Northwest Indian College Space Center

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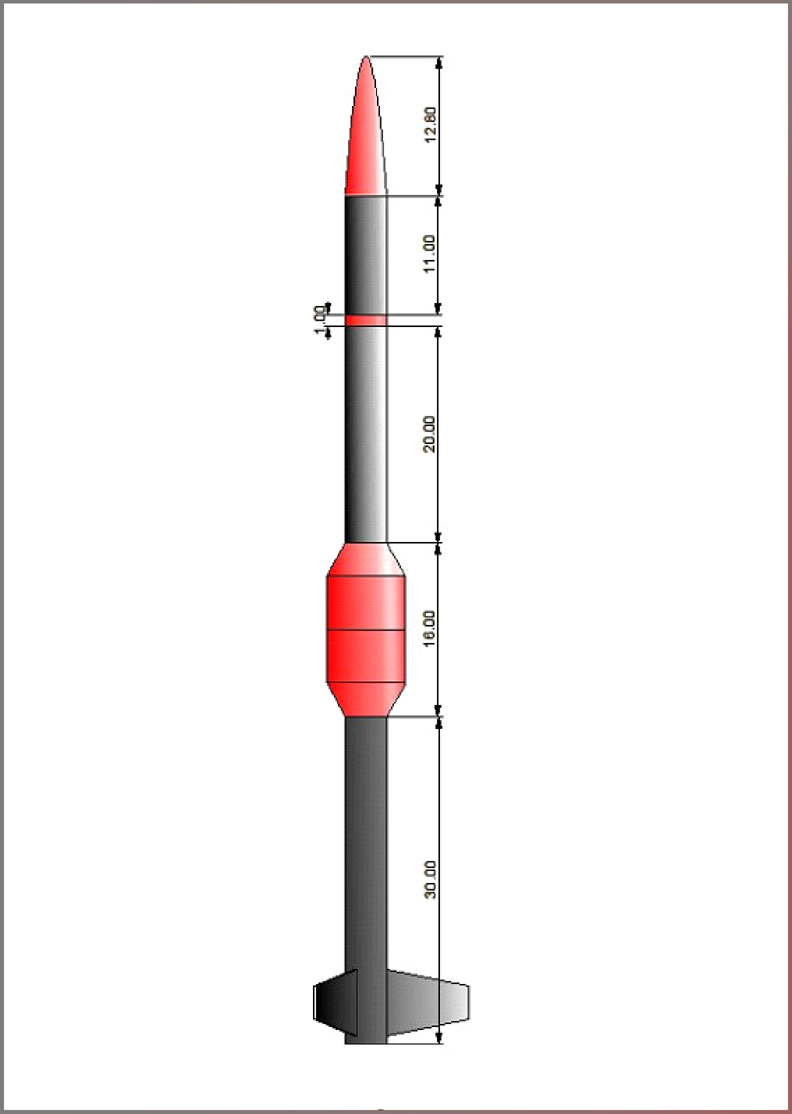
RezRiders

Mission statement

Through the USLI program the Northwest Indian College Space Center’s RezRiders Team enhances its involvement in science, math, engineering and technology and encourages others in Tribal communities to do the same.

Initial Vehicle Dimensions, Materials and Justifications

Dimensions and Materials



<u>Materials</u>
Nose cone: Polystyrene
Body tube: Phenolic cardboard
Transitions: Fiberglass
Fins: Plywood

These materials & parts are easily attainable and the parts are industry standard.

Static Stability Margin

Static Stability Margin
(with motor)

Center of Gravity	Center of Pressure	Static Margin	Length	Weight	Span
57.46	75.99	2.42	90.8	19.51	20

Plan for Vehicle Verification and Testing

Verification Plan and Its Status

We've adapted our Schedule and Time Line to reflect anticipated difficulties.

Mission	Criteria as of 11/19	Completion or Test Date	Data Recovery %	Success %
Scale rocket	Complete	10/20	N/A	100%
Scale rocket flown	Yes	11/6	N/A	100%
Altitude prediction	3000'	11/6	100%	72%
BP test	Eject drogue & main	11/3	N/A	100%
GPS tracker test	Track rocket	11/6	100%	100%
Competition rocket built	90% complete	11/19	N/A	
Competition rocket launch		11/30	N/A	
Competition altitude prediction	3000'	11/30		
Photography	Capture images	11/6	100%	100%
Photos properly oriented	98% vertical	1/15		
Competition rocket launch	Competition motor	1/15		
Altitude prediction	100%	1/15		
Prototype science modules built	50%	1/29		
Prototype science module tests	50%	1/29		
Actual science modules built		2/15		
Actual science modules flight tested				
Competition rocket launch	Competition motor	1/29		
Altitude prediction	100%	1/29		
Competition rocket launch	Competition motor	2/19		
Altitude prediction	100%	2/19		
Competition rocket launch	Competition motor	3/12		
Altitude prediction	100%	3/12		

Initial Motor Selection, Justification & Thrust to Weight Ratio Determination

Motor Selection and Justification

Newtons	Pounds	Ratio	Motor	RockSim Altitude	Lift Off Velocity
862.878	193.983	12.958	K828FJ	6195	67.2
1066.155	239.681	16.011	K1275R	6251	80.1
430.600	96.803	6.466	K375NW	6504	73.1
545.300	122.588	8.189	K480W	6764	57.6
635.592	142.887	9.545	K700W	6815	64.3

All of the above motors meet the minimum thrust to weight ratio and have the necessary total impulse to reach the competition altitude as determined by RockSim. The ratio was derived with this formula:

Thrust-to-Weight Ratio = Pounds of Thrust / Weight of RezRider

We have chosen the Aerotech K1275R for our initial flight

Plan for Motor Safety Verification and Testing

Motor Safety Verification and Testing

- Using RockSim and OpenRocket, several motors were analyzed and considered for use
- All are Areotech K impulse motors
- All of our potential motors are commercially produced
- The primary considerations for the motors were the average thrust and total impulse
- The average thrust was used to determine if the motor would provide the necessary thrust to weight ratio for stable flight
- Once that was determined, a motor was tested in RockSim and OpenRocket to find the predicted altitudes
- Test launches will be used to refine the motor selection

Baseline Payload Design

Payload Criteria

Payload Integration

- Easily integrated with the other subsystems.
- Weight is a crucial parameter to optimize because this determines what size motor and parachutes are is needed to reach the target altitude as well as perform the science experiments.
- Each experiment is self-contained and independent of any other experiment.
- The payload is designed so that all of the components can be assembled before launch day and then can easily be installed into the rocket structure.
- On launch day fresh batteries will be checked and installed, and then the payload will be installed into the rocket.
- Screws will fasten together the upper and lower halves of the science payload bay.

Science Payload

We are conducting the NASA Science Mission Directorate's scientific payload that monitors several weather and atmospheric phenomena. We are adding two additional measurements to the required list. The measurements that we'll be monitoring are:

- Barometric pressure
- Atmospheric temperature,
- Relative humidity
- Solar irradiance
- Ultraviolet radiation

Additional Experiments

- Science payload bay temperature
- Rocket roll detection and measurement

Payload

- **Primary Mission:** The measurements shall be made at least every 5 seconds during descent and every 60 seconds after landing. Furthermore, surface data collection operations will terminate 10 minutes after landing. Data from the payload shall be stored onboard and transmitted to the ground station after completion of surface operations.

- **Secondary Mission:** This requires recording at least two pictures during descent and three after landing. The pictures need to portray the sky toward the top of the frame and the ground toward the bottom of the frame.

- **Methodology:** We will be dedicating a microcontroller, power supply and data logger for each sensor. Having a dedicated system for each sensor ensures that some data will be collected in the event of a single or multiple sensor malfunctions. A totally catastrophic failure is the only reason that we wouldn't be able to collect meaningful data.

- There will be a stack of four BASIC Stamp microcontroller boards and their respective data logger electronics and power supplies. The microcontroller boards are 4 x 3 x 1 inches in size. A fifth layer will support the solar irradiance and ultraviolet radiation processing units.

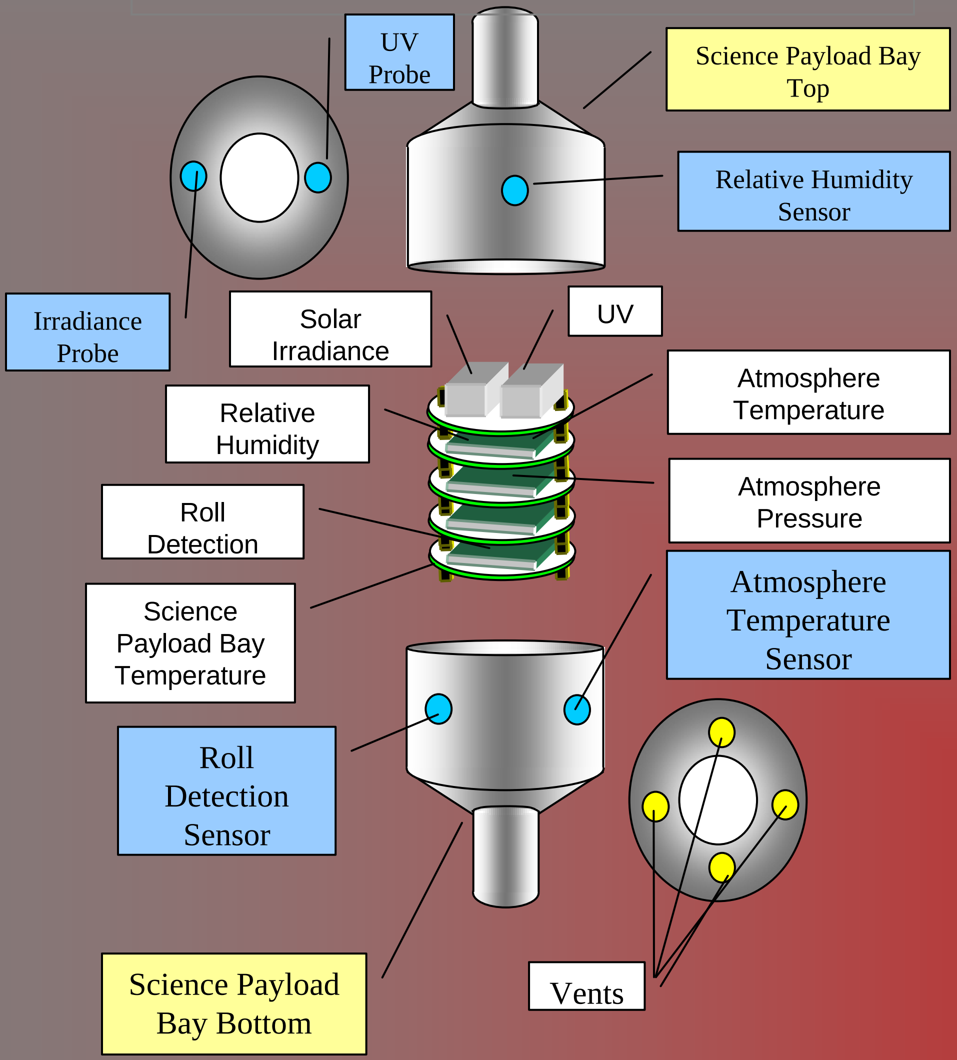
Payload continued…

- Our preliminary investigations for the design and construction of the scientific payload, indicate that the payload bay will have to be 7.5 inches in diameter and 10 inches long. It will have to descend as vertically as possible for some of the atmospheric measurements and for the photography. The science payload bay will be constructed from 7.5 inch diameter phenolic airframe tubing from LOC Precision and fiber glassed to provide strength and rigidity. The payload bay will be separated into two parts for ease of access to the components. The two halves will slide over a 7.5 inch airframe coupler and secured with self-tapping screws. Fore and aft transitions from the 7.5 inch payload bay to the 4 inch rocket air frame will be 3 inches in length. This will provide sufficient room for the solar irradiance and the ultraviolet probes to be mounted in the forward transition in order that they have a higher probability of maintaining an attitude in the direction of the sun. Both the drogue and main parachutes deploy above the science payload bay thus ensuring a vertical orientation.

- Vents in the bottom transition will permit atmospheric equilibrium for the barometric pressure sensor. The relative humidity, atmosphere temperature, and the roll detection sensors will be mounted vertically on the science payload bay walls..

- The Memory Stick Datalogger is a USB host bridge which creates a connection between a USB mass storage device, such as a Thumb Drive, to the BASIC Stamp microcontroller. The data can be transferred to a computer via the USB mass storage device. Each of the four BASIC Stamp controlled sensors will have a memory stick data logger and each are independent of each other.

Northwest Indian College Science Payload Bay Concept
(Click for images)



Data Recovery

- Data retrieval will take place after recovery
- The USB data storage drives will be removed from their appropriate sensor modules and the data downloaded to the team's laptop computer
- The data will be downloaded to at least two computers for data safety
- Camera data will be treated the same

Plan for Payload Safety Verification and Testing

Payload Safety & Testing

Payload is:

- Self-contained
- Securely fastened to airframe
- Monitors environmental data
- Monitors on-board data
- Ground tests and flight tests

Baseline Recovery System Design

Recovery

- Double redundant recovery system
- One PerfectFlite altimeter shall provide primary parachute deployment functionality
- Second PerfectFlite altimeter will provide secondary deployment functionality
- Single drogue parachute
- Single main parachute
- Separate set of ejection charges
- Separate electrical system
- Each set of ejection charges are to be ignited in sequence, with a short delay (~1 second) between ignitions

Altimeter Electronics Bay

- 2 PerfectFlite MAWD altimeters for redundant dual deployment
- 2 9v batteries provide independent power supply
- Its weight is 22 ounces with the electronics

Recovery Criteria

We want the science payload to remain as vertical as possible during the recovery phase. Therefore both the drogue and the main parachutes will be deployed forward of the payload bay. The drogue will follow the ejected nose cone and the main will follow the ejected upper airframe section. Preliminary descent rates are 56 fps and 19 fps for the drogue and the main respectively. The next slide illustrates the results of the parachute calculations based upon descent rates.

Parachute Calculations

Calculation Results for Main Parachute at **19 fps (CD=1.5)**

Size	8.5	feet
	102	inches
Shroud Line Length	133	inches
Area	26.86	square feet
	3868.3	square inches

Calculation Results for Drogue Parachute at **56 fps (CD=1.5)**

Size	3	feet
	36	inches
Shroud Line length	47	inches
Area	3.35	square feet
	481.9	square inches

Plan for Recovery System Safety Verification and Testing

Black Powder (BP) Ejection Charge Determination

Factors that affect the amount of BP that will be needed:

- Diameter of airframe (base of nose cone)
- Volume of parachute chamber
- How tightly parts (airframe/coupler) fit
- Leakiness of the airframe

The ejection charge equation is:

$$Wp = dP*V/R*T$$

Where:

dP is the ejection charge pressure in psi

R is the combustion gas constant, 22.16 (ft-lbf/lbm R) for FFFF black powder (Multiply by 12 in/ft to get in terms of inches)

T is the combustion gas temperature, 3307 degrees R for black powder

V is the free volume in cubic inches. Volume of a cylinder is cross section area times length L, or from diameter D, V=L*p*D2/4

Wp is the charge weight (mass, actually) in pounds. (Multiply by 454 g/lb to get grams)

BP & Recovery Verification Test

- Ground testing can reveal the minimum amount needed under ***ideal conditions***
- Usually best to not fly with the minimum amount of BP that works under ***ideal conditions***
- Multiple black powder ejection charge tests prior to flying the scale model
- Used 1.9 grams of black powder for the main parachute ejection charge
- Used 1.1 grams for the drogue separation charge
- Successful separation for both ground tests and actual flight
- Parachute bays are secured to the ebay subsystem by two #2-56 nylon screws acting as shear pins
- Literature indicates that each screw has a breaking strength of 25 pounds (50 pounds total) which is well under the calculated ejection force for the main and drogue ejection charges