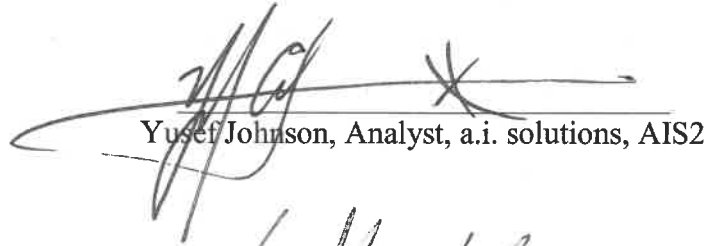


ELVL-2018-0045490
February 22, 2019

**Orbital Debris Assessment for the NEUTRON-1 CubeSat
per NASA-STD.8719.14A**

Signature Page



Yusef Johnson, Analyst, a.i. solutions, AIS2



Scott Higginbotham, Mission Manager, NASA KSC VA-C

National Aeronautics and
Space Administration



John F. Kennedy Space Center, Florida
Kennedy Space Center, FL 32899

ELVL-2018-0045490

Reply to Attn of: VA-H1

February 22, 2019

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 NEUTRON-1 CubeSat

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, delivered 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
- I. HQ OSMA Email:6U CubeSat Battery Non Passivation Suzanne Aleman to Justin Treptow, 8 August 2017

The intent of this report is to satisfy the orbital debris requirements listed in ref. (a) for the NEUTRON-1 CubeSat, which will be deployed from the International Space Station. 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.

RECORD OF REVISIONS		
REV	DESCRIPTION	DATE
0	Original submission	February 2018

The following table summarizes the compliance status of the NEUTRON-1 CubeSat to be deployed from the Cygnus spacecraft. NEUTRON-1 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 2.16 yrs
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	No planned tether release for NEUTRON-1

Section 1: Program Management and Mission Overview

NEUTRON-1 is sponsored by the Human Exploration and Operations Mission Directorate at NASA Headquarters. The Program Executive is John Guidi. Responsible program/project manager and senior scientific and management personnel are as follows:

NEUTRON-1: Lloyd French, University of Hawaii at Manoa, - Project Manager
Dr. Peter Engler, University of Hawaii at Manoa, Principal Investigator

Program Milestone Schedule	
Task	Date
CubeSat Selection	October 30 th , 2018
Delivery to Nanoracks	August 1 st , 2019
Launch	October 19, 2019
Deployment	Q1 2020

Figure 1: Program Milestone Schedule

NEUTRON-1 will be launched as a payload on the Antares launch vehicle executing the NG-12 mission. NEUTRON-1 will be deployed from the ISS. NEUTRON is identified in Table 2: Attributes.

NEUTRON-1 weighs approximately 4.4 kg.

Section 2: Spacecraft Description

Table 2: outlines the generic attributes of the spacecraft.

Table 2: NEUTRON-1 Attributes

CubeSat Names	CubeSat Quantity	CubeSat size (mm³)	CubeSat Masses (kg)
NEUTRON-1	1	340 x 100 x 100	4.37

The following pages describe the NEUTRON-1 CubeSat.

NEUTRON-1 – H-Bar Research – 1U

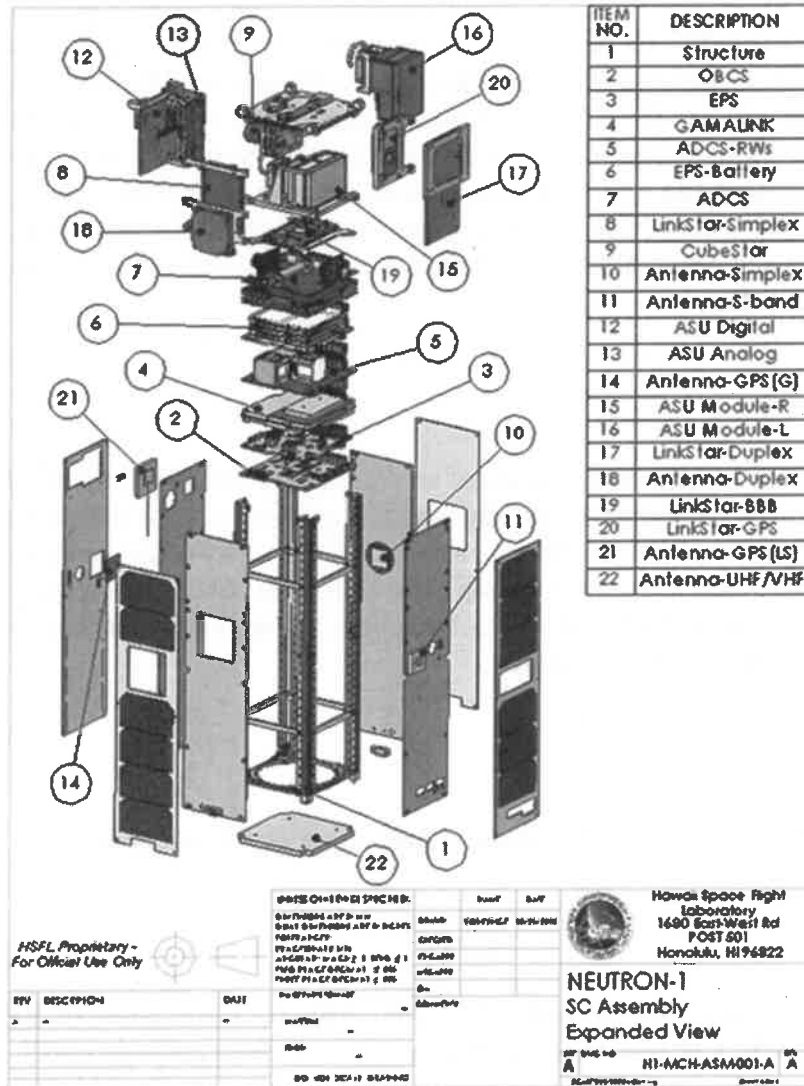


Figure 2: NEUTRON-1 exploded view

Overview

NEUTRON-1 will perform science and technology investigations: Neutron detection, COSMOS flight software operations, and COTS ADCS validation. The science investigation uses an ASU neutron detector to investigate global neutron counts. The instrument operation is also a flight verification and validation of the instrument payload for the LunaH-Map mission. The COSMOS operations investigation will explore unique integrated software tools for coordinated mission commanding, data management, and ground operations. The COTS ADCS investigation will verify vendor specifications during flight with respect to the pointing accuracy, pointing knowledge, and attitude jitter.

CONOPS

Upon release, the UHF/VHF antennas are deployed. NEUTRON-1 will power up spacecraft systems, perform orbital checkout, begin beaconing GPS and time data via the GlobalStar network, and the ADCS will begin detumble operation. After the first few orbits, the OBCS will contact the ground station and perform COSMOS Operations. After ground contact, the ADCS will perform orientation control maneuvers by performing pointing, slew, and tracking commands. Once healthy operation is established, science data collection operation will be conducted, and science data will be downlinked via S-Band.

Materials

The primary CubeSat structure is made of an Aluminum 6082-T6 frame with titanium structural rods. The 3U CubeSat contains standard commercial off the shelf (COTS) electrical components, PCBs, materials, solar cells, and an in-house designed and built OBC. The solar panels are multi junction solar cells with cover glass using standard silicone adhesives upon G-10 substrate. The circuit board components are encapsulated with conformal coatings for protection.

Hazards

There are no pressure vessels, hazardous materials, or exotic materials.

Batteries

The electrical power system consists of a ClydeSpace 3rd Generation 3U EPS and a ClydeSpace 40Whr CubeSat battery, containing two lithium polymer pouch cells. The battery features over-current and under-voltage protections, multiple high-side and low-side solid-state inhibits, as well as voltage, current and temperature telemetries to monitor battery operation. The cells are qualified to NASA standards EP-Wi-032. The battery cells are UL recognized component according to UL 1642.

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 for NEUTRON-1, 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 NEUTRON-1 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))

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 2.16 years maximum, NEUTRON-1 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.

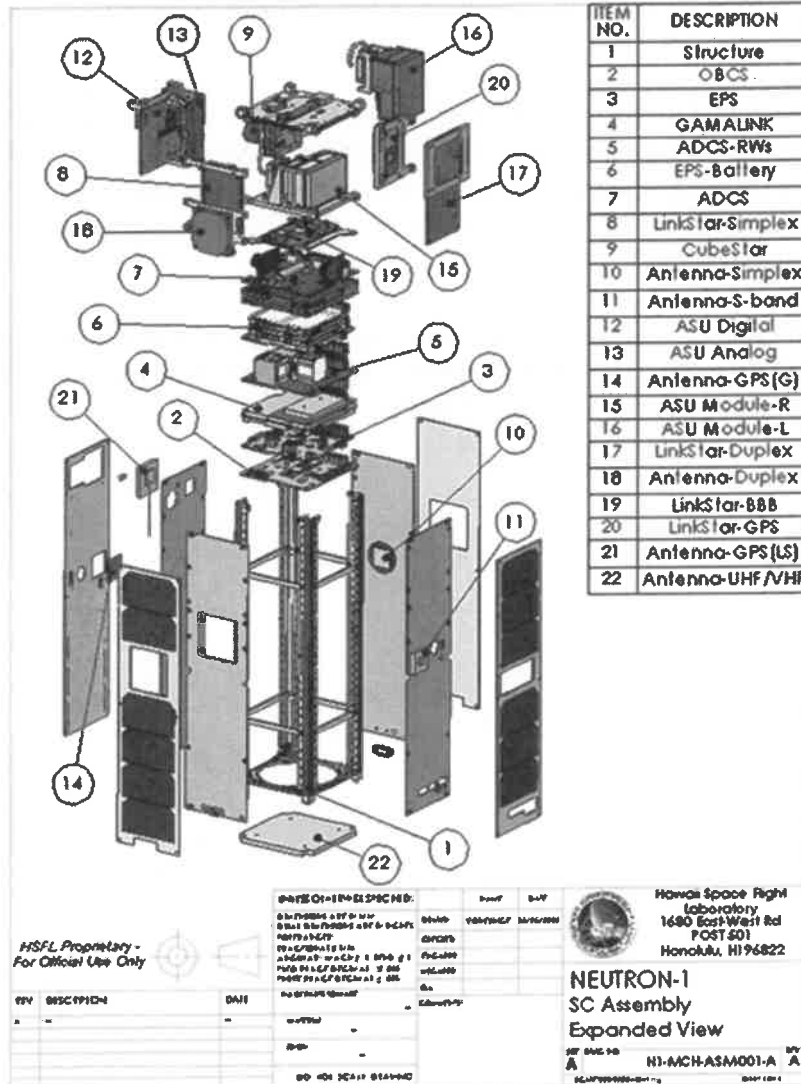


Figure 4: NEUTRON-1 Expanded View

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

Equation 1: Mean Cross Sectional Area for Convex Objects

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

Equation 2: Mean Cross Sectional Area for Complex Objects

The CubeSat evaluated for this ODAR are stowed in a convex configuration, indicating there are no elements of the CubeSat obscuring another element of the same CubeSat

from view. Thus, the mean CSA for the stowed CubeSat was calculated using Equation 1. This configuration renders the longest orbital life times for all CubeSat.

Once a CubeSat has been ejected from the CubeSat dispenser and deployables have been extended, 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 NEUTRON-1 (4.4 kg) orbit at deployment will be 424 x 410 nm at a 51.6° inclination. With an area to mass ratio of 0.006 m²/kg, DAS yields 2.16 years for orbit lifetime for its stowed state, which in turn is used to obtain the collision probability. NEUTRON-1 is calculated to have a probability of collision of 0.0. Table 3 below provides complete results.

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		NEUTRON-1
	Mass (kg)	4.37

Stowed	
Mean C/S Area (m²)	0.027
Area-to Mass (m²/kg)	0.006
Orbital Lifetime (yrs)	2.16
Probability of collision (10^{^X})	0.0000

Deployed	
Mean C/S Area (m²)	0.037
Area-to Mass (m²/kg)	0.008
Orbital Lifetime (yrs)	1.9
Probability of collision (10^{^X})	0.0000

Solar Flux Table Dated
12/18/2018

Table 3: CubeSat Orbital Lifetime & Collision Probability

The probability of NEUTRON-1 colliding 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.

NEUTRON-1 has no capability nor have plans for end-of-mission disposal, therefore requirement 4.5-2 is not applicable.

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

Section 6: Assessment of Spacecraft Postmission Disposal Plans and Procedures

NEUTRON-1 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 NEUTRON-1 in its stowed configuration as the worst case. The area-to-mass is calculated for is as follows:

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

Equation 3: Area to Mass

$$\frac{0.027 \text{ m}^2}{4.37 \text{ kg}} = 0.006 \frac{\text{m}^2}{\text{kg}}$$

The assessment of the spacecraft illustrates they are compliant with Requirements 4.6-1 through 4.6-5.

DAS 2.1.1 Orbital Lifetime Calculations:

DAS inputs are: 424.5 km maximum apogee 409.8 km maximum perigee altitudes with an inclination of 51.6° at deployment no earlier than January 2020. An area to mass ratio of ~0.006 m²/kg for the NEUTRON-1 CubeSat was used. DAS 2.1.1 yields a 2.163 years orbit lifetime for NEUTRON-1 in its stowed state.

This meets requirement 4.6-1. For the complete list of CubeSat orbital lifetimes reference **Table 3: CubeSat Orbital Lifetime & Collision Probability**.

Assessment results show compliance.

Section 7: Assessment of Spacecraft Reentry Hazards

A detailed assessment of the components of NEUTRON-1 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: NEUTRON-1 High Melting Temperature Material Analysis

Name	Material	Total Mass (kg)	Demise Alt (km)	Kinetic Energy (J)
UHF/VHF Antenna	Stainless Steel 316	.48	0	14
Payload Module Gadolinium	Gadolinium	.03	0	0

The majority of stainless steel components demise upon reentry and NEUTRON-1 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 for NEUTRON-1

Name	Status	Risk of Human Casualty
NEUTRON-1	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 NEUTRON-1 has a 1:0 probability as none of its components have more than 15J of energy.

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

Section 8: Assessment for Tether Missions

NEUTRON-1 will not be deploying any tethers.

NEUTRON-1 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/Mr. Higginbotham
VA-C/Mrs. Nufer
VA-G2/Mr. Treptow
SA-D2/Mr. Frattin
SA-D2/Mr. Hale
SA-D2/Mr. Henry
Analex-3/Mr. Davis
Analex-22/Ms. Ramos

Appendix Index:

Appendix A. NEUTRON-1 Component List

Appendix A. NEUTRON-1 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	Neutron-1	4		3U Box	4374.8	-	-	-	No	-	Demise
2	Clydespace 3U Cubesat Structure	2	Aluminum Al 6082-T6	Box	390	100	100	340.5	No	-	Demise
3	Solar Panel Encore BTJM Photovoltaic Cells Triple-Junction with Monolithic Diode	8	BTJM InGaP/InGaAs/Ge	Rectangle	53.52	39.7	69.1	0.5	No	-	Demise
4	UHF/VHF Antenna	8	Stainless Steel 316, aluminum, pcb	Rod	480	98	98	10	Yes	2500°	0 km
5	S-Band Patch Antenna	8	Ceramic	Box	3	25	25	4.84	No	-	Demise
6	Gamalink GPS Patch Antenna	32	Ceramic	Box	23.3	25	25	5.3	No	-	Demise
7	NovAtel Taoglas GPS Antenna	1	Ceramic	Box	14	35	35	6.9	No	-	Demise
8	GlobalStar Patch Antenna (duplex)	1	Ceramic	Cylinder	82	48.41	48.41	9.66	No	-	Demise
9	GlobalStar Patch Antenna (simplex)	1	Ceramic	Box	30	35	N/A	9.25	No	-	Demise
10	CubeSpace ADCS Deployable Magnetometer	4	Alodined Aluminum and PTFE harness	Box	15	17.2	83.3	6.7	No	-	Demise
11	CubeSpace ADCS Static Magnetometer	3	Alodined Aluminum and PTFE harness	Box	4	16.8	23.2	6.3	No	-	Demise
12	Cirelip E-Type 1.5mm	1	Stainless Steel		0.02	1.5	0.4	N/A	No	-	Demise
13	Plastic Bearing	2	iglidur® X	Cylinder	0.06	3.5	3	N/A	No	-	Demise
14	Deployment Compression Spring	2	Stainless Steel	Spring	0.02	0.6	5	0.25	No	-	Demise
15	Deployment Plunger Pin	1	Stainless Steel 316L	Pin	1.02	3	16	N/A	No	-	Demise
16	Deployment Switch Mount	1	Aluminum Al 6082-T6	Box	0.28	5	7	1.5	No	-	Demise
17	Separation Spring	1	Stainless Steel 316L	Spring	1.42	2	7	0.2	No	-	Demise
18	M1.7 x 6 Cross Recessed Screw	1	Stainless Steel A2	Screw	0.64	1.7	6	N/A	No	-	Demise
19	M1.7 Hex Full Nut	1	Stainless Steel A4	Nut	0.4	4	1.5	N/A	No	-	Demise

20	M2 x 6 TX6 CSK Machine Screw	1	Stainless Steel A4	Screw	1.04	2	6	N/A	No	-	Demise
21	M2.5 x 4 Ultra Low Head Hex Cap Screw	1	Stainless Steel A2	Screw	6.08	2.5	4	N/A	No	-	Demise
22	Flight Computer Board	1	PCB	PC104 form factor	67	96	90	14	No	-	Demise
23	ClydeSpace 3rd Generation 3U EPS	1	PCB	PC104 form factor	86	96	90	13.5	No	-	Demise
24	ClydeSpace 40Wtr CubeSat Battery	2	lithium ion polymer cells	PC104 form factor	447	96	90	27.35	No	-	Demise
25	CubeSpace ADCS PC104 PCB	2	PCB	PC104 form factor	120	96	90	10	No	-	Demise
26	CubeSpace ADCS Reaction Wheels	2	Brass with TBC (Possibly ABS)	Box	180	28	31	26	No	-	Demise
27	CubeSpace ADCS Magnetic Coil	2	Aluminum and Enamel coated wire	Square	46	96	90	8	No	-	Demise
28	CubeSpace ADCS Magnetorquers	2	Anodized Aluminum, PVDF Kynar	Rod	56	18	61	17	No	-	Demise
29	CubeSpace Nadir and Sun Sensor Cameras	2	Glass and Aluminum Lenses and ABS holder	Lens	25.4	31	40	19	No	-	Demise
30	CubeSpace Star Tracker	2	Aluminum and Glass	Lens	66	35	50	55	No	-	Demise
31	Gamalink Radio Board	2	PCB with ELPEMER 2467 Soldermask	PC104 form factor	100	96	90	19.2	No	-	Demise
32	Radio Board Daughter Shield	2	Aluminum 6082 T6	Plate	17	37.3	66.4	5.5	No	-	Demise
33	Radio Board BottomShield	2	Aluminum 6082 T6	Plate	80	88.5	94.2	5	No	-	Demise
34	NovAtel OEM719 GPS Board	2	PCB	Board	31	46	71	11	No	-	Demise
35	LinkStar GSP1720 Duplex Radio	2	PCB	Board	60	61	118.7	3.6	No	-	Demise
36	LinkStar STX3 Simplex Radio with BBB	2	PCB	Board	48.2	54.7	86.4	29.1	No	-	Demise
37	Payload Digital Board		PCB FR4	Board	47	75	82	10	No	-	Demise
38	Payload Analog Board	1	PCB FR4	Board	73	32	75	20	No	-	Demise
39	Payload Module Enclosure	1	Aluminum 7075-T7351 with clear chemfilm finish	Boot	426	45.2	68.2	38.7	No	-	Demise
40	Payload CLYC Detector Module	2	Various materials listed in the rows below	Boot	574	45	69	60	No	-	Demise
41	Payload Enclosure CLYC Scintillator	2	Cs2LYC16	Box	336	-	-	-	No	-	Demise

42	Payload Laird Thermal Electric Cooler	2	Bismuth Telluride semiconductor material and thermally conductive Aluminum Oxide ceramics	Box	14	-	-	-	No	-	Demise
43	Payload Module Photomultiplier Tube R11265-100	2	Hamamatsu R11265-100 Photomultiplier Tube	Box	50	26.2	17.8	-	No	-	Demise
44	Payload Module Voltage Divider Network PCB	2	PCB FR4	Board	8	30	6.3	-	No	-	Demise
45	Payload Module Gadolinium	2	Gadolinium	Sheets	30	-	-	-	Yes	2394°	0 km
46	Payload insulation	2	Ultem 1000 (PEI)	Insulation	10	-	-	-	No	-	Demise
47	Payload Enclosure Silicone Pad	2	Bisco BF1000 Silicone Foam	-	1	-	-	-	No	-	Demise
48	Payload Enclosure Optical Pad	2	Polydimethylsiloxane (PDMS) EJ-560 is BC-634A Equivalent material	-	4	-	-	-	No	-	Demise
49	Payload Enclosure Window	2	Quartz	Plate	8	35	1.4	-	No	-	Demise
50	Payload Enclosure Epoxy Window Seal	2	3M 1838	-	4	-	-	-	No	-	Demise
51	Payload Enclosure Epoxy Lid Seal	2	Ablestik 285/Cat 11	-	6	-	-	-	No	-	Demise
52	Payload Module PMT Optical Pad	2	Polydimethylsiloxane (PDMS) EJ-560 is BC-634A Equivalent material	-	2	-	-	-	No	-	Demise
53	Payload High Voltage Copper Foil	2	110 ETP Copper covered with Conathane EN11/EN4 Coating	Foil	4	-	-	-	No	-	Demise
55	Payload Module PTFE Alignment	2	Polyphenylene Sulfide (PPS) Designation:TECHT RON™ PPS	Connector	6	-	-	-	No	-	Demise
56	Payload Enclosure Reflector	2	Expanded PTFE Gore Gasket	-	0.4	-	-	-	No	-	Demise
57	CubeSpace ADCS CSS Harness	2	Expanded PTFE Gore Gasket	-	10	-	-	-	No	-	Demise
58	Stack Header Connectors / Pins	10	TFE, Teflon, LCP	-	10	-	-	-	No	-	Demise

59	Threaded Rod	22	Liquid Crystal Polymer (LCP) / Phosphor Bronze	Stack Connector	176	5	66.5	11	No	-	Demise
60	Fasteners	-	Titanium Ti-6Al-4V	Rod	40	3	320.5	N/A	No	-	Demise
61	Fasteners	-	Stainless Steel 18-8 Mil. Spec.	Screw	0	-	-	-	No	-	Demise
62	Fasteners	-	Stainless Steel 304, SS A2	Screw	0	-	-	-	No	-	Demise
63	Fasteners	-	Stainless Steel 316, SS A4	-	0	-	-	-	No	-	Demise
64	Cabling/Wiring	-	Brass	-	0	-	-	-	No	-	Demise

