



**Texas Tech University – Space Raiders**  
USLI Project Proposal 2017 – 2018

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Safety Waivers Signed

# 1. BASIC

1.1 SCHOOL INFORMATION	
<b>Organization Name:</b>	Raider Aerospace Society (RAS) Texas Tech University (TTU)
<b>Faculty Advisor:</b>	Andrew Mosedale 806-834-6146 Andrew.mosedale@ttu.edu
<b>Team Leader:</b>	Davis Hall 214-995-4990 davis.hall@ttu.edu
<b>Team Mentor(s)/ NRA contact</b>	Bill Balash 806-681-6452 billbalash@sbcglobal.net
<b>Safety Officer:</b>	Derrick Slatton 806-881-3781 derrick.slatton@ttu.edu
<b>Adult Educator(s):</b>	Barre Wheatley 806-681-4716 mrbarre1@suddenlink.net

**MEMBERS:** The Raider Aerospace Society consists of roughly 70 active members both upper and lower classman, with a separate branch, “The Rocketeers” that is 25 highly involved upper and lower classmen focusing on the Student Launch Initiative. The SLI team has been organized into subgroups: (1) Safety, (2) Recovery, (3) Payload, (4) Vehicle, (5) Reports, with each subgroup containing 3-9 people and overlap to create synergy amongst subgroups.

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**Members and Roles:**

Derrick

- Safety Officer
- RAS president
- Vice Project Lead
- Proposal Member

Davis

- Project Lead
- RAS external Vice President
- Proposal Member

David

- Recovery Group Member
- RAS Internal Vice President

Jacob H.

- Payload Lead
- RAS Historian
- Proposal Member

Matthew

- Recovery Lead
- Proposal Member

Edward

- Vehicle Lead
- Proposal Member

Oswaldo

- Vehicle Member

Carlos

- Payload Member

Hector

- Vehicle Member

Hans

- Payload and Vehicle Member
- Safety Member

Braden

- Recovery Member

Jacob S.

- Payload Member

Brianna

- Vehicle Member

Chris

- Recover Member

Connor

- Payload Member

Daniel

- Vehicle Member

Jericho

- Recovery Member

Reid

- Vehicle Member

Ronald

- Payload Member

Spencer

- Recovery Member

Trevor

- Recovery Member

Zoe

- Vehicle Member

Saul

- Vehicle Member

## 1.2 FACILITIES AND EQUIPMENT

### 1.2.1 Lab Space

The Raider Aerospace Society has been approved by Texas Tech University to use the Advance Vehicle Prototyping Lab which is located at the Reese Technology Center. This building will act as our main meeting place; secure storage facility to house the rocket. We will be sharing some of the general common areas in the Advance Vehicle Prototyping Lab with other academic clubs such as: TTU's Solar Racing Team, Formula SAE, Robo Raiders, and TTU's chapter of ASME. There at Reese, we will have a separate locked room for us to store our Rocket and its components securely and a specially marked, flame retardant, cabinet for any flammable material used in the fabrication of our rocket. The Facility at Reese will be accessible 24/7 after completing the Reese safety certification.

In addition to the Location at Reese, we have been granted permission to use the main mechanical engineering shop located in the basement or the Mechanical Engineering North building located at Texas Tech's central campus. This shop will be utilized heavily by the team designing the payload for our vehicle but will be open to any member of the team that needs the tools provided by the shop. In order to be approved for time in the shop one must provide a detailed technical document and have it approved by the shop staff before any work can begin on the part or parts. This shop is only open from 9am to 5pm and there is a one hour gap from noon till 1pm for lunch where all students must leave the shop and return at a later time.

Both of the facilities follow Texas Tech's Environmental Health and Safety guidelines as they are part of the Texas Tech University system, as such, all guide lines will be followed by every member of Texas Tech's USLI team.

With the help of our mentor Bill Balash, we have been given permission to use Panhandle Of Texas Rocketry (POT Rocks) launch facility in order to access a secure and safe place to test and fabricate most parts for the rocket and the payload for the subscale model and all test firings for the full-scale rocket. The facility is located Northwest of Amarillo in Boys Ranch, Texas. Along with the launch facility, we have been granted access to POT-Rocks fabrication facility which is also located in Amarillo, Texas. This Facility is equipped with a wide variety of different tools specifically for working with and fabricating different parts out of PMC's. Additionally, it is equipped with basic hand and power tools this facility is equipped with mandrels mainly used for the construction of rocket bodies and fins and will be used accordingly. With POT-Rocks not being a part of Texas Tech University, we will be supervised at all times by our mentor or a qualified POT-Rocks officer to comply with their safety standards. Along with following POT-Rocks' safety procedures, we will follow the additional safety procedures outlined by Reese Technology Center and Texas Tech University.

### 1.2.2 Personnel and Equipment

Raider Aerospace Society is a student organization under the glorious leadership of Derrick Slatton with approximately 70+ different members. With the USLI competition being a rigorous and competitive design build competition, we have chosen approximately 25 of the most dedicated members that are most involved with the student organization. Of the 25 members working on the rocket, we have split them up into sub-groups in order to evenly distribute the workload more evenly and let members focus on their specific interest. These groups vary in size and include: Payload (6), Vehicle (9), Recovery (7), Proposal (5), Safety (2). These groups are not set in stone as a member can be part of more than a single group depending on what they are most interested in. Along with this we have a couple members that are specifically assigned to be a bridge between each of the compartmentalized groups in order to aid in connecting the different aspects of the design build process.

In order to comply with all federal, state, and instructional rules and laws, the safety officer Derrick Slatton and our mentor Bill Balash will go over each step of the design, fabrication, and testing of the rocket. Flight testing of the sub-scale and full-scale rockets will be done with assistance from the local Tripoli chapter POT-Rocks. The testing of all sub components including the payload will be done at the Reese Technology Center in compliance with all of their safety procedures and in compliance with all Texas Tech Universities Lab procedures and Environmental Health and Safety procedures.

### 1.2.3 Computer Equipment

Most of the rocket design will be done in computer simulations or computer aided design software such as Autodesk Inventor or AutoCAD. With the most of the design process being done on a computer it is imperative for team members to have access to a personal computer or laptop. If a member of the team does not have access to a personal computer, Texas Tech has an abundance of university-provided computers that allow students to access both Autodesk Inventor and AutoCAD so they can assist in the design of different parts for the project. All members of this team will fully abide to the Universities Student Handbook regarding use of school computers, resources, and software licenses for this project. In order to simulate our rockets flight, we have used OpenRocket for this proposal. We look to gain access to RockSim in the future either through our mentor or by purchasing a license for RAS to use for the USLI project and for any other club projects that RockSim could aid with.



### 1.2.4 Computer Software

- Microsoft Office
- OpenRocket
- Autodesk Inventor
- AutoCAD
- RockSim
- SolidWorks
- ANSYS
- MATLAB

### 1.2.5 Web Presence and Documentation

The Raider Aerospace society will established a website in order to hold all information relating to the USLI Project Rover. This website will be updated and contain reports of the team's status on the project as well as required deliverables in pdf format. Currently, information on Raider Aerospace Society can be found through the group's Orgsync page at <https://orgsync.com/136115/chapter>. In addition, progress will be documented through the Raider Aerospace Society's social media pages (Facebook, Instagram, Snapchat, Youtube, and Twitter).

Documentation of official team meetings, work days, and other events will be kept by Jacob Hinojos, RAS Historian and Payload Team Lead. Meeting minutes and documentation of work completed on work days will allow the team to stay organized and on track to meet all deadlines.

## 2. SAFETY

### 2.1 TEAM MENTOR

Bill Balash and Barre Wheatley - As a level 3 certified members of Tripoli, Mr. Balash and Mr. Wheatley will be able to advise and ensure the Space Raiders adhere to the Tripoli safety statements listed further in section 2. This is in reference to safety in the construction and testing in a controlled environment.

### 2.2 SAFETY PLAN

#### 2.2.1 Hazard Recognition and Accident Avoidance

- Use only certified rocket motors.
- Do not dismantle, reload, or alter a disposable or expendable rocket motor, nor alter the components of a reloadable rocket motor or use the contents of a reloadable rocket motor reloading kit for a purpose other than that specified by the manufacture in the rocket motor or reloading kit instructions. C. Do not install a rocket motor or combination of rocket motors that will produce more than 40,960 N-s of total impulse.
- Rockets with more than 2560 N-s of total impulse must use electronically actuated recovery mechanisms.
- When more than one high power rocket is being launched simultaneously, a minimum of 10 ft (3M) shall exist between each rocket involved.
- Appropriate PPE will be provided at all times consisting but not limited to: Gloves, safety goggles, breathing mask, full clothing coverage, and disposable lab coats.
- Appropriate safety equipment will be on construction site at all times: Fire extinguisher, distilled water, fire blanket.
- Safety signs are visible and frequent among the construction area as a constant reminder of what behaviors/procedures are prohibited.

#### 2.2.2 Outline of Hazard Recognition and Briefing

The Hazards Recognition Briefing will be given as a presentation with handouts to each member of the team prior to rocket construction. It will bring awareness to materials and processes that could cause harm and promote accident avoidance via hazard recognition as well as general safety.

Slide(s) and Video(s) to be referenced: [Model Rocketry Safety Code Pre-Launch Test](https://www.nasa.gov/audience/forstudents/studentlaunch/hp_rocketry_video_series)  
[https://www.nasa.gov/audience/forstudents/studentlaunch/hp\\_rocketry\\_video\\_series](https://www.nasa.gov/audience/forstudents/studentlaunch/hp_rocketry_video_series)

#### 2.2.3 Tripoli High Power Safety Code

*Space Raiders will abide and adhere to all safety policies addressed by the Tripoli Safety code found in Appendix II.*

#### 2.2.4 Pre-Launch Briefing

Launch Operations

1. Do not launch with surface winds greater than 20 mph (32 km/h) or launch a rocket at an angle more than 20 degrees from vertical.
2. Do not ignite and launch a rocket horizontally, at a target, in a manner that is hazardous to aircraft, or so the rocket's flight path goes into clouds or beyond the boundaries of the flying field (launch site).

3. A rocket shall be pointed away from the spectator area and other groups of people during and after installation of the ignition device(s).
4. Firing circuits and onboard energetics shall be inhibited until the rocket is in the launching position.
5. Firing circuits and onboard energetics shall be inhibited prior to removing the rocket from the launching position.
6. When firing circuits for pyrotechnic components are armed, no person shall be allowed at the pad area except those required for safely arming/disarming.
7. Do not approach a rocket that has misfired until the RSO/LCO has given permission.
8. Conduct a five second countdown prior to launch that is audible throughout the launching, spectator, and parking areas.
9. All launches shall be within the Flyer's certification level, except those for certification attempts.
10. The RSO/LCO may refuse to allow the launch or static testing of any rocket motor or rocket that he/she deems to be unsafe.

### **2.2.5 Caution Statements**

- A. All funding provided by RAS and sponsors of RAS will not be held responsible for any damages or injuries if any are to be encountered.
- B. Appropriate personnel will be on site at all times during construction, testing, and launching.
- C. Texas Tech University will not be responsible for any damages or injuries if any are to be encountered.

### **2.2.6 Acknowledgment of Federal, State, and Local Laws Regarding Rocket Launch and Motor Handling**

The safety officer will brief the team with information on unmanned rocket launches and motor handling during all pre-launch briefings. These briefings will include the following codes as they are applicable. An explanation by our safety officer will outline any and all instances where a violations of the following three codes may arise and outline all the procedures our team will implement in order to comply with these laws and regulations.

Federal Aviation Regulations 14 CFR, Subchapter F, Part 101, Subpart C; Amateur Rockets  
*See Appendix I*

Code of Federal Regulation 27 Part 55: Commerce in Explosives; and fire prevention

NFPA 1127 “Code for High Power Rocket Motors.”

### **2.2.7 Purchasing and Handling Rocket Motors**

The motors and reloadable cores will be purchased by our level 3 certified mentor. Personnel must be either the safety officer or on the safety committee to handle motor(s). The motor(s) will be stored and secured in a flame-retardant hazard cabinet at the Reese Technology Center lab. All loading of the rocket motor(s) will be overseen by the safety officer and mentor.

### 2.2.8 Transportation of Rocket to Huntsville

Texas Tech provides applications to provide compensation for organizations to travel. In the event of being declined, we have arranged a surplus of funds to strictly compensate all members travel and lodging.

All Rocket equipment and tools will be transported by a rented U-Haul or enclosed trailer of some sorts. We will abide by all Texas Tech Environmental Health and Safety policies when transporting any and all hazardous material along with any state laws that may govern the transport of high powered rocket motors.

### 2.2.9 Safety Agreement

Safety Agreements from all active rocket team members are attached.

*See Appendix IV*

## 3 MISSION STATEMENT

### 3.1 MISSION MOTIVATION

The projected expansion of the human population and the subsequent decline in available resources on the planet earth, in addition to ongoing destabilizing conflicts and the constantly shifting socio-economic-political landscape makes survival as a species heavily dependent on the ability to become an inter-planetary species. In order to establish proper settlements for resource collection and communities in which people can live, habitable planets must be found and explored. With current constraints on extra-solar travel the need to explore neighboring planets is crucial; however; it is progressing at a snail's pace with slowly produced rovers, drones and probes which are easily damaged and tremendously expensive. The Raider Aerospace Society aims to deploy a semi-autonomous land rover system that will be compact, easily deployable and damage resistant in hazardous environments and most importantly easily and quickly fabricated.

This rover will consist of a frame capable of being compacted in order to minimize its footprint within the body of the launch vehicle and will employ internal structures that will allow the rover to be semi-hollow while still retaining all strength benefits of a solid structure. The main structures will be fabricated using additive manufacturing techniques from models designed with the aid of finite element analysis software in order to account for the potential shock damage incurred if there is improper deployment of the recovery system. The rover will be controlled using a raspberry pi model 3B which will have onboard charging due to deployable solar panels regulated through a solar control module. The rover will be deployed with the goal of gathering data such as magnetic field strength of the planet, humidity, temperature, and mechanical data related to precession of the body. This will be accomplished using a sense HAT module similar to the one employed on the ISS. All functions will be handled through a linux based operating system that will allow for closed loop functioning of the system and semi-autonomy using the onboard sense HAT in addition to ultrasonic sensors allowing for proper navigation of the terrain. Said navigation will be made feasible through the use of lightweight brushless DC motors and custom built all-terrain wheels that minimize rotational inertia thus allowing for a high-top speed in the deployment environment.

The payload will be deployed by a rocket employing a self-orienting containment structure within the rocket body in order to maintain optimal center of gravity and center of pressure so that proper deployment of the recovery systems and the payload is achieved thus mitigating any sort of damage that may occur should any system or subsystem fail. This system will be a mechanical device employing rotational bearings and a self-locking mechanism that allow the frame holding the payload to re-orient itself due to changes in trajectory experienced by the rocket.

This is done to provide a test-bed for remedying in-flight changes that under normal circumstances would cause destruction of the vehicle or improper flight patterns that would lead to deploying the payload incorrectly. This project also will lend credence to the feasibility of deploying cost-effective mass amounts of unmanned vehicles, in order to facilitate rapid exploration by covering more ground. The rocket-payload system is designed with mass production and reusability in mind in order to minimize the economic loads incurred by private and government bodies looking to invest in the future of space-flight, exploration and subsequently the survival and expansion of the human race.

### **3.2 Mission Statement**

The Raider Aerospace Society prides itself on being able to operate effectively on a limited budget by employing creative design and efficient business practices. It is with this in mind that the design team's goal is to produce a launch and deployment system that is capable of being rapidly deployed and which is capable of rectifying issues with ascent trajectories due to an internal balance system which actively maintains the payload in an optimal position throughout the mission duration. The mission payload will be the test bed for the concept of mass rover deployment systems that are cost effective and easily manufactured both on and off earth using rapid prototyping and open source hardware and software. The rover will have the objective of obtaining data pertaining to the viability of the landing site for further manned exploration as well as recharging itself through on-board solar panels. The combined vehicle-payload system will further demonstrate the concepts of quick deployment, rapid prototyping and manufacturing in order to facilitate an increased rate of exploration of neighboring celestial bodies. At a minimum the rover will deploy upright at time of landing, traverse an unknown terrain at least 5 feet, deploy 2 solar cell panels which will charge the power supply and collect environmental data. The team plans on reaching this goal in accordance with all design constraints given in the 2017-2018 USLI Handbook.

### 3.3 Constraints

- Rocket Apogee should be 5280 feet (1 mile).
- Rocket cannot exceed 5600 feet.
- Must carry one NASA altimeter for official altitude monitoring.
- Must use series of beeps to relay altitude.
- Each altimeter must have its own power source.
- Each altimeter must have external arming switch.
- Altimeters must be located in separate sections from other radio transmitting devices and shielded from all onboard devices which may generate magnetic waves.
- Must use dual deployment recovery system.
- Recovery system electronics must be separate and shielded from any other on-board electronics.
- Must perform successful ground ejection test for both drogue chute and main chute before subscale and full-scale launch
- Vehicle must not have more than 4 segments.
- Will take no more than 3 hours to prepare for launch
- Must be able to sit on launch pad for at least 1 hour prior to launch.
- Use standard 12-V launcher system.
- Only commercially available (NAR/TRA certified) engines can be used.
- Total impulse cannot exceed 5,120 newton-seconds.
- Rocket must move at 52 fps before exiting launch rail.
- Must launch and recover sub-scale model.
- Maximum Kinetic energy at landing cannot exceed 75feet-lbf.
- Utilize removable shear-pins.
- Each component not affixed to rocket system must have a tracking device.
- Students must do 100% of all work for USLI project.

### 3.4 Mission Requirements

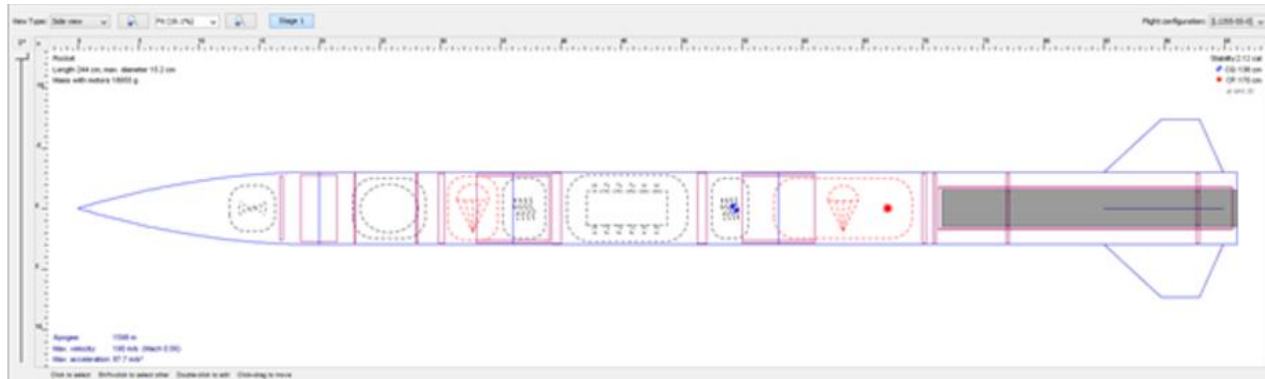
The mission requirements are as follows:

- The launch vehicle will meet the following objectives:
  - Reach near 5,280 feet at apogee
  - Limited to a single stage
  - Relay altitude back to base
  - Deploy rover at landing
  - Rocket will land within a 2500 feet radius from launch pad
- The Rover Payload package will meet the following objectives:
  - Safely house the rover for the entirety of flight and landing
  - Depart from launch vehicle at time of landing
  - Autonomously travel 5 feet in any direction after remote activation
  - Deploy collapsible solar cell panels at end of journey

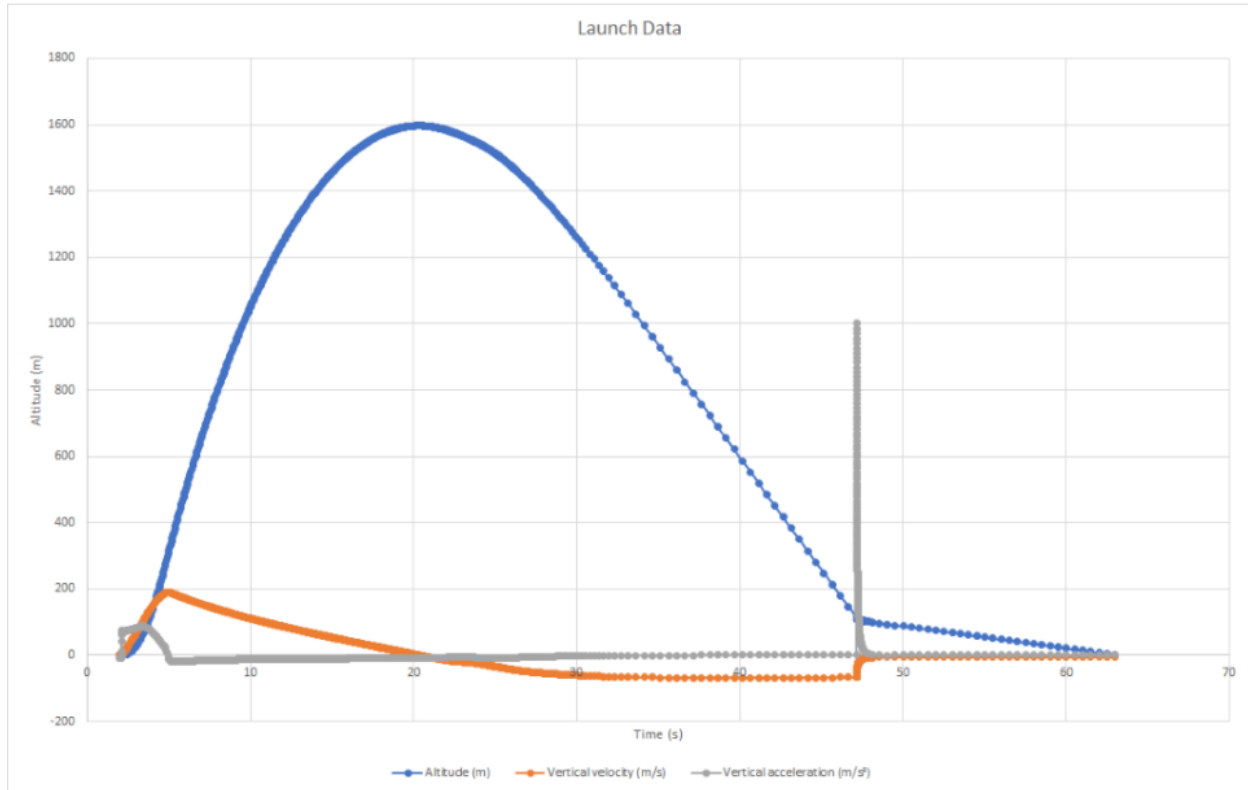
## 4 ROCKET DETAILS

### 4.1 ROCKET DESIGN

The rocket (launch vehicle) that will be used for this project will utilize a single solid-state L motor in order to propel it approximately 5,280 feet and deploy a ground rover at landing. The rocket will use a dual-deployment recovery system utilizing a traditional drogue and main parachute set up in order to allow for reusability.



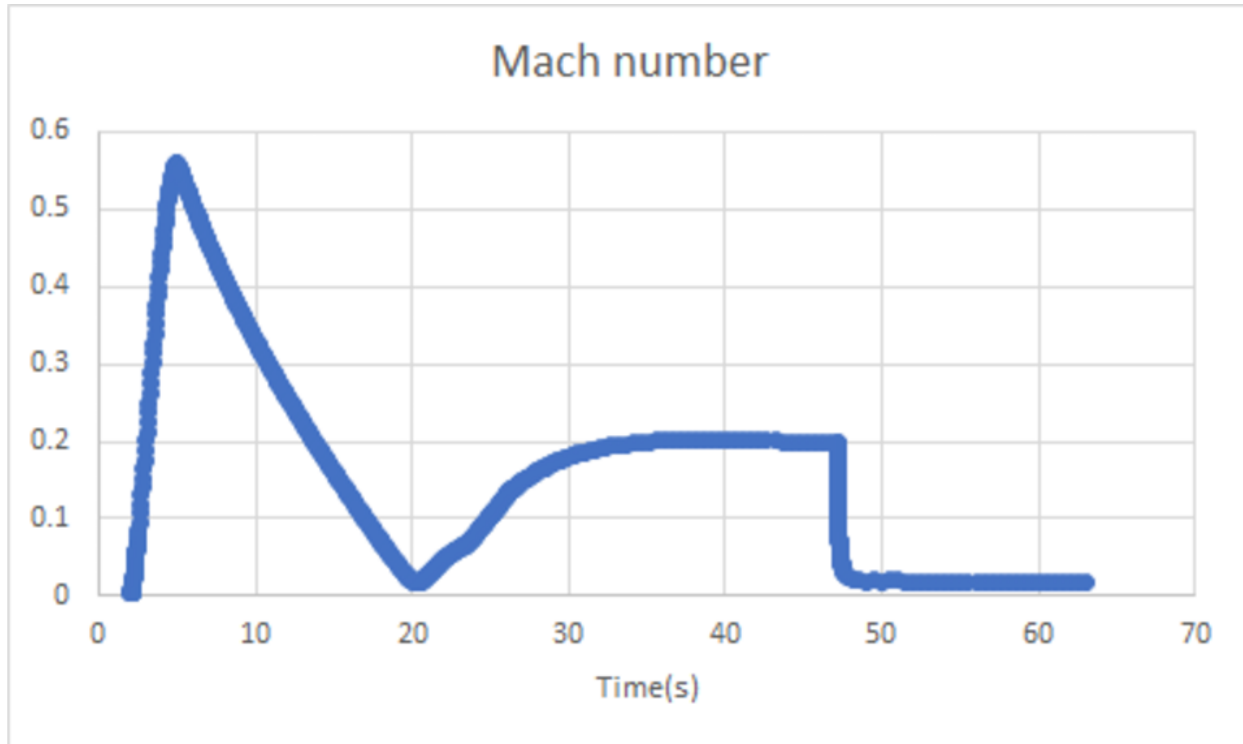
The launch vehicle will have an outside diameter of 6 inches (152.4mm) and span a total length of 8 feet (2438.4mm). The housing material will be Blue Tube or a PMC such as carbon fiber if cloth and matrix materials are provided from sponsors/industry partners. The total weight will be 41.79 lbs (18955grams) with a Cesaroni L1355-SS reloadable solid fuel motor. The total impulse is 4025 newton seconds and the projected altitude is 1597 meters (5239.5 feet). The center of pressure pressure of the rocket is isolated at 170 cm from the tip of the nosecone, and the center of gravity is at 138 cm, thus giving a stability factor of 2.12 cal.



(Data exported from OpenRocket)

The rocket will be comprised of 3 main body sections that will hold the scientific payload flight computers and recovery systems stable during the entirety of the flight. The nosecone will contain a counter weight in the form of electronics and or sand/weights that will be adjustable to help maintain rocket stability. The rover package and drogue shoot will be separated via bulkhead in the 1<sup>st</sup> section beneath the nosecone. The flight computer and primary electronics bay will be housed in the seconded (middle) section and isolated by bulkheads and shields. Finally, the main parachute will share the final section with the motor. 24 ft shock chords will be used between sections to absorb energy during parachute deployment.





(Vehicle remains subsonic throughout entirety of flight)

#### 4.1.1 Flight Operations

The flight will comprise of three stages; Launch, Descent, and Recovery. The goal for each stage is described in the field below.

##### 4.1.1.1 Launch

Before launch, a checklist will be executed and safety will be a priority before initiating the launch sequence. At the time of launch, the vehicle will reach at least 52 feet per second before leaving the launch rail. From then, the vehicle will remain accelerating until full burn of the solid-state motor. The vehicle will relay altitude data during the entirety of the flight. At the time of apogee, a dual deployment parachute system will activate.

#### 4.1.1.2 Descent

At apogee the rocket will deploy a drogue shoot measuring 4ft in diameter. This deployment will be the first separation of the main body and take place between the forward and middle sections of our rocket. The two sections will be connected by a flat elastic shock cord to two separate bulkheads by a 5-point system to reduce stress on the bulkhead and reduce the risk of failure. Our main shoot will be deployed at around 800ft and will measure 12ft in diameter. This separation will be between the middle and aft most section of the rocket. Again, the two sections will be connected via shock cord to a bulk head using a 5-point system. With the added stress of the main chute this shock cord will be substantially thicker than the one used in the first stage of separation. Both stages of separation will be caused by a controlled detonation of black-powder with the actual amount of powder used for each stage of separation being carefully calculated by our mentor. The shock cords will be approximately 24ft in length as per the recommendations of the manufacture. All measurements for chute size and deployment were carried out by OpenRocket.

#### 4.1.1.3 Recovery

After the deployment of the main shoot our rocket is projected to decelerate to impact velocity of 5.53 m/s which, when broken down into parts, would be within the design specifications. The vehicle will be equipped with a remote tracking system located in the nose cone of the and on an independent electrical system from the main flight controller. There will also be a transmitter connected to the rocket in the nose cone for the aid of rocket recovery once on the ground and initializing the deployment of our payload. The altimeters, both ours and NASA's, will be in the middle most section of the rocket where it will be EM shielded from any and all outside electromagnetic wave. Our Altimeter will be connected to our main flight computer which will control the separation and deployment of the drogue and main chutes and ultimately control the decent and recovery of the rocket.

\*Note: Some aspects of the rocket's design (fin dimensions, mass distribution, material, and motor selection) are undergoing continuous updates to match ideal flight performance from analyzing simulation data and finalizing component specifications.

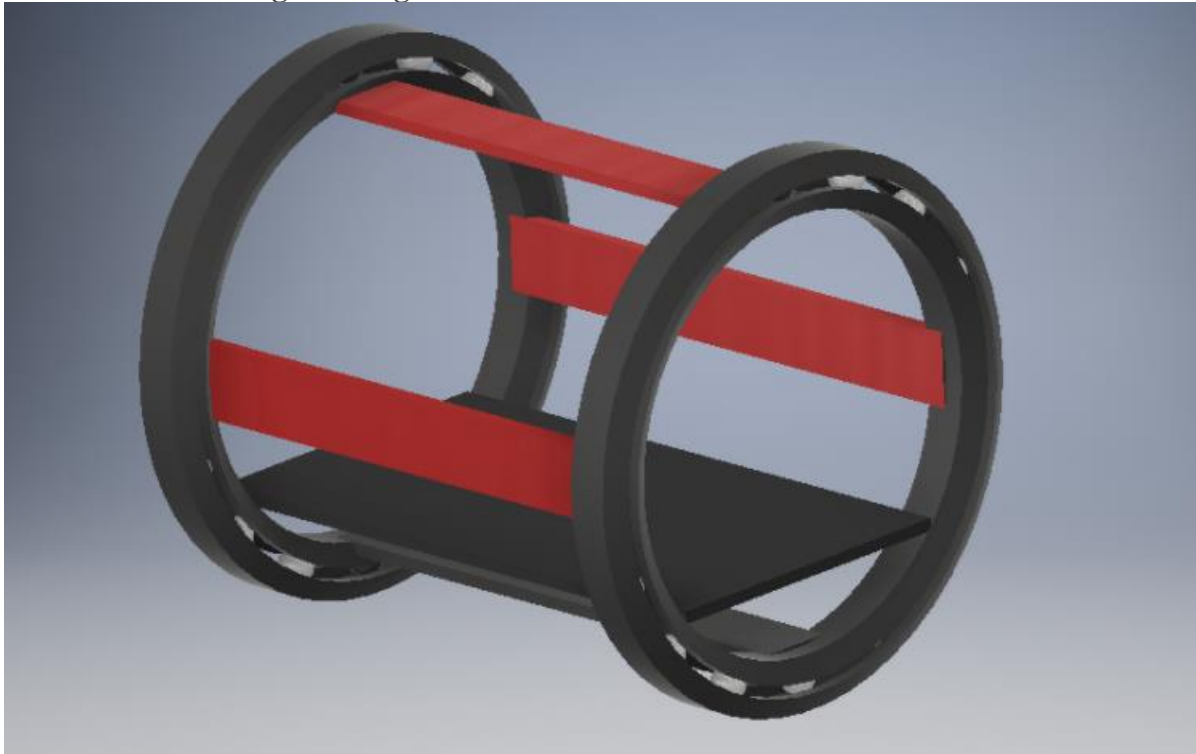
## 4.2 PAYLOAD DETAILS

The Space Raiders will launch a rover experiment, which will deploy from the interior of the rocket upon landing. The rover will be located near the top of the rocket, and will exit at the connection between the main airframe and the nose cone. In order to ensure that the rover is positioned correctly, it will be held in a self-orienting housing that will rotate to an upright position after landing. Upon landing the team will engage an autonomous function that will activate the rover. It will be equipped with special all-terrain wheels in order to traverse rugged terrain. In addition to the solar panel deployment, the rover will gather climate and geo-magnetic data of the deployment area.

### 4.2.1 Mechanical Design

The primary structure of the rover will consist of a central platform (which will house the control systems and electronics, as well as the solar panel and sensors), and four wheels. Because of the size constraints of an X” inner diameter rocket, the rover will be designed to fit compactly in the interior of the rocket, and expand after deploying. The four wheels will be mounted on two axles that will rotate on brackets upward toward the central platform, decreasing the overall height of the rover. After exiting the airframe, a trip wire will pull the stop pins, allowing the spring-loaded axle brackets to extend to full size.

#### 4.2.1.1 Self-Orienting Housing



Because the Space Raider can land in any orientation about its central axis, the rover will be fixed within a self-orienting housing. The rover will be secured to the inner rings of two bearings, while the outer rings will be secured to the airframe, allowing the rover to rotate upright with a properly designed weight distribution. This housing will be mechanically secured in place during launch and the duration of the flight in order to maintain the center of mass and prevent structures within the rocket from rotating during flight. After landing, the housing will be released, and the rover will rotate to an upright position.

#### 4.2.1.2 Materials and Manufacturing Methods

The primary materials used for both the rover and housing will be machined high density polyethylene (HDPE) and 3D printed plastics. The use of plastics is primarily for the weight benefits as opposed to metals. Testing will be done to determine if steel balls are required for the bearings, or if a lighter material can be used. The rest of the bearings and housing will be HDPE.

### 4.2.2 Electrical System

The overall objective of the rover payload is to gather solar energy to replenish its batteries in addition to collecting scientific data pertaining to the deployment region's climate; these objectives will be managed by the rover's electrical system. The rover will be controlled with a Raspberry Pi model 3-B (1.2 GHz, 64-bit quad core ARMv8 CPU 1GB RAM), the operating system for the pi module will be Rasbian which is an optimized version of linux. The pi module will be activated upon receiving a signal (2.4 GHz) from ground operators. This signal will be sent to a relay module within the rocket body that will convert the signal from radio to a binary signal through the use of an Arduino, this binary signal will then be transmitted through an onboard Bluetooth 4.1 module to the pi module Bluetooth 4.1 transceiver/receiver module, effective range of this connection will be up to 30 meters. This set up will allow for long distance transmission of the start command and the subsequent transmission of data back to the ground crew without the use of large power hungry long-distance radio transmitters. The rover will be powered by a lithium-polymer battery, which will be connected to the Raspberry Pi and the solar panels through a voltage regulator and solar control module, the raspberry pi has input voltage of 5 V and input current at 2.5 A). Battery size will be dependent on motor power consumption in addition to sensor consumption. Given their small size, the solar panels will trickle charge the batteries, they will have a combined surface area of 15 inches squared. The panels themselves will be deployed by a small servo which will be connected to the Raspberry Pi through a motor controller; this motor controller will also connect to the driving motors for the rover which will be lightweight brushless DC motors sized appropriately for the rover. The raspberry pi will be receiving input from the environment via ultrasonic sensors (40 kHz bursts at a range of between 2 cm and 450 cm) that will be placed round the rover which will provide feedback. A sense HAT module will be connected which has on board magnetometer (+/- 4/8/12/16 Gauss), gyroscope (+/-245/500/2000dps), accelerometer (+/-2/4/8/16 g), barometer (260 – 1260 hPa absolute range, +/- 0.1 hPa under normal conditions), temperature sensor (+/- 2 deg C in the 0-65 deg C range), and a relative humidity sensor (+/- 4.5% in the 20-80%rH range, accurate to +/- 0.5 in 15-40 deg C range). All connections will be standard GPIO pin connections and additional connections will be added via input/output expanders, GPIO cobbler unit, ribbon cables, and additional solderless breadboards. All wiring will be placed through internal structures to minimize the chance of snags. All collected data will be saved to a 16 GB microSD card.

### 4.3 ROCKET AND PAYLOAD REQUIREMENTS

The rocket and payload have many requirements that must be met. In section 3.3, we listed out most of the requirements and constraints and all of the requirements are listed in the NASA 2018 Student Launch Handbook page 6. We plan to comply to all national and local regulations from the FAA, Tripoli, National Association of Rocketry (NAR), and other regulations and launch rules. (See Appendix I)

Payload specific requirements include:

1. The vehicle must land safely
  - a. Both of the parachute systems must function and be tested before hand to ensure the safe landing of the vehicle
  - b. No part of the vehicle can impact in excess of 75ft-lbs of energy.
2. The vehicle must successfully pass a flight test prior to the Flight Readiness Review
  - a. This requires multiple tests and allow for time to adjust if a failure occurs
  - b. This requires the entire system to be prepared on time to be fully tested

### 4.4 CHALLENGES AND SOLUTIONS

#### 4.4.1 Rocket

Reaching exactly 1 mile high at apogee

Rocket simulation software can model the flight trajectory. To keep a basic explanation of the factors the following parameters will be modified to approximate 5280 feet AGL.

$W_{avg}$ : Average weight of the rocket including propellant and payload (wet weight) during thrust phase

F: Average thrust of rocket engine (L-class 5120 N-s)

g: acceleration due to gravity

t: thrust burn time in seconds

Ensuring parachute deployment(s)

The recovery system will be programmed to deploy the drogue parachute shortly after apogee, while the main parachute will deploy before the vehicle reaches 200 meters above ground level to ensure a safe recovery.

#### 4.4.2 Payload

Ensuring that the rover is oriented upright and free to exit the rocket interior

The rover will be secured in a housing that is on two bearings within the rocket. These bearings will be released upon landing, which will allow the rover to orient itself upright. The difficulties in ensuring a proper release (of both the housing from the structure of the rocket, and the rover from the housing structure) will be solved through rigorous testing of the system, to reach a point where nominal release is consistent.



## 5.2 BUDGET SUMMERY

System	Sub-System	Cost
<b>Launch Vehicle</b>	Propulsion	\$500
	Airframe	\$100
	Internal Structure	\$60
	Electronics	\$125
	Recovery	\$150
<b>Rover</b>	Solar Panels	\$150
	Wheels	\$20
	Motor(s)	\$60
	Electronics	\$100
	Vehicle Structures	\$40
	Housing Structures	\$30
	Suspension/steering	\$20
<b>Total Rocket Cost</b>		
<b>Support</b>	Launch equipment	\$100
	Testing	\$400
	Team Travel	\$2000
	Rocket transportation	\$800
<b>Total Project Cost</b>		

## 5.3 TESTING

### 5.3.1 Launch Vehicle Testing

Live fire launch vehicle testing will be done in accordance with all regulations and only after securing permission from authorities. The PotRocks rocket club base (Amarillo, TX) will serve as our full-scale testing site, as it meets all qualifications and has an active launch pad for high powered rockets of the same classification as the rocket described in this document and that of greater.

### 5.3.2 Rover Testing

Rover testing will be done in various lab spaces listed in section 1.2.1 (Lab spaces) where it will be fabricated, programmed, and run through multiple trials until achieving desired functionality.

### 5.3.3 Recovery System Testing

The altimeters can be tested by using a vacuum chamber to simulate the barometric pressure at the selected altitudes for deploying chutes. Using LED' lights wired to the outputs of the altimeter we will be able to determine that the altimeters are reading correctly.

## 6 EDUCATIONAL ENGAGEMENT

### 6.1 USLI RAIDER AEROSPACE OUTREACH

#### 6.1.1 Purpose of Outreach

Our goals as members of the Raider Aerospace Society is to bring interest and engagement of aerospace projects to the Panhandle region. In order to achieve this goal, we have organized two community outreach events that target elementary to middle school students in hopes of growing their enthusiasm about science and technology. These events will have both aviation and rocketry themes. We hope to inspire a future generation of engineers through our projects and outreach to k-12 school districts. We feel that reaching out to these students will have an impact on their futures and will be a great learning experience for the Raider Aerospace Society.

#### 6.1.2 Cal Farley's Boys Ranch Outreach

One of our mentors, Barre Wheatley, works very closely with Cal Farley's Boy's Ranch in Amarillo in their community engagement center. The outreach serves as a hub to promote learning and preparing kids for post-high school higher education. The Raider Aerospace society is planning on visiting Cal Farley's and holding a fun with STEM day where we will engage the kids with hands on activities that directly relates to aerospace and STEM. This outreach event is designed to inspire these kids to pursue a degree in a STEM field after high school by showing them that learning about airplanes and rockets can be fun yet challenging and rewarding.

#### 6.1.3 Elementary School Visit, November 3rd

The Raider Aerospace Society President, Derrick Slatton, will be visiting Lamar Elementary in the Pampa Independent School District. Upon force and motion lessons being covered in class, Derrick has arranged to introduce applications to the construction and execution of balsa wood gliders. This will allow the students to learn what each component does and how they're assembled. Students will be given the chance to customize and put their glider to the test flying it through an obstacle course. At the end of this demonstration, the students will be familiar with the application of force and motion where planes are considered. Being able to take the gliders home as a souvenir will act as a constant reminder of aerospace science as they sit proudly on their shelf's.

### 6.2 ROCKET PROGRAM SUSTAINABILITY

The Raider Aerospace society is an on-campus organization that maintains a member base of 70+ students. The goal to expand interest and education in aerospace and aeronautics in the engineering community with hopes of establishing an aerospace program within the Texas Tech College of Engineering. Recruitment of new members is an on-going process as it expands the club population which allows for participation in large group projects and ensures the sustainability of the society for years to come.

Page Break



## APPENDIX I

### FEDERAL AVIATION ADMINISTRATION GUIDELINES

CFR, SUBCHAPTER F, PART 101, SUBPART C – AMATEUR ROCKETS

#### §101.21 Applicability.

(a) This subpart applies to operating unmanned rockets. However, a person operating an unmanned rocket within a restricted area must comply with §101.25(b)(7)(ii) and with any additional limitations imposed by the using or controlling agency.

(b) A person operating an unmanned rocket other than an amateur rocket as defined in §1.1 of this chapter must comply with 14 CFR Chapter III.

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008]

#### §101.22 Definitions.

The following definitions apply to this subpart:

(a) *Class 1—Model Rocket* means an amateur rocket that:

- (1) Uses no more than 125 grams (4.4 ounces) of propellant;
- (2) Uses a slow-burning propellant;
- (3) Is made of paper, wood, or breakable plastic;
- (4) Contains no substantial metal parts; and
- (5) Weighs no more than 1,500 grams (53 ounces), including the propellant.

(b) *Class 2—High-Power Rocket* means an amateur rocket other than a model rocket that is propelled by a motor or motors having a combined total impulse of 40,960 Newton-seconds (9,208 pound-seconds) or less.

(c) *Class 3—Advanced High-Power Rocket* means an amateur rocket other than a model rocket or high-power rocket.

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008]

#### §101.23 General operating limitations.

(a) You must operate an amateur rocket in such a manner that it:

- (1) Is launched on a suborbital trajectory;
- (2) When launched, must not cross into the territory of a foreign country unless an agreement is in place between the United States and the country of concern;
- (3) Is unmanned; and
- (4) Does not create a hazard to persons, property, or other aircraft.

(b) The FAA may specify additional operating limitations necessary to ensure that air traffic is not adversely affected, and public safety is not jeopardized.

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008]

#### §101.25 Operating limitations for Class 2-High Power Rockets and Class 3-Advanced High-Power Rockets.

When operating *Class 2-High Power Rockets* or *Class 3-Advanced High-Power Rockets*, you must comply with the General Operating Limitations of §101.23. In addition, you must not operate *Class 2-High Power Rockets* or *Class 3-Advanced High-Power Rockets*—

- (a) At any altitude where clouds or obscuring phenomena of more than five-tenths coverage prevails;
- (b) At any altitude where the horizontal visibility is less than five miles;
- (c) Into any cloud;
- (d) Between sunset and sunrise without prior authorization from the FAA;

- (e) Within 9.26 kilometers (5 nautical miles) of any airport boundary without prior authorization from the FAA;
- (f) In controlled airspace without prior authorization from the FAA;
- (g) Unless you observe the greater of the following separation distances from any person or property that is not associated with the operations:
  - (1) Not less than one-quarter the maximum expected altitude;
  - (2) 457 meters (1,500 feet.);
- (h) Unless a person at least eighteen years old is present, is charged with ensuring the safety of the operation, and has final approval authority for initiating high-power rocket flight; and
- (i) Unless reasonable precautions are provided to report and control a fire caused by rocket activities.

[74 FR 38092, July 31, 2009, as amended by Amdt. 101-8, 74 FR 47435, Sept. 16, 2009]

#### **§101.27 ATC notification for all launches.**

No person may operate an unmanned rocket other than a Class 1—Model Rocket unless that person gives the following information to the FAA ATC facility nearest to the place of intended operation no less than 24 hours before and no more than three days before beginning the operation:

- (a) The name and address of the operator; except when there are multiple participants at a single event, the name and address of the person so designated as the event launch coordinator, whose duties include coordination of the required launch data estimates and coordinating the launch event;
- (b) Date and time the activity will begin;
- (c) Radius of the affected area on the ground in nautical miles;
- (d) Location of the center of the affected area in latitude and longitude coordinates;
- (e) Highest affected altitude;
- (f) Duration of the activity;
- (g) Any other pertinent information requested by the ATC facility.

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008, as amended at Doc. No. FAA-2007-27390, 74 FR 31843, July 6, 2009]

#### **§101.29 Information requirements.**

- (a) *Class 2—High-Power Rockets.* When a Class 2—High-Power Rocket requires a certificate of waiver or authorization, the person planning the operation must provide the information below on each type of rocket to the FAA at least 45 days before the proposed operation. The FAA may request additional information if necessary to ensure the proposed operations can be safely conducted. The information shall include for each type of Class 2 rocket expected to be flown:
  - (1) Estimated number of rockets,
  - (2) Type of propulsion (liquid or solid), fuel(s) and oxidizer(s),
  - (3) Description of the launcher(s) planned to be used, including any airborne platform(s),
  - (4) Description of recovery system,
  - (5) Highest altitude, above ground level, expected to be reached,
  - (6) Launch site latitude, longitude, and elevation, and
  - (7) Any additional safety procedures that will be followed.

(b) *Class 3—Advanced High-Power Rockets*. When a Class 3—Advanced High-Power Rocket requires a certificate of waiver or authorization the person planning the operation must provide the information below for each type of rocket to the FAA at least 45 days before the proposed operation. The FAA may request additional information if necessary to ensure the proposed operations can be safely conducted. The information shall include for each type of Class 3 rocket expected to be flown:

- (1) The information requirements of paragraph (a) of this section,
- (2) Maximum possible range,
- (3) The dynamic stability characteristics for the entire flight profile,
- (4) A description of all major rocket systems, including structural, pneumatic, propellant, propulsion, ignition, electrical, avionics, recovery, wind-weighting, flight control, and tracking,
- (5) A description of other support equipment necessary for a safe operation,
- (6) The planned flight profile and sequence of events,
- (7) All nominal impact areas, including those for any spent motors and other discarded hardware, within three standard deviations of the mean impact point,
- (8) Launch commit criteria,
- (9) Countdown procedures, and
- (10) Mishap procedures.

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008, as amended at Doc. No. FAA-2007-27390, 74 FR 31843, July 6, 2009]

## APPENDIX II

### 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
		High Power G or smaller				
<b>0.01 to</b>	160		100	30	200	61
<b>160.01</b>	320	H	100	30	200	61
<b>320.01</b>	640	I	100	30	200	61
<b>640.01</b>	1280	J	100	30	200	61
<b>1,280.01 to</b>	2,560	K	200	61	300	91
<b>2,560.01 to</b>	5,120	L	300	92	500	152
<b>5,120.01 to</b>	10,240	M	500	153	1,000	305
<b>10,240.01 to</b>	20,480	N	1,000	305	1,500	457
<b>20,480.01 to</b>	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

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## APPENDIX III

### RAIDER AEROSPACE SOCIETY REESE AIR FORCE PARK SAFETY PROTOCOL

Document Disclosure: This document has been drafted per request of Texas Tech professor, Dr. Gale, in order to appropriately ensure efficiency and safety during the use of this facility.

Tool Disclosure: For specific procedures and regulations, refer to the RoboRaider's Safety Exam:

[https://docs.google.com/forms/d/e/1FAIpQLSep1fB0\\_4bH5-M5h1R-F5xtqwybu\\_13TJ\\_1lAHWV1Xp9gKnpQ/viewform](https://docs.google.com/forms/d/e/1FAIpQLSep1fB0_4bH5-M5h1R-F5xtqwybu_13TJ_1lAHWV1Xp9gKnpQ/viewform)

\*Equipment is used at your own risk and neither the Raider Aerospace Society nor Reese Technology Center accepts any responsibility

Members of R.A.S. will adhere to the following:

#### Behavior and Conduct

- Horseplay or aggressive actions towards any and all persons at the facility will not be tolerated
- The consumption, possession, and the presence of alcohol will not be tolerated on the facility property
- Members will be limited to a maximum of two guests to avoid overcrowding
- All food and drinks must be kept out of construction zones
- Access to equipment other than that owned by R.A.S. must be approved by a credible representative of ownership
- Members should NEVER run inside of the workspace building
- NEVER use equipment you are not familiar with and haven't been introduced to by an authorized officer
- Never work in poor lit areas
- Keep yourself well balanced and never overreach.
- Never work with material that is broken or unclean.
- Always consult a RAS officer before using any special equipment or setups.
- Never stand near danger zones or close to anyone operating equipment.

#### General Equipment Behavior

- Always keep hands, arms, or legs out of the cutting path of equipment.
- Position your body out of harms way while operating any equipment
- NEVER use faulty equipment that is subject to replacement.
- NEVER test the sharpness or temperature of a tool with an appendage of a body.
- Equipment will be used solely for its functions and are not to be considered toys
- The appropriate use of tools for a given action must be considered in order to avoid error in equipment performance and protection.
- Only authorized members may use both the given equipment of the facility and equipment purchased by the organization.
- Equipment is not to be removed from the premises unless for club events or repairs
- Properly use secure support surfaces while operating any equipment in order to ensure safety to both equipment and adjacent people.
- Always store or secure tools away from potential harm to yourself, other person(s), or the equipment itself.
- Cutting edges must be sharp and within operating conditions.



- Equipment should always be adjusted and calibrated before attempting a given task.
- Always consult a RAS officer before making adjustments or performing maintenance to equipment.
- Never force or apply uneven pressure while performing any tasks with equipment.

#### Cleanup and Awareness

- Keep workspaces clear and organized
- Keep isles clear of loose materials
- Never use your hand or body parts to remove scraps or shavings away from equipment operating area.
- Remove any special attachments from equipment as well as reset both safety guards and standard settings to equipment.
- Don't leave spills or hazardous materials unattended.
- All equipment and tools will be returned to their designated storage area(s)/container(s)
- Maintain cleanliness of equipment to insure equipment functions properly

#### Clothing Standards and PPE (Personal Protective Equipment)

- Always use personal protective equipment while operating any equipment.
- Complete coverage of feet must be worn
- Hair should be secured with proper hair accessories
- Jewelry must be removed before using any equipment
- No baggy clothing will be worn while using equipment
- Pants must be worn while using equipment.
- Shirts should be tucked in and long sleeves neatly rolled up
- Do not wear gloves while operating equipment unless handling rough materials
- Wear ear protection while around working around loud equipment
- Use proper ventilation and wear masks to avoid breathing in harmful material debris.

#### Shop Maintenance

- If you are not certain on cleaning procedures or cannot identify spilled substances, notify a RAS officer immediately.
- Always know where and how to use fire extinguishers.
- Always keep cabinet doors and drawers closed
- If you disconnect power to a machine at the circuit breaker, use a lock out system or put up a sign: "Don't Connect."

#### Chemical Use and Storage

- Chemicals include but are not limited to:
  - o Potassium nitrate, ammonium nitrate and potassium chloride, liquid oxygen, oxidizers, lithium, fluorine, methane, water, etc.
- All chemicals must be properly secured and stored when not in use
- Any chemicals with noxious and flammable fumes must remain in airtight containers until directly in use.
- All flammable materials must be properly stored within given fire cabinets
- While handling any dangerous fumes proper use of the fume hood, masks, goggles, lab coat, and gloves must be enforced.
- Chemical expiration's must be documented and properly disposed of.
- Disposal of chemicals must be done properly and safely
- Chemicals must be properly and eligibly labeled

#### Materials:

- Materials include but are not limited to:
  - o PVC pipe, wood, aluminum, steel, carbon fiber, polyethylene, polyurethane, polystyrene, various plastics and foams, etc.

#### Hand Tools

- Tools include but are not limited to:
  - o Non-powered equipment such as: screwdrivers, pliers, hammers, etc.
- Hand tools are to be used in a safe manner at all times and should never be used outside of their designed purpose.
- Proper maintenance and replacement of hand tools should be exercised by all RAS members

#### Power Tools

- Tools include but are not limited to:
  - o Table saw, Band saw, power drill, drill press, routing tools, sander, jig saw, circular saw, lathe, etc.
- Electric Power tools must be grounded or double insulated to prevent electric shock. If equipment does not meet that standard, it will not be used.
- Re-assure power tool as been turned off before connecting to a power source to avoid any unscripted equipment actions.
- Always make sure equipment has been turned off and unplugged before any adjustments or maintenance is performed.
- Always wait for machine to reach operating position/speed before use.
- Unplug or turnoff any equipment not being used

#### Specialized Machine and Equipment

- Policies and procedures for any heavy equipment not listed above will be added under this given section as the need arises.
- \*Failure to adhere to the policies listed above will result in being given a warning appropriate to the offense. Repeated offenses will encourage suspension from construction activities

## APPENDIX IV

### TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Davis Hall agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: DH By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: DH In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: DH I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Davis Hall

Name (Print)

D. Hall

9/19/17

Name (Signature)

(Date)

D. Hall

9/19/17

Rocket Team Leader (Signature)

(Date)

## TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Carlos J. Lucero agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: CL By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: CL In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: CL I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Carlos J. Lucero

Name (Print)

[Signature]

Name (Signature)

09/19/17

(Date)

D. Hall

Rocket Team Leader (Signature)

9/19/17

(Date)

## TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Matthew Rose agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: MR By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: MR In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: MR I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Matthew Rose

Name (Print)

Matthew

Name (Signature)

9/18/17

(Date)

V Hill

Rocket Team Leader (Signature)

9/18/17

(Date)

## TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Zoe Smith agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: ZS By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: ZS In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: ZS I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Zoe Smith

Name (Print)

Zoe Smith

Name (Signature)

9/19/17

(Date)

V. Hill

Rocket Team Leader (Signature)

9/19/17

(Date)

## TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Reid Yentzen agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: RY By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: RY In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: RY I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Reid Yentzen

Name (Print)

[Signature]

Name (Signature)

9/18/17

(Date)

[Signature]

Rocket Team Leader (Signature)

9/19/17

(Date)

## TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Edward Hieb agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: EH. By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: EH. In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: EH. I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Edward Hieb

Name (Print)

Edward Hieb

Name (Signature)

9/18/17

(Date)

V. Kell

Rocket Team Leader (Signature)

9/18/17

(Date)



### TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Branco Mares agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: BM By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: BM In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: BM I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Branco Mares

Name (Print)

[Signature]

Name (Signature)

9/19/17

(Date)

D. Hall

9/19/17

(Date)

Rocket Team Leader (Signature)

## TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Connor Lard agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: \_\_\_ By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: \_\_\_ In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: \_\_\_ I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Connor Lard  
Name (Print)

Connor Lard  
Name (Signature)

9/18/17  
(Date)

D. Hall  
Rocket Team Leader (Signature)

9/19/17  
(Date)

## TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I David Hilburn agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: DH. By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: DH. In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: DH. I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

David Hilburn

Name (Print)

David Hill

Name (Signature)

9/19/17

(Date)

D Hill

Rocket Team Leader (Signature)

9/20/17

(Date)

## TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Derrick Slotton agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: DS By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: DS In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: DS I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Derrick Slotton

Name (Print)

Derrick Slotton

Name (Signature)

9-19-2017

(Date)

V Hall

Rocket Team Leader (Signature)

9/20/17

(Date)

## TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Trevor Dunn agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: TD By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: TD In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: TD I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Trevor Dunn

Name (Print)

Trevor Dunn

Name (Signature)

09/14/2017

(Date)

D. Hall

9/20/17

Rocket Team Leader (Signature)

(Date)

## TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Oswaldo Vasquez agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: OV By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: OV In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: OV I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Oswaldo Vasquez

Name (Print)

Oswaldo Vasquez

Name (Signature)

9/19/17

(Date)

J. Hall

9/19/17

Rocket Team Leader (Signature)

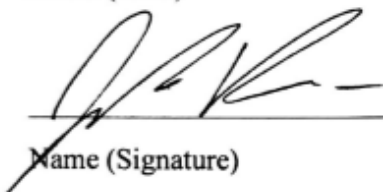
(Date)

## TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Jericho Rivas agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: JR By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: JR In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: JR I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Jericho Rivas-Rivas

Name (Print)



Name (Signature)

9-19-17

(Date)

D. Hall

Rocket Team Leader (Signature)

9/19/17

(Date)

## TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Jacob Steckbeck agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: JS By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: JS In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: JS I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Jacob Steckbeck

Name (Print)

Jacob Steckbeck

Name (Signature)

9/14/17

(Date)

J. Hall

Rocket Team Leader (Signature)

9/19/17

(Date)



## TTU RAIDER AEROSPACE SOCIETY SAFETY AGREEMENT

By signing this document, I Jacob Hinojos agree to abide by all the laws, regulations, safety standards, and procedural guidelines in the High Powered Rocketry Safety Code, the National Association of Rocketry Handbook, the Academy of Model Aeronautics Handbook, all pertinent Federal Aviation Regulations relating to high powered rocketry, all Texas Environment and Safety Laws, and any Material Safety Data Sheets (MSDS) for all materials used from the design to the conclusion of the TTU Raider Aerospace Society's entry into the NASA University Student Launch Initiative (USLI). Initial here: JH By signing this document, I also agree to abide by and/or accept any ruling of or command given by the Huntsville Area Rocketry Association (HARA) Range Safety Inspector. I understand that if any single one of us does not comply with Safety and Mission Assurance (SM&A), our team will not be allowed to launch any rocket. I agree to abide by the Minimum Distance Table when launching any rocket in any state for any purpose related to the TTU Raider Aerospace Society's entry in the NASA USLI competition, whether it be for testing, National Association of Rocketry (NAR) certification, or other launches. Initial here: JH In addition, I agree to abide by any commands, rules, and procedures outlined by the TTU Raider Aerospace Society's Environment, Health, and Safety (EHS) representative, Team Faculty Advisor, and Team Leader at all times when working on anything related to USLI, working in the TTU Raider Aerospace Society laboratory, or during any TTU Raider Aerospace Society related launch even when these safety rules go beyond what is required by any code or handbook mentioned in the first paragraph. I agree to use laboratory equipment related to the manufacture of composites only under the supervision of the Rocket Team Leader or mentor until granted permission to do so without supervision by the Team Leader or another person who has been approved with the power to grant permission to do so without supervision. Initial here: JH I understand that my failure to comply with any of the above statements can result in me being permanently disbanded from the Rocket Team and all activities related to USLI.

Jacob Hinojos

Name (Print)

Jacob Hinojos

Name (Signature)

9/18/17

(Date)

D. Hall

Rocket Team Leader (Signature)

9/18/17

(Date)