AIAA Orange County Section

Student Launch Initiative 2011-2012

Proposal

Rocket Deployment of a Bendable Wing Micro-UAV for Data Collection

Submitted by:
AIAA Orange County Section
NASA Student Launch Initiative Team
Orange County, CA

Submitted to:
Marshall Space Flight Center
Huntsville, Alabama

September 19, 2011

Image From: XPRS.ORG

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1. Organization Information

1.1. AIAA Information

The American Institute of Aeronautics and Astronautics is the professional society for the field of Aerospace Engineering. Our SLI team is sponsored by the Orange County section in California. The board meets on the first Tuesday of every month. In their educational outreach, they provide professional guidance and assistance to youth who wish to pursue projects related to aerospace. The organization of the board of the Orange County section is as follows:

Chair	Kimberly Castro
Chair Elect	Jeff Norton
Treasurer	Philip Ridout
Secretary	Ronald Freeman
Technical	Dino Roman
Honors & Awards	Bob Davey
Programs	Scott Roland
Membership	Bob Welge
Young Professionals	Lee Cheng
Communications	Enrique Castro
At Large	Justin Joseph
At Large	John Rose
At Large	Toby Holtz
Public Policy	Kemal Shweyk
Education	Jann Koepke (Mentor to SLI)
TARC and SLI	Bob Koepke (Mentor to SLI)
Past Chair	James Martin

1.2. Name of organization and title of project

The AIAA Orange County Section Student Launch Initiative team is composed of students from several high schools in Orange County, California under the direction of the American Institute of Aeronautics and Astronautics Orange County Section. The project is entitled "Rocket Deployment of a Bendable Wing Micro-UAV for Data Collection".

1.3. Name of administrative staff member (team official)

Administrative staff members serving as the Team Officials and mentors are Robert Koepke and Janet Koepke. Contact information:

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Orange, CA 92869
(714) 288-0321
rkoepke@socal.rr.com

1.4. Mentors (will attend many meetings and launches, directing the team)

1.4.1. Robert Koepke (Electrical Engineer, Programmer, Level 2 NAR)

Robert has been co-leading TARC teams for 4 years and 4H rocketry projects for 13 years. He has a BS degree in Electrical Engineering from USC and has worked as an electronics designer, programmer, and now a director of the software department doing embedded programming for thermal printers. Robert worked on the F-20 Tigershark while at Northrop. Robert launched his first rockets shortly after Sputnik in 1957 and has continued in rocketry with his own children and grandchildren, Indian Princesses and Indian Guides, and 4H.

1.4.2. Jann Koepke (Artist, Mom, Level 1 NAR)

Jann has been co-leading TARC teams for 4 years and 4H rocketry projects for 11 years. She has a bachelor's degree in Fine Arts from Cal State University Los

Angeles in 1979. She has worked in electronic business as an assembler and in the accounting office. Now she is retired. She has been doing Rocketry for 25 years with her husband children and grandchildren. Jann is the AIAA OC Section Council member in charge of education. She has been in 4-H for 11 years and has been doing rocketry in 4-H for 11 years. She has also led 4H projects in livestock including lambs, goats, and beef.

1.4.3. Michael Stoop (Software Engineer, Level 3 NAR, California Pyro 3)

Mike Stoop is currently the CTO of PriceDoc, Inc, a healthcare related web services company. Mike has been in the software industry for 30 years and an avid rocketeer for 40 years. Mike achieved his level 3 certification in 2002 and has participated in many individual and team 'M" class and above rocket projects. He has launched K and larger engines with electronic dual deploy many more than 15 times. Mike is also the owner of Madcow Rocketry, a mid/high power rocket kit manufacturer.

1.4.4. Andrea Earl (Educator)

Andrea Earl has been teaching math and science for over 25 years and is a strong proponent of STEM education. Andrea currently teaches 7^{th} grade Pre-Algebra at Mendez Fundamental Intermediate School in Santa Ana, California. In addition to her teaching responsibilities, Andrea is the site technology coordinator, coordinates parent involvement activities and is an instructional technology trainer for the Orange County Department of Education. Andrea has a Bachelor's degree from UCLA and a master's degree in Education. Andrea's interest in rocketry and space began as a young child with the launch of the first Apollo rockets and she vividly remembers watching Neil Armstrong walk on the moon. As a SLI team mentor, Andrea will provide guidance and support in the areas of fundraising and community outreach.

1.5. Advisors (available for questions and help in problem solving in their area of expertise)

1.5.1. Dr. James Martin

Dr. Martin holds degrees from West Virginia University, Massachusetts Institute of Technology, and George Washington University. He has worked at the NASA Langley Research Center, The University of Alabama, and Boeing. His work has mostly involved the design and evaluation of reusable launch vehicles. Some recent work has been on crew escape for the Shuttle, the Space Launch Initiative, and a robotic lander on the moon. Dr. Martin retired from Boeing when the Launch vehicle business was sold. He continues to be active in aerospace doing consulting, as an Associate Editor for AIAA J. Spacecraft and Rockets, and as Chair of the local AIAA Orange County Section.

1.5.2. Dr. Robert Davey

Dr. Robert Davey is a senior retired faculty from the Department of Aerospace Engineering at Cal Poly Pomona with a Ph.D. from Cal Tech. Dr. Davey worked on the instrumentation for the Viking Mars lander and the Pioneer Venus entry probe. He has been an avid RC flyer, designing and building his own planes for over 50 years. He is a council member at the AIAA Orange County section.

1.5.3. Douglas Weibel

Doug Weibel is the lead software developer for the ArduPilotMega/ArduPlane open source UAV Autopilot program. And he is DIY Drones resident fixed wing expert. Doug is a PhD Student and Research Associate at the University of Colorado in Aerospace Engineering Science. He started his professional life as a EE/Systems engineer but was able to switch to something he really enjoyed. Although in Colorado, Doug will be helping this Southern California based team via email and Skype.

1.5.4. Jonathan Mack (Electrical Engineer and Programmer)

Jonathan graduated with a Bachelor of Science from Long Beach State. Currently he is an electronics design engineer involved in hardware and software development including diverse fields such as toys, audio, and currently printing. He has led a 4H project in mechanical, electrical and software design areas in robotics. At home his hobbies mainly focus on improving DIY (Do It Yourself) knowledge, including everything from mad science projects to more mundane things like welding and cooking (usually not at the same time.)

1.5.5. Guy Heaton (Mechanical Engineer)

Guy graduated with a Bachelor of Science from Pepperdine University. Currently he is a Senior Mechanical Engineer and has been working on printing solutions for 12 years. Responsibilities include designing for injection and blow molding and extrusions. He also does mechanical systems, drive trains, cabling, durability testing, and sheet metal design. When not designing new printers he does manufacturing time analysis, line balancing, and documentation

1.5.6. Khoa Le (Mechanical Engineer)

Khoa graduated with a BS in Mechanical Engineering and is working on his Masters in Mechanical Engineering emphasizing Design and Materials for Manufacturing with a minor emphasis on Automated Manufacturing. Currently he is a Mechanical Design Engineer and conducts structural analysis for other engineers within the department. As a Mechanical Design Engineer, he designs and evaluates mechanical components, based upon theory using finite element analysis and core Mechanical Engineering concepts.

1.5.7. Michael Updegraff (Software Engineer, Level 2 NAR)

Michael Updegraff is the Sr. Principal Engineer at PriceDoc.com. Michael has been involved in web application development for 15 years working alongside Google's engineers in Public API (Application Programming Interface – a common defined interface between software modules) consumption. Michael holds a level 2 NAR certification and participates in FAR (Friends of Amateur Rocketry is a licensed non-profit organization dedicated to experimental rocketry) experimental launches in the Mojave Desert.

1.5.8. Doug Jacobs (Fiberglassing)

Doug Jacobs is the person at West Marine in Orange, CA that is very familiar with fiber glassing using the West System. He will conduct a training session about using the West Marine system, at the store, for the benefit of team members. In addition, he is available for questions

1.5.9. AIAA Orange County Section

Since we are attached to the American Institute of Aeronautics and Astronautics, we can reach out to the hundreds of aerospace professionals in Southern

California for help in designing airplanes, rockets, and construction with composite materials.

1.5.10. Other help

We contacted Irvine Sensors, a local company in Costa Mesa, Ca with a similar bendable wing UAV product similar to our payload called the Towhawk but received no response yet. We will also be contacting Prioria Robotics in Gainsville, Florida since they have a similar product to our payload called the Maveric (video here) as well as the University of Florida, Gainesville which is where much of the research on the bendable wing design for Prioria took place. One of our mentors works 1 week per month in Orlando and can arrange a visit if they are receptive.

1.6. Student Participants and responsibilities

All student members in the team are listed below. These members will be responsible for completing all of the work (e.g. written documents, presentations, design, construction, and launching) using mentors and advisors only for guidance. Team members represent four high schools in Orange County.

1.6.1. Sjoen (Program Manager – Recovery, and Safety)

Sjoen is a senior at El Modena High School in Orange. She has been in TARC for five years, rocketry for twelve years, and has helped out her parents with numerous rocketry projects, which has sparked interested the interest of youth in Rocketry and Engineering. She is interested in going into business administration and wants a degree in engineering. Sjoen holds a level 1 Junior NAR certification.

1.6.2. Mika (Propulsion, Vehicle Design, and Web Site)

Mika is a junior and is enrolled at El Modena High School in Orange and has been in rocketry for six years and in TARC for three years. He is an avid RC flyer and has participated in the MESA Program (Mathematics, Engineering, Science, Achievement) and got 5th place for a pentathlon. He is also a cross-country and track runner for El Modena. Mika holds a level 1 Junior NAR certification.

1.6.3. Justin (Recovery, Website, and Design)

Justin is a senior at Sunny Hills High School in Fullerton, CA, ending his junior year with a weighted GPA of 4.1. He is enrolled in AP Biology, AP Calculus BC, AP English Literature, AP Human Geography, AP Spanish Language, and Economy. He has participated in this program last year and was part of the recovery team. He is currently preparing himself for college by taking different tests and doing his college applications.

1.6.4. Insang (Recovery, and Propulsion)

Insang is a senior in Sunny Hills High School in Fullerton, CA. He took AP Chemistry, AP Physics, AP Calculus AB, and AP Computer Science. He is currently enrolled in AP Calculus BC and AP Biology this year. He was part of recovery in SLI last year. He is highly interested in aerospace engineering and physics, and planned to major in that area in college. He has AP Physics tutor experience, and currently doing it too. Since he is really into this particular area, SLI will provide him some advanced experience and overview of what he is interested in.

1.6.5. Divya (Recovery, Fundraising, Educational Engagement, and Public Relations)

Divya is a senior at Sunny Hills High School in Fullerton, CA. At the end of her junior year, she had a weighted GPA of 4.48. She is currently enrolled in IB English 4, AP Calculus BC, AP/IB Spanish 4, AP Biology, IB Economics, IB History of the Americas, AP Government, and IB Theory of Knowledge.

1.6.6. Maitri

Maitri is a senior at Sunny Hills High School in Fullerton, CA, ending her junior year with a GPA of 4.83. She is enrolled in AP Biology, IB History of the Americas HL, IB English 4, AP Calculus BC, AP/IB Spanish 5, IB Theory of Knowledge, and IB Economics HL.

1.6.7. Joshua (Historian - Public Relations - Web Site)

Joshua is a senior at Sunny Hills High School in Fullerton, Ca, ending his junior year with a GPA of 4.5. He is currently enrolled in AP Literature, AP Statistics, AP Human Geography, AP Biology, AP Art History, AP Economics, and AP Government.

1.6.8. Joseph (Payload, Vehicle Design and Propulsion)

Joseph is currently an 11th grader at Tarbut V'Torah High School. He is enrolled in AP Chemistry and AP Calculus BC. He has a lot of experience with basic and advanced robotic engineering and rebuilds and fixes computers in his spare time. Joseph is a second degree Black Belt in traditional Tae Kwon Do, plays the guitar and is an Eagle Scout. Joseph has been building model rockets since he was in elementary school and participated in the SLI project last year with the AIAA team.

1.6.9. Jonathan (Crew and Design)

Jonathan is a senior at Sunny Hills High School in Fullerton, CA ending his junior year with a 3.5 GPA. He is enrolled in AP Human Geography, British Literature, ROP Principles of Engineering, and Math Analysis. He is new to the SLI team.

1.6.10. Mitchell (Payload, and Crew)

Mitchell is a senior at Sunny Hills High School in Fullerton, CA, ending his junior year with 3.5 GPA. He is enrolled in AP calculus, AP Micro and macro economics, Human anatomy and AP English composition. He is new to the SLI team.

1.6.11. Lekha (Design, and Crew)

Lekha is a freshman at Troy High School in Fullerton Ca. She is enrolled in the IB Tech Program. She is new to the SLI team. Her middle school GPA was 3.9.

1.6.12. Nicholas (Payload, and Crew)

Nicholas is a junior at El Modena High School in Orange, CA. He likes to whittle. He is a new member to the SLI team. He takes Krav Maga classes and a boxing class some weekends. He is taking Spanish III, AP language, AP US history, Pre calculus and physics.

1.6.13. Tina (Payload, and Website)

Tina is a sophomore at Irvine High School in Irvine, Ca. She is interested in software development and has taken several classes at community colleges involving programming. She is taking AP biology and AP chemistry and will be involved in a research project in micro biomechanics at UCI.

1.6.14. Jimmy (Recovery, Historian and Propulsion)

Jimmy is a junior attending Sunny Hills High School in the Fullerton School District. He is currently enrolled in the IB program at Sunny Hills. His classes include IB Physics, IB Econ, and AP US History. He is part of the high school varsity tennis team. Jimmy holds a black belt degree in Tae Kwon Do martial arts. He has been to the NASA headquarters in Florida and participated in a tour.

1.6.15. Muzna (Public Relations, Web Site, Payload)

Muzna is a senior at Sunny Hills High School in Fullerton, CA, ending her junior year with a GPA of 4.83. She is enrolled in IB History of the Americas HL, IB English 4, AP Calculus BC, AP/IB Spanish 4, IB Theory of Knowledge, Yearbook Publications, and IB Economics HL.

1.6.16. Bill (Recovery and Propulsion)

Bill is a junior at Sunny Hills High School in Fullerton, CA. He is aiming to receive the AP National Scholar Award from Collegeboard and his classes include AP Biology, AP Calculus BC, and AP US History. He is part of the high school Conservatory of Fine Arts and wants to graduate high school with a music diploma with distinction.

1.7. NAR/TRA Section for launch assistance, mentoring, reviewing

The AIAA OC Section rocketry is NAR Section #718. Launches will be held at Lucerne Dry Lake in the Mojave Desert near Lucerne Valley, California. NAR section #538, the Rocketry Organization of California (ROC) holds launches on the weekends around the second Saturday of each month. Mentors Robert and Jann Koepke have been members of ROC for several years and team members have attended many ROC launches over the past 5 years. Many ROC members hold level 1 – 3 certifications and have always provided mentoring and review assistance to anyone asking. ROC currently has an FAA waiver allowing flights to 7,000' AGL, with call-in windows available to 19,000' AGL (http://www.rocstock.org) at their monthly launches.

2. Facilities and Equipment

2.1. Description of facilities

We are not part of school, but we still we have access to facilities that provide equipment and resources as needed. These include:

- The Koepke's home where we have built all TARC rockets as well as last year's SLI rocket where youth and others have built scores of rockets from micro-maxx engines through Level 2 over the past 12 years. Equipment includes
  - Six computers loaded with most of the software listed below and with access to the Internet
  - Oscilloscopes
  - Soldering station
  - Hand Tools
  - Power tools
    - Band Saw
    - Table Saw
    - Drill Press and hand drills
    - Bench grinder
    - Sander
    - Air compressor

- The Evans' garage with a complete workshop. Mr. Evans led 4H projects in woodworking for several years and is a general contractor. He has an extensive collection of power and hand tools required for virtually any woodworking project.
- Datamax-O'Neil where Mr. Koepke and many of the advisors work. We have access to
  - Computers with compilers and cross compilers for many embedded microprocessors
  - Soldering stations
  - Computers with Solid Edge and Pro-E mechanical CAD (Computer-Aided Design) systems
  - Conference room with computer and web cam with access to the Internet

2.2. Necessary personnel

The respective mentor and advisors are available at each location to help guide team members in the use of the equipment and to answer questions as they arise.

2.3. Computer equipment

2.3.1. Hardware

- Access to the six IBM Personal Computers at the Koepke's
- One IBM PC laptop to take to launches to check design and calculations and to record flight data
- One IBM C laptop to use for the ground station for the UAV
- Access to the conference and engineering computers and Datamax-O'Neil
- Each team member has at least one desktop and one laptop computer. These are either IBM PCs or Macintoshes.
- Webcam and speakers as required for the WebEx sessions

2.3.2. Software

2.3.2.1. Microsoft Office

A suite of products that will be used to write proposals as well as the design reviews. The suite includes Word, a word processor used to create written documents, PowerPoint used to create presentations, and Excel used to track budgets and schedules/timelines

2.3.2.2. Microsoft Visio

A program used to create block and flow diagrams as well as organizational charts

2.3.2.3. Adobe Photoshop

A program used to manipulate and edit photographs and drawings

2.3.2.4. Adobe Acrobat

A program used to create .pdf files which is a universal method to distribute documents since a .pdf reader is free and on most PCs.

2.3.2.5. Apogee RockSim

A CAD program used to help design the vehicle. In addition, this program calculates center of pressure and center of gravity to determine stability of the vehicle. It also allows flight simulation to help assure a stable rocket and safe launch.

2.3.2.6. Winroc

Winroc is a suite of programs allowing quick calculation of some essential vehicle parameters including Center of Pressure and Altitude based upon minimal data entry. It also allows engine thrust data entry and graphing. The Alticalc program allows quick estimation of essential flight data such as altitude, maximum velocity, maximum acceleration, speed at the end of the launch rod and more by entering only the weight, Cd, diameter and the engine type

2.3.2.7. DoubleCad XT (From ImsiSoft)

Double CAD is a free two dimensional CAD program for mechanical drawings. It is similar to the commonly used AutoCad program.

2.3.2.8. Eagle Light (from CadSoft)

This is a free version of a program that allows schematic entry and PCB (Printed Circuit Board) layout. The schematic entry capabilities are important for the payload, recovery, and tracking electronics.

2.3.2.9. SolidWorks

A 3D mechanical drawing program allowing a better representation of how various parts fit together mechanically.

2.3.2.10. Box.net (On-Line Collaboration Site)

Although strictly not software, the box.net site allows the team to share documents. Each team member has editor rights, so they can retrieve and post documents. As research is done and documents identified or written, they are posted on box.net.

2.3.2.11. AT&T Connect (Similar to WebEx for remote web based meetings)

Since not all members of the team can physically meet together all of the time due to geographic separation, we will occasionally meet via WebEx (AT&T Connect). Use of this software tool has been donated by Datamax-O'Neil in Irvine, CA (where several of the mentors and advisors work)

2.3.3. Web Presence

The SLI team has a tab on the AIAA OC Section Rocketry web site at http://aiaaocrocketry.org . At the top is a tab labeled "SLI". Under that tab is last year's pages (-> SLI 2010-2011) and this year's pages (-> SLI 2011-2012). Under the SLI 2011-2012 tab will be separate tables for "DOCUMENTS", "CALENDAR", "MSDS", "MANUALS", "PHOTOS", and "VIDEOS".

2.3.4. WebEx Facilities

We will use the Datamax-O'Neil Executive Conference Room in Irvine. Several of the mentors work at this location. Conferences and WebEx's are held frequently there and it is permanently equipped with:

- IBM PC computer
- Video projector and screen
- Two large plasma displays
- T1 line connected to the Internet
- Audio system with speakers
- ShoreTel conference phone

We provide a Logitech C910 web cam. In case of problems, all mentors from Datamax-O'Neil are familiar with the WebEx and network. If additional help is needed, Matthew Huecker or Jeff are the IT professionals on site. In addition, help from our headquarters in Keene, NH is available 24 hours each day at extension 12929.

2.4. Implementation of the Architectural and Transportation Barriers Compliance Board for Electronic and Information Technology

Section 508 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794d) assures that Federal Employees with disabilities as well as the general public have the same access and use of information and data as employees and the public without disabilities when Federal Agencies develop or use electronic and information technology (unless undue burden would be imposed on the agency). Teams that are part of the SLI are participating in a NASA (Federal Agency) project, and therefore fall under the same restrictions as the Federal Agency. This applies to three subparts:

- 1194.21 Software applications and operating systems: No software applications or operating systems are to be delivered
- 1194.22 Web-based intranet and internet information and applications: Documents will be posted on the Internet and accessible to all with Internet access, regardless of their disabilities. Any documents posted that were developed in Microsoft Office have built in accessibility provisions through layout and zoom, keyboard shortcuts, customization of toolbars, and task automation. In addition, Microsoft Office permits speech recognition as well as narration. Any documents posted using Adobe Acrobat can be used with the accessibility preferences which include colors, contrast, and layout including keyboard options.
- 1194.26 Desktop and portable computers: There are currently no team members with special needs in the AIAA OC Section SLI team. But the team uses standard IBM PCs on low tables which would be accessible by any disabled members, tools used with accessibility options are outlined in the paragraph above, and provisions will be made as-needed.

3. Safety

3.1. Level 2 and/or level 3 mentor designated as owner of rocket for liability purposes

For liability purpose the designated owner of the rocket is Robert Koepke. Robert is a mentor of the team, holds a level two NAR certification. His NAR membership number is 86144.

3.2. Written safety plan

Safety is very important; it's said to be crucial in this project. Without safety regulations SLI, TARC and all other projects of the same type would not be possible. This is written to aid the understanding of our team regarding regulations and procedures. Everyone will understand and demonstrate all proper procedures and safety rules while at a meetings and at outings. Everyone on the team has signed a formal agreement stating that they understand all safety procedures and regulations that should be carried out. Our complete safety plan for launches is located in Appendix B. Our complete shop safety plan is in Appendix C.

3.2.1. Description of plan for NAR/TRA personnel to perform on ensure the following

3.2.1.1. Compliance with NAR safety requirements

A summarization of all NAR and TRA safety requirements can be found in Appendix A. This table also shows how we comply with each NAR and TRA requirement.

3.2.1.2. Performance of all hazardous materials handling and operation

The performance and handling of hazardous products is very important. The MSDS is there to provide an overview of how to work safety with or how to handle each chemical. Each one has to contain certain information per OSHA 29 CFR 1910.1200. All of the students need to obey by all the rules that are stated in Appendix D.

3.2.1.3. Description of plan for briefing students on hazard recognition and accident avoidance and conducting the pre-launch briefings

There will be a power point presentation to brief students on recognizing hazardous materials, working with tools, and how to conduct a safe launch. Every team member is required to attend this presentation, and sign that they have attended the safety training and fully understand all the requirements that need to be met.

3.2.1.4. Description of methods to include necessary caution statements in plans, procedures, and other working documents.

Appendix D, the safety plan for Safety Rules when using Hazardous Materials requires that each document that contains instructions involving hazardous operations or materials point out that hazard in the document.

HAZARDOUS MATERIAL – SEE MSDS

HAZARDOUS OPERATION – SEE SAFTEY PLAN

3.3. Evidence we are cognizant of federal, state, and local laws regarding unmanned rocket launches and motor handling.

3.3.1. FAA regulations 14 CPF Subchapter F, part 101, subpart C

We have reviewed this document and the rules that pertain to SLI that are not already covered in the NAR or TRA rules govern rockets that are flown under the following conditions:

- The operation not conducted within five miles of an airport. We will be launching at Lucerne Dry Lake, which is located more than five miles away from any airport.
- In the manner that creates a collision with hazard with an aircraft. Our launch rules state we must check the sky and call out "Sky is clear".
- In a controlled airspace. Lucerne Dry Lake is not a controlled airspace.
- At an altitude where clouds or obscuring phenomena of more than five-tenths coverage prevails. This is part of our "Sky is clear" check.
- At an altitude where horizontal visibility is less than five miles. This is in our launch rules.
- Into any cloud. This is in our launch rules.
- Between sunrise and sunset. This is in our launch rules

When launching this or any other high power rocket, notice will be given to the FAA twenty four to forty eight hours before the launch, including the following information (all high powered launches will be done at sanctioned Rocketry Organization of California (ROC) launches – they obtain a waiver to at least 7,000 feet AGL (Above Ground Level) for each launch)

- Names and addresses of the operators.
- Estimated number of rockets to be launched.
- Estimated size and weight of the rocket.
- Estimated altitude.
- Location of the Launch
- Date and time of the launch.

Most other states, except California, abide by the same set of rules and regulations for Rocketry. California laws are set forth in the CalFire "Fireworks in California" document. In addition to the federal rules, California adds the requirement that all motors be certified in the state of California and bear the California State Fire Marshall's seal of approval.

3.3.2. Code of Federal Regulations part 55

The CFR part 55 covers explosives. Up until recently APCP (Ammonium Perchlorate Composite Propellant) motors were regulated as an explosive. However, the NAR and TRA brought a lawsuit against the BATF (Bureau of Alcohol, Tobacco, and Firearms) to have APCP removed as an explosive, and the NAR and TRA won that lawsuit. Consequently, "…APCP has been removed from the list of explosive materials…. As a result, APCP is no longer regulated under the Federal Explosives law 18 U.S.C. Ch 40.

Even though APCP is no longer classified as an explosive, it will still be treated as a hazardous substance. To eliminate the danger of storage, engines required for launch will be purchased at the ROC launches and used at that launch. Black powder is a low explosive and regulated except for small qualities for sport shooting; electric matches are similarly regulated. One mentor, Mr. Mike Stoop has a Low Explosives User Permit (LEUP) and suitable storage so that we can purchase and store these items.

3.3.3. NFPA (National Fire Protection Association) 1127

The NFPA document provides definitions of a single stage high power rocket propelled by a combination of model rocket motors having an installed total impulse of more the 320 Ns or a total of 125 g of propellant.

The NFPA document has been reviewed and was found to be the source of many of the NAR and TRA rules and therefore are covered elsewhere in this document.

3.4. Written statement that all team members understand and will abide by the safety regulations

The presentation referenced in section 3.2, which reflects our safety rules as well as those of NAR and TRA shows that there will be Range inspections of each rocket before flown, the Range Safety Officer has the final say, and emphasizes that any tem that does not comply with the safety requirements will not be allowed to launch their rocket. Members have received training and have signed that they have viewed the safety presentation and understand the rules and regulations. This is in Appendix F.

3.5. Risk Mitigations

For the separate major parts of the rocket, vehicle, recovery, and payload, the team has created separate risk analysis and respective mitigation. Mitigations to the risks that we see that could happen with different parts of the rocket and how we are going to address them:

3.6. Vehicle Risks and Mitigation

1. Risk: Engine does not ignite properly Mitigation: the team will measure the igniter to make sure the igniter is all the way in the engine to ensure that the motor ignites properly	4. The rocket caves in on itself Mitigation: the team is using carbon fiber material which will not cave in and the rocket will not be exceeding mach	7. Risk: Electronic matches fall out Mitigation: the electronic matches will be checked before putting in the sheer pins to ensure that they have been tightened down enough
2. Risk: Engine does not properly fit Mitigation: use the proper engine casing and make sure that the engine is in the motor mount	5.Quick links aren't attached Mitigation: the team will double check all connections to ensure that the rocket is assembled completely before preparing the rocket for launch.	8. Risk: Motor Explodes Mitigation: the engine will be built by the instructions and there will be no distractions present when building the engine.
3. Risk: Sabot tangles in shroud lines	6. Risk: Sheer pins don't sheer	9. Risk: Parachute was not packed correctly and does

Mitigation: the team members will make sure and double check that the rocket it packed correctly	Mitigation: the team will perform ground tests to test the amount of black powder to ensure that the sheer pins sheer, and the backup charge will have a higher amount of gunpowder	not deploy Mitigation: back up ejection charges with a higher amount of black powder and the team will double check fitting of the parachutes in the body tube

3.7. Recovery Risks and Mitigations

1. Risk: UAV doesn't deploy Mitigation: back up ejection charges	4. Risk: The drogue chute fires at the wrong altitude Mitigation: double check that the electronics are programmed correctly and that there is a pressure hole in the avionics bay	7. Risk: Main chute doesn't deploy Mitigation: back up ejection charges
2. Risk Main deploys with drogue Mitigation: double check the Fruity 'Chutes Tender Descender is set up correctly	5. Risk: The main chute fires at the wrong altitude Mitigation: double check that the electronics are programmed correctly and that there is a pressure hole in the avionics bay	8. Risk: Batteries of recovery electronics fall out Mitigation: The team will use battery holders and zip ties to ensure that the batteries do not fall out
3. Risk: HCX SD Card isn't inserted Mitigation: double check the SD Card is in the HCX before flight.	6. Risk: Drogue doesn't deploy Mitigation: back up ejection charges	9. Risk: Batteries fail Mitigation: Use fresh batteries and make sure the electronics will power up first in a test second before flight

3.8. Payload Risks and Mitigations

1. Risk: UAV doesn't detach from parachute Mitigation: double check the parachute connection to the	4. Autopilot isn't programmed correctly Mitigation: test autopilot on a scale and with full UAV model, make sure that the	7. UAV does get out of range Mitigation: the team is using a high power transmitter and most

AUV	team can take the UAV off of autopilot	sensitive receiver to ensure that we can communicate to the UAV
2. Risk: Batteries aren't connected Mitigation: double check that the batteries are connected	5. Risk: Servos Fail Mitigation: test and check battery connection to the servos	8.Risk: Motor fails Mitigation: check battery and test the motor before flight
3. Risk: Frequencies inference/cancelation Mitigation: the team will use a wide range of different frequencies, and will check to make sure no one is on the same frequency as the other	6. Risk: Telemetry doesn't work Mitigation: check display, ground station, to see that the telemetry is working properly	9. Risk: Wings don't fold out Mitigation: test the UAV to make sure wings work properly

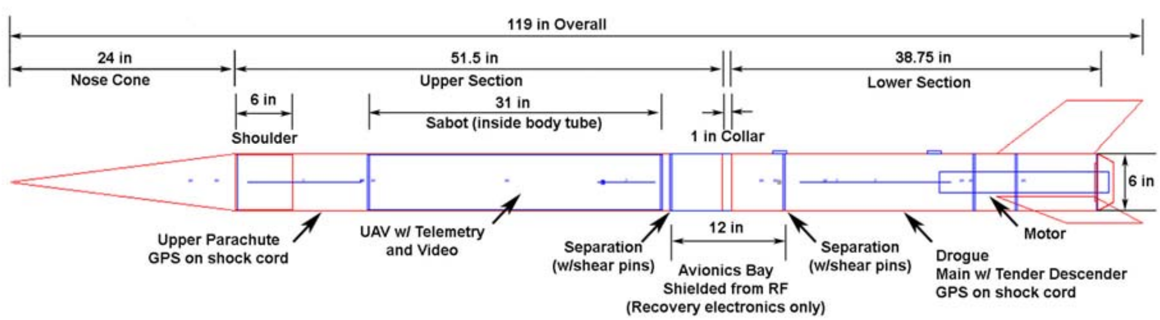
4. Technical Requirements

One of Akin's laws of spacecraft design seemed appropriate: "To design a spacecraft right takes an infinite amount of effort. This is why it's a good idea to design them to operate when some things are wrong." And that is what we have tried to do. The vehicle and payload are both able to be reused after each flight.

4.1. Vehicle design and dimensions

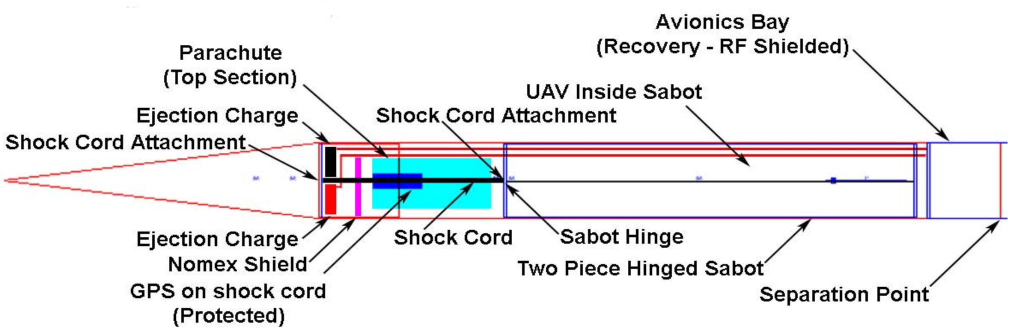
4.1.1. Overall Vehicle

Our rocket is a custom design using .028 inches thick carbon fiber body tubes and .25 inch thick composite bulkheads and centering rings. It will be composed of 3 main sections totaling a height of 119 in. The sections below and above the avionics bay are secured to the bay with #2 nylon shear pins to minimize the possibility of early separation before the ejection charge for that section fires.



4.1.2. Upper Section of Vehicle

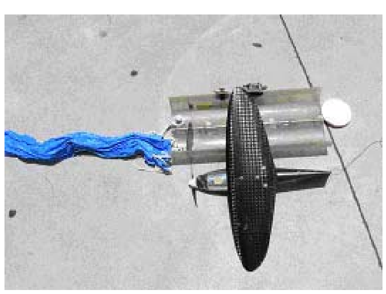
The upper section of our rocket will be 51.5 inches long and have a 24 inch long nosecone (with a 6 inch shoulder). There will be a composite bulkhead at the top of the nosecone shoulder that will conceal the GPS unit for the top section. This bulkhead will be secured with exterior bolts and will have an I-bolt in it for the attachment of a rip stock nylon shock cord. The top body section will hold a sabot that will hold our UAV during the flight along with a parachute for the upper section. There will be a parachute packed between the upper bulkhead and the sabot.



4.1.2.1. Sabot

The sabot will be 31 inches long and have a hinge at the top end. There will be an I-bolt on either side of the hinge with one consecutive loop of nylon cord tied through them to force the sabot open after deployment. The sabot will be made by sealing two bulkheads to either side of a coupler and cutting it in half. Since it will most likely be cut in half by a wide saw blade, this will reduce the outer diameter when closed, causing it to easily fit inside the body tube.

The photos below are from “Development of a Composite Bendable-Wing Micro Air Vehicle”

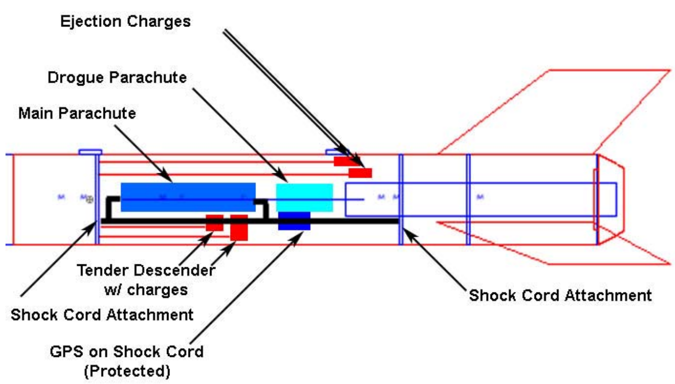


4.1.3. Avionics Bay

The middle section of the rocket will be the avionics bay. It will be made out of a 12 inch tube coupler with a 1 inch strip of outer tubing in the middle, leaving 5.5 inches of overlap into both the upper and lower sections of the rocket. It will be secured using 3 #2 nylon shear pins on either side of the coupler. The end bulkheads will be secured by 2 threaded metal rods secured at one end with nylon locking nuts and wing nuts on the other.

4.1.4. Sustainer

The sustainer (lower section of the rocket) will be 38.75 inches long with a 1.75 inch long tail cone. This section will hold an 18 inch long 54mm motor mount. It will also contain both our drogue and main parachutes for the lower section.



4.1.4.1. There will be three fins equally placed around the outside of the lower section 28.4167 inches from the front of the containing section. The fins will have a root chord length of 10.3333 inches, tip chord length of 8 inches, a sweep length of 7.4427 inches, a sweep angle of 53.285^{o}, a semi span of 5.5 inches, and they will be 0.1875 inches thick. The fins will be made out of a composite with honeycomb plate with a layer of .028 inch thick carbon fiber.

Main Parachute: 84 inch, Drogue Parachute 24 inch, UAV Parachute: 36 inch, Top Section Parachute: 60 inch, “K” 1050 motor (see below for details)
The initial size estimate of the parachutes required are based upon the estimated weight of the vehicle. And the liftoff weight will be different than the weight under recovery since the propellant will have burned off. For the initial estimates, we chose 6 different rocket engines across a rather narrow impulse range. The weights of those engines are as follows:

Motor	Grains	Loaded weight (g)	Propellant weight (g)	Burnout weight (g)
K828FJ	No Data	2223g	1373g	850g
K750-RL	6	2057g	1321g	733g
K820-BS	6	1982g	1164g	750g

K590-DT	6	1994g	1169g	755g
K660	6	1949g	1177g	734g
K1050	No Data	2128g	1362g	776g

For the vehicle weight estimate, we built a model in Rocksim with all weights accounted for totaling 7275g without a motor loaded. The top section weighs 111oz and the bottom section (with burnt motor) weighs 139oz. The following table was derived by using an on-line calculator for parachute size (http://www.aeroconsystems.com/tips/descent_rate.htm) with a main parachute size of 84", a drogue size of 24", UAV size of 36", and the top section size of 60" (based upon commercial availability).

There will be three main flight events and the rocket will fall in 2 pieces with the UAV on a separate parachute to validate full deployment before release. The first event will be the drogue deploying at apogee. The second is the top section separating from the sustainer and deploying the UAV at 1000ft (probably lower for visibility), and finally our main for the sustainer deploying at 500ft. As you can see from the tables below, we are under the 2500ft barrier in 15mph winds as required and with all pieces unless in winds 20MPH or over (which we are not allowed to launch in anyway).

Drogue (5820ft-1000ft)

Weight (oz)	Parachute size (in)	Velocity (ft/s)	Wind Speed (MPH)	Drift (ft)
304.5	24	80	5	391
304.5	24	80	10	784
304.5	24	80	15	1177
304.5	24	80	20	1569

UAV (1000ft-0ft)

Weight (oz)	Parachute size (in)	Velocity (ft/s)	Wind Speed (MPH)	Drift (ft)
34.2	36	18	5	406
34.2	36	18	10	815
34.2	36	18	15	1222
34.2	36	18	20	1630

Top Section (1000ft-0ft)

Weight (oz)	Parachute size (in)	Velocity (ft/s)	Wind Speed (MPH)	Drift (ft)
88.5	60	17.5	5	417
88.5	60	17.5	10	838
88.5	60	17.5	15	1257
88.5	60	17.5	20	1675

Sustainer after UAV (1000ft-500ft)

Weight (oz)	Parachute size (in)	Velocity (ft/s)	Wind Speed (MPH)	Drift (ft)
159.5	24	58	5	63
159.5	24	58	10	126
159.5	24	58	15	190

159.5	24	58	20	253

Main (500ft-0ft)

Weight (oz)	Parachute size (in)	Velocity (ft/s)	Wind Speed (MPH)	Drift (ft)
159.5	84	16.5	5	221
159.5	84	16.5	10	445
159.5	84	16.5	15	667
159.5	84	16.5	20	889

Total Drift for Top Section

Wind Speed (MPH)	Drogue Drift (ft)	Top Section Drift (ft)	Total Drift (ft)
5	391	417	808
10	784	838	1622
15	1177	1257	2434
20	1569	1675	3244

Total Drift for UAV

Wind Speed (MPH)	Drogue Drift (ft)	UAV Drift (ft)	Total Drift (ft)
5	391	406	797
10	784	815	1599
15	1177	1222	2399
20	1569	1630	3199

Wind Speed (MPH)	Drogue Drift (ft)	Sustainer After UAV Drift (ft)	Main Drift (ft)	Total Drift (ft)
5	417	63	221	675
10	838	126	445	1355
15	1257	190	667	2034
20	1675	253	889	2711

Total Drift for Sustainer

The top section returning under its own parachute has a mass of 88.7 grams, or 2.52 Kg. The lower section has a mass of 159.6 oz or 4.52 Kg. Under those conditions the heaviest section can fall at 20 ft/sec and still be under the required 75 ft lbf using: Kinetic Energy (joules) = ½ mv2 where m is in Kg and V is in m/s

		Kinetic Energy ft lbf	
Descent rate ft/s	**Descent rate m/s**	**88.75 oz (2.52 Kg)**	**159.6 oz (4.52 Kg)**
10 ft/s	3.048 m/s	8.64 ft lbf	15.47 ft lbf
15 ft/s	4.572 m/s	19.43 ft lbf	34.84 ft lbf
20 ft/s	6.096 m/s	34.53 ft lbf	61.94 ft lbf

The weight of this airframe is estimated to be (using the largest and smallest motor above):

Component	Weight (oz)			
Airframe, electronics bay, fins	121			
GPS Electronics + Battery + Frame	16			
Recovery electronics with battery	11			
Payload electronics, battery, Frame				
Adhesive, paint, misc hardware	4			
Upper Section parachute 72”	18			
Sustainer Main parachute 96”	26			
Drogue parachute 24”	6			
UAV parachute 24”	6			
Casing	12			
Motor K950-DT Loaded Weight	70			
Motor K950-DT Burnout Weight		26.5		
Motor K828FJ Loaded Weight			78.5	
Motor K828FJ Burnout Weight				30
Total weight of vehicle without engine	277			
Total Weight K950-DT during ascent	347			
Total Weight K950-DT during descent		303.5		
Total Weight K828FJ during ascent			335.5	
Total Weight K828FJ during descent				307

Before the full scale launch vehicle is built, a scale model will be designed, built, and flown to help assure success with the final vehicle.

References:

“Gene’s L3 Project Main Event” by Gene Engelgau from Fruity Chutes: Series of web pages showing the construction of Gene’s Level 3 carbon fiber/composite rocket. Construction of centering rings: http://www.fruitychutes.com/l3_docs/01-Composit_centering_rings.pdf Construction of fins: http://www.fruitychutes.com/l3_docs/05-Make_the_composite_fins.pdf .

“Composite Structures Curing Oven” by John Rockdale (using the plans from Shadow Aero): http://www.jrockdale.com/curing_oven.htm

“Vacuum Bagging Techniques” from West Systems: http://www.westsystem.com/ss/assets/HowTo-Publications/Vacuum-Bagging-Techniques.pdf

“The Ultimate Io Carbon Fiber Test Vehicle“ 7ft 6in long, 6”diameter, 4.25 lbs on H-180 built with Ultra-Lite PML body tubes: http://www.publicmissiles.com/UltimateIo.htm

‘The Advanced Composite Construction Video Series” and “The Composite Curing Ovens Plans Set”: http://www.shadowaero.com/page2/page2.html
Yahoo Groups on Composite Rockets (membership in group required to access files): http://groups.yahoo.com/group/CompositeRockets/files

"Kitchen Vacuum Bagging" by John Coker – Using the kitchen Food Saver as a vacuum pump for composite component construction:
http://www.jcrocket.com/kitchenbagging.shtml

4.2. Preparation and Launch

The team will generate a checklist for launch preparation. That checklist will guide the team through safe and complete preparation for launch and will include details on the following: preparation for launch and that all safety interlock switches should be off and batteries uninstalled. The battery for the GPSs will be installed but will remain off. The battery for the payload will be installed but will remain off. Six ejection charges will be prepared and installed (1 for the drogue, 1 for the main, and 1 for the UAV for each of the redundant and backup electronics). The two ejection charges for the main will be in two separate Tender Descenders from Fruity Chutes, and these will be in series. The safety interlock switches will be verified as "OFF" and batteries for the recovery electronics will be installed. The sustainer GPS will be placed in a foam cutout and secured to the shock cord. The parachutes will both be located in the sustainer section of the rocket, with the drogue parachute packed first then the main parachute put in a parachute bag attached to the Tender Descenders. The payload will be turned on when it deploys from the rocket via parachute, so a trip switch will be set up to trip when the electronics deploy the UAV. This will be done by pushing the bar of the trip switch down while placing it in the rocket and compressing the trip switch. The UAV will remain off until it is deployed as said before. The UAV will first be attached to the UAV parachute, the UAV parachute will be placed into the sabot followed by the UAV itself. The sabot will then be attached to the upper section parachute for the upper section, and then the upper section parachute will be attached to the upper section. Now the sheer pins can be put into place holding the vehicle sections above and below the avionics bay. The GPS device for the upper section will also be encased in a foam cut out and secured to the shock cord. The rocket can now be placed on the pad (standard launch rail), electronics armed, igniter installed and connected to the electronics launch system. To launch, it is necessary only to apply power to the igniter. Total time should be less than 2 hours.

4.3. Recovery Electronics

The vehicle will use redundant dual deployment for recovery and one more ejection for payload. The top section will be connected to the sabot with the parachute in between via a nylon shock cord, and the sustainer and the avionics bay will also be connected via a nylon shock cord. However, the avionics bay and the sustainer will have both a drogue and a main parachute between them. Recovery will occur in three phases – near apogee a small drogue parachute will be deployed that is designed to slow the rocket for initial decent. Much later, at an altitude of 1000 feet, our top section will separate deploying the UAV (with its own parachute) and deploying a larger parachute just for the top section and sabot. This separation will also lighten the sustainer and avionics bay allowing it to slow down. Finally the main will deploy via a fruity chutes Decender at 500 feet slowing us down to a safe landing speed. Each half of the redundant recovery electronics will use a different sensing device. In this way, if there is a bug in the design of either device that would affect the recovery during our flight it will not be replicated in the backup electronics. Each of the two recovery electronics has its own separate battery capable of powering the electronics for a minimum of 1 hour dwell time plus flight time. That battery is disconnected through an interlock key switch accessible on the outside of the vehicle approximately 3.5 ft above the fin end of the rocket so that the electronics is unarmed and not powered until it is safe to do so (when on the launch pad). They key can be removed only when the switch is locked ON. The recovery electronics will ignite a measured portion of gunpowder using an electric match. Recovery electronics are totally independent of the payload electronics and power. To assure that the recovery electronics will be minimally affected by the RF transmitters on board the vehicle, the interior of the avionics bay is sprayed with MG Chemicals SuperShield. One to two mil coating provides 40dB - 50dB shielding across a frequency range of 5 to 1800MHz. On board transmitters are at or near 420, 450, 900, and 1280 MHz. We also have receivers at 2.4GHz but do not transmit.

4.3.1. Recovery Electronics "A"

The main set of electronics will use a G-Wiz HCX controller. This device is similar to the MAWD except the range is higher (70,000 ft). And altitude is sensed via barometric pressure and accelerometer; this provides an additional level of security in the event there are barometric pressure anomalies during the flight causing a false trigger.

4.3.2. Recovery Electronics "B"

The backup electronics will use a Raven altimeter. This device will work up to 32,736 feet above the pad and records and reports the altitude audibly. It will store over 35 minutes of flight data after a prelaunch buffer of 0.352 to 0.704 seconds are stored into flash memory. It will deploy the drogue at a specific altitude or apogee and will deploy the main parachute at a specific height. The device measures 0.8" x 1.8" x 0.5" and weighs 6.6 grams. Altitude is determined via velocity and barometric pressure.

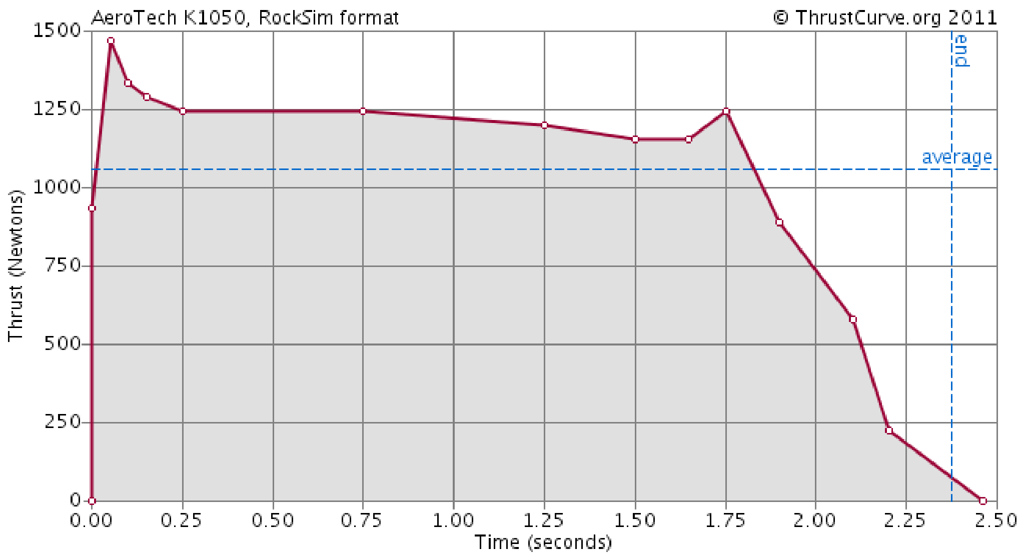
4.4. Motor type and design

The estimated vehicle design was entered into in Rocksim with a series of "K" motors and total vehicle weight to estimate the altitude that design and weight would reach. Based upon these simulated flights, the most probable motor for this design is a 54 mm Aerotech K1050. This motor will lift the vehicle and payload to the proper altitude (close to, but not exceeding 5,280 ft), will not subject the payload to any extreme acceleration force, and will keep the maximum speed under mach (1125 ft/s). The results of the simulations are shown below:

Vehicle = 277oz (17lbs 7oz) before the engine weight

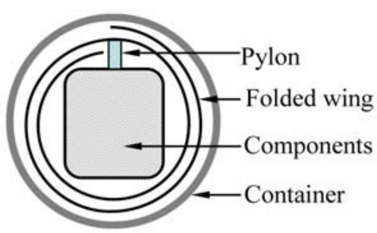
Engine	Total Impulse (Ns)	Total Mass (g)	Max Altitude (ft)	Max Velocity (ft/s)	Max Accel (ft/s/s)
K828FJ	2157	2223g	4234	621	394
K750-RL	2362	2057g	4778	657	291
K820-BS	2383.5	1982g	4865	672	539
K590-DT	2415	1994g	5011	611	573
K660	2437.5	1949g	5003	652	329
K1050	2522	2128g	5117	730	433

The thrust curve for the K1050 shows enough thrust quickly to get the vehicle up to speed while still on the launch pad for early flight stability, with a reasonable sustaining burn to reach altitude without subjecting the payload to any unreasonable forces, as also shown in the tables above. In addition, if needed, engines are available with less thrust should adjustment be needed in the final product. However, if we need more thrust, we will need to reduce the total weight of our rocket.



4.5. Science or engineering payload

The payload will be a small (Approximately 30" wingspan by 30" length) UAS/UAV deployed from a sabot in a section of the body tube in the nose end of the rocket. The UAV will be modeled after the Maveric UAV from Priori Systems (photo at right).



The wings of the UAV will be bendable and wrapped around the girth of the foam fuselage as illustrated in the drawing from "Development of a Composite Bendable-Wing Micro Air Vehicle" from the University of Florida in Gainesville.

By using this design, the aircraft will fit into a sabot inside a section of body tube 6" in diameter. The aircraft wings will automatically unroll and be flight worthy when released from the tube as indicated by this series of photos from a marketing video by Prioria Systems.

As required by the FAA in Advisory Circular AC 91-57, the UAV will be controlled from the ground via an RC link and capable of both RC and autonomous flight. The aircraft will be operated autonomously only at an altitude of 400 ft or lower. The system will include the following (note that frequencies are spread across the spectrum to minimize chances of interference):

- RC Control at 2.4GHz
- Autonomous Control
- Telemetry at 900 MHz
  - Airspeed
  - Altitude
  - Compass heading
  - Artificial horizon through a 3 axis magnetometer
  - GPS position
- Video at 1280 MHz
- Separate battery for electric motor and balance of electronics

When under autonomous control, using the ArduPilot Mega, this autopilot will be preprogrammed with a course that will contain waypoints and instructions with what do at each waypoint. This will include circling and climbing as well as going to the next way point. During this time, the UAV will return video of the flight as seen from the aircraft using the on board camera and separate transmitter at 1280 MHz as well as telemetry data from the flight using an X-Bee downlink on 900 MHz.

Autonomous/RC Control and Telemetry

Item	Mfg	Model	Size	Power	Weight
RC Receiver 2.4 GHz	Spektrum	AR8000 8 channel	1.35"x1.27"x.45"	3.5V-9.6V 80ma (est)	15.8g
Servos x2	EXI	D213F	22.6x11.4x22.2mm	4.8V – 6V	9g
CPU for autopilot	SparkFun	Arduino Mega 2560	4" x 2.1"	7-12 volts 50 ma	40g
Control and sensor interface	DIY Drones	IMU Shield/Oilpan Rev H	4" x 2.1"	25ma (est)	13g
3 axis magnetometer	DIY Drones			10ma (est)	8g
Airspeed	DIY Drones	Board with MPXV7002		10ma (est)	4g
Barometric pressure	DIY Drones	BMP085		10ma (est)	4g
GPS	DIY Drones	MediaTek MT3329	16mm x 16mm x 6mm	2.7 – 3.6V 40 ma (from	8g

				Shield)	
900 MHZ X-Bee (Telemetry – 1.8 miles)	Digi	XBee-PRO 900	1.3" x .96"	3.3v 210ma Tx 80ma Rx 60 ua stby	3g
Video Camera	Sony	DV-D3130CDNH	30x30mm	9~12.6V 50ma (est)	48g
Video Transmitter (1280Mhz	Lawmate	TM-121800	26x50x13mm	12V 450 mA	30g
TOTAL				935ma	182.8g

Aircraft

Item	Material/Type	Size	Comments	Weight
Fuselage	Foam	30 inch length (approx)	Rigid Fuselage	EST 138g
Wing	Carbon Fiber	29 inch span (approx)	Bendable Wing	EST 70g
Horizontal Stabilizer	Carbon Fiber or Foam	As mandated by final design	With controllable elevator	EST 30g
Vertical Stabilizer	Carbon fiber or foam	As mandated by final design	With controllable rudder	EST 30g
Brushless Motor	OutRunner Brushless Motor, Alpha 480	Length:36mm Diameter: 35mm	22~28A, 1020Kv	110g
Folding Propeller	APC	9x5	APCLP09050F	1g
Folding Prop Hub	APC	45mm Hub	APCLPFH3	3g
Electronic Speed Control	Volcano	45x24x11mm	07E04-Proton-30A	25g
TOTAL				407g

Power Supply

All electronics in the payload is battery powered. Several small batteries are used rather than one or two large batteries to assure that, in the event of a battery failure, some portions of the UAV will remain operational. All electronics remains powered off until the UAV is deployed. At that point, a microswitch closes which turns on the two solid state relays powering the entire plane – electronics and power train

Use	Technology	Volts	Capacity	Est Life	Weight
Receiver & Servos & Autopilot & Telemetry	LiFe Battery	6.6	1300 mAh	1 hour @ 935 ma	68g
Electric motor Plus video camera	LiPolymer Blue LiPo 83P-3000mAH-3S1P-11120C	11.1V	3000 mAh		145x50x17mm 269g

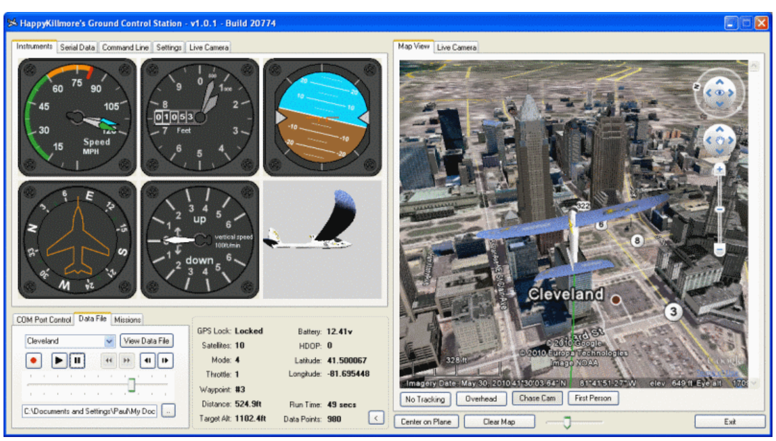
	Battery				
Relay (1)	Solid State				60g (est)
relay (1)	Solid State				40g (est)
Microswitch					10g (est)
Total					379g

Autonomous/RC Control and Telemetry	**182.8g**
Aircraft	**407g**
Power Supply	**379g**
TOTAL	**968.8g**

Ground Station

Item	Mfg	Model	Size	Weight
RC Transmitter	Spektrum	DX8	n/a	n/a
Laptop	HP		n/a	n/a
900 MHZ X-Bee (Telemetry)	Digi	XBee-PRO 900	n/a	n/a
Video Receiver	Lawmate	RX-1260CK	n/a	n/a
Video to USB converter	Multiple	Multiple	n/a	n/a

Ground Station Software
The Open Source community has written a program called Happy Killmore that provides a Graphical User Interface to all data returned from the UAV. The program runs on a laptop and accepts telemetry data via X-BEE and Video data from a receiver and a converter that makes the video signal appear as if it had been received from a USB WebCam



The Happy Killmore interface shows all telemetry data as well as video on a laptop

References with fabrication details:

- "Flexible-Wing Based Micro Air Vehicles", Peter G. Ifju, David A. Jenkins, Scott Ettinger§, Yongsheng Lian§ and Wei Shyy; Department of Aerospace Engineering, Mechanics and Engineering Science University of Florida, Gainesville, FL 32611-6250 and Martin R. Waszak; Dynamics and Control Branch, NASA Langley Research Center, Hampton, VA 23681
- "Development of a Composite Bendable-Wing Micro Air Vehicle", Baron Johnson, Daniel Claxton, Bret Stanford, Vijay Jagdale, Peter Ifju; Department of Mechanical and Aerospace Engineering, University of Florida, Gainesville, FL 32611-6250
- The Mechanics of Micro Air Vehicle Flexible Wings, (Presentation), Peter Ifju, Bret Stanford and Kyu-Ho Lee, Mechanical and Aerospace Engineerin, University of Florida
- The AIAA OC Section Web Page devoted strictly to the amateur UAVs including the DIY Drones autonomous control and associated community.

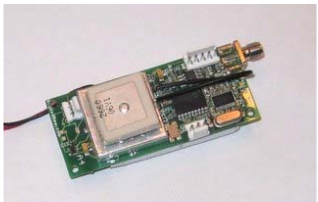
4.6. Requirements for rocket and payload

Each section of the vehicle that returns separately must have its own tracking electronics. The UAV has a GPS that transmits its location through the 900 MHz telemetry for the other UAV functions. The forward section of the vehicle has a GPS transmitting to a base station at the bottom of the 420-450 MHz ham band and the rear section of the vehicle has a GPS transmitting to a base station at the top end of the 420-450 MHz ham band. When active both are outside of carbon fiber. Frequencies of all devices are spread over the available spectrum to minimize chances of interference. Some frequencies require an amateur radio license; two mentors have license.

4.6.1. GPS (Global Positioning System)

Since there are two separate sections of the vehicle, two separate GPS electronic tracking systems will be included – one in the forward section and one in the rear section. This system will transmit the location of that portion of the vehicle (latitude, longitude, and altitude) to a ground station via an RF link. The system will consist of three separate components: Two GPS receivers and downlink transmitters (on separate frequencies) located in the rocket sections, on the shock cord to avoid attenuation by the carbon fiber body tube, and a downlink receiver, data converter, and display at the ground station that can be switched between the two transmitters

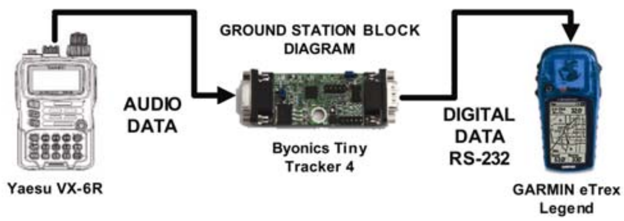
4.6.1.1. GPS and Downlink Transmitters



The GPS and Downlink Transmitters will be the Beeline GPS from Big Red Bee measuring 2 7/8" x 1 1/4", the antenna is 6.25" long. This device is an integrated GPS receiver and 70cm amateur transmitter (two mentors to the team have an amateur radio license) with a microcontroller translating the position received from the GPS receiver into AX.25 APRS (Automatic Packet Reporting System) information packets containing the latitude, longitude, and altitude of the rocket. This information is then transmitted as audio information via an integrated FM transmitter on any frequency of our selection in the 70 cm amateur radio band (420 – 450 MHz). Since two devices will be transmitting periodically from the same vehicle, each GPS will be set to transmit at opposite ends of the 420 – 450 MHz band. Each device is powered from its own single cell 750 mAH lithium battery (approximately 4.2 volts) which provides power for up to 10 hours. The device will also store 10 minutes of location data after launch is detected.

4.6.1.2. Ground Station

The GPS tracking station on the ground will enable the data received via the RF downlink to be interpreted by the team on the ground. It consists of three parts: (1) A Yaesu RX-6R handheld transceiver capable of receiving most frequencies from .5 to nearly 1000 MHz. It will be used on the two selected frequencies in the 70 cm amateur radio band. The audio output from this device is connected to a Byonics Tiny Track 4. This device is an interface that translates the encoded audio signals from the receiver into RS-232 data that can be sent to a GPS device that understands NMEA (National Marine Electronics Association). This output is then sent to (3) a Garmin eTrex Legend handheld GPS receiver that can show our current ground station location as well as the location of the rocket.



4.6.2. RF Devices (Including UAV Payload)

The following table shows the RF devices (receive and transmit) that are present in the vehicle. The frequencies have been spread across the spectrum to minimize the chances of interference.

Device	Frequency	Tx Power	Location
Big Red Bee Beeline GPS	Near 420 MHz	16 mw	Nose Section
X-Bee	900 MHz band	100 mw	UAV
Video Transmitter	1280 MHz	1 watt	UAV
RC Control	2.4 GHz	receive	UAV
Big Red Bee Beeline GPS	Near 450 MHz	16 mw	Motor Section

4.7. Testing

Testing is a vital portion of this project. If any one of the subsystems listed below fails, it puts the entire project in jeopardy. In addition to the testing of the subsystems, the team needs to become familiar with the set up of these subsystems and RC and autonomous control of the payload:

Vehicle and tracking ground testing

- Range and functionality of entire GPS system. Range tests will be done with each GPS in its final location in the vehicle
- Battery life tests will be run to assure there is sufficient battery capacity to run the GPS and recovery electronics for pad, flight, and recovery time
- Proper sizing of ejection charges vs. vehicle size and shear pins to assure parachute ejection – both scale model and full sized model with the vehicle in its full and final configuration.

- Functionality of deployment electronics – make certain we understand how to set up properly

Payload pre-test and electronics validation

- A foam "trainer" RC plane kit such as the Multiplex Easy Star will be built with radio, servos, electric motor. All team members in the Payload section will learn to fly via RC; one is already a skilled flyer and can help teach others
- The RC Plane will be modified to include the ArduPilot Mega (APM); the APM will be programmed and verified.
- The configuration and programming will be verified as possible on the ground
- The RC Plane will be flown again in RC mode, then switched to autonomous mode and the actual flight verified against the programmed flight

Actual payload ground and flight testing

- The UAV will be designed and constructed; initial flight tests will be gliding only
- RC electronics will be integrated and validated to work on the ground
- The UAV with RC will be taken to the desert and flown and verified airworthy and controllable and tuned as needed
- The APM from the RC plane kit will be integrated into the UAV and validated as possible on the ground
- The UAV will be taken to the desert for flight tests to validate RC and autonomous control
- The fully loaded UAV will be tested to assure sufficient range for control
- The fully loaded UAV will be tested for return of proper telemetry data and range of telemetry system
- The fully loaded UAV will be tested to assure sufficient battery life

Payload deployment ground testing

- The section of the vehicle to contain the UAV and sabot will be built
- That section of the vehicle with the UAV will be armed with ejection charges and verified for proper deployment of the vehicle before flight.

Vehicle with payload ground and flight tests

- A scale model will be designed and validated as stable through Rocksim with all electronics and payload.
- A payload glider will be built scaled for the smaller vehicle from the actual full-sized payload, but with the same bendable wing design
- The scale model will be built and ejection charges ground tested for recovery and payload sections. All testing will be done with all components present as if it were an actual launch.
- The scale model will then be flown as a glider to test stability as well as payload deployment. The UAV will have the rudder set to circle.
- This will be repeated for the final full sized vehicle, with the final UAV design as a glider with mass added to simulate the electronics
- This test will then be repeated with the full UAV with electronics. We do not believe it is sufficient, with this project, to test the full sized vehicle without the final payload.

4.8. Major challenges and solutions

This project can be challenging, including gathering and presenting all the required information, and making sure it's well written. Our major challenges are summarized in the table below:

Challenge	Solution

New more difficult payload, UAV	Work hard and have enough drive behind the project to complete it and make it successful. Our team is full of inspired students who want to do something that MIT and other Universities couldn't.
Our team's experiment will need more money this year than NASA's grant will give us. Carbon Fiber and composite construction is new to us.	We will start our fundraising earlier in the year. We will also incorporate new ideas into our fundraising plan, while still keeping some of our ideas from last year. We will continue our See's candy sales from last and have another car wash. One of our new ideas for this year is to send letters to large corporations, such as Raytheon, to donate money to our experiment.
Attaining exactly the 5,280 ft altitude required without going over	When the design is finalized, we will run RockSim simulations to determine we are close to the altitude. Then we plan more than one test launch of our vehicle to assure the simulations match reality

5. Educational engagement

5.1. Written plan for soliciting additional community support

We have already begun our educational engagement through raising additional support from the community. Phase I included

- Talk to local industry to inform them about this project and determine if there are individuals with expertise needed by the team. Our list of advisors is a result of this effort so far. The list includes software programmers, electrical engineers, mechanical engineers, web developers, and rocketry enthusiasts with Level 1 through Level 3 certifications, and a marine store will teach us how to fiberglass.
- Talk to vendors of rocketry and other supplies for donations and discounts
- Use the AIAA network to reach out to AIAA members in Southern California so they can in turn reach out to the schools those members are involved with to make them aware of SLI and TARC.
- Contact local newspapers for help in reaching the public by publishing articles on the team's progress.

Phase II will include more emphasis on fundraising and less on technical expertise:

- Contact the Discovery Science Center in Santa Ana for possible session with youths and rocketry.
- Letters to local businesses requesting financial aid
- Letters to aerospace companies requesting financial aid
- Garage sales, Mary Kaye, chocolate and more (already proven to work for TARC fundraising) and See's candy sales worked well for SLI last year.

5.2. At least two educational projects that engage a combined total of 75 or more younger students – to be completed prior to launch week 4/16/2011

- The SLI team will be part of the AIAA booth at Education Alley, which is a part of the AIAA Space 2011 Conference and Exposition. From September 27 through September 29th, hundreds of school classes visit Education Alley on a field trip to learn about space and even hear astronauts speak.
- The SLI team will take part in ROCtober with the Rocketry Organization of California (ROC) on October 8-9, 2011. ROCtober is a youth launch sponsored by the ROC where scouts, 4H, and any youth are invited to Lucerne Dry Lake to learn

about and launch rockets. Saturday is "Meet the Mentors and Teams" day where team members will be present in a booth all day to meet younger rocketeers and talk about rocketry, TARC, and SLI. On Sunday team members will be present in a booth to help these younger rocketeers build and prepare to fly their rockets. We did this last year and it was very successful.

- The SLI team will help Girl Scouts in the Marina Del Ray area build rockets at a large meeting on October 22, 2011 and another build meeting in Long beach on November 5, 2011. The younger scouts will be at the Marina Del Ray build meeting, while the older scouts will be at the Long Beach build meeting. We did this last year and it was very successful.
- The SLI team will help at the Girl Scout rocket launch in San Gabriel on November 19, 2011 (tentative date). They will promote rocketry, TARC, and SLI and help with preparation and the launch. This is the launch not only for the girl scouts that attended build meetings above but also for several other rocketry build sessions for the Girl Scouts in other cities. We did this last year and it was very successful
- The SLI team will have a booth at Youth Expo sometime in April (the dates have yet to be decided for this event). The team members will be promoting TARC, SLI, NAR, AIAA and aerospace at this event. We did this last year and were able to reach a lot of teachers and students.
- The SLI team will contact Discovery Science Center to attempt to participate in an event to promote SLI and aerospace. Last year at a fundraiser for SLI someone from Discovery Science Center spoke with the team about participating with Discovery Science Center.

6. Project Plan

This includes the budget, timeline and educational standards. This is basically with what were going to do it with, by when we're going to have it done and what were learning while we are working on this project. This section is essential for organization, so our team in fact gets everything done and submitted by the time necessary. This also lets us know if we need to start fundraising and by how much we need to make.

The timeline is located in Appendix G. This timeline includes the dates where we have to have things done by, or the dates we have to be working on the given project. There is a lot to be considered before a project is to be started. This timeline will help outline how we are to get things done.

The budget is located in Appendix H. This is the expense of the project. This includes everything from parts to travel. The budget has categories to locate the expense for the Vehicle, Recovery, GPS system, motors and travel. You can find the estimated total at the bottom where it says, Total Estimated project expenses.

6.1. Curriculum Framework - Outline of standards met locally

This project meets the educational standards by having the students investigate and analyze the data that the rocket receives. We have to use scientific calculations using calculus and physics, which includes Newton's laws of motion, gravitation pull, projectile motion, electrical power, density and pressure. We meet after school and weekends, since we are not a school.

6.2. Curriculum Framework - Outline of standards met nationally

Aspects of this project address the following:

- Develop short term goals for students

- Science meets the students learning ability
- Working together as a team
- Interactions with students
- Encourage all students to participate
- Have available time
- Make sure a safe work environment
- To be able to measure task are authentic
- Have the opportunity to present their data
- Study of motions and forces
- Investigating energy and mater
- Understanding technological design
- Understanding science and technology that are applicable to this project

7. Plan for sustainability of the rocket project in the local area.

The SLI team is part of the AIAA OC Section educational outreach whose goal is to inspire youth in science and engineering, especially aeronautical and astronautical engineering. The team mentors have formed the AIAA OC Section Rocketry Club (NAR Section #718). This club and group of SLI team members in turn guide a group of young rocketeers each month as they meet to learn about aerospace and build their rockets. In addition, the club has at least one launch outing each month. The club encourages participation in TARC (Team America Rocketry Challenge) and already has two teams this year, one all junior high school students and the other all high school students. As the youth continue to mature in their rocketry skills we will begin to offer larger scale and more challenging group projects. This program works as we have had several members go on to get their NAR Level 1 Jr certifications and go on to pursue aerospace engineering careers at Purdue and Cal Poly Pomona.

The team and rocketry club has taken and will continue to take an active roll in the Rocketry Organization of California ROCtober event which is a youth oriented event and launch at Lucerne Dry Lake.

The team and rocketry club last year started a "tradition" of participating in the Orange County Fairgrounds Youth Expo. The booth was well-received by the attendees as well as the Youth Expo staff and were excited that we will continue to return in subsequent years.

We have spoken with a retired high school physics teacher at the ROC Launches who would like to form a launch for all TARC teams that did not make the finals. We will actively pursue this together with the AIAA to start this launch tradition.

8. Deliverables

The deliverables per this proposal include:

- A reusable rocket and UAV payload available for NASA MSFC display and ready for launch in April 2012
- A scale model of that rocket with a glider only UAV payload flown before the CDR. A report of the data from that flight and the vehicle itself will be presented during the CDR
- A web presence by November 4, 2011. This already exists at http://aiaaocrocketry.org -> SLI->SLI 2011-2012. The web site will be updated with the team's progress, documents, photos, and videos throughout the year
- PDR report, PowerPoint presentation and Flysheet posted on the web site by November 28, 2011 with email notification and subsequent live WebEx presentation
- CDR report, PowerPoint presentation and Flysheet posted on the web site by January 23, 2012 with email notification and subsequent live WebEx presentation
- FRR report, PowerPoint presentation and Flysheet posted on the web site by March 26, 2012 with email notification and subsequent live WebEx presentation
- PLAR report for the rocket and payload posted on the web site by May 7, 2012 with email notification.
- Copies of any other products developed (journal, 3-D animation, media coverage, video, scrapbook, etc.) shall be delivered to the NASA MSFC Academic Affairs Office prior to the final launch.
- An electronic copy of the comprehensive report pertaining to the implemented educational engagement or activities shall be submitted prior to the launch in April 2012.
- An electronic copy of the comprehensive report pertaining to the implemented educational engagement or activities shall be submitted prior to the launch in April 2012.
- A safety plan outlining how NAR safety requirements will be implemented and how safety will be incorporated into all manufacturing, testing, and launching activities. The risk assessment will include such things as (but not limited to) the following: risks associated with faculty support, school support, financial/sponsor support, use of facilities, partnering arrangements, schedule risks, and risks associated with chosen designs. This will be updated throughout the program and presented at the CDR and FRR. The initial plan will be due with the PDR on November 28, 2011.

APPENDIX A
NAR and TRA Safety Rule Summary and Compliance

A brief summary of the NAR safety rules is listed below; these rules are the ones that apply to SLI and SLI only. The actual NAR rules can be found here. The actual TRA rules can be found here.

RULE	AIAA SLI Team Compliance
NAR: Person(s) will posses and fly only high power motors in their range of certification and required licensing TRA: The person who is a certified flyer shall operate and fly a high power rocket.	Only the team mentor with a minimum of Level 2 certification will purchase, possess, and load the high power motors ("K")
NAR: Materials that are lightweight such as; paper, wood, rubber, plastic, fiberglass, will be used to construct the rocket. Only when required will ductile metal be used for the construction of the rocket. TRA: The high power rocket vehicle is intended to be propelled by one or more high power solid propellant rocket motor(s) shall be constructed using lightweight materials such as paper, wood, plastic, fiberglass, or when necessary ductile metal.	The vehicle will be made primarily of fiberglass, with some wood, paper, and plastic as required in the payload and recovery areas. Metals will be those commonly used in the payload and recovery sections
NAR: The rocket motors that will be used will be certified and commercially made. They will not be tampered with or be used for anything except what is recommended by the manufacture. No smoking, open flame or any heat source will be allowed within twenty five feet of these motors. TRA: The motors that are used will be certified commercially made rocket motors. They will not be dismantled, reloaded, or altered disposable or expendable high power rocket motors. Only use the rocket motor for only the purpose stated by the manufacturer.	The rocket motor that has been selected for use is manufactured by Cesaroni, a commercial entity that makes motors for hobby rocketry. A no smoking sign will be posted near the motor loading area
NAR: Rockets will be launches with an electrical launch system and with electrical motor igniters that will be installed in the motor after the rocket is at the launch pad or in the designated prepping area. The launch system that is used will have a safety interlock that works with the launch	A Pratt Hobbies launch system is used for all team launches that have a safety interlock switch to turn the system on as well as a momentary launch button. The ROC launch area at Lucerne Dry Lake in the Mojave desert has a similar system.

switch that is not installed until the rocket is ready for launch and the launch switch will return to the off position after the launch. If the rocket contains an onboard ignition systems for the motors or recovery devices, they will have safety interlocks that will interrupt the current path until the rocket reaches the launch pad. TRA: The ignition system that is used is remotely controlled, electrically operated, and contains a launching switch that will return to "off" when released. The ignition system must contain a removable safety interlock device in series with the launch switch. The launch system and igniter combination must be designed, installed and operated so the liftoff of the rocket must occur within three seconds of actuation of the launch system. Ignition device must be installed in a high power rocket motor only at the launch site and at the last practical moment before the rocket is placed on the launcher	The rocket will be designed with a locking mechanism that keeps all power off of the electronics. Once safely on the pad, this key will be activated
NAR: If the rocket doesn't launch after the button on the electrical launch system has been pressed, the launcher's safety interlock will be removed or the battery will be disconnected. Sixty seconds will be waited before anyone will be allowed to approach the rocket.	This requirement is in our AIAA OC Section launch safety plan
NAR: If the rocket doesn't launch after the button on the electrical launch system has been pressed, the launcher's safety interlock will be removed or the battery will be disconnected. Sixty seconds will be waited before anyone will be allowed to approach the rocket. TRA: You can launch the high power rocket if you have the immediate knowledge, permission and attention of the safety monitor. Everyone should be standing and facing the launcher during a countdown and launch. The countdown should be audible by everyone. Don't approach the high power rocket that has had a misfire until the safety inter-lock has	This requirement is in our AIAA OC Section launch safety plan At our own launches we make certain to have everyone's attention, as is also true at the ROC launches

been removed or the batter has been disconnected from the ignition system, one minuet had passed and the safety monitor has given permission for a single person to approach the misfired rocket to inspect it.	
NAR: Before a rocket is launched there will be a five second countdown. No one will be any closer to the launch pad than allowed by the minimum distance table. In case of a problem a means of communication will be there to warn participants and spectators. Before the rocket is launched it will be checked for stability, it will not fly if stability cannot be determined. TRA: The person who fly's a high power rocket must first have it inspected and approved for flight by Safety Monitor for compliance with the applicable provisions of this code.	This requirement is in our AIAA OC Section launch safety plan. All launches require an RSO (Range Safety Officer) (Safety Monitor) to assure each rocket to be launched is safe to fly. In addition, ROC launches have an RSO to inspect the rocket after the SLI team inspection
NAR: The rocket will be launched from a stable device that provides rigid guidance until the rocket reaches the speed that guarantees a stable flight and is pointed within twenty degrees of vertical. If wind exceeds five miles per hour, the launcher will be adjusted to the length that permits the rocket to attain a safe speed before leaving the launcher. A blast deflector will be in place to prevent the motors exhaust from hitting the ground. No dry grass will be around the launch pad, the minimum distance table will be referred to when determining this, and will increase the distance by a factor of one point five if the rocket motor being launched uses titanium sponge in the propellant. TRA: The high power rocket should be launched from a stable device that provides rigid guidance until the rocket has reached adequate speed to ensure a safe flight path. A jet deflector should be in place to prevent rocket motor exhaust from impinging directly on flammable materials. The launch pad should be at an angle less than twenty degrees off vertical. Make sure the	This requirement is in our AIAA OC Section launch safety plan – we use a launch rail system as is also available at the ROC launches.

end of the launch rail or rod is capped to prevent eye injury.	
NAR: The rocket will not contain a combination of motors that totals more than 40,960 N-sec of total impulse. The rocket will not weigh more at liftoff than one-third of the certified average thrust of the high power motors intended to be ignited at launch. TRA: Make sure the rocket weighs less than the rocket motor manufacturer's recommended maximum liftoff weight for the rocket motor(s) used for the flight. During the preflight inspection the safety monitory may or may not request documentary proof of compliance. Do not install a rocket motor or combination of rocket motors that will exceed 40,960 N-Seconds of total impulse.	The AIAA SLI vehicle will contain a single "K" engine which, by definition, will contain no more than 2,560 Newton-seconds of thrust The vehicle is estimated to weigh approximately 220oz (13.75 lbs). A small "K" engine provides over 200 lbs of force.
NAR: The rocket will not be launched at targets, clouds, near airplanes, or on trajectories that take it directly over the heads of spectators or beyond boundaries of the launch site. The rocket will not have a flammable or explosive payload. The rocket will not be launched if the wind speeds exceed over twenty miles per hour. The person(s) launching the rocket will comply with Federal Aviation Administration airspace regulations when flying and will ensure the rocket does not exceed any applicable altitude limited in effect at the launch site. TRA: The person(s) flying the rocket must comply with the "Airspace Control and Facilities", Federal Activation Act of 1958 and other applicable federal, state, and local laws, rules, regulations, statutes, and ordinances TRA: Do not launch the high power rocket at a target, clouds or beyond the boundaries of the launch site. Do not launch a high power rocket if the wind exceeds twenty miles per hour. Do not launch the high power rocket if there is an aircraft in the window.	This requirement is in our AIAA OC Section launch safety plan. All high power launches will be done at a regularly scheduled ROC (Rocketry Organization of California). They regularly have at least a 7,000 ft AGL FAA waiver. The launch site is in the BLM (Bureau of Land Management) jurisdiction and ROC has obtained all permissions and complies with all rules.

NAR: The rocket will be launched outdoors, in an open area where trees, power lines, buildings and persons not involved in the launch do not present a hazard and that is at least as large as the smallest dimensions as one-half of the maximum altitude to which rockets are allowed to be flown at the site or 1500 feet, whichever is greater. TRA: The launch sight of high power rocketry should only be outdoor area, power lines, and building will not present a hazard to the safe flight operation of a high power rocket in the opinion of the safety monitor. Do not locate a launcher closer to the edge of the launch site than one-half the radius of the minimum launch site dimension. The launch site must be at least as large as the stated in the launch site dimension table.	The launch site is in the Mojave Desert at Lucerne dry lake. This area is best described as miles and miles of nothing but miles and miles. Measuring from Google Maps, the area is a minimum of 2 miles on each side – without vegetation, power lines, structures etc.
NAR: The launcher will be 1500 feet away from an inhabited building or from any public highway on which traffic flow exceed ten vehicles per hour, not including traffic flow related to the launch. It also won't be closer than the appropriate Minimum Personnel Distance from the accompanying table from any boundary of the launch site. TRA: The launcher location must be more than 1,500 feet from any occupied building. Make sure that the ground for a radius of ten feet around the launcher is clear of brown grass, dry weeds, or other flammable substances. TRA: No person(s) can be closer to the launch pad of a high power rocket than the person actually launching the rocket and those with the title of safety monitor. All spectators must remain within the area determined by the safety monitor and behind the safety monitor and the person who Is launching the rocket.	This requirement is in our AIAA OC Section launch safety plan. At Lucerne Dry Lake we are approximately 1 mile from the nearest road with no buildings in site. The ROC launch has pads out to ½ mile as needed. A spectator area is identified away from the pads. The ground is dried silt void of vegetation
NAR: The recovery system in the rocket will return all parts of the rocket safely and undamaged and can be flown again. The	The design for the vehicle returns all sections tethered together with dual deployment. Nomex or Kevlar shields are

rocket will use only a flame-resistant or fireproof recovery system wadding in the rocket. TRA: The rocket must contain a recovery system that will return all parts of the rocket safely to the ground, and so the rocket may be flown again. One flame resistant recovery wadding should be installed if wadding is required by design f the rocket.	used to protect the parachutes from damage by the ejection charges
NAR: The person(s) recovering the rocket will not attempt to recover the rocket from any power lines, tall trees, or other dangerous places. Therefore it will be flown under conditions where it is likely to recover in spectator areas or outside the launch site; no person(s) will attempt to catch the rocket as it approaches the ground. TRA: No person(s) should attempt to catch a high power rocket as it approaches the ground. No person(s) should retrieve a high power rocket from a place that is hazardous to people	This requirement is in our AIAA OC Section launch safety plan. At Lucerne Dry Lake, there are no nearby trees or power lines. The spectator area is regulated by the ROC.
TRA: The high power rocket should be constructed to withstand the operating stresses and retain structural integrity under conditions expected or known to be encountered during the flight	Materials used are those that have proven themselves to stand up to high power stresses (e.g. fiberglass body tube and fins instead of cardboard and fiberglass). Epoxy used is West System which is 5 times the strength of hobby store glue
TRA: The person intending to operate the high power rocket will determine its stability before flight, providing documentation of the location of the center of pressure and center of gravity of the high power rocket to the safety monitor, if requested.	The vehicle will have been shown to be stable using RockSim. In addition, the vehicle will bear a CP (Center of Pressure) decal at the location of the CP determined by RockSim. CG (Center of Gravity) can then be determined after the motor is loaded at time of launch to verify the CG is at least 1 caliper ahead of the CP.
TRA: The payload in the high power rocket should not be flammable, explosive, or cause harm. Don't fly vertebrate animal in a high power rocket.	The payload is an electronic experiment consisting of printed circuit boards and sensors and is not considered flammable

TABLE 1: SAFE DISTANCE

Installed Total Impulse (N-sec)	Equivalent Motor Type	Minimum Diameter of Cleared Area (ft.)	Minimum Safe Distance (feet)	Complex Minimum Safe Distance (feet)	Minimum Site Distance (feet)	Equivalent Distance (miles)
160.01 - 320.00	H	50	50	100	1,500	.28
320.01 - 640.00	I	50	100	200	2,500	.50
640.01 - 1280.00	J	50	100	200	5,280	1.00
1280.01 - 2560.00	K	75	200	300	5,280	1.00
2560.01 - 5120.00	L	100	300	500	10,560	2.00
5120.01 - 10240.00	M	125	500	1,000	15,480	3.00
10240.01 - 20480.00	N	125	1,000	1,500	21,120	4.00
20480.01 - 40960.00	O	125	1,500	2,000	26,400	5.00

APPENDIX B
AIAA OC Section Launch Safety Rules
For all rocketry activities (Youth – TARC – modified for SLI)

In an emergency, dial 911
California Poison Control Center: 1-800-222-1222

Our teams own rules completely comply with the rules stated above. The AIAA Orange County Sections rules are stated below and contain a table similar to the one included above.

- The materials that will be used will be lightweight materials such as; paper, wood, rubber, plastic, fiberglass or only when it's necessary, metal.
- The motors that will be used will be certified commercially made rocket motors. They will not be tampered with or used for anything except recommended by the manufacturer. There will not be smoking, open flames or any other heat sources within 25 feet of the motors.
- The rocket will be launched with an electrical launch system, and with electrical motor igniters that are installed when the rocket is on the launch pad or in the designated prepping area. The launch system will have a safety interlock that is in series with the launch switch that is not activated until the rocket is ready for launch and will use a launch switch that returns to the off position when released. If the rocket has an onboard ignition systems for motors and or recovery devices, they will have safety interlock that interrupts the current path until the rocket is at the launch pad. If the ignition systems has a second battery and relay at the pad, than the batter will be disconnected while the rocket is placed on the launch pad and the igniter is connected to the launch system.
- The launcher that is used will be a stable device that provides rigid guidance until the rocket has attained a speed that ensures a stable flight , and is pointed within twenty degrees of vertical. If the wind is over five miles per hour then the launcher length that permits the rocket to attain safe velocity before separation from the launcher. A blast defector will be used to prevent the motors exhaust from hitting the ground. There will be no dry grass around each launch pad in accordance with the minimum distance table.
- If the rocket doesn't launch, then the launchers safety interlock or disconnect the battery. Sixty seconds will be waited after the launch attempt before allowing anyone to approach the rocket. If the ignition system has a second battery and relay at the pad, that battery will be disconnected before approaching the rocket.
- The rocket will be checked for stability, a sound construction and any previous damage before it is allowed to fly. The rocket will not have a total thrust more than 40,960 N-Sec.
- The launch pad area will be checked to make sure there is no one closer to the launch pad than the minimum distance table states. The sky will be checked above the launch site to make certain there are no airplanes, helicopters or any other aircraft in the area before

launching. Stating “Range is clear” and “Sky is clear” before proceeding to launch. This will be followed by a five second count down to warn anyone in the area of launch.

- The rocket will not be launched at targets into clouds or obscuring phenomena, near airplanes or on trajectories that make it directly over the heads of spectators or beyond the boundaries of the launch site and will not have a flammable or explosive payload in the rocket. The rocket will not be launched to an altitude where the horizontal visibility is less than five miles. If the wind exceeds twenty miles an hour the rocket will not be launched. The person(s) launching the rocket will comply with the Federal Aviation Administration airspace regulations when flying and will make sure our rocket does not exceed any applicable altitude limit in effect at the launch site.

- The rocket will not be launched between sunset and sunrise e.g. not in the dark.

- The rocket will be launched outdoors in an open area where trees, power lines, buildings and person(s) not involved in the launch do not represent a hazard, and that is at least as large on its smallest dimension as one-half of the maximum altitude which rockets are allowed to be flown at that site, or 1500 feet, whichever is greater.

- The launcher location will be at least 1500 feet away from any inhabited building or from any public highway on which traffic flow exceeds ten vehicles per hour, not including traffic flow related to the launch. It will also be no closer than the appropriate Minimum Personnel Distance from the accompanying table from any boundary of the launch site.

- No person(s) shall be closer to the launch of our rocket than the person who is actually flying the rocket. All spectators shall remain behind the person launching the rocket. No person(s) shall be closer to the launch that the minimum safe distance table.

- The rocket will use a recovery system so that all parts of the rocket return safety and undamaged and can be flown again. We will use only flame-resistant or fireproof recovery system wadding and heat shields in our rocket.

- No person(s) will attempt to recovery the rocket from power lines, tall trees, or other dangerous places, fly it under conditions where it is likely to recovery in spectators areas or outside the launch site, nor attempt to catch it as it approaches the ground.

Two jobs exist to ensure safety, the range safety officer and the launch control officer.

The RSO (Range Safety Officer): has the overall control responsibility for the safety of the range and can shut down the launch site if it deems necessary. They are responsible to make certain that each rocket that is flown is safe to fly before it is launched. They make certain the fins and launch lug are present and securely fastened to the body tube. They make certain that the engine is installed properly and that the recovery system is functional. Although all persons responsible for designing and building a rocket need to make certain it is safe to fly, the range safety officer has the ultimate responsibility.

The LCO (Launch Control Officer) is responsible for supervising the actual launching of the rockets and that all conditions are safe to do so. This includes making sure that the launch pads are not armed when people are close to them. Before each launch they must check for people, including spectators, in an unsafe location and nearby aircraft. For the first launch of a rocket or if the launch includes any unusual risks, the flight will be announced as a "Heads-Up" flight. This person must track each flight until the rocket returns to ground level. Again, although all persons are responsible for designing and building the rocket, need to take these same precautions, the launch control officer has the ultimate responsibility.

APPENDIX C
AIAA OC Section Shop Safety Rules
For all rocketry activities (Youth – TARC – modified for SLI)

In an emergency, dial 911
California Poison Control Center: 1-800-222-1222

There is always a risk when someone is handling shop tools or near someone who is handling shop tools. Great precaution should always be there. Here are the AIAA Orange County Section shop rules

In general:

- Keep work area clean and orderly; neatly arrange equipment and material. Put all tools and materials back where you found them.
- If you are unsure about safe operation or process, request assistance from the program manager or mentor.
- When working with chemical, X-Acto knives, electrical tools or any tool where there is a danger of fumes or particles entering your eyes where safety glasses.
- If there is any unsafe conditions report them to your program manager or Mentor immediately. Rely on your own judgment and knowledge of safety to guide you.
- Horseplay is forbidden.
- If lifting a heavy object, lift with your legs not with your back, keep your back straight.
- Flammable liquids such as paints, solvents and thinners have to be stored in their original containers or in an approved safety cans with flamer arresters.
- Never use an air hose for cleaning or dusting yourself off. Never point it at anyone.
- If you have long hair you must tie it back or tuck it under a cap so it won't be caught in rotating tools.
- Think through the entire tasks before starting them and never rush or take chances.
- Using heavy glues and house hold chemicals should only be done in well ventilated areas; heavy sanding, painting and use of chemicals should only be done outdoors.
- When creating documents that require work with potentially hazardous tools or operations, that section will be marked with the following:

HAZARDOUS OPERATION – SEE SAFETY PLAN

Electrical Tools

- Don’t work with power tool sunless there is at least one other person present.
- Before operating any machine or equipment be certain alls safety guards are in place. The guards must be in replaced as soon as repairs or servicing on a machine has been completed and put into operation.
- Never tie down, block out or otherwise make inoperative of any type of safety device, attachment method or guard.
- Before energizing or operating any equipment verify the safety of all personnel.
- When a machine is de-energizing for the purpose of changing the setup or making a minor adjustment, turn off the machine and pull the plug. Allow the machine to come to a complete before proceeding with your task.
- Never oil, remove guards or attempt to repair machinery while it is on and in motion.
- Never use electrical equipment while standing on damp or wet surfaces or when your hands are wet.
- Wear clothes suitable for the work that you are doing. Loose clothing, neckties, rings, and watches, and even gloves create a hazard when operating tools. Long sleeves non-synthetic clothes should be worn when sparks or hot metal is present.
- Never use a rag near moving machinery.

APPENDIX D
Safety Rules when using Hazardous Materials

In an emergency, dial 911
California Poison Control Center: 1-800-222-1222

In the course of completing the launch vehicle, team members will come into contact with many hazardous substances. These substances will not pose a threat to the team members as long as rules are followed when handling. Material of concern includes adhesives and paints as well as the actual materials used to build the vehicle. The manufacturer of that material knows best the hazards posed. The manufacturer and safety organizations publish MSDS for each product.

An MSDS (Material Safety Data Sheet) is there to provide the overview of how to work safely with or how to handle this chemical or material. This is compiled by the manufacture of the particular chemical. MSDS do not have a particular format but are required to have certain information per OSHA (Occupational Safety and Health Administration) 29 CFR 1910.1200. A listing of the required information can be found on this website;
<http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10099>.

Threats to team member's safety that must be accounted for include (see details below the table):

Risk	Mitigation
Impact to the body	Gloves, apron, goggles
Cut or puncture	Gloves and Apron
Chemicals – fumes and/or direct contact	Gloves, respirator, goggles
Heat/cold	Gloves
Harmful Dust and small particles	Mask and Goggles
Loud noises	Earplugs

The team will keep a copy of the MSDS for all materials used in the construction of the vehicle, when an MSDS exists for that material. In addition, the following items will be present and available for use by team members whenever they are working or constructing the vehicle or payload, or whenever launching.

- Safety goggles
- Rubber gloves
- Leather gloves
- Respirators / Dust Masks
- Protective aprons
- Ear Plugs

Eye protection must be worn whenever there is a danger of

- Dust, dirt, metal or wood chips entering the eye. This can happen when sawing, grinding, hammering, or using power tools. When at a launch this can occur during strong winds (common at Lucerne Dry Lake)
- Chemical splashes including use of paints, solvents, or adhesives
- Objects thrown (intentionally or inadvertently) or swinging into a team member

Gloves must be worn to protect the team member's hands whenever there is a danger of contact with a hazardous material

- Latex or rubber gloves for possible contact with a hazardous chemicals such as adhesive, paint, or thinners, or even some solid materials
- Leather gloves to protect against impact or getting cut or abraded (e.g. in the use of some power tools such as grinders)

Team members will always work in a clean, well-ventilated area. Protection for a team member's lungs (dust mask or respirator) must be used whenever:

- Working with a chemical emitting fumes (e.g. paints and solvents) the team member must wear a respirator
- Working in an environment where there is dust (e.g. sanding and working with power tools) the team member must wear a dust mask.

Body protection, such as an apron must be worn whenever there is danger of

- Splashes or spills from chemicals
- Possible impact from tools

Ear protection (plugs or ear muffs) must be worn whenever there are loud noises present, which includes

- Using loud power tool or hammers
- At launches when launching larger rocket motors

When creating documents that require work with potentially hazardous materials including chemicals, that section will be marked with the following:

HAZARDOUS MATERIAL – SEE MSDS

A sample MSDS is included in the next appendix to show what is included. As materials are identified during the research and design phases of this project, suitable MSDS for all materials used will be obtained and made available to all team members in hard copy form in the work area as well as being posted on the web site.

APPENDIX E
Excerpts from the MSDS for NaCl (Table Salt)

MSDS Number: **S3338** * * * * * *Effective Date:* ***08/17/09*** * * * * * *Supercedes:* ***11/09/06***

MSDS *Material Safety Data Sheet*

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

From: **Mallinckrodt Baker, Inc.**
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS

J.T.Baker

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

---

1 SODIUM CHLORIDE

1.1 1. Product Identification

Synonyms: Salt; Rock Salt; Saline; Table Salt
CAS No.: 7647-14-5
Molecular Weight: 58.44
Chemical Formula: NaCl
Product Codes:
J.T. Baker: 3624, 3625, 3626, 3627, 3628, 3629, 4058, 4924
Mallinckrodt: 4577, 5519, 7361, 7503, 7532, 7534, 7540, 7544, 7576, 7581, 7713, V482

1.2 2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Sodium Chloride	7647-14-5	99 - 100%	Yes

1.3 3. Hazards Identification

Emergency Overview

WARNING! CAUSES EYE IRRITATION.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT; PROPER GLOVES
Storage Color Code: Green (General Storage)

Potential Health Effects

Inhalation:
May cause mild irritation to the respiratory tract.
Ingestion:
Very large doses can cause vomiting, diarrhea, and prostration. Dehydration and congestion occur in most internal organs. Hypertonic salt solutions can produce violent inflammatory reactions in the gastrointestinal tract.
Skin Contact:
May irritate damaged skin; absorption can occur with effects similar to those via ingestion.
Eye Contact:
Causes irritation, redness, and pain. (For salt concentrations greater than the normal saline present.)
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
No information found.

1.4 4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
If large amounts were swallowed, give water to drink and get medical advice.
Skin Contact:
Wash exposed area with soap and water. Get medical advice if irritation develops.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get medical attention if irritation persists.

1.5 5. *Fire Fighting Measures*

Fire:
Not considered to be a fire hazard.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

1.6 6. *Accidental Release Measures*

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal. Small amounts of residue may be flushed to sewer with plenty of water.

1.7 7. *Handling and Storage*

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

1.8 8. *Exposure Controls/Personal Protection*

Airborne Exposure Limits:
None established.
Ventilation System:
In general, dilution ventilation is a satisfactory health hazard control for this substance. However, if conditions of use create discomfort to the worker, a local exhaust system should be considered.
Personal Respirators (NIOSH Approved):
For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator (NIOSH type N95 or better filters) may be worn. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:

Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

1.9 9. *Physical and Chemical Properties*

Appearance:
White crystals.
Odor:
Odorless.
Solubility:
36g/100cc water @ 20C (68F)
Specific Gravity:
2.16
pH:
6.7 - 7.3 (aqueous solution)
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
1413C (2575F)
Melting Point:
801C (1474F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
1.0 @ 865C (1589F)
Evaporation Rate (BuAc=1):
No information found.

1.10 10. *Stability and Reactivity*

Stability:
Stable under ordinary conditions of use and storage. Hygroscopic.
Hazardous Decomposition Products:
When heated to above 801C (1474F) it emits toxic fumes of chloride and sodium oxide.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Lithium, bromine trifluoride.
Conditions to Avoid:
Incompatibles.

1.11 11. *Toxicological Information*

Oral rat LD50: 3000 mg/kg.

Inhalation rat LC50: > 42 gm/m3 /1H.
Skin rabbit LD50: > 10 gm/kg. Investigated as a mutagen, reproductive effector.

--------\Cancer Lists\--

	---NTP Carcinogen---		
Ingredient	Known	Anticipated	IARC Category
Sodium Chloride (7647-14-5)	No	No	None

1.12 12. *Ecological Information*

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

1.13 13. *Disposal Considerations*

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

1.14 14. *Transport Information*

Not regulated.

1.15 15. *Regulatory Information*

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Sodium Chloride (7647-14-5)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

		--Canada--		
Ingredient	Korea	DSL	NDSL	Phil.

Sodium Chloride (7647-14-5)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Sodium Chloride (7647-14-5)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Sodium Chloride (7647-14-5)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No

SARA 311/312: Acute: Yes Chronic: No Fire: No Pressure: No

Reactivity: No (Pure / Solid)

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

1.1616. Other Information

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
WARNING! CAUSES EYE IRRITATION.
Label Precautions:
Avoid contact with eyes.
Wash thoroughly after handling.
Label First Aid:
In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation develops or persists.
Product Use:
Laboratory Reagent.
Revision Information:
No Changes.
Disclaimer:
****

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (314) 654-1600 (U.S.A.)

APPENDIX F
Written statement from team members regarding safety)

We, the team members of the Student Launch Initiative team of the AIAA OC Section understand will abide by the following safety regulations:

- Range safety inspections of each rocket before it is flown. Each team shall comply with the determination of the safety inspection.
- The Range Safety Officer has the final say on all rocket safety issues. Therefore, the Range Safety Officer has the right to deny the launch of any rocket for safety reasons.
- Any team that does not comply with the safety requirements will not be allowed to launch their rocket.
- The NAR and TRA safety rules
- AIAA OC Section launch, shop, and hazardous materials safety rules

We, the team members of the Student Launch Initiative team of the AIAA OC Section understand will abide by the following safety regulations:

- Range safety inspections of each rocket before it is flown. Each team shall comply with the determination of the safety inspection.
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- Any team that does not comply with the safety requirements will not be allowed to launch their rocket.
- The NAR and TRA safety rules
- AIAA OC Section launch, shop, and hazardous materials safety rules

No.	Date	Name	Signature
1	9/17/11	Sjoen Koepke	[signature]
2	9/17/11	Jonathan Baek	[signature]
3	9/17/11	Joey Earl	[signature]
4	9/17/11	Nicholas Friebert	[signature]
5	9/17/11	Mika Janbahan	[signature]
6	9/17/11	Jimmy Kim	[signature]
7	9/17/11	Justin Paek	[signature]
8	9/17/11	Maitri Patel	[signature]
9	09/17/11	Divya Patil	[signature]
10	09-17-11	Lekha Patil	[signature]
11	9-17-11	Mitchell Tao	[signature]
12	9/17/11	Tina Zhu	[signature]
13	9/17/11	Hyun Sub Jung	[signature]
14	9-18-11	Joshua You	[signature]
15			
16			
17			
18			
19			
20			

APPENDIX G
Project Timeline

AIAA SLI Project Timeline

		Sept						Oct					Nov				Dec					Jan				Feb				Mar				Apr						
Items	**Due Date**	4	10	11	17	18	19	8	15	17	21	29	5	9	19	28	5	14	17	24	31	6	14	23	28	1	10	11	25	4	11	18	26	2	11	18	19	20	21	7
Prepare Proposal																																								
Proposal due for review	9/19/2011																																							
Electronic Proposal Due to NASA	9/19/2011																																							
ROCtober fest (outreach)	10/8-10/9																																							
NASA accepts our proposal	10/17/2011																																							
Girl scouts - present/assist in rockets (outreach)	10/15/2011																																							
SLI team teleconference	10/21/2011																																							
Girl scouts - present/assist in rockets (outreach)	10/29/2011																																							
Establish and create website																																								
Website presence established	11/9/2011																																							
Girl Scout Launch (outreach)	11/5/2011																																							
More detailed design of full sized rocket	11/28/2011																																							
More detailed design of scientific payload	11/28/2011																																							
Prepare PDR report presentation	11/28/2011																																							
PDR report and presentation on website	11/28/2011																																							
PDR presentation	12/5-12/14																																							
Integrate GPS electronics (vehicle and ground)	12/3-12/17																																							
Build Payload and Recovery Electronics	12/3-12/17																																							
Design Scale Model Rocket	12/3-12/17																																							
Build Scale Model Rocket	12/3-12/17																																							
Test GPS functionality and Range	12/17/2010																																							
Launch Scale Model Rocket	12/17- 1/6																																							
Fly Foam and Glider	12/17-1/6																																							
Prepare CDR report and presentation	12/3-1/22																																							
CDR reports and presentation posted on website	1/23/2012																																							
CDR presentation	2/1-2/10																																							
Finalize design of full size rocket	2/4-3/3																																							
Build full size rocket	2/4-3/3																																							
Build UAV	2/4-3/3																																							
Test Gunpowder for dual deployment	1/28- 2/10																																							
Launch Full Sized Rocket with UAV	2/25- 3/10																																							
Prepare FRR report and presentation	2/11-3/10																																							
FRR reports and presendtation posted on website	3/26/2012																																							
FRR Presentations	4/2-4/11																																							
Travel to Huntsville	4/18/2012																																							
Flight Hardware and Safety Checks	4/19- 4/20																																							
Launch Day	4/21/2012																																							
Prepare Post Launch Assessment Review	4/21-4/28																																							
Post-Launch Assessment Review posted on Web	5/7/2012																																							
Arrange outreach events & publicity	on-going																																							
Fundraising	on-going																																							

APPENDIX H
Project Budget

Description	unit costs	extended costs
Scale vehicle and engines		
scale vehicle, engines and engine retainer	160.00	
H size motors (each)	30.00	
Tender Descender HDPE	60.00	
Total Scale Vehicle Cost		**$250.00**
contigent second rocket in case rocket is destroyed	250.00	
Vehicle		
6" diameter body tubes 90"	$274.94	
Couplers	90.00	
Bulk Heads (3 @ $15)	75.00	
Centering rings(3 @ $10)	30.00	
Nosecone	$202.34	
Material for fins	60.00	
Tail cone	100.00	
"U" Bolts, Closed "eye" Bolts	75.00	
metal rods	10.00	
saftey interlock switches (4 @ $5)	20.00	
engine retainer	20.00	
Launch Lugs	7.00	
K1050 54mm engines (3@ 135.99)	408.00	
Total vehicle cost		**$1,372.28**
contingent second rocket in case rocket is destroyed	1,372.28	
Recovery		
Raven Altimeter	155.00	
Download Cable for MAWD	From Last Year	
G-Wiz Partners HCX/50 flight computer	From Last Year	
Download Cable for HCX	From Last Year	
Mini Sd card for HCX 8GB	From Last Year	
Electric Matches - 30 at $1.50 each	From Last Year	
Gun Powder FFFF 1 Lb	From Last Year	
Sheer Pins	4.00	
Batteries	5.00	
Battery Holders	From Last Year	
Terminal Block	From Last Year	
Saftey Switches	From Last Year	
Remove Before Flight Switches 2 at $5.00 each	From Last Year	
Misc (wiring, rubber gloves, cable ties, ect.)	From Last Year	
Main Parachute	From Last Year	
Drogue Parachute	From Last Year	
UAV Parchute	From Last Year	
Copper Screen	34.00	
Total Recovery Cost		**$198.00**
Contingent second recovery just in case first is destroyed	198.00	

Payload		
Ardu Pilot Mega Kit w/ GPS	250.00	
X Bee Telemitry Kit	150.00	
Lawmate transmitter	85.00	
Lawmate Reciever	43.99	
Sony Video Camera D3130CDNH	99.99	
Roll/Tilt Camera Mount	19.99	
H5-55 Micro Servo (2) at 12.99 each	25.98	
Blue Lipo 3 cell 3,000 mA a Battery	15.58	
Alpha 480 (1020 kv) OutRunner Brushless Motor	16.70	
Absolute Pressure and Temperature Sensor- BMP085	24.95	
UAV Body	25.00 est	
UAV Wing	75.00 est	
UAV Rudder	50.00 est	
Horizontal Stabilizer	50.00 est	
Vertical Stabilizer	50.00 est	
Folding Propellor	4.46	
Folding Prop Hub	3.95	
Electronic Speed Control	15.00	
Total Payload Cost		**1,005.59**
Contingent second payload just in case first is destroyed	1,005.59	
GPS System		
Beeline GPS (70 cm)	From Last Year	
Byonics Tiny Track 4	From Last Year	
Garmin Legend Handheld GPS Navigator	From Last Year	
Misc (wiring, connectors, etc.)	From Last Year	
Beeline GPS (70 cm, on different frequency)	300.00	
Total Payload Cost		**300**
Contingent GPS Rocket Transmitter (Beeline)	300.00	
Educational Outreach		
Travel to local launches (per vehicle)	50.00	
Travel to educational Events (per vehicle)	25.00	
Printing Costs (flyer, brochures)	100.00	
Rocket Kits	100.00	
Total Educational Outreach		**275.00**
Travel (16 team members, 4 days)		
Travel to Huntsville, Alabama ($450 per person)	7,200.00	
Cost of food ($30 per person)	480.00	
Cost of hotel ($200 per person at 2 per room)	3,200.00	
Total Travel (estimated)		**10,880.00**
Total Estimated Project Expenses		**$17,406.74**

APPENDIX I
Technical Requirements Cross Reference

No.	Requirement in SOW	Proposal Section
1	The Vehicle shall carry a science or engineering payload of the team's discretion	4.5
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).	4.4
3	The recovery system electronics shall have the following characteristics:	See Below
3a	The recovery system shall contain redundant altimeters. The term “altimeters” includes both simple altimeters and more sophisticated flight computers.	4.3
3b	Each altimeter shall be armed by a dedicated arming switch.	4.3
3c	Each arming switch shall be accessible from the exterior of the rocket airframe.	4.3
3d	Each arming switch shall be capable of being locked in the ON position for launch.	4.3
3e	The recovery system shall be designed to be armed on the pad.	4.3
3f	The recovery system electronics shall be completely independent of the payload electronics.	4.3
3g	Each altimeter shall have a dedicated battery.	4.3
3h	Each arming switch shall be a maximum of six (6) feet above the base of the launch vehicle.	4.3
4	The launch vehicle and science or engineering payload shall remain subsonic from launch until landing.	Table in 4.4
5	The launch vehicle and 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.	4
6	The launch vehicle shall stage the deployment of its recovery devices, where a drogue parachute is deployed at apogee and a main parachute is deployed at a much lower altitude. Tumble recovery from apogee to main parachute deployment is permissible, provided that the kinetic energy is reasonable.	4.3
7	The recovery system electronics shall be shielded from all onboard transmitting devices, to avoid inadvertent excitation of the recovery system by the transmitting device(s).	4.3
8	Removable shear pins shall be used for both the main parachute compartment and the drogue parachute compartment.	4.1.1
9	The launch vehicle shall have a maximum of four (4) independent or tethered sections.	4.1.4.1

9a	At landing, each independent or tethered sections of the launch vehicle shall have a maximum kinetic energy of 75 ft-lbf.	4.1.4.1
9b	All independent or tethered sections of the launch vehicle shall be designed to recover with 2,500 feet of the launch pad, assuming a 15 mph wind.	4.1.4.1
10	The launch vehicle shall be capable of being prepared for flight at the launch site within 2 hours, from the time the waiver opens.	4.2
11	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.	4.3, 4.5
12	The launch vehicle shall be launched from a standard firing system (provided by the Range) using a standard 10-second countdown	4.2
13	The launch vehicle shall require no external circuitry or special ground support equipment to initiate the launch (other than what is provided by the Range).	4.2
14	Data from the science or engineering payload shall be collected, analyzed, and reported by the team following the scientific method.	4.5
15	An electronic tracking device shall be installed in each independent section of the launch vehicle and shall transmit the position of that independent section to a ground receiver. Audible beepers may be used in conjunction with an electronic, transmitting device, but shall not replace the transmitting tracking device.	4.6.1
16	The launch vehicle shall use a commercially available solid motor propulsion system using ammonium perchlorate composite propellant (APCP) which is approved and certified by the National Association of Rocketry (NAR), Tripoli Rocketry Association (TRA) and/or the Canadian Association of Rocketry (CAR).	4.4
17	The total impulse provided by the launch vehicle shall not exceed 2,560 Newton-seconds (K-class). This total impulse constraint is applicable to any combination of one or more motors.	4.4
18	The rocket shall use commercially available solid motor propulsion system using ammonium perchlorate composite propellant (APCP) which is approved and certified by the National Association of Rocketry (NAR), Tripoli Rocketry Association (TRA) and/or the Canadian Association of Rocketry (CAR)	4.4
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.	4.7

	b. The vehicle and recovery system shall have functioned as designed.	
20	The following items are prohibited from use in the launch vehicle:	See Below
20a	Flashbulbs. The recovery system must use commercially available low-current electric matches.	4.3
20b	Forward canards	4.1.1
20c	Forward firing motors	4.1.1
20d	Rear ejection parachute designs	4.1.1
20e	Motors which expel titanium sponges (Sparky, Skidmark, MetalStorm etc.)	4.4
21	Each team shall use a launch and safety checklist. The final checklist shall be included in the FRR report and used during the flight hardware and safety inspection and launch day.	4.2
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.	1.6
23	The rocketry mentor supporting the team shall have been certified by NAR or TRA for the motor impulse of the launch vehicle, and the rocketeer shall have flown and successfully recovered (using electronic, staged recovery) a minimum of 15 flights in this or a higher impulse class, prior to PDR.	1.4.3

APPENDIX J
Proposal Requirements Cross Reference

No.	Section Requirement in Proposal	Proposal Section
School Information		
1	Name of school/organization and title of project	1.1 1.2
2	Name and title of the administrative staff member (this person will be referred to as the "team official") dedicated to the project.	1.3
3	Names and titles of a minimum of two dedicated educators or mentors.	1.4 1.5
4	Approximate number of student participants who will be committed to the project and their proposed duties.	1.6
5	Include an outline of the project organization that identifies the key managers (students and/or administrators) and the key technical personnel. Short resumes should be included in the report for these key positions (first names only)	1.4 1.5 1.6
6	Name of NAR/TRA section the team is associating with for the launch assistance, mentoring, and reviewing.	1.7
Facilities and Equipment		
7	Description of facilities and hours of accessibility that will be used for the design, manufacture, and test of the rocket components; the rocket; and the science payload.	2.1
8	Necessary personnel, facilities, equipment, and supplies (not otherwise provided by the Government) that are required to design and build a rocket and payload. The team shall make provisions for verifying the altitude of the rocket.	2.2 2.1
9	Computer equipment: Describe the type of computer equipment accessible to participants for communications; for designing, building and hosting a team Web site; and for document development to support design reviews.	2.3
10	The team shall provide and maintain a Web presence where the status of the project will be posted, as well as a list of needed materials and/or expertise. The team official will provide the capability to communicate via e-mail with the NASA SLI Project Office. The information technology identified could include computer hardware, computer-aided drafting (CAD) system capability, Internet access, e-mail capability, and presentation simulation software.	2.3.3
11	The team shall provide additional computer equipment needed to perform WebEx video teleconferencing. Minimum requirements include the following: ●● Windows, Mac, Linux, Unix, or Solaris computer systems. ●● Broadband internet connection	2.3.4

	●● Speakerphone capabilities in close proximity to the computer. ●● USB webcam or analog video camera. ●● Personal name and contact information for WebEx/connectivity issues.	
12	SLI teams must implement the Architectural and Transportation Barriers Compliance Board Electronic and Information Technology (EIT) Accessibility Standards (36 CFR Part 1194) (http://www.acquisition.gov/far/current/ html/Subpart%2039_2.html#wp1004775) Subpart B-Technical Standards (http://www.section508.gov/index.cfm?FuseAction=Content&ID=12): ●● 1194.21 Software applications and operating systems. (a-l) ●● 1194.22 Web-based intranet and internet information and applications. 16 rules (a-p) ●● 1194.26 Desktop and portable computers. (a-d)	2.4
Safety		
13	The Federal Aviation Administration (FAA) [www.faa.gov] has specific laws governing the use of airspace. A demonstration of the understanding and intent to abide by the applicable federal laws (especially as related to the use of airspace at the launch sites and the use of combustible/flammable material), safety codes, guidelines, and procedures for building, testing, and flying large model rockets is crucial.	3.3.1
14	The procedures and safety regulations of the National Association of Rocketry (NAR) [http://www.nar.org/safety.html] should be used for flight design and operations. The team official and NAR/Tripoli Rocketry Association (TRA) mentors shall oversee launch operations and motor handling	3.4 Appendix A
15	Each team is responsible for contacting their local NAR or TRA chapter and establishing a relationship with a currently certified level 2 or 3 NAR/TRA mentor. This person's name and contact information should be included as a team member. The NAR/TRA mentor will be instrumental in helping the team learn sport rocketry practices and will be responsible for safety inspections. The NAR/TRA team member is designated as the individual owner of the rocket for liability purposes and MUST accompany the team to the SLI launch in April.	1.4.1 1.4.3 1.5.7 1.7
16	Provide a written safety plan addressing the safety of the materials used, facilities involved, and person responsible for insuring that the plan is followed.	Appendix C Appendix D
17	A risk assessment should be done for all these aspects in addition to proposed mitigations. Identification of risks to the successful completion of the project should be included. a. Provide a description of the plans for NAR/TRA personnel to perform or ensure the following:	3.6, 3.7, 3.8
17a	▪▪ Compliance with NAR safety requirements.	Appendix A

17b	▪▪ Performance of all hazardous materials handling and hazardous operations	Appendix D
18	b. Describe the plan for briefing students on hazard recognition and accident avoidance, and conducting pre-launch briefings.	Appendix F
19	c. Describe methods to include necessary caution statements in plans, procedures and other working documents.	3.2 1.4
20	Control of all hazardous materials (applicable Materials Safety Data Sheets (MSDS) for your project must be included in your proposal under safety plan).	Appendix D MSDS tab on web site
21	Each team shall provide evidence that they are cognizant of federal, state, and local laws regarding unmanned rocket launches and motor handling. Specifically, regarding the use of airspace, Federal Aviation Regulations 14 CFR, Subchapter F, Part 101, Subpart C; the handling and use of low-explosives (Ammonium Perchlorate Rocket Motors, APCP), Code of Federal Regulation 27 Part 55: Commerce in Explosives Note: These regulations are not applicable to most hybrid motors); and fire prevention, NFPA 1127 "Code for High Power Rocket Motors."	3.3
22	A written statement that all team members understand and will abide by the following safety regulations: a. Range safety inspections of each rocket before it is flown. Each team shall comply with the determination of the safety inspection. b. The Range Safety Officer has the final say on all rocket safety issues. Therefore, the Range Safety Officer has the right to deny the launch of any rocket for safety reasons. c. Any team that does not comply with the safety requirements will not be allowed to launch their rocket.	Appendix F
Technical Design		
23	A proposed and detailed approach to rocket and payload design.	4.1, 4.5
24	Include projected general vehicle dimensions.	4.1
25	Include projected motor type and size.	4.4
26	Include a projected science payload.	4.5
27	Address the primary requirements for rocket and payload.	4.1, 4.5
28	Include major challenges and solutions.	4.8
Educational Engagement		
29	A written plan for soliciting additional "community support," which could include, but is not limited to, expertise needed, additional equipment/supplies, monetary donations, services (such as free shipping for launch vehicle components, if required, advertisement of the event, etc.), or partnering with industry or other public, private, or parochial schools.	1.5.8 5.1
30	Include plans for at least two educational projects that engage a combined total of 100 or more middle school educators or students in a hands-on rocketry experience to be completed prior to launch week,	5.2

	April 18, 2012. Comprehensive feedback on the activities must be developed and submitted along with an educational engagement form. The Educational Engagement form will need to be completed and submitted within two weeks after completion of an event.	
Project Plan		
31	Provide a top-level development schedule/timeline which should outline the project milestones and the basic schedule for designing, building, testing, and launching the rocket and payload(s).	Appendix G
32	Provide a budget for all proposed activities, including travel to/from Huntsville. This should include a detailed plan on how the project will be funded.	Appendix H
33	Describe how the project meets curriculum framework and national education standards. a. Outline standards met at your local level b. Outline standards met at the National level.	6.1
34	1. Develop a clear plan for sustainability of the rocket project in the local area. This plan should include how to provide and maintain established partnerships and regularly engage successive classes of students in rocketry. It should also include partners (industry/community), recruitment of students, funding sustainability, and educational engagement.	7.0