Milestone Review Flysheet 2020-2021

Institution	Auburn University

Milestone	CDR

Vehicle Properties

Total Length (in)	119
Diameter (in)	6.2
Gross Lift Off Weigh (lb)	50.7
Airframe Material(s)	8.5oz 2x2 Twill Fiberglass E Cloth, Twill 6K Carbon Fiber Cloth
Fin Material and Thickness (in)	Twill 12K Carbon Fiber Cloth (core), Twill 6K Carbon Fiber Cloth (linings), 0.15 in
Coupler Length(s)/Shoulder Length(s) (in)	(Nose cone/ 3 in), 2x (9 in/ 6 in)

Motor Properties

Motor Brand/Designation	Aerotech L2200G
Max/Average Thrust (lb)	697/494.6
Total Impulse (lbf-s)	1147.42
Mass Before/After Burn (oz)	168/78.8
Liftoff Thrust (N)	2480.1
Motor Retention Method	Aeropack flanged motor retainer (bolted)

Stability Analysis

Center of Pressure (in. from nose)	90.2
Center of Gravity (in. from nose)	71.2
Static Stability Margin (on pad)	3.04 cal
Static Stability Margin (at rail exit)	3.131 cal
Thrust-to-Weight Ratio	11:1
Rail Size/Type and Length (in)	1515 Rail - 144"
Rail Exit Velocity (ft/s)	90.8

Ascent Analysis

Maximum Velocity (ft/s)	651
Maximum Mach Number	0.58
Maximum Acceleration (ft/s^2)	422
Target Apogee (ft)	4000
Predicted Apogee (From Sim.) (ft)	4976

Recovery System Properties - Overall

Total Descent Time (s)	86.01
Total Drift in 20 mph winds (ft)	2,491

Recovery System Properties - Energetics

Ejection System Energetics (ex. Black Powder)		Black Powder, Mechanical
Energetics Mass - Drogue Chute	Primary	3

Recovery System Properties - Recovery Electronics

Primary Altimeter Make/Model	Stratologger PerfectFlite
Secondary Altimeter Make/Model	Stratologger PerfectFlite
Other Altimeters (if applicable)	
Rocket Locator (Make/Model)	Adafruit LoRa Featherwing
Additional Locators (if applicable)	Beitian BN-880 GPS, 433MHz RF beacon, Featherweight GPS Tracker
Transmitting Frequencies (all - vehicle and payload)	433MHz, 915MHz, 2.4GHz, 5.8GHz,
Describe Redundancy Plan (batteries, switches, etc.)	An identical recovery deployment system exists through a second altimeter, second key switch, and second set of charges for each event. There exists a delay so that these secondary events do not occur at the same time as the primary event.
Pad Stay Time (Launch Configuration)	8hrs

Recovery System Properties - Drogue Parachute

Manufacturer/Model		Auburn University / Circular		
Size or Diameter (in or ft)		2.88ft		
Main Altimeter Deployment Setting		Apogee		
Backup Altimeter Deployment Setting		Apogee+1sec		
Velocity at Deployment (ft/s)		0		
Terminal Velocity (ft/s)		85		
Recovery Harness Material, Size, and Type (examples - 1/2 in. tubular Nylon or 1 in. flat Kevlar strap)		5/8 inch Tubular Nylon		
Recovery Harness Length (ft)		1x15, 1x10		
Harness/Airframe Interfaces	(2x) Quick Link to U-Bolt mounted in bulk plate			
Kinetic Energy of Each Section (Ft-lbs)	Section 1	Section 2	Section 3	Section 4
	2053.1	2829.4		

Above KE is in flight and not during landing; sections further separate and slow on descent

Recovery System Properties - Main Parachute

Manufacturer/Model	Auburn University / Hemispherical
Size or Diameter (in or ft)	8ft
Main Altimeter Deployment Setting (ft)	750
Backup Altimeter Deployment Setting (ft)	650
Velocity at Deployment (ft/s)	85
Terminal Velocity (ft/s)	15.7
Recovery Harness Material, Size, and Type (examples - 1/2 in. tubular Nylon or 1 in. flat Kevlar strap)	5/8 inch Tubular Nylon

Energetics Mass - Drogue Chute (grams)	Backup	3.5
Energetics Mass - Main Chute (grams)	Primary	4
	Backup	4.5
Energetics Mass - Other (grams) - If Applicable	Primary	
	Backup	

Recovery Harness Length (ft)			1x15, 1x10	
Harness/Airframe Interfaces	(2x) Quick Link to U-Bolt mounted in bulk plate			
Kinetic Energy of Each Section (Ft-lbs)	Section 1	Section 2	Section 3	Section 4
	70	25.1	35.25	60

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Payload

Payload 1 (official payload)	**Overview** This year's payload system will consist of 2 active subsystems. The Mechanical Active Release System(MARS) will be responsible for the payload's retention and release at approximately 700ft AGL. The Fully-Active Levelling Lander System(FALLS) will be responsible for untethering itself from an independent parachute, semi-autonomously flying itself to a desired landing zone using its own propulsive force, levelling itself to within five degrees of vertical, and finally capturing a 360 degree photo and relaying that to the ground team.
Payload 2 (non-scored payload)	**Overview** An on-board altitude control system with four variable aerodynamic control surfaces is designed to fulfill the main goal of slowing the vehicle down by deploying the airbrakes and matching the flight appogee with the target apogee. The secondary mission is use the estimated realtime data to provide the payload with vehicle current state updates and serve as fallback system in case of altimeter failure. The collected flight will be used for post-mission analysis and future mission predictions.

Test Plans, Status, and Results

Ejection Charge Tests	The explosive separation of the recovery system is crucial to the deployment of the drogue and main parachutes. This separation is dependent on the pressurisation of the recovery tube by black powder charges in order to detach shear pins. The correct pressure must be reached by running through the process safely on the ground until the tube separates with the correct amount of force. If too little black powder is used,the tubes will not separate. If too much black powder is used, the explosion could damage the structure of the vehicle or its components. The correct amount of black powder will be recorded and used in launch. The subscale ejection testing was successfully completed on 10/23/20. The full scale ejection test will be attempted on 1/10/21, or at least a week before any planned launch.
Sub-scale Test Flights	The team has built and launched a complete sub-scale model of the launch vehicle. This launch ensured the design of the launch vehicle is aerodynamically stable and robust. The recovery system successfully demonstrated its parachute deployment and staging. The payload system gathered flight data and tested the MARS and NARS interfacing and jettison systems successfully. The subscale model was launched at SEARS on 11/7/20 , where the payload and recovery systems experienced a complete success but the vehicles altitude underperformed, which was likely due to inaccurate models or a faulty motor. It was decided to relaunch at SEARS on 12/5/20, where the vehicle was unknowingly outfitted with a bad motor which resulted in a failed test launch. The first launch still met the requiremnets for a success, but it would have been nice to have another launch to determine what caused the altitude malfunction and aquire more data.
Vehicle Demonstration Flights	The full scale launch vehicle will be launched until all the systems operate as planned and all the criteria is met. A failed launch would occur unless the chutes deploy at the correct times, the payload successfully demonstrates a successful mission, all hardware is intact and reusable, and the target altitude is within a certain margin of error. If a failed test launch should occur, the team will analyze all data gathered from the launch and fix the point of failure that caused the unsuccessful launch. Future planned launches include but are not limited to: HARA 1/9/21 and SEARS 2/6/21, with preference to the earlier date.

Payload Demonstration Flights	The payload will undergo a significant amount of testing. The payload is a complicated drone system which requires it to be meticulously tuned. In this test the team will anchor the drone to the ground and actively tune it using the flight test software from a safe distance. This test will be carried out until the drone is effectively calibrated and enough flight data has been acquired. A flight test, drop test and range test will be completed before the payload demonstration flight. All of the systems responsible for the nosecone and payload jettison were tested at the subscale launch. The FALLS for this was inert, but the entire subscale mission served as a proof of concept for the MARS/NARS combination. A full scale payload will be ready for the first fullscale flight for a full mission verification. If something does not work as planned, the payload will be prepared for a second demonstration flight before the FRR deadline

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Transmitter #1

Location of transmitter:	Altitude Control System		
Purpose of transmitter:	Low-range wireless link		
Brand	Xbee	RF Output Power (mW)	1
Model	XB24CAWIT-001	Specific Frequency used by team (MHz)	2400
Handshake or frequency hopping? (explain)	handshake		
Distance to closest e-match or altimeter (in)	8 inches		
Description of shielding plan:	Carbon fiber body and bulkplate		

Transmitter #2

Location of transmitter:	Altitude Control System		
Purpose of transmitter:	Telemetry & GPS Tracking		
Brand	Adafruit LoRa Featherwing	RF Output Power (mW)	100
Model	RFM95	Specific Frequency used by team (MHz)	915
Handshake or frequency hopping? (explain)	handshake		
Distance to closest e-match or altimeter (in)	8 inches		
Description of shielding plan:	Carbon fiber body and bulkplate		

Transmitter #3

Location of transmitter:	Payload bay (FALLS)		
Purpose of transmitter:	Transmits captured panoramic image		
Brand	Nordic Semiconductor	RF Output Power (mW)	1
Model	NRF24L01+	Specific Frequency used by team (MHz)	2400
Handshake or frequency hopping? (explain)	Handshake - Radios are pre-configured to communicate only with each other		
Distance to closest e-match or altimeter (in)	33 inches		
Description of shielding plan:	Carbon fiber bulkplates will separate the transmitter and any e-matches		

Transmitter #4

Location of transmitter:	Payload bay (FALLS)		
Purpose of transmitter:	Controls autopilot functions		
Brand	3D Robotics	RF Output Power (mW)	100
Model	SiK Telemetry Radio	Specific Frequency used by team (MHz)	900
Handshake or frequency hopping? (explain)	Handshake - Radios are pre-configured to communicate only with each other		
Distance to closest e-match or altimeter (in)	33 inches		
Description of shielding plan:	Carbon fiber bulkplates will separate the transmitter and any e-matches		

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Transmitter #5			
Location of transmitter:	Payload bay (FALLS)		
Purpose of transmitter:	Transmits analog video signal for landing site evaluation		
Brand	Holybro	RF Output Power (mW)	800
Model	Atlatl HV V2	Specific Frequency used by team (MHz)	5805
Handshake or frequency hopping? (explain)	Analog video is transmitted on selected frequency, receiver is tuned to match		
Distance to closest e-match or altimeter (in)	33 inches		
Description of shielding plan:	Carbon fiber bulkplates will separate the transmitter and any e-matches		
This Transmitter will be disabled or operating at a lower power until lander jettison			

Transmitter #6			
Location of transmitter:	Payload bay (FALLS)		
Purpose of transmitter:	Provides direct remote control of the lander system		
Brand	FrSky	RF Output Power (mW)	25
Model	R-XSR	Specific Frequency used by team (MHz)	2400
Handshake or frequency hopping? (explain)	Uses FrSky's frequency hopping ACCST protocol to avoid interference		
Distance to closest e-match or altimeter (in)	33 inches		
Description of shielding plan:	Carbon fiber bulkplates will separate the transmitter and any e-matches		

Transmitter #7			
Location of transmitter:	Nosecone		
Purpose of transmitter:	GPS location and tracking		
Brand	Featherweight Altimeters	RF Output Power (mW)	<100
Model	Featherweight GPS Tracker	Specific Frequency used by team (MHz)	919.8
Handshake or frequency hopping? (explain)	Handshake - LoRa radio is configured to communicate only with the ground station		
Distance to closest e-match or altimeter (in)	44 inches		
Description of shielding plan:	Carbon fiber bulkplates will separate the transmitter and any e-matches		

Additional Comments

The team plans to fully paint the launch vehicle with auto paint. This has not yet been implemented into the simulations, hence the apogee overshoot. Additionally, some components that have yet to be 3D-printed will be printed at higher densities to optimize the apogee overshoot further and to increase structural integrity. Any leftover overshoot will be adjusted by the ACS.