Milestone Review Flysheet 2023-2024

Institution	North Carolina State University	Milestone	Flight Readiness Review

Vehicle Properties

Total Length (in)	107.43
Diameter (in)	6.17
Aspect Ratio	17.41 1
Gross Lift Off Weight (lb)	51.6
Ballast Amount (lb) / Material / Location	2.58 / Steel Washers / RFS and AV
Launch Vehicle Burn Out Weight (lb)	47.58
Airframe Material(s)	G12 Giberglass
Fin Material and Thickness (in)	G10 Fiberglass, 1/8
Coupler Length(s)/Shoulder Length(s) (in)	3 (Nosecone), 4.5 (AV), 6 (AV)

Motor Properties

Motor Brand/Designation	AeroTech L1940X
Max/Average Thrust (lb)	521.21/435.97
Total Impulse (lbf-s)	973.24
Mass Before/After Burn (oz)	8.50/4.47
Liftoff Thrust (N)	509.05
Motor Retention Method	AeroTech Motor Retainer, RFS Centering Rings

Stability Analysis

Center of Pressure (in. from nose)	77.65
Center of Gravity (in. from nose)	63.53
Static Stability Margin (on pad)	2.29
Static Stability Margin (at rail exit)	2.38
Max/ Avg Thrust-to-Weight Ratio	10.16/8.53
Rail Size/Type and Length (in)	1515/144
Rail Exit Velocity (ft/s)	70.02

Ascent Analysis

Maximum Velocity (ft/s)	558.84
Maximum Mach Number	0.496
Maximum Acceleration (ft/s^2)	294.99
Target Apogee (ft)	4050
Predicted Apogee (From Sim.) (ft)	4056.32

Recovery System Properties - Overall

Total Descent Time (s)	80.81; 61.67
Total Drift in 20 mph winds (ft)	2370.5; 1809.12

Recovery System Properties - Energetics

Ejection System Energetics (ex. Black Powder)		#FFF Black Powder
Energetics Mass - Drogue Chute (grams)	Primary	2
	Backup	2.5
Energetics Mass - Main Chute (grams)	Primary	5
	Backup	5.5
Energetics Mass - Other (grams) - If Applicable	Primary	N/A
	Backup	N/A

Recovery System Properties - Recovery Electronics

Primary Altimeter Make/Model	MissleWorks RRC3
Secondary Altimeter Make/Model	Eggtimer Quasar
Other Altimeters (if applicable)	N/A
Rocket Locator (Make/Model)	Eggtimer Quasar
Additional Locators (if applicable)	Big Red Bee 900
Transmitting Frequencies (all - vehicle and payload)	420.25 MHz 900 MHz
Describe Redundancy Plan (batteries, switches, etc.)	The Quasar tracker and duel deploy altimeter will have its own battery, and the RRC3 pirimatry altimeter will have its own battery. Each altiemter has its own e-matches, mechanical arming switch, and two ejection charges.
Pad Stay Time (Launch Configuration)	2.9 Hr

Recovery System Properties - Drogue Parachute

Manufacturer/Model				Fruity Chutes Classic Elliptical
Size or Diameter (in or ft)				15 in
Main Altimeter Deployment Setting				Apogee
Backup Altimeter Deployment Setting				Apogee + 1 second
Velocity at Deployment (ft/s)				0
Terminal Velocity (ft/s)				112.82
Recovery Harness Material, Size, and Type (examples - 1/2 in. tubular Nylon or 1 in. flat Kevlar strap)				5/8 in. Tubular Kevlar
Recovery Harness Length (ft)				24
Harness/Airframe Interfaces		Quick links will be attached to bowline knots in the shock cord. The quick links will be attached to U-bolts on the bulkheads		
Kinetic Energy of Each Section (Ft-lbs)	Section 1	Section 2	Section 3	Section 4
	1317.38	2545.67	3283.91	N/A

Recovery System Properties - Main & Nose Cone Parachute

Manufacturer/Model				Fruity Chutes Compact Elliptical; Fruity Chutes Classic Elliptical
Size or Diameter (in or ft)				96 in ; 48 in
Main Altimeter Deployment Setting				800 ft
Backup Altimeter Deployment Setting				700 ft
Velocity at Deployment (ft/s)				112.82
Terminal Velocity (ft/s)				15.38; 21.64
Recovery Harness Material, Size, and Type (examples - 1/2 in. tubular Nylon or 1 in. flat Kevlar strap)				5/8 in. Tubular Kevlar 1/4 in. Tubular Kevlar
Recovery Harness Length (ft)				10; 15
Harness/Airframe Interfaces		Quick links will be attached to bowline knots in the shock cord. The quick links will be attached to U-bolts on the bulkheads		
Kinetic Energy of Each Section (Ft-lbs)	Section 1	Section 2	Section 3	Section 4
	48.77	47.31	61.11	N/A

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Payload

	Overview
Payload 1 (official payload)	The payload on board this year's launch vehicle is the STEMnauts Atmosphere Independent Lander, or SAIL. The goal of this payload is to safely transport four non-living passengers, known as STEMnauts, from the launch vehicle to the ground without the use of a parachute. This will be achieved by using a contra-rotating set of rotor blades powered by an electric motor. The lander will be contained within a body tube know as the deployment bay. The deployment bay will contain electronics for release and a latch that holds the SAIL in place. Upon separation from the launch vehicle, the SAIL will descend in the deployment bay, which will be under a parachute. Once RSO permission is given, an RF controlled latch will release the SAIL from the deployment bay, unfolding the rotor blades and legs and sending it into free fall. At this point, the motor will start spinning the rotor blades, generating lift to slow down the SAIL. The rotor blades will continue to operate based on pre-derived lift curves until landing. The SAIL will land in an upright orientation on the four deployed landing legs.
	Overview
Payload 2 (non-scored payload)	N/A

Test Plans, Status, and Results

Ejection Charge Tests	Full-scale ejection was completed on February 19th, 2024. A second ejection test was required since the first attempt failed to separate the nose cone from the rest of the launch vehicle. Ejection testing ensures that the charges have been sized correctly. Black powder was loaded into the launch-day-appropriate sections. A manual switch was used to activate the charges. The e-matches were connected to a 9V battery, and upon a completed circuit, the charges detonated. On the second attempt, both main and drogue charges adequately separated the desired launch vehicle sections. The final charge amounts to be used for VDF can be viewed in Recovery System Properties - Energetics.
Sub-scale Test Flights	The subscale test flight took place on November 18th, 2023. During the flight, all subscale launch vehicle systems operated successfully. The simulated payload mass deployed properly and all recovery events were successful. The RF command signal was successfully recieved by the nose cone reciever during descent, making it a viable method for on-command payload release for the fullscale design. Flight data and recovery images from this launch were included in the CDR report. This flight verifies NASA SL Requirement 2.18.
Vehicle Demonstration Flights	The Vehicle Demonstration Flight was completed on Febraury 24th, 2024. All launch vehicle subsystems and payload deployment subsystems worked as predicted. The launch vehicle reached an apogee of 4247 ft and was recovered successfully with no damage reported. All launch vehicle requirments have been verified prior to this flight. This flight directly satisifes NASA SLI Requirement 2.19.1.
Payload Demonstration Flights	The Payload Demonstration Flight is planned for March 23rd-24th, 2024. This flight will determine if all team derived and NASA requirements have been met by the payload subsytem. This will satisfy the NASA SLI Requirement 2.19.2.

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Transmitter #1			
Location of transmitter:	Avionics Bay		
Purpose of transmitter:	Launch Vehicle Tracking Device		
Brand	Eggtimer Rocketry	RF Output Power (mW)	100 mW
Model	Quasar	Specific Frequency used by team (MHz)	420.2 MHz
Handshake or frequency hopping? (explain)	Fixed Frequency, ID 8		
Distance to closest e-match or altimeter (in)	1 in		
Description of shielding plan:	There will be a sheet of aluminum foil added between the tracker and other recovery electronics on the sled.		

Transmitter #2			
Location of transmitter:	Nose Cone Sled		
Purpose of transmitter:	Nose Cone Tracking Device		
Brand	BigRedBee	RF Output Power (mW)	250 mW
Model	BRB900	Specific Frequency used by team (MHz)	900 MHz
Handshake or frequency hopping? (explain)	Fixed Frequency, ID 8		
Distance to closest e-match or altimeter (in)	35		
Description of shielding plan:	There will be a sheet of aluminum foil added around the tracker to shield from payload electronics in nose cone.		

Transmitter #3			
Location of transmitter:			
Purpose of transmitter:			
Brand		RF Output Power (mW)	
Model		Specific Frequency used by team (MHz)	
Handshake or frequency hopping? (explain)			
Distance to closest e-match or altimeter (in)			
Description of shielding plan:			

Transmitter #4			
Location of transmitter:			
Purpose of transmitter:			
Brand		RF Output Power (mW)	
Model		Specific Frequency used by team (MHz)	
Handshake or frequency hopping? (explain)			
Distance to closest e-match or altimeter (in)			
Description of shielding plan:			

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Transmitter #5			
Location of transmitter:			
Purpose of transmitter:			
Brand		RF Output Power (mW)	
Model		Specific Frequency used by team (MHz)	
Handshake or frequency hopping? (explain)			
Distance to closest e-match or altimeter (in)			
Description of shielding plan:			

Transmitter #6			
Location of transmitter:			
Purpose of transmitter:			
Brand		RF Output Power (mW)	
Model		Specific Frequency used by team (MHz)	
Handshake or frequency hopping? (explain)			
Distance to closest e-match or altimeter (in)			
Description of shielding plan:			

Additional Comments

Note: The Recovery System Properties - Main & Nose Cone Parachute section of this flysheet includes both the main parachute and the parachute connected to the nose cone. The format of the entries in that section is as follows: Main parachute entry; Nose cone parachute entry. The same holds true for the Recovery System Properties - Overall section (descent/drift under main; descent/drift under nose cone parachute).