Flight Readiness Review Report

I) Summary of PDR report

Team Name: The Rocket Men

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Mentor:

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NAR Number is 83791, Level 2 Certified

Launch Vehicle Summary

The length of the rocket is 81.95 inches, and the mass is 16.7 lbs.

Motor Choice: Cesaroni K2045 Vmax

We have a dual Deployment Recovery System with a 15 inch drogue parachute and a 72 inch main parachute.

Milestone Review Flysheet - separate document that is on the website

Payload Summary

Payload Name: Heliacal Sky

In the experiment we will have a solar panel array deployed from the rocket at apogee. The data logger will be measuring the current gathered by the solar panel while it is descending. It will continue to record data until it contacts the ground, where the change in current will stop. From the data we get, we will look for a correlation between energy and height. We hope to find a mathematical equation that compares height to solar efficiency.

II) Changes made since the CDR

Changes made to Launch Vehicle

The most important change made to the rocket, was that we added a 1.5 inch ring around the Electronics Bay. This needed to be done, so that the payload could fit into the back half of the rocket. Since our shock cord material is so thick, it took up excess space in the back half of the rocket that was not planned to occupy. As a result, we had to add the ring below, the already 1 inch ring that was in the center of the Electronics Bay. After adding this 1.5 inch ring around the Electronics Bay, there is still enough of the Electronics Bay in the back half of the rocket to give us safe and good flights. We have tested this already in the launch setting, and our rocket did much better than it did before, without the ring.

Changes made to Payload

There was one major change made to the payload based on the materials that were ordered. The payload’s orientation in the rocket changed. When we received our acrylic tubing, it was too large. As a result, our payload is now in line with the shock cord, as opposed to its perpendicular orientation like it was before. This is advantageous for the stability of the rocket. The payload is also less likely to tangle within the other components of the rocket.

Changes made to Project Plan

Although we have gone over our proposed budget, we have also funded more than we expected. People have generously donated to our group, and have supported us through our project. As we get growing support in the community, we have also gotten more opportunities, such as being invited to the Lion’s Club Dinner. This is important to the team, to build a bond with the community, since they are the ones supporting us through our project. Our schedule has also changed. Our rocketry workshop has been pushed back to the end of March due to full-scale rocket construction. We also still need to have at least one more launch before we go to Huntsville, to ensure that our rocket is safe and ready, and that we get some good payload data.

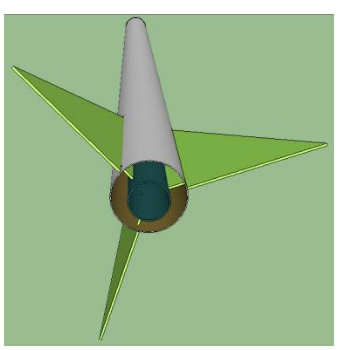
III) Vehicle Criteria

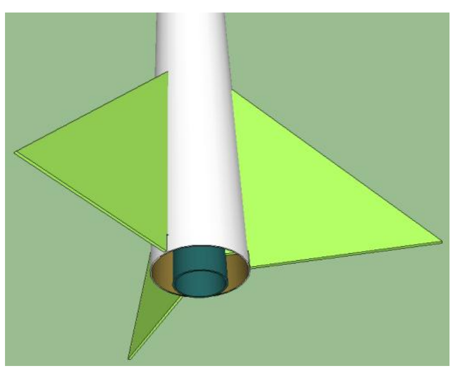
Design and Construction of Vehicle

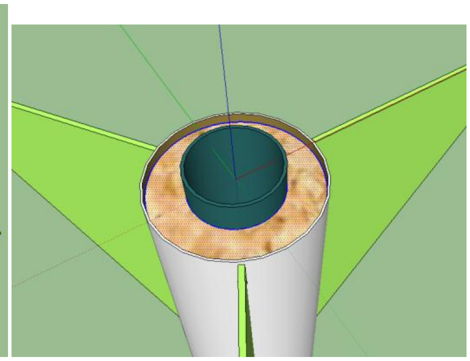
- Description of the design and construction of the launch vehicle
  - Structural Elements

The airframe of the rocket is constructed from Public Missiles Ltd. fiberglass-wrapped phenolic tubing. The phenolic tubing inside the fiberglass wrap is a resin impregnated, spiral wrapped, heat cured tube, which in itself is somewhat robust. With the addition of the fiberglass to the outside of the body, the rocket becomes a very resilient component to the rocket, capable of handling the normal stress encountered by the rocket. The tubing comes already prepared from the manufacture, Public Missiles Limited, providing less of an inconvenience to the team in its preparation.

The fins on the rocket are made from 1/8" G10 FR4 Fiberglass epoxy sheets. The sheet is a glass-cloth reinforced with epoxy to make it much more robust. The fiberglass absorbs next to no moisture at all and has great dimensional solidity as it does not change much with temperature. The epoxy resin binder in the case of this material is self-extinguishing, making the fiberglass flame resistant, and nice fit around the motor that burns so hot. The fins are attached to the rocket with as many contact points as possible. To maximize the surface area to bond the fins to the rocket, fin tabs were used, which protrude into the body of the rocket and allow for a total of six epoxy fill-its to be placed on each fin to reinforce the fins and make sure that the rocket is completely recoverable with little to no damage. Another method that we have used to maximize the bonding surface for the fins to the rocket is a rough sanding on both the fins where they were attached to the rocket body and on the rocket body near where the fins would be attached.

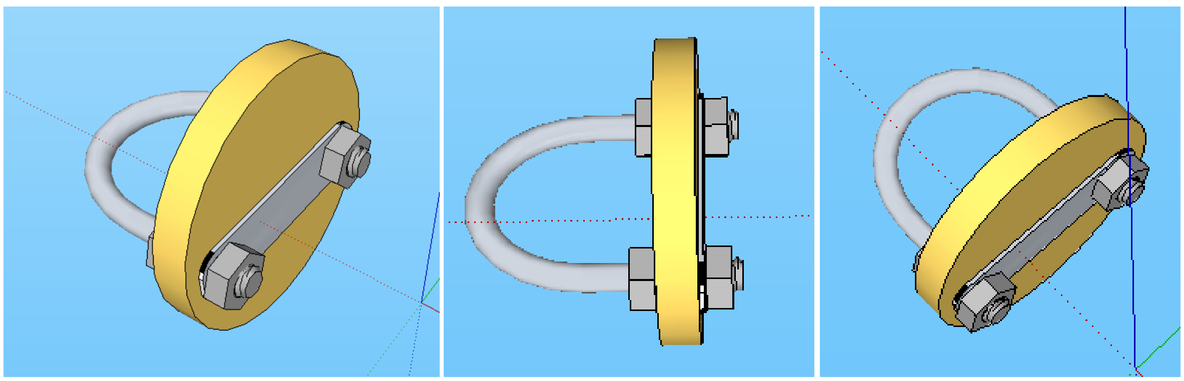




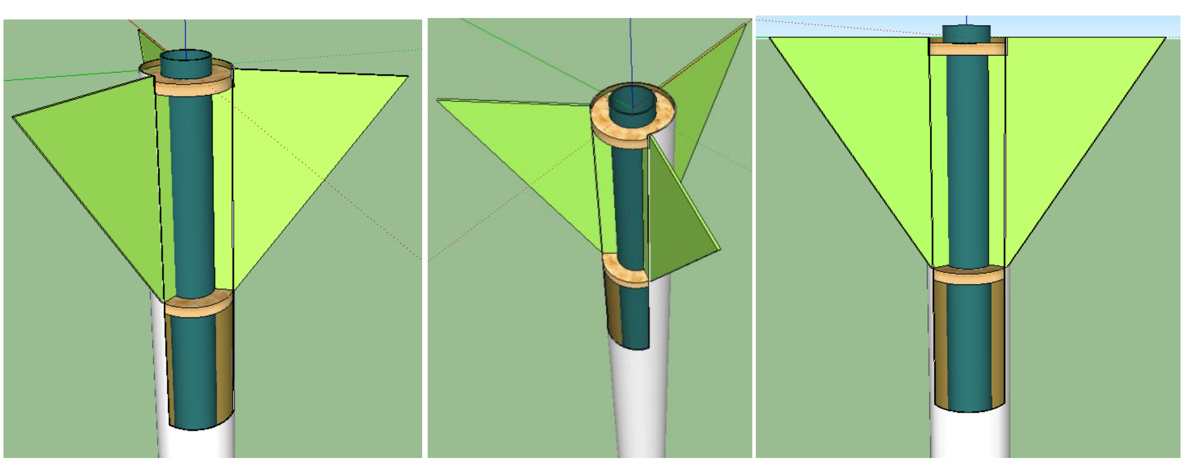


The bulkheads that we are using inside the rocket are made from ½" plywood and were cut out on a CNC router for precision fit into the rocket. The bulkheads were then sanded around the outer edge and the inside of the rocket was sanded where the bulkheads were being placed, in order to ensure that the epoxy would create a better bond between the rocket and the bulkheads. The epoxy was placed as best as possible on both sides of the bulkheads and between the bulkheads and the inside wall of the rocket.

The U-bolts in the rocket are made from 5/16 inch stainless steel. They are attached through the bulkheads and secured on the other side with a reinforcement bar and two nuts that have been attached with epoxy to the threads. The metal bar on the back side helps to distribute the force on the U-bolt across the bulkhead to ensure that the U-bolt does not simply rip through the bulkhead.



The centering rings are a major component to our rocket, as they must be able to keep the strong force of the K2045 Vmax motor from pushing up through the rocket and play another role as a fin support. The centering rings are positioned directly above and below the fin tab, keeping the fin from rotating and breaking off. There is epoxy both above and below the forward centering ring (the one just above the fin tab), and about ¼" of epoxy below the aft centering ring to ensure that it does not come out. There is little to no epoxy above this centering ring, as it was very difficult to put epoxy on that side, because the aft centering ring closes off the motor mount bay.



- Electrical Elements

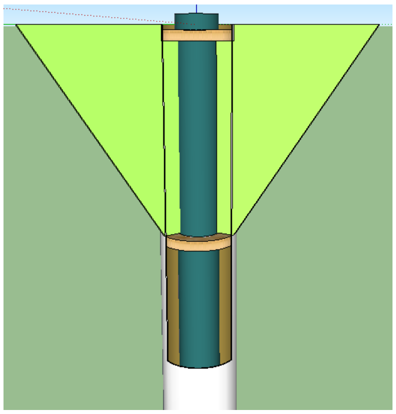
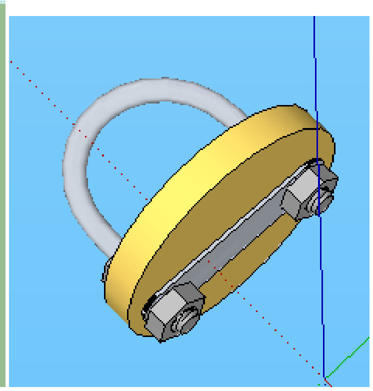
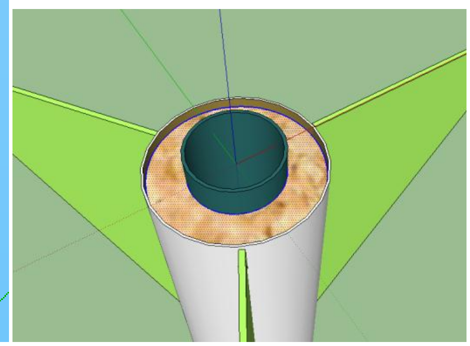
The wiring in the electronics bay is a very simple setup. There are two altimeters in the e-bay to coincide with the redundancy of the recovery system. Both altimeters are connected to a 9 Volt battery power supply. A positive or negative wire leads from its corresponding port on the altimeter down to the 9 Volt batteries resting on the bottom of the bay. From there, another wire leads from the opposite lead on the battery terminal to a terminal on the key switch. The circuit continues through the key switch, as another wire is fastened onto the other lead on it, and leads back to the other lead on the altimeter. All wires in the electronics bay have been made long enough to make the altimeter sled removable, and the side of the e-bay housing the batteries removable to make accessing the batteries easier and more efficient. The wire we used on the e-bay of one rocket was 18-gauge stranded wire, and on the spare electronics bay we used 22-gauge stranded wire. As we learned, the stranded wire makes removal and installment of the altimeter sled quicker, and also prevents leads from breaking off under the stress of removal and insertion. The other wires in the electronic bay are for the ejection charges. From both altimeters, these wires lead directly to their corresponding terminal strip (the drogue wires leading to the terminal strip for the drogue chute ejection charges, and the main chute wires leading to the terminal strip for the main chute ejection charges.

The key switches that we are using are from Aerocon Systems, and they are Key Switch Type 2. We started out by using Key Switch Type 3, but we found out that Key Switch Type 3 was not durable enough to use continually. The shell of it is made of plastic, which caused leads to break free. Also, when we were soldering wires onto the key switches, the plastic melted too easily, and the leads started pulling out from the switch. Instead, we started using Key Switch Type 2, which is encased in more metal, and creates a more durable arming switch for our altimeters.

The batteries in our electronics bay are attached with a plastic casing that the 9 Volts snap into. The plastic casings have been attached with epoxy upside-down on the bottom of the E-bay. By upside-down, we mean that the leads for the battery are on the underside, so that when the rocket takes off, the battery is forced down onto the leads. This battery casing also allows for easy removal and insertion of a battery after every test flight, as the batteries must be swapped every time to ensure that they have enough power to fully set off the igniters.

The attachment of the altimeters to the sled is a very crucial configuration to ensure that none of the altimeters shear off during flight. The attachment hardware for the altimeter to the sled is broken up into three pieces. The first two pieces attach the hardware for mounting to the sled, and the last piece just screws through the holes in the altimeter to attach it to the mounting hardware. The two pieces that get mounted directly onto the sled are comprised of a nut and a screw. The screw comes through the back side, up into a nut. Then, we secured the screw by tightening it and coating over the head of it with some epoxy. The last piece of the attachment hardware (the piece that directly attaches the altimeter to the mounting hardware) is just placed through the holes in the altimeter and the screw is tightened to prevent it from falling off. This method of attaching altimeters allows for a strong connection of the altimeters to the sled, while keeping it in a configuration that allows altimeters to be swapped out if needed.

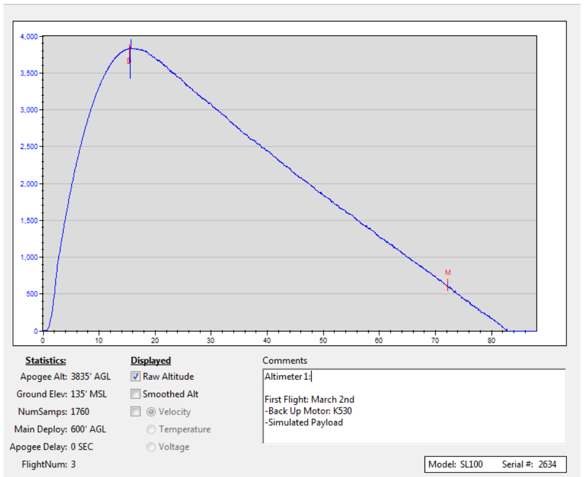
- Drawings and sketches

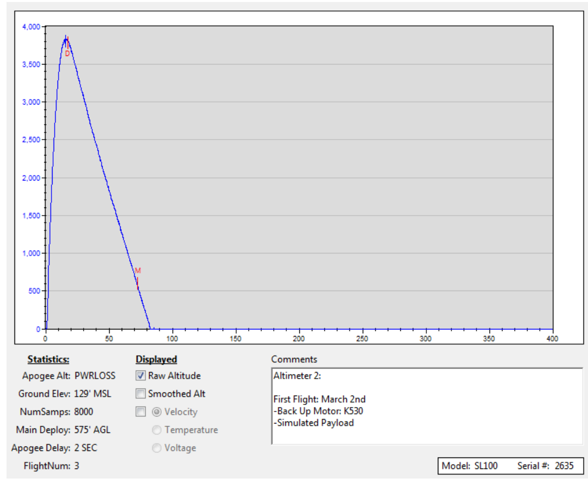




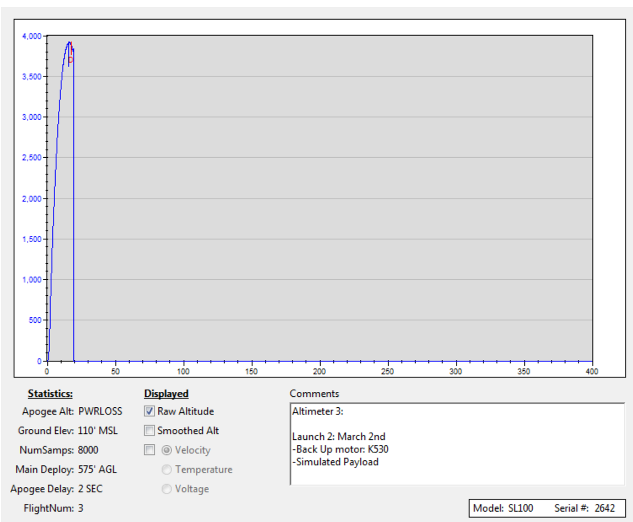
- Flight Reliability Confidence

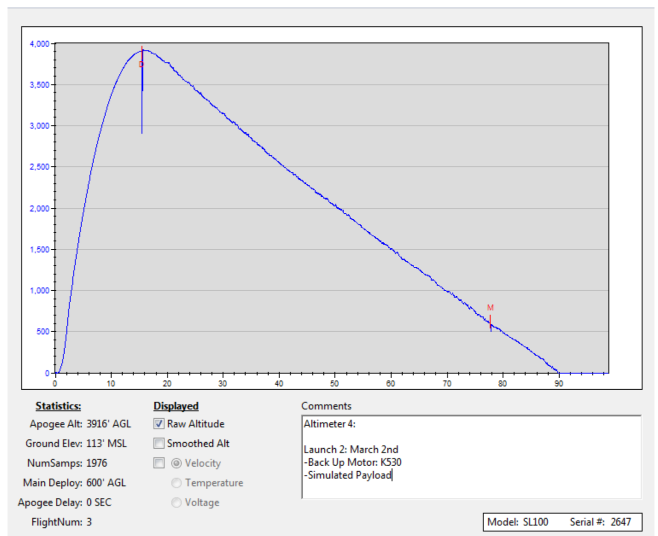
The rocket was launched twice on March 2nd . Both times the main rocket was launched, the main parachute failed to come out of the rocket, and just stayed lodged within the rocket. We concluded the parachute was not packed in a tight enough wrap to fit loosely within the rocket. With a little more research, we were able to determine a more tight packing technique which would work. The technique included wrapping the shroud lines around the chute, which concerned us that the parachute may not unwrap. Instead, we tested the folding technique by running with the parachute. The parachute unraveled within about twenty feet of where it began. Repeated tests showed that the technique would be effective for use in the full-scale rocket. On March 17th, the rocket flew successfully three times, with a main chute deployment every time, fulfilling the requirement of a recoverable and reusable rocket. Out of six total full-scale rocket launches, all flights have been stable and straight, leaving the team confident in their design and confident that the rocket will perform reliably. After launching the rocket, it’s clear that the rocket will not be able to meet the height requirement set forth the Statement of Work due to a large increase in mass from the rocket file. A test of ejection charges yielded that we should be using 1.5 grams of black powder to separate the rocket with two shear pins on each side of the e-bay.

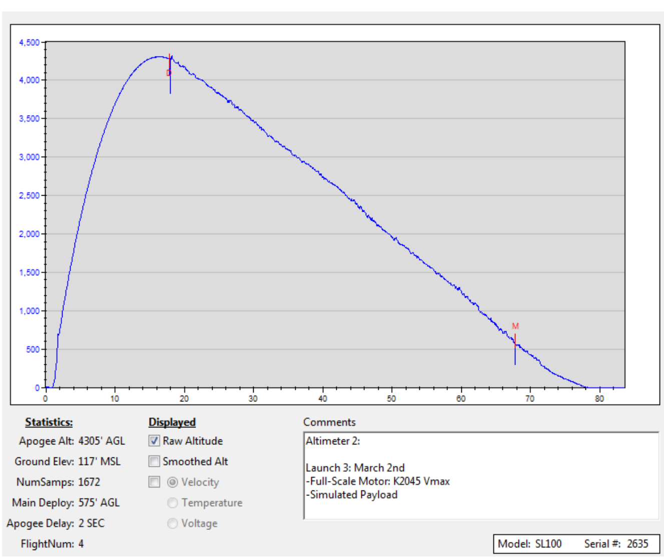
- Test Data and Analysis











The flight data above represents the altitude vs. time graphs of the first few launches. These launches were conducted before parachute problems were resolved in the rocket. Therefore, the slope of the graph does not change after the main chute deployment. This is a major concern, as it is what ultimately led to the destruction of the back half of one of our rockets. Once the parachute problems were resolved, however, the rocket landed more gently, therefore the slope of the altitude vs. time graph flattened out. Many components of the rocket were tested in the full-scale test flight, such as the integrity of the motor retention system, the fins, and the airframe. The motor retention subsystem seems to be structurally sound, as it did not get damaged during flight, or even when the rocket crashed into the ground with just a drogue chute. The fins are structurally sound during flight, however, when the main chute failed to deploy, and the rocket hit the ground, it fractured the epoxy fill-its on the outside of the fins. The fins were still attached though, despite the impact. The airframe proved to be the weakest component of the rocket. During flight, the back half of the rocket has a tendency to get partially torn by the shock cord in a zippering effect. This could possibly be because of altimeters firing too close together, and causing the parts of the rocket to fly apart too fast and zipper the back half.

- Workmanship

The team has already built three rocket back halves and two rocket front halves. They were able to systematically replicate parts to receive similar flight results. The team is able to work efficiently and quickly to construct pieces of the rocket. So far, the team has also been able to fix any problems that have arisen so far, such as the major problem of integrating the parachute into the rocket. The team is dedicated to their work on the rocket, in order to perfect a flight. They repeat procedures that lead to good results, and all take part, somehow, in preparing the rocket for flight. All of these qualities of the team are what make them so successful in their goal of achieving mission success.

- Safety and Failure Analysis

Failure Modes	Causes	Effects	Mitigations
The main parachute fails to deploy	-The parachute is too large for the diameter of the rocket -The parachute is not packaged in the most efficient method possible and gets stuck in the rocket	The rocket hits the ground with only the drogue chute to slow it down. The rocket is either damaged with minor fractures, or is damaged beyond repair.	Research methods for folding the main parachute, and what sizes fit which tubes. Practice folding several different ways to see which one works the best.
The rocket zippers	-Both altimeters deployed their ejection charges at around the same time. -The shock cord isn't long enough and isn't absorbing enough shock. -The structural integrity of the body tube is too weak.	The rocket part damaged by the shock cord must either be trashed and rebuilt, or fixed in a way that it doesn't not leave the rocket in a state of major structural vulnerability.	Try using a longer shock cord if you can, or spread out the delay on the one altimeter from the other, so that they do not interfere with each other.
The main chute deploys before it is supposed to.	-The shear pins were not strong enough. -Not enough shear pins were used. -The ejection charge for the drogue chute was too strong	The rocket drifts out of the 2500 ft radius of the launch pad. The rocket causes damage to property outside of the launch radius.	Make sure that the amount of black powder being used in the ejection charges is what was tested for that many shear pins.
The rocket assumes an unpredictable, unsafe flight path	-The rocket is unstable -Launch Lugs are not aligned properly	The rocket damages property, hurts someone, or becomes damaged itself.	Use a launch rail to align the launch lugs onto the rocket. Check them when their finished to make sure they're still straight.
The payload gets lodged in the rocket and doesn't come all the way out the tube to collect data.	-The payload fits too tightly within the rocket body tube -The shock cord gets wedged between the payload and the inside wall of the rocket	No data is collected on the payload.	Drill holes below the payload in the rocket to relieve pressure.

The drogue parachute is burnt by the ejection charges	-The wadding wasn't properly covering the parachute -The altimeters fire with too short of an interval of each other, causing too much heat.	The drogue chute either provides little support on the way down, or needs replaced soon after its recovery.	Set the delay between the two altimeters to a larger interval, or find a way to keep the ejection charges from burning the chute with the wadding.
The shock cord breaks when the section containing it splits.	-The shock cord was weakened from all of its previous tests in the rocket -The Quicklink on the end of it was not closed, and it came off in flight.	Parts of the rocket fall without a parachute	

- Full-Scale Flight Data

With the full-scale motor (K2045), the rocket traveled to a peak altitude of 4305 feet. On OpenRocket, it was predicted that the rocket would go 5274 feet in a 10 mph wind, just shy of one mile. However, the rocket should have gone 5274 feet, if its final weight was 171 oz. just as it is in the rocket design program. However, our rocket ended up weighing 270 ounces, which explains the drop in altitude from the predicted height.

- Mass Report

The mass of the rocket from the OpenRocket file should have been around 171 oz. Instead, the mass of the rocket ended up at about 270 ounces, a 99 oz increase from the simulation. This 57.9% increase in mass from the simulated rocket to the real rocket is the main reason that the rocket is not flying at around 5278 feet. The increase in mass of the rocket is mainly because of the large amounts of epoxy that we used to secure the centering rings and bulkheads.

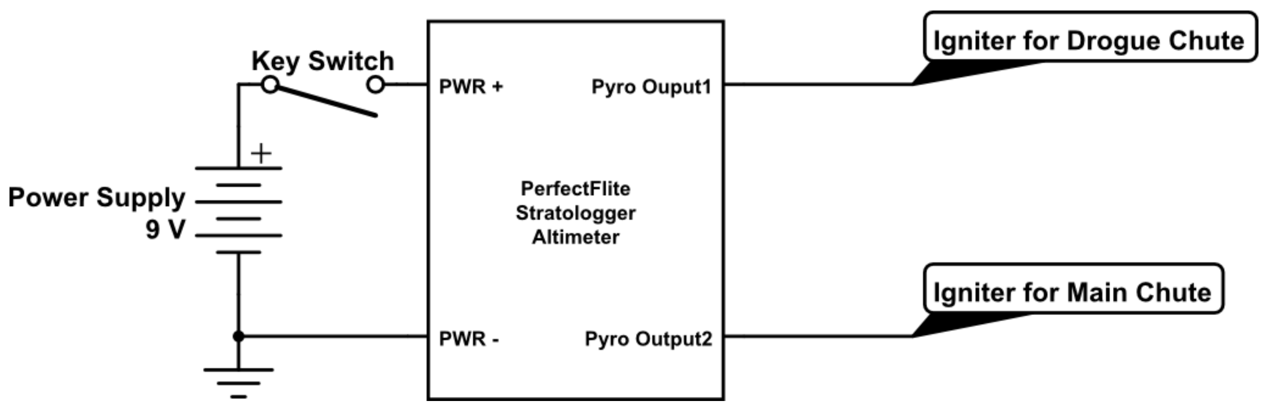
Recovery Subsystem

Our bulkheads are made out of half inch ply wood. These bulkheads are then attached by sanding the inside of the body tube. Then after being tacked into place with super glue a layer of West Systems epoxy was poured to make a solid ring of epoxy in the seam of the bulkheads and body tube. With multiple layers the bulkheads will be robust enough to withstand the forces that will act on it. A half inch of wood will not crack very easy. The chosen West Systems epoxy has a 24 hour cure time which will make it a bond that will endure the stress applied to it. Attached to the bulkhead is a U-bolt for attachment to the quick links on the shock cord. Two holes were drilled into the bulkhead; the U-bolt was then attached with two nuts. Around the nuts and holes epoxy was applied to prevent the nuts from loosening. To attach the shock cord to the U-bolts we are using .23622 inch quick links. These quick links are rated for 880 pounds of force. With the U-bolt and quick link combination our recovery attachment system will be robust enough to withstand all the stress it will undergo in the ejection process.

The PerfectFlite StratoLogger altimeters are produced by PerfectFlite. These altimeters are very well constructed. We have used them PerfectFlite altimeters before and have had no problems. The key switches chosen are attached with custom made holes from the outside of the electronics bay to the inside. The switches are placed within the holes and a nut on the inside to secure the switch. This system will keep the switches in place during flight. The battery mount leads are attached to the wires with solder then covered with potting epoxy. This keeps the wires in place and continuity. The same is done to the battery terminals. These 9-volt terminals are epoxied to the bottom bulkhead of the electronics bay so that they will not move. They are also placed there so if they were to move they stay at the bottom of the electronics bay. With all of the precautions taken into consideration the electronics bay is robust enough to withstand the needed forces and be reusable.

The electronics bay in this rocket were designed for redundancy. There are two PerfectFlite StratoLogger altimeters. Both altimeters are attached to a terminal strip where e-matches can be installed for the four ejection charges. There are four ejection charge wells on the electronics bay. There are two on the top, for the main parachute ejection and two on the bottom for drogue parachute ejection. Each altimeter will be wired to one charge for each side of the electronics bay. With this setup two ejection charges will be ignited for each parachute ensuring complete separation of the separate pieces of the rocket. The altimeters are programmed so that the charges are lit at different heights to avoid over pressurization of the rocket.

For the drogue parachute we are using a 15” parachute manufactured by Fruitychutes. It is deployed at apogee and is will slow the rocket down to a suitable speed for the main parachute to deploy at 600 feet. The main parachute is 72” Iris parachute from Fruitychutes. This was chosen because when deployed at 600 feet it will slow it down to 19.1 ft/s before landing. This is a safe speed to avoid damage to the rocket upon impact with the ground. The drogue parachute is attached to the shock cord with a quick link and that shock cord is attached to the electronics bay. The one gram of black powder is sufficient even to break apart the rocket and deploy the drogue parachute. The drogue parachute provides enough drag to pull out the remainder of the shock cord as well as the payload from the back half of the rocket. Then, at 600 feet the other set of ejection charges are fired and the main parachute is deployed. During our test launches the recovery system worked exactly as planned. The ejection charges were powerful enough to separate the rocket. The main parachute was also large enough to slow the rocket so the rocket withstood no damage and all pieces are fully reusable.



The transmitting device is a Radio Controlled Airplane ELT System, produced by Communications Specialist Inc. The operating frequency we are using is 222.270 MHz. The 25 millisecond pulse generally will not be picked up by conventional FM transceivers. This model covers frequencies from 222.000 to 224.990 MHz in 10kHz steps.

The recovery system is not very sensitive to transmitting devices that would create an electromagnetic field. The only electronics in the electronics bay are the two altimeters. They are not sensitive to the field for they use a pressure difference when detecting things such as apogee and height for drogue shoot deployment.

Safety/Failure Risk	Cause	Effect	Risk Mitigation
Parachute does not deploy	Ejection charge not fired, parachute not properly packed	Rocket will come down too fast, mild to serious damage to rocket	Follow proper folding and packing techniques and ensure altimeters work properly
Rocket not fully separated	Ejection charges not lit, not powerful enough	Rocket will come down too fast, mild to serious damage to rocket	Test black power charges before launches, test for continuity in altimeters to ensure charges will be set off
Ejections charges do not fire	Current not sent through ematches	Parachutes do not deploy, rocket does not separate, minor to serve damage to rocket	Test for continuity in the altimeters before filling charges, test the altimeters with the packaged computer program
Wires in electronics bay break	Too much use, bending wire in unnatural directions	Wires must be replaced and time is lost	Use stranded wire, keep wires tidy
Rocket over pressurized by the ejection charges	Both ejection charges set off at the same time, too much black powder	Serious airframe damage, damage to electronics bay and recovery aspects	Stagger the fire height of the redundant charges, test black powder charges before hand

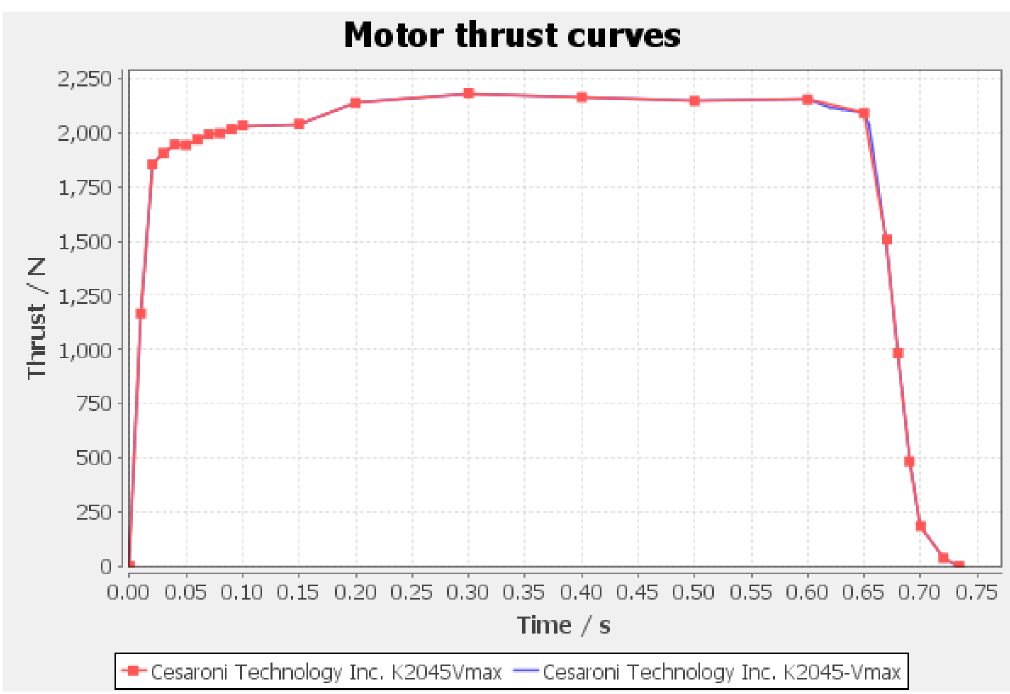
Mission Performance Criteria

Section 1: Mission Performance Criteria

Our goal is to build and test a rocket that will achieve an altitude of one mile, eject a scientific payload, and return safely to the ground. In order to do this, we must first create a stable and reasonable rocket design on a simulation program such as Rocksim. Our scientific payload will be equipped with solar panels and will be deployed at apogee along with the drogue parachute. The solar panels will be connected to a data logger that will record the voltage gathered from the panels. Using these measurements, we can then determine whether or not higher altitudes have an effect on the amount of current produced. At 600 feet, the main parachute will be ejected from the rocket, allowing it to land safely and nearby. This will be accomplished by using computer software to program an altimeter to eject the bottom half of the rocket containing the payload at apogee and the top half of the rocket deploying the main parachute at 600 feet. To ensure safety and to maintain a reliable ejection system, there will be a second altimeter programmed to eject at the same flight events, except with a slight delay.

Section 2: Simulated Vehicle Data

Name	Motors	Velocity off rod	Apogee	Velocity at depl…	Max. velocity	Max. acceleration	Time to apogee	Flight time	Ground hit velocity
No wind	[K2045Vmax-P]	148 ft/s	5279 ft	N/A	965 ft/s	1504 ft/s^2	15.8 s	129 s	86.8 ft/s
5-mph	[K2045Vmax-P]	148 ft/s	5278 ft	N/A	967 ft/s	1506 ft/s^2	15.8 s	129 s	93.4 ft/s
10-mph	[K2045Vmax-P]	148 ft/s	5274 ft	N/A	967 ft/s	1510 ft/s^2	15.8 s	129 s	98.2 ft/s
15-mph	[K2045Vmax-P]	148 ft/s	5260 ft	N/A	967 ft/s	1513 ft/s^2	15.8 s	125 s	99.6 ft/s
20-mph	[K2045Vmax-P]	148 ft/s	5247 ft	N/A	966 ft/s	1513 ft/s^2	15.8 s	105 s	92.5 ft/s



Parts Detail

Stage

Part	Material	Dimensions	Length	Mass
Nose cone	Polystyrene PS (1.05 g/cm^3)	Ogive	Len: 16.8 in	Mass: 10.3 oz
Bulkhead	Plywood (birch) (0.63 g/cm^3)	Dia$_{out}$ 3.75 in	Len: 0.5 in	Mass: 2.01 oz
Top Body Tube	Quantum tubing (1.05 g/cm^3)	Dia$_{in}$ 3.9 in Dia$_{out}$ 4.09 in	Len: 27.7 in	Mass: 20.4 oz
Main Chute	Rip stop nylon (66.8 g/m^2)	Dia$_{out}$ 70 in	Len: 0.98 in	Mass: 9 oz
Shroud Lines	Braided nylon (3 mm, 1/8 in) (3.5 g/m)	Lines: 8	Len: 72 in	
Ebay Body Tube	Quantum tubing (1.05 g/cm^3)	Dia$_{in}$ 3.9 in Dia$_{out}$ 4.09 in	Len: 1 in	Mass: 0.74 oz
LOC Electronics Bay with Altimeter	Cardboard (0.68 g/cm^3)	Dia$_{in}$ 3.78 in Dia$_{out}$ 3.94 in	Len: 10 in	Mass: 3.74 oz
Ebay Upper Bulkhead	Plywood (birch) (0.63 g/cm^3)	Dia$_{out}$ 3.78 in	Len: 0.25 in	Mass: 1.02 oz
Altimeter and Electronics		Dia$_{out}$ 0.98 in		Mass: 10.8 oz
Ebay Lower Bulkhead	Plywood (birch) (0.63 g/cm^3)	Dia$_{out}$ 3.78 in	Len: 0.25 in	Mass: 1.02 oz
Bottom Body Tube	Kraft phenolic (0.96 g/cm^3)	Dia$_{in}$ 3.9 in Dia$_{out}$ 4.09 in	Len: 36 in	Mass: 23.8 oz
Electronics Bay w/ Payload	Paper-BT (1.12 g/cm^3)	Dia$_{in}$ 2.88 in Dia$_{out}$ 3 in	Len: 8 in	Mass: 2.97 oz
Top Bulkhead for Payload Ebay	Plywood (birch) (0.63 g/cm^3)	Dia$_{out}$ 2.97 in	Len: 0.25 in	Mass: 0.63 oz
Electronics for Solar Panel Stuff		Dia$_{out}$ 0.98 in		Mass: 10.6 oz
Lower Bulkhead for Payload Ebay	Plywood (birch) (0.63 g/cm^3)	Dia$_{out}$ 2.97 in	Len: 0.25 in	Mass: 0.63 oz
Drogue Parachute	Rip stop nylon (66.8 g/m^2)	Dia$_{out}$ 15 in	Len: 0.98 in	Mass: 0.38 oz
Shroud Lines	1/16 In. braided nylon (1.02 g/m)	Lines: 8	Len: 15 in	
Bulkhead for Bottom half	Plywood (birch) (0.63 g/cm^3)	Dia$_{out}$ 3.9 in	Len: 0.5 in	Mass: 2.18 oz
Motor Mount Tube	Kraft phenolic (0.96 g/cm^3)	Dia$_{in}$ 2.15 in Dia$_{out}$ 2.28 in	Len: 16 in	Mass: 4.01 oz
Lower Centering ring	Plywood (birch) (0.63 g/cm^3)	Dia$_{in}$ 2.28 in Dia$_{out}$ 3.9 in	Len: 0.5 in	Mass: 1.43 oz
Upper Centering ring	Plywood (birch) (0.63 g/cm^3)	Dia$_{in}$ 2.28 in Dia$_{out}$ 3.9 in	Len: 0.5 in	Mass: 1.43 oz
Fins (3)	G10 fiberglass (LOC) (1.91 g/cm^3)	Thick: 0.13 in		Mass: 18.4 oz

The altimeter analysis of the March 2nd launches:

Altimeter 1:
First flight (Smokey Sam) - This altimeter recorded a height of 3835 feet.
Third flight (V-max) - It seems that this altimeter didn't even record anything during the flight.

Altimeter 2:
First flight (Smokey Sam) - On the data recorded, it says that this altimeter experienced a power loss at apogee.
Third flight (V-max) - This altimeter recorded a height of 4305 feet.

Altimeter 3:
Second flight (Smokey Sam) - This altimeter experienced a power loss as well at apogee.

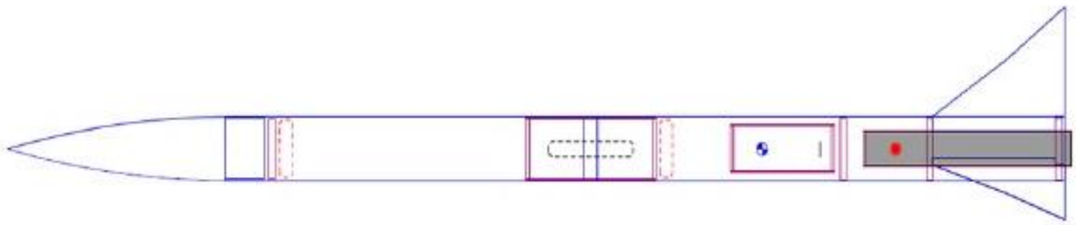
Altimeter 4:
Second flight (Smokey Sam) - This altimeter recorded a height of 3916 feet.

Section 3: Validity of Analysis

The scale rocket is 64% of the actual rocket. The predicted mass from Open Rocket was 41 oz and the actual mass of the subscale rocket was 42.4 oz. The stability margin was about 5.2. This means that the subscale was stable enough to be launched safely. The launch later on supported this because we noticed that the rocket flew up straight and steady. The motor used for the subscale was an Aerotech G64 motor. The predicted altitude of the subscale rocket was 1113 ft. Unfortunately, the actual altitude of the subscale was only 719 ft. under wind speeds of 2.7 mph at launch. This could have occurred because the wind speeds might have been much higher as the rocket climbed in altitude. This would have put more fluid resistance on the rocket, causing it to lose altitude. The weather on launch was very cold and windy, so the higher density of air could have affected the rocket as well. Overall, the results were successful and this shows that the full scale rocket should be stable and should be relatively close to the projected mass and altitude. The full scale rocket mimicked what was noticed on the subscale rocket. The actual weight of the rocket was 16.7 pounds, which is 64.0% higher than the predicted weight of about 10.7 pounds. Also, the altitude of the full scale rocket when launched with the Cesaroni K2045 Vmax was 4305 feet. This is about 18.5% lower than the predicted one mile high altitude. This loss in altitude may been due to the increase in mass of the rocket. Using this data, we can improve our predictions by assuming that an increase in weight of 6.0 pounds and wind speeds of 5.5 mph will result in an altitude of 975 feet lower than what is expected.

Section 4: Stability

Rocket Design



Rocket
Stages: 1
Mass (with motor): 171 oz
Stability: 2.51 cal
CG: 58.1 in
CP: 68.4 in

Center of Gravity (CG): 58.1 in from nose cone

Center of Pressure (CP): 68.4 in from nose cone

The top half of the rocket is calculated to have 14.79 ft-lbf of Kinetic Energy at the moment that the rocket hits the ground. The electronics bay housing the altimeter and tracking device should hit the ground with 6.15 ft-lbf of Kinetic Energy. The payload, which is also tethered to the rocket, should hit the ground with around 5.26 ft-lbf of Kinetic Energy. The last section of the rocket (the bottom half) should have 25.39 ft-lbf at the time it hits the ground. The total kinetic energy of the rocket is 60.71 ft-lbf when it hits the ground. This is well under the maximum of 75 ft-lbf of Kinetic Energy at the time of touchdown set by the Statement of Work.

Management of Kinetic Energy

The rocket is under a lot more stress when it is ascending until apogee. At apogee the kinetic energy is 0, causing the rocket to fall back towards Earth due to the acceleration due to gravity, which is 9.80 m/s^2. When the rocket descends the kinetic energy increases again, but does not reach nearly as high as the kinetic energy needed to propel the rocket into the atmosphere.

At apogee, the drogue chute is deployed to slightly lower the Kinetic Energy of the rocket in its descent, without causing it to drift too far. Once the drogue chute and rocket have reached terminal velocity, the rocket will have a total Kinetic Energy of 1193 ft-lbf. The top half will have 486 ft-lbf, the payload will have 100 ft-lbf, and the bottom half will have 607 ft-lbf. The next important phase in the rocket's flight is its landing. At the time of landing, the rocket will have a total Kinetic Energy of 53.3 ft-lbf. The top half of the rocket will have 15.8 ft-lbf, the E-bay will have 5.5 ft-lbf, the payload will have 6.2 ft-lbf, and the back half of the rocket will have 6.2 ft-lbf.

Altitude of Launch Vehicle

The altitude of the rocket with no wind is predicted to be 5279 feet. At wind speeds of 5 mph, the predicted altitude is 5278 feet. At 10 mph, the rocket is predicted to reach 5274 feet. At 15 mph, the altitude of the rocket is predicted to be at 5260 feet. At the wind speed of 20 mph, the rocket is predicted to reach 5247 feet. Because all components of the rocket are being tethered to each other, the drift distance for all components will be relatively the same. With no wind, the rocket drifts 4.35 feet from the launch pad. With a 5 mph horizontal wind, the rocket is estimated to drift 474.32 feet from the launch pad. With a 10 mph horizontal wind, it is calculated that the rocket will drift 939.08 feet from the launch pad. With a 15 mph wind, the rocket is calculated to drift 1401.2 feet from the launch pad. With a 20 mph wind, the rocket should only drift 2037.9 feet from the launch pad, ensuring that even under the most extreme launching conditions allowed by the NAR (in reference to wind speed), the rocket will stay within the 2500 foot radius of the launch pad.

IV) Payload Criteria

a) Creativity and Originality

Our payload has a completely original design. We built our electronics from scratch, to ensure that our data is precise enough to measure the difference in the amount of solar current collected at different altitudes.

b) Uniqueness and Significance

The significance of our payload is to experimentally determine the relationship between solar energy collected and altitude. With this relationship we will be able to conclude if it would be more beneficial to put solar panels at higher altitudes.

Science Value

c) Science Payload Objectives

At the beginning of our project, we proposed to have a completely original idea. As we brainstormed we came across the concept of renewable energy, and specifically solar energy. With this discovery, we thought of many ways how to use solar energy, capture it, and use it to our advantage. In this process we also considered some of the disadvantages of solar energy, to come up with a way that we may be able to improve it. One of the biggest problems with solar energy is that using solar panels, takes up so much room. By noticing this problem, we also considered the key factors that a rocket would have on solar energy. The main relationship that we considered was the one between the altitudes a rocket could obtain and the amount of solar energy a solar panel could collect if it were closer to the sun. This relationship could be revolutionary. If the amount of solar current increases as the attitude increases, then we would be able to have more efficient solar panels if they were put at higher altitudes. The main goal of our payload is to find a mathematical relationship between the current generated by the solar panel array and the altitude of the payload. The goal of the solar panel payload is to determine if a mile of atmosphere will affect the current generated by the solar panel array. We will have one solar panel array that deploys at apogee, gathering data as it descends, and the current change should stop once it hits the ground. Next, we will compare the two currents at apogee and the ground, thus giving us our rate of solar energy collected in the amount of time it took for the solar panel to descend.

d) Mission Success Criteria

To have a successful payload, we must also have a successful launch first. If the rocket does not perform at its best, than neither can the payload. If the rocket's recovery system does not deploy correctly, then damage could not only be done to the rocket, but also the payload. To prevent this, we made a stimulated payload that acted as a simulated mass within the rocket. The simulated payload did not have the same outer material as the payload since that material is so expensive, but it did have the same type of fit that the actual payload did. This helped us prepare for such a tight fit within the rocket. The payload slides perfectly into the bottom half of the rocket, just like the simulated payload does. The payload must also be able to withstand the amount of force exerted by the ejection charges. This is why we chose to protect the solar panel from any force or residue from the black powder, with a Lucite cylinder. The Lucite cylinder fits snuggly around the payload due to the lips that were created on the bulk heads at each end of the payload. These ends need this lip, so any extra pressure, is not exerted directly onto the electronics. As a result, the electronics are safe from the ejection charges

e) Experimental Logic, Scientific Approach, and Method of Investigation

To prove our hypothesis, we will first need to determine if there is a change in the amount of current collected, at different altitudes. To do this, we will first need to create a circuit that is able to read the amount of solar energy collected by our solar panel.

f) Tests and Measurements

Our electronics have a special type of measurement system. The first special electronic we used, is the Arduino. We decided to use the analog inputs on our Arduino since that scale has a wider range of number, that coordinate to a smaller number in the standard scale of current. The Arduino measures current from 0-1023, and when programmed correctly, can be converted back to a value between 0-200 mA.

g) Expected Data and Accuracy

We expect our payload to give us consistent data with each launch we get. The measurements that the Arduino take with the analog inputs make the measurements more precise. This is important, because the change in current can be very minute at a lower altitude.

h) Experiment Process Procedures

To start the Arduino writing data, the batteries need to be put in parallel with the circuit. Putting the batteries in parallel gives the Arduino a longer battery life. This is advantageous for our launch pad stay time, which is about four hours.

Payload Design

i) Design and Construction

There are two main parts of the payload. Those two parts are the payload’s airframe and the electronics subsystem. The payload’s airframe was designed to maximize the amount of space that could be used for the electronics. The payload’s design consists of a modified sled that houses all of the electronics on it. The sled is not a perfect sled like the Electronics Bay, because the Arduino is so large. Despite this fact, we have made a modified sled that is very strong. It has reinforced pieces, to strengthen the main, most important parts of the structure. The payload can go under lots of stress, because it has a strong structure, and strong electrical connections.

j) Repeatability of Measurement

The payload is an important form of renewable energy. This type of energy is repeatable, but not always consistent. The amount of sun, or solar power, varies by day and weather. The most important trend that we need to observe, is the basic trend of increasing current with height. can easily log more data on an SD card. Data can be downloaded, to get raw data, and then interpreted to either use or discard if it did not work properly.

k) Flight Performance Predictions

We have flown our payload safely already. However, there was a malfunction with the electronics, causing the data not to record. We will continue to do tests and launch before we go to Huntsville, to get data that we can compare to our Huntsville launch data. The payload was working before the launch, and any problems that could have happened are being analyzed, fixed, and then tested again.

l) Workmanship to Achieve Mission Success

The payload has continuously been worked on during the construction phase, to make sure it is working at the best it possibly can. On the first day of launches, our rockets were coming down faster than what was expected from our simulations. However, with some research, we went back for our second launch day and had three safe and successful launches. On our second launch day, an unexpected problem arose. Our payload did not write data during the flight. Despite this technical mishap, the payload has worked in test trials, including the one before the actual launch. Even though this mistake occurred, we plan on launching again before arriving in Huntsville, to get data that we can use to compare to data collected for the launch in Huntsville. This will also give us a chance to ensure that our rocket is safe, still ready for flight, and in good condition. This will also give us good data, since our rocket is already flying successfully and safely. We plan to continue to make the payload better, by strengthening connections, analyzing the circuit, and reviewing the program to see what may have went wrong. This should further prevent this from happening again, and will ensure that we get successful test data before our launch in Huntsville.

m) Test and Verification Program

With each of our flights, we will analyze each part of the payload, to ensure that no part of the payload is infringing upon the experiment. We will continue to do tests on the payload, to make sure all of the connections are clear, and that it is as precise as possible. To verify that our payload is working, we have tools such as a multimeter, to make sure both sides of the circuit are equivalent in resistance. This will help us get accurate data. Using the mathematical relationship of power versus altitude, we should be able to see a trend if all of the parts of the payload are working correctly. This trend would show that the higher the altitude, the higher the power.

Verification

Payload Requirement:	**Verification:**
3.1.1 The engineering or science payload may be of the team's discretion, but shall be approved by NASA. NASA reserves the authority to require a team to modify or change a payload, as deemed necessary by the Review Panel, even after a proposal has been awarded.	Complete payload analysis
3.2 Data from the science or engineering payload shall be collected, analyzed, and reported by the team following the scientific method.	Test launch, Payload test, Inspect data
3.3 Unmanned aerial vehicle (UAV) payloads of any type shall be tethered to the vehicle with a remotely controlled release mechanism until the RSO has given the authority to release the UAV.	N/A
3.4 Any payload element which is jettisoned during the recovery phase, or after the launch vehicle lands, shall receive real-time RSO permission prior to initiation the jettison event.	N/A
3.5 The science or engineering payload shall be designed to be recoverable and reusable. Reusable is defined as being able to be launched again on the same day without repairs or modifications.	Payload inspection, electronics tests
Ensure Arduino is turned on.	light test, electronics test
Adjust Potentiometer, to make sure the same amount of resistance is present on each side of the electrical circuit.	Multimeter test
Prevent short circuits in full payload circuit.	Multimeter test, full circuit test
Make sure all connections are fluid and reliable.	Multimeter test, full circuit test, full circuit inspection
Remove and Replace all exposed wires.	Full circuit inspection

Use new batteries before each flight for maximum pad stay time.	Multimeter test, inspect data
Observe that current flows in on direction.	Multimeter test, full circuit test

Safety and Environment for Payload

There are a limited amount of environmental concerns with the launching of this rocket. Since there are a lot of controlled variables in this experiment, the probability of these problems are very slim. One environmental concern would be a small effect on the ecosystem. This could include an unexpected motor ejection, a rocket's recovery system unpredictably faults, or the rocket coincidently getting stuck in a tree. The smoke that comes from the motor may be potentially harmful to the environment and the organisms within it, including humans. If the rocket disappears into a wooded area, it may endanger an animal's life if it gets hit, or if it tries to digest a part or parts of the rocket. With the specified launch site, these problems should not arise, and have a very small chance of happening.

V) Launch Operations Procedures

Safety and Quality Analysis

Safety Officer:

Our team safety officer is NAR Level 2 Representative Tom Aument who will watch over us and ready all explosives and ejection wells.. On our team Jordan Stine is in charge to make sure people are doing their jobs and doing them in a safe and efficient manner to get ready for Huntsville.

Reasonable Data:

Our team has taken all measures possible to ensure safety and reduce the chance of any bodily harm. We have had no injuries sustained so far in our subscale and full-scale launches with the use of smart decisions and proper techniques.

Protective Eyewear- Goggles or safety glasses are to be worn at all times while operating, or within a close proximity of someone operating any power tool or working with any form of material that may release particles into the air that could be harmful to someone's eyes along with during the launch procedure.

Operation of Power Tools- Any member of the team who will be operating will be briefed on tool specific safety procedures by one of the team safety officer before operation. Safety officers will have access to tool specific manuals and will be responsible for ensuring operation is executed in a safe manner.

Transporting or Lifting Heavy Materials- No one will be allowed to attempt moving or lifting any object beyond their physical capabilities. All lifting will be done using proper form, using the legs not the back, in order to avoid strain or injury. Any object requiring two or more people to transport will be supervised by members not involved in lifting and carrying to ensure object are not run over or knocked into.

Chemical Work- Prior to any use of or work with chemicals members shall review an MSDS (Appendix A-MSDS) and proper handling procedures. All chemical work will require eye protection and gloves as appropriated.

Pre-Launch & Assembly Checklist

Inventory:

- ☐ Motors and Casings
- ☐ Inspect Parachutes (Main, Drogue)
- ☐ Inspect the Nomex Blankets x 2
- ☐ Inspect the Shock Cords x 3
- ☐ Inspect Condition of Payload
- ☐ Inspect Shock Cord Sleeves x 2
- ☐ Check inventory of Quick Links
- ☐ Check inventory of spare Key Switches
- ☐ Motor Retainer Cap
- ☐ Motor Casing
- ☐ 9 Volt Batteries
- ☐ Shear Pins x 6 for each launch
- ☐ Masking Tape
- ☐ Pliers
- ☐ Screwdriver
- ☐ Hammy
- ☐ Signal Output Device for Tracking System
- ☐ Handheld Tracker
- ☐ Extra Wire for the Ebay and Payload
- ☐ Check battery for Video Camera
- ☐ Video Camera
- ☐ Program Altimeters
- ☐ Altimeters x 4 (+ a few spare)
- ☐ Shock Cord (all three parts for each rocket + spares)
- ☐ 5-minute epoxy
- ☐ Spare hardware for Altimeter attachment
- ☐ Electrical Tape
- ☐ Portable Soldering Iron
- ☐ Extra Butane
- ☐ Charge battery[s] for Dremel
- ☐ Portable Dremel
- ☐ Scissors/Shears
- ☐ X-acto knives
- ☐ Rulers/ Meter Stick
- ☐ Sanding Drum Kit
- ☐ Solder

Pre-Flight Preparation (Pre-RSO Rocket Assembly)

- Re-check Inventory
- Check to make sure that all batteries (especially EBay) are new
- Test to make sure altimeters are beeping
- Make sure altimeters are OFF
- Make sure tracking device battery is still working
- Install 1.5 grams BP in ejection charge wells x 4
  - Insert igniters x 4
  - Tape over wells x 4
- Prep & install Payload
  - Load Batteries x 2
  - Make sure power lights are on
  - Install an SD card
  - Check wire connections
  - Attach Shock cord Quicklinks x 2
  - Slide sled in and tighten wing nuts
  - Fold Shock Cord below payload and install around U-bolt
  - Slide Payload down Back half of rocket
- Prep & install Drogue Chute
  - Roll and Pack Chute
  - Install a Quicklink onto chute, along with Nomex sleeve and Blanket
  - Knot shock cord where Drogue Quicklink attaches
  - Pack shock cord up to the Nomex sleeve
  - Install parachute
  - Lay Nomex sleeve on top, and Nomex Blanket surrounding all of it
- Insert e-bay into lower half (make sure stuff lines up)
- Attach e-bay to lower half with shear pins
- Prep & install main chute
  - Roll and pack main chute
  - Install Quicklink to shock cord and tie it off
  - Insert most shock cord above parachute
  - Insert parachute with shock cord and blanket wrapped over it
- Insert top half of rocket onto lower half
- Insert shear pins to keep it all together
- Build Motor
- Prepare igniter- DO NOT INSTALL YET!!!

Final Assembly

- [ ] Notify RSO in accordance with required launch waiver
- [ ] Fill out flight card & paperwork, take to RSO
- [ ] Install Motor

Checklist: RSO

- [ ] Have RSO check Rocket
- [ ] Verify Tracking device is functional

Launch Pad Checklist:

- [ ] Take to launch pad:
    - Tape
    - Motor Igniter
    - Camera
- [ ] Load rocket on rail carefully
- [ ] Secure pad in upright position
- [ ] Activate one altimeter
- [ ] Verify Annunciation
- [ ] Activate other altimeter
- [ ] Verify Annunciation
- [ ] Remove both keys
- [ ] Insert igniter, BACK UP to launch system, check continuity

Launch:

- [ ] Re-verify tracking system is working
- [ ] Notify Everybody
- [ ] Check for planes

Countdown: 5…4…3…2…1…LAUNCH!

Post-Flight Checklist

Successful Launch:

- ☐ Verify that it is not hazardous to retrieve
- ☐ Verify that all pyro charges have burned
- ☐ Listen to altitude beeps
- ☐ Walk rocket back to camp
- ☐ Inspect for damage, signoff on no damage
- ☐ Download altimeter data and Payload data to PC

Contingency- Abort launch, misfire, or other reason

- ☐ Unload gear and charges
- ☐ Unload motor and igniter, store until ready to use

Contingency- Crash Landing

- ☐ Take photos of landing
- ☐ Dig out of the ground and locate all the components
- ☐ Dispose of charges
- ☐ Analyze the rocket for damage, and reusability
- ☐ Correct next rocket for what went wrong

Failure Modes with Proposed and Completed Mitigations:

Failure Modes	Proposed and Completed Mitigations
The rocket motor does not function properly.	Our Safety Officer has loaded and tested Cesaroni motors before; therefore, he has experience with the type of motor that we are using. We plan on having him practice using the specific motor that we will use during the full-scale launch: a K2045. This will prevent major catastrophic failure of the motor, along with recognition of common motor or igniter complications, if any.
The parachute fails to deploy and causes the rocket to plummet unsafely to the ground.	Our Safety Officer has tested how much black powder needs to be placed in the ejection charge wells, and has finalized how much we will be using based on test results. Also, methods for packaging recovery system components have been researched in order to prevent the payload or other components from getting lodged in the rocket.
The rocket travels along a path that is unplanned and is either unsafe or will prevent the rocket from reaching one mile.	The rocket design has been tested on OpenRocket to make sure that it is stable for launch. Also, the rocket will be inspected after assembly to ensure that nothing can break loose during flight. The

	full-scale flight will also yield data on whether or not the rocket contains any major flaws, and those can be addressed before another test is conducted.
Electrical Circuitry within the payload loses its functionality as a result of wires becoming detached.	The payload circuitry will be tested after its completion to ensure that it functions properly. Once this is confirmed, any components that can be soldered will be, and a specialized epoxy will coat over components and junctions that must not be tampered with.
The payload was not constructed properly, and as a result poses a major problem that could affect the system's functionality.	All parts of the payload will be assembled only while at least two well-versed persons in its construction are present. The two people will come to an agreement as to where components are to be attached, or what line of code needs to be used in operation, before it is executed. Both people who are working on its construction will ensure that precautions are being taken to prevent injury or improper material usage.
The switch which enables data to be recorded fails and no data is recorded.	A pre-launch testing of the payload operation will be conducted to ensure that the switch functions as it is supposed to. Once this has been ensured, the switch will be activated and secured in the correct position to continue recording data.
The solar panel is damaged by either the pressure from the ejection charges, or by other means.	We plan on using a Lucite cylinder around the flexible solar panel, which will allow the solar array to gather solar energy; however the solar panels will not be subject to the direct pressure of the ejection charges. The solar panels will be handled carefully when not covered in the Lucite cylinder, and will be stored in the proper environment to prevent its malfunction.
The code for the Arduino is not written correctly, and the proper data is not recorded.	The Arduino and its components will be tested after assembly to check for functionality with the code that has been written for it. All sensors will be checked to see if they are producing accurate and usable data, before the payload setup is considered completed. In order to surpass complications in code writing, a series of

	Youtube tutorials will be referenced, or a teacher well versed in computer programming will be referenced for help.
The payload is not attached properly to the shock cord within the rocket, and it becomes an independent section of the rocket that is falling	Methods will be researched to find out the most effective way of attaching the shock cord to the eye bolt. This will ensure that the payload section will not become independent from the rest of the rocket.

Environmental Concerns

All members of the team understand the consequences of improper use of materials and the damage it could have on the environment. We believe that we will have a minimal effect on wildlife or on the ecosystem. If at all the smoke from the motor ignition, will be absorbed by the atmosphere and not harm the wildlife. If the rocket ends up in a tree it will not affect the entire tree or damage the tree majorly. Overall we will make sure that:

- All waste material will be disposed of properly
- Biodegradable and flame resistant wadding will be used
- Consideration of environmental concerns will be made when making plans
- Proper blast shields will be used to defer motor exhaust fumes
- We will make sure to use extra caution when being around, using or disposing of;
    - West Systems Epoxy Resin
    - West Systems Hardener
    - Lithium Batteries
    - Black Powder
    - Ammonium Perchlorate Composite Propellent

VI) Project Plan

Budget Plan

As of right now, almost all purchases have been made for the project. As of the CDR, we projected to spend $3052.86 on our rocket, and we have actually spent $5604.49 on the rocket. However, this is including purchases on tools we bought for the duration of our project, and on extra parts to ensure we have spares in case of any incident. We plan to spend $8535.00 on hotel rooms and food for the trip to Huntsville. Also, no other major purchases should be made from this point. To spread awareness throughout our community we are using small rocket kits to build with children in our school in a workshop. These kits were donated to us by AquaPhoenix, and we will start these seminars within weeks.

Funding Plan

Currently, enough funding has been completed to pay for the entire projected project, including rocket parts, transportation, food, and hotel rooms for the trip to Huntsville. The total funds collected to date amount to $14,465.00. Total expenses on the rocket currently stand at $5604.49, not including any future purchases. No future funding is expected to occur, since we have collected more money than the projected project, accounting for multiple possibilities that would raise the projected project cost. We plan to have approximately $5000 for next year's team. More purchases will most likely be made for the rocket to ensure we have sufficient resources to be ready for a launch at Huntsville. Also, not included in the spreadsheet is hotel rooms and food for the duration of the trip to Huntsville and practice launches.

August 2012

1: Request for proposal goes out to all teams
2: Start of Initial Proposal
31: One electronic copy of complete proposal along with web presence due to NASA Marshall Space Flight Center

September 2012

27: Schools notified of selection
28: Start of PDR and Edited Proposal

October 2012

4: Team teleconference
11: PDR question and answer session
22: Web presence establishment for each team
29: PDR reports, presentation slides, and flysheet posted on the team Web site by 8:00 a.m. Central

November 2012

7-16: PDR presentations

December 2012

3: CDR question and answer session
31: CDR rough draft due to team captain

January 2013

7: CDR final draft due to team captain
14: CDR reports, presentation slides, and flysheet posted on the team web site by 8:00 a.m. Central
22-23: 7^{th}-8^{th} grade presentations
23-Feb 1: CDR presentations
31: 9^{th} grade presentation

February 2013

11: FRR question and answer session
23: Full scale launch

March 2013

3: Full scale launch
4: FRR rough draft due to team captain
11: Final Draft of FRR due to team captain
18: FRR reports, presentation slides, and flysheet posted on the team web site by 8:00 a.m. Central
25-Apr 3: FRR presentations

April 2013

17: 5:00 p.m.: All teams arrive in Huntsville, AL

5:30 p.m.: Team lead meeting
6:30 p.m.: Launch Readiness Reviews begin
18-19: Welcome to MSFC/LRRs continue20: Launch Day
21: Launch Day Rain Day
23: PLAR rough draft due to team captain
29: PLAR final draft due to team captain

May 2013
6: Post Launch Assessment Review posted on team web site by 8:00 a.m. Central
17: Winning USLI team announced

Educational Engagement

We have already done our presentations for the educational engagement aspect of our project. Before we got to Huntsville, we will be having our rocketry workshop. This has been delayed due to the construction of our full-scale rocket, and other events that have infringed with the planned workshop times. The planned week for the workshop is the last week of March. This will give us a chance to work with the students early, and have more time get prepared for the trip to Huntsville. The workshop will consist of the SLI members, each individually teaching a group of four students how to build a small model rocket. The purpose of the workshop is to educate students about rocketry, while teaching them how to work as a team and exposing them to new science interests with this unique, free, opportunity. We were able to make this workshop free, due to our official sponsors, AquaPhoenix. They decided to donate the kits, after hearing about how we wanted to educate students in science, which is a goal also dear to AquaPhoenix's owner, Frank Lecrone. Lecrone, also invited the SLI Team to his facility to show the SLI Team his company, and gave the team the materials they needed to build their own kits on an assembly line at his facility. The team all worked together to make the kits, and we all look forward to teaching the students of the next generation about rocketry.

VII) Conclusion

Overall our project has been very successful. Our recent launch was the best we have had. The educational engagement rocketry workshop will be starting shortly. Our budget is under control, despite going over our initial budget. The project is a success so far, we just need another launch for our payload data, and we will be ready for Huntsville.