NASA Student Launch 2017

Proposal

September 20, 2017

SOCIETY OF AERONAUTICS AND ROCKETRY

4202 East Fowler Avenue MSC Box 197

Tampa, Florida 33620

Table of Contents

Table of Figures

1 Team Summary

1.1 Team Name & Mailing Address

Society of Aeronautics and Rocketry (SOAR) at University of South Florida (USF)
4202 East Fowler Avenue MSC Box 197
Tampa, Florida 33620

1.1 Team Personnel

1.1.1 Team Mentor, NAR/TRA Number and Certification Level

Team mentor: Jim West, Tripoli 0706 (Tripoli advisory panel member), Certification Level 3, 863-712-9379, jkwest@tampabay.rr.com

1.1.2 Team Academic Advisor

Team academic advisor: Dr. Manoug Manougian, Professor & Director of STEM Education Center, 813-974-2349, manoug@usf.edu

1.1.1 Safety Officer

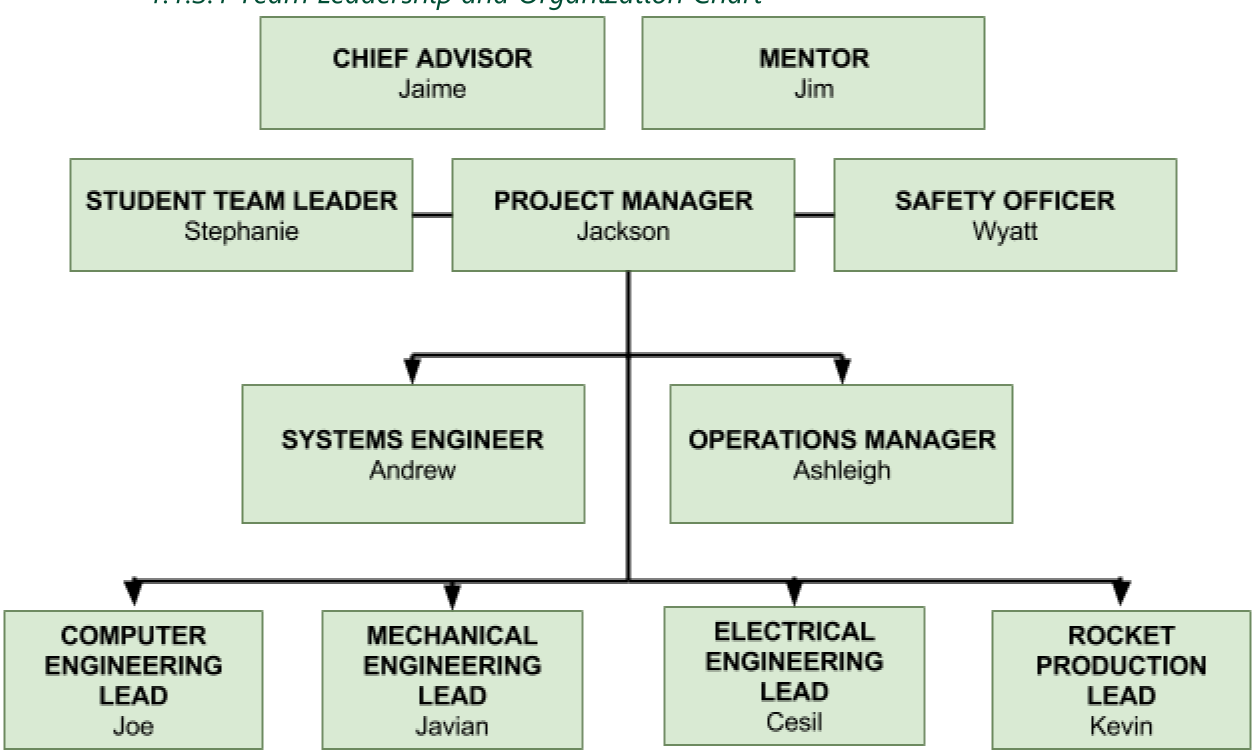
Team Safety Officer: Wyatt Boyatt, Sophomore Undergraduate, Mechanical Engineering, 352-874-0193, wyattboyatt@mail.usf.edu

1.1.2 Student Team Leader

Student Team Leader: Stephanie Bauman, Junior Undergraduate, Physics, 334-549-9144, sbauman1@mail.usf.edu

1.1.3 Team Structure and Members

1.1.3.1 Team Leadership and Organization Chart



1.1.3.2 Team Members

SOAR's 2018 NASA Student Launch Initiative Team consists of approximately 25 members, including the leaders listed above in the organizational chart.

1.2 NAR/TRA Affiliates

The Society of Aeronautics and Rocketry at the University of South Florida will seek guidance and collaboration with the Tampa prefecture (#17) of the Tripoli Rocket Association for the designing and construction of this year's NSL rocket. The local TRA chapter also provides a site for our sub-scale and full-scale launches under experienced supervision.

2 Facilities and Equipment

2.1 Facilities with Available Equipment

2.1.1 USF Design For X Labs

2.1.1.1 Description

Located within the ENB engineering building, this space is designed for engineering organizations and clubs on campus by providing a clean and effective workspace for projects. Tools and equipment are found here, from screwdrivers and hammers to 3D printers. SOAR will utilize this space for meetings and rocket/payload construction.

2.1.1.2 Equipment:

- LPKF ProtoMat S63 PCB Milling Machine
- Benchman MX CNC Milling Machine
- FSLaser – Pro LF 36 Laser Cutter
- MakerBot – Replicator 3D Printer
- MakerBot – Replicator Z18 3D Printer
- MakerBot – Replicator 2X 3D Printer
- Stratasys – uPrint SE PLUS 3D Printer
- Misc Power Tools
- Compressed Air
- Power Drops
- Wifi/wired Internet
- Function Generators
- Network Analyzers
- Solder Station
- Hot Air Rework Tool
- Mixed Domain Oscilloscope
- Multimeter
- LCR Meter
- Frequency Counter
- Fume Extractor
- Electronics Vice
- Dremel Tool
- Arbitrary Waveform Generators
- Vacuums
- Work Benches
- Vinyl Cutter
- MakerBot 3D Scanner
- General Purpose Computers
- Drafting/design workstations
- Paper Cutter
- Haptic Devices
- Small Hand Tools
- Powered Hand Tools
- 3D Printers
- Laser Cutters
- Lathe

2.1.1.3 Hours

Monday - Friday 7:00 am to 5:00 pm

2.1.1.4 Personnel

Senior Lab Manager: Michael Celestin, Ph.D., 813-974-5186, mcelesti@mail.usf.edu

2.1.2 Engineering Research Building (ENR)

2.1.2.1 Description

This is a workspace dedicated to engineering groups and organizations on campus. The open floor plan and adequate space will make for a comfortable and effective build environment. It is located just north of the Marshall Student Center, a center point of the campus. Only basic tools are provided.

2.1.2.2 Equipment

- Small Hand Tools
- Powered Hand Tools
- Drill Presses
- Manual Milling Lathes
- Buffer
- Cold Saw
- Shear
- Arbor Press
- Bandsaw

2.1.2.3 Hours

Monday - Friday 9:00 am to 3:00 pm

2.1.2.4 Personnel

SOAR Safety Officer: Wyatt Boyatt, Sophomore Undergraduate, Mechanical Engineering, 352-874-0193, wyattboyatt@mail.usf.edu

2.1.3 Engineering Machine Shop (ENG)

2.1.3.1 Description

The Engineering Machine Shop provides custom services to student clubs and projects. A machining facility and woodshop run by professional machinists with over 70 years in experience, they can meet numerous design needs requiring precise cutting and quality materials.

2.1.3.2 Equipment

- CNC Milling Machines
- CNC Lathe
- Manual Milling Machines
- Manual Milling Lathes
- Surface Grinder
- Radial Arm Drill Press
- Vertical Bandsaw
- Horizontal Bandsaw
- Cold Saw
- Abrasive Cut-Off Saw
- Oxy-Acetylene Torch
- Plasma Cutter
- TIG Wedler
- MIG Welder
- Stick Welder
- Hand-held Spot Welder
- Shear
- Bending Brake
- Beverly Shear
- Tubing Bender

- Notcher
- Drill Press
- Arbor Press
- 17.5 Ton Hydraulic Press
- Buffer
- Drill Grinder

2.1.3.3 Hours

Monday - Thursday 7:30 am to Noon, 1:00 pm to 4:30 pm
Friday 7:30 am to Noon, 1:00 pm to 4:00 pm

2.1.3.4 Personnel

Facilities and Safety Manager: Chris Taylor, 813-974-5451, cmtaylor2@usf.edu
Senior Research Machinist: Tony Villicana, 813-974-1471, avillica@usf.edu
Research Machinist: Chester Tarnawa, 813-974-1471, czeslaw@usf.edu

2.1.4 Varn Ranch (Plant City, FL)

2.1.4.1 Description

This is the official launch site of the Tampa Tripoli Rocket Association, and where SOAR's largest rockets have flown. The area has a 10,000 ft waiver, well over the project parameters for launching the NSL rocket. Our mentor from the Tripoli Rocket Association, and his fellow colleagues will supervise and enforce TRA launch rules and protocol. Only essential launch equipment is provided.

2.1.4.2 Equipment

- Launch Rails
- Launch System Electronics

2.1.4.3 Hours

Third Saturday of each Month, 9:00 am - 3:00 pm

2.1.4.4 Personnel

Tampa TRA President: Jim West, (863) 712-9379, jkwest@tampabay.rr.com
Rick Waters: Tampa TRA Prefect, (813) 226-7570, rick@theo-group.com

2.1.5 NEFAR Launch Site (Bunnell, FL)

2.1.5.1 Description

The Northeast Florida Association of Rocketry (NEFAR) is a location and launch site for Chapter 563 of the National Association of Rocketry, and Chapter 35 of the Tripoli Rocket Association. This launch site has waivers for altitudes up to 10,000 feet, and regularly collaborates with student and recreational rocket clubs. The NEFAR site has both TRA and NAR personnel to supervise and enforce the rules of safety.

2.1.5.2 Equipment

- Launch Rails
- Launch System Electronics

2.1.5.3 Hours

Second Saturday of each Month, 10:00 am - 3:00 pm

2.1.5.4 Personnel

Tampa TRA President: Jim West, (863) 712-9379, jkwest@tampabay.rr.com

Rick Waters: Tampa TRA Prefect, (813) 226-7570, rick@theo-group.com

2.2 Computer Programs & Aids

2.2.1 Communication

SOAR has multiple online tools and programs to use. We will continue to use Slack, a communications app, from last year. Slack has group chats within our organization that will allow communication across projects for collaboration and peer evaluations.

2.2.2 Design and Analysis

Our team will utilize the 3D rendering software SolidWorks, which is provided free of charge by the University of South Florida to all students through the application gateway. ANSYS Simulation Software is another resource that will be employed, and it is also available to all students. These softwares will allow the team to draft feasible mechanical models as well as engineering analysis simulations.

The USF application gateway also provides students with access to MATLAB, a resource that will prove invaluable for data processing and mathematical modelling.

Additionally, for precision rocket prediction and simulation we will use a combination of RockSim, a well-known commercial design and simulation program and OpenRocket, a java-based open-source, free-to-use program designed for model rocket analysis. Correlation between these programs will provide a model of best fit.

2.2.3 Document Development

For document development, and storage, we will use organizational cloud storage, SOAR's Google Drive. This database allows us to instantaneously communicate and work collaboratively on documents and presentations. This free-to-use program gives all users cloud storage and software such as Google Docs, Slides, Forms, even Drawings.

2.2.4 Website Compliance

SOAR's website is www.usfsoar.com. Although used to host the documents for the NASA Student Launch, its primary purpose is to communicate with our partners, students, sponsors, and team members. It includes such features as

- Keeping the public up to date on the project
- Inform educators of educational outreach programs
- Host articles, pictures, bios and videos of SOAR team members and officers
- Provide links to social media

3 Safety

Safety is a critical and necessary component in any STEM activity, especially the handling and construction of rockets and its hazardous counterparts. The Society of Aeronautics and Rocketry is dedicated to promoting the concept of space exploration through amateur rocketry, while ensuring our members are informed and safe during every process and step.

3.1 Safety Officer Duties & Responsibilities

The safety officer will be in charge of ensuring the team and launch vehicle is complying with all NAR safety regulations. The following is the list of the Safety Officer's responsibilities:

1. Ensure all team members have read and understand the NAR and TRA safety regulations.
2. Provide a list of all hazards that may be included in the process of building the rocket and how they are mitigated, including MSDS, personal protective equipment requirements, and any other documents applicable.
3. Compile a binder that will have all safety related documents and other manuals about the launch vehicle.
4. Ensure compliance with all local, state, and federal laws.
5. Oversee the testing of all related subsystems.
6. Ensure proper purchase, transportation, and handling of launch vehicle components.
7. Identify and mitigate any possible safety violations.
8. Identify safety violations and take appropriate action to mitigate the hazard.
9. Establish and brief the team on a safety plan for various environments, materials used, and testing.
10. Establish a risk matrix that determines the risk level of each hazard based off of the probability of the occurrence and the severity of the event. Ensure that this type of analysis is done for each possible hazard.
11. Enforce proper use of Personal Protective Equipment (PPE) during construction, ground tests, and test flights of the rocket.

3.2 NAR/TRA Safety

3.2.1 Procedures

The following launch procedure will be followed during each test launch. This procedure is designed to outline the responsibilities of the NAR/TRA Personnel and the members of the team.

1. A level 2 certified member and an NAR/TRA Personnel will oversee any test launch of the vehicle and flight tests of the vehicle.

2. The launch site Range Safety Officer will be responsible for ensuring proper safety measures are taken and for arming the launch system.

3. If the vehicle does not launch when the ignition button is pressed, then the RSO will remove the key and wait 90 seconds before approaching the rocket to investigate the issue. Only the Project Manager and Safety Officer will be allowed to accompany the RSO in investigating the issue.

4. The RSO will ensure that no one is within 100 ft. of the rocket and the team will be behind the RSO during launch. The RSO will use a 10 second countdown before launch.

5. A certified member will be responsible for ensuring that the rocket is directed no more than 20 degrees from vertical and ensuring that the wind speed is no more than 5 mph. This individual will also ensure proper stand and ground conditions for launch including but not limited to launch rail length, and cleared ground space. This member will ensure that the rocket is not launched at targets, into clouds, near other aircraft, nor take paths above civilians. Additionally, this individual will ensure that all FAA regulations are abided by.
6. Another certified member will ensure that flight tests are conducted at a certified NAR/TRA launch site.
7. The safety officer will ensure that the rocket is recovered properly according to Tripoli and NAR guidelines.

3.2.2 Safety Codes

SOAR conducts launches under both NAR and TRA codes and will abide by the appropriate High Power Rocketry Safety Code Requirements during all operations.

3.2.2.1 NAR Safety Code (Appendix 1)

3.2.2.2 TRA Safety Code (Appendix 2)

3.3 Hazardous Materials

3.3.1 Listing of Hazardous Materials

SOAR will maintain a list of all hazardous chemicals used on-site. The Safety Officer will ensure that material safety data sheets are requested and obtained from the supplier of any new product ordered by the SOAR. The Safety Officer will maintain a master listing of all hazardous materials and MSDS for all materials.

3.3.2 Labels

Material received by SOAR must have intact, legible labels. These labels must include the following:

- The name of the hazardous substance(s) in the container
- A hazard warning
- The name and address of the manufacturer or other responsible party

3.3.3 Training

A Safety Officer will be appointed by SOAR's Executive Board will insure that all members at sites where hazardous materials are kept or used receive training on hazardous material handling. The training program will include the following:

- The location and availability of the MSDS and files
- Methods and procedures that the employee may use to detect the presence or accidental release or spill of hazardous materials in the work area, including proper clean up
- Precautions and measures employees can take to protect themselves from the hazardous materials

Annual training will be conducted for all members who deal with hazardous materials. Each new member will be trained in the handling of hazardous materials at the possible opportunity. Training must be conducted for all members when any new chemical or hazardous material enters the work site. This training must occur before the chemical or hazardous material is used by any member. After each training session, the trainer will certify a roster of all participants. Included with the roster will be a list of all hazardous materials included in the training.

3.3.4 HEALTH, SAFETY AND EMERGENCY PROCEDURES

The following information will be available at the work site, if requested or required:

- A list of all hazardous materials used on site
- Unusual health and environmental hazards (both air and water) that may result from the release of specific quantities of hazardous substances

3.4 Safety Briefing

3.4.1 Hazard Recognition

The team Safety Officer will orchestrate all potentially hazardous activities, as well as brief the members who may participate in such activities on proper safety procedures, and ensuring that they are familiar with any personal protective equipment which must be worn during those activities. If a member fails to abide by the safety procedures, he/she will not be permitted to participate in the potentially hazardous activities. In addition to briefing the members on safety procedures, the team Safety Officer must remain in the immediate vicinity of the hazardous activity as it is occurring, so as to mitigate any potentially dangerous incidents and answer any safety questions which may arise.

3.4.2 Accident Avoidance

It will be the duty of the team Safety Officer to verify, in advance, that procedures planned for testing or construction of materials by team members satisfy safety requirements. In the event that the Safety Officer judges a planned procedure to be unsafe, said procedure will thus be revised or eliminated.

3.4.3 Launch Procedures

At the team meeting most closely preceding the launch, the Safety Officer will be given time to help the members review launch safety and precautionary measures. Topics discussed at this time include but are not limited to: laws and regulations mandated by the Federal Aviation Administration (FAA), the National Fire Protection Association (NFPA), and Florida State Statutes; prohibited launchpad activities and behaviors; maintaining safe distances; and safety procedures pertaining to any potentially hazardous chemicals which will be present during the launch. All team leaders must be in attendance at this briefing, and they are obliged to address the other members with any further safety concerns they are aware of that were not mentioned by the Safety Officer. At this time, launch procedures will be scrutinized, paying special attention to the parts involving caution.

3.5 Caution Statements

3.5.1 Definitions

Warnings, cautions, and notes are used to emphasize important and critical instructions and are used for the following conditions.

3.5.1.1 Warning

An operating procedure, practice, etc., which, if not correctly followed, could result in personal injury or loss of life.

3.5.1.2 Caution

An operating procedure, practice, etc., which, if not strictly observed, could result in damage to or destruction of equipment.

3.5.1.3 Note

An operating procedure, condition, etc., which is essential to highlight.

3.6 Checklists

3.6.1 Warnings

Warnings will be typed in red and will appear just prior to the step in the checklist to which they apply, the warning will include possible consequences of failure to heed warning and list any appropriate personal protective equipment required.

3.6.2 Cautions and Notes

Each checklist will include a column labeled Caution/Note. This column will display the caution or note associated with the relevant step in the checklist. Cautions will be typed in orange.

3.7 Safety Manual

3.7.1 Warnings

Warnings will be typed in red and will appear just prior to the step, procedure or equipment to which they apply, the warning will include possible consequences of failure to heed warning and list any appropriate personal protective equipment required.

3.7.2 Cautions

Cautions will be typed in orange and will appear just prior to the step, procedure or equipment to which they apply, the caution will include possible consequences of failure to heed caution.

3.7.3 Notes

Notes will be typed in bold black and will appear just prior to the step, procedure or equipment to which they apply.

3.8 Legal Compliance

The Safety Officer and Project Manager have read all relevant laws and regulations that apply to this project in order to ensure compliance with these laws. As well, the team members will also be briefed on these laws as they apply to the project. The material reviewed includes:

3.8.1 Federal Aviation Regulations (FARs)

- 14 CFR: Aeronautics and Space, Chapter 1, Subchapter F, Part 101, Subpart C: Amateur Rockets
- 27 CFR: Part 55: Commerce in Explosives
- NFPA 1127 "Code for High Power Rocket Motors"

3.8.2 State of Florida Laws and Regulations

- Florida Statute: Title XXV: Aviation, Chapter 331: Aviation and Aerospace Facilities and Commerce
- Florida Statute: Title XXXIII: Regulation of Trade, Commerce, Investments, and Solicitations, Chapter 552: Manufacture, Distribution, and Use of Explosives

3.9 Purchase, Transportation & Storage of Motor

The motor will be purchased and stored by one of our organization's mentors. This person is certified for the purchase of high powered rocket propellant and Society of Aeronautics and Rocketry 21 well versed in storage. The propellant will be stored in an off-campus garage, where several other rocket components have been stored carefully. There will be a clear indication that there is propellant in the room, by large lettering on the magazine and yellow/black cautionary tape. There will also be a clear indication to keep away, in addition to warning about fire in the area. Our mentor shall maintain primary access to the propellant upon storage and shall prep it for transportation. It will be secured carefully within a vehicle, bound down to avoid unnecessary motion and without the risk of any other object resting or falling on top of it.

3.10 Statement of Compliance

All team members understand and will abide by the following safety regulations:

- 1.6.1. Range safety inspections of each rocket before it is flown. Each team shall comply with the determination of the safety inspection or may be removed from the program.
- 1.6.2. 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.
- 1.6.3. Any team that does not comply with the safety requirements will not be allowed to launch their rocket.

3.11 Hazard Analysis

3.11.1 Hazard Categories

3.11.1.1 Controls Risk Assessment

The hazards outlined in this section will discuss the risks associated with the launch vehicle mechanical and electrical controls. This is critical as failures in any system will result in a failed mission.

3.11.1.2 Hazards to Environment Risk Assessment

The hazards outlined in are risks that construction, testing or launching of the rocket can pose to the environment.

3.11.1.3 Logistics Risk Assessment

The hazards outlined are risks to the schedule associated with parts ordering, milestone accomplishment, and project completion. These hazards may also be associated with the physical movement of the launch vehicle from its current location to the launch site.

3.11.1.4 Launch Pad Functionality Risk Assessment

The hazards outlined are risks linked to the launch pad functionalities.

3.11.1.5 Payload Capture Device Risk Assessment

The hazards outlined in this section will discuss the risks associated with the payload capture device. The payload capture device interfaces with multiple systems, making it prone to hazards.

3.11.1.6 Recovery Risk Assessment

The hazards outlined are risks associated with the recovery. Since there are three recovery systems onboard, many of the failure modes and results will apply to all of the systems but will be stated only once for conciseness.

3.11.1.7 Shop Risk Assessment

Construction and manufacturing of parts for the rocket will be performed in both on-campus and off-campus shops. The hazards assessed are risks present from working with machinery, tools, and chemicals in the lab.

3.11.1.8 Stability and Propulsion Risk Assessment

The hazards outlined are risks associated with stability and propulsion. The team has multiple members of the team with certifications supporting that they can safely handle motors and design stable rockets of the size that the team will be working with. This area is considered a low risk for the team, but it is still important to address any potential problems that the team may face throughout the project.

3.11.2 Risk Level Definitions

3.11.2.1 Severity

The severity of each potential risk is determined by comparing the possible outcome to criteria based on human injury, vehicle and payload equipment damage, and damage to environment. Severity is based on a 1 to 3 scale, 1 being the most severe. The severity criteria are provided below.

Severity Definitions – A condition that can cause:					
Description	Personnel Safety and Health	Facility/Equipment	Range Safety	Project Plan	Environmental
1 – Catastrophic	Loss of life or a permanent disabling injury.	Loss of facility, systems or associated hardware that result in being unable to complete all mission objectives.	Operations not permitted by the RSO and NFPA 1127 prior to launch. Mission unable to proceed.	Delay of mission critical components or budget overruns that result in project termination.	Irreversible severe environmental damage that violates law and regulation.
2 – Critical	Severe injury or occupational related illness.	Major damage to facilities, systems, or equipment that result in partial mission failure.	Operations not permitted by the RSO and NFPA 1127 occur during launch. Mission suspended or laws and regulations are violated.	Delay of mission critical components or budget overruns that compromise mission scope.	Reversible environmental damage causing a violation of law or regulation.
3 – Marginal	Minor injury or occupational related illness.	Minor damage to facilities, systems or equipment that will not compromise mission objectives.	Operations are permitted by the RSO and NFPA 1127, but hazards unrelated to flight hardware design occur during launch.	Minor delays of non-critical components or budget increase.	Mitigatable environmental damage without violation of law or regulations where restoration activities can be accomplished.

3.11.2.2 Probability

The probability of each potential risk has been assigned a level between A and E, A being the most certain. The scale of probabilities is determined by analyzing the risks and estimating the possibility of the accident to occur. Table depicts the levels of probability for each risk.

Description	**Qualitative Definition**	**Quantitative Definition**	**Letter**
A – Frequent	High likelihood to occur immediately or expected to be continuously experienced.	Probability is > 90%	A
B – Probable	Likely to occur or expected to occur frequently within time.	90% ≥ probability > 50%	B
C – Occasional	Expected to occur several times or occasionally within time.	50% ≥ probability > 25%	C
D – Remote	Unlikely to occur, but can be reasonably expected to occur at some point within time.	25% ≥ probability > 1%	D
E – Improbable	Very unlikely to occur and an occurrence is not expected to be experienced within time.	1% ≥ probability	E

3.11.3 Risk Assessment Levels

Each risk is finally assigned a risk level based upon a combination of the risk's severity and probability. These levels range from high (red) to minimal (white) and are defined.

Probability	**Severity**			
	1 - Catastrophic	**2 - Critical**	**3 - Marginal**	**4 - Negligible**
A – Frequent	1A	2A	3A	4A
B – Probable	1B	2B	3B	4B
C – Occasional	1C	2C	3C	4C
D – Remote	1D	2D	3D	4D
E - Improbable	1E	2E	3E	4E

Level of Risk	**Definition**
High Risk	Highly Undesirable. Documented approval from the RSO, NASA SL officials, team faculty adviser, team mentor, team leads, and team safety officer.
Moderate Risk	Undesirable. Documented approval from team faculty adviser, team mentor, team leads, team safety officer, and appropriate sub-team lead.
Low Risk	Acceptable. Documented approval by the team leads and sub-team lead responsible for operating the facility or performing the operation.
Minimal Risk	Acceptable. Documented approval not required, but an informal review by the sub-team lead directly responsible for operating the facility or performing the operation is highly recommended.

3.11.4 Current and Probable Risk

Through past years of rocket design and competition, as well as what orders are already underway below is a table of risk that shall continue to grow and be edited by the safety officer throughout the project.

Area	Hazard	Cause	Effect	Pre RAC	Mitigation	Post RAC	Verification

Environ mental	Harmful substances permeating into the ground or water.	Improper disposal of batteries or chemicals.	Impure soil and water can have negative effects on the environment that in turn, affect humans and animals, causing illness.	2E	Batteries and other chemicals will be disposed of properly in accordance with the MSDS sheets. Should a spill occur, proper measure are to be followed in accordance with the MSDS sheets and any EHS standards.	2E	MSDS sheets will be kept on hand in the shop and at the launch field.
Environ mental	Spray painting.	The rocket will be painted.	Water contamination. Emissions to environment.	3D	All spray painting operations will be performed in a paint booth by trained individuals. This prevents any overspray from entering into the water system or the air.	3E	Paint booth will be marked with appropriate signage for hazardous material. Training will be documented for designated individuals.
Environ mental	Plastic and fiberglass waste material.	Plastic used in the production of electrical components and wiring and fiberglass used in production of launch vehicle components.	Plastic or fiberglass material produced when shaving down or sanding components could harm animals if ingested by an animal. Plastic could find its way down a drain and into the water system.	3D	All plastic material will be disposed of in proper waste receptacles. Personnel will used protective equipment when sanding or cutting plastic and fiberglass.	4E	Waste receptacles will be available and properly marked. Protective equipment is on hand.

Environ mental	Wire waste material.	Wire material used in the production of electrical components .	Sharp bits of wire being ingested by an animal if improperly disposed of.	3D	All wire material will be disposed of in proper waste receptacles.	4E	Waste receptacles will be available and properly marked.
Logistic	Not enough time for adequate testing.	Failure to create a precise timeline.	Imprecision in the launch vehicle design and less verification of design.	3C	Create a rigorous timeline and ensure everyone stays on schedule. Make due dates at least three days in advance for deliverables. Use shared calendar to keep all personnel apprised of deadlines. A more detailed schedule was created to make sure the team remains on track. Each task has a description and expected deliverables. Full scale completion date moved earlier in the schedule to allow more testing. Alternate launch site (Bunnell) may be used if needed.	3E	Project schedule has been set with sufficient buffer time to absorb delays.
Logistic	Parts ordered late or delayed in shipping.	Long shipping times and delays, failure to order parts in timely fashion.	Project schedule delayed. Selected functions unavailable.	2C	Shared calendar will be used to keep all personnel apprised of deadlines. Reminder notifications will be sent to technical leads well in advance of deadlines. When possible, suitable substitute parts will be maintained on hand. Finance managers will be recruited and trained to track budget and parts ordering.	2E	Project schedule has been shared to all team members. Finance manager has been hired.

Shop	Using power tools and hand tools such as blades, saws, drills, etc.	Improper use of PPE. Improper training on the use of equipment.	Mild to severe cuts or burns to personnel. Damage to rocket or components of the rocket. Damage to equipment	3C	Individuals will be trained on the tool being used. Those not trained will not attempt to learn on their own and will find a trained individual to instruct them. Proper PPE must be worn at all times. Shavings and debris will be swept or vacuumed up to avoid cuts from debris.	4D	Training will be documented for designated individuals.
Shop	Sanding or grinding materials.	Improper use of PPE. Improper training on the use of equipment.	Mild to severe rash. Irritated eyes, nose or throat with the potential to aggravate asthma. Mild to severe cuts or burns from a Dremel tool and sanding wheel.	2C	Long sleeves will be worn at all times when sanding or grinding materials. Proper PPE will be utilized such as safety glasses and dust masks with the appropriate filtration required. Individuals will be trained on the tool being used. Those not trained will not attempt to learn on their own and will find a trained individual to instruct them.	4E	Training will be documented for designated individuals.
Shop	Working with chemical components resulting in mild to severe chemical burns on skin or eyes, lung damage due to inhalation of toxic fumes, or chemical	Chemical splash. Chemical fumes.	Mild to severe burns on skin or eyes. Lung damage or asthma aggravation due to inhalation.	2C	MSDS documents will be readily available at all times and will be thoroughly reviewed prior to working with any chemical. All chemical containers will be marked to identify appropriate precautions that need to be taken. Chemicals will be maintained in a designated area. Proper PPE will be worn at all times when handling chemicals. Personnel involved in motor	3E	Training will be documented for designated individuals. Certificates will be kept on file for trained individuals until the individuals graduate and leave the organization.

	spills.				making will complete the university's Lab and Research Safety Course. All other individuals will be properly trained on handling common chemicals used in constructing the launch vehicles.		
Shop	Damage to equipment while soldering.	Soldering iron is too hot. Prolonged contact with heated iron.	The equipment could become unusable. If parts of the payload circuit become damaged, they could become inoperative.	3C	The temperature on the soldering iron will be controlled and set to a level that will not damage components. For temperature sensitive components sockets will be used to solder ICs to. Only personnel trained to use the soldering iron will operate it.	4D	Training will be documented for designated individuals.
Shop	Dangerous fumes while soldering.	Use of leaded solder can produce toxic fumes.	Team members become sick due to inhalation of toxic fumes. Irritation could also occur.	3D	The team will use well ventilated areas while soldering. Fans will be used during soldering. Team members will be informed of appropriate soldering techniques.	4E	Training will be documented for designated individuals.
Shop	Overcurrent from power source while testing.	Failure to correctly regulate power to circuits during testing.	Team members could suffer electrical shocks which could cause burns or heart arrhythmia.	1D	The circuits will be analyzed before they are powered to ensure they don't pull too much power. Power supplies will also be set to the correct levels. Team members will use documentation and checklists when working with electrical	2E	When available, an electrical engineering student will supervise electrical operations.

					equipment.		
Shop	Use of white lithium grease.	Use in installing motor and on ball screws.	Irritation to skin and eyes. Respiratory irritation.	3D	Nitrile gloves and safety glasses are to be worn when applying grease. When applying grease, it should be done in a well ventilated area to avoid inhaling fumes. All individuals will be properly trained on handling common chemicals used in constructing the launch vehicles.	4E	Training will be documented for designated individuals.
Shop	Metal shards.	Using equipment to machine metal parts.	Metal splinters in skin or eyes.	1D	Team members will wear long sleeves and safety glasses whenever working with metal parts. Individuals will be trained on the tool being used. Those not trained will not attempt to learn on their own and will find a trained individual to instruct them.	4D	Training on this equipment is provided by the university through the Design for X Labs orientation and safety training program.
Environ mental	UV exposure.	Rocket left exposed to sun for long periods of time.	Possibly weakening materials or adhesives.	3D	Rocket should not be exposed to sun for long periods of time. If the rocket must be worked on for long periods of time, shelter should be sought.	3E	Rocket is constructed and maintained in an air conditioned workshop.

4 Launch Vehicle Summary

4.1 Initial Design

The initial design is launch vehicle of 82 inches long and weighing at about 29.4 pounds with the Cesaroni L995 motor equipped. The static stability margin rests at 2.33 calipers, with the Center of Gravity (CG) at 56.485 inches from the nosecone and the Center of Pressure at 68.481inches from the nosecone. The payload in this module is 8 inches long and 5 pounds, projected to be the highest possible weight. Every measurement and factor of the payload and internal rocket subsystems are subject to change.

The airframe is constructed primarily of fiberglass tubing with a fixed fin system. We chose fiberglass because of its high tensile and compressive strengths as well as its availability. The fins may be constructed of fiberglass or carbon fiber. Both materials would be strong and readily available. Fiberglass would be the less costly option, while carbon fiber would be more resilient.

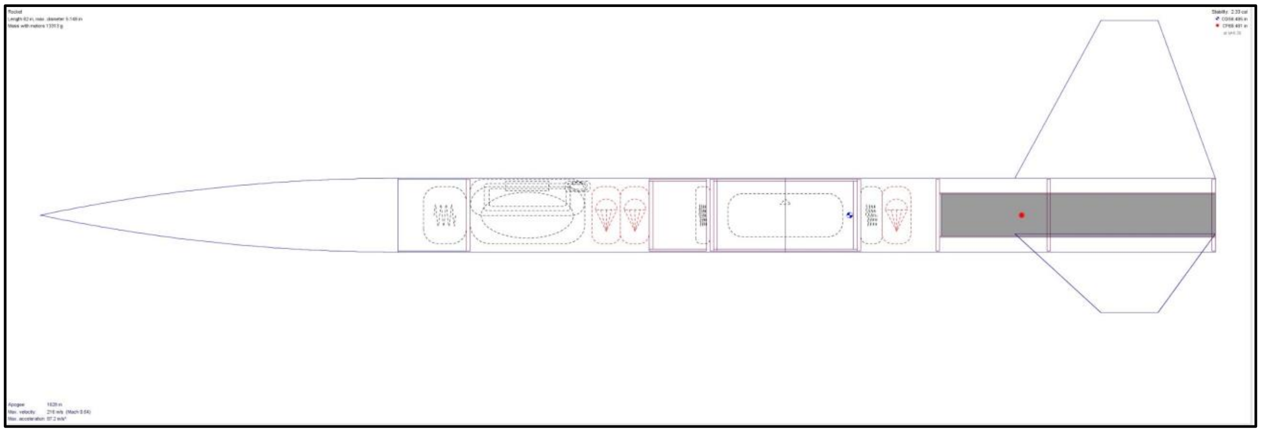
4.2 Construction

To construct the rocket we will begin with the fin can. We will epoxy the fins onto the motor mount with chopped carbon fiber in the epoxy for added strength. Once that is complete we will cut slits in the outer tube and slide the fin can into the aft fiberglass tube. We will add fillets with epoxy on the outer and inside of the outer tube for increased stability of the fins. A bulkhead will be added to the end of the motor mount to hold the motor mount in place. Above this bulkhead is where the landing mechanisms will be placed. Above the mechanisms will be a removable bulkhead with a forged eyebolt on it to attach to the parachutes.

4.3 Size and Mass

Diameter	5.148 in
Length	82 in
Projected Unloaded Weight	21.4 lbs
Projected Loaded Weight	29.4
Projected Motor	L995
Airframe Material	Fiberglass

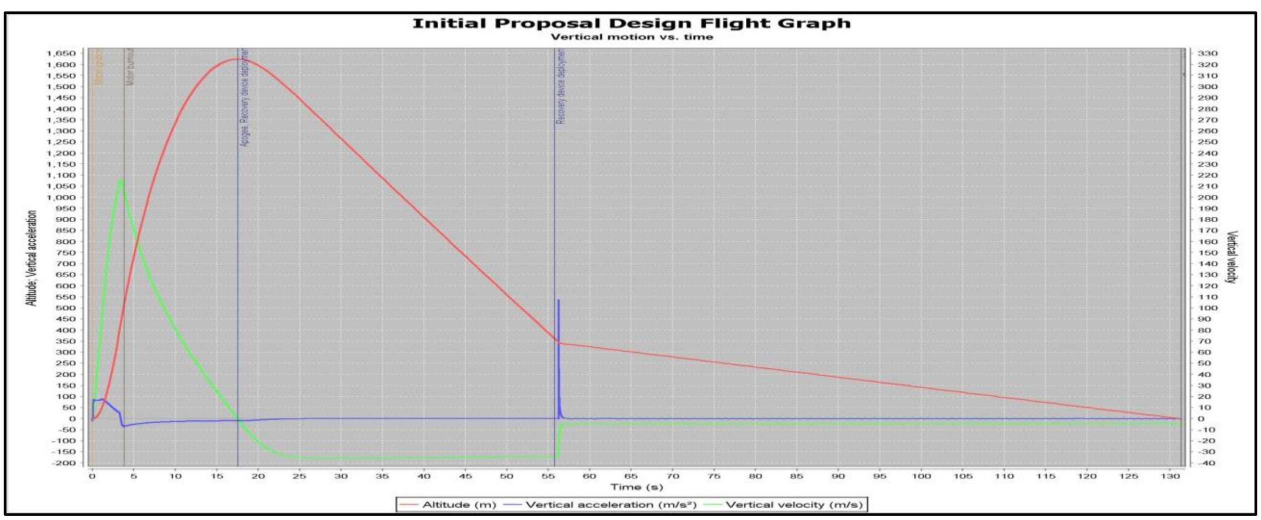
Figure 1: Overview drawing of launch vehicle assembly.



4.4 Projected Altitude

The projected altitude was calculated using OpenRocket and the design sketch in Figure 1. The projected altitude was 1628 meters, or about 5,341 feet. Though over the target altitude, this apogee can be reduced by building the rocket and reevaluating CG, CP, and weight given factors unaccounted for in the software. The subtle differences in measurement given the nature of a simulation versus a physical, tangible rocket; we can change and manipulate fin design or add ballast weight to reach our target altitude of 5,280 feet. The proposed motor has considerable thrust and specific impulse for the initial rocket design, and can be controlled accordingly.

Figure 2: Graph of flight profile.



4.5 Projected Recovery System

4.5.1 Recovery System

A dual deployment system will be sequentially staged from two different recovery bays. This configuration will allow for complete separation of the rover compartment in order to reduce the possibility of entanglement of shock cords and obstruction of the exit area for the rover. The system will consist of one drogue, two main parachutes, a piston system, and a tender descender detachment system. The piston system will be placed between the rover and the altimeter bay and will protect the rover from damage due to the separation charge. The tender descender detachment system will prevent the rover compartment from being dragged along the ground and also prevent the parachute from obstructing the rover's exit from the compartment.

4.5.2 Deployment Procedure

Three deployment events will occur and are listed below

1. At apogee, the launch vehicle will separate above the booster section and below the altimeter bay using a black powder charge and shear pin configuration. This event releases the drogue parachute to reduce the descent rate until event 2.
2. At 800 feet, the launch vehicle will separate above the altimeter and below the rover using a black powder charge and shear pin configuration. The altimeter bay and booster section will descend under a separate parachute from the rover compartment, which will remain attached to the nosecone.
3. Upon impact with the ground, as determined by an on-board altimeter, the parachute attached to the rover compartment will be separated from the rover compartment via a black powder charge in the tender descender, which will be attached to the shock cord near the exit area of the rover compartment.

4.5.3 Payload Recovery System

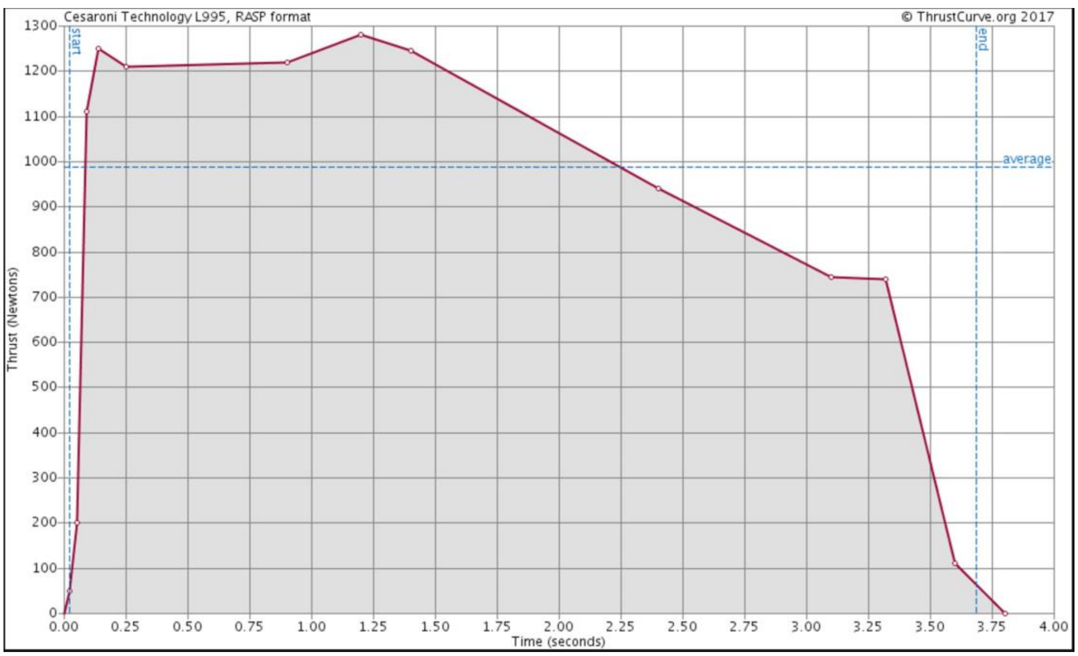
Large Cert-3 SkyAngle parachute system that has a surface area of 57.0 square feet. The parachute will be secured by a shock cord in the nosecone and rover compartment that will be secured to the airframe using epoxy. The Tender Descender that will disconnect the shock cord will be at the exit end of the rover compartment. The Tender Descender will be triggered with an e-match and light black powder sequence to disconnect the payload parachute, removing any possible obstruction from the parachute.

4.6 Projected Motor

The motor selected for use in the launch vehicle is the Cesaroni L995 75mm motor with the following specifications. The motor was chosen because the thrust available made reaching an apogee of 5,280 feet possible while allowing for fine adjustment of projected apogee through alteration of fin design, size, sweep angle, and tip and root chord. Also, this motor, under most configurations slightly exceeds the target apogee altitude and, in our previous experience, the constructed rocket is most often somewhat heavier than the simulated weight due to epoxy and parts not accounted for in the simulation software.

Average Thrust	996.5N
Maximum Thrust	1404.5N
Total Impulse	3618.0Ns
Burn Time	3.6s
Case Info	Pro75-3G

Figure 3: Cesaroni L995 Thrust Curve.



4.7 Projected Payload

4.7.1 Payload Requirements

Deployable rover payload has been chosen. It will be designed according to the following criteria:

1. Teams will design a custom rover that will deploy from the internal structure of the launch vehicle.
2. At landing, the team will remotely activate a trigger to deploy the rover from the rocket.
3. After deployment, the rover will autonomously move at least 5 ft. (in any direction) from the launch vehicle.

4. Once the rover has reached its final destination, it will deploy a set of foldable solar cell panels.

4.7.2 Rover Design

4.7.2.1 Means of locomotion

Several different design solutions were considered during the design process for this payload. A wheeled vehicle was one design option, but it was deemed that a tracked or multi-tracked vehicle would be better suited to the terrain and be better able to surmount any physical obstacles. This solution is still being reviewed and may be subject to change prior to the PDR. The team also decided that it is best to have the power supply of the rover should within the launch vehicle and tethered to allow more room and less weight to add more powerful motors to move the vehicle.

Figure 4: Top view of payload.

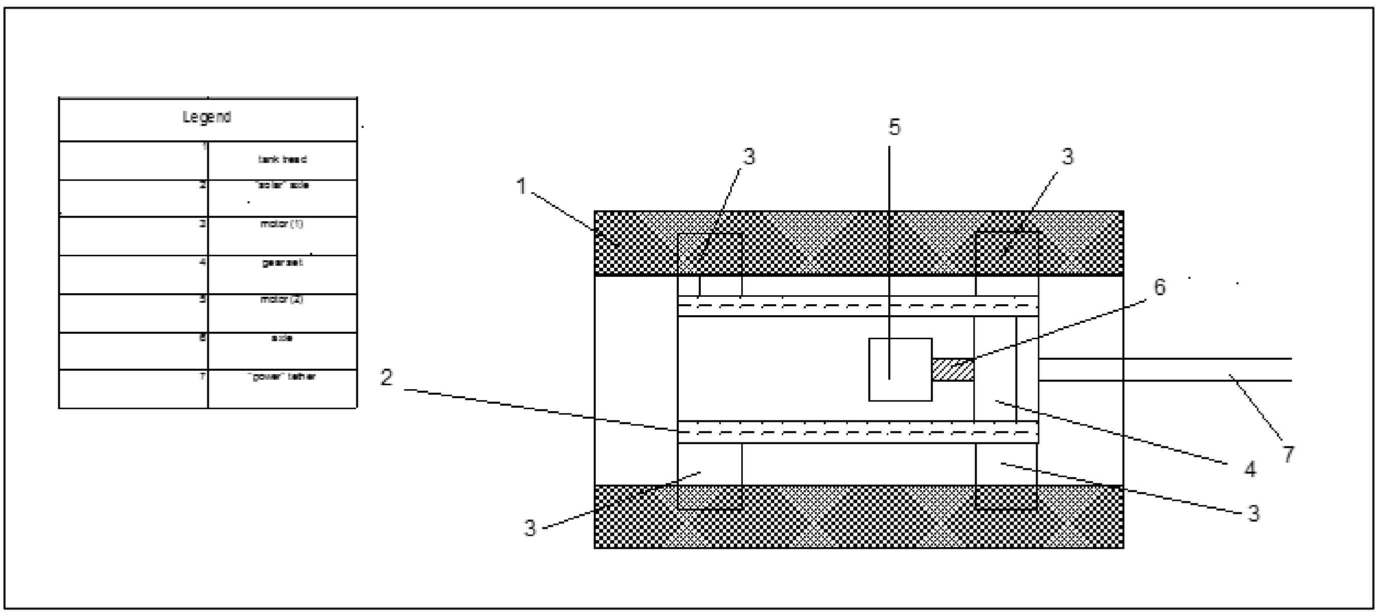
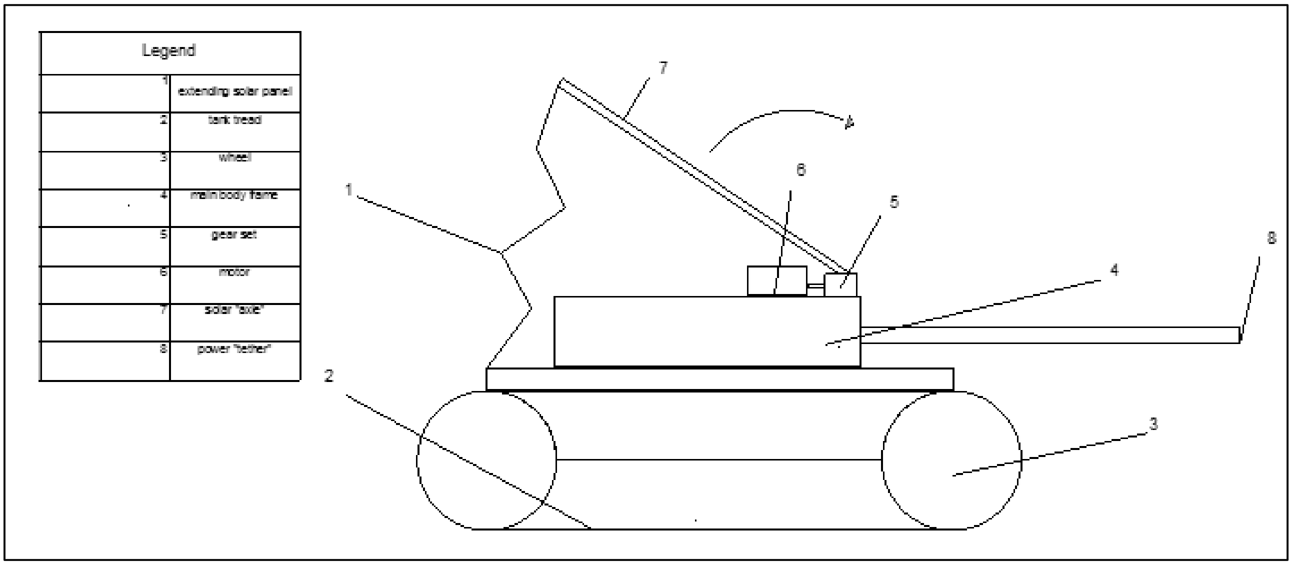


Figure 5: Top view of payload.



4.7.2.2 Deployment Method

The rover will be secured to the rocket by using a series of powered clamps. These clamps will be attached to the guide rail of the rover apparatus, secured in a linear configuration on the inside of the airframe, and be part of the first set of actions upon the deployment trigger. With the trigger, the clamps will release tension on the guide rail, allowing the rover the ability to mobilize itself out of the rocket. Once the clamps release and the rover is detached, the next command for the onboard computers will be to move the rover forward towards the opening. This second command of movement will be responsible for delivering the rover out of the launch vehicle and moving at least 5 feet from the point of exit.

Figure 6: Design of guide rail.

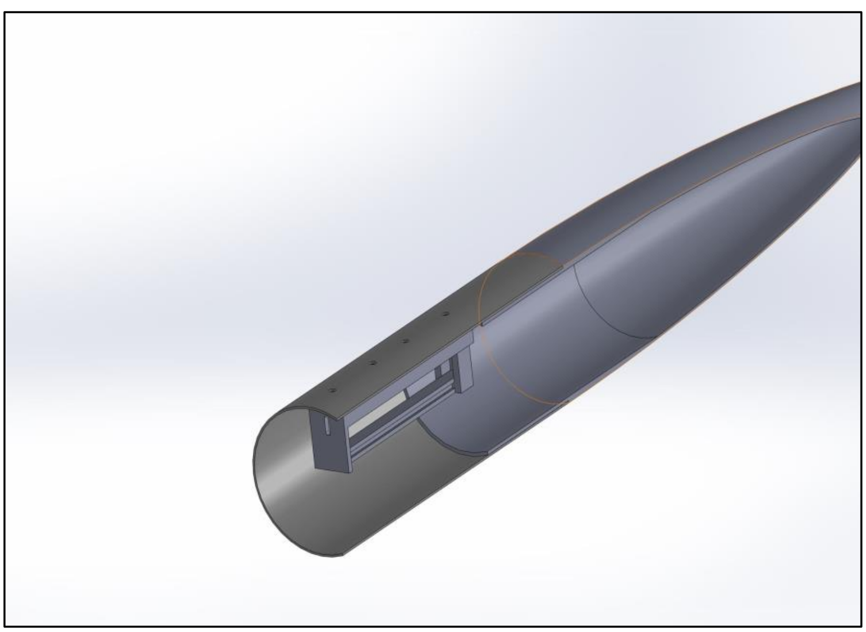
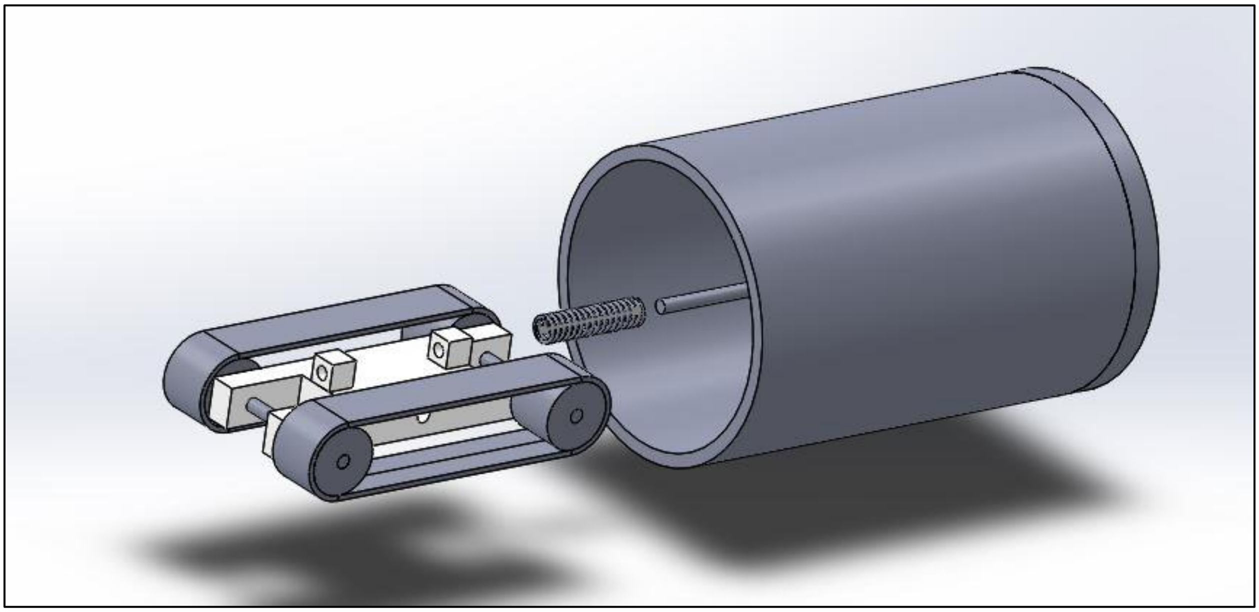


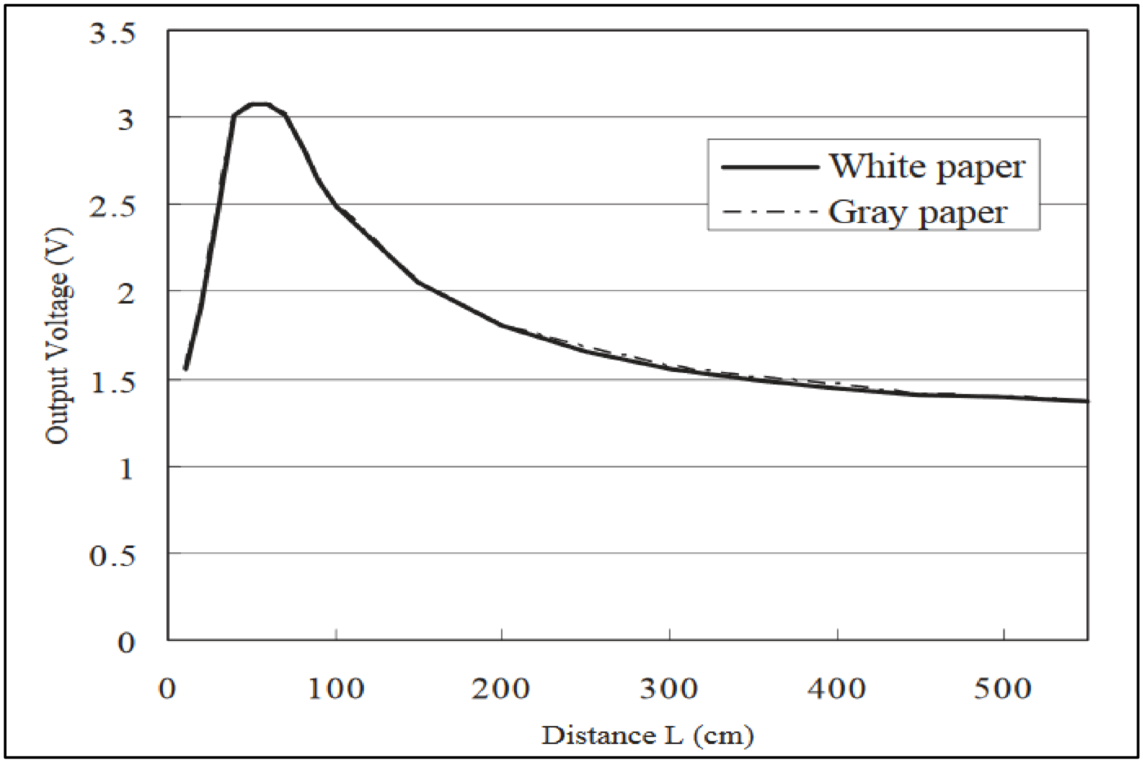
Figure 7: Rover deployment system with guide rail, and adapters.



4.7.2.3 Means of navigation

Upon landing, the rover will be triggered remotely by our ground team. The trigger will first release the clamps that secure the rover to the inner apparatus, thus allowing the rover to then advance out of the launch vehicle. The rover will then move towards the opening in the launch vehicle, and utilize a SHARP GP2Y0A710K0F infrared (IR) Sensor to detect a reflective white background. The IR Sensor will then measure the distance from the rocket by detecting an analog output voltage. The displacement will be recorded and once the proper displacement has been detected and satisfied, the programming of the rover will then transfer its function to the solar panel deployment system. If all system requirements are met on the rover and perform properly to the mission, our team will install a payload monitoring system. The payload monitoring system will consist of a small camera mounted on or near the nose cone bulkhead inside the rover compartment, pointed in the direction of the rover that will provide a live video feed for the team members to monitor the status and progress of the rover. The camera will be activated on impact in order to preserve battery charge.

Figure 8: IR Sensor Output Voltage/Distance.



5 Educational Engagement

SOAR plans to participate in USF's Engineering Expo which is the largest annual engineering event on campus. In February, the event will host thousands of elementary, middle, and high school students with demonstrations by student engineering organizations, USF research labs, and engineering companies. Along with these, the Expo wants to show is these students the importance of math, science, engineering, and technology within their everyday lives. During this two-day event, we will be engaging with a large number of students actively through hands-on activities and passively with information about rocketry.

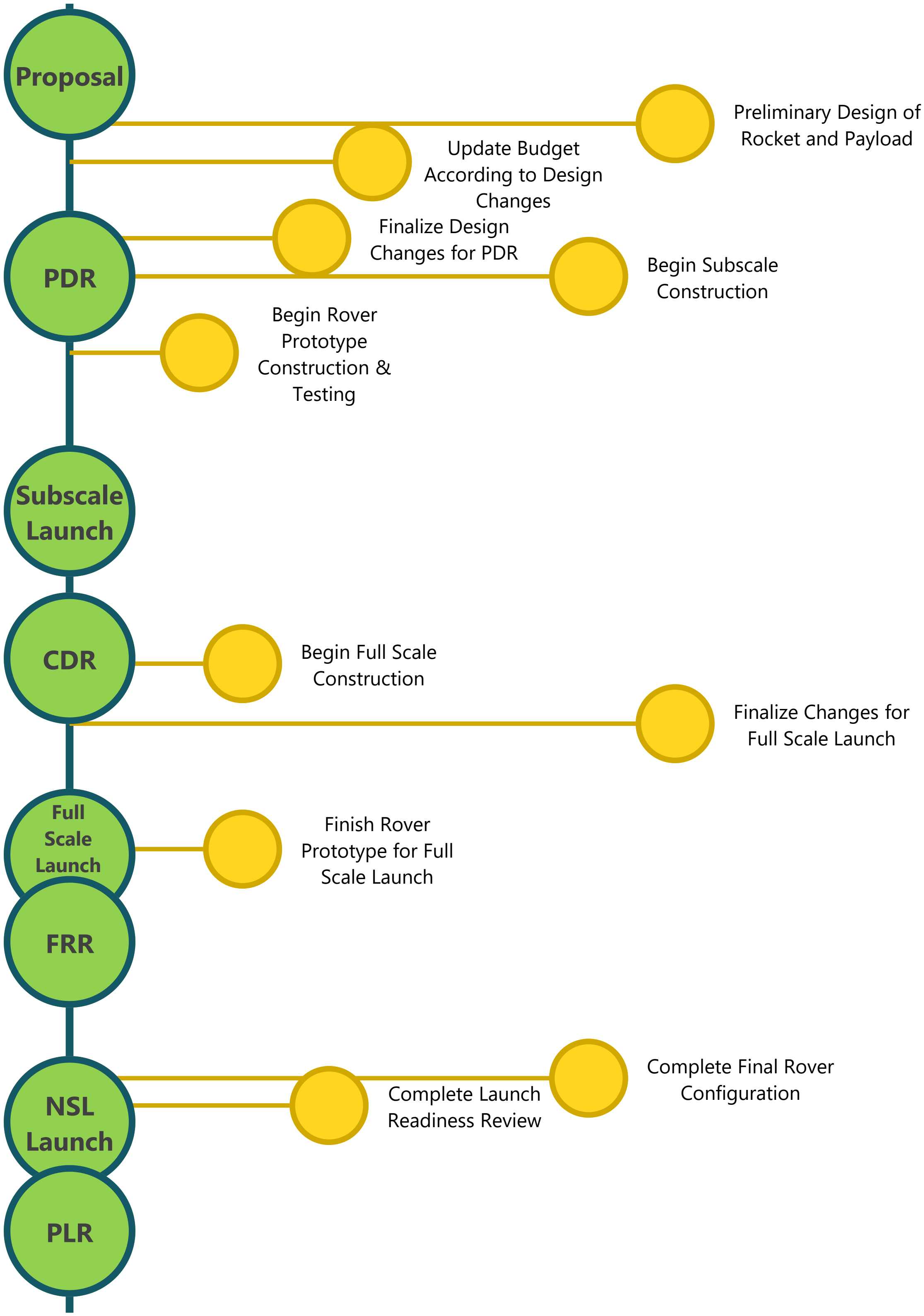
We also intend to partner with local schools, having members visit and engage with students through hands-on activities and demonstrations. Details of this engagement are unknown, but our members are currently reaching out to local schools to see what possible activities and/or demonstrations we could do with the students.

6 Project Schedule

- September 20th, 2017 - Proposal Due
- October 6th, 2017 - Preliminary Design of Rocket and Payload
- October 13th, 2017 - Update Budget According to Design Changes
- October 27th, 2017 - Finalize Design Changes for PDR
- November 3rd, 2017 - Preliminary Design Report Due

- November 4th, 2017 - Begin Subscale Construction
- November 17th, 2017 - Begin Rover Prototype Construction & Testing
- December 16th, 2017 - Launch Subscale Rocket
- January 12th, 2018 - Critical Design Review Due
- January 13th, 2018 - Begin Full Scale Construction
- January 24th, 2018 - Finalize Changes for Full Scale Launch
- February 16th, 2018 - Finish Rover Prototype for Full Scale Launch
- February 17th, 2018 - Launch Full Scale Rocket
- March 5th, 2018 - Flight Readiness Review Due
- March 30th, 2018 - Complete Final Rover Configuration
- April 4th, 2018 - Complete Launch Readiness Review
- April 7th, 2018 - Competitive Launch Day
- April 27th, 2018 - Post-Launch Assessment Report Due

Project Timeline Visualization



7 Project Budget

Rocket Materials	$1,000
Launch Motors	$400
Test Launch Motors	$800
Subscale Materials	$600
Subscale Motor	$350
Payload	$800
Miscellaneous Hardware	$400
Travel	$1,500
TOTAL	$5,850

8 Sustainability

8.1 Local Exposure

SOAR receives local exposure in the community in several ways and has appeared in television news spots on more than one occasion. We have also been featured in the marketing video for the College of Engineering and the University President's Fall Address. We are also regularly featured on Bulls Radio, the university radio station.

https://youtu.be/kpY0wlrDEg8
https://youtu.be/oUmmI9Sj6oQ
https://www.facebook.com/USouthFlorida/videos/10159272101650084/
https://www.youtube.com/watch?v=DA4Q4E-EPjU

8.2 Recruitment and Retention

SOAR has participated in or hosted four recruiting events since the beginning of this semester. We presented our organization to students at USF's weekly Bull Market, the Student Organization Showcase, and the Engineering Council Showcase. We also hosted our own event, the First Annual Rocket Exhibition, featuring a rocket museum, a virtual reality goggle view of our 2017 NASA Student Launch, a beanbag toss game, and demonstrations of rocket simulations and future project plans.

Retention plans include maximizing the number of projects so that every member is able to actively participate, hosting social events, build days, and speaking events that benefit our members. Each project will incorporate several leadership and technical positions so that each member maximizes participation and ownership.

8.3 Continuing Funding

In addition to student government funding, SOAR conducts fundraising at the local launches by selling food during lunch time. We are also currently working closely with the College of Engineering Directors of Development to open an account through the USF Foundation, a tax-deductible donation account, and create a sponsorship package to recruit local business sponsors. Once this is established, we can also initiate crowd funding through Bull Herder, the university's version of Kickstarter that also deposits funds to the USF Foundation account.

9 Appendix

9.1 Contributors

- **Project Management/Logistics**
    - Jackson Stephenson
    - Ashleigh Stevenson
    - Andrew Sapashe
- **Launch Vehicle**
    - John Dougherty
    - Jackson Stephenson
    - Kevin Kirkolis
- **Editing and Formatting**
    - Stephanie Bauman
    - Jackson Stephenson
- **Electronics/Coding**
    - Joe Caton
    - Cesil Alex
    - Linggih Saputro
    - Simon Wilson
    - Ian Sanders
- **Rover**
    - Jackson Stephenson
    - Jaime Gomez
    - Joe Caton
    - Javian Hernandez
    - Cesil Alex
    - Andrew Sapashe
    - James Waits
- **Educational Engagement**
    - Jackson Stephenson
    - Ashleigh Stevenson
    - Andrew Sapashe
- **Safety**
    - Stephanie Bauman
    - Wyatt Boyatt

9.2 NAR Safety Code

1. Certification. I will only fly high power rockets or possess high power rocket motors that are within the scope of my user certification and required licensing.
2. Materials. I will use only lightweight materials such as paper, wood, rubber, plastic, fiberglass, or when necessary ductile metal, for the construction of my rocket.
3. Motors. I will use only certified, commercially made rocket motors, and will not tamper with these motors or use them for any purposes except those recommended by the manufacturer. I will not allow smoking, open flames, nor heat sources within 25 feet of these motors.

4. Ignition System. I will launch my rockets with an electrical launch system, and with electrical motor igniters that are installed in the motor only after my rocket is at the launch pad or in a designated prepping area. My launch system will have a safety interlock that is in series with the launch switch that is not installed until my rocket is ready for launch, and will use a launch switch that returns to the "off" position when released. The function of onboard energetics and firing circuits will be inhibited except when my rocket is in the launching position.
5. Misfires. If my rocket does not launch when I press the button of my electrical launch system, I will remove the launcher's safety interlock or disconnect its battery, and will wait 60 seconds after the last launch attempt before allowing anyone to approach the rocket.
6. Launch Safety. I will use a 5-second countdown before launch. I will ensure that a means is available to warn participants and spectators in the event of a problem. I will ensure that no person is closer to the launch pad than allowed by the accompanying Minimum Distance Table. When arming onboard energetics and firing circuits I will ensure that no person is at the pad except safety personnel and those required for arming and disarming operations. I will check the stability of my rocket before flight and will not fly it if it cannot be determined to be stable. When conducting a simultaneous launch of more than one high power rocket I will observe the additional requirements of NFPA 1127.
7. Launcher. I will launch my rocket from a stable device that provides rigid guidance until the rocket has attained a speed that ensures a stable flight, and that is pointed to within 20 degrees of vertical. If the wind speed exceeds 5 miles per hour I will use a launcher length that permits the rocket to attain a safe velocity before separation from the launcher. I will use a blast deflector to prevent the motor's exhaust from hitting the ground. I will ensure that dry grass is cleared around each launch pad in accordance with the accompanying Minimum Distance table, and will increase this distance by a factor of 1.5 and clear that area of all combustible material if the rocket motor being launched uses titanium sponge in the propellant.
8. Size. My rocket will not contain any combination of motors that total more than 40,960 N-sec (9208 pound-seconds) of total impulse. My rocket will not weigh more at liftoff than one-third of the certified average thrust of the high power rocket motor(s) intended to be ignited at launch.
9. Flight Safety. I will not launch my rocket at targets, into clouds, near airplanes, nor on trajectories that take it directly over the heads of spectators or beyond the boundaries of the launch site, and will not put any flammable or explosive payload in my rocket. I will not launch my rockets if wind speeds exceed 20 miles per hour. I will comply with Federal Aviation Administration airspace regulations when flying, and will ensure that my rocket will not exceed any applicable altitude limit in effect at that launch site.
10. Launch Site. I will launch my rocket outdoors, in an open area where trees, power lines, occupied buildings, and persons not involved in the launch do not present a hazard, and that is at least as large on its smallest dimension as one-half of the maximum altitude to which rockets are allowed to be flown at that site or 1500 feet, whichever is greater, or 1000 feet for rockets with a combined total impulse of less than 160 N-sec, a total liftoff weight of less than 1500 grams, and a maximum expected altitude of less than 610 meters (2000 feet).

11. Launcher Location. My launcher will be 1500 feet from any occupied building or from any public highway on which traffic flow exceeds 10 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.

12. Recovery System. I will use a recovery system such as a parachute in my rocket so that all parts of my rocket return safely and undamaged and can be flown again, and I will use only flame-resistant or fireproof recovery system wadding in my rocket.

13. Recovery Safety. I will not attempt to recover my rocket from power lines, tall trees, or other dangerous places, fly it under conditions where it is likely to recover in spectator areas or outside the launch site, nor attempt to catch it as it approaches the ground.

MINIMUM DISTANCE TABLE

Installed Total Impulse (Newton-Seconds)	Equivalent High Power Motor Type	Minimum Diameter of Cleared Area (ft.)	Minimum Personnel Distance (ft.)	Minimum Personnel Distance (Complex Rocket) (ft.)
0 — 320.00	H or smaller	50	100	200
320.01 — 640.00	I	50	100	200
640.01 — 1,280.00	J	50	100	200
1,280.01 — 2,560.00	K	75	200	300
2,560.01 — 5,120.00	L	100	300	500
5,120.01 — 10,240.00	M	125	500	1000
10,240.01 — 20,480.00	N	125	1000	1500
20,480.01 — 40,960.00	O	125	1500	2000

Note: A Complex rocket is one that is multi-staged or that is propelled by two or more rocket motors

9.3 TRA Safety Code

Safety Code for High-Power Rocketry

Tripoli Rocketry Association

This High-Power Rocketry Safety Code is the product of many years of effort on behalf of the hobby by those who care about it and whose prime interest is safety This document sets minimum standards, intended to preserve the hobby in a safe environment. Using this Code as the minimum, it will be your responsibility to regulate your own launches safely for the conditions of each launch site. This Safety Code shall be the standard at all Tripoli Sanctioned Launches.

The Tripoli High-Power Safety Code ***supplements*** **NFPA 1127 Code for High Power Rocketry** with sections that are specific to Tripoli. The foundation of the Tripoli High Power Safety Code is NFPA 1127.

1 General Requirements

1-1 Scope

1-1.1 This code shall set practices for safe operation of High Power rocket launches. It will also address some aspects of safe rocket design, and construction, and limitations of motor power, for use by the certified user for the purposes of education, recreation and sporting use.

1-2 Purpose

1-2.1 The purpose of this code shall be to establish guidelines for reasonably safe operation of rockets at Tripoli Sanctioned Launches.

1-3 Definitions:

For the purposes of this code, the following terms shall be defined as stated in this section. Some of these may be redundant from NFPA 1127.

Insured Flier: A flier that has insurance provided by Tripoli or any rocketry organization that TRA has insurance reciprocity with. At this writing this includes NAR only. Note: some types of TRA membership do not include insurance (e.g. Associate, and Honorary members).

Adult Flier: An *Insured Flier* that is 18 years old or older.

High Power Rocketry Flier (HPR Flier): An *Adult Flier* that is certified to fly High Power rockets at their certification level.

Model Rocket Fliers (MR Flier): An Insured Flier who is not certified to fly High Power rockets.

Invited Guests of Fliers (Guests): A person who is not a member of a recognized rocketry organization/not covered by insurance.

Tripoli Rocketry Association – High Power Safety Code April 2017 – Page: 1

Launch Director (LD): A Level 2 or Level 3 flier who has overall administrative responsibility for the launch.

Participants. Persons that are either:

- **HPR Fliers**.
- **Model Rocket Fliers**.
- **Invited Guests of Fliers.**

Range Safety Officer (RSO). A Level 2 or Level 3 flier who has the authority to ensure the safe operation of the range.

Sanctioned Launch. A sanctioned launch is a ***Tripoli Insured Launch***. Any *Sanctioned Launch* shall meet ***ALL*** of the following requirements:

- Responsible person of launch shall be member of Tripoli in good standing.
- Follows the appropriate Tripoli Safety Code.
- All AHJ (e.g. FAA waiver) requirements/regulations met and any required permits secured.
- Landowner permission has been formally obtained.

Shall. Indicates a mandatory requirement.

Should. Indicates a recommendation or that which is advised but not required.

Spectator. A nonparticipant whose primary purpose is to view a rocket launch.

Spectator Area. An area designated where spectators view a rocket launch.

Tripoli Mentoring Program (TMP). Program to permit Tripoli Junior members to participate in supervised high power rocketry activities.

Tripoli (TRA). Tripoli Rocketry Association, Inc.

Requirements for High Power Rocket Operation

2 **Operating Clearances.** A person shall fly a high-power rocket only in compliance with:

- This code and NFPA 1127;
- *Federal Aviation Administration Regulations*, Part 101 (Section 307,72 Statute 749, Title 49 United States Code, Section 1348, "Airspace Control and Facilities," Federal Aviation Act of 1958);
- Other applicable federal, state, and local laws, rules, regulations, statutes, and ordinances.
- Landowner permission.

3 Legality

3-1 The Tripoli Rocketry Association does not claim Rocketry to be legal in every municipality, state or political jurisdiction.

4 Insurance

4-1 Tripoli rocketry activities are only insured when the provisions of this code are followed.

4-2 No Tripoli member shall misrepresent to any authority or landowner that Tripoli activities are insured .

5 Participation,

Participation Note: The information provided below identifies the minimum requirements for individuals that participate/attend Tripoli Sanctioned Launches.

A Launch Director has the authority to impose more stringent rules.

Participation and Access at Tripoli Launches shall be limited to the following:

5-1 HPR Fliers may access and conduct flights from the High-Power Launch Area and/or Model Rocket Launch Area.

5-2 Non-Tripoli Members age 18 and over who are students of an accredited educational institution may participate in joint projects with Tripoli members.

5-2.1 These individuals are only allowed in the High-Power Launch Area while supervised by an HPR Flier.

5-2.2 They are only allowed in the Model Rocket Launch Area while supervised by an Adult Flier.

5-2.3 The maximum number of nonmember participants shall not exceed five (5) per supervising flier.

5-3 Tripoli Junior Members who have successfully completed the TMP may access and conduct flights from the High-Power Launch Area while under the direct supervision of a Tripoli HPR Flier in accordance with the rules of the TMP.

5-3.1 The maximum number of TMP participants shall not exceed five (5) per supervising flier.

5-4 Children younger than 18 years of age may conduct flights from the Model Rocket Launch Area under the direction of an Adult Flier.

5-5 An invited guest may be permitted in the Model Rocket Launch Area and preparation areas upon approval of the RSO. Invited guests are not permitted in the High-Power Launch Area.

5-6 Spectators are only permitted in the spectator area(s); they are not permitted in the High-Power Launch Area or Model Rocket Launch Area.

6 Tripoli Launch Operations

6-1 Insured Fliers shall provide proof of membership and certification status upon request.

6-2 All flights and static motor tests conducted by a member shall be within the member's certification level, with the exception of permitted certification attempts.

6-3 When three or more rockets are to be launched simultaneously, the minimum spectator and participant distance shall be the value set forth in the Safe Distance Table for a complex rocket with the same total installed impulse, but not more than 610 m (2000 ft), or 1.5 times the highest altitude expected to be reached by any of the rockets, whichever is less.

6-4 No range activity shall be conducted when a thunderstorm has been reported within ten miles, or less, of the launch site or if thunder or lightning is present.

6-5 No rockets shall be launched when the surface winds exceed 20 MPH (32 KPH)

6-6 The minimum safe standoff distance from the spectator area for the Model Rocket Launch Area shall be 50 feet (15 meters).

6-7 All flights planned to exceed 50,000ft AGL shall be submitted to the Class 3 review Committee for approval.

6-8 Launch Director and Range Safety Officer

6-8.1 The LD or RSO may refuse to allow the launch, or static testing, of any rocket or rocket motor that they deem to be unsafe.

6-8.2 The LD or RSO may require greater Safe Standoff Distances than specified in this code.

6-9 Recovery

6-9.1 **A** rocket shall be launched only if it contains a recovery system that is designed to return all parts of the rocket to the ground safely.

6-9.2 Rockets that employ passive recovery (e.g. tumble recovery, aero-braking) need not employ an active recovery system.

Minimum spectator and Participant Safe Distance Standoffs

Total Installed Impulse, N-s		Motor type	Non-Complex		Complex	
			feet	meters	feet	meters
0.01 to	160	High Power G or smaller	100	30	200	61
160.01	320	H	100	30	200	61
320.01	640	I	100	30	200	61
640.01	1280	J	100	30	200	61
1,280.01 to	2,560	K	200	61	300	91
2,560.01 to	5,120	L	300	92	500	152
5,120.01 to	10,240	M	500	153	1,000	305
10,240.01 to	20,480	N	1,000	305	1,500	457
20,480.01 to	40,960	O	1,500	457	2,000	610

7 Referenced Publications

The following documents or portions thereof are referenced within this code. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

7-1 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, P.O. Box *9101, Quincy, MA 02269-9101*

NFPA 1122, Code for Model Rocketry.

NFPA 1125, Code for the Manufacture of Model Rocket Motors.

NFPA 1127, Code for High Power Rocketry

7-2 Government Publications.

Superintendent of Documents, U.S. Government Printing Office, Washington DC 20402.

Federal Aviation Administration Regulations, from the Code of Federal Regulations. Federal

Hazardous Substances Act, from the United States Code (re. Airspace Control)

7-3 TRA Publications.

Tripoli Rocketry Association, Inc., P. O. Box 87, Bellevue NE 68005.

Articles of Incorporation and Bylaws

Tripoli Motor Testing Committee (TMT), Testing Policies

Appendix A - Additional Tripoli Rulings

A-1 NFPA 1127 was adopted by the Tripoli Board of Directors as the Tripoli Safety Code. (*Tripoli Report*, April 1994, Tripoli Board Minutes, New Orleans, 21 January 1994, Motion 13.)

A-2 All Tripoli members who participate in Association activities shall follow the Tripoli Certification Standards.

A-3 Any Board action(s) with regard to safety, made previous to or after publication of this document, shall be a part of the Tripoli Safety Code.

A-4 Increased descent rates for rocket activities conducted at the Black Rock Desert venue are acceptable if needed to insure a controlled descent to remain inside the FAA approved Dispersion Area.

A-5 A rocket motor shall not be ignited by using:

a. A switch that uses mercury.
b. "Pressure roller" switches