Institution	Oregon State University

Milestone	FRR

Vehicle Properties

Total Length (in)	119
Diameter (in)	6.25
Gross Lift Off Weigh (lb)	57.9
Airframe Material(s)	Carbon Fiber/fiberglass
Fin Material and Thickness (in)	Carbon Fiber 0.25
Coupler Length(s)/Shoulder Length(s) (in)	15/6.5

Motor Properties

Motor Brand/Designation	AeroTech L2200G
Max/Average Thrust (lb)	697/504
Total Impulse (lbf-s)	1147
Mass Before/After Burn (lb)	10.5/4.93
Liftoff Thrust (lb)	557
Motor Retention Method	Aero Pack 75mm Motor Retainer

Stability Analysis

Center of Pressure (in. from nose)	88.65
Center of Gravity (in. from nose)	71.89
Static Stability Margin (on pad)	2.62
Static Stability Margin (at rail exit)	2.67
Thrust-to-Weight Ratio	11.4:1
Rail Size/Type and Length (in)	1515/144
Rail Exit Velocity (ft/s)	73.4

Ascent Analysis

Maximum Velocity (ft/s)	573
Maximum Mach Number	0.5
Maximum Acceleration (ft/s^2)	366
Target Apogee (ft)	4000
Predicted Apogee (From Sim.) (ft)	4601

Recovery System Properties - Overall

Total Descent Time (s)	76.6
Total Drift in 20 mph winds (ft)	1467

Recovery System Properties - Energetics

Ejection System Energetics (ex. Black Powder)		Black Powder
Energetics Mass - Drogue Chute (grams)	Primary	2.4 g
	Backup	3.0 g
Energetics Mass - Main Chute (grams)	Primary	5.3 g
	Backup	6.7 g
Energetics Mass - Other (grams) - If Applicable	Primary	N/A
	Backup	N/A

Payload Deployment

Location: Air or Ground (if applicable)	Ground
Altitude of Deployment (if applicable)	0 ft AGL

Recovery System Properties - Recovery Electronics

Primary Altimeter Make/Model	Missile Works RRC3 Altimete
Secondary Altimeter Make/Model	TE MS5038 - Avionics
Other Altimeters (if applicable)	TE MS5038 - BEAVS
Rocket Locator (Make/Model)	ublox SAM-M8Q -
Additional Locators (if applicable)	ublox SAM-M8Q -
Transmitting Frequencies (all - vehicle and payload)	***Required by CDR*** (Complete on pages 3 and 4)
Pad Stay Time (Launch Configuration)	
Describe Redundancy Plan (batteries, switches, etc.)	The avionics bay will have additional batteries for twice the required time with backups in BEAVS.

Recovery System Properties - Drogue Parachute

Manufacturer/Model			Apogee Rockets X-Form	
Size or Diameter (in or ft)			36 in	
Main Altimeter Deployment Setting			4000ft	
Backup Altimeter Deployment Setting			3950ft	
Velocity at Deployment (ft/s)			1.7	
Terminal Velocity (ft/s)			136	
Recovery Harness Material, Size, and Type (examples - 1/2 in. tubular Nylon or 1 in. flat Kevlar strap)			1in flat Nylon Strap	
Recovery Harness Length (ft)			38ft	
Harness/Airframe Interfaces	Eye bolts			
Kinetic Energy (Ft-lbs)	Section 1	Section 2	Section 3	Section 4
	73.19	19.47	74.9	N/A

Recovery System Properties - Main Parachute

Manufacturer/Model			Fruitychutes	
Size or Diameter (in or ft)			12ft	
Main Altimeter Deployment Setting (ft)			600	
Backup Altimeter Deployment Setting (ft)			500	
Velocity at Deployment (ft/s)			136	
Terminal Velocity (ft/s)			532	
Recovery Harness Material, Size, and Type (examples - 1/2 in. tubular Nylon or 1 in. flat Kevlar strap)			1in flat Nylon strap	
Recovery Harness Length (ft)			15ft	
Harness/Airframe Interfaces	Eyebolts and butterfly knot			
Kinetic Energy (Ft-lbs)	Section 1	Section 2	Section 3	Section 4
	73.19	19.47	74.9	N/A

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Payload

Payload 1 (official payload)	**Overview** The payload is retained in the fore section of the airframe by a lead screw styled ejection system. This system will eject the nose cone, then payload from the airframe. Ground operations will then be performed by a rover styled system. The rover utilizes a bi-axial dual motor drivetrain, and expandable wheels to navigate. The wheels collapse to a stowed diameter of 6.25 in. in the airframe, then expand to a 10 in. diameter once ejected from the airframe. At this point a carbon fiber tail will unfurl. This mechanical motion is used to switch a relay turning on the rover electronic system. The rover then uses a plow styled collection system, powered by a leadscrew linear actuator to collect and store the simulated ice sample. The rover itself is comprised of a laser cut wooden chassis, manual machined aluminum supports, and 3D printed PLA parts.
Payload 2 (non-scored payload)	**Overview**

Test Plans, Status, and Results

Ejection Charge Tests	Subscale black powder ejection charge tests were conducted, and showed that the calculated charge size was able to fully deploy both the drogue and the main parachute in their respective tests. Therefore the subscale drogue and subscale main deployment tests were successful. The next step is to test full scale drogue and full scale main parachute deployments, however, in order to do this, the full scale parachutes need to be purchased and delivered, and the nomex blankets need to be created.
Sub-scale Test Flights	The subscale test flight took place under ideal conditions, having a clear sky and minimal wind. The launch rail was aimed directly up with no wind correction as per the RSO instructions. The launch vehicle left the rail accelerating straight up into the air and coasting past motor burnout arcing slightly above the launch site RSO table. Drogue deployed at apogee, with a noticeable deployment of the secondary charge 1 second later as programmed. The launch vehicle glided down to 600 ft AGL with the wind carrying it slightly past the launch rail, and deployed the main parachute. Again with a noticeable deployment of the secondary backup charge as the vehicle passed approximately 500 ft AGL. This was also exactly as designed and programed by OSRT. The launch vehicle then landed approximately 250 ft past the launch rail.
Vehicle Demon-stration Flights	When the team arrived at the launch site at approximately 08:00, the weather was clear but cold with a temperature around 35 degrees Fahrenheit.he flight path of the launch vehicle was as follows: The launch vehicle came off the launch rail, and came off the rail straight. From the simulation OpenRocket, it was predicted the launch vehicle would reach an apogee of 4131 ft. With this data, the coefficient of drag calculated by OpenRocket was an average of 0.469 between motor burnout and apogee. According to the two Missile Works RRC3 altimeters and the avionics data, which comes from the avionics in the nose cone, the launch vehicle reached an altitude of approximately 4456 ft. From the primary RRC3, once the launch vehicle reached apogee, the main drogue charge was then detonated. However, it appeared from the ground that the drogue parachute did not deploy immediately at apogee, and that it deployed 0.95 s later when the backup drogue charge detonated. The team originally thought that the drogue parachute did not inflate, however, photographic evidence, shows that the drogue parachute did indeed inflate. It was just so far away at the time, and the drogue parachute was so small as it is, that it looked like the drogue parachute was not having much of an impact on the launch vehicle's descent. The main parachute primary and secondary charges deployed in tandem at 53.8 seconds into flight, which was where both the nose cone became detached and fell approximately 500 ft. The remained of teh launch vehicel landed without further damage or incident landig aproximatly 2500 ft away from the launch rail.
Payload Demon-stration Flights	The official payload demonstration flight will be on 3/7/2020. For this flight the payload will flown as it willl be at competition, then perform a ground mission to simulate ice collection. This will be the second launch with payload on board the launch vehicle. The first launch was on 2/22/2020 and the payload assembly was flow without rover electronics. For this flight the payload was succesfully retained for the duration of the flight. After inspection all components were found to be undamaged.

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Transmitter #1			
Location of transmitter:	Nose Cone		
Purpose of transmitter:	To track rocket altitude during flight		
Brand	HOPERF electronic	RF Output Power (mW)	100mW
Model	XBee pro	Specific Frequency used by team (MHz)	915
Handshake or frequency hopping? (explain)	Yes, to ensure that payload is not ejected prematurely. It will involve handshakes and acknowledgement.		
Distance to closest e-match or altimeter (in)	68		
Description of shielding plan:	It will be separated by a bulk head and will be surrounded by a ground plane.		

Transmitter #2			
Location of transmitter:	Payload Bay		
Purpose of transmitter:	Ejection of Payload		
Brand	DIGI	RF Output Power (mW)	100mW
Model	XBee Pro XSC SC3B	Specific Frequency used by team (MHz)	915
Handshake or frequency hopping? (explain)	Handshake to verify correct reception of data.		
Distance to closest e-match or altimeter (in)	19		
Description of shielding plan:	It will be shielded by a bulk head and surrounded by the ground plane between itself and the altimeters.		

Transmitter #3			
Location of transmitter:	Rover		
Purpose of transmitter:	Rover Control		
Brand	DIGI	RF Output Power (mW)	100mW
Model	XBee Pro XSC SC3B	Specific Frequency used by team (MHz)	915
Handshake or frequency hopping? (explain)	Handshake to verify correct reception of data.		
Distance to closest e-match or altimeter (in)	38.95		
Description of shielding plan:	It will be off until the Payload is ejected from the rocket. It will also be surrounded by a ground plane		

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