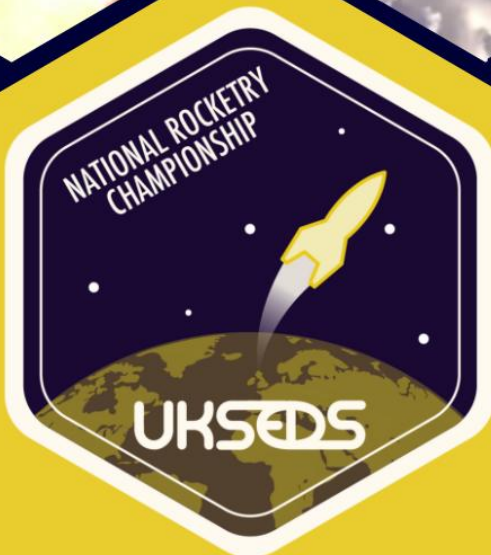




NATIONAL ROCKETRY CHAMPIONSHIP 2025-26

Critical Design Review

Team Ursa



SUPPORTED BY





UKSEDS National Rocketry Championship Critical Design Review

2025 - 2026

Team Ursa



Issued by (Project Lead):

Luke A. Franklin

University:

Queen Mary University of London





Table of Contents

1	Introduction	4
1.1	Mission Statement	4
1.2	Objectives	4
2	Project Management	4
2.1	Team Members	4
2.2	Financial Budget	5
2.3	Project Risks and Mitigations	5
2.4	Project Plan	9
2.5	Work Breakdown Structure	9
3	Preliminary Concept	10
3.1	Launch Vehicle	10
3.1.1	Launch Vehicle Overview	10
3.1.2	Concept Of Operations (CONOPS)	10
3.1.3	OpenRocket Simulation	11
3.1.4	Recovery System Design	14
3.1.5	Launch Vehicle Components	15
3.2	Rideshare Payload	16
3.2.1	General Overview	16
3.2.2	PCB Schematics	17
3.2.3	System Integration	17
4	Systems Engineering	18
4.1	Requirement Compliance Analysis	18
4.2	Budgets	20
5	Manufacturing Processes	21
5.1	Launch Vehicle	21
5.2	Rideshare Payload	22
5.3	Issues and Solutions	22
6	Testing	23
6.1	Test Matrix	23
6.2	Test Results	23
7	Final Design	24
7.1	Design Changes	24
7.2	Improvements and Future Work	24
8	Acknowledgements	25
9	References	25





1 Introduction

1.1 Mission Statement

The goal of this project is the successful launch and recovery of a rocket which will deliver a customer payload to a target apogee of 2,200 feet and provide relevant data for analysis. The launch vehicle will be made up of a custom rideshare payload and airframe with a suitable recovery system for safe recovery. The rideshare payload will obtain relevant altitude and temperature data, including apogee.

1.2 Objectives

Our project has several key objectives. Principally, we aim to design, manufacture, launch and recover a rocket which will reach an apogee of 2,200 feet whilst carrying a customer and rideshare payload. Our assembled rocket must be capable of providing sufficient power to the payload bay (which includes a customer and rideshare payload) and will be deemed successful by the apogee it reaches, and the quality of data recovered.

Reaching an apogee of 2,200 feet exactly is the first critical objective and achieving this will mean our launch vehicle was appropriately designed to meet our target. Our apogee value will be determined using pressure values from our onboard barometer, calculated by our Raspberry Pi controller, and displayed on an OLED screen when calculated. This apogee value will then be compared with pre-flight OpenRocket simulations. Beyond apogee, several other types of data will be recorded to assess the rocket's performance, including temperature, pressure, velocity and acceleration. This data will be used to inform future designs and will be compared with expected results from computational models.

Our objectives also extend to the performance of the launch vehicle throughout all stages of flight. A safe launch, well timed recovery system deployment and smooth descent and landing are all key measures of success for this project. A fully functional and tested recovery system will be used on launch day. This will be a single stage system to reduce the risk of a 2-stage system failure, which would lead to ballistic impact. A good landing system deployment will slow the launch vehicle down to a velocity of $\sim 5 - 7.5\text{m/s}$. This suitable landing velocity will reduce the risk of damage to mission critical payloads and prevent the launch vehicle from being substantially blown off-course by crosswinds. Safe and efficient recovery of the vehicle and flight data are key aims.

A successful project will ultimately see Team Ursa be one of the first teams at Queen Mary University of London to compete in NRC and successfully launch a rocket. The team aims to deliver a quality launch vehicle that meets competition requirements and advances The Aurora Initiative's technical ability and knowledge of rocketry and payload integration.

2 Project Management

2.1 Team Members

Team selection processes for Ursa took place partway through Semester 1, with all team members being Aurora members as well. Following a review from last year's NRC team, CosmiQ, it was decided that a smaller team of maximum 10 members would be better suited to NRC competition workload.

Table 1 – Team Information

Name	Position	Year/Course	Email
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Luke Franklin	Project Lead	2 nd Year Mechanical Engineering	
Sanjana Chowdhury	Avionics	3 rd Year Robotics Engineering	
Lousie Paterson	Airframe Lead	1 st Year Aerospace Engineering	
Hiresh Rughwani	Airframe	2 nd Year Aerospace Engineering	
Veselin Velchev	Avionics Lead	MSc Robotics & AI	
Charikleia Kokkini	Avionics & Airframe	1 st Year Physics	
Harold Henrique Oliveira Nery	Systems & Airframe	1 st Year Aerospace Engineering	
Sancho Mir	Airframe	1 st Year Aerospace Engineering	
Avish Sood	Airframe	2 nd Year Aerospace Engineering	
Mohammed Shaikh	Avionics	2 nd Year Electrical & Electronic Engineering	

Workload responsibilities are divided into 2 main categories: Avionics (which includes electronics and payload design) and Airframe (which includes recovery system and propulsion). There is, however, some flexibility within roles to allow team members to gain knowledge and experience of each discipline.

2.2 Financial Budget

The Aurora Initiative society at QMUL has been granted SU funding to support launches and rocketry projects. In addition, funding has been accumulated through membership subscriptions to allow ample resources for Team Ursa to design and construct a launch vehicle entirely from scratch.

Table 2 – Team Ursa Current Budget

	Area(s) / Item(s)	Estimated Cost (£)	Allocated Budget (£)
Components / Materials	Airframe / Structure	80	100
	Propulsion	30	30
	Recovery	12	20
	Avionics	96	100
Manufacturing	Tools / Facilities	0 - 50	~20
BMFA Insurance	2x	98	98
	Totals:	316 - 366	~358

Not included in this table is an estimate for travel to and from the launch site. The cost of travel will depend on the method of transport used (train or coach), in addition to any accommodation costs incurred by the team. This will likely be booked for all 4 NRC teams in The Aurora Initiative, making it difficult to provide an accurate prediction of costs at this stage.

2.3 Project Risks and Mitigations

The design, manufacture and launch of model rockets has inherent risks given the nature of rocketry and the intense vibrations a launch vehicle experiences during take-off, flight and landing. There are also





various project risks to consider and appropriately mitigate to ensure smooth progression and confident submissions. These risks and mitigation strategies are included in the table below.

Table 3 – Team Ursa Project Risks & Relevant Mitigation Strategies

Category	Risk	Description	Mitigation Strategy
Aerodynamics & Flight Dynamics	Stability Margin Failure	The CG for the launch vehicle may shift too far aft compared to the CP, resulting in an unstable flight.	Run several OpenRocket simulations to ensure that stability margin is between 1.75 and 2.5 diameters for all phases of flight until apogee. Measure physical CG of the fully loaded rocket before launch and add nose weights if necessary.
Aerodynamics & Flight Dynamics	Severe Weathercocking	High winds on launch day (>15m/s) cause the launch vehicle to tilt into the wind, resulting in a non-vertical flight, missing the apogee target of 2200ft and potentially landing outside the 700m perimeter.	Optimise fin design and simulate a wide variety of wind speeds on OpenRocket. Monitor wind conditions on launch day.
Aerodynamics & Flight Dynamics	Rail Binding or Tip-off	Misaligned rail buttons or high friction causes the rocket to snag on launch.	Ensure perfect linear alignment of rail buttons on the airframe and test the rocket on the rail prior to launch.
Aerodynamics & Flight Dynamics	Altitude Control and Apogee Issues	Failure to reach 2200ft target apogee or exceeding NOTAM limit of 3500ft.	Adjust rocket mass and drag coefficients through iterative simulations. Continually update and review OpenRocket models with accurate weight values and any subtle design changes.
Manufacturing & Assembly	Overweight Launch Vehicle	The physical rocket ends up being significantly heavier than estimated due to excess epoxy / materials / heavier hardware.	Conduct frequent component weigh-ins during manufacturing. Continuously update the OpenRocket model with true weight values.





Manufacturing & Assembly	Epoxy/Adhesive Failure	Fins or internal components detach during high-stress phases of flight due to poor surface contact, application or curing.	Thoroughly sand and clean any application surfaces before applying adhesive. Use structural epoxy with fillets, and where necessary use small screws to secure vital internal components. Ensure epoxy cures in appropriate temperature conditions.
Propulsion & Structure	Weak Motor Mounting	Motor shifts, detaches, or misaligns during flight, leading to instability or structural failure.	Reinforce motor mount with filleted epoxy and structural supports (bulkheads, additional thrust rings and screws). Select a threaded motor casing to prevent shifting.
Propulsion & Structure	Ignition Failure	Motor misfires, ignition fails or launch conditions become unstable.	Use a dependable, verified igniter system. Ensure proper motor installation with no blockages and test motor mount setup with a dummy motor before launch day. Launch only in safe weather conditions and with approval from Site Manager.
Recovery System	Zippering of the Airframe	Ejection charge fires while the rocket is moving a high velocity, causing the shock cord to rip through the body tube.	Determine the correct motor delay time for the ejection charge. Ensure that shock cord is 3-4 times the length of the rocket to properly absorb kinetic energy. Use eye rings to prevent the shock cord from being torn out of the airframe.
Recovery System	Premature Separation	Friction fitting between the 2 halves of the rocket is too loose, causing mid-flight separation due to drag.	Ensure a good friction fitting by using masking tape and conducting ground swing tests. Use shear pins if testing shows that friction fitting will





			be unsuitable for the launch vehicle.
Recovery System	Parachute Deployment Failure	The recovery system does not deploy correctly or gets tangled.	Use tested and reliable parachute materials. Perform ground ejection tests (where possible and allowed) to verify deployment reliability and packing methods.
Avionics & Electronics	Barometer Inaccuracy	Barometer provides inaccurate readings due to weather changes or poor venting.	Calibrate the barometer to local pressure settings and ensure the payload bay is properly vented with correctly sized static ports to detect atmospheric changes.
Avionics & Electronics	Raspberry Pi Failure	Sensitive to voltage changes (memory loss) or suffers damage due to vibrations, ejection charges or landing impact.	Use a stable power supply and multi core wires. Secure vertically for flight and use rubber rings to limit the effect of vibrations. Tie down all wiring and test all soldered joints.
Avionics & Electronics	Faulty Screw Switches	High stresses can lead to forces turning the switch off.	Fasten switches securely and mount them in low-stress areas of the airframe.
Avionics & Electronics	OLED Screen Disconnection	Screen disconnects during launch, flight or landing. May be damaged by ejection charge forces.	Ensure wiring and pin connections are firmly attached and make sure the screen is securely attached to the rideshare payload frame. Using rubber dampers or small rings to reduce the forces transmitted to the screen.
Avionics & Electronics	Wire Disconnection / Failure	Wires may become disconnected or fracture when exposed to stresses and vibrations.	Use only multi-core wire and
Project Management & Safety	Schedule Slippage	Delays in manufacturing, testing	Maintain a strict Gantt chart featuring a



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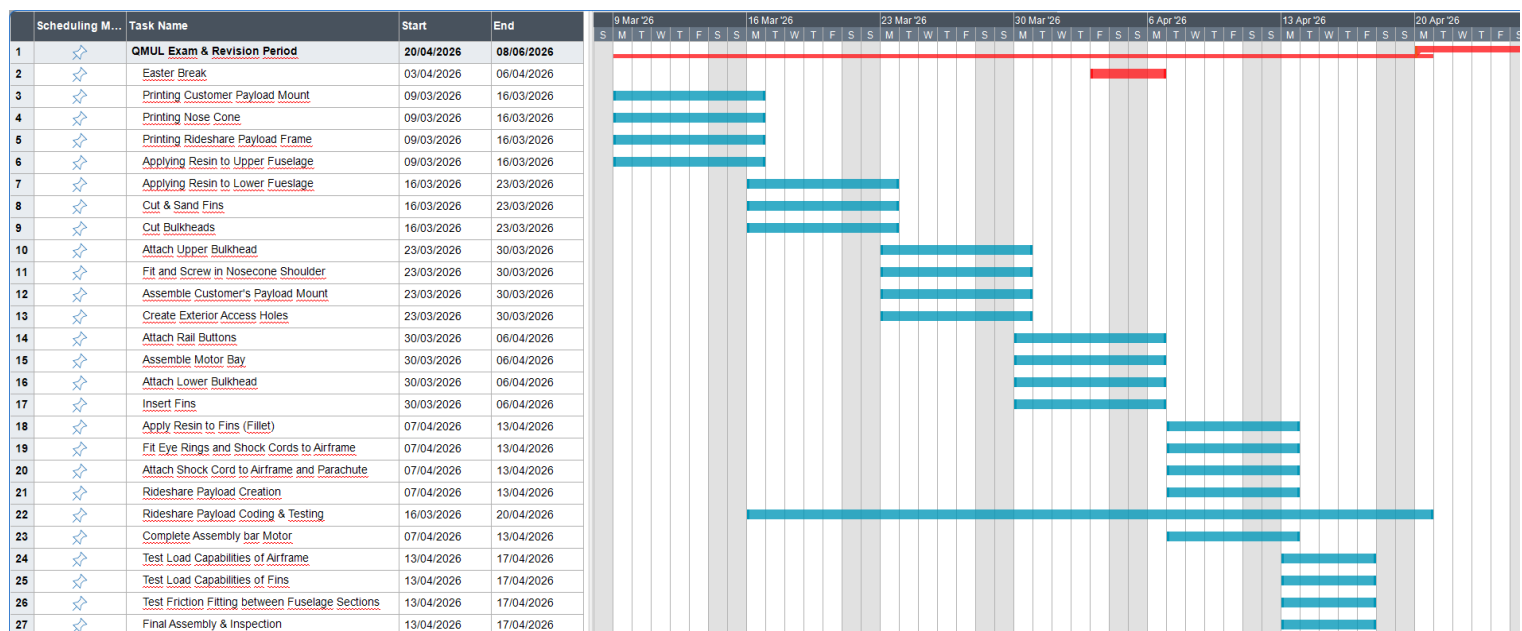
NRC-CDR-001 Critical Design Review



		or documentation leading to a rushed final assembly or missing the launch window.	Critical Path Analysis (CPA). University blackout periods (exams, holidays, major coursework deadlines) have been actively blocked out in the schedule to ensure targets remain realistic. Buffer weeks are built in before the final launch window.
Project Management & Safety	Procurement Delays	Critical components (PCBs, parachute, materials) take weeks or months to arrive.	Order long-lead time items ASAP following submission of CDR. Identify backup suppliers for critical components.
Project Management & Safety	Violating UKRA Safety Code	Non-compliance leads to launch disqualification or safety hazards.	Review UKRA safety regulations thoroughly and conduct safety briefings. Confirm pre-launch checklists are followed.

2.4 Project Plan

As with any project, having a plan



2.5 Work Breakdown Structure



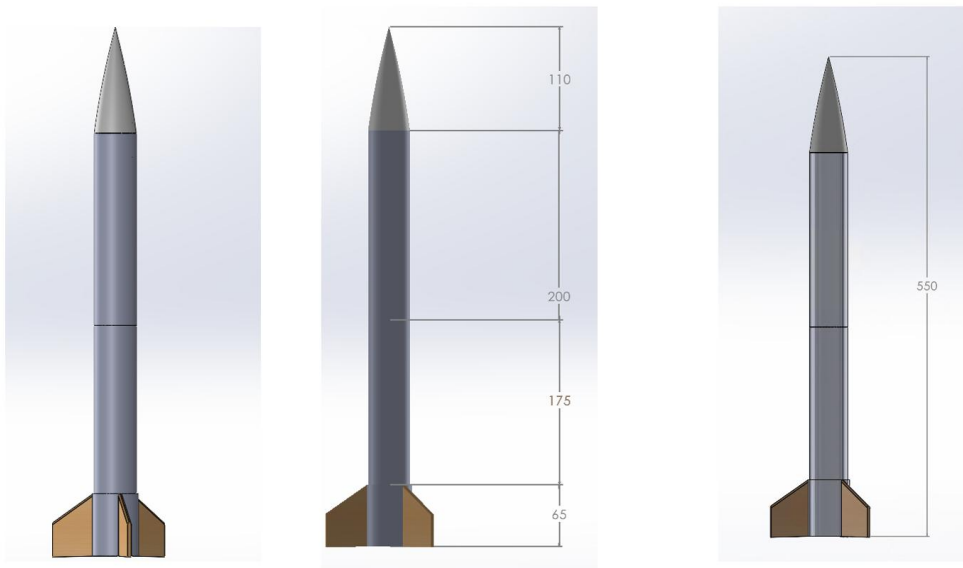
An example is provided [here](#).

3 Preliminary Concept

3.1 Launch Vehicle

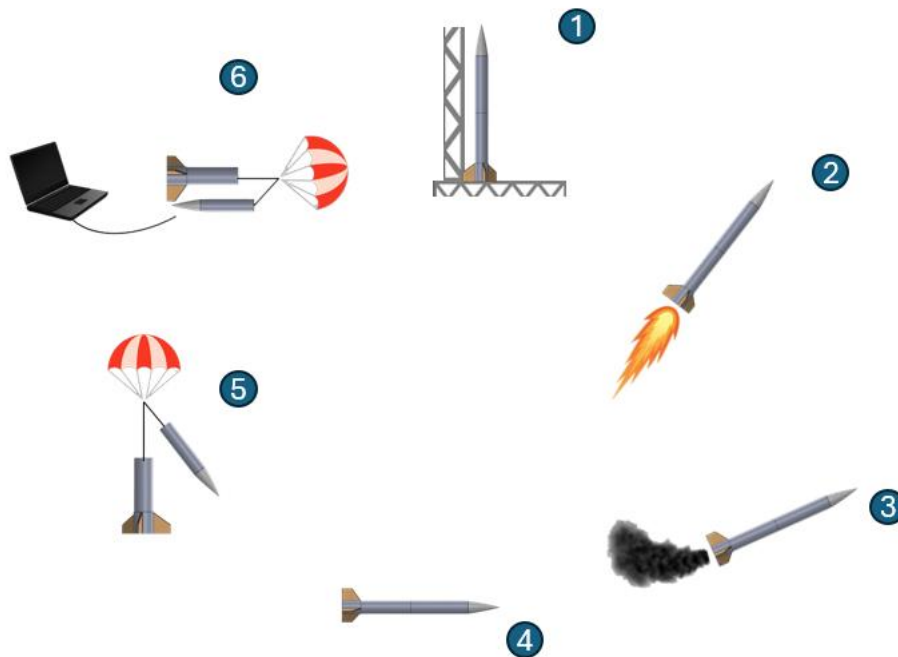
3.1.1 Launch Vehicle Overview

Detailed diagram of the launch vehicle.



3.1.2 Concept Of Operations (CONOPS)

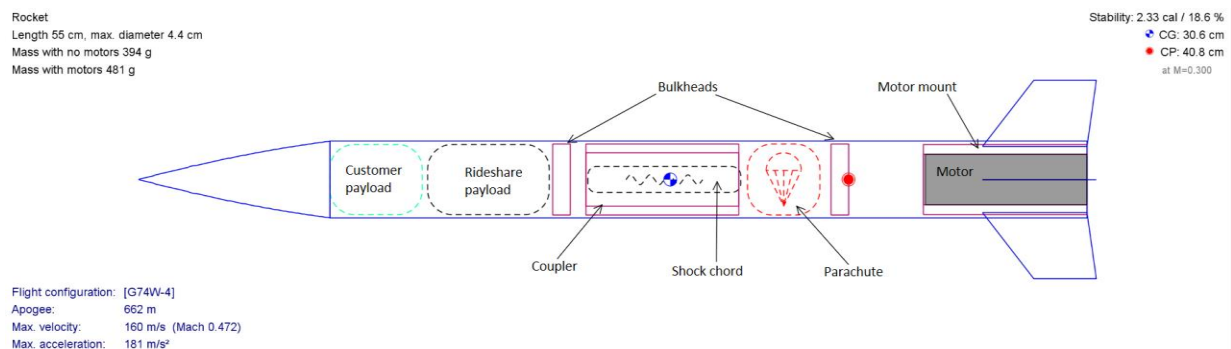
Please provide a concept of operations diagram. Please see an example diagram from a previous Mach entry (to be deleted).

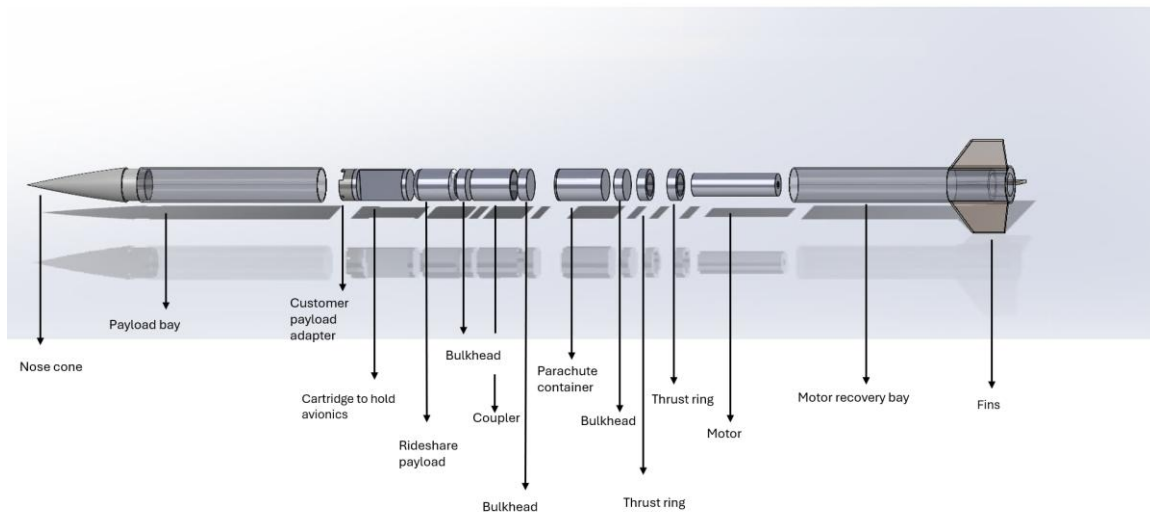


1. Switches are turned on and both the rideshare and customer payload are switched on as the electronic system is armed.
2. After all the systems are checked and functional the fuse of the motor is lit and ignites
3. When thrust begins to decrease as the fuel is exhausted and burnout is reached the 9 second charge delay begins.
4. After these 9 seconds the rocket trajectory would have reached its highest apogee for the flight and ejection charge will cause the rocket to separate.
5. The parachute is deployed to slow the rockets descent to about 4.59m/s.
6. Once the rocket reaches the ground and recovered the data is collected and displayed within 10 minutes.

3.1.3 OpenRocket Simulation

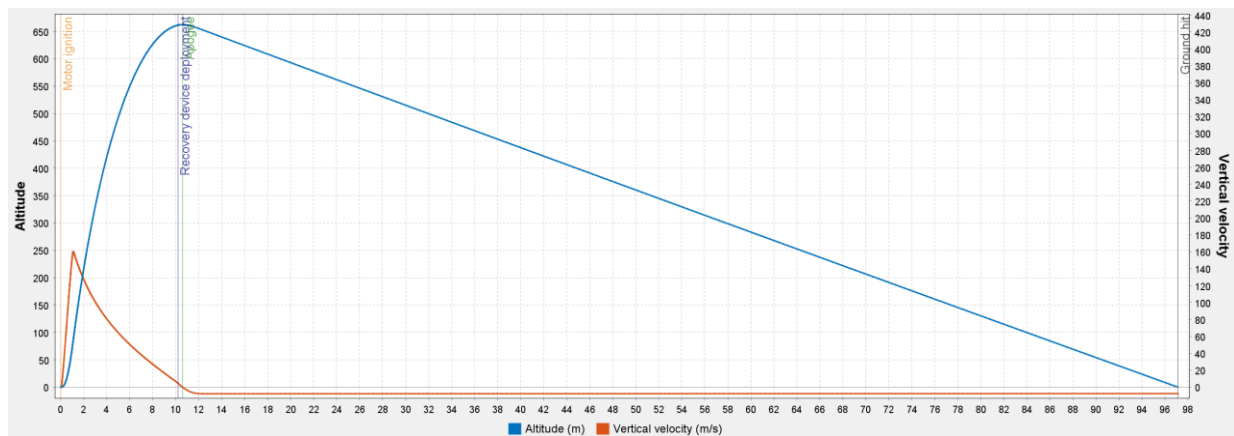
Below is an annotated diagram of our design in OpenRocket as well as in CAD.





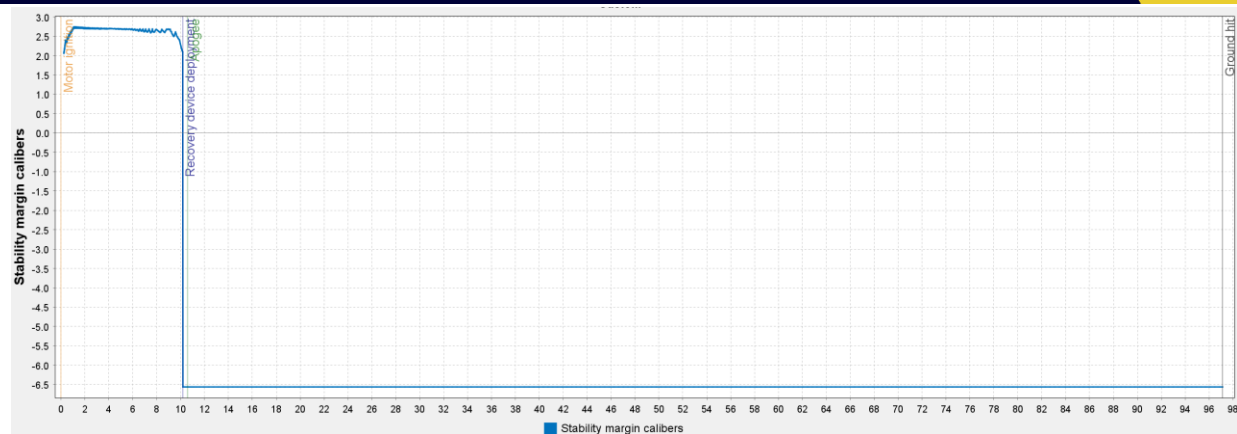
Note that for all simulations the recovery system was set to deploy 10.2s after motor ignition since the time to motor burnout is approximately 1.2s and our ejection charge has a delay of 9s.

For our first simulation, we used an average windspeed of 2m/s with a standard deviation of 0.2m/s and a turbulence intensity of 10%, at a launch angle of 90° from the ground. Below is a graph of vertical velocity and altitude against time. This simulation is aimed to model ideal conditions.



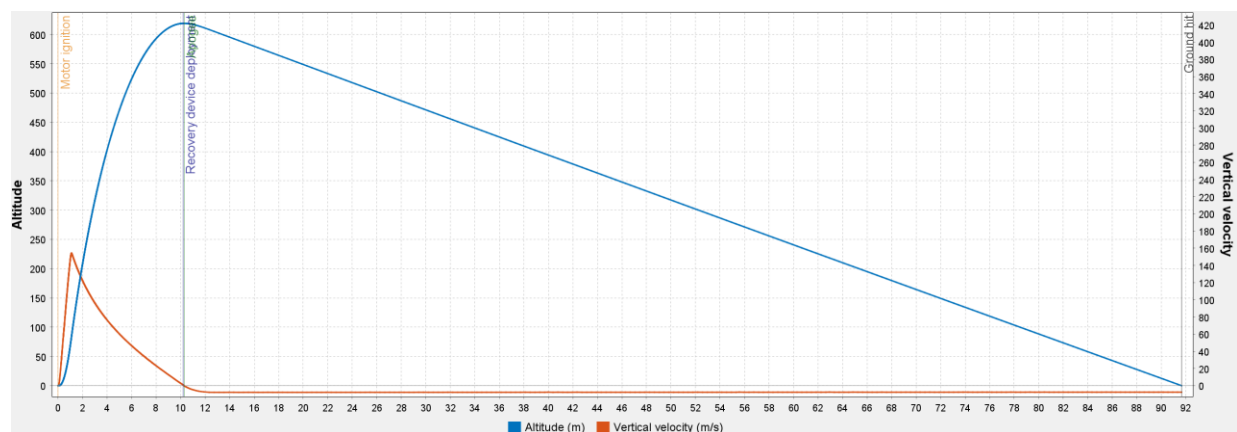
Notable features include apogee at an altitude of 662m (2172ft) and final vertical speed of approximately 7.6m/s which is compliant with requirement RS-TSN-RRS-002.

For the same simulation, below is a graph of stability margin calibers against time.



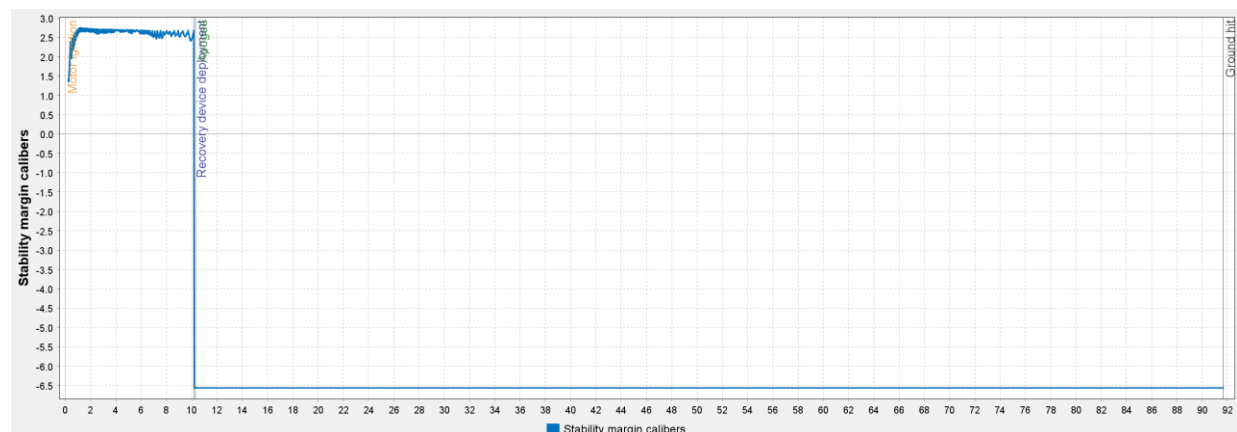
Excluding the times shortly after motor ignition and after recovery system deployment, the stability margin ranges from 2.52 to 2.75. For this simulation, the lateral distance at the time of ground hit was 134.3m and the total flight time was 97.13s.

For our second simulation, we used an average windspeed of 10m/s with standard deviation 1m/s and a turbulence intensity of 10%, at a launch angle of 90° from the ground. This simulation aimed to investigate if our design was compliant with requirement RS-MRD-MIS-008. Below is a graph of vertical velocity and altitude against time.



Notable features include apogee at an altitude of 619m (2031ft) and the final vertical speed of approximately 7.6m/s which is compliant with requirement RS-TSN-RRS-002.

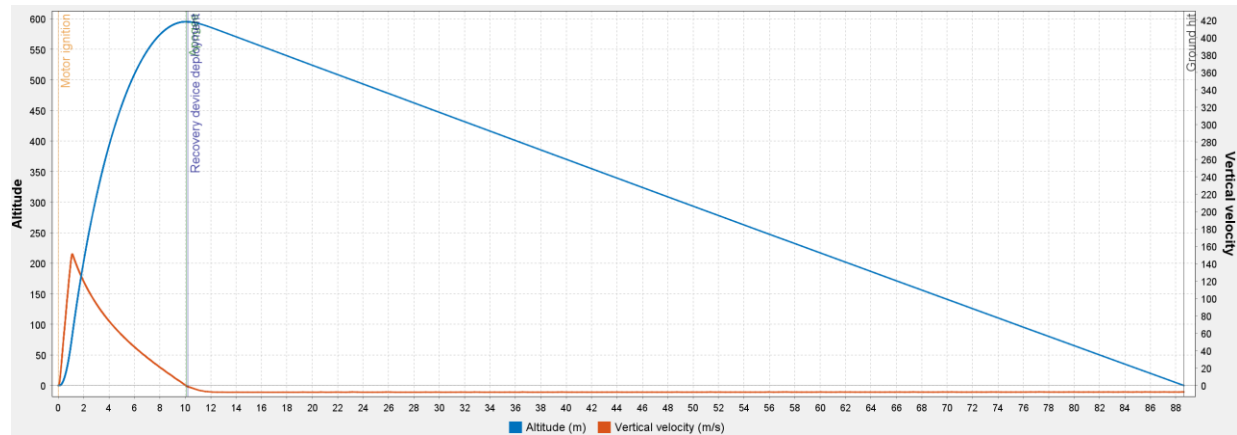
For the same simulation, below is a graph of stability margin calibers against time.



Excluding the time after recovery system deployment and just after motor ignition, the stability margin ranges from 2.52 to 2.74. For this simulation, the lateral distance at the time of ground hit was 620.8m and the total flight time was 91.65s which complies with requirement RS-MRD-MIS-008.

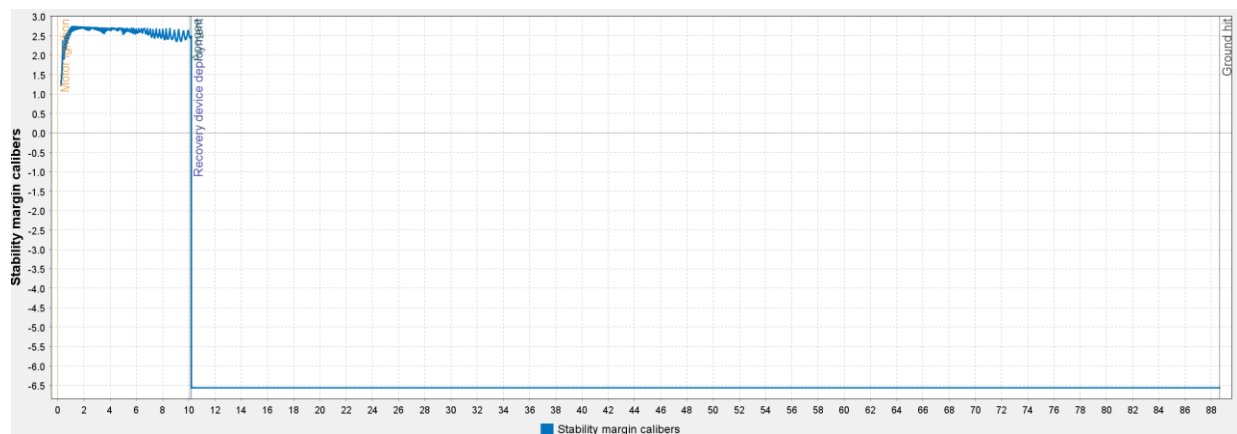


For our third simulation, we used an average windspeed of 15m/s with standard deviation 1.5m/s and a turbulence intensity of 10%, at a launch angle of 90° from the ground. This simulation aimed to investigate if our design was compliant with requirement RS-TSN-RRS-003. Below is a graph of vertical velocity and altitude against time.



Notable features include apogee at an altitude of 595m (1952ft) and the final vertical speed of approximately 7.6m/s which is compliant with requirement RS-TSN-RRS-002.

For the same simulation, below is a graph of stability margin calibers against time.



Excluding the time after recovery system deployment and just after motor ignition, the stability margin ranges from 2.41 to 2.74. For this simulation, the lateral distance at the time of ground hit was 937.65m and the total flight time was 88.64s which complies with requirement RS-TSN-RRS-003.

3.1.4 Recovery System Design

A single deployment system will be used as it is a method which allows the rocket to have less mass compared to a dual deployment system and it's simpler to implement. The selected motor will be used as the ejection charge, and this has a 9s delay fuse. The OpenRocket simulations revealed that the time to apogee was roughly 10.0s to 10.6s and the total flight time is 88.6s to 97.1s. We have to find a parachute that can reduce its speed down to less 15 m/s for the rocket to not exceed speed restrictions when landing. The parachute will be made out of Ripstop Nylon. The parachute will be hexagonal with a diameter of 45.72cm. Simulations have been ran on this parachute using OpenRocket and the landing speed was well below the 15m/s landing speed limit for all tested wind speeds. **The parachute is in the bottom half of the rocket and the top half of the rocket, and the bottom half is put together by a coupler. A bulkhead will located below the parachute and the shock cord.**





3.1.5 Launch Vehicle Components

Here is your opportunity to give a detailed description of your launch vehicle components. Some examples are the nose cone, airframe, payload bay, parachute and shock cords, fins, motor mount, and retention and launch buttons.

Nose cone: The nose cone is the forward-most section of the rocket, designed to minimise aerodynamic drag and protect the internal payload during flight. Its smooth, streamlined profile enables efficient passage through the atmosphere, improving overall performance and stability. The nose cone will be manufactured from PETG due to its excellent strength, impact resistance, and slight flexibility. These material properties reduce the likelihood of cracking upon landing while ensuring long-term durability and structural integrity.

Payload Bay: The payload bay is a specific compartment within the rocket that contains the rideshare payload and the customer payload. This section allows for an easy installation of the customers payload on the day of the competition and access to both the payloads and data collections this will be a cartridge style design.

Parachute: The parachute serves as the primary recovery device and is deployed shortly after apogee via the motor's ejection charge to ensure a controlled and safe descent of the rocket. Upon deployment, the canopy inflates, significantly increasing aerodynamic drag and thereby reducing the rocket's descent velocity to a safe landing speed. The parachute will be constructed from ripstop nylon due to its excellent strength-to-weight ratio and high elasticity, which allow it to effectively absorb opening shock loads during deployment. Additionally, its enhanced tear resistance and abrasion durability make it well-suited for repeated use in demanding flight and landing conditions.

Shock Cords: The shock cords are high-strength, flexible connectors that integrate the rocket's recovery components. Their primary function is to absorb and dissipate the forces generated during parachute deployment. As the parachute inflates, the shock cord elongates, reducing peak loads and minimising stress on the airframe and recovery system. The cords will be constructed from Kevlar, selected for its exceptional tensile strength, heat resistance, and durability. The length of the cords will be about 2m to prevent excessive stress concentrations and ensure reliable recovery system performance.

Fins: The fins are stabilising surfaces at the rear of the rocket that help maintain flight stability and help prevent unwanted rotation. The fins help generate aerodynamic forces and correct the rockets orientation if tilt occurs ensuring trajectory remains straight. They will be made of balsa wood.

Motor Mount: The motor mount is a structural component that securely holds the rocket motor within the fuselage. Its main purpose is to keep the motor aligned and effectively transfer thrust forces to the rocket. The motor mount consists of thrust rings; a motor can and clamp to help ensure the motor remains in place during ignition and flight. The thrust rings are designed to act as load bearing anchor which withstand the forward pressure generated by the motor and ensure the force is generated to the airframe preventing the motor from shifting backwards under thrust. The motor clamp is a device designed to securely fasten the motor to the airframe it prevents unwanted movement of the motor due to thrust forces or ejection charges.

Fuselage: The fuselage serves as the primary structural body of the rocket, housing and protecting all critical internal components, including the propulsion system, avionics, and payload. It ensures accurate axial alignment of these subsystems while providing the structural integrity required to withstand aerodynamic forces, thrust loads, and handling stresses encountered throughout all phases of flight. The airframe will be constructed from thick, layered card sections, externally reinforced with a resin coating.





This construction method provides an effective balance between structural strength and mass efficiency. The layered card increases stiffness and resistance to bending under thrust and aerodynamic loading, while the resin coating enhances overall rigidity, improves surface finish, and provides additional protection against moisture and surface abrasion. Together, these materials create a lightweight yet sufficiently durable structure capable of withstanding the mechanical stresses experienced during launch, ascent, and recovery.

Rail Buttons: Rail buttons are small guides attached to the rockets body that helps it stay aligned along a launch rail helping a straight and stable ascent.

Screw switches: Screw switches are small electrical switches that are used to activate and deactivate onboard electronics on the rideshare and customers payload. These function by inserting a screw into a switch which completes the circuit inside turning the device on. When the screw is removed the device turns off as the circuit is broken. This allows for the safe arming and disarming of the rocket.

Bulkheads: Bulkheads are flat plates that divide sections. These provide structural reinforcement. They will be mounted inside the fuselage and will separate the payload bay from the recovery or motor section. These also can be used to secure internal components such as the shock cords and the avionics as they can be used as attachment points.

Eye Bolts: Eye bolts are metal fasteners used as attachment points for the recovery system. These are screwed into the bulkheads or other structural parts of the rocket secured with a bolt on the other side they provide secure connections for various element.

3.2 Rideshare Payload

3.2.1 General Overview

Mission Purpose: The rideshare payload is designed to measure altitude, temperature, pressure, acceleration, GPS and gyroscopic data.

Mass: Approximately 107g

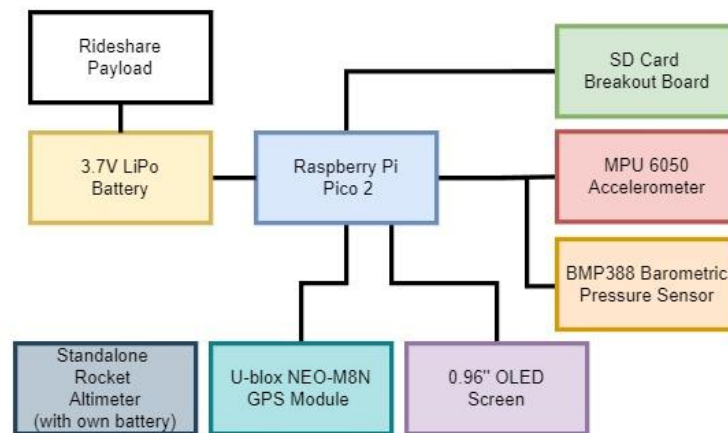
Dimensions: TBD

Components:

- MPU6050 6-DOF IMU Accelerometer and Gyroscope
- Pi Hut 0.96" OLED Display Module
- MicroSD Card SPI Breakout Board
- 8GB MicroSD Card
- U-blox NEO-M8N GPS Module
- BMP388 Barometric Pressure Sensor



3.2.2 PCB Schematics



Microcontroller: Raspberry Pi Pico 2

Power Source: 3.7V LiPo battery

Sensors: Accelerometer, Temperature & Pressure, GPS, Altimeter

Data communication/storage: Data from the Raspberry Pi Pico will be automatically saved to an SD card, which can be easily accessed following the recovery of the rocket. Moreover, the apogee value will be shown in a screen inside of the rocket.

3.2.3 System Integration

Payload Bay Location: Below the nosecone

Launch Site Assembly Procedure: Due to the design of the rocket, the Customer payload will slide inside of the rocket using guiding rails.

Integration Timeline:

Discuss how the rideshare and the Customer's payload will be integrated into your launch vehicle. Consider the short period of time you will have to secure the Customer's payload at the launch site.



4 Systems Engineering

Whilst we have included a systems engineering section, we expect you to refer to requirements throughout the CDR.

4.1 Requirement Compliance Analysis

At a minimum, this should cover all UKSEDS' requirements. If you have derived your own requirements, you may also include these. This is likely to be quite a long table, but it is still included in the page limit.

Requirement ID	Met? [Yes, No, Partially]	Rational
RS-TSN-MOR-001	Yes	We will purchase motor thrust rings to mount the rocket motor within the airframe
RS-TSN-MOR-002	Yes	Will be tested with weights
RS-TSN-MOR-003	Yes	Will also be tested with weights
RS-TSN-SMN-001	Yes	OpenRocket simulation states the velocity off-rod is 25.1m/s in all scenarios tested (Note a launch rod of length 2m was used as mentioned in the requirements).
RS-TSN-SMN-003	Yes	According to OpenRocket the CG is 306mm and the CP is 408mm from the tip of the nosecone. So, the distance between them is 102mm which is 2.3 times the diameter of the rocket (44mm), in line with this requirement.
RS-TSN-SAR-001	Yes	
RS-TSN-SAR-002	Yes	Highly dependent on installation method and testing
RS-TSN-SAR-003	Yes	Material testing must be done
RS-TSN-SAR-004	Yes	Carboard coated in resin is rigid enough to not deflect
RS-TSN-SAR-005	Yes	
RS-TSN-SAR-006	Yes	Motor mount strength remains in question
RS-TSN-SAR-007	Yes	
RS-TSN-SAR-008	Yes	
RS-TSN-ESS-001	Yes	Battery not yet selected
RS-TSN-ESS-002	Yes	
RS-TSN-ESS-003	Yes	Rocket does not contain a single core wire





RS-TSN-ESS-004	Yes	
RS-TSN-RRS-001	Yes	Parachute that deploys after apogee has been reached
RS-TSN-RRS-002	Yes	Vertical speed after recovery system is deployed is less than 15m/s for all scenarios tested. See section 3.1.3 for more details.
RS-TSN-RRS-003	Yes	OpenRocket simulation estimates the rocket will drift 937.65m laterally with 15m/s winds. See section 3.1.3 for more details.
RS-TSN-RRS-004	Yes	The Arduino Nano RP2040 is a commercial off the shelf component
RS-TSN-RRS-005	Yes	Recovery system will not be powered by a battery anyway
RS-TSN-RRS-006	Yes	
RS-TSN-RRS-007	Yes	Recovery system does not involve a flight computer
RS-TSN-RRS-008	Yes	Recovery loads will be transmitted via eyebolts
RS-TSN-ARY-001	Yes	
RS-TSN-ARY-002	Yes	Link to the UKRA safety code: https://ukra.org.uk/safety/model-rocket-safety-code/
RS-TSN-ARY-003	Yes	We are not using active stabilisation anyway
RS-MRD-MIS-001	Yes	Current OpenRocket simulations indicate the apogee will be 2172ft in the ideal scenario (with 2m/s winds) which is slightly short of the required 2200ft.
RS-MRD-MIS-002	Yes	OpenRocket simulations currently indicate the apogee will be 2172ft in the best-case scenario which is far below the 3000ft limit.
RS-MRD-MIS-003	Yes	OpenRocket simulations currently indicate the apogee will be 2172ft in the best-case scenario which is far below the 3500ft limit.
RS-MRD-MIS-004	Yes	
RS-MRD-MIS-005	Yes	Our chosen motor is supplied by Aerotech.
RS-MRD-MIS-006	Yes	





RS-MRD-MIS-007	Yes	Our current estimate for the mass of the rideshare payload is 107g.
RS-MRD-MIS-008	Yes	OpenRocket simulation indicates the rocket will drift 620.8m at a windspeed of 10 m/s which is well below the 750m limit.
RS-MRD-CPD-001	Yes	
RS-MRD-CPD-002	Yes	
RS-MRD-CPD-003	Yes	
RS-MRD-CPD-004	Yes	
RS-MRD-CPD-005	Yes	
RS-MRD-CPD-006	Yes	
RS-MRD-CPD-007	Yes	
RS-MRD-CPD-008	Yes	
RS-MRD-CPD-009	Yes	
RS-MRD-CPD-010	Yes	
RS-MRD-CPD-011	Yes	
RS-MRD-RPD-001	Yes	
RS-MRD-RPD-002	Yes	The rideshare payload includes a barometric altimeter (Nano V1) that will record altitude.
RS-MRD-RPD-003	Yes	The Nano V1 altimeter records detailed flight logs, including continuous altitude measurements. It can be connected to a computer using the included USB port to access the flight logs.
RS-MRD-RPD-004	Yes	An OLED screen will be mounted to the payload frame to display our apogee immediately upon landing, this will be tested.
RS-MRD-RPD-005	Yes	Silkscreen has yet to be printed.
RS-MRD-RPD-006	Yes	Either temperature or roll angle.

4.2 Budgets





e.g. mass budget, power budget.

5 Manufacturing Processes

Briefly describe the manufacturing processes you used/will use to construct individual components if they are not commercial off-the-shelf components (e.g. 3D-printed fin). Also include the manufacturing process of integrating all components into your launch vehicle.

5.1 Launch Vehicle

The launch vehicle structure is manufactured using a combination of commercially available components and custom fabricated structural elements. Manufacturing prioritises structural integrity, repeatability, and mass efficiency.

5.1.1 Airframe Preparation

The fuselage consists of layered cardboard tubing externally reinforced with a resin coating.

Manufacturing steps:

- i. The body is cut to the required 550mm length using a guided cutting tool to ensure perpendicular end faces
- ii. Ends are sanded flat to ensure flush mating with bulkheads and couplers
- iii. The outer surface is lightly abraded to promote resin adhesion
- iv. A thin, uniform resin coating is applied externally
- v. The tube is left to cure for 24 hours under stable conditions
- vi. After curing, the surface is inspected and lightly sanded where required.

Resin application is controlled to minimise mass increase while improving rigidity and surface durability.

5.1.2 Nose cone Manufacture

The nose cone is manufactured from PETG using FDM 3D printing

Manufacturing steps:

1. The CAD model is exported to slicing software
2. Printing parameters are selected to ensure sufficient wall thickness and structural length.
3. The component is printed with internal infill to balance strength and mass.
4. After printing, support material is removed
5. The surface is lightly sanded to remove imperfections.

The printed component is inspected for layer adhesion defects and dimensional accuracy before integration

5.1.3 Fin Manufacture

The fins are manufactured from balsa wood sheets.

Manufacturing process:

1. Fin geometry is transferred from CAD/OpenRocket templates onto the balsa sheet.
2. Fins are cut slightly oversize using a sharp craft blade or fine saw.
3. Each fin is sanded to final dimensions using a sanding block to ensure consistency across all fins.
4. Leading edges are rounded and trailing edges tapered to achieve the desired aerodynamic profile.
5. Root edges are sanded flat to maximise bonding surface area.
6. Exposed edges are sealed using thin cyanoacrylate (CA) glue to increase surface hardness and reduce moisture absorption.
7. Once sealed, fins are lightly sanded again to ensure smooth surfaces.

Each fin is checked against a master template to ensure dimensional repeatability.

5.1.4 Fin Attachment

Fins are surface mounted to the airframe using structural epoxy.

Attachment procedure:





1. Fin locations are marked on the airframe using a wrap around guide to ensure equal angular spacing between.
 2. The bonding surfaces on both the fin root and airframe are lightly abraded.
 3. Each fin is dry fitted to confirm alignment.,
 4. Two-part structural epoxy is applied to the root interface
 5. The fin is positioned and aligned using visual reference and guide markings
 6. Once the primary bond begins to set, external epoxy fillets are applied along both sides of the root joint.
 7. The assembly is left undisturbed for a full 24 hour cure period
- After curing, alignment is visually inspected to confirm symmetry and consistent spacing.

5.1.5 Motor Mount Installation

The motor mount assembly includes the motor tube, thrust rings, and retention system.

Manufacturing steps:

1. Thrust rings are installed into the motor tube and bonded using structural epoxy.
2. The motor tube is aligned concentrically within the fuselage.
3. The assembly is bonded into the airframe using structural epoxy.
4. The retention clamp is installed to secure the motor during flight.

Alignment is checked to ensure the motor axis remains coincident with the airframe axis.

5.1.6 Bulkheads and Recovery Integration

Bulkheads are installed within the fuselage to separate structural compartments.

Installation steps:

1. Bulkheads are cut to match internal diameter.
2. Eye bolts are installed through bulkheads and secured using washers and locking nuts
3. Bulkheads are bonded into the airframe using structural epoxy.
4. Kevlar shock cords are attached to the eye bolts.

All mechanical fasteners are checked for secure installation prior to final assembly.

5.1.7 Rail Button Installation

Rail buttons are installed through pre-drilled holes in the airframe.

They are mechanically fastened and aligned with the rocket axis to ensure smooth travel along the launch rail.

5.2 Rideshare Payload

The ride share payload is manufactured using a custom PCB and commercial off the shelf components.

PCB Assembly

1. The PCB is fabricated using FR4 substrate
2. Components include the Arduino Nano RP2040 and Nano V1 altimeter are soldered using temperature controlled soldering equipment.
3. Each solder joint is visually inspected for cold joints or bridging.
4. The completed board is powered and tested prior to integration

Payload Housing and Integration

1. The PCB is mounted within the 200 mm payload bay using mechanical fasteners.
2. The cartridge style housing allows for quick access and installation of the customer payload.
3. Screw switches are installed to allow safe arming and disarming of electronics.
4. All wiring is secured to prevent movement during flight.

Final functional checks are performed prior to launch integration.

5.3 Issues and Solutions





Issue 1: Structural Verification

No physical structural tests have yet been conducted. To mitigate uncertainty, planned testing includes:

- Fin bond strength testing
- Motor mount axial load testing
- Shock cord tensile testing

These tests will validate structural assumptions prior to launch

Issue 2: Launch Rail Departure Velocity

Current simulations indicate a low velocity off the launch rail. Potential mitigation strategies include:

- Increasing rail length
- Reducing structural mass
- Minor geometric optimisation

Issue 3: Apogee Target Margin

Predicted apogee is currently below the 2200 ft target. Mitigation includes:

- Mass optimisation
- Surface finishing improvements
- Refinement of fin geometry

6. Testing

Include any tests and results that have been or will be conducted on your individual components or overall launch vehicle. Hint: look at the UKSEDS requirements to find the minimum tests that we expect you to carry out.

6.1 Test Matrix

There are many different test matrix table formats, but the chosen format should show all the tests you are planning to carry out and the corresponding requirements these tests are trying to verify/validate. [See example.](#)

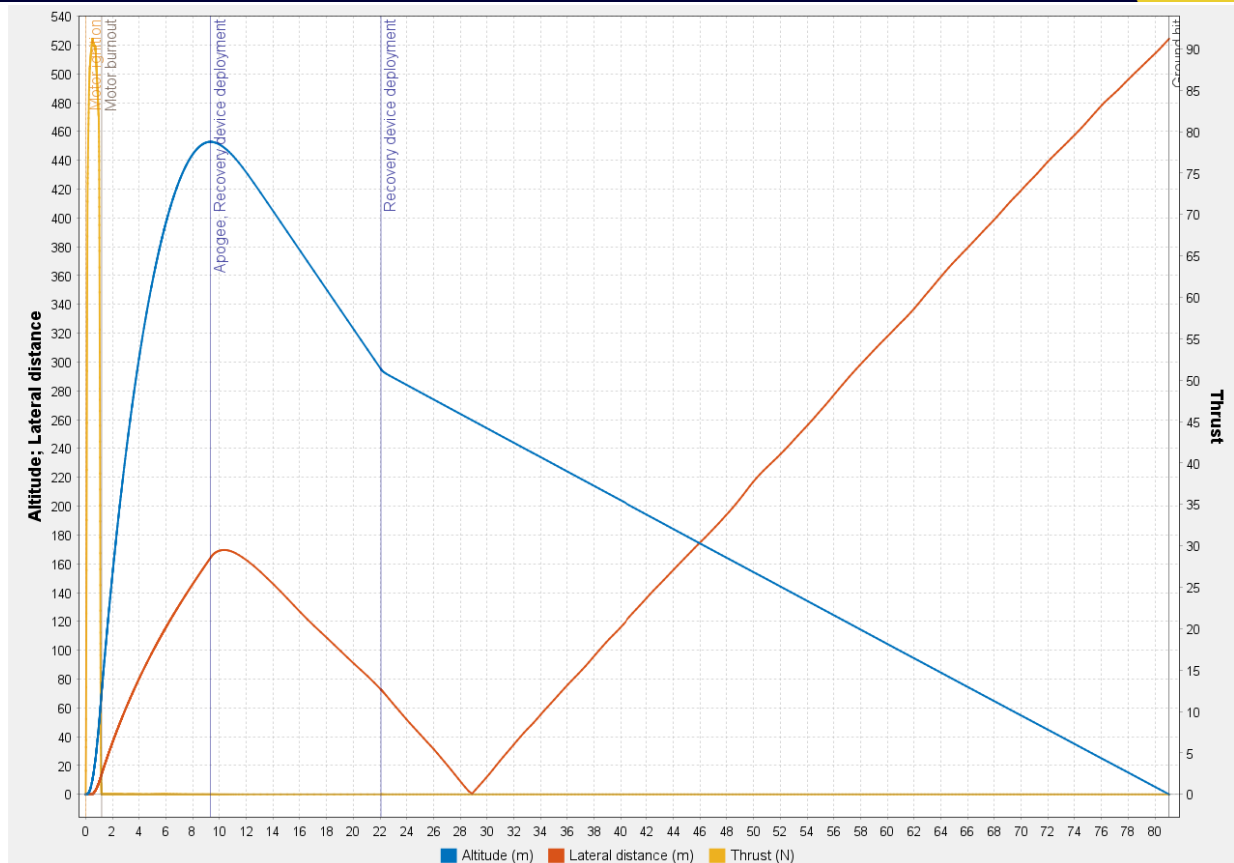
Requirement ID	Test case ID	TC 1 - Fin Load testing	TC 2 - Bulkhead Load testing	TC 3 - Thrust ring Load testing	TC 3 - Rigidity test	TC 4 - Test circuit	TC 5 - Airframe load testing	# of test cases for respective requirement
RS-TSN-MOR-002			X	X				2
RS-TSN-MOR-003			X	X				2
RS-TSN-SAR-002	X							1
RS-TSN-SAR-004					X			1
RS-TSN-SAR-006	X	X	X	X			X	4
RS-TSN-ESS-001						X		1

6.2 Test Results

Please include plenty of diagrams showing your test setups, pictures and discussion.

So far, no physical tests have been performed. At the moment, we only have OpenRocket simulations. Below is a graph produced by our OpenRocket simulation:





7. Final Design

7.1 Design Changes

Describe any changes from your design between the PDR and CDR submissions.

7.2 Improvements and Future Work

Describe any future changes that you are planning. Please also detail what you intend to do between now and the next deliverable.





8. Acknowledgements

Use this section to recognise anyone who assisted with or contributed to the project, but was not part of the team.

9. References

No particular reference style is preferred. Include citations in the text.

Appendices

Any supplementary material, which is not essential to the project but provides a more comprehensive overview of the project, can be included as appendices. **Anything in this section will not be directly marked.**

If you have carried out a large number of trade-offs, you may place the tables here and refer to them in the main text.

