University of North Dakota
Department of Physics
Frozen Fury Rocketry Team

NASA Student Launch Initiative for Colleges and Universities

Submitted by:
University of North Dakota Frozen Fury Rocketry Team
Witmer Hall, Room 213
101 Cornell Street Stop 7129
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I. GENERAL INFORMATION

1. Administrative Staff Member/Team Official

Dr. Tim Young
- Email: Tim.Young@email.und.edu
- Physics professor at UND
- Acts as advisor to NASA Student Launch team

2. Safety Officer

Drew Ross
- Email: drew.g.ross@und.edu
- Establish a strong culture of safety within team
- Use principles of industrial hygiene to anticipate, recognize, evaluate, and control any potential health and safety hazards
- Act as team liaison to meet with relevant advisers to establish and maintain safe competition guidelines
- Conduct team trainings on environmental, health, and safety regulations
- Establish tool, quality assurance, and a FOD control program to ensure flight safety

3. Team Lead

Stefan Tomovic
- Email: Stefan.tomovic@und.edu
- Administrative duties and organization of the team
- Maintenance of team website

4. Student Participants

- We have 13 students that make up the team. These students all come from different disciplines of studies. There is a mix of graduate and undergraduate students on the team. We also have two foreign nationals that are part of the team.

Focus	Team Member
Safety	Drew Ross
Experiment (Rover)	Stefan Tomović Drew Ross Nick Sponsel Nanette Valentour Taren Wang James Sutton Walker Cage Tori Fisher Rakesh Ravishankar John Heide Ross Dietzsch Andrew Gonzales Ethan Smith Elizabeth Remitroff
Outreach	Stefan Tomović Drew Ross Nick Sponsel
Budget	Stefan Tomović
Foreign Nationals	Tori Fisher (Canada) Rakesh Ravishankar (India)

Table 1: *Member list*

5. ***NAR/TRA association***

a. Kevin Rezac

- Holds a level two NAR certification
- Plans to work with purposes of mentoring
- Reviews team designs and documentation
- Assistants team launch

b. Dr. Tim Young

- Holds a level two NAR certification (NAR# 76791)
- Plans of completing his level three certification
- Available for consultation during all phases of project
- Provides oversight during safety checks and launches

II. FACILITIES AND EQUIPMENT

1. ***Facility Information***

The meetings and construction of the rocket will take place in Witmer Hall, the physics and mathematics building on UND's campus.

a. Meeting Place:

The meetings are held in the student workspace, which is open from 9:00 a.m. to 9:00 p.m. in Witmer Hall. This area has a large work desk, as well as several computers available for use. The computers in this room are outfitted with RockSim and OpenRocket.

b. Physics Department Workshop:

- Construction will be done in the workshops in the basement of Witmer Hall. They are accessible to students from 8:00 a.m. to 9:00 p.m. on weekdays and by request on weekends.
- The workshop contains a multitude of equipment, including but not limited to, drills, saws, screwdrivers, welders, and sanders.
- All combustible materials will be stored in a flammable storage locker denoted will all applicable labeling requirements. Our mentor Tim Young has access to this locker and can retrieve any materials we need from it.
- Storage room is available in the basement.
- James Garber, a retired manufacturing engineer has years of experience in construction, design and knowledge of laboratory safety procedures.

c. Electrical Engineering Computer Lab:

- The computer lab is available at all hours of the day for electrical engineering students. The computers are equipped with programs such as Pro-Engineer, MatLab, C++, AutoCad, MultiSim, LabView, Microsoft Office, and more.

d. Engineering Lab:

- This lab contains power sources, voltmeters, oscilloscopes, and soldering irons. We plan on using this space to assemble, program, and test the payload.

2. Computer Equipment

- Communication and collaborations will partly be done through personal laptops belonging to each team member. The physics department also has several desktop computers available for use as mentioned in the facility information.
- The team website will be hosted from a third party service reducing the need for website hosting hardware, dedicated internet connectivity, and special website editing software. The website will be accessible for revisions by any team member with access to a personal computer and internet connection; however, team members must communicate all necessary changes to the member responsible for the site maintenance. Website participation will be strongly encouraged this year as a method for increasing educational engagement, recruitment, and partnership development. In addition to the team's official website, local media and social networking resources will be used to increase public interest in the team's project.

3. EIT Standards

The SL Frozen Fury team has read and will implement the Architectural and Transportation Barriers Compliance Board Electronic and Information Technology (EIT) Accessibility Standards (36 CFR Part 1194).

III. SAFETY

1. Team Member Certifications:

a. Dr. Tim Y. Young

- Certification 2 NAR# 76791

2. Written Safety Plan

The written safety plan is the backbone of any successful safety program. As such, the written safety plan will consist of the following documents: High Power Rocket Safety Code (NAR Standards), Title 14 – Aeronautics and Space Chapter under Section 1 of the FAA, DOT part 101-moored balloons, kites, unmanned rockets and balloons, North Dakota Rocketry Association (NDRA) regulations, OSHA General Industry Standards (to be detailed further below). These documents and plans have been included to provide an all-encompassing safety program.

3. Team Member Training

Prior to the construction of any component for this event, a required series of trainings will be given to the team. The trainings will be based on the above referenced guidance documents as well as a full series of OSHA General Industry Standards (29 CFR 1910) including: Hazard Communication (1910.1200), Bloodborne Pathogens (1910.1030), Occupational Noise Exposure (1910.95), Personal Protective Equipment (1910.132), Walking-Working Surfaces (1910 Subpart B), Fire Safety (PASS Fire Extinguisher Methodology – 1910 Subpart L). Safety Training attendance documentation can be found in Appendix A. A special documentation form for selected team members who undertake the PASS fire extinguisher training will also be incorporated into Appendix A.

In addition, to the full trainings, a "toolbox talk" will be held once a week prior to construction activities. The talks will consist of a five – ten minute discussion on rotating safety topics. These are meant to reinforce a strong safety culture within the build team. Further, any large construction or chemical handling activities will be preceded by a safety briefing on the hazards that may be present.

4. Construction Safety

Construction of all rocket associated parts shall be completed in the rocket work shop. All work will adhere to the following requirements:

- James Garber, the shop foreman, shall be present during all shop activities.
- Appropriate PPE must be worn including safety glasses, safety work shoes, and hearing protection.
- The ventilation system must be utilized when working with epoxy or spray paint
- All tools and parts must be accounted for

- Any special tool use must be allowed by the Shop Foreman
- Jim, Tim, or Drew must be present when handling a hazardous chemical (See Appendix B for MSDS/SDS review prior to chemical issuance).

The team will encounter several health and safety risks during the course of construction. All efforts were taken to anticipate, recognize, evaluate, and control all hazards in order to mitigate safety risk. However, due to the variable environment of constructing a rocket, non-anticipated safety hazards may be present. In the event that this should occur, work will cease and an investigation into the cause of the safety hazard will be evaluated and corrected prior to work resuming. See Table 2 for anticipated safety hazards.

Table 2: Assessment of possible risks

Risk	Degree of Risk	Impact	Mitigation
Hazardous Substances Handling	High	Minor skin or gland irritation, decrease in work performance	Ventilation, Gloves, proper application of tools (proper handling of product, briefing of hazardous material effects on the body)
Ammonium Perchlorate	High	Minor to serious bodily injury	Proper, and certified personnel use only
Black Powder	High	Serious injuries	Proper, and certified personnel use only
Power tools	Moderate	Serious injuries including loss of limbs, blindness	Proper handling of tools, use of safety equipment
Flammable Materials	High	Fire, burns, damaged equipment	Certified team members only
Test Launch Failure	Moderate	Loss of funding, behind schedule, possible program collapse	Experienced members as team leaders, redundancy, and positive reinforcement for the team members
Payload Failure	Moderate	Loss of scientific data	Redundancy and pretest of equipment
Loss of Funding	Moderate	Program failure	Diversify and reallocation of funding
Member Fatigue	Low	Decrease in work performance and low crew moral	Adequate amounts of rest and proper program planning
Hazardous Material Transportation	High	Fire, serious injury, potential loss of limbs, death	Store all hazardous materials in flammable storage locker during transportation. Vehicle and locker shall be clearly marked.

5. Launch Safety

The launch of the rocket is the most significant safety risk during the competition. As such, the safety officer will consult with the range safety officer (when available) to determine all applicable safety measures at the range. After consulting with the range safety officer, a full briefing on the launch process, up to and including the setup, launch and recovery will be conducted prior to setting the rocket on range for launch.

The launch will only be permitted if there are limited clouds within a five mile radius and the wind must be below 20 mph. The wind will first be checked using local weather forecasts. In the event the wind is approaching 15 mph, a hand held anemometer will be used to measure wind speed on site. In addition to the cloud and wind requirements, all flight operations will take place in rural areas and near roads that are limited to <5 cars per hour.

6. Quality Assurance/Foreign Object Debris (FOD) Control/Tool Control

Quality Assurance (QA) and FOD control programs are the backbone of any successful rocket program. As such, the interdependence between a strong QA and FOD control program is crucial to ground and flight safety operations.

A QA representative for the project will be on site during all construction where torque specifications have been provided. The team member performing the construction will contact the QA representative to witness the torque on the part, thus mitigating flight safety risk due to in flight structural failure. QA representatives will also inspect areas enclosed by panels to ensure FOD is not found in the panel area. The OK to close will be given once this step is complete.

The FOD control program will consist of a designated team member who will lead a walk of the immediate area around the rocket prior to beginning construction for the day. In the event of a lost part or tool during construction, all activities will cease immediately and a FOD walk will be conducted to locate the missing part.

The tool control program is an integral portion of the FOD control program. All tools must be accounted for prior to beginning construction on the rocket for the day and at the end of every shift to prevent damage from missing/lost tools.

7. Hazard Materials Handling

All purchasing of rocket motors will be done through Dr. Young. Any purchased motors will be stored in a trailer magazine owned by university. Rocket Motors will only be transported by Dr. Young in a portable magazine. Proper usage of these motors will be enforced under the supervision of Dr. Young.

8. *Traveling Arrangements for Rocket Motors*

While traveling down to Huntsville, AL., the team will be towing a trailer containing all hazardous materials. To prevent any harm from unintentional ignition of the motors, the portable magazine will be locked and then secured in the trailer. In addition, all appropriate DOT labeling will be prominently displayed on the outside of the vehicle based on the classification hazard of the rocket motor materials.

9. *Documentation*

- The rocket team recognizes that every member of the team is integral to the success of the competition. As the most critical resource in the competition, team members will be safeguarded through training, provision of appropriate work surroundings, and procedures that foster protection of health and safety. As such, all team members have signed a pledge to adhere to safety requirements during the entirety of the competition. This pledge can be found in Appendix A.
- All Material Safety Data Sheets/Safety Data Sheets for hazardous materials used in the build process can be found in Appendix B.

IV. TECHNICAL DESIGN

1. *Rocket and payload design*

a. Vehicle Dimensions

We are currently planning on using a fiberglass body tube with birch plywood fins and a fiberglass nose cone. All size information below is based on a preliminary Rocksim design with these specifications and is subject to change. The mass of our rocket also includes simulated masses for the payloads we plan to include, and because we do not have accurate measurements for these values they are subject to significant change.

	English system	Metric system
Length	79.847 in	2.02 m
Mass	21.56 lbm.	9.779 kg
Mass no engine	13.375 lbm.	6.845 kg
Diameter	6.0 in	0.152 m
Center Pressure	56.296 in	1.429 m
Center Gravity	49.479 in	1.257 m
Safety margin	1.09	

	English system	Metric system
Fin characteristics:		
Root Length	15.0 in	0.381 m
Tip Length	8.0 in	0.203 m
Span Length	5.0 in	0.130 m
Sweep Length	3.033 in	0.077 m
Simulated Altitude (calculated in OpenRocket)	5289 ft	1612 m

Table 3: *Vehicle Dimensions*

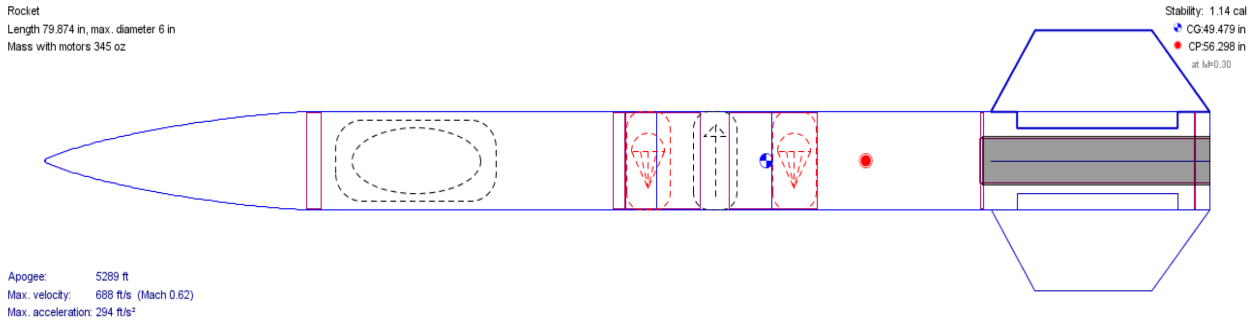

Figure 1: *OpenRocket Design of launch vehicle (side profile) Note: Subject to change*

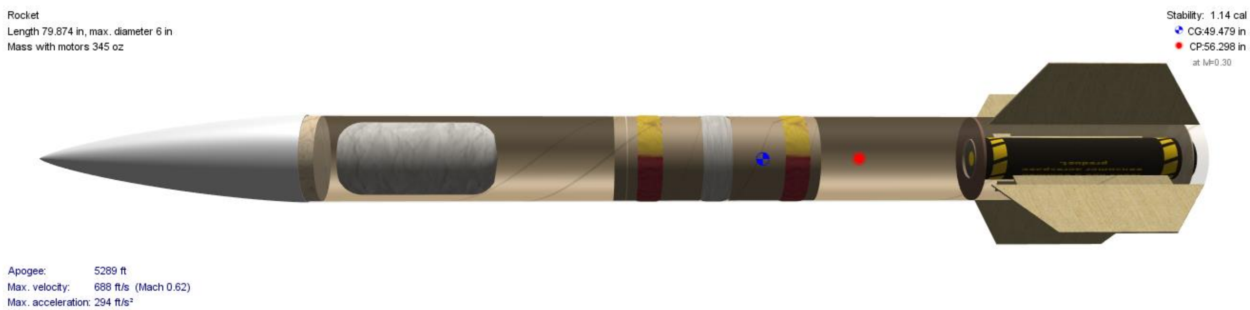

Figure 2: *3D Render of launch vehicle. Note: Subject to change*

b. Motor Type

We selected the following motor because it will allow us to reach a higher altitude, this will allow our rocket to experience microgravity for a longer period of time.

- Motor Model: Aerotech K780R
- Propellant Weight: 1267.84 g
- Total Weight: 2934.4 g
- Average Thrust: 809 N
- Peak Thrust: 953.578 N
- Total Impulse: 2361.06 Ns
- Class: 84% K
- Thrust Duration: 2.92 s

c. Parachute System

We will be using 2 parachutes:

- 1 Drogue 36” that will open at Apogee.
- 1 Main Parachutes 96”

d. Experiment(s): Deployable Rover

- There are some major technical challenges concerning the rover payload. There is the issue of how to get the rover to deploy from the launch vehicle in the right orientation. Another challenge is how to get the rover to traverse the terrain in which it lands.
- The rover’s design will implement continuous track vehicle propulsion driven by electric motors. The rover will be autonomous and will exit the rocket from just beneath the nose cone. The rover will be situated on a platform upon a rail system within the payload bay. Linear actuators will extend the rails. The platform bay will rotate on the rail system via a rack and pinion gearing system to perform the desired rotation. Upon landing, linear actuators will be remotely activated to push on the nose cone, breaking the shear pins holding it in place. To make sure the rover exits the rocket in the right orientation, a gyro-system will be applied to correctly position the rover and its deployment system perpendicular to the ground. As the linear actuators operate, the platform will begin exiting the launch vehicle. Once the platform protrudes enough from the launch vehicle it will engage the rack and pinion gear and will begin to rotate. When the platform is perpendicular with the rail system, the rover will be remotely released and engaged. The rover will then traverse five feet away from the launch vehicle and deploy a set of foldable solar arrays. (The rotation of the platform ensures that the rover does not impact the removed nose cone as it travels.)

2. Scale Rocket

- The scale model will be based off of a kit rocket purchased from LOC/Precision. The kit used will be the LOC Forté model. Modifications will be made during assembly to make a better scale of our actual rocket. We will base our scale off of the 3” diameter size that this rocket comes in and then cut the length to make the width to length ratios equivalent. Along with this, the fins on the kit will not be used as we will be constructing fins based off of the design of the launch rocket. This will be launched using a first-class G motor and the actual specifications of the rocket with a 3” diameter are shown in the picture below.
- We are using a kit to model our rocket because building it will introduce the new members of the group to the different procedures of building the rocket without creating unrealistic time demands on the members. This helps the new members get accustomed to the shop equipment, the names

of the parts used to assemble the rocket, the placement of these parts, the handling procedures of a motor, and the use of a payload.

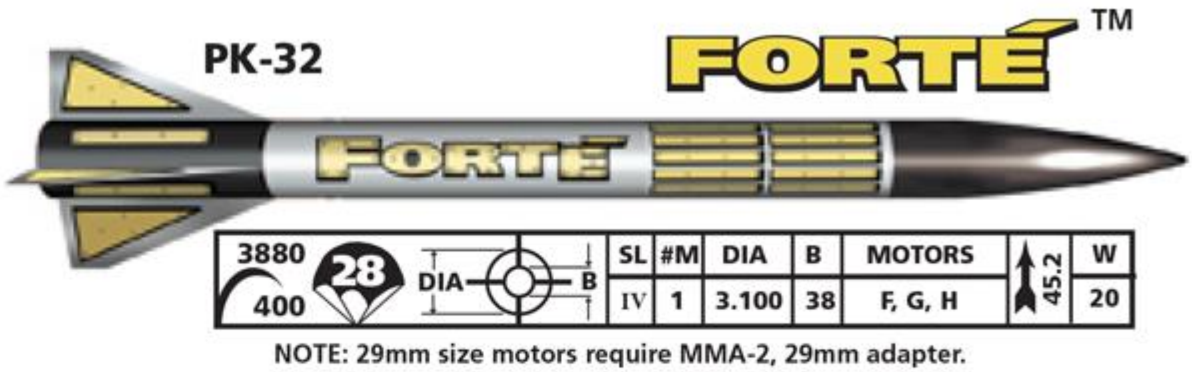

Figure 3: *The rocket kit image from the LOC/Precision website*

V. <u>EDUCATIONAL ENGAGEMENT</u>

1. Community Support

- The Frozen Fury rocket team will engage the youth of Grand Forks and surrounding areas. Presenting to local special interest groups will allow us to gain access to interested community members, such as the North Dakota Space Grant Consortium (NDSGC). From there, we can gain insight into our rocket and design, as well as obtain potential resources.
- Partnership with outreach organizations, such as Dakota Science Center, the Grand Forks Public Library, and K-12 schools throughout Minnesota and North Dakota will allow for greater dissemination of our team's goals and objectives and allow for greater collaboration within the Grand Forks community.

2. Educational Projects

- During the academic school year, students from grade schools throughout North Dakota and Minnesota come to visit the Space Studies lab at the university. Through the recommendation of NDSGC, teachers and students from K-12 classrooms up to an hour away come to visit our university and lab. The Frozen Fury Team will be sending parts used in previous competitions to this lab for students of all ages to see. Further, a representative will be present during each tour of the lab to explain the purpose of the club and answer questions from the visiting students. It is estimated that 50 students per month will go through the lab and see the area dedicated to the rocket team.

- As the Frozen Fury Rocket Team has done in the past, we plan on continuing our role as mentors to area high schools working on small-scale rocketry projects on their own. We will hold mini-seminars with schools participating in the Team America Rocketry Challenge (TARC) in order to teach them the basics of rocket science, as well as give hands-on demonstrations of essential skills, such as using the OpenRocket program.
- We plan on presenting a colloquium presentation during the spring semester as a part of the physics colloquia series. While the topics are not yet set, possibilities include the future of NASA, history of the rocket age, and getting started in rocketry. These colloquia have historically been attended by 30 students, faculty, and community members.
- The Frozen Fury rocket team is working with Dakota Science Center to create a series of lesson plans geared towards middle school and high school physical science and physics classes. The curriculum will focus on aspects of physics and rocket science and will meet North Dakota and Minnesota state science standards and fulfill STEM requirements in these states.
- Team members will host a table at science fairs at elementary and middle schools throughout the neighboring counties. Each science fair is estimated to include at least 100 students. An administrator at a local elementary school has reached out to 18 different instructors in planning a classroom visit from the Frozen Fury Team.
- Local high schools, in particular, have shown an interest in collaboration. The Frozen Fury Team is working with a science teacher and a career resource educator at Community High School in Grand Forks. The science teacher is interested in having students from the team come in to talk about the equipment, tools, concepts, and skills needed to work on the team. At the end of the presentation, the rocket team representatives will discuss their academic history and plans for careers.
- At Community High School's annual career fair, the rocket team will have a booth set-up amongst dozens of academic and corporate sponsors. The team will display previous years' rocket designs and sign-up sheets for student participation in test launches. It is estimated that the team will be able to interact with over 150 high school students at this fair.

- The Frozen Fury rocket team will participate in Physics Day at UND. This is a program for local high school students to learn about the many different facets of physics. We will have a table set up with demonstrations to show groups of students. This will reach about 100 students.

VI. PROJECT PLAN

1. Schedule

The following is a projected schedule for the year. We normally have team meetings every Tuesday and Thursday with construction expected on weekends. As we get further into the project, we will add more detailed timeline for the completion of rocket and payload construction, and educational outreach.

Date	Event
Oct. 06, 2017	Awarded proposals announced
Oct. 12, 2017	Kickoff and Preliminary Design Report (PDR) Q&A
Oct. 16, 2017	Preliminary team website meeting
Oct. 23, 2017	PDR draft meeting
Oct. 30, 2017	Team website Final Review
Oct. 30, 2017	PDR Final Review
Nov. 03, 2017	Team web presence established
Nov. 03, 2017	PDR report, presentation slides, and flysheet posted on the team website by 8:00 a.m. CST

Nov. 06 - Nov. 29, 2017	PDR video teleconferences
Dec. 06, 2017	Critical Design Review (CDR) Q&A
Dec. 11 2017	CDR
Dec. 15, 2017	CDR
Dec. 16, 2017 - Jan. 09, 2018	Winter Break
Jan. 12, 2018	CDR report, presentation slides, and flysheet posted on the team website by 8:00 a.m. CST
Jan 16 – Jan 31, 2018	CDR video teleconferences
Feb. 07, 2018	Flight Readiness Review (FRR) Q&A
Feb. 12, 2018	FRR draft meeting
Mar. 05, 2018	FRR reports, presentation slides, and flysheet posted to team Website by 8:00 a.m. CDT
Mar. 06 - Mar. 22, 2018	FRR video teleconferences
Apr. 04, 2018	Teams travel to Huntsville, AL and Launch Readiness Review (LRR)
Apr. 05 2018	LRR’s and safety briefing

Apr. 06, 2018	Rocket Fair and Tours of MSFC
Apr. 07, 2018	Launch Day
Apr. 08, 2018	Backup launch day
Apr. 27, 2018	PLAR posted on the team Website by 8:00 a.m. CDT.

Table 4: *Project Timeline*

2. *Budget*

The following is a preliminary budget for the year. Several items such as the parachute can likely be re-used from previous rockets, so the total cost may be less than projected. Some parts may be printed in the 3D printers available on campus to save money.

2016-17 UND Rocket Team "Frozen Fury" Budget			
Scale Launch			
Materials	Quantity	Unit Cost ($)	Total Cost
Rocket Kit	1	80	80
Scale Rocket Motors	2	35	70
Total for Scale Launch			$ 150.00
Full Scale Launch			
Materials	Quantity	Unit Cost ($)	Total Cost
Retrieval			
Parachute (96")	1	90	90
Drogue Parachute (36")	1	21	21
Shock Cord	6	1.1	6.6
Sub Total			$ 117.60
Engine			
K780R	4	136	544
Casing	1	450	450
Motor Mount Tube	1	15	15

Sub Total			$ 1,009.00
Body			
6" G12 Fiberglass Filament Wound Tube 48" long	2	207	414
6" Diameter Phenolic Coupler Tube	4	15	60
Sub Total			$ 474.00
Nose Cone			
6" Fiberglass Conical 5:1 Nose Cone	1	116	116
Sub Total			$ 116.00
Electronics			
Arduino MEGA 2560 REV3 Circuit Board	2	50	100
Gyro and Accelerometer Module	3	5	15
25' 20 Gauge Red/Black Wire	1	6.5	6.5
Logitech Webcam	1	40	40
D/C Motor	1	28	28
Li-Po Battery 5000mAh	2	54.67	109.34
Battery Charger	1	37	37
StratoLogger CF Altimeter	3	55	165
Sub Total			$ 500.84
Fabrication			
Nuts & Washers	20	.50	10
1/4" by 6' Plywood	1	15	15
1/8" by 6' Plywood	1	15	15
Xacto Knife	1	2	2
Paint and Gloss	1	30	30
Sub Total			$ 72.00
Total for Full Scale Launch			$ 2,289.44
Travel			
Items	Quantity	Unit Cost ($)	Total Cost
ND State Van	1	700	700
4/5/18 Hotel Room	11	85	935
4/6/18 Hotel Room	11	85	935
4/7/18 Hotel Room	11	85	935
4/8/18 Hotel Room	11	85	935
4/9/18 Hotel Room	11	85	935
Total for Travel			$ 5,375.00

Grand Total			**$ 7,814.44**

Table 5: *Project Budget*

3. *Funding*

- We will solicit donations from local business, previous donors, and personal connections, as well as grant funding from other departments, including the physics, the engineering, and the aerospace departments.
- We will seek out sponsorships from companies in exchange for logos on the rocket.
- North Dakota Space Grant Consortium in the past has supported travel fund of $3,500.
- Lockheed Martin has agreed to fund the rocket this year on the order $2,500.

4. *Sustainability*

- To maintain and build upon student participation, we will strive to promote a project team consisting of a mixture of undergraduates and graduate students from a variety of departments across campus. We will continue to remain in close contact with project-relevant departments including engineering, physics, and space studies while also attempting to create new departmental relationships by participating in engagement activities around campus.
- To encourage recruitment, we will continue to reach out to new departments and will participate in local engagement activities. We will also attempt to publicize our activities to the local community by advertising events that the public can view, such as our test launches, and by maintaining an up to date and easily accessible website which shows our progress and achievements with our current project.
- Because of continued support since the beginning of the Frozen Fury team, it is anticipated that we will continue to receive support from The North Dakota Space Grant Consortium as well as the University of North Dakota Physics, Engineering, and Space Studies departments. Additionally, other support will be sought from local sources.
- To encourage educational engagement, we will be participating in several educational events. At the collegiate level, we will be doing presentations on our project at campus sponsored activities that focus on science, space, and physics. We plan to reach out to the schools in our area and talk to students about our project and general rocket science information. For all interested participants, we would like to publicize our launch events and present educational information in conjunction with those launches.
- As ninth year USLI participants, we are committed to continuously improving and advancing the scope of our project to reflect the experience of a veteran team. To do this, we will maintain records of all previous year's work and challenge ourselves to build upon each success and failure.

- The most important element which we have improved this year, as pertaining to sustainability is organization. In the past the team has been weakened by a lack of internal structure but in these past years leading to this competition we have shown improvement and will continue to insure the longevity of our rocket team.

I. <u>Appendix A:</u> Sign of competition safety requirements

By signing this document, I understand and will abide by the following safety regulations found within the NASA Student Launch Handbook and this proposal document

- Range safety inspections of each rocket before it is flown. Each team shall comply with the determination of the safety inspection or may be removed from the program
- The Range Safety Officer has the final say on all rocket safety issues. Therefore, the Range Safety Officer has the right to deny the launch of any rocket for safety reasons
- Any team that does not comply with the safety requirements will not be allowed to launch their rocket.

Nicholas Sponsel
John Heide
Ross Dietzsch
Tori Fisher
Walker Cage
Andrew Gonzales
Taren Wang
Drew Ross
Nanette Valentour
Ethan Smith
Elizabeth Demitroff
Nathan Hall
Steven Russell
Rakesh Ravishankar
Stefan Tomović

II. <u>Appendix B:</u> MSDS/SDS data sheet

- West Systems Epoxy
    - Product Name: WEST SYSTEM® 105! Epoxy Resin.
    - Chemical Family: Epoxy Resin.
    - Chemical Name: Bisphenol A based epoxy resin.
    - http://www.westsystem.com/ss/assets/MSDS/MSDS105-resin.pdf
- West Systems Hardener
    - Product Name: WEST SYSTEM® 205! Fast Hardener.

  - Chemical Family: Amine.
  - Chemical Name: Modified aliphatic polyamine.
  - http://www.westsystem.com/ss/assets/MSDS/MSDS205.pdf
- West Systems Hardener
  - Product Name: WEST SYSTEM® 404! High-Density Filler.
  - Chemical Name: Calcium Metasilicate, silicon dioxide blend.
  - http://www.westsystem.com/ss/assets/MSDS/MSDS405.pdf
- West Systems Fiber Glass
  - Product Name: WEST SYSTEM® 727 Episize! Biaxial 4" Glass Tape,
    WEST SYSTEM® 737 Episize Biaxial Fabric
    WEST SYSTEM® 738 Episize Biaxial Fabric with Mat.
  - Chemical Name: Fibrous Glass.
- Ammonium Perchlorate
  - Product Name: Ammonium perchlorate
  - Catalog Codes: SLA2725
  - CAS#: 7790-98-9
  - RTECS: SC7520000
  - TSCA: TSCA 8(b) inventory: Ammonium perchlorate
  - http://www.sciencelab.com/msds.php?msdsId=9922929