Milestone Review Flysheet 2018-2019

Institution	Oregon State University

Milestone	FRR

Vehicle Properties

Total Length (in)	129.375
Diameter (in)	6.25
Gross Lift Off Weigh (lb)	56.9
Airframe Material(s)	Carbon Fiber, Fiberglass
Fin Material and Thickness (in)	Carbon Fiber, 0.125
Coupler Length(s)/Shoulder Length(s) (in)	12" Nosecone/Fore; 6.875" shoulder; 23.5" Fore/Aft; 7"shoulder

Motor Properties

Motor Brand/Designation	Cesaroni L2375-WT
Max/Average Thrust (lb)	586.3 / 533.7
Total Impulse (lbf-s)	1102.69
Mass Before/After Burn (lb)	9.71 / 4.06
Liftoff Thrust (lb)	553.5
Motor Retention Method	6061 Aluminum Threaded Retainer

Stability Analysis

Center of Pressure (in. from nose)	84.7
Center of Gravity (in. from nose)	71.0
Static Stability Margin (on pad)	2.14
Static Stability Margin (at rail exit)	2.2
Thrust-to-Weight Ratio	10.3
Rail Size/Type and Length (in)	1515 / 144
Rail Exit Velocity (ft/s)	83.4

Ascent Analysis

Maximum Velocity (ft/s)	573
Maximum Mach Number	0.52
Maximum Acceleration (ft/s^2)	309
Target Apogee (ft)	4,500
Predicted Apogee (From Sim.) (ft)	4,642

Recovery System Properties - Overall

Total Descent Time (s)	67.07 (fore), 70.83 (aft)
Total Drift in 20 mph winds (ft)	1967.4 (fore), 2077.7 (aft)

Recovery System Properties - Energetics

Ejection System Energetics (ex. Black Powder)		Black Powder
Energetics Mass - Drogue Chute (grams)	Primary	4, 5.5
	Backup	6, 8
Energetics Mass - Main Chute (grams)	Primary	0.33, 4
	Backup	0.33, 4
Energetics Mass - Other (grams) - If Applicable	Primary	0.33, 4
	Backup	0.33, 4

Recovery System Properties - Recovery Electronics

Primary Altimeter Make/Model	Missile Works RRC3
Secondary Altimeter Make/Model	Missile Works RRC3
Other Altimeters (if applicable)	N/A
Rocket Locator (Make/Model)	Xbee Pro 900HP
Additional Locators (if applicable)	Texas Instruments CC 1200
Transmitting Frequencies (all - vehicle and payload)	CC 1200: 433 MHz Xbee PRO 900HP: 900 MHz
Describe Redundancy Plan (batteries, switches, etc.)	Two altimeters for each section, separate batteries for each altimeter, separate charges for each altimeter, two Tender Descenders per main chute.
Pad Stay Time (Launch Configuration)	Altimeters: 8+ hours Tracking Unit: 8+ hours

Recovery System Properties - Drogue Parachute

Manufacturer/Model		Top Flight Recovery / XTEAR-18		
Size or Diameter (in or ft)		18 in. (fore) / 18 in. (aft)		
Main Altimeter Deployment Setting		Apogee		
Backup Altimeter Deployment Setting		Apogee +1 s		
Velocity at Deployment (ft/s)		1.99		
Terminal Velocity (ft/s)		111 (fore) /112 (aft)		
Recovery Harness Material, Size, and Type (examples - 1/2 in. tubular Nylon or 1 in. flat Kevlar strap)		1 in. Nylon Webbing		
Recovery Harness Length (ft)		20 (fore) / 20 (aft)		
Harness/Airframe Interfaces		3/8 in. forged steel eyebolts connected to altimeter bay bulkheads.		
Kinetic Energy of Each Section (ft-lbs)	Section 1	Section 2	Section 3	Section 4
	3485.0 (fore)	3922.4 (aft)	970.8 (nosecone)	N/A

Recovery System Properties - Main Parachute

Manufacturer/Model		Fruity Chutes Toroidal		
Size or Diameter (in or ft)		8 ft (fore) / 8 ft (aft)		
Main Altimeter Deployment Setting (ft)		800		
Backup Altimeter Deployment Setting (ft)		800, 700		
Velocity at Deployment (ft/s)		111(fore) / 112 (aft)		
Terminal Velocity (ft/s)		15.1(fore) / 14.2 (aft)		
Recovery Harness Material, Size, and Type (examples - 1/2 in. tubular Nylon or 1 in. flat Kevlar strap)		1 in. Nylon Web		
Recovery Harness Length (ft)		20 (fore) / 20 (aft)		
Harness/Airframe Interfaces		3/8 in. forged steel eyebolts connected to altimeter bulkheads.		
Kinetic Energy of Each Section (Ft-lbs)	Section 1	Section 2	Section 3	Section 4
	64.1 (fore)	62.7 (aft)	17.9 (nosecone)	N/A

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Payload

	Overview
Payload 1 (official payload)	The rover is contained within the fore section of the airframe. Upon landing, the rover ejects from the airframe using black powder charges sized to: 1.2 g Primary and 2.0 g Backup. The rover has two coaxial, independently driven wheels with a chassis suspended between them. A spring-loaded stabilizer arm acts as a third point of contact with the ground. An Arduino Teensy 3.6 development board autonomously controls the motors to move the rover, receiving input from a sensor array including active sonar, passive sonar, and a nine-degree-of-freedom IMU. An auger is mounted in the center of the chassis. When the rover is deployed the auger periodically gathers soil samples and stores them in an internal containment unit. After collection, the rover autonomously drives to a Scientific Base Station where it performs an additional scientific experiment.

	Overview
Payload 2 (non-scored payload)	None

Test Plans, Status, and Results

Ejection Charge Tests	Test Plan: A remote ignition system was used to ignite charges and ensure proper seperation and drogue parachute ejection with selected amount of black powder. Status: Completed. Results: Five consecutive successful tests for all sections.
Subscale Test Flights	Test Plan: Subscale launch vehicle was constructed with a 4 in. diameter airframe and launched twice on December 8th, 2018 and January 4th, 2019. Status: Completed. Results: The December 8th flight resulted in a main parachute deployment at apogee. The January 4th flight never had a main parachute deployment. The flights demonstrated several mistakes in the recovery system design, which have been accounted for.
Vehicle Demon-stration Flights	Test Plan: The full scale launch vehicle was manufactured and launched on February 22nd, 2019. The full scale launch vehicle had all competiton components on board with the payload retained within the airframe. Status: The full scale launch vehicle demonstration flight was completed on February 22nd, 2019. Results: The launch vehicle reached an apogee altitude of 5,079 ft. with a rail exit velocity of 71.85 ft/s from a 8.08 ft rail. At apogee, the launch vehicle successfully separated into three sections and released the 18 in. drogue parachute. The fore section unfurled the main parachute at 262 ft above ground level (AGL), landing with a kinetic energy of 38.45 ft-lbf with a total descent time of 72.6 s. The aft section unfurled the main parachute at 380 ft AGL, landing with a kinetic energy of 65.87 ft-lbf with a total descent time of 79.55 s. The total drift was calculated to be 313 ft from the launch pad.
Payload Demon-stration Flights	Test Plan: The payload demonstration flight is scheduled to be March 16th, 2019 with the competition payload retained inside the fore airframe with the same design as in the launch vehicle demonstration flight. Upon landing, the payload will be ejected from the fore airframe. Status: Manufacturing is complete. OSRT is ready to complete the payload demonstration flight on March 16th, 2019. Results: Demonstration not yet completed.

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Transmitter #1			
Location of transmitter:	x1 Nosecone, x1 Aft above motor		
Purpose of transmitter:	Tracking/Telemetry		
Brand	Digi	RF Output Power (mW)	250
Model	XBP9B-DMST-002 (Xbee Pro 900HP)	Specific Frequency used by team (MHz)	900
Handshake or frequency hopping? (explain)	Frequency hopping, 400 kHz wide channels		
Distance to closest e-match or altimeter (in)	2, 2		
Description of shielding plan:	Conductive tape RF shielding around recovery electronics to ensure no interference with recovery electronics and to ensure that ejection takes place at the correct altitude.		

Transmitter #2			
Location of transmitter:	x1 Nosecone, x1 Aft above motor		
Purpose of transmitter:	Tracking/Telemetry		
Brand	Texas Instruments	RF Output Power (mW)	40
Model	CC 1200	Specific Frequency used by team (MHz)	433
Handshake or frequency hopping? (explain)	Frequency hopping		
Distance to closest e-match or altimeter (in)	2, 2		
Description of shielding plan:	Conductive tape RF shielding around recovery electronics to ensure no interference with recovery electronics and to ensure that ejection takes place at the correct altitude.		

Transmitter #3			
Location of transmitter:	Fore section above payload bay		
Purpose of transmitter:	Payload Ejection Controller Receiver		
Brand	Digi	RF Output Power (mW)	250
Model	XBP9B-DMST-002 (Xbee Pro 900HP)	Specific Frequency used by team (MHz)	900
Handshake or frequency hopping? (explain)	Frequency hopping, 400 kHz wide channels		
Distance to closest e-match or altimeter (in)	1 (wired to e-matches)		
Description of shielding plan:	Conductive spray paint RF shielding around recovery electronics to ensure no interference with recovery electronics, electrically shielded e-match wiring. Receiving only, no transmission.		

Transmitter #4			
Location of transmitter:	Ground Station		
Purpose of transmitter:	Coordinate data reception, transmitting PLEC trigger signal		
Brand	Digi	RF Output Power (mW)	250
Model	XBP9B-DMST-002	Specific Frequency used by team (MHz)	900
Handshake or frequency hopping? (explain)	Frequency hopping, 400 kHz wide channels		
Distance to closest e-match or altimeter (in)	N/A (isolated from launch vehicle)		
Description of shielding plan:	N/A (isolated from launch vehicle)		

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Transmitter #5

Location of transmitter:	Ground Station		
Purpose of transmitter:	Coordinate data reception		
Brand	Texas Instruments	RF Output Power (mW)	40
Model	CC 1200	Specific Frequency used by team (MHz)	433
Handshake or frequency hopping? (explain)	Frequency hopping		
Distance to closest e-match or altimeter (in)	N/A (isolated from launch vehicle)		
Description of shielding plan:	N/A (isolated from launch vehicle)		

Transmitter #6

Location of transmitter:	Payload		
Purpose of transmitter:	Tracking/Telemetry for launch vehicle avoidance		
Brand	Digi	RF Output Power (mW)	250
Model	XBP9B-DMST-002 (Xbee Pro 900HP)	Specific Frequency used by team (MHz)	900
Handshake or frequency hopping? (explain)	Frequency hopping, 400 kHz wide channels		
Distance to closest e-match or altimeter (in)	5 (not powered during flight)		
Description of shielding plan:	Conductive spray paint RF shielding around recovery electronics to ensure no interference with recovery electronics and to ensure that ejection takes place at the correct altitude. Not powered during flight.		

Additional Comments

None