NORTHWEST INDIAN COLLEGE SPACE CENTER

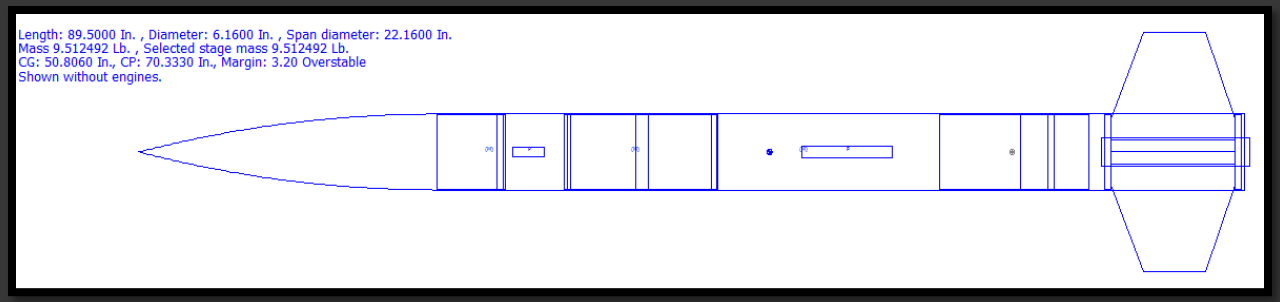
Team RPGs

Critical Design Review

Vehicle Dimensions

Length	89.50	Diameter	6.00
Weight	6.75/14.5	Fin Span	22.00
*Center of Gravity	50.80/57.77	Center of Pressure	70.33
*Static Stability	3.20/2.06		

*unload/loaded



Materials

- The rocket airframe is carbon fiber
- The nosecone is carbon fiber
- The fins are ¼” aircraft-grade plywood
- Three fins are attached through the wall to the 54 mm motor tube 1/2 inch above the aft edge of the airframe.
- The fins are fastened in place with West Systems 2-part epoxy resin and reinforced with a fiberglass inlay across the inside.

Design Features

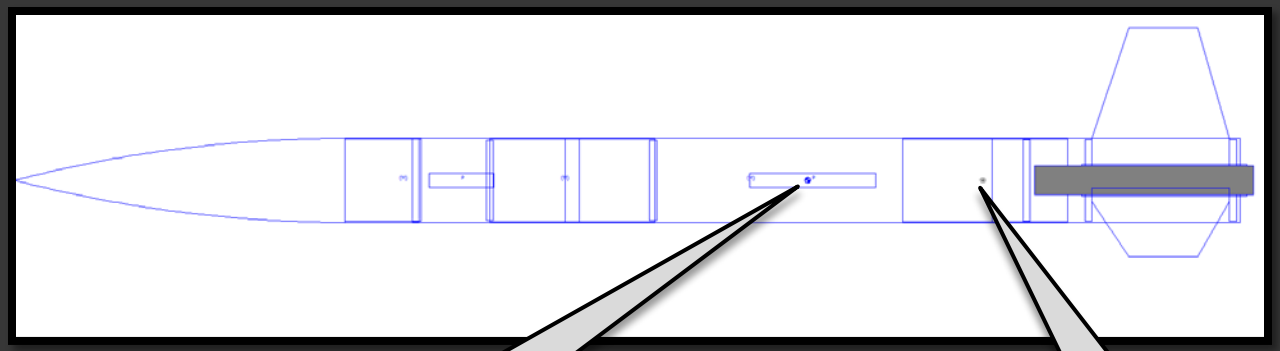
- Water resistant rocket.
- Very lightweight rocket for our engineering project
- Carbon fiber had the best qualities over fiberglass and Blue tube
- Payload is a multirotor (quadcopter) vehicle that will tow rocket back to launch pad

Motor Selection & Justification

Cesaroni Technology Incorporated (CTI) Pro54 K445 Classic

- Motor has enough thrust to get the rocket safely off the launch rail.
- Motor has enough thrust to achieve the predicted altitude.

Static Stability Margin



Center of Gravity
57.60

Center of
Pressure
70.33

Center of Gravity	57.60
Center of Pressure	70.33
Static Stability	2.09

Stability Margin
2.09 with motor

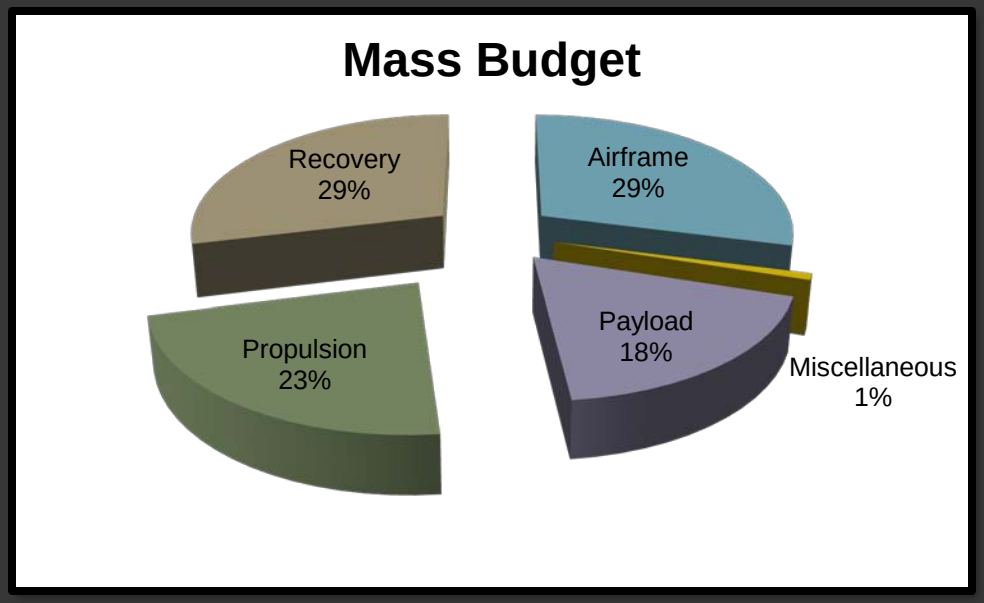
Stability Margin = (CP-CG)/Diameter

Thrust-to-Weight Ratio

Thrust to Weight Ratio = Pounds of Thrust/Weight of Salish Star

Motor	Max Thrust	Load Weight	Ratio
K445	149.453	15.3	10:1

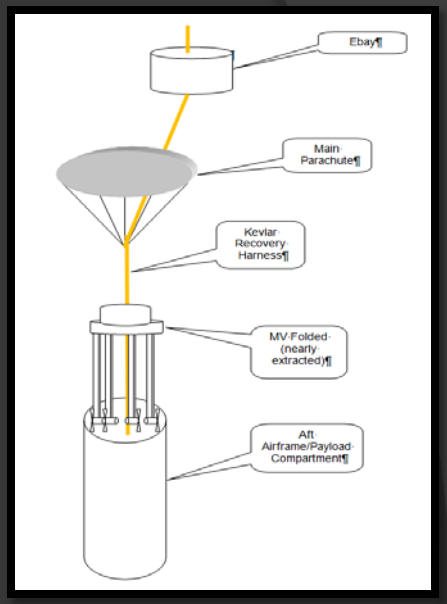
Mass Statement and Margin

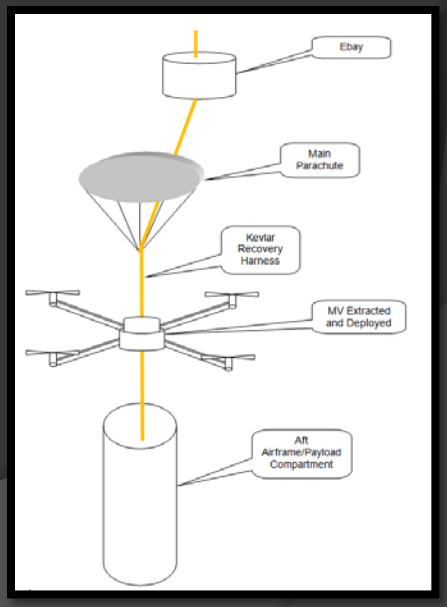


The selected motor has reserve power for up to 13 extra pounds and still deliver a safe liftoff and flight.

Recovery System (1 of 2)

	DIA.	TENSILE STRENGTH (lbs.)	WEIGHT (lbs. per 100ft.)
Kevlar	1/8"	1,500	0.650
Tubular Nylon	1/2"	2,000	2.065
	1"	4,000	4.200
Eyebolt	1/4"	500	0.090 lbs
	3/8"	1,200	0.190 lbs





- Parachute: Main: 52”
- Parachute: Drogue: 28”
- Recovery harnesses – 1/8” Kevlar with a 24” head and tail of 9/16” tubular nylon.
- Drogue harness - 24 feet long.
- Main harness - 24 feet long.
- Each harness end is connected to a 1/8” Kevlar loop with quicklinks.

Recovery System Properties (2 of 2)

Drogue Parachute				
Manufacturer/Model	Top Flite			
Size	28			
Altitude at Deployment (ft)	5,280			
Velocity at Deployment (ft/s)	0.0024			
Terminal Velocity (ft/s)	59.41			
Recovery Harness Material	Kevlar			
Harness Size/Thickness (in)	1/8”			
Recovery Harness Length (ft)	24			
Harness/Airframe Interfaces	1/8” Kevlar Loops			
Kinetic Energy During Descent (ft-lb)	Section 1	Section 2	Section 3	Section 4
	417	64	324	

Main Parachute				
Manufacturer/Model	Top Flite			
Size	50			
Altitude at Deployment (ft)	800			
Velocity at Deployment (ft/s)	59.41			
Landing Velocity (ft/s)	21.27			
Recovery Harness Material	Kevlar			
Harness Size/Thickness (in)	1/8”			
Recovery Harness Length (ft)	24			
Harness/Airframe Interfaces	1/8” Kevlar Loops			
Kinetic Energy Upon Landing (ft-lb)	Section 1	Section 2	Section 3	Section 4
	67	10	52	

Predicted Drift from the Launch Pad

Wind Speed (Kts)				
0-2	3-7	8-14	15-25	20-30
159	451	749	825	1641

Test Plans and Procedures (1of 2)

Safety Officer – Justin is responsible for ensuring that all safety procedures, regulations, and risk assessments are followed.

The Northwest Indian College Space Center has a 5000 foot waiver from the US and the Canadian aviation agencies. We can launch our rockets from 9:00 to 1300 on Friday, Saturday or Sunday.

Safety Rules and Regulations
Potential Failure Modes and Mitigation

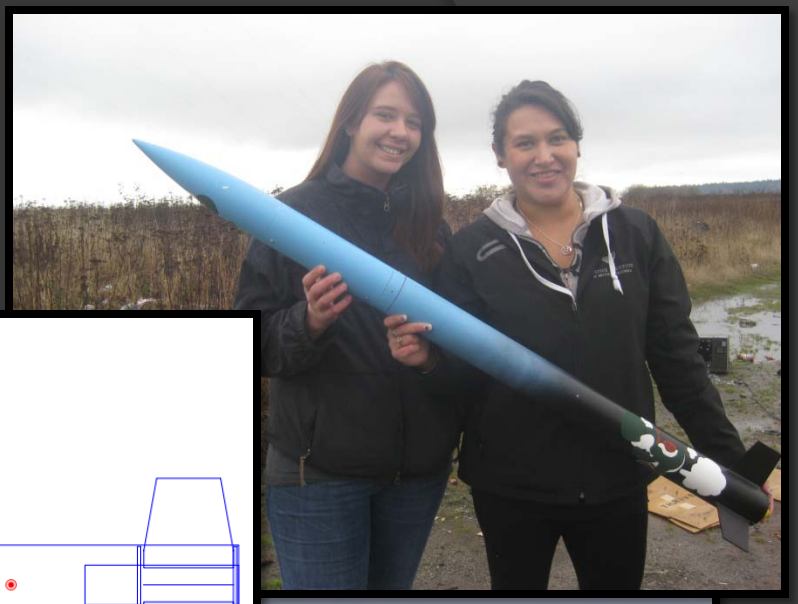
Launch Vehicle Verification (1of 2)

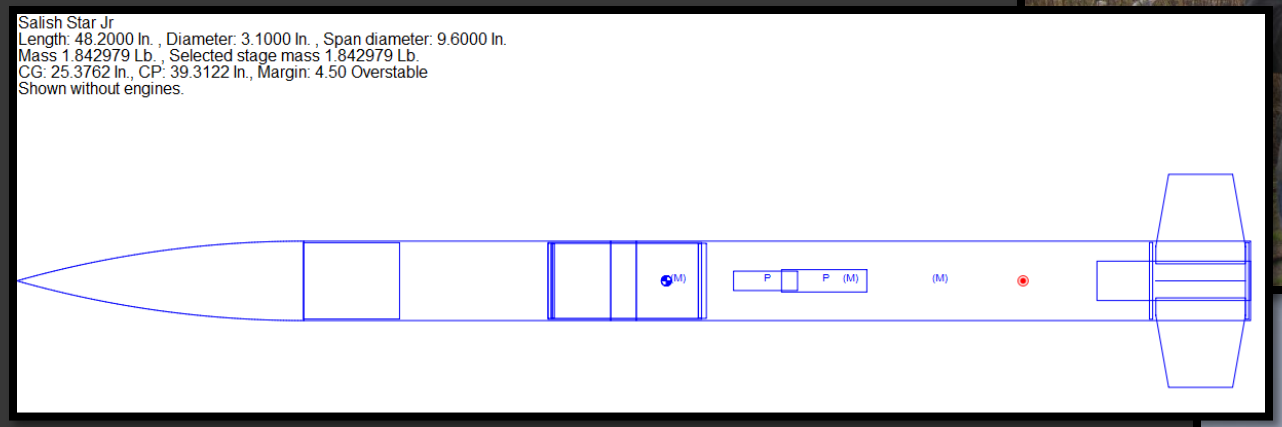
- Ground Tests
- Simulation Examinations
- Visual Inspections
- NAR Mentor Inspections
- Test Flights
- Data Analysis

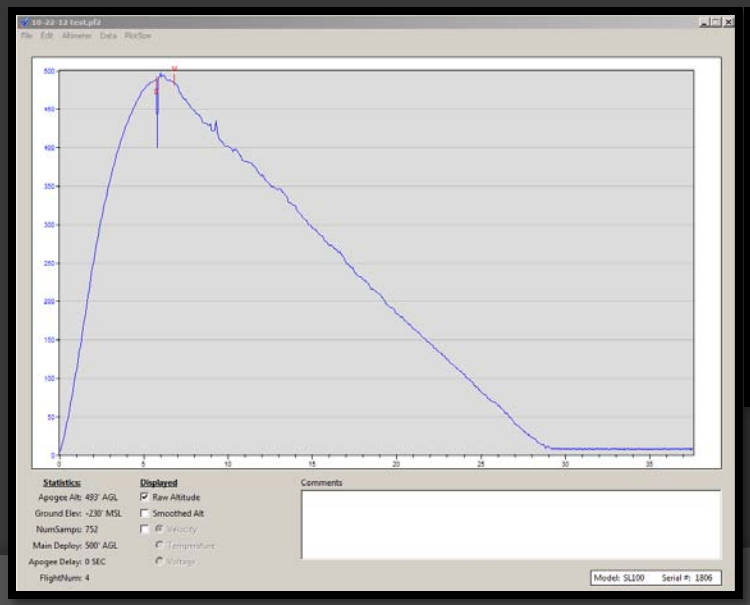
Test Plan Overview

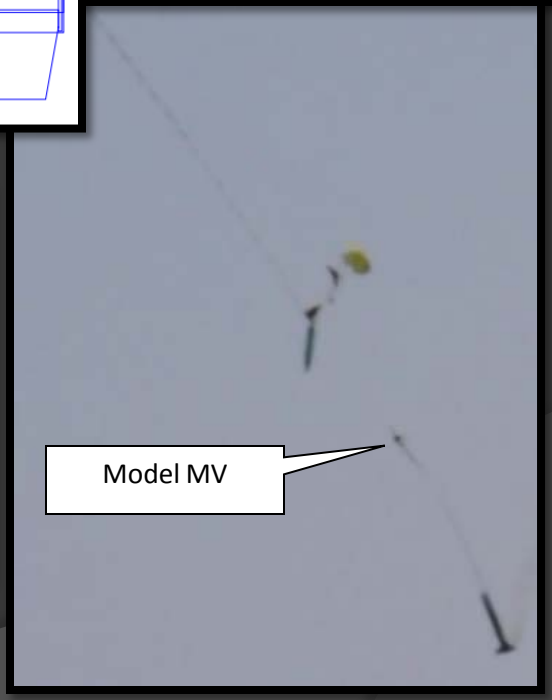
- Black Powder Ground Tests
- Avionics Inspection and Tests
- Visual Inspections
- NAR Mentor Inspections
- Scheduled Test Flights
- Data Analysis

Scale Test Flight







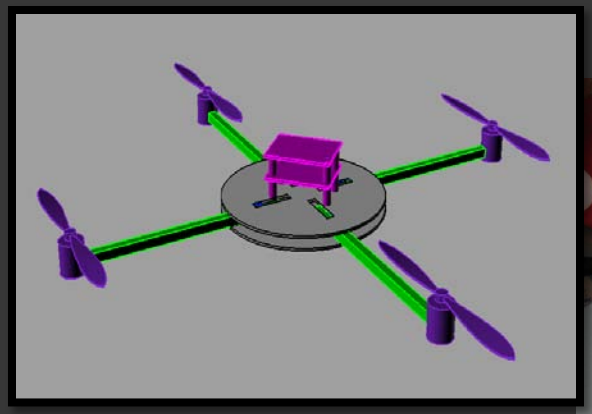


Staged Recovery System Tests

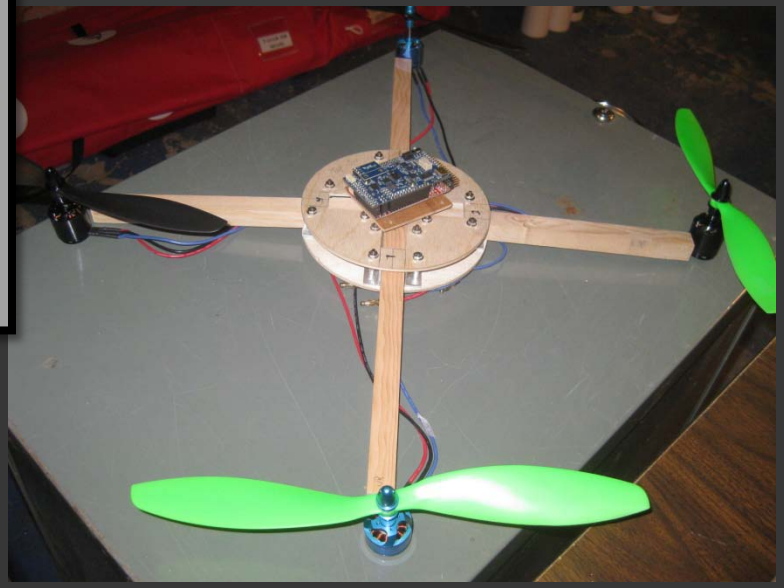
- Black Powder Ground Tests
- Manually extracted recovery system for test purposes
- Subscale Flight Test
- Full Scale Flight Test
- Manually extracted recovery system for test purposes

Science Payload

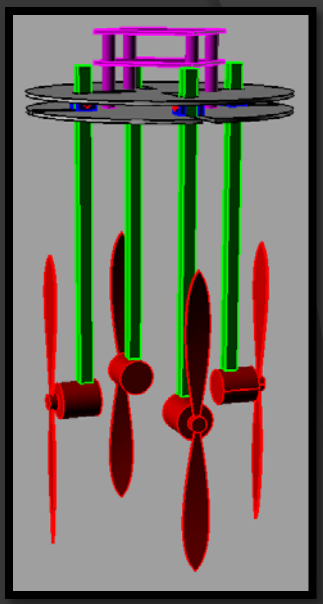
	Diameter In.	Height In.
Folded	5.75	26.00
Extended	18.00	6.00



Plan View



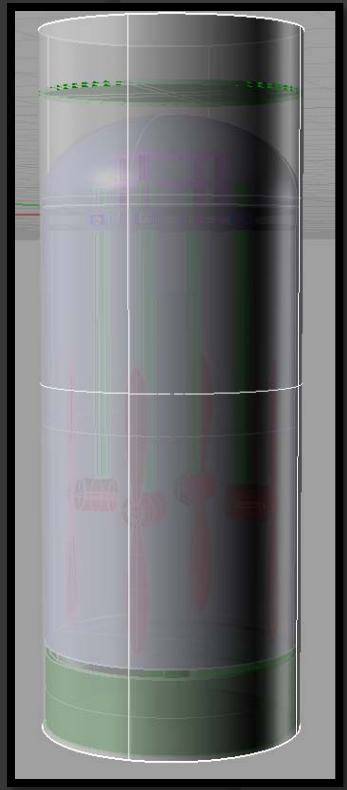
Multirotor Vehicle

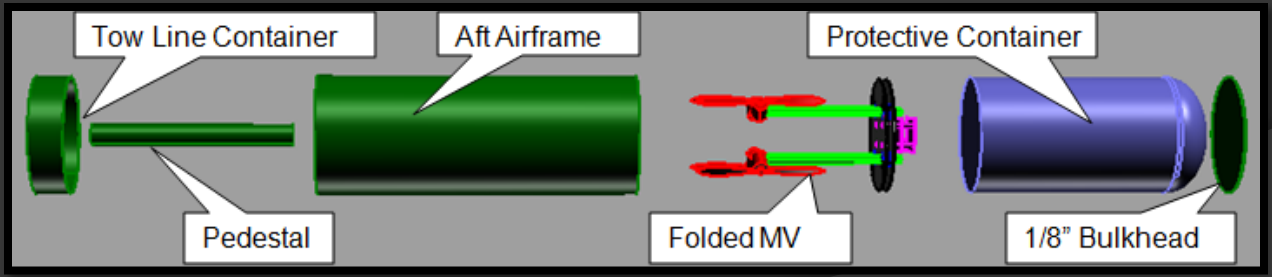


Folded View

Final Payload Design Overview

System	Subsystem	Evaluation	Verification
Fuselage	Body	Construction Inspection	Test Flights
	Arms		
Propulsion	Motors	Thrust Tests	
	ESC	Voltage tests	
	Propellers	Balancing	
Electronics	Batteries	Voltage check	
	Flight Controller	Bench testing	
	Autopilot	Bench testing	
Tow Harness	Upper Section	Ground and air testing	
	Lower Section		
	Connecting quicklinks		
RC Equipment	Transmitter and Receiver	Ground and air testing	





Payload Test & Verification

Feature	Verification Plan	Status
Construct MV fuselage	Inspection	Complete
Arm folding	Inspection	Work in progress
Motor thrust testing	Bench test	Complete
Propeller balancing	Bench test	Complete
Flight controller construction	Inspection	Complete
Flight controller testing	Bench test	Complete
Autopilot construction	Inspection	Complete
Autopilot testing	Bench test	Work in progress
RC Testing	Flight tests	Work in progress

Payload Test Plan

- Test each component as it's built
- Gather baseline data for each component
- Integrate one component at a time and verify it's functioning satisfactorily
- Ground test entire system
- Flight test payload

Interfaces

- Constructed of lightweight carbon fiber
- Permanent Joints Connected with West Systems Epoxy
- Temporary Connections Fastened with 10-54 T-nuts and Screws
- Ebay Fastened with #2-56 Nylon Machine Screws acting as shear pins

Requirements Verification Status

Requirement	Design Feature	Verification	Status
2. The launch vehicle shall deliver the science or engineering payload to, but not exceeding, an altitude of 5,280 feet. above ground level (AGL). One point will be deducted for each foot achieved below the target altitude. Two points will be deducted for each foot achieved above the target altitude. Any team whose vehicle travels over 5,600 ft. according to their competition altimeter will be disqualified from being able to receive the overall competition award and will receive a score of zero for the altitude portion of their total score.	Design through Rocksim 9, Power Management System	Test	Work in Progress
a. The official, marked altimeter is damaged and/or does not report an altitude after the team's competition flight.	Safe Recovery will preclude this	Inspection	Work in Progress
b. The team does not report to the NASA official designated to record the altitude with their official marked altimeter by 5:00 pm on the day of the launch.	Check list will preclude this		Work in Progress
11. The launch vehicle shall be capable of being prepared for flight at the launch site within 2 hours, from the time the waiver opens.	Designed as required	Check lists	Work in Progress
12. The launch vehicle shall be capable of remaining in launch-ready configuration at the pad for a minimum of 1 hour without losing the functionality of any onboard component.	Battery power calculated to last at least 2 hrs for each device using a battery	Simulation analysis	Work in Progress
15. Data from the science or engineering payload shall be collected, analyzed, and reported by the team following the scientific method.	Data analysis will be examined post flight	Testing will follow payload completion prior to the competition flight	Work in Progress
18. The total impulse provided by the launch vehicle shall not exceed 5,120 Newton-seconds (L-class). This total impulse constraint is applicable to any combination of one or more motors.	Designed as required, L motor largest permissible	Inspection	Complete

Requirements Verification Status

19. All teams shall successfully launch and recover their full scale rocket prior to FRR in its final flight configuration.			
a. The purpose of the full scale demonstration flight is to demonstrate the launch vehicle's stability, structural integrity, recovery systems, and the team's ability to prepare the launch vehicle for flight.	Test flights scheduled prior to FRR	Test flight	Work in Progress
b. The vehicle and recovery system shall have functioned as designed.	Extensive ground testing where possible, test flights for the vehicle		Work in Progress
c. The payload does not have to be flown during the full-scale test flight.			

Requirements Verification Status

e. The success of the full scale demonstration flight shall be documented on the flight certification form, by a Level 2 NAR/TRA observer.	Our mentor and 2 other NAR L2 individuals are available	Test flight	Work in Progress
f. After successfully completing the full-scale demonstration flight, the launch vehicle or any of its components shall not be modified without the concurrence of the NASA Range Safety Officer.	No changes will be made.		Work in Progress
22. Students on the team shall do 100% of the work on the project, including design, construction, written reports, presentations, and flight preparation with the exception of assembling the motors and handling black powder charges.	Implemented as required	Inspection	Work in Progress
24. The maximum amount teams may spend on the rocket and payload is $5000 total. The cost is for the competition rocket as it sits on the pad, including all purchased components and materials and the fair market value of all donated components and materials. The following items may be omitted from the total cost of the vehicle:			In Progress