# Project Heimdall

Proposal

Cedar Falls High School

1015 Division Street, Cedar Falls, IA 50613

September 20th, 2021

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# Section 1: General Information

## 1.1 Adult Educator/Mentors

Educator: Mr. Zeb Nicholson

Mentor: Mr. Tyler Sorensen

## 1.2 Student Team Leader

Harrison Redfern

## 1.3 Safety Officer

Jefferson Roberts

## 1.4 Team Members and Their Roles

The team includes eighteen students and three adults. The students consist of eight females and ten males; five seniors, nine juniors, and four sophomores. The adult educator, Zeb Nicholson, is a teacher at Cedar Falls High School and has past mechanical engineering work experience. Mentor Tyler Sorensen is a former member of the CFHS Rocket Club as well as the University of Wisconsin - Platteville 'Pioneer Rocketry' team where he held several positions including Safety Lead and Vice-President. Mr. Sorensen will supervise vehicle construction, oversee motor assembly and energetics, and help out anywhere as needed. Mentor Dale Stout is a new mentor that went to the Advanced Rocketry Workshop this summer and received his Level 1 High-Power Rocketry certification in August 2021. He will help supervise the payload software as well as help anywhere else as necessary.

The team is divided into six subgroups: Safety, Vehicle Design/Construction, Payload Design/Construction, Outreach, Visual Design, and Fundraising. There will also be a Project Planning group to organize the overall project and necessary administrative work. Each subgroup has a group leader to delegate tasks and ensure productivity. The group leaders report back to the Student Team

Leader to make sure everything is running smoothly. The mentors and Student Team Leader are also available to answer any questions or difficulties to support the team members as needed.

**Members and Roles:**

Harrison Redfern

- Student Team Leader
- Fundraising Group Leader
- Vehicle Design/Construction

Jefferson Roberts

- Safety Officer
- Outreach
- Vehicle Design/Construction

Owen Tresemer

- Vehicle Design/Construction Group Leader
- Outreach
- Payload Design/Construction

Jackson Plummer

- Vehicle Design/Construction
- Payload Design/Construction
- Outreach

Sean Radke

- Payload Design/Construction Group Leader
- Outreach
- Project Planning

Jillian Kellum

- Outreach Group Leader
- Vehicle Design/Construction
- Project Planning

Natalie Slade

- Visual Design Group Leader
- Outreach
- Vehicle Design/Construction

Becca Nicholson

- Outreach
- Fundraising
- Safety

Luke Shuttleworth

- Payload Design/Construction
- Vehicle Design/Construction
- Project Planning

Cale Wellnitz

- Payload Design/Construction
- Outreach
- Fundraising

Torin Brown

- Vehicle Design/Construction
- Payload Design/Construction
- Fundraising

Renee Fischer

- Outreach
- Vehicle Design/Construction
- Fundraising

Addie Carlson

- Fundraising
- Outreach
- Project Planning

Maddy Stoakes

- Fundraising
- Safety
- Outreach

Nate Venem

- Vehicle Design/Construction
- Payload Design/Construction
- Project Planning

Grant Redfern

- Vehicle Design/Construction
- Fundraising
- Project Planning

Anna Scannell

- Vehicle Design/Construction
- Outreach
- Project Planning

Claire Shaw

- Payload Design/Construction
- Outreach
- Project Planning

Zeb Nicholson

- Adult educator - Teacher at Cedar Falls High School
- Technical Advisor - NAR Level 2 HPR certified

Tyler Sorensen

- Team Mentor - NAR/TRA Level 2 HPR certified
- Safety Advisor
- UW-Platteville Rocket Club Range Safety Officer & former vice president.
    - Competed in and won several collegiate rocket contests through UW-P

Dale Stout

- Team Mentor - NAR Level 1 HPR certified
    - Software background

## 1.5 NAR/TRA Section Affiliation

For the purpose of mentoring, review of designs and documentation, and launch assistance, the team will work with Tripoli Minnesota Association, TRA Prefecture #45.

## 1.6 Project Proposal Time Log

The team worked a total of 81.75 individual hours on the proposal over a span of 21 days. This excludes the team meetings, which grossed 11 hours on its own. The team meetings are reserved for group planning, progress reports, and task delegation to team members. Team meetings also serve as time to ask questions to group leaders, the Team Leader, or the adult educators. The 81.75 individual hours consist of time spent on delegated tasks and small group meetings. All of these hours have been focussed on the proposal, with the time divided into outreach planning, vehicle/payload design, fundraising/budgeting, and safety management planning, for the purposes of the proposal.

# Section 2: Facilities/Equipment

## 2.1 Facilities & Equipment

***Facilities:***

- Cedar Falls High School engineering room (Rm.# 31) will be the main meeting location for the Cedar Falls Rocket Club on Tuesdays, and Thursdays. In this room, the team will meet to work on Project Heimdall and collaborate. Vehicle storage and construction will also take place here. The team will also use the space for the subgroups to meet individually to complete work before their deadlines.
- There is a Makerspace located in Waterloo, Iowa that the team has been permitted to use throughout this project by a generous donation from the Cedar Valley Makers. This area will provide the team with the capabilities to construct the launch vehicle with the proper tools and machines at the team's disposal, as well as electronics equipment to build and test the payload.
- Cedar Falls Public Library: this will be the after-school hours meeting place where presentations and future reports will be practiced and discussed. There is one meeting room that provides the team with a second meeting location for after school.
- For sub group meetings during later hours, the houses of some team members are available for use.
- University of Northern Iowa - Main Library: this will be a secondary meeting location for after-school needs. This library is open much later and has several meeting rooms that can be reserved.
- The soccer practice fields of the University of Northern Iowa, which are located in the team's hometown, will be used for low power launches (educational outreach, scale testing, etc.)
- The ISOAR (Tripoli Iowa club) launch site located in Indianola, IA will be the expected site for all subscale vehicle launches.
- The Tripoli Minnesota launch site located in North Branch, MN will also be an expected site for launching the team's full-scale vehicle.

## *Equipment:*

- In the Makerspace, students will have a woodshop, machine shop, and various rapid prototyping machines available to use. In the woodshop, there are table saws, drill presses, planars, several sanders, band saws, and various hand tools. In the machine shop, there is a lathe, mill, CNC router, a welder, and more sanders. For the rapid prototyping machines, the team will have access to two different 3D printers with the ability to print in ABS and PLA. They will also have access to a laser cutter.
- In Cedar Falls High School Room 31: the room offers a CNC lathe and router, 3D printer, foam cutter, drill press, band saw, laser cutter, along with other commonly used hand and power tools used for launch vehicle construction. The team will also use the space for meetings of the large group and subgroups.
    - The team also has access to the simulation programs RockSim and OpenRocket to help with the design of the launch vehicle. Autodesk Inventor Professional, as well as OnShape, will also be used to model the electronics and payload sections. To use these programs, team members have individual Chromebooks (provided by the school district) as well as desktops in Room 31 in Cedar Falls High School.

At any of the facilities, the use of all equipment will be done under the supervision of a team mentor. At this time, the team does not anticipate the need to acquire any additional equipment beyond what is already possessed. In regards to the launching and ground-testing procedures, Jefferson Roberts, the team's Safety Officer, will oversee all launches to make sure NAR safety codes are followed such as distance of cleared area and distance to stand away from launchpad. The mentors and adult educator will also both be overseeing launch procedures, ensuring NAR safety codes are followed, and overseeing to make sure the team follows the safety plan laid out in this document. The Safety Officer will discuss the safety expectations with the team before entering any facility, as well as before any launches take place.

# Section 3: Safety

## 3.1 Safety Plan

Members of the Cedar Falls Rocket Club will be briefed on the hazardous materials and how to properly handle them according to information provided by OSHA and included in safety data sheets. Safety data sheets will be available in all facilities with close proximity to these materials. A risk assessment will be included in the working document (see Appendix 2). Members will also be briefed on rules and emergency action procedures for any facility that they work in. During the construction and launching of the vehicle and other activities during the course of the project, the Safety Officer, members of the safety team, team leaders, and mentors will be keeping a watchful eye to make sure everyone is behaving safely and using appropriate PPE. They will also be looking for any unintentional safety violations that could result in injury.

## 3.2 Procedures for NAR/TRA and Hazard Recognition and Material Handling

A certified team mentor will order and handle the transport of the motors. That mentor will also claim the launch vehicle as is required with certification. The safety procedures for the launch of the vehicle will be enforced by the Range Safety Officer (RSO) and the team's Safety Officer, Jefferson Roberts. Other team members and spectators will follow guidelines that pertain to them. NAR Level One certified team members Harrison Redfern, Jefferson Roberts, and Jillian Kellum will use and oversee the usage of materials and equipment within their certification limits. All other hazardous materials and equipment that exceeds the certification level of members will be handled by adult mentors.

Each day at the beginning of all meetings, the Safety Officer will lead a mandatory meeting to review all applicable safety procedures for the tools and equipment, as well as any hazardous materials being used that day. Meetings will also review all Material Safety Data Sheets (MSDS) to ensure that all team members can handle dangerous materials. Hazardous material warnings will be on all vehicle plans and proposals using the correct materials. The proper Personal Protective Equipment (PPE) will be displayed and demonstrated during the meetings to ensure that all members of the team are aware of

how the proper PPE is to be used during the various phases of construction. Proper PPE usage (dust masks, safety glasses, gloves) will be emphasized before every construction session where fiberglass or any other hazardous material is handled. Safety officers will be on the lookout for potential safety hazards or safety violations. Hazards will be dealt with accordingly, to mitigate the risk of any injuries. Team members violating the safety rules will be asked to stop work and correct the violation. Repeated violations will have administrative consequences.

## 3.3 Accident Avoidance/Mitigation

In order to recognize potential hazards and avoid any accidents, the Safety Officer will brief the team at the beginning of any meeting about potentially hazardous materials being handled. Proper PPE will be provided and worn at all times in order to ensure that all team members are protected while working with fiberglass, as well as any other unsafe materials or equipment. To mitigate risk, proper training will be required for all members before they are allowed to operate any type of machinery, including simple hand tools. To prevent hazardous incidents, mandatory presentations will be given by the Safety Officer prior to construction meetings and launches (see Appendix 3).

## 3.4 Documentation of Safety Plans/Procedures

Every member on the team agrees to and has signed a statement (see Appendix 4) that acknowledges the safety risks and procedures designated by the Safety Officer and adult educator. Personal Protective Equipment (PPE) will be worn at all times when needed. Caution statements will be included in all plans and reports to inform participants of any hazards during project related activities. Members not adhering to the agreement or rules of the facilities will be subject to administrative consequences by the Safety Officer, adviser, or Student Team Leader.

Due to the coronavirus and the delta variant still being at large, the team continues to follow CDC guidelines and state recommendations. The team has several procedures set up in the event that someone on the team has been exposed, listed below:

If a member exhibits the symptoms of COVID-19, including but not limited to, cough, fever or chills, sore throat, shortness of breath or difficulty breathing, etc., they will refrain from participating in any activities in which they will come into contact, directly or indirectly, with other members of the team until the said member receives a negative COVID-19 test or all symptoms have passed.

If a member has tested positive for COVID-19, they will refrain from participating in activities in which they come into contact, directly or indirectly, with other members until they receive a negative COVID-19 test *and* all symptoms have passed.

If a member has been in contact with someone who has tested positive for COVID-19, they will:

a) Monitor symptoms and continue activities as usual if they were in contact for <15 minutes.
b) Monitor symptoms, social distance, and continue to wear a mask until a negative test has been produced if they were in contact for >15 minutes.
c) Avoid team meetings regardless of lack of symptoms until a negative test has been produced if they live with the said infected.

If more than 25% of the team has simultaneously tested positive for COVID-19 or been in contact with someone who has tested positive for COVID-19, the team will continue working on the project virtually until all symptoms have passed or negative COVID-19 tests have been received. A negative COVID-19 test and no symptoms of COVID-19 are required for members who contracted COVID-19. Normal activities will resume when the terms listed above have been satisfied. These guidelines are subject to change per the current CDC guidelines.

## 3.5 Plan to Comply with Laws

The Safety Agreement (located in Appendix 4) was created to ensure that members read the safety regulations and understand all of the safety hazards and laws. A presentation to brief the students on the launchings of the vehicle beforehand will be included in Appendix 3 for reference. For each launch, the FAA ceiling will be acknowledged and honored, and research on the state laws will have been conducted to make sure the launch does not breach any laws. During launching events, student and spectator safety will be the highest priority. The Safety Officer will be in charge of monitoring regulations from NAR/TRA along with the safety procedures of the competition and launch site. Before

launch days, team members will conduct regulation checks to ensure compliance with federal, state, and local laws. Prior to launch day, NAR/TRA officials that have sponsored the launch event will ensure proper paperwork and permission is obtained from a legal perspective for all launches. Specific to the use of air space, Federal Aviation Regulations 14 CFR, Subchapter F, Part 101, Subpart C; Amateur Rockets, Code of Federal Regulation 27 part 55: Commerce in Explosives; fire prevention, NFPA 1127 "Code for High Power Rocket Motors." will be followed. Thorough knowledge of regulations regarding airspace and the use of high-powered motors will be extremely important and will be known by the Safety Officer and Safety Advisor. The officers will make sure the team follows regulations for any launch (high powered or low powered) performed by the team.

## 3.6 Purchase, Storage, Transportation, and Usage Plan of all Energetic Devices

Motors will be ordered through Off We Go Rocketry by the team mentor Mr. Zeb Nicholson, who has Level 2 certification. The motors for testing will be shipped by Off We Go Rocketry to the team's mentor, where he will store, handle, and deal with the transportation of the motors. That mentor will claim the launch vehicle as is required with certification. Before the vehicle is launched, the motor will remain separate from the launch vehicle and will be transported to the launch site, following proper storage and transportation regulations. A Level 2 certified adult mentor will then assemble the motor in the launch vehicle. Any additional storage, purchase, transportation, or usage of energetic devices will be handled by the team members or mentors with the appropriate credentials and/or certification level.

## 3.7 Student Safety Regulation Agreement Forms

The Safety Agreement (located in Appendix 4) was created to ensure members understand all of the safety hazards, the applicable safety regulations, and the consequences of not following safety guidelines. All members have signed the agreement and agree to comply with the requirements listed.

# Section 4: Technical Design

## 4.1 General Vehicle

The preliminary launch vehicle design will have dimensions of 8 feet and 8 inches in overall height, and a body tube diameter of 6 inches. Simulation software data for the preliminary design indicates that the vehicle will have a static margin of between 2.00 and 2.50 (currently 2.33) with the motor installed, and a rail exit velocity of 67.32 ft/sec. As for other launch vehicle design information: 3 trapezoidal-shaped fins (6-inch span, 13-inch root length) will be used. The estimated mass of the vehicle is approximately 21.25 pounds without a motor. The launch vehicle, including the body, fins, and nose cone, will be constructed out of fiberglass with an 1⁄8 inch thickness. Fiberglass was chosen over other materials for the structural vehicle design due to its superior properties, both physical and chemical. Fiberglass shows increased durability and resistance to multiple forms of corrosion. Fiberglass's resistance to corrosion makes it an excellent choice for the fins and booster section of the vehicle, as those sections often come into contact with corrosive exhaust from propellants. In addition, fiberglass has a high strength to weight ratio when compared to materials of similar weight. Another advantage of fiberglass is that it does not have a directional grain pattern, therefore, it will be strong in any direction force is applied to it, increasing the vehicle's overall durability. Due to its desirable strength, fiberglass is a good choice for the body and nose cone as well. Excellent dimensional stability and high heat resistance is another benefit. Due to the launch vehicle being subject to high speeds, altitudes, and changes in internal pressure during ejection, fiberglass is the best choice in terms of strength. Lastly, the cost-benefit ratio for fiberglass makes it a worthy investment. Despite recent increases in prices, the structural benefits, as well as ability to work with, make fiberglass a logical choice. Some parts of the launch vehicle will be made using ABS plastic that is 3D printed because the students possess the proper skills to design unique parts needed for their vehicles. Construction procedures will consist of a significant amount of cutting of fiberglass, one of the most hazardous parts of the construction process.  Cutting fiberglass can create small particles that result in skin and respiratory irritation. To secure the fins and other parts of the vehicle together, students will be using Rocketpoxy and other high-strength adhesive materials. To ensure different sections of the launch vehicle remain together during ascent, the team will use commercially available plastic rivets and shear pins as necessary.

## 4.2 Projected Altitude

The team has run preliminary simulations in RockSim (Fig. 4.1) using the desired K590 motor from CTI. The apogee of 4,669 feet AGL is near the middle of the acceptable range of 3,500 - 5,500 feet AGL. It also gives a velocity off the rail of 67.32 ft/sec, which exceeds the minimum rail exit velocity requirement of 52 ft/sec. It is predicted that the launch vehicle may end up reaching a lesser altitude due to more weight with all the given electronics and/or having a greater coefficient of drag, but apogee will remain close to the team's target of 4,500 ft.


Figure 4.1

The drag coefficient was assumed to be 0.75 since there was no way to determine this number without experimental data collection. The vehicle will vary in its performance due to a few reasons: vehicle motor thrust variance, the actual drag coefficient, the vehicle's stability, and any changes in air density or mass.

## 4.3 Projected Recovery System

The projected recovery system will consist of a dual-deployment system. Once the vehicle reaches apogee, the booster and payload section of the vehicle will separate, untethered from each other. This will be done using a black powder charge that will be ignited via the main altimeter, separating the launch vehicle and allowing an 18 inch Recon Recovery drogue parachute to be deployed from each independent section as the vehicle separates. A back-up (larger) black powder charge, with its own independent altimeter, will be set to go off at Apogee + 1 second to ensure the vehicle is fully separated. This will only slightly slow each section down. Once each individual vehicle component is at 700 ft AGL, the main altimeter in each independent section of the vehicle will deploy the main parachute to slow them each to an acceptable rate of descent and land with less than the max allowable 75 ft-lbf of kinetic energy.  Proper ground testing of the black powder charges (FFFFg or 4Fg black powder) will be

conducted prior to both the subscale as well as all full-scale launches to ensure the charges are big enough to separate the vehicle components. The team may utilize a chute release instead of black powder charges for the main parachute deployment. If a chute release is used, each chute release will be tested to ensure no mechanical errors prevent the main chute from deploying. Each main chute will be a traditional circular shaped parachute with an approximate diameter of 60 inches. The size of the main chutes and deployment altitude is subject to change to ensure both parts of the vehicle land within the 90 second requirement.

## 4.4 Projected Motor Choice

A Cesaroni K590 motor will be used because it provides enough power to reach the projected altitude of approximately 4,500 ft AGL (see simulation under section 4.a.ii), and at the same time provides a quick, high-thrust take-off at the pad from it's dual thrust design to give the launch vehicle a high rail-exit velocity and therefore a more stable rail exit. In addition, the Cedar Falls High School Rocket Club Team has used Cesaroni brand motors in the past and are satisfied with the quality and reliability of the motor.

## 4.5 Projected Payload

The team would like to propose a multi-faceted project payload. As NASA and many space companies/organizations do, the team is looking at this project as an opportunity to accomplish multiple smaller missions. The team's goal is to continue pursuing previous interest in commercial space travel. The first aspect of the mission will be to land the booster section of the vehicle in an upright position by utilizing landing legs that will deploy during descent. This will test the effectiveness of an upright landing on preventing damage and excessive wear to the booster section of the vehicle. This part of the mission is inspired by SpaceX and their ability to land boosters in an upright position, enabling them to reuse the booster and reduce costs. The mission is also partially inspired by the certification flights of two of the team members in which the vehicles they worked hard to build sustained minor damages to the booster sections. If done effectively, an upright landing should increase the longevity of the booster, allowing it to be used for more experimental flights and data collection, with minimal repair work. This should allow the team to save costs for high powered flights used for research or other engineering

based payloads. The second payload mission aims to bring rocket flight closer to the public by providing a digital flight experience. The payload will house multiple video cameras that will record the entire flight of the vehicle through small acrylic windows. The footage from these cameras will then be 'stitched' together in post-processing to get a full 360-degree video of the flight. This can then be used as a virtual reality video, bringing the experience of flight to the general public. A flight computer will also measure nine degrees of freedom in the form of acceleration, magnetic field movement, and gyroscopic rotation, along with altitude and temperature. This data will be collected about 20 times per second. This data would allow for the vehicle's flight to be recreated in a full "4-D" virtual simulation, further enhancing the virtual experience and bringing space travel closer to the public. These three payload missions, while distinctly separate, all aim towards the same overall goal: efficiently bringing space travel to the general population. The gyroscope, accelerometer, and other data will be cross-referenced with the flight's video to improve the digital experience, while the upright landing can be utilized to reduce damage and costs, making flights and experiments more affordable.

## 4.6 Requirements

### General

The students on the team will be solely responsible for all aspects of the project. The only exceptions include handling of black powder, electric charges, and electric matches (which will be done by the Team Mentor). Members will utilize mentors and advisors for advice and recommendations but all project work will be student led. The team will limit use of past work and understands the penalties that come with excessive use. Students attending launch week will actively engage in the project throughout the entire year. These members will be confirmed by the Critical Design Review deadline. Any foreign national members will be identified at this time. Currently, the team has no foreign national members. In accordance with the STEM Engagement criteria, the team plans to visit elementary level students across the region. These interactions will be completed before the FRR due date, and will exceed the 250 participant minimum. The team will establish social media accounts on different platforms including Instagram, Twitter, and Facebook. The accounts will post frequent updates on what the team is working on and will encourage STEM activities. The team understands the late submission penalties and will submit all deliverables on time, in PDF form, including table of contents and page

numbers, to the NASA project management team. When presenting, the team will use the Cedar Falls High School conference room equipped with the necessary technology for video conferencing with the review panel. The team has appointed Zeb Nicholson as the mentor. Mr. Nicholson has Level Two NAR certification and works for the Cedar Falls School District as an engineering and mathematics teacher. He has worked as a mechanical engineer for several years before working for Cedar Falls Schools. Mr. Nicholson will claim the vehicle for liability purposes. A spreadsheet using AppScript is utilized to track each team member's contribution (in hours) for each milestone of the project, as well as the total number of hours spent as a team.

## Vehicle

The launch vehicle will be delivering the payload to a projected apogee altitude of 4,500 feet AGL. The commercially available altimeter that the team will be using is the Stratologger CF to determine how close the launch vehicle gets to the specified target goal. Due to the use and success of this altimeter in past Student Launch Projects and hundreds of flights by the team's mentors over the past 10 years, the team has deemed it the most reliable. The team will use dedicated arming switches that will allow altimeters to be turned on from the outside of the launch vehicle and locked in the ON position. The vehicle recovery system will have dedicated Duracell batteries. Each altimeter will be powered by individual batteries. Duracell was chosen because of their high quality, reliability, and familiarity. The batteries will be protected from impact, brightly colored, marked as a fire hazard, and easily distinguishable from the other pieces of the payload. The launch vehicle will be constructed in such a way that it will be recoverable and reusable for multiple launches within a single day. There will be 3 sections to the vehicle: 1) a booster section with the motor, the drogue chute, main chute, landing gear, protective wadding, and GPS tracker in it, 2) a payload section with its own main parachute, cameras, data collection devices, and the designated payload chute deployment electronics bay, and 3) the nose cone section as well as the GPS to locate the launch vehicle after landing (note: section 2 and 3 will remained teathered throughout flight). The nose cone will be metal tipped with a light, ductile metal as there will not be any excessive and/or dense metal anywhere on the vehicle according to rules defined in the handbook. Also, the preliminary design does not include any ballast. If design changes include ballast, total ballast weight will not exceed ten percent of total vehicle weight after burn out. At all in-flight separation points, the coupler/airframe shoulders will be 12 inches in length, and the nosecone

shoulder will be a minimum of 4.0 inches in length. The team will use a single stage K590 dual thrust motor powering the launch vehicle in its flight. This motor is commercially available and uses ammonium perchlorate composite solid propellant. According to the calculations, the total impulse of the motor is 2397.6 N/s and will not exceed 2,560 N/s. Also, the projected rail exit velocity is 67.32 ft/sec, which exceeds the minimum of 52.0 ft/sec. The vehicle will be designed to accommodate the launch rail specifications given for the competition. If a motor change is deemed necessary before the CDR, the team will declare it. If a motor change is necessary after the CDR, the team will submit their change for review by the NASA Range Safety Officer. The launch vehicle will be able to be prepared within 2 hours. The igniter that will be used will be charged using a standard twelve volt battery, and this igniter comes with the motors that the team will be buying. Because of the many batteries and failsafes in the team's design, both the payload and separate internal electronics will be able to stay active for up to 2 hours on the launchpad. Using RockSim, the team has calculated that the static stability (the distance between the center of pressure and center of gravity) is 2.33 calibers. The subscale vehicle will be created and flown on or before November 26, 2021, and will be powered by an H-class or I-class motor. The team will use a weight in place of a payload as well as mock-up landing gear attached to the outside of the airframe to replicate a full scale launch vehicle's flight stability and capabilities. The subscale vehicle will carry a Stratologger CF altimeter that will record the subscale flight altitude. The students will construct a brand new launch vehicle to meet the requirements for this year's project. After flight, proof of the flight's altimeter data will be submitted into the CDR report. The launch vehicle used for the vehicle demonstration flight will be the same flown on launch day to ensure the demonstrated stability, structural integrity, recovery systems, and the team's ability to prepare the launch vehicle for flight. The vehicle and recovery system will function as designed, as proven in the vehicle demonstration flight. The full scale launch vehicle will be fully constructed this year, designed and built by student team members. To demonstrate the launch vehicle's payload weight contribution during flight, ballast will be used to mimic the payload's weight and will be located in the same place where payload would be stored. The launch vehicle and any of its components will not be modified without the permission of the NASA RSO after completion of the full scale demonstration flight. Proof of a successful flight shown by altimeter data output will be supplied in the FRR report. The students will have built and launched the final launch vehicle by the required date of March 4, 2022 so as to verify the readiness and stability of the vehicle. The launch vehicle will not have any protuberances on it. There will be no forward canards, forward firing motors, hybrid motors, or clusters of motors on the

launch vehicle. The design will utilize an Aeropack retainer for the motor retention to avoid a friction fitting motor. With the current weight and power of the team's motor, the launch vehicle will not exceed Mach 1 during any part of the flight. The launch vehicle's weight will be fairly evenly distributed. The motor itself will increase the amount of weight near the bottom of the vehicle, but this will quickly be eliminated as the motor burns out. The team's name and contact information will be on each component of the launch vehicle that separates and will be able to be retrieved without separating or opening the vehicle.

## Recovery

The recovery system the team plans to use includes an 18-inch drogue chute for each independent section of the vehicle that will be released at apogee to let each section of the launch vehicle descend at a reasonable rate until a larger, 60 inches in diameter, main parachute within each section of the vehicle will open at 700 ft. AGL that will slow the vehicle to a safe rate as it reaches the ground. Each parachute event will have redundant electronic altimeters to ensure a successful deployment. Before the team leaves for test flights in Minnesota, Wisconsin, and Iowa, they will do ground ejection charge tests, as well as electronics testing, to make sure the drogue and main parachute properly deploy and the black powder charges provide enough energy to separate the launch vehicle components without damaging any of them. Using calculations, the team will make sure that the launch vehicle has a large enough parachute to slow it down to have an acceptable amount of kinetic energy of 75 ft-lbf or less at landing. The batteries powering the recovery system circuits will be completely independent from any payload batteries that power the payload electronics. The batteries powering the recovery electronics will be commercially available Duracell batteries. Neither the primary or secondary chute deployments will use the motor ejection to deploy, except in the scenario where it needs to be used as a tertiary backup. Instead they will use electronically controlled charges, which will be powered with their own independent batteries. Each parachute deployment will have two independent/redundant altimeters with black powder charges to eject the drogue chutes. Chute releases will deploy the main parachutes. Both drogue shoot deployments will have a back up black powder charge set for 1 second after the initial. Both main parachute deployments will be set to release at 700 ft AGL. By lowering the deployment altitude of the main parachute to 700 ft AGL, the vehicle will land in the 2500 foot recovery zone. The vehicle's projected descent time is roughly 42 seconds after main chute deploys, so this falls

within the 90 second descent time. The main and drogue chute compartments will also utilize removable shear pins. Before the vehicle is launched on launch day, electronic devices will be double-checked for their functionality. The vehicle will land two independent sections, so two electronic tracking devices will be needed for the entire launch vehicle. The team will be using a commercially available tracking device purchased from Off We Go Rocketry, which will allow the team to find the vehicle in the range it could cover from launch to land. The launch vehicle will not have any radio transmitting devices on board, so no recovery devices will have any adverse effects on other electronic devices such as the altimeter.

## Payload

No energetics of any type will be used for any surface operations. Energetics are only being used for the deployment of the drogue and main parachutes. The team will follow all regulations set forth by the NAR and FAA on the flight of high powered rockets. No pieces will be jettisoned off of the vehicle at any time during the vehicle's flights without having their own recovery systems. The payload will not consist of any unmanned aircraft systems.

## Safety

The team will utilize a launch and safety checklist for every launch that will occur throughout this entire process. The team safety officer is Jefferson Roberts, who will be responsible for the safety of all of the team’s processes. He will look over the following to make sure there are no safety concerns: design and payload of the launch vehicle, construction of the launch vehicle and attachment of the payload, assembly of the launch vehicle and payload, ground testing, sub-scale and full-scale launch tests, launch day, recovery activities, and all activities that happen throughout the team’s educational engagement. He will make sure all guidelines created by the team for construction, assembly, launch, and recovery are followed so risk is reduced. Jefferson will work to help write and revise all safety codes and analyses required by the team. The entire team will follow all regulations of the local rocket club’s RSO. The team will also relay their intentions to the local club’s president before attending any NAR or TRA launch. All rules created by the FAA will be followed by the entire team to ensure safety

of the team and of those around it. Jefferson will give safety presentations over launch safety and construction safety to ensure all team members know the safety requirements and expectations.

## 4.7 Technical Challenges/Solutions

A possible technical challenge would be within the recovery systems of the vehicle. The team would like to use a Chute Release to deploy the main parachute on the booster section, but if the planned usage of chute releases is deemed unreliable or lacking redundancy the team must use a different solution. If this happens, the team can modify the vehicle design to include chambers for the release of a main chute using energetics (black powder charges).

Another technical challenge the team may face is the reliability of the deployment of the "landing legs" on the booster. The intention is to keep the design as simple as possible to reduce the number of areas for possible failures. The team may find that the deployment system may be too disruptive to the airflow/stability of the rocket by being housed on the outside of the airframe. If that happens, the team is prepared to design a system that keeps the outside airframe of the vehicle smoother and therefore keeping the flight more stable.

The last big technical challenge the team will face is the design of the windows that each of the cameras will need to have in order to record the flight. It will not be ideal to have an entire section of the body tube be acrylic-type material from a strength perspective, but it would be ideal from the video recording perspective. The team's solution is currently to design a coupler-type piece that will be internal to the body tube and then have small windows precision cut out of the body tube to optimize the strength as well as visual aspects of flight. Another potential solution is to house the cameras on the outside of the vehicle, but again this will interrupt the airflow and this is not ideal.

# Section 5: STEM Engagement

In order to engage the community in STEM-related learning, the team will run direct engagement events at the elementary school level. Due to the large school district, the team has seven elementary schools to draw from, which will allow the team several opportunities to reach/exceed the 250 participant requirement for the STEM Engagement Activity Report. The team will communicate with the schools' administrators and staff to align the engagement within the students' curriculum so learning and comprehension are maximized. Team members will visit 4th grade through 6th grade level classrooms, as well as various Boy Scout troops and Cub Scout packs to engage younger audiences in STEM learning. Visiting the troops/packs will extend the team's STEM engagement across other community groups, rather than just the Cedar Falls School District.

## 5.1 Primary School Level Plan

The team will demonstrate how aerodynamics and drag are affected by the vehicle's shape. The team will organize a brief discussion on how shape might affect the vehicle's flight. The participants will then have the opportunity to assemble their own simple model rockets, as well as creatively modify them. The team will have several kits available with different sizes and shapes of vehicles to demonstrate the drag differences. After the participants finish the assembly, they will launch them via a PVC pipe attached to an empty 2-liter pop bottle. This interactive demonstration will inspire the participants to think about how some rockets differ from others and why. After launching, the participants will have time to talk about their discoveries and ask deeper questions. The students will also take home instructions and supplies (designed and produced by Rocket Club members through CAD and 3D printing) on how to build their own model rockets so they can continue their learning outside the classroom.

# Section 6: Overall Project Plan

## 6.1 Schedule/Timeline

Upon acceptance of the proposal, the Cedar Falls Rocket Club plans on having bi-weekly meetings as a large group, as well as having smaller meetings for each subgroup of the project. The group leader of each subgroup will meet with others in their group to get the required material completed. The group leader will also meet with the subgroup leaders to discuss hard deadlines for certain parts of the project and to also make sure the group is moving forward as scheduled. The team also has a project calendar to stay on track (shown in Appendix 1).

## 6.2 Budget

Total budget: $10,500

a. The team is budgeting $500 to the motors for this year's launch vehicles. The team plans on using K590 Cesaroni motors for the full-scale launches, which cost $156.40 (up to $175) each after Hazmat shipping. The team plans on needing to use 2 of these; one for the full-scale test launch and one for the final flight in Huntsville. They are budgeting for one extra motor if a second test launch is deemed necessary.

b. The team will be budgeting $5,000 towards travel (see Figure 6.1). For the Huntsville trip, Huntsville is around 763 miles away from Cedar Falls High School and will require 3 vehicles (vans) to transport all members down there requiring around 300 gallons of a gas round trip (50 gallons per trip per van). At the current price of gas in Iowa, that will cost $815, but an additional $85 will be added to the budget to account for any gas price variance between states, locations, and the cost of gas rising. Furthermore, the team will need a total of eight hotel rooms for 4 nights to house all the members. Approx $3,800 will be devoted to that cost, as the average hotel room in Huntsville is around $120. In addition, the team will budget another $300 for gas for launch trips to North Branch, MN . All of these expenses added together account for the team's budget of $5,000 for travel.

c. The team will be budgeting $500 towards the scale model version of the team's launch vehicle that is a requirement of the project. The team will need to pay for the fiberglass needed for the body/fins and nose cone, the parachute and its shock cord, the motor, motor mount, fasteners, and any additional materials/equipment needed to complete it.

d. The Cedar Falls Rocket Club is going to need to spend about $3,000 on materials for the final launch vehicle (see Figure 6.2). It will cost a substantial amount of money to make the vehicle due to the current costs of materials, including fiberglass body tubes, nose cones, and fins. The upright landing equipment, accompanying electronics, and payload features that will be necessary will account for another large part of the budget.

e. The itemized budget plus travel expenses total just over $8,500, but the total budget is set at $10,500. As part of the team's safety plan, they want to account for unexpected expenses such as broken parts, extra items needing to be purchased, and additional travel expenses. The team is using a 20% overage as the basis for the Total Budget amount. They will also plan to continue to fundraise after they have reached this target and aim for $12,000 fundraised this year so that they can have a start-up fund ready for next year's team.

| 2022 NSL Budget - Travel | | | | | |
|---|---|---|---|---|---|
| **Hotel:** | **Cost per room** | **Number of Rooms** | **Number of nights** | | **Total Cost** |
| | $120.00 | 8 | 4 | | $3,840.00 |
| | | | | | |
| **Gas:** | **Cost per Gallon** | **Number of gallons for one-way trip** | **Number of Vehicles** | **Trips** | **Total Cost** |
| | $3.00 | 50 | 3 | 2 | $900.00 |
| | | | | | |
| | | | | | |
| **Gas:** | **Cost per Gallon** | **Number of gallons for one-way trip** | **Number of Vehicles** | **Trips** | **Total Cost** |
| | $3.00 | 14 | 3 | 2 | **$252.00** |
| **Total Travel Budget** | | | | | **$4,992.00** |

**Figure 6.1: Travel Budget**

| 2022 NSL Budget - Materials Only | | | |
|---|---|---|---|
| **Item:** | **Cost:** | **Quantity:** | **Total Cost:** |
| Cesaroni K590 Motor | $148.95 | 3 | $446.85 |
| 6" Fiberglass bodytube (per ft) | $46.25 | 7 | $323.75 |
| Cesaroni 54mm 6-Grain Hardware Set | $135.00 | 1 | $135.00 |
| 5:1 Ogive Filament Wound Fiberglass 5" nosecone | $150.00 | 1 | $150.00 |
| 60" Parachute | $100.00 | 2 | $200.00 |
| 18" Drogue Parachute | $19.95 | 2 | $39.90 |
| 6" Fiberglass body tube coupler | $60.00 | 1 | $60.00 |
| RocketPoxy structurual adhesive | $65.00 | 1 | $65.00 |
| G10 Fiberglass 12"x12"x0.125" sheet (for fins) | $18.00 | 3 | $54.00 |
| Kevlar Shock Cord - 1500#- Main Chute (per ft.) | $0.97 | 40 | $38.80 |
| Kevlar Shock Cord - 1500#- Drogue Chute (per ft.) | $0.97 | 40 | $38.80 |
| Tube Bulkhead - 6" | $7.99 | 4 | $31.96 |
| 3/8" U-bolts | $5.49 | 4 | $21.96 |
| Motor Mount Tubing - 54mm fiberglass | $27.00 | 1 | $27.00 |
| Centering Ring - 6" x 54mm inner dia. Fiberglass | $10.00 | 4 | $40.00 |
| AeroPack Retainer - 54mm | $31.03 | 1 | $31.03 |
| 1/4" quick links | $0.99 | 6 | $5.94 |
| 4-40 Nylon shear pins (20-pack) | $1.00 | 6 | $6.00 |
| Removable Plastic Rivets (10-pack) | $5.00 | 5 | $25.00 |
| 1/4" threaded steel rod (3ft. each) | $1.75 | 2 | $3.50 |
| PerfectFlight StrattologgerCF altimeter | $54.95 | 2 | $109.90 |
| Landing "Legs" / misc. hardware | $100.00 | 1 | $100.00 |
| Video Camera | $100.00 | 4 | $400.00 |
| 9-dof sensor | $25.00 | 1 | $25.00 |
| Misc. Payload electronics/hardware | $75.00 | 1 | $75.00 |
| Scale Model | $500.00 | 1 | $500.00 |
| Cesaroni Motor for Scale Model | $50.00 | 1 | $50.00 |
| Rocket Tracker Transmitter | $150.00 | 1 | $150.00 |
| Rocket Tracker Receiver | $190.00 | 1 | $190.00 |
| | | | |
| **Total Cost** | **$3,344.39** | | |

**Figure 6.2: Materials Budget**

## 6.3 Funding Plan

The team's funding plan includes 'work for donation' opportunities, small business contributions, and large business sponsorships. The team will also use the Iowa Space Grant Consortium as a source of fundraising. The Cedar Falls area includes many family-owned businesses that are willing to donate to our program. The team plans on asking around Main Street and communicating with their owners about supporting our team. The team will talk to them about our program and how their donation would fuel our ambitious NASA project, and why our team is a great choice for donation. We will extend an offer to all of these businesses we meet with an advertisement opportunity in the form of logos on our team shirts or on our full scale competition vehicle. There are also 'work for donation' opportunities, where the team would help businesses such as Pizza Ranch bus tables while allowing customers to donate to the Cedar Falls Rocket Club. These donations will cover the team's budget, but the students are also targeting larger business sponsorships.

## 6.4 Sustainability

To maintain the presence of rocketry in the area, students plan on engaging students on the primary and middle school level. For students closer in age to the team's members, students will spread information through word of mouth. The team members will spread the word about the team through the STEM engagement activities, expanding on the Rocket Club program and what it is all about. The team also grew in size due to its success from last year. The Rocket Club will continue to grow because people from all parts of the school are interested, not just engineering students. Students with a business focus are interested as well as the Fine Arts. The team acknowledges that maintaining a successful rocketry program requires students with skills in all areas, and the team uses Cedar Falls High School students' broad talents to sustain their program. Social media presence will also play a role in making the presence of the organization known and recruiting future members.

In addition to making the team well known in the community, the club will also compete in The American Rocketry Challenge (TARC) this year. With such a large team this year, the younger members new to rocketry will compete in TARC to gain a better understanding of rocketry and work towards the team goal of establishing Journeyman Status for NSL.

# Appendix 1 - Project Calendar

**August 2021**

| *Sunday* | *Monday* | *Tuesday* | *Wednesday* | *Thursday* | *Friday* | *Saturday* |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18<br>Request for Proposal (RFP) released | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30<br>Team meeting | 31<br>Team meeting | | | | |

**September 2021**

| *Sunday* | *Monday* | *Tuesday* | *Wednesday* | *Thursday* | *Friday* | *Saturday* |
|---|---|---|---|---|---|---|
| | | | 1 | 2<br>Team meeting | 3 | 4 |
| 5 | 6 | 7<br>Team meeting | 8 | 9<br>Team meeting | 10 | 11<br>Proposal revisions- 3pm and 8pm |
| 12 | 13 | 14<br>Team meeting | 15 | 16<br>Team meeting | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Submit Proposal by 8 a.m. CST. | Team meeting | | Team meeting | | |
| 26 | 27 | 28<br>Team meeting | 29 | 30<br>Team meeting | | |

**October 2021**

| *Sunday* | *Monday* | *Tuesday* | *Wednesday* | *Thursday* | *Friday* | *Saturday* |
|---|---|---|---|---|---|---|
| | | | | | 1 | 2 |
| 3 | 4 | 5<br>Team meeting, Awarded proposals announced | 6 | 7<br>Team meeting Kickoff and PDR Q&A | 8 | 9 |
| 10 | 11 | 12<br>Team meeting, start ordering materials | 13 | 14<br>Team meeting | 15 | 16<br>Outreach event dates scheduled |
| 17 | 18 | 19<br>Team meeting | 20<br>Sections I-III of PDR completed | 21<br>Team meeting Social media handle list sent to project office by 8 a.m CDT. | 22 | 23 |
| 24 | 25<br>Sections IV-VI of PDR completed | 26<br>Team meeting | 27 | 28<br>Team meeting PDR revisions, PDR | 29 | 30 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | presentation completed | | |
| 31<br>PDR completed and submitted | | | | | | |

**November 2021**

| *Sunday* | *Monday* | *Tuesday* | *Wednesday* | *Thursday* | *Friday* | *Saturday* |
|---|---|---|---|---|---|---|
| | 1<br>PDR, presentation slides, and flysheet submitted to NASA project management by 8 a.m. CST. | 2<br>Team meeting<br>PDR video teleconferences **begin** | 3 | 4<br>Team meeting | 5 | 6 |
| 7 | 8 | 9<br>Team meeting | 10 | 11<br>Team meeting | 12 | 13 |
| 14 | 15 | 16<br>Team meeting | 17 | 18<br>Team meeting | 19 | 20 |
| 21 | 22 | 23<br>Team meeting | 24 | 25<br>Team meeting<br>Complete scale model | 26 | 27<br>Launch scale model |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | PDR video teleconferences **end** | | | | |
| 28 | 29<br>CDR sections I-III complete | 30<br>Team meeting<br>CDR Q&A | | | | |

**December 2021**

| *Sunday* | *Monday* | *Tuesday* | *Wednesday* | *Thursday* | *Friday* | *Saturday* |
|---|---|---|---|---|---|---|
| | | | 1 | 2<br>Team meeting | 3 | 4 |
| 5 | 6 | 7<br>Team meeting | 8 | 9<br>Team meeting | 10 | 11 |
| 12 | 13 | 14<br>Team meeting | 15 | 16<br>Team meeting | 17 | 18 |
| 19 | 20 | 21<br>Team meeting | 22 | 23<br>Team meeting, Order full scale parts, start full scale physical build | 24 | 25 |
| 26 | 27 | 28<br>Team meeting, Finish CDR sections | 29 | 30<br>Team meeting, Finish CDR presentation, CDR report revisions | 31 | |

**January 2022**

| *Sunday* | *Monday* | *Tuesday* | *Wednesday* | *Thursday* | *Friday* | *Saturday* |
|---|---|---|---|---|---|---|
| | | | | | | 1 |
| 2<br>Submit CDR | 3<br>Subscale Flight Deadline *and* Critical Design Review (CDR) report, presentation slides, and flysheet submitted to NASA project team management by 8:00 a.am CST. | 4<br>Team meeting | 5 | 6<br>Team meeting<br>CDR video teleconfere-nces **begin** | 7 | 8 |
| 9 | 10 | 11<br>Team meeting | 12 | 13<br>Team meeting | 14 | 15 |
| 16 | 17 | 18<br>Team meeting | 19 | 20<br>Team meeting | 21 | 22 |
| 23<br>Team meeting<br>Finish full scale rocket | 24 | 25<br>Team meeting | 26<br>CDR video teleconfere-nces **end** | 27<br>Team meeting, FRR Q&A | 28<br>Sections I-IV of FRR completed | 29 |
| 30 | 31 | | | | | |

**February 2022**

| *Sunday* | *Monday* | *Tuesday* | *Wednesday* | *Thursday* | *Friday* | *Saturday* |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 1<br>Team meeting | 2 | 3 | 4 | 5 |
| 6 | 7 | 8<br>Team meeting | 9 | 10<br>Team meeting | 11 | 12 |
| 13 | 14 | 15<br>Team meeting | 16 | 17<br>Team meeting Sections V-VII of FRR completed | 18 | 19<br>Full scale rocket launch completed |
| 20 | 21 | 22<br>Team meeting FRR presentation complete | 23 | 24<br>Team meeting | 25 | 26 |
| 27 | 28<br>Outreach interactions completed by now | | | | | |

***March 2022***

| *Sunday* | *Monday* | *Tuesday* | *Wednesday* | *Thursday* | *Friday* | *Saturday* |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 6<br>Check over FRR presentation and report | 7<br>Vehicle Demonstrati-on Flight deadline *and* Flight Readiness Review (FRR) report, | 8<br>Team meeting | 9<br>FRR video teleconferen-ces **start** | 10<br>Team meeting | 11 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | presentation slides, and flysheet submitted to NASA project management team by 8:00 a.m. CST. | | | | | |
| 13 | 14 | 15<br>Team meeting | 16 | 17<br>Team meeting | 18 | 19 |
| 20 | 21 | 22<br>Team meeting | 23 | 24<br>Team meeting | 25 | 26 |
| 27 | 28<br>FRR video teleconferences **end** | 29<br>Team meeting | 30 | 31<br>Team meeting | | |

**April 2022**

| *Sunday* | *Monday* | *Tuesday* | *Wednesday* | *Thursday* | *Friday* | *Saturday* |
|---|---|---|---|---|---|---|
| | | | | | 1 | 2 |
| 3 | 4<br>Payload Demonstration Flight and Vehicle Demonstration Re-flight deadlines, *and* FRR Addendum submitted to NASA project management | 5<br>Launch window opens for teams not traveling to Launch Week. PLAR must be submitted within 14 days of Launch. | 6<br>Launch Week Q&A | 7 | 8 | 9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | team by 8:00 a.m CDT. (Teams completing additional Payload Demonstration Flights and Vehicle Demonstrati-on Re-flights only) | | | | | |
| 10 | 11 | 12 | 13 | 14 | 15 | 16<br>Have LRR documents ready |
| 17 | 18 | 19<br><br>Evening Departure to Huntsville, AL. | 20<br><br>Teams travel to Huntsville, AL, Launch Readiness Review (LRR) for teams arriving early | 21<br><br>Official Launch Week Kickoff, LRRs, Launch Week activities | 22<br><br>Launch Week activities | 23<br><br>Launch Day and Awards Ceremony |
| 24<br><br>Backup Launch Day | 25 | 26 | 27 | 28 | 29 | 30 |

**May 2022**

| *Sunday* | *Monday* | *Tuesday* | *Wednesday* | *Thursday* | *Friday* | *Saturday* |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9<br><br>Teams travelling to Launch Week: | 10 | 11 | 12 | 13 | 14 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Post-Launch Assessment Review (PLAR) submitted to the NASA project management team by 8:00 a.m. CDT *and* Launch window closes for teams not traveling to Launch Week. PLAR must be submitted within 14 days of launch. | | | | | |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | | | | |

# Appendix 2 - Risk Assessment & Mitigation

| Risk | Causes | Risk Level | Mitigation |
|---|---|---|---|
| Power tool usage | Lack of proper training | Medium | Before any team member uses a power tool they must demonstrate to a supervisor that they have a proficient knowledge over the usage of that tool. PPE will be worn depending on the tool being used. For tools requiring electricity extra care will be taken to prevent injury. Only team leaders will be allowed to use any tools deemed especially dangerous. |
| Sanding fiberglass | Lack of proper training | High | When handling any fiberglass team members are required to wear proper PPE (gloves, eye protection, safety masks). |
| Hazardous chemical usage | Spillage | High | Any hazardous materials will only be |

| | | | |
|---|---|---|---|
| | | | handled by individuals with proper training or certification. All members will be informed on the location of the nearest fire extinguisher and eye wash station. Material Safety Data Sheet for any materials used will be available. |
| Fumes/injury while soldering | Contact with hot iron, melting plastic, melting lead | Medium | Soldering will only be done by team members with the proper experience. Soldering will be done in a well ventilated area to help mitigate fumes. |
| Hand tool usage | Lack of proper training | High | Before any team member uses a hand tool they must demonstrate to a supervisor that they have a proficient knowledge over the usage of that tool. PPE will be worn depending on the tool being used. |
| Epoxy usage (uncured) | Contact with skin/eyes | Low | When using epoxy |

| | | | |
|---|---|---|---|
| | | | team members will be required to wear gloves and eye protection. |

Appendix 3- Safety Presentations (Launch and Construction)

# 13 Rules For Safe Rocketing

2021-2022 NSL Launch Safety Presentation

## Safety is always the number one priority

## 1: Certification

- May only possess and use motors one is certified to handle

## 2: Materials

- One will only use lightweight materials for rocket construction
- Paper, wood, rubber, plastic, fiberglass, ductile metals

## 3: Motors

- One may only use certified, commercial produced motors
- Motors will not be tampered with
- No smoking, open flame, or heat sources within 25 ft of motors

## 4: Ignition Systems

- One will only launch with an electrical launch system and electrical motor igniters
- Igniters must be installed on launch pad
- Launch system must have safety interlock in series with the launch switch, and launch switch must be returned to off after ignition

## 5: Misfires

- If rocket does not launch when ignition is pressed the safety interlock or battery must be disconnected and 60 second must pass before anyone can go inspect the rocket

## 6: Launch Safety

- One must perform a five second countdown to launch, and have means available to warn spectators of danger
- No one may be closer than the minimum safe distance (200 ft)
- Rocket must be determined to be stable before launch

# 7: Launcher

- Rocket must be launched from a device that provides rigid guidance until it reaches a speed that ensures stable flight, and it within 20 degrees of vertical
- If windy rocket must be launched away from spectators
- Blast deflector must be used to protect ground, and debris must be cleared from around launch pad

# 8: Size

- Rocket must not contain any combination of motors with more than a total of 40,960 N-sec
- Rocket must not weigh more than ⅓ the average thrust of the motor being used

# 9: Flight Safety

- Rocket must not be launched at a target, into clouds, near airplanes, or on a trajectory that takes it above spectators or outside of the bounds of the launch site, or with any flammable or explosive payloads
- Rocket must not be launched when wind speed exceeds 20 mph
- One must comply with FAA rules and regulations, and make sure rocket does not exceed approved ceiling

# 10: Launch Site

- Rocket must be launched outdoors, in an area free of trees, power lines, occupied buildings, and without persons not involved in the launch
- Open area must have a minimum diameter of half the launch ceiling, or 1500 ft

## 11: Launcher Location

- Launcher must be 1500 ft from any occupied building or public highway with traffic heavier than 10 vehicles per hour
- Must not be closer to launch site than minimum distance allowed (200 ft)

## 12: Recovery System

- A recovery system where all parts of the rocket return safely and undamaged in a way in which they can be flown again must be used
- Only flame resistant or fireproof materials may be used in recovery system

## 13: Recovery Safely

- One must not attempt to recover rocket from power lines, tall trees, or other dangerous places
- One must fly it under conditions where it not likely to land in spectator areas or outside of launch boundaries
- One may not attempt to catch a rocket on its descent

# 9 Rules for Safe Rocket Constructioning

2021-2022 NSL Construction Safety Presentation

# Safety is always the number one priority

## 1: Handling Motors

- Team members may only handle motors that they are certified to handle
- Only Harrison, Jefferson, and Jillian are certified to handle L1 motors

## 2: Handling Wood

- Unsanded wood may give splinters
- When sanding wood avoid sanding oneself

## 3: Handling Fiberglass

- Fiberglass will also gives splinters
- Wear gloves when handling
- Wear a mask when sanding to avoid breathing in fiberglass splinters

## 4: Soldering

- Only solder in a well ventilated area to avoid inhaling fumes
- Be careful not to burn yourself with soldering iron or solder

## 5: Handling Electronics

- Be careful not to electrocute yourself
- Do not touch exposed wires
- Do not work on anything connected to a power source

## 6: Handling Chemicals

- Always wear appropriate PPE (gloves, glasses, closed toed shoes, ect)
- Know proper spill or skin contact responses
- Try to avoid all contact with skin or eyes, and do no ingest any materials used in rocket construction

## 7: Handling Epoxies and Adhesives

- The epoxies used in construction are near permanent
- Avoid contact with skin, hair, and clothes

## 8: Handling Hand Tools

- Do not use any tool you do not know how to use
- Always wear proper PPE

## 9: Handling Power Tools

- Do not use any tool you do not know how to use
- Always wear proper PPE
- Be careful when using electricity
- Some tools may only be used by team leads or adult mentor

# Appendix 4 - Safety Agreement

## NASA Student Launch 2022

### Cedar Falls High School Rocket Club

### Safety Agreement

By signing this document, I _____ agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not, then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

_____

Name (Printed)

_____ _____

Name(Signature) Date

_____ _____

Rocket Team Leader Date

_____ _____

Rocket Team Leader Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Harrison agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Harrison Redfern

Name (Printed)

Harrison Redfern — 9/9/21

Name(Signature) — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

# NASA Student Launch 2022

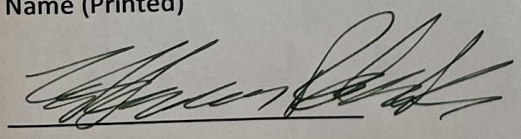
## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Jefferson Roberts agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Jefferson Roberts

Name (Printed)



Name(Signature)

9/9

Date

Harrison Redfern

Rocket Team Leader

9/9/21

Date

Harrison Redfern

Rocket Team Leader

9/9/21

Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Cale Wellnitz agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Cale Wellnitz

Name (Printed)

Cale Wellnitz — 9-9-2021

Name(Signature) — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Torin Brown agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Torin Brown

Name (Printed)

Torin Brown

Name(Signature)

09/09/2021

Date

Harrison Rodfern

Rocket Team Leader

9/9/21

Date

Harrison Rodfern

Rocket Team Leader

9/9/21

Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Becca Nicholson agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Becca Nicholson

Name (Printed)

Becca Nicholson — 09/09/21

Name(Signature) — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Owen Tresemer agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Owen Tresemer

Name (Printed)

Owen Tresemer — 09-09-2021

Name(Signature) — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Maddy Stoakes agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Maddy Stoakes

Name (Printed)

Maddy Stoakes

Name(Signature)

09/09/21

Date

Harrison Redfern

Rocket Team Leader

9/9/21

Date

Harrison Redfern

Rocket Team Leader

9/9/21

Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Renee Fischer agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Renee Fischer

Name (Printed)

Renee Fischer — 9-9-21

Name(Signature) — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Natalie Slade agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Natalie Slade

Name (Printed)

Natalie Slade — 9/9/21

Name(Signature) — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Sean Radke agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Sean Radke

Name (Printed)

Sean Radke — 9/9/2021

Name(Signature) — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Nate Venem agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Nate Venem

Name (Printed)

Nate Venem — 9/09/21

Name(Signature) — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

Harrison Redfern — 9/9/21

Rocket Team Leader — Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Grant Redfern agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Grant Redfern

Name (Printed)

Grant Redfern

Name(Signature)

9/9/21

Date

Harrison Redfern

Rocket Team Leader

9/9/21

Date

Harrison Redfern

Rocket Team Leader

9/9/21

Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Jackson Plummer agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Jackson Plummer

Name (Printed)

Jackson Plummer — September 9, 2021

Name(Signature) — Date

Harrison Rodfern — 9/9/21

Rocket Team Leader — Date

Harrison Rodfern — 9/9/21

Rocket Team Leader — Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Jillian Kellum agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Jillian Kellum

Name (Printed)

Jillian Kellum

Name(Signature)

9/14/21

Date

Harrison Redfern

Rocket Team Leader

9/19/21

Date

Harrison Redfern

Rocket Team Leader

9/19/21

Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Anna Scannell agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not, then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Anna Scannell

Name (Printed)

anna Scannell — 9/17/21

Name(Signature) — Date

Harrison Redfern — 9/19/21

Rocket Team Leader — Date

Harrison Redfern — 9/19/21

Rocket Team Leader — Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Luce S. agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not, then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Luce Shuttleworth

Name (Printed)

Luce

Name(Signature)

9/17/2021

Date

Harrison Redfern

Rocket Team Leader

9/19/21

Date

Harrison Redfern

Rocket Team Leader

9/19/21

Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Claire Shaw agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not, then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Claire Shaw

Name (Printed)

Claire Shaw — 9/17/21

Name(Signature) — Date

Harrison Redfern — 9/19/21

Rocket Team Leader — Date

Harrison Redfern — 9/19/21

Rocket Team Leader — Date

# NASA Student Launch 2022

## Cedar Falls High School Rocket Club

## Safety Agreement

By signing this document, I Addie agree to abide by laws, regulations, safety standards, and procedural guidelines in the National Association of Rocketry 25 Handbook and safety code, The Federal Aviation Administration state and federal laws relating to high powered rocketry, National Fire Protection Association (NFPA) regulations and rules relating to high powered rocketry, all states Environment and Safety laws where launches take place, and any Material Safety Data Sheets (MSDS) for all materials used from design to conclusion of Cedar Falls S.T.A.R.S. entry to NASA Middle school and High school Student Launch (NSL_M&HS). I understand that regulations specific to the launch site will be followed and I will listen to the Range Safety Officers (RSO) command. If not then our team will not be able to launch a rocket. I agree to follow minimum distance tables when launching rockets in any state for any purpose relating to NSL competition. I agree to abide by any commands, rules, and procedures outlined by Cedar Falls S.T.A.R.S. safety officer, Team Leaders, and Adult Educator when working in the workspace, or during any team related launch. I agree that if I do not follow all safety guidelines my role on this team will be terminated as well as all relation to NSL.

Addie Carlson

Name (Printed)

Addie Carlsone

Name(Signature)

9-16-21

Date

Harrison Redfern

Rocket Team Leader

9-19-21

Date

Harrison Redfern

Rocket Team Leader

9/19/21

Date