Milestone Review Flysheet 2017-2018

Institution	University of Notre Dame

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Vehicle Properties

Total Length (in)	136
Diameter (in)	Fore: 7.74 Aft: 5.54
Gross Lift Off Weigh (lb.)	45.25
Airframe Material(s)	Phenolic, Fiberglass, Birch Plywood PVC
Fin Material and Thickness (in)	Plywood
Coupler Length/Shoulder Length(s) (in)	6" minimum

Motor Properties

Motor Brand/Designation	Cesaroni L1395-BS
Max/Average Thrust (lb.)	Max: 400.1, Avg: 313.8
Total Impulse (lbf-s)	1100.5
Mass Before/After Burn (lb.)	37.5
Liftoff Thrust (lb.)	400.1
Motor Retention Method	Glue on motor retainter screw on cap

Stability Analysis

Center of Pressure (in from nose)	102
Center of Gravity (in from nose)	79.99
Static Stability Margin (on pad)	2.86
Static Stability Margin (at rail exit)	2.9
Thrust-to-Weight Ratio	8.84
Rail Size/Type and Length (in)	1515, 12ft
Rail Exit Velocity (ft/s)	63.5

Ascent Analysis

Maximum Velocity (ft/s)	647
Maximum Mach Number	0.58
Maximum Acceleration (ft/s^2)	245
Predicted Apogee (From Sim.) (ft)	5404

Recovery System Properties
Drogue Parachute

Manufacturer/Model	Fruitychutes/Iris Ultra			
Size/Diameter (in or ft)	24"			
Altitude at Deployment (ft)	Apogee (Ideally 5280)			
Velocity at Deployment (ft/s)	0			
Terminal Velocity (ft/s)	78			
Recovery Harness Material	Nylon			
Recovery Harness Size/Thickness (in)	9/16"			
Recovery Harness Length (ft)	42			
Harness/Airframe Interfaces	Quicklinks connect the shock cords to the eyebolts of the CRAM. The shockcords are secured 2/3 of the way down their length to a parachute then attached to a bulkhead eyebolt on the other side.			
Kinetic Energy of Each Section (Ft-lbs)	Section 1	Section 2	Section 3	Section 4
	0	0	0	N/A

Recovery System Properties
Main Parachute

Manufacturer/Model	Fruitychutes/Iris Ultra			
Size/Diameter (in or ft)	144			
Altitude at Deployment (ft)	650			
Velocity at Deployment (ft/s)	78			
Terminal Velocity (ft/s)	13			
Recovery Harness Material	Nylon			
Recovery Harness Size/Thickness (in)	16-Sep			
Recovery Harness Length (ft)	42			
Harness/Airframe Interfaces	Quicklinks connect the shock cords to the eyebolts of the CRAM. The shockcords are secured 2/3 of the way down their length to a parachute then attached to a bulkhead eyebolt on the other side.			
Kinetic Energy of Each Section (Ft-lbs)	Section 1	Section 2	Section 3	Section 4
	1280	1100	1900	N/A

Recovery Electronics

Altimeter(s)/Timer(s) (Make/Model)	Featherweight/Raven3
Redundancy Plan and Backup Deployment Settings	Three independent subsystems will ensure parachute deployment. **Drogue:** (1) Apogee, (2) Apogee +1 sec, (3) Apogee +2 sec. **Main:** (1) 650 ft AGL, (2) 600 ft AGL, (3) 550 ft AGL
Pad Stay Time (Launch Configuration)	4 hours (based on predicted battery life)

Recovery Electronics

Rocket Locators (Make/Model)	Hengjiaan JDY-08 CC2541	
Transmitting Frequencies (all - vehicle and payload)	915 MHz ISM Band and 2.4GHz ISM Band	
Ejection System Energetics (ex. Black Powder)	Black Powder	
Energetics Mass - Drogue Chute (grams)	Primary	4
	Backup	4
Energetics Mass - Main Chute (grams)	Primary	5
	Backup	6
Energetics Masses - Other (grams) - If Applicable	Primary	6
	Backup	7

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Payload

Deployable Rover Payload (official payload)	**Overview** The Deployable Rover Payload is required to deploy a rover contained within the rocket for the duration of the flight. Upon deploying the rover, it will autonomously move five feet away from the rocket and unfold two sets of solar panels. Radio frequency will be used to activate the rover after blowing off the nose cone. Ejection charges of black powder will remove the nose cone after landing to allow the rover to exit the rocket cleanly. Tracks have been placed on both top and bottom of the rover to allow it to drive out whether the rocket lands “upside-down”, or “right side up”. A LiDAR (Light Detection and Ranging) sensor will be used for object avoidance so the rover can safely move 5 feet away from the rocket in order to deploy the solar cells. The solar cells will be attached to a fireproof cloth and a metal frame to allow for ease of deployment. The rover will be cut from HDPE to allow for customization.
Air Braking System (non-scored payload)	**Overview** The purpose of the air braking system is to assist the vehicle with reaching an apogee of exactly 5280 ft. This has been done using three different subsystems working together. The aerodynamic subsystem is used to induce an additional, controllable drag force on the rocket using four drag tabs, thus allowing the overall drag on the rocket to be manipulated as necessary. The aerodynamic subsystem is connected to the mechanical subsystem, which uses a central shaft driven by servo motors to manipulate the drag tabs through a crank-slider mechanism. The servo motors are controlled by the electronic subsystem, which runs a control code on a microcontroller to adjust the induced drag as needed.

Test Plans, Status, and Results

Ejection Charge Tests	Ground testing before subscale launch on December 2nd, 2017 and before full scale launch on March 3rd, 2018. This helped to optimize black powder and shear pin levels with each connecting point on the rocket. A malfunction in the recovery system calls for the need for additional black powder testing, to be done on March 8th, 2018. This will finalize the black powder and shear pin numbers for each section of the rocket.
Sub-scale Test Flights	Two launches on December 2nd, 2017. First launch with no scaled Air Braking System in order to obtain altitude measurements to compare with computer simulations. The second launch had a scaled, 3D printed Air Braking System in order to compare with the control flight. The experimental flight verified that the Air Braking Tabs have a significant impact on the apogee of the rocket, as it was diminished by approximately 60 feet under the same conditions.
Full-scale Test Flights	Full scale launch on March 3rd, 2018. This test has a successful launch, but a malfunction in the recovery payload caused the main parachute to be deployed at apogee and the nose cone to fall from this height. Two test launches were therefore scheduled for March 17th, 2018. The first launch will be a control flight with a non-active Air Braking System. The Deployable Rover Payload will be simulated by ballast in the forward section of the rocket. The second launch will be with an activated Air Braking System in order to measure its impact on the vehicles flight. The Deployable Rover Payload will also be active during this flight in order to test its capabailites upon successful landing.

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Additional Comments