A PROPOSAL TO THE NASA 2010 UNIVERSITY STUDENT LAUNCH INITIATIVE

MEASURING ATMOSPHERIC OXYGEN AND WATER VAPOR USING AN INTEGRATED ROCKET SPECTROMETER

BY

HARDING FLYING BISON
2010 USLI ROCKET TEAM

October 8, 2009

Edmond Wilson, Ph.D., Team Official
## Contents

1 **SCHOOL INFORMATION**

1.1 Name and Title of Project 4  
1.2 Name and Title of Team Official 4  
1.3 Name and Title of the Safety Officer 4  
1.4 Student Participants 4  
1.4.1 Number of Student Participants 4  
1.4.2 Duties of Participants 4  
1.4.3 Project Organization Chart 4  
1.5 National Association of Rocketry Section Sponsor 6  

2 **FACILITIES AND EQUIPMENT**  

2.1 Description of Facilities and Hours of Accessibility 6  
2.2 Resources for Designing, Building Rocket and Science Payload 6  
2.2.1 Expert Personnel Available 6  
2.2.2 Facilities Available 7  
2.2.3 Equipment 7  
2.2.4 Supplies 7  
2.2.5 Altitude Verification of Rocket Flight 7  

2.3 Computer Resources, Communications, Software, Web Site 7  
2.3.1 Computer Resources for Communication 7  
2.3.2 Computer Resources for Web Site Creation and Maintenance 8  
2.3.3 Document Development for Design Reviews 8  
2.3.4 Team Official – NASA USLI Project Lead Email Communications 8  
2.3.5 Software Tools Available 8  
2.3.6 Video Teleconferencing Equipment 8  
2.3.7 Preferred Teleconferencing with Marshall Space Flight Center (MSFC) 8  

2.4 Implementation of Architectural and Transportation Barriers Compliance Board 8  
Electronic and Information Technology (EIT) Accessibility Standards 9  

3 **SAFETY AND MISSION ASSURANCE**  

3.1 National Association of Rocketry (NAR) Level 2 Certified Mentor 9  
3.2 Written Safety Plan 9  
3.2.1 Safety of Materials Used 10  
3.2.2 Safety of Facilities Involved 10  
3.2.3 Manager of Safety Plan 10  
3.2.4 Mitigations and Risk Assessment 10  
3.2.5 Procedures for National Association of Rocketry (NAR) Personnel to Perform 10  
3.2.6 Compliance with NAR High Power Safety Code Requirements 10  
3.2.7 Performance of all Hazardous Materials Handling and Hazardous Operations 10  
3.2.8 Plan for Briefing Students on Hazard Recognition and Accident Avoidance 10  
3.2.9 Plan for Pre-Launch Briefings 10  
3.2.10 Inclusion of Caution Statements in Plans, Procedures and Working Documents 10  
3.2.11 Control of Hazardous Materials 11  
3.2.12 MSDS Data Sheets Applicable to This Project 11  

3.3 Laws Regarding Unmanned Rocket Launches and Motor Handling 11
3.3.1 Federal Laws Regarding Unmanned Rocket Launches and Motor Handling 11
3.3.2 State Laws Regarding Unmanned Rocket Launches and Motor Handling 11
3.3.3 Local Laws Regarding Unmanned Rocket Launches and Motor Handling 11
3.3.4 Federal Aviation Regulations Regarding Unmanned Rocket Launches and Motor Handling 11

3.3.5 Handling and Use of Low-Explosives (Ammonium Perchlorate Rocket Motors) 11
3.3.6 NFPA 1127 Code for High Power Rocket Motors (Fire Prevention) 12
3.4 Capability to Purchase, Store, Transport and Use Rocket Motors 12
3.5 Security and Control of Rocket Motors While Traveling To and From USLI Rocket Competition 12
3.6 Written Statement That Team Members Will Abide by Safety Regulations 12

4 TECHNICAL DESIGN 13

5 EDUCATIONAL ENGAGEMENT 13

6 PROJECT PLAN 13
  6.1 Project Plan with Key Milestones 13
  6.2 Budget 13

7 SECOND YEAR PLAN FOR SUSTAINABILITY 15
  7.1 Providing and Maintaining Partnerships 15
  7.2 Engaging Younger Students in Rocketry 15
  7.3 Funding Sustainability 16
  7.4 Educational Engagement 16

8 DELIVERABLES FROM THIS PROJECT 16

APPENDIX A RESUMES OF MANAGERS AND TEAM MEMBERS 18
APPENDIX B STUDENT AGREEMENT FORM TO OBEY NARA/HARA SAFETY REGULATIONS 23
1 SCHOOL INFORMATION

1.1 Name and Title of Project

Measuring Atmospheric Oxygen and Water Vapor As a Function of Altitude Using an Integrated Rocket Spectrometer

1.2 Name and Title of Team Official

Edmond W. Wilson, Jr., Ph.D., Professor of Chemistry, Harding University, Searcy, AR 72149

1.3 Name and Title of the Safety Officer

Edmond W. Wilson, Jr., Ph.D., National Association of Rocketry (NAR) Member Number #86424, NAR HPR Certification Level 2, Expires October 2010.

1.4 Student Participants

1.4.1 Number of Student Participants

Student Team Members: Sixteen team members, including two high school seniors, one foreign national and representing nine majors: mechanical engineering (5), biochemistry and molecular biology (2), chemistry (2), physics (1), mathematics (1), aeronautical engineering (1), computer science (1), computer engineering (1), psychology (1) make up the Harding University Flying Bison 2010 USLI Rocket Team.

1.4.2 Project Organization Chart

Table 1. Table of Participants, Managers and Allocation of Human Resources

<table>
<thead>
<tr>
<th>Team Official</th>
<th>Project Progress Manager</th>
<th>Safety Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edmond Wilson</td>
<td>Cortney, Mgr.</td>
<td>Edmond Wilson</td>
</tr>
<tr>
<td>Airframe</td>
<td>Motor</td>
<td></td>
</tr>
<tr>
<td>Elizabeth</td>
<td>Libby</td>
<td></td>
</tr>
<tr>
<td>Libby</td>
<td>Josh</td>
<td></td>
</tr>
<tr>
<td>Hunter</td>
<td>Lisa</td>
<td></td>
</tr>
<tr>
<td>Matt G.</td>
<td>Nathan</td>
<td></td>
</tr>
<tr>
<td>April</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science Payload</td>
<td>Science Payload</td>
<td></td>
</tr>
<tr>
<td>Darah, Mgr.</td>
<td>Chi, Mgr.</td>
<td></td>
</tr>
<tr>
<td>Chi</td>
<td>Hunter</td>
<td></td>
</tr>
<tr>
<td>Li</td>
<td>Elizabeth</td>
<td></td>
</tr>
<tr>
<td>Patrick</td>
<td>Nancy</td>
<td></td>
</tr>
<tr>
<td>Matt I.</td>
<td>Mgr.</td>
<td></td>
</tr>
<tr>
<td>Hunter</td>
<td>Shailer</td>
<td></td>
</tr>
<tr>
<td>Matt G.</td>
<td>Shailer</td>
<td></td>
</tr>
<tr>
<td>Elizabeth</td>
<td>Cortney</td>
<td></td>
</tr>
<tr>
<td>Hunter</td>
<td>Meredith</td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>Knowing</td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td>Launch Operations</td>
<td></td>
</tr>
<tr>
<td>Matt I.</td>
<td>Mgr.</td>
<td></td>
</tr>
<tr>
<td>Matt G.</td>
<td>Shailer</td>
<td></td>
</tr>
<tr>
<td>Matt I.</td>
<td>Cortney</td>
<td></td>
</tr>
<tr>
<td>Launch Operations</td>
<td>Recovery</td>
<td></td>
</tr>
<tr>
<td>Shailer</td>
<td>Meredith</td>
<td></td>
</tr>
<tr>
<td>Cortney</td>
<td>Shailer</td>
<td></td>
</tr>
<tr>
<td>Outreach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hunter</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.4.3.1 Duties of Airframe Division

- Choose hybrid motor and airframe to achieve project goals
- Model rocket flight using RockSim 9 to aid in motor/airframe choice
- Coordinate with Motor, Payload, Recovery and Avionics Divisions to insure airframe can accommodate all necessary component parts
- Conduct tensile strength and compression testing of airframe components
- Conduct wind tunnel tests of a scale model of rocket
- Build and paint airframe
• Supervise installation/integration of motor, payload, avionics and recovery components into airframe

1.4.3.2 Duties of Motor Division
• Order and maintain all hardware and materials necessary for motor installation, ignition, flight, recovery and maintenance, including fuel, oxidizer and expendables
• Prepare a procedures check list for preparation of the rocket for flight
• Prepare a safety document for motor, fuel and oxidizer transportation, flight preparation, ignition, flight, recovery, maintenance and stowage
• Carry out static motor firings to measure thrust and record spectra of exhaust plumes

1.4.3.3 Duties of Science Payload Division
• Design and build the science payload, an atmospheric spectrometer
• Choose embedded microcontroller to operate spectrometer
• Interface science payload with microcontroller and write operational software
• Laboratory test science payload/microcontroller complete
• Field test science payload before USLI competition
• Write procedure for deployment of science payload
• Install science payload into the airframe
• Recover science payload, download data
• Interpret data and prepare a science report from the results

1.4.3.4 Duties of Avionics Division
• Acquire G-Wiz and Perfect Flight computers and instruction manuals
• Learn operation of flight computers
• Laboratory test flight computers as a function of air pressure and prepare calibration charts
• Write procedure for deployment of flight computers
• Install flight computers into airframe
• Download flight data after recovery of rocket and report to USLI field committee

1.4.3.5 Duties of Launch Operations Division
• Launch Operations Division responsible for preparing an inventory of all materials, supplies and equipment to be transported to USLI competition launch site
• Set up rocket preparation area
• Set up rocket launch platform
• Maintain supply of nitrous oxidizer and all equipment needed to fill oxidizer tank on rocket
• Maintain temperature of nitrous tanks for optimum safe operating pressure
• Maintain and deploy ignition system; charge batteries, test ignition system
• Prepare detailed list of all steps in rocket preparation, mounting on launch platform and carrying out pre-launch tests of ignition system, oxidizer system, avionics system and payload system
• Notify USLI Range Officer when Harding Flying Bison Rocket ready for launch
• Fire rocket under command from USLI range officer
• Clean rocket prep area and stow all equipment and supplies on van after launch and recovery
1.4.3.6 Duties of Recovery Division

- Choose proper size drogue and main chutes and size and length of shock cords
- Use RockSim 9 software to insure recovery system is optimized
- Prepare ejection charges and test for efficient rocket separation
- Install recovery components on rocket
- Monitor flight to minimize search time for landed rocket
- Proceed to and recover rocket; report on state of recovered rocket

1.4.3.7 Duties of Outreach Division

- Design, prepare, create and maintain Harding Flying Bison USLI 2010 Rocket Team Website
- Upload PDR, CDR, FRR and Final Report on website at required times
- Carry out outreach activities at Westside Elementary School
- Carry out outreach activities at Bradford, AR Girl Scouts of America, Troop 76, Karen Reed Troop Leader, 501 280 0031. Work with Brownie Troop also
- Prepare article about USLI competition for Harding University Bison Newspaper
- Prepare information for organizations editor of Harding Petit Jean Yearbook
- Prepare safety manual for Flying Bison USLI 2010 Rocket Team
- Create scrapbook of activities for this year
- Record and maintain minutes of meetings of Flying Bison
- Keep a photographic/video file of this year Flying Bison activities
- Seek external funding for carrying out teams goals
- Recruit students for next year’s Flying Bison team

1.5 National Association of Rocketry Section Sponsor

Mid-South Rocket Society NAR Section #550, Marie Holyfield, Secretary-Treasurer
Ph: 901 340 8586, meholyfield@att.net, 9180 Fletcher Trace Pkwy, Lakeland, TN 38002

2 FACILITIES/EQUIPMENT

2.1 Description of Facilities and Hours of Accessibility

There is a large shop containing metal and woodworking tools, a science laboratory with electronic test equipment and tools and an additional shop with tensile strength instrument and wind tunnel. These are available to the Flying Bison USLI Rocket Team. There are several computer laboratories in the Pryor-England Science and Engineering Center available for student use. All facilities, shops and computer laboratories items are open and available from 7 a.m. to 10 p.m. These facilities are described in detail below.

2.2 Resources for Designing, Building Rocket and Science Payload

2.2.1 Expert Personnel Available

David Stair is a retired NASA model maker and is expert in designing models, fixtures, electronics equipment. He is also an outstanding graphics artist and has helped us in each of the three preceding years of the competition. Edmond Wilson, Team Official, has extensive experience in electronics and
optics instrument building and calibration. Wilson has successfully directed the Harding Flying Bison USLI Rocket Team for all three years of its existence and is proficient in metal working shop skills. He is an expert using National Instruments hardware and software as well as MatLab software. Brad Miller, Assistant Professor of Engineering, is proficient in wind tunnel operation, tensile strength measurements and SolidWorks software.

2.2.2 Facilities Available

The planned research and experimentation can be accomplished using existing equipment and facilities available to the Flying Bison Rocket Team at Harding University. Adequate laboratory space, 1400 sq. ft., is available for the proposed rocket and payload design and assembly. In addition, a 27 ft. by 30 ft. machine shop for construction of the rocket and its payload is at the disposal of the team. All facilities, shops and computer laboratories items are open and available from 7 a.m. to 10 p.m.

2.2.3 Equipment

Shop equipment includes a 9” x 42” ENCO Turret Vertical Mill with digital electronic readout, EMCO Compact 10, Swiss made, Lathe, Ramco Vertical/Horizontal Metal Cutting Bandsaw, Phase II 8-inch rotary table with Phase II Tailstock and 18” Vertical Metal-Cutting Bandsaw. Also, a variety of woodworking equipment, including a Delta 10” Contractor’s Saw with 30” Biesemeyer Fence, Delta 6” Jointer, 14” Craftsman Bandsaw and 15½” Craftsman Drill Press, is available for building the rocket airframe. Available for sheet metal work is an ENCO 48” Sheet Metal Pan & Box Brake and a Jet Bench Model Sheet Metal Roller, 2” x 48”.

Also available is an Aerolab 12” x 12” x 14” Windtunnel and an INSRON 5569 Tensile Strength Instrument that can operate to 50 kN.

2.2.4 Supplies

Supplies are purchased on an “as needed basis.” However, some supplies from previous competitions, are available for use on this project.

2.2.5 Altitude Verification of Rocket Flight

The team will use a G-WIZ MC2 flight computer to monitor flight altitude. This will be in addition to the PerfectFlight miniAlt/WD flight computer.

2.3 Computer Resources, Communications, Software, Web Site

The Harding University Rocket Team has at its disposal a number of computer labs that available to students and faculty. Software needed and available in these computer laboratories are RockSim, SolidWorks, and Visual Studio. All of the rocket components, excess building supplies, and related materials from previous competition years are available for team use.

2.3.1 Computer Resources for Communication

All team members have more than adequate access to computers in order to maintain communications lines open. Many of the students have their own computers and all have web access in
their dorm rooms. Moreover, cell phones with texting are taking over a large majority of communications between team members.

2.3.2 Computer Resources for Web Site Creation and Maintenance

There are more than adequate computer resources for web site creation. This is a non-issue

2.3.3 Document Development for Design Reviews

Five brand new HP 4510s Laptop computers, loaded with RockSim 9, Microsoft Word 2007, EXCEL 2007, SolidWorks 2009, MatLab 2009a, LabVIEW 8.6.1, are available to be used/checked out by Flying Bison Rocket Team use in carrying out engineering studies, science studies, flight simulations and report creation. This is in addition to the computer resources mentioned above.

2.3.4 Team Official – NASA USLI Project Lead E-mail Communications

The Team Official, Edmond Wilson, has the following contact information:

HU10849, Harding University, Searcy, AR 72149-0849
Office Phone: 501 279 4513   Cell Phone: 501 278 7268
E-mail: wilson@harding.edu   FAX: 501 279 4706

Edmond Wilson will serve as the sole contact person representing the Harding Flying Bison 2010 USLI Rocket Team with the NASA USLI Project Lead.

2.3.5 Software Tools Available

All rocket team members have access to at least the following software:

RockSim 9   Microsoft Word 2007   EXCEL 2007
SolidWorks 2009   MatLab 2009a   LabVIEW 8.6.1
Adobe PDF maker   Google Chrome   CorelDraw X4
PowerPoint 2007   StellarNet 2009

2.3.6 Video Teleconferencing Equipment

The Smart Classroom in the Harding University School of Education will be used for video conferencing. In this way, all members of the team can participate in the video reviews.

Additional teleconferencing equipment is available. Equipment manufactured by INSORS (www.insors.com), is located in Room 167 of the Pryor-England Science and Engineering Center. It will provide interactive video/audio feed. The computer equipment available for videoconferencing meets the minimum requirements indicated. This will be our back up system.

2.3.7 Preferred Teleconferencing with Marshall Space Flight Center (MSFC)

Final information to decide the answer to this question is being gathered and will be sent to NASA USLI Office as soon as available.

2.4 Implementation of Architectural and Transportation Barriers Compliance Board
Harding University is actively implementing the requirements of the Americans with Disabilities Act Accessibility Guidelines, ADAAG. Renovations and new buildings are carried out so as to meet the American Disabilities Act, ADA and the American Barriers Act, ABA guidelines. Harding University presently meets presently meets most of the standards.

The Harding Flying Bison 2010 USLI Rocket team implements the Architectural and Transportation Barriers Compliance Board Electronic and Information Technology (EIT) Accessibility Standards (36 CFR Part 1194). In particular, it meets the Subpart B Technical Standards

- 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

The Team Official, Edmond Wilson, will work to accommodate any student with disabilities who wishes to be a member of the team in such a way that team members with disabilities have easy access to all rooms, equipment and software.

3 SAFETY AND MISSION ASSURANCE

3.1 National Association of Rocketry (NAR) Level 2 Certified Mentor

Edmond Wilson, Team Official, serves as the National Association of Rocketry (NAR) Level 2 Certified Mentor. I am the individual owner of the rocket for liability purposes and I will accompany the team and the rocket to the USLI launch in April 2010.

3.2 Written Safety Plan
   3.2.1 Safety of Materials Used

A written safety plan will be prepared for the construction and deployment of the rockets used in this project. MSDS sheets for all chemicals will be included an appendix. Particular instructions will be prepared for each area of rocket construction and firing and this information will be used to educate the team members before they begin work.

Materials used in this project are listed below:
- Quantum tubing (plastic) for the airframe, polyethylene for the nose cone, boat tail, tail cones
- Fiberglass for reinforcing airframe
- Epoxy glue for mating and securing airframe components
- Phenolic tubing for the couplers
- Plywood for the spacers and coupler bulkheads
- Steel for the hybrid motor casing and motor thrust rings, snap rings
- Graphite for motor nozzle
- Nitrous Oxide liquid and gas for rocket motor oxidizer
- Steel screws, eye-bolts, nuts, washers
- Aluminum for optical bench of science payload
- Glass for diffraction grating of science payload
- Electrical circuit boards for computers and data collectors
- Fiber optic cable (glass fiber + plastic coating) for science payload
- Spray can acrylic paint for painting the airframe
- Nylon for parachutes and shock cords
- FFFG Black Powder for ejection charges
- J-Tek 2’ Electric Matches ([www.electricmatch.com](http://www.electricmatch.com))
- Carbon composition resistors for motor ignition system
- Pyrodex Pellets for motor ignition system
- Hydroxyterminate polybutadiene, HTPB, for hybrid rocket fuel

### 3.2.2 Safety of Facilities Involved

Safety of the classrooms and laboratories are governed by the Safety Plan for Harding University. When using the machine shops or launching the rockets, students are required to wear protective eyewear, closed toed shoes and gloves (at their discretion). They are supervised and taught proper use of each machine.

### 3.2.3 Manager of Safety Plan

The Safety Plan Manager for our area of Harding University is Dr. Keith Schramm. He has received training in safety and is responsible for maintaining a safe environment for staff and students. Forms are used to record minor and major accidents in order to minimize future accidents. A Safety Plan document is located in several places in the area. One is located in the student computer work area. MSDS sheets are constantly being acquired and rules adjusted to improve the quality of the workplace.

### 3.2.4 Mitigations and Risk Assessment

### 3.2.5 Procedures for National Association of Rocketry (NAR) Personnel to Perform

### 3.2.6 Compliance with NAR High Power Safety Code Requirements

### 3.2.7 Performance of all Hazardous Materials Handling and Hazardous Operations

### 3.2.8 Plan for Briefing Students on Hazard Recognition and Accident Avoidance

Before each construction procedure, the team members will be briefed on hazard recognition and accident avoidance. This procedure will be conducted for pre-launch briefings, including action for misfires, non-firing motors, ballistic landing, etc.

### 3.2.9 Plan for Pre-Launch Briefings

Before each launch, the team members will be briefed on hazard recognition and accident avoidance. This procedure will be conducted for pre-launch briefings, including action for misfires, non-firing motors, ballistic landing, etc. This will be done by the Memphis Rocket Club Range Officer.

### 3.2.10 Inclusion of Caution Statements in Plans, Procedures and Working Documents

All plans, procedures and working documents will include caution statements whenever hazards might be encountered. These will be marked in special bold type to draw attention to the potential for harm.
3.2.11 Control of Hazardous Materials

Hazardous materials used in this project will be stored in the chemical vault of the Harding University Department of Chemistry. Use of hazardous chemicals will be monitored by the Safety Officer in order to insure that they are handled in a reasonable safe manner.

3.2.12 MSDS Data Sheets Applicable to This Project

MSDS Data Sheets for each chemical used will be collected and a set placed in the shop where the chemicals will be used. Team members will be made aware of these sheets and told how to handle these materials in a safe and responsible manner.

3.3 Laws Regarding Unmanned Rocket Launches and Motor Handling

3.3.1 Federal Laws Regarding Unmanned Rocket Launches and Motor Handling

Before each launch, the Safety Officer will review Federal Laws regarding unmanned rocket launches and motor handling. In addition, he will confer with the range officer of the launch site to insure that all Federal laws are observed.

3.3.2 State Laws Regarding Unmanned Rocket Launches and Motor Handling

Before each launch, the Safety Officer will review State Laws regarding unmanned rocket launches and motor handling. In addition, he will confer with the range officer of the launch site to insure that all State laws are observed.

3.3.3 Local Laws Regarding Unmanned Rocket Launches and Motor Handling

Before each launch, the Safety Officer will review Local Laws regarding unmanned rocket launches and motor handling. In addition, he will confer with the range officer of the launch site to insure that all Local laws are observed.

3.3.4 Federal Aviation Regulations Regarding Unmanned Rocket Launches and Motor Handling

Before each launch, the Safety Officer will review Federal Aviation regulations regarding unmanned rocket launches and motor handling. In addition, he will confer with the range officer of the launch site to insure that all Federal Aviation regulations are observed. The use of a hybrid rocket system is advantageous for safety, because there are no legal requirements for the handling of the inert fuel grains. The components of the hybrid motor system are completely inert by themselves, and will only ignite when placed in the hybrid motor system. The oxidizer will be nitrous oxide. We have obtained the proper valves and regulators to control nitrous flow from a distance of 200 feet. Ignition of the motor will be effected from the same distance.

3.3.5 Handling and Use of Low-Explosives (Ammonium Perchlorate Rocket Motors)
Whenever Low-Explosives are used in rocket launches, all Federal, State and Local Laws and regulations will be observed. A recent court finding states that ammonium perchlorate rocket motors are not explosives and therefore not subject to federal law restricting use of low-power explosives. Any ammonium perchlorate rocket motors purchased will be stored in an appropriate case in the chemical vault of the Harding University Department of Chemistry. These rocket motors will be transported in the same case. Only enough motors will be obtained and stored as necessary to be used in a short amount of time for a particular event.

DOT regulations are not applicable to Contrail Rockets hybrid motors because the fuel grain is an inert thermoplastic, and all other rocket components are completely inert. Nitrous oxide will be acquired from racing supply stores in Little Rock or Memphis, TN in approved DOT tanks and stored in a locked laboratory (Room 142) used by the rocket team in the Harding University Department of Chemistry.

3.3.6 NFPA 1127 Code for High Power Rocket Motors (Fire Prevention)

A copy of NFPA 1127 Code for High Power Rocket Motors will be procured and all operations covered by the Code will be observed.

3.4 Capability to Purchase, Store, Transport and Use Rocket Motors

The Safety Officer will apply for an Explosives Transaction Record Form 5400.4, also known as the Yellow Sheet to insure the teams ability to legally purchase ammonium perchlorate rocket motors. The motors will be stored in a Type IV or equivalent magazine (See 27 CFR 55.210). The Searcy Fire Marshall will be notified orally before the end of the day on which storage of the explosive materials commenced and in writing within 48 hours from the time such storage commenced.

Hybrid motor casings and hardware manufactured by Contrail Rockets have been purchased previously; any fuel grain reloads can be purchased from the Contrail Rockets webstore and shipped via US Mail.

3.5 Security and Control of Rocket Motors While Traveling To and From USLI Rocket Competition

Security and Control of Rocket Motors While Traveling To and From USLI Rocket Competition will be handled by the Safety Officer alone.

3.6 Written Statement That Team Members Will Abide by Safety Regulations

All team members have read and signed a statement acknowledging that they are aware of and will follow the following regulations: Federal Aviation Regulations 14 CFR, Subchapter F, Part 101, Subpart C; Code of Federal Regulation Part 55; and NFPA 1127, “Code for High Power Rocket Motors.” All team members will comply with any and all other state and local regulations. This statement is in Appendix B of this document.
4 TECHNICAL DESIGN

4.1 The outer diameter of the launch vehicle will be 4.09”, with a full length of approximately 8.5 feet.
4.2 After rigorous component mass analysis, the projected weight of the rocket is 24.5 lbs, assuming a combined science payload and avionics weight of 4 lbs.
4.3 The motor for the launch vehicle will be a Contrail Rockets K888 hybrid rocket motor. This motor provides an average thrust of 896 N and total impulse of 2400 Ns. This motor is 39” long and 75mm in diameter. The fuel will be hydroxyterminated polybutadiene, HTPB, and nitrous oxide oxidizer.
4.4 Preliminary simulations predict an altitude no greater than 5639 feet. We allow this margin of ~350 feet above the target altitude to permit the inclusion of unforeseen weight in the building process.
4.5 The simulated center of gravity is at 52.6” from the nose of the launch vehicle, and the simulated center of gravity is 66.3” from the nose. This gives a predicted overstability of 3.43 body calibers.
4.6 Given the above simulations and projections, generated using RockSim 9, we predict a thrust-to-weight ratio of 8.21.

5 EDUCATIONAL ENGAGEMENT

5.1 The collegiate members of the team will be taught fundamentals of high powered rocket construction and will be encouraged to try for the appropriate NAR Level 1 or 2 Certification. Each team member will contribute a written section of the PDR, CDR, FRR.
5.2 At least one girl scout troop and brownie troop will be mentored on topics dealing with NASA science and rocketry. GSA Troop 76 in Bradford, Arkansas has agreed to work with us.
5.3 At least one elementary class will be given instructions in building water bottle rockets and flying them. Two or three lectures about planetary exploration and rockets will also be presented to this class. Westside Elementary, Grade 1, Sherry Wilson, Teacher has worked with us for the past three years while teaching the fourth grade at Sydney Deener Elementary and then at Westside.
5.4 We are planning to have an exhibit of our rockets at the Harding University Library and a program presented to the entire student body of approximately 5000 students.

6 PROJECT PLAN

6.1 Key Milestones
The Integrated Master Schedule in Figure 6-1 shows the workflow in order to achieve the key milestones (shown as diamonds).
<table>
<thead>
<tr>
<th>Task</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary Design Report Due 4 Dec 2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preliminary Design Review, PDR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical Design Report Due 20 Jan 2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical Design Review, CDR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flight Readiness Report Due 17 Mar 2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flight Readiness Review, FRR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USLI Launch Competition, 14-19 Apr 2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Post Launch Assessment Review, PLAR, 7 May 2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Launch of Scale Model with Science Payload Prototype</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Airframe Division</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Design of Airframe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Order Materials for Airframe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Conduct Testing of Airframe and Airframe Components</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Build and Paint Airframe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Motor Division</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Order Motor and Ignition Hardware and materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Prepare Detailed Procedure for Motor Preparation and Flight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Prepare Safety Document for Motor, fuel and oxidizer transportation, flight preparation, ignition, flight, maintenance, stowage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Static Testing of Rocket Motors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Science Payload Division</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Design and Build Spectrometer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Choose and Purchase Embedded Controller</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Integrate Spectrometer and Controller into Airframe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Laboratory Test Spectrometer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Prepare Operations Guide for Spectrometer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Avionics Division</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Laboratory Test of Avionics Computers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Install Flight Computers into Airframe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Prepare Operations Guide for</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Launch Operations Division</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Prepare Inventory of Materials, Equipment, Supplies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Order Needed Materials and Supplies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Prepare Detailed Procedure for Launch of Rocket with Safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Test Launch Rocket in Memphis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Prep and Launch Rocket at USLI Competition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Recovery Division</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Use RockSim to Choose Recovery Parachutes and Supplies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase Parachutes and Supplies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrate Recovery Hardware into Airframe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitor Flight and Recover Rocket at Memphis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitor Flight and Recover Rocket at USLI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outreach Division</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Design and Implement Harding Flying Bison USLI Website</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outreach Project at Westside Elementary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outreach Project with Girls Scouts and Brownies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepare Safety Manual for Flying Bison USLI Rocket Team</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carry Out and Record Publicity Projects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seek External Funding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recruit New Team Members</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 6.1 Table of Workflow
### 6.2 Budget

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocket Airframe</td>
<td>1100.00</td>
</tr>
<tr>
<td>Parachutes and Safety Harness</td>
<td>200.00</td>
</tr>
<tr>
<td>Construction Hardware and Consumables</td>
<td>1000.00</td>
</tr>
<tr>
<td>Perfect Flight MAWD</td>
<td>100.00</td>
</tr>
<tr>
<td>Materials for Science Payload</td>
<td>800.00</td>
</tr>
<tr>
<td>Contrail Rocketry Hybrid Motor System and Reloads</td>
<td>1200.00</td>
</tr>
<tr>
<td>Nitrous Oxide, Motor Fuel Grains, Launch Consumables</td>
<td>600.00</td>
</tr>
<tr>
<td>NAR Level 1 and Level 2 Licensure</td>
<td>200.00</td>
</tr>
<tr>
<td>Outreach</td>
<td>100.00</td>
</tr>
<tr>
<td>Travel to Competition Launch at Marshall Space Flight Center (14 Travelers)</td>
<td>3200.00</td>
</tr>
</tbody>
</table>

**Total Estimated Expense** 8500.00

### 6.2b Source of Funding

A proposal to the Arkansas Space Grant Consortium for $8500.00 will be submitted at their November 2009 Meeting requesting funds for the Harding University Flying Bison USLI Rocket Team to participate in this year’s competition. The committee has enthusiastically supported this competition for the past three years. It is anticipated that our request will be funded for the full amount.

### 7 SECOND YEAR PLAN FOR SUSTAINABILITY

#### 7.1 Providing and Maintaining Partnerships

The Harding Flying Bison USLI Rocket Team has never had any partnership. We tried to work with the Civil Air Patrol last year but could not find a place to demonstrate a rocket launch and they lost interest. We will try again this year. The team will try to establish a partnership with BEI in Little Rock, Arkansas. BEI is heavily involved in NASA missions that require precision pointing devices.

#### 7.2 Engaging Younger Students in Rocketry

The Flying Bison team has recruited two Search High School students who desire to train for an aerospace career. They have worked faithfully from the beginning and are a valuable part of the team.
Each year the number of participants on the team has increased and this trend is expected to continue. The team is looking forward to the time it can field two rocket teams for the USLI competition.

7.3 Funding Sustainability

The Harding Flying Bison USLI Teams have been funded for all three past years by the NASA/Arkansas Space Grant Consortium. This year should be no exception and an even larger amount of funding will be requested because of a larger number of participants and expanded outreach projects. The ASGC has been approved for an additional five years of support and so our financial base is secure as long as we produce a product worthy of funding.

7.4 Educational Engagement

Many of the team members will present oral and/or poster presentations of their work at the Arkansas Undergraduate Research Conference, the Arkansas Space Grant Consortium Annual Symposium, the Central Arkansas Chapter of Sigma Xi Annual Poster Competition and at a poster session of our research group at Harding University, all during April of 2010. We are developing a library of rocket books and copies of the NAR magazine for team members. We are expanding our project to include laboratory testing of many of the individual components of the competition rocket.

8 DELIVERABLES FROM THIS PROJECT

8.1 A scale model of the rocket design with a payload prototype. This model should be flown prior to the Critical Design Review (CDR). A report of the data from the flight and the model will be brought to the CDR.

8.2 Reports and PowerPoint presentations due on December 4, January 20, and March 17 will be submitted to the Academic Affairs Office on schedule. Reports and presentations will be posted on the team Web site by the due date.

8.3 The Post-Launch Assessment Review (PLAR) for the rocket and payload will be submitted to the MSFC Academic Affairs Office no later than May 7, 2010.

8.4 The team will have a web presence no later than November 12th. The web site will be maintained/updated throughout the period of performance. It will be judged at random times throughout the year.

8.5 Copies of any products developed (journal, 3-D animation, media coverage, video, scrapbook, etc.) will be displayed during launch.

8.6 An electronic copy of the comprehensive report pertaining to the implemented educational engagement activities will be presented.

8.7 A safety plan outlining how NAR safety requirements will be implemented and how safety will be incorporated into all manufacturing, testing, and launching activities will be prepared. The risk assessment will include such things as (but not limited to): risks associated with faculty support, school support, financial/sponsor support, use of facilities, partnering arrangements, schedule risks, risks associated with chosen designs. This will be updated throughout the program and presented at the Critical Design Review (CDR) and Flight Readiness Review (FRR). The initial plan will be due with the Preliminary Design Review on December 4, 2009.

8.8 A reusable rocket and science payload (available for NASA/MSFC display) ready for launch in April of 2010. The team will participate in a Preliminary Design Review (PDR) (December 2009), Critical Design Review (CDR) (January 2010), Flight Readiness Review (FRR) (March 2010), and Launch (April 17-
18, 2010). (Dates are tentative and subject to change.) The CDR and FRR will be presented to NASA at a time and location to be determined by NASA/MSFC Academic Affairs Office. The presentation will be done using Video Teleconferencing/Web casting capabilities and PowerPoint presentation and should be available on the team Web site no later than 7 days prior to the review board meetings.
Resumes of Managers and Team Members (in alphabetical order by last name)

Shailer

Major: Biochemistry and Molecular Biology, Junior

Career Goal:

Experience: This is my second year on the Flying Bison USLI Rocket Team. I attend all meetings and helped on the launch team at the USLI Competition in 2009 at Huntsville, Alabama. Last year, I built a high powered rocket and will launch it to seek NAR Level 1 Certification this fall. I received a NASA/ASGC Travel Grant last year and visited NASA/Ames Research Center where I visited with the rocket and robotic scientists there.

Patrick, Recovery Manager

Major: Mechanical/Aerospace Engineering

Career goal: Earn MS and PhD in Aerospace Engineering

Experience: I am a freshman and have just started my studies. I look forward to advancing my knowledge and aptitude dealing with rocket science and everything that the field entails. I plan to apply for a NASA/Arkansas Space Grant Undergraduate Researchers Fellowship and work on NASA related research at Harding University

Hunter

Major: Searcy High School Senior

Career Goal: Engineering

Experience: I have been working with the Flying Bison Rocket Team all semester and have gained a great deal of practical experience in shop skills and RockSim simulations.

Lisa

Major: Chemistry, Sophomore

Career Goal:

Experience:

Josh
Major: Mechanical Engineering, Senior

Career Goal: BS in Mechanical Engineering

Experience: I worked in the Summer of 2009 doing research as a NASA/Arkansas Space Grant Undergraduate Researcher at Harding University. I partially redesigned and built a Mars Rover-type robot to be used as a test platform for astrobiology sensors. I have various mechanical and practical knowledge gained from experiences growing up on a farm. I gained further experience this summer creating my own parts for the Mars Rover robot using a lathe and milling machine. I also built and flew a NAR Level One rocket this summer.

Matthew G., Motor Manager

Major: Mechanical Engineering, Senior

Career Goal: I plan to graduate in May 2009 with a B.S in Mechanical Engineering. In the fall of 2009, I will attend graduate school and work towards a Master of Science Degree in Biomedical Engineering. After graduation, I would like to work in the field of prosthetics.

Experience: This is my second year on the Flying Bison Rocket Team. I received a NASA/Arkansas Space Grant Consortium Undergraduate Research Fellowship and spent the summer of 2009 designing and constructing a hybrid rocket motor test stand and a high powered rocket launch pad under the supervision of Dr. Ed Wilson. I maintain a 3.7 GPA through 127 hours and am currently taking 15 hours.

April

Major: Mechanical Engineering, Senior

Career goal: Receive my B.S. in Mechanical Engineering and become a professional engineer.

Experience: During my three years at Harding I have worked as a chemistry lab assistant. I received the Outstanding Mechanical Engineering Student during my sophomore year. I have also worked as an intern for the Trane Company during the summer. I received a NASA/Arkansas Space Grant Consortium Undergraduate Research Fellowship for the 2009-2010 school year. I am designing and building a sensitive tilt and pan instrument to aim a Mars Laser Spectrometer being built at Harding University. I have a cumulative GPA of 3.37 and am currently taking 16 hours.

Nathan

Major: Computer Science, Sophomore

Career goal: Earn a B.S. degree in Computer Science and seek employment in the area of security and cryptography.

Experience: I am a second-year member of the Harding University Programming Team. After receiving a NASA/Arkansas Workforce Development Undergraduate Research Fellowship, I spent the summer of 2009 at Harding University doing NASA research interfacing a diode laser spectrometer with a computer
using National Instruments hardware and LabVIEW software. Currently, I am a sophomore with 36 hours and I maintain a GPA of 4.0 with 16 hours in progress.

Matthew L., Launch Operations Manager

Major: Mechanical Engineering, Junior

Career Goal:

Experience:

Elizabeth (Libby)

Major: High School Senior, Searcy High School

Career Goal: To work for an aerospace industry like Boeing or NASA after graduation from MIT as an Aerospace Engineer.

Experience: Measuring emission spectra of hybrid rocket plumes at the Harding University Hybrid Rocket Motor Test Facility. I have rudimentary machine shop skills using a metal working lathe and milling machine. Familiarity with SolidWorks 2009 cad software.

Current science and math courses: completed AP physics; currently enrolled in AP chemistry, AP Biology and AP calculus. Currently, I am salutatorian of my class and have a 4.2 GPA.

Chi, Avionics Manager

Major: Chemistry, Senior

Career Goal: Achieve a Ph.D. in organo-metallic chemistry

Experience: In the summer of 2009, I began work with Dr. Wilson at Harding University as a NASA Research Infrastructure Development (RID) Undergraduate Researcher. My research involves concentrating biogenic gases under conditions found on Mars. I was awarded Outstanding Organic Student from the American Chemical Society my junior year. I currently have a GPA of 3.80.

Gregory, Airframe Manager, NAR # 88751 Level 1

Major: Physics/Mathematics Double Major, Senior

Career Goal:

Experience:

Darah, Science Payload Manager
Major: Biochemistry and Molecular Biology, Sophomore

Career Goal: I am still investigating career choices. At the present time, I am considering an advanced degree in pharmacy or dentistry.

Experience: I have been involved in NASA related research this semester working on the design of a Mars Biogenic Gas Spectrometer as part of a NASA/EPSCoR Grant. I am working as a NASA/EPSCoR Undergraduate Researcher with Dr. Ed Wilson at Harding University. I will be applying for a NASA/Arkansas Space Grant Undergraduate Researcher Fellowship in November 2009. My skills include using a metal working lathe and milling machine as well as soldering and general shop work.

Cortney, Project Progress Manager

Major: Biochemistry and Molecular Biology, Senior

Career Goal: Earn an M.D. degree and practice emergency medicine

Experience: Phlebotomist at White County Medical Center for five years. Volunteer for Susan G. Komen Foundation for breast cancer research. Volunteer for Hospice Home Care. I have conducted NASA science outreach activities at Westside Elementary School two years) and Sydney Deener Elementary School (one year). I tutor students at Searcy High School in math and science. I received a NASA/ASGC Undergraduate Researcher Fellowship to conduct studies related to the atmosphere on Mars. This was done under the supervision of Dr. Ed Wilson at Harding.

Elizabeth, Outreach Manager

Major: Computer Engineering, Sophomore

Career Goal: To obtain a Master of Science Degree and practice in my chosen field of computer engineering.

Experience: Tutored math students in high school and belonged to the math club. I am Historian of the math club at Harding. I intend to apply for a NASA/Arkansas Space Grant Consortium Undergraduate Research Fellowship and work on NASA research at Harding University.

Honors: High School Math Award

Meredith

Major: Psychology, Junior

Career Goal:

Experience: I am building a high powered rocket in order to achieve National Association of Rocketry (NAR) Level 1 Certification. I am interested in the field of rocketry because my father is a director of a rocket division at NASA Marshall Space Flight Center.
Edmond Wilson, Team Official, Safety Officer

Experience: This is my forth year as organizer and Team Official for the Harding Flying Bison USLI Rocket Team. During this time I have constantly gained valuable knowledge in rocket construction and testing, particularly rockets that use hybrid motors. I have also participated as a NASA/EPSCoR researcher developing sensors for hybrid rocket motors. I have experience in spectroscopy of hybrid rocket exhaust plumes. I have achieved National Association of Rocketry, NAR, Level 1 and Level 2 Certification after building, launching and recovering two high powered rockets plus passing an examination on rules and regulations associated with high powered sport rocketry. I have served five years as a Solar System Ambassador for Jet Propulsion Laboratory in order to spread the interesting work done by JPL and NASA.
Safety Regulations

HARA will provide range safety inspections of each rocket before it is flown. Each school team shall comply with the determination of the safety inspection.

The HARA Range Safety Officer has the final say on all rocket safety issues. Therefore, the HARA Range Safety Officer has the right to deny the launch of any rocket for safety reasons.

Any team that is found non-compliant with Safety & Mission Assurance (SAMMA) will not fly their rocket at the Huntsville launch.

Below is a list and signatures of team members that understand and will abide by the above three safety statements.

1. Darrin McDaniel
2. Nathan Henry
3. April Hargreaves
4. Matt Goodhart
5. Elizabeth Phillips
6. Chie Le.
7. Keith Jones
8. Hunter Comer
9. Patrick Reed
10. Meredith Taylor
11. Courtney Owen
12. Greg Lyons
13. Josh Dorris
14. Matthew Irvine