A breakdown of the determined probabilities follows:

Table 5: Requirement 4.7-1 Compliance by CubeSat

Name	Status	Risk of Human Casualty
SPOC	Compliant	1:0

*Requirement 4.7-1 Probability of Human Casualty > 1:10,000

If a component survives to the ground but has less than 15 Joules of kinetic energy it is not included in the Debris Casualty Area that inputs into the Probability of Human Casualty calculation. This is why CubeSats that have surviving components like SPOC have a 1:0 probability as none of its components have more than 15J of energy.

SPOC is shown to be in compliance with Requirement 4.7-1 of NASA-STD-8719.14A.

Section 8: Assessment for Tether Missions

SPOC will not be deploying any tethers.

SPOC satisfies Section 8's requirement 4.8-1.

Section 9-14

ODAR sections 9 through 14 pertain to the launch vehicle, and are not covered here. Launch vehicle sections of the ODAR are the responsibility of the CRS provider.

If you have any questions, please contact the undersigned at 321-867-2098.

/original signed by/

Yusef A. Johnson
Flight Design Analyst
a.i. solutions/KSC/AIS2

cc: VA-H/Mr. Carney
VA-H1/Mr. Beaver
VA-H1/Mr. Haddox
VA-C/Ms. Nufer
SA-D2/Mr. Frattin
SA-D2/Mr. Hale
SA-D2/Mr. Henry
Analex-3/Mr. Davis
Analex-22/Ms. Ramos

Appendix Index:

Appendix A. SPOC Component List

Item Number	Name	Qty	Material	Body Type	Mass (g) (total)	Diameter / Width (mm)	Length (mm)	Height (mm)	High Temp	Melting Temp (F°)	Survivability
1	Spectral Ocean Color Satellite(SPOC)	1		Cube	3619.826389	106.7	109.81	344	No	-	Demise
2	SPOC Payload	1		Cube	1171.23538	93	93	130.5	No	-	Demise
2.1	Payload Camera Housing	1		Cuboid		52.5	42.5	126.5	No	-	Demise
2.1.1	PYLD CMOS Board	1	-	Cuboid	6.6	17.7	1.651	52.578	No	-	Demise
2.1.2	SPOCeye Housing Top	1	Aluminum 6061	Cuboid	48.205	2	98.018	110.5	No	-	Demise
2.1.3	SPOCeye Housing Bottom	1	Aluminum 6061	Cuboid	340.425	52.5	42.5	126.5	No	-	Demise
2.1.4	SPOCeye Mirror Retaining Ring	1	Aluminum 6061	Rectangular	12.611	2	98.018	110.5	No	-	Demise
2.1.5	Polarizing Scrambler	1	Crystal Quartz	Cuboid	1.1066	12.5	2.345	12.5	No	-	Demise
2.1.6	Edmond Lens Housing #45137	1	Stainless Steel 316	Cuboid	49.612	25.5	19	25	Yes	2500°	Demise
2.1.7	Longpass Filter	1	UV Grade Fused Silica	Cube	0.616	12.5	2	-	No	-	Demise
2.1.8	Edmond Lens #45137	1	N-SF10 / N-BAF10	Cylinder	1.7242	12.5	5	-	No	-	Demise
2.1.9	Mirror Mount 1	1	Stainless Steel 316	Cuboid	13.369	19	7	29	Yes	2500°	Demise
2.1.10	Mirror 1	1	Glass	Cuboid	0.336	15	3	15	No	-	Demise
2.1.11	Edmond Lens Housing #45103	1	Stainless Steel 316	Cuboid	46.835	20	16.58	25	Yes	2500°	Demise
2.1.12	Edmond Lens #45103	1	N-SF10 / N-BAF10	Cylinder	3.7637	15	7.58	-	No	-	Demise
2.1.13	Slit Plane	1	Sodalime Glass	Cuboid	0.4788	12.7	1.5	-	No	-	Demise
2.1.14	Mirror Mount 2	1	Stainless Steel 316	Cuboid	13.369	19	7	29	Yes	2500°	Demise
2.1.15	Mirror 2	1	Glass	Cuboid	0.336	15	3	15	No	-	Demise
2.1.16	Payload Housing Top	1	Aluminum 6061	Cuboid	84.69	96	96	15.25	Yes	1600°	Demise
2.1.17	Payload Housing Bottom	1	Aluminum 6061	Cuboid	80.8889	96	96	14	Yes	1600°	Demise
2.1.18	Edmond Lens Housing #49934	1	Stainless Steel 316	Cuboid	27.612	25.5	10	25	Yes	2500°	Demise
2.1.19	Edmond Lens #49934	1	N-SF10 / N-BAF10	Cylinder	5.0367	20	6	-	No	-	Demise

2.1.20	Diffraction Grating Holder	1	Stainless Steel 316	Cuboid	26.536	21.45	11.6	29	No	-	Demise
2.1.21	Diffraction Grating	1	N-SF10 / N-BAF10	Cuboid	2.9516	12.7	6	12.7	No	-	Demise
2.1.22	Edmond Lens Housing #45349	1	Stainless Steel 316	Cuboid	66.821	35	24	25	Yes	2500°	Demise
2.1.23	Edmond Lens #45349	1	N-SF10 / N-BAF10	Cylinder	4.0985	18	5.85	-	No	-	Demise
2.1.24	Custom Lens Housing	1	Stainless Steel 316	Cuboid	23.515	18	9	25	No	-	Demise
2.1.25	Custom Lens	1	BK-7 Glass	Cylinder	1.292	12	4	-	No	-	Demise
2.1.26	CMOS Mounting Bracket	1	Aluminum 6061	Rectangular	17.707	45.35	5	55.118	No	-	Demise
2.1.27	Housing Clamping Bolts	3	18-8 Stainless Steel	Cylinder	7.494	7.9375	49.276	-	Yes	1600°	Demise
2.1.28	Housing Cap Screw	2	18-8 Stainless Steel	Cylinder	0.664	4.6482	12.3698	-	No	-	Demise
2.1.29	Housing to SPOC Mounting Bolts	8	18-8 Stainless Steel	Cylinder	3.401	7.9248	20.701	-	No	-	Demise
2.1.30	Lens Housings to Base Screws	11	18-8 Stainless Steel	Cylinder	0.548	4.6482	9.1948	-	No	-	Demise
2.1.31	CMOS Mounting Flange to Housing Base	4	18-8 Stainless Steel	Cylinder	0.545	6.477	7.9375	-	No	-	Demise
2.1.32	CMOS to Mounting Flange	5	18-8 Stainless Steel	Cylinder	0.256	5.0038	6.35	-	No	-	Demise
2.1.33	Housing Clamping Washers	22	18-8 Stainless Steel	Cylinder	0.575	10.16	1.143	-	No	-	Demise
2.1.34	Base to Lens Housing Washers	14	18-8 Stainless Steel	Cylinder	0.097	6.477	1.143	-	No	-	Demise
2.1.35	LH1 Mounting Washer	2	18-8 Stainless Steel	Cylinder	0.033	4.572	0.4826	-	No	-	Demise
2.1.36	Housing Clamping Nuts	3	18-8 Stainless Steel	Cylinder	2.656	9.525	6.35	-	No	-	Demise
2.1.37	Housing to SPOC Nuts	8	18-8 Stainless Steel	Cylinder	2.447	7.9248	20.701	-	No	-	Demise
2.1.38	CMOS Board Mounting Nuts	5	18-8 Stainless Steel	Cylinder	0.21	4.7625	1.5875	-	No	-	Demise
2.1.39	Adjustment Screw Nut	3	18-8 Stainless Steel	Cylinder	0.559	7	2.2	-	No	-	Demise
2.1.40	LH1 & LH4 Adjustment Screw	2	Stainless Steel 303	Cylinder	2.179	3.4	38.4	-	No	-	Demise
2.1.41	Adjustment Screw Bushing	3	Brass 360	Cylinder	1.019	5.5	8.3	-	No	-	Demise
2.1.42	LH5 Adjustment Screw	1	Stainless Steel 303	Cylinder	1.387	3.4	19.1	-	No	-	Demise
2.1.43	Mirror Oval-tipped adjustment screws	5	18-8 Stainless Steel	Cylinder	0.335	2.8448	9.525	-	No	-	Demise
2.1.44	Diffraction Grating Oval-tipped adjustment screws	1	18-8 Stainless Steel	Cylinder	0.158	2.8448	9.525	-	No	-	Demise

2.1.45	Helicoils	5	18-8 Stainless Steel	Cylinder	0.349	4.7625	25.4	-	No	-	Demise
2.1.46	Support Post	1	18-8 Stainless Steel	Cylinder	3.505	3.175	8.5344	-	No	-	Demise
2.2	Payload Electronics								No	-	Demise
2.2.1	PYLD SPOCeye Motherboard	1	-	Rectangular	69.3	85.5	100.7	13.5	No	-	Demise
2.2.2	PYLD PicoZED	1	-	Rectangular	31	57.15	101.6	9.3	No	-	Demise
2.2.3	Motherboard Heatsink 1	1	Stainless Steel 316	Cuboid	24.321	4.5	45.67	17.8	Yes	2500°	Demise
2.2.4	Motherboard Heatsink 2	1	Stainless Steel 316	Cuboid	24.352	4.5	44.47	17.9	Yes	2500°	Demise
2.2.5	PicoZED Standoff Screws	2	18-8 Stainless Steel	Cylinder	1.007	5.5	15	-	No	-	Demise
2.2.6	PicoZED Standoff Washer	6	18-8 Stainless Steel	Cylinder	0.146	7	0.6	-	No	-	Demise
2.2.7	PicoZED Standoff Locknut	4	18-8 Stainless Steel	Cylinder	0.5387	6.5	3.3	-	No	-	Demise
2.2.8	Motherboard Heatsink Screw	4	18-8 Stainless Steel	Cylinder	0.81	5.5	11	-	No	-	Demise
2.2.9	Custom Standoff 1	1	Stainless Steel 316	Cuboid	11.783	18	8	13.5	Yes	2500°	Demise
2.2.10	Custom Standoff 2	1	Stainless Steel 316	Cuboid	12.607	18	8	12.5	Yes	2500°	Demise
2.2.11	Motherboard Hex Standoff	2	18-8 Stainless Steel	Cylinder	0.753	4.5	8	-	No	-	Demise
2.2.12	PicoZED Hex Standoff Screw	2	18-8 Stainless Steel	Cylinder	0.483	5.7	7.65	-	No	-	Demise
2.2.13	Electronics Mounting Screw	4	18-8 Stainless Steel	Cylinder	0.723	6.477	12.7	-	No	-	Demise
2.2.14	Finderscope Mounting Screw	4	18-8 Stainless Steel	Cylinder	0.664	4.6482	12.3698	-	No	-	Demise
2.3	Payload Finderscope					32	32	21	No	-	Demise
2.3.1	Finderscope Mounting Screw	4	18-8 Stainless Steel	Cylinder	0.149	2.4384	11.049	-	No	-	Demise
2.3.2	Finderscope Mounting Screw	4	18-8 Stainless Steel	Cylinder	0.079	2.4384	4.699	-	No	-	Demise
2.3.3	Hex Standoff	4	18-8 Stainless Steel	Cylinder	0.672	3.175	11.113	-	No	-	Demise
2.3.4	Finderscope Mounting Washer	8	18-8 Stainless Steel	Cylinder	0.011	2.5146	0.4572	-	No	-	Demise
2.3.5	Finderscope Mounting Bracket	1	Aluminum	Cuboid	30.718	32	6.35	124.46	Yes	1220°	0 km
2.3.6	uCAM-III	1	-	Cylinder	6	32	32	21	No	-	Demise
2.3.7	Shunt Resistor Screw	2	18-8 Stainless Steel	Cylinder	0.784	4.6482	15.5448	-	No	-	Demise
2.3.8	Shunt Resistor Nut	2	18-8 Stainless Steel	Cylinder	0.567	6.35	2.38125	-	No	-	Demise

2.3.9	Shunt Resistor	1	Aluminum 6061	Cylinder	12.896	26.97	27.43	14.25	No	-	Demise
3	EPS				901				No	-	Demise
3.1	EPS Mother Board	1	-		86	90.17	95.8	23.24	No	-	Demise
3.1.1	Adhesive Fixing	-	Araldite 2014 Epoxy	Rectangular	-	-	-	-	No	-	Demise
3.1.2	Conformal Coating	-	1B31 Acrylic	-	-	-	-	-	No	-	Demise
3.1.3	Adhesive Fixing on Modifications	-	DC 6-1104	-	-	-	-	-	No	-	Demise
3.1.4	Adhesive Fixing	-	Stycast 2850	-	-	-	-	-	No	-	Demise
3.1.5	PCB Board	-	PCB material	-	-	-	-	-	No	-	Demise
3.1.6	Low activity flux to avoid corrosion	-	Flux	-	-	-	-	-	No	-	Demise
3.1.7	PEMs	-	300 Series Stainless Steel	-	-	-	-	-	No	-	Demise
3.1.8	Expansion Header	-	Berylium Copper	-	-	-	-	-	No	-	Demise
3.1.9	Cubesat Header	-	Vectra E-130i	-	-	-	-	-	No	-	Demise
3.1.10	Cubesat Header	-	Crastin SK662FR	-	-	-	-	-	No	-	Demise
3.1.11	Cubesat Header	-	Phosphor Bronze	-	-	-	-	-	No	-	Demise
3.1.12	Cubesat Header	-	Nickel Underplating	-	-	-	-	-	No	-	Demise
3.1.13	Cubesat Header	-	Gold	-	-	-	-	-	No	-	Demise
3.1.14	Electronic Connectors	-	Polyamide	-	-	-	-	-	No	-	Demise
3.1.15	Electronic Connectors	-	Brass	-	-	-	-	-	No	-	Demise
3.1.16	Electronic Connectors	-	Phosphor Copper	-	-	-	-	-	No	-	Demise
3.1.17	M3 Fasteners	-	A4 Stainless Steel (316L)	-	-	-	-	-	No	-	Demise
3.1.18	Solder	-	Solder	-	-	-	-	-	No	-	Demise
3.1.19	Low activity flux to avoid corrosion	-	Flux	-	-	-	-	-	No	-	Demise
3.2	EPS 40Whr Batteries	1	-	Cuboid	335	90.17	95.89	27.35	No	-	Demise
3.2.1	Adhesive Fixing	-	Araldite 2014 Epoxy	-	-	-	-	-	No	-	Demise
3.2.2	Conformal Coating	-	Arathane 5750	-	-	-	-	-	No	-	Demise
3.2.3	Adhesive fixing on modifications	-	DC 6-1104	-	-	-	-	-	No	-	Demise

3.2.4	Thermally Conductive RTV	-	Stycast 5952	-	-	-	-	-	No	-	Demise
3.2.5	IP Protective Layer	-	Stycast 2850	-	-	-	-	-	No	-	Demise
3.2.6	PCB Board	-	PCB Material	-	-	-	-	-	No	-	Demise
3.2.7	Cubesat Header	-	Vectra E-130i	-	-	-	-	-	No	-	Demise
3.2.8	Cubesat Header	-	Crastin SK662FR	-	-	-	-	-	No	-	Demise
3.2.9	Cubesat Header	-	Phosphor Bronze	-	-	-	-	-	No	-	Demise
3.2.10	Cubesat Header	-	Nickel Underplating	-	-	-	-	-	No	-	Demise
3.2.11	Cubesat Header	-	Gold	-	-	-	-	-	No	-	Demise
3.2.12	Electronic Connectors	-	Polyamide	-	-	-	-	-	No	-	Demise
3.2.13	Electronic Connectors	-	Brass	-	-	-	-	-	No	-	Demise
3.2.14	Electronic Connectors	-	Phosphor Copper	-	-	-	-	-	No	-	Demise
3.2.15	Solder Resist	-	Solder Resist	-	-	-	-	-	No	-	Demise
3.2.16	Solder	-	Solder	-	-	-	-	-	No	-	Demise
3.2.17	Flux	-	Flux	-	-	-	-	-	No	-	Demise
3.3	Solar Panels		-	Rectangular	540				No	-	Demise
3.3.1	EPS 3U Solar Panels	3	-	Rectangular	160	322.5	83	7.13	No	-	Demise
3.3.2	EPS 1U Solar Panel	1	-	Rectangular	60	98	98	4.77	No	-	Demise
3.3.3	Solar Cell Adhesive	-	NuSil	-	-	-	-	-	No	-	Demise
3.3.4	Wire Stalking	-	Araldite 2014 Epoxy	-	-	-	-	-	No	-	Demise
3.3.5	Cell Tab Coverage	-	Stycast	-	-	-	-	-	No	-	Demise
3.3.6	Wire Insulation	-	PTFE	-	-	-	-	-	No	-	Demise
3.3.7	Epoxy resin bonded fiber flass laminate	-	FR4	-	-	-	-	-	No	-	Demise
3.3.8	Electronic Connectors	-	Polyamide	-	-	-	-	-	No	-	Demise
3.3.9	Electronic Connectors	-	Brass	-	-	-	-	-	No	-	Demise
3.3.10	Electronic Connectors	-	Phosphor Copper	-	-	-	-	-	No	-	Demise
3.3.11	Array to EPS Connector	-	-	-	-	-	-	-	No	-	Demise
3.3.12	Array to ADCS Connector	-	-	-	-	-	-	-	No	-	Demise

3.3.13	Coarse Sun Sensor	-	-	-	-	-	-	-	No	-	Demise
3.3.14	RBF Inhibit Extension	-	-	-	-	-	-	-	No	-	Demise
3.3.15	Magnetorquer	-	-	-	-	-	-	-	No	-	Demise
4	COMM								No	-	Demise
4.1	Antenna			Cylinder					No	-	Demise
4.1.1	S-Band Antenna	1	-	Cylinder	50	81.5	13.6		No	-	Demise
4.1.2	GPS Antenna	1	Composite	Rectangular	22.7	5	3	0.5	No	-	Demise
4.1.3	UHF Antenna	1	-	Rectangular	100	102	102	6	No	-	Demise
4.1.4	RF Cable	-	-	-	-	-	-	-	No	-	Demise
4.1.5	S-band Patch Element	-	-	-	-	-	-	-	No	-	Demise
4.1.6	RF Phaser	-	-	-	-	-	-	-	No	-	Demise
4.1.7	Burn Wire	-	-	-	-	-	-	-	No	-	Demise
4.1.8	Antenna Elements	-	-	-	-	-	-	-	No	-	Demise
4.1.9	Power and Data Connection	-	-	-	-	-	-	-	No	-	Demise
4.1.10	Micrcontroller	-	-	-	-	-	-	-	No	-	Demise
4.1.11	Temperature Sensor	-	-	-	-	-	-	-	No	-	Demise
4.1.12	GLAD.01 EVB Board	-	FR4 0.8t	-	-	-	-	-	No	-	Demise
4.1.13	SMA(F) ST	-	Brass	-	-	-	-	-	No	-	Demise
4.1.14	Capacitor 8pF (0402)	-	Ceramic	-	-	-	-	-	No	-	Demise
4.1.15	Resistor 0Ohm (0402)	-	Ceramic	-	-	-	-	-	No	-	Demise
4.1.16	Capacitor 2.2pF (0402)	-	Ceramic	-	-	-	-	-	No	-	Demise
4.2	Communication Boards								No	-	Demise
4.2.1	S-Band Transmitter	1	-	Rectangular	95	90.17	95.89	18.77	No	-	Demise
4.2.2	UHF Transceiver	1	-	Rectangular	85	90.17	95.89	18.09	No	-	Demise
4.2.3	CubeSat Header	-	-	-	-	-	-	-	No	-	Demise
4.2.4	FPGA	-	-	-	-	-	-	-	No	-	Demise
4.2.5	Dual Digital to Analog Convertor	-	-	-	-	-	-	-	No	-	Demise

4.2.6	Power Supply Unit	-	-	-	-	-	-	-	No	-	Demise
4.2.7	Modulator	-	-	-	-	-	-	-	No	-	Demise
4.2.8	Pre-Amplifier	-	-	-	-	-	-	-	No	-	Demise
4.2.9	Power Amplifier	-	-	-	-	-	-	-	No	-	Demise
4.2.10	RF Out Connection	-	-	-	-	-	-	-	No	-	Demise
4.2.11	Adhesive Fixing	-	Araldite 2014 Epoxy	-	-	-	-	-	No	-	Demise
4.2.12	Conformal Coating	-	1B31 Acrylic	-	-	-	-	-	No	-	Demise
4.2.13	Adhesive Fixing	-	DC 6-1104	-	-	-	-	-	No	-	Demise
4.2.14	PCB Board	-	PCB Material	-	-	-	-	-	No	-	Demise
4.2.15	-	-	Solder Resist	-	-	-	-	-	No	-	Demise
4.2.16	-	-	Solder	-	-	-	-	-	No	-	Demise
4.2.17	Cubesat Header	-	Vectra E-130i	-	-	-	-	-	No	-	Demise
4.2.18	Cubesat Header	-	Crastin SK662FR	-	-	-	-	-	No	-	Demise
4.2.19	Cubesat Header	-	Phosphor Bronze	-	-	-	-	-	No	-	Demise
4.2.20	Cubesat Header	-	Nickel Underplating	-	-	-	-	-	No	-	Demise
4.2.21	Cubesat Header	-	Gold	-	-	-	-	-	No	-	Demise
4.2.22	Electronic Connectors	-	Polyamide	-	-	-	-	-	No	-	Demise
4.2.23	Electronic Connectors	-	Brass	-	-	-	-	-	No	-	Demise
4.2.24	Electronic Connectors	-	Phosphor Copper	-	-	-	-	-	No	-	Demise
5	ADCS								No	-	Demise
5.1	ADCS Mother Board	1	-	Rectangular	86	90.17	95.89	44.49	No	-	Demise
5.1.1	Adhesive Fixing	-	Araldite 2014 Epoxy	-	-	-	-	-	No	-	Demise
5.1.2	Conformal Coating	-	1B31 Acrylic	-	-	-	-	-	No	-	Demise
5.1.3	Adhesive Fixing	-	DC 6-1104	-	-	-	-	-	No	-	Demise
5.1.4	PCB Board	-	FR4	-	-	-	-	-	No	-	Demise
5.1.5	-	-	Solder Resist	-	-	-	-	-	No	-	Demise
5.1.6	-	-	Solder	-	-	-	-	-	No	-	Demise

5.1.7	Cubesat Header	-	Vectra E-130i	-	-	-	-	-	No	-	Demise
I sent 5.1.8	Cubesat Header	-	Crastin SK662FR	-	-	-	-	-	No	-	Demise
5.1.9	Cubesat Header	-	Phosphor Bronze	-	-	-	-	-	No	-	Demise
5.1.10	Cubesat Header	-	Nickel Underplating	-	-	-	-	-	No	-	Demise
5.1.11	Cubesat Header	-	Gold	-	-	-	-	-	No	-	Demise
5.1.12	Electronic Connectors	-	Polyamide	-	-	-	-	-	No	-	Demise
5.1.13	Electronic Connectors	-	Brass	-	-	-	-	-	No	-	Demise
5.1.14	Electronic Connectors	-	Phosphor Copper	-	-	-	-	-	No	-	Demise
5.2	ADCS Reaction Wheels Daughterboard	3	-	Cylinder	236	95.89	90.17	34.86	-	-	Demise
5.2.1	Adhesive Fixing	-	Araldite 2014 Epoxy	-	-	-	-	-	No	-	Demise
5.2.2	Conformal Coating	-	1B31 Acrylic	-	-	-	-	-	No	-	Demise
5.2.3	Adhesive Fixing	-	DC 6-1104	-	-	-	-	-	No	-	Demise
5.2.4	PCB Board	-	PCB Material	-	-	-	-	-	No	-	Demise
5.2.5	-	-	Solder Resist	-	-	-	-	-	No	-	Demise
5.2.6	-	-	Solder	-	-	-	-	-	No	-	Demise
5.2.7	Spacer	-	Black Delrin AF	-	-	-	-	-	No	-	Demise
5.2.8	Mounts	-	AL 6082-T6	-	-	-	-	-	No	-	Demise
5.2.9	Fly Wheel 1	-	Stainless Steel	-	28.23	-	-	-	-	2500°	0 km
5.2.10	-	-	Braycote 601 EF	-	-	-	-	-	-	-	Demise
5.2.11	Motor 1	-	-	-	22	-				-	Demise
5.2.12	Fly Wheel 2	-	Stainless Steel	-	28.23	-	-	-	-	2500°	0 km
5.2.13	-	-	Braycote 601 EF	-	-	-	-	-	-	-	Demise
5.2.14	Motor 2	-	-	-	22	-				-	Demise
5.2.15	Fly Wheel 3	-	Stainless Steel	-	28.23	-	-	-	-	2500°	0 km
5.2.16	-	-	Braycote 601 EF	-	-	-	-	-	-	-	Demise
5.2.17	Motor 3	-	-	-	22	-	-	-	-	-	Demise
5.2.18	Cubesat Header	-	Vectra E-130i	-	-	-	-	-	-	-	Demise

5.2.19	Cubesat Header		Crastin SK662FR	-	-	-	-	-	-	-	Demise
5.2.20	Cubesat Header		Phosphor Bronze	-	-	-	-	-	-	-	Demise
5.2.21	Cubesat Header		Nickel Underplating	-	-	-	-	-	-	-	Demise
5.2.22	Cubesat Header		Gold	-	-	-	-	-	-	-	Demise
5.2.23	Electronic Connectors		Polyamide	-	-	-	-	-	-	-	Demise
5.2.24	Electronic Connectors		Brass	-	-	-	-	-	-	-	Demise
5.2.25	Electronic Connectors		Phosphor Copper	-	-	-	-	-	-	-	Demise
5.3	Fine Sun Sensor	2	-	Stadium Cylinder	6.5	43	14	5.9	No	-	Demise
5.3.1	Sun Sensor to ADCS Connection	-	-	-	-	-	-	-	No	-	Demise
5.3.2	UART Controller	-	-	-	-	-	-	-	No	-	Demise
5.3.3	Analog to Digital Converter	-	-	-	-	-	-	-	No	-	Demise
5.3.4	Axis Diodes	-	-	-	-	-	-	-	No	-	Demise
6	Command and Data Handling								No	-	Demise
6.1	OBC Motherboard	1	-	Rectangle	61.9	95.89	90.17	23.24	No	-	Demise
6.1.1	Adhesive Fixing	-	Araldite 2014 Epoxy	-	-	-	-	-	No	-	Demise
6.1.2	Conformal Coating	-	1B31 Acrylic	-	-	-	-	-	No	-	Demise
6.1.3	PCB Board	-	PCB Material	-	-	-	-	-	No	-	Demise
6.1.4	-	-	Solder Resist	-	-	-	-	-	No	-	Demise
6.1.5	-	-	Solder Resist	-	-	-	-	-	No	-	Demise
6.1.6	Expansion Header	-	Berylium Copper	-	-	-	-	-	No	-	Demise
6.1.7	Cubesat Header	-	Vectra E-130i	-	-	-	-	-	No	-	Demise
6.1.8	Cubesat Header	-	Crastin SK662FR	-	-	-	-	-	No	-	Demise
6.1.9	Cubesat Header	-	Phosphor Bronze	-	-	-	-	-	No	-	Demise
6.1.10	Cubesat Header	-	Nickel Underplating	-	-	-	-	-	No	-	Demise
6.1.11	Cubesat Header	-	Gold	-	-	-	-	-	No	-	Demise
6.1.12	Electronic Connectors	-	Polyamide	-	-	-	-	-	No	-	Demise
6.1.13	Electronic Connectors	-	Brass	-	-	-	-	-	No	-	Demise

6.1.14	Electronic Connectors	-	Phosphor Copper	-	-	-	-	-	No	-	Demise
6.2	CAIB Board	1	-		75	95.89	90.17	4.7	No	-	Demise
6.2.1	S-Band Patch to STX-B								No	-	Demise
6.2.1.1	1 pin SMA Male to female right angle jack: ***	2	-	-	-	-	-	-	No	-	Demise
6.2.1.2	Male to male SMA wire 135101-01-06.00	1	-	-	-	-	-	-	No	-	Demise
6.2.2	GPS to Antenna								No	-	Demise
6.2.2.1	1 pin MMCX to SMA Male to Male Connector:	1	-	-	-	-	-	-	No	-	Demise
6.2.3	Fine Sun Sensor to 3-Axis Reaction Wheels								No	-	Demise
6.2.3.1	10 pin Female Housing: DF13-10DS-1.25C	1	-	-	-	-	-	-	No	-	Demise
6.2.3.2	6 pin Female Housing: DF13-6S-1.25C	1	-	-	-	-	-	-	No	-	Demise
6.2.3.3	1 pin Crips for Housing: DF13-2630SCFA	8	-	-	-	-	-	-	No	-	Demise
6.2.4	Solar Panel to EPS								No	-	Demise
6.2.4.1	5 pin Female Housing: DF13-5S-1.25C	6	-	-	-	-	-	-	No	-	Demise
6.2.4.2	1 pin Crimp for Housing: DF13-2630SCFA	30	-	-	-	-	-	-	No	-	Demise
6.2.5	Solar Panel to ADCS								No	-	Demise
6.2.5.1	6 pin Female Housing: DF13-6S-1.25C	6	-	-	-	-	-	-	No	-	Demise
6.2.5.2	1 pin Crips for Housing: DF13-2630SCFA	36	-	-	-	-	-	-	No	-	Demise
6.2.6	ISIS COMM Antennas to T/Rx								No	-	Demise
6.2.6.1	MMCX male R-A to SMC fem R-A cable and jacks 102185	1	-	-	-	-	-	-	No	-	Demise
6.2.6.2	MMCX male R-A to SSMC fem R-A cable and jacks 102538	1	-	-	-	-	-	-	No	-	Demise
6.2.7	ISIS COMM Antenna to CAIB Connectors								No	-	Demise
6.2.7.1	9 pin Male Bi-Lobe Connector: A28000-009	4	-	-	-	-	-	-	No	-	Demise

6.2.8	SPOCeye PYLD to CAIB Wires								No	-	Demise
6.2.8.1	30 pin Interface Connector: TFSD-15-28-H-06.00-S	1	-	-	-	-	-	-	No	-	Demise
6.2.8.2	24 pin Debug Connector: TCSD-12-D-05.00-01-S	1	-	-	-	-	-	-	No	-	Demise
6.2.9	CAIB Headers								No	-	Demise
6.2.9.1	52 pin Cubesat Header: ESQ-126-38-G-D	4	-	-	-	-	-	-	No	-	Demise
6.2.9.2	30 pin SPOCeye Interface: SFM-115-02-S-DH	2	-	-	-	-	-	-	No	-	Demise
6.2.9.3	24 pin SPOCeye Debug: EHT-112-01-S-D	2	-	-	-	-	-	-	No	-	Demise
6.2.9.4	9 pin ISIS Antenna Interface: A29100-009	4	-	-	-	-	-	-	No	-	Demise
6.2.9.5	EGSE Interface USB - C: 1054500101	2	-	-	-	-	-	-	No	-	Demise
6.2.9.6	EGSE Interface RJ45: PRT-08534	2	-	-	-	-	-	-	No	-	Demise
6.2.9.7	Mini HDMI SMT Horizontal WR-COM	4	-	-	-	-	-	-	No	-	Demise
6.2.9.8	OBC Debug Mode Select DF13-2P-1.25DSA	4	-	-	-	-	-	-	No	-	Demise
6.2.9.9	OBC Debug JTAG DF13-10P-1.25DSA	4	-	-	-	-	-	-	No	-	Demise
6.2.9.10	Solar Panel Sim DF13-5P-1.25DSA	4	-	-	-	-	-	-	No	-	Demise
6.2.9.11	Battery Inhibits DF13-2P-1.25DSA	10	-	-	-	-	-	-	No	-	Demise
6.2.9.12	Sun Sensor DF13-6P-1.25DSA	14	-	-	-	-	-	-	No	-	Demise
7	Structure				330.087				No	-	Demise
7.1	Frame				330.087	100	100	340.5	No	-	Demise
7.1.1	Rail X+ Y+	1	Aluminum 6082-T6	Cuboid	25	18.75	18.75	340.5	No	-	Demise
7.1.2	Rail X+ Y-	1	Aluminum 6082-T6	Cuboid	25	18.75	18.75	340.5	No	-	Demise
7.1.3	Rail X- Y+	1	Aluminum 6082-T6	Cuboid	25	18.75	18.75	340.5	No	-	Demise
7.1.4	Rail X- Y-	1	Aluminum 6082-T6	Cuboid	25	18.75	18.75	340.5	No	-	Demise
7.1.5	Panel (X-) (Y-) (Y+)	3	Aluminum 6082-T6	Rectangle	30	83	1	322.5	No	-	Demise
7.1.6	Panel X+	1	Aluminum 6082-T6	Rectangle	21.627	83	1	322.5	No	-	Demise

7.1.7	Ribs	1	Aluminum 6082-T6	-	17.36	98	98	5	No	-	Demise
7.1.8	Z+ Endcap	1	Aluminum 6082-T6	Rectangle	25.6	100	100	6.5	No	-	Demise
7.1.9	Z- EndCap	1	Aluminum 6082-T6	Rectangle	24.36	100	100	6.5	No	-	Demise
7.1.10	M1.7 x 6 Machine Screw	8	SS A2	-	0.08	-	-	-	No	-	Demise
7.1.11	M1.7 x 6 Hex full nut	8	SS A4	-	0.05	-	-	-	No	-	Demise
7.1.12	M2 x 6 TX6 CSK Machine Screw	8	SS A4	-	0.13	-	-	-	No	-	Demise
7.1.13	M2.5 x 4 Ultra Low Head Hex Cap Screw	32	SS A2	-	0.19	-	-	-	No	-	Demise
7.1.14	Payload Support Through Rods	4	Aluminum 6082-T6	-	9.77	-	-	-	No	-	Demise
7.1.15	Deployment Plunger Pin	2	SS 316L	-	0.51	-	-	-	No	-	Demise
7.1.16	Deployment Switch Lever	2	-	-	0.27	-	-	-	No	-	Demise
7.1.17	Deployment Switch Roller	2	-	-	0.29	-	-	-	No	-	Demise
7.1.18	Deployment Switch Mount	4	Aluminum 6082-T6	-	0.07	-	-	-	No	-	Demise
7.1.19	Deployment Compression Spring	2	SS	-	-	-	-	-	No	-	Demise
7.1.20	Separation Spring	2	SS	-	0.71	-	-	-	No	-	Demise
7.1.21	Circlip E-Type 1.5 mm	2	SS	-	-	-	-	-	No	-	Demise
7.1.22	Plastic Bearing	2	iglidur X	-	0.03	-	-	-	No	-	Demise
7.2	Standoffs								No	-	Demise
6.2.28	ADCS RWs to OBC 1	4	18-8 Stainless Steel	-	1.006	6	17	-	No	-	Demise
6.2.29	ADCS RWs to OBC 2	4	18-8 Stainless Steel	-	1.069	6	16	-	No	-	Demise
6.2.30	OBC to CAIB	4	18-8 Stainless Steel	-	0.755	6	12	-	No	-	Demise
6.2.31	ADCS RW to ADCS mobo	-	18-8 Stainless Steel	-	1.006	6	12	-	No	-	Demise
6.2.32	ADCS mobo to UHF	-	18-8 Stainless Steel	-	1.069	6	16	-	No	-	Demise
6.2.33	UHF to S-Band	-	18-8 Stainless Steel	-	1.069	6	16	-	No	-	Demise
6.2.34	Struct to EPS-MB	4	18-8 Stainless Steel	-	0.789	6	12.55	-	No	-	Demise
6.2.35	Battery to EPS-MB	8	18-8 Stainless Steel	-	1.006	6	25	-	No	-	Demise
6.2.36	Structural Rib to S Band Transmitter	4	18-8 Stainless Steel	-	0.126	6	16	-	No	-	Demise

6.2.37	40WHr Bat to Structural Rib	4	18-8 Stainless Steel	-	1.572	6	2	-	No	-	Demise
6.2.38	Caib to Payload standoff	4	18-8 Stainless Steel	-	-	6	18	-	No	-	Demise
8	Misscellaneous Components								No	-	Demise
8.1	Conformal Coating	1	-	-	20	-	-	-	No	-	Demise
8.2	Vibra-Tite Thread Adhesive	1	-	-	8	-	-	-	No	-	Demise
8.3	Wiring Harness	1	-	-	175	-	-	-	No	-	Demise