2020-2021

12th Annual
First Nations Launch
Student Competition Handbook

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Acronym Dictionary

AGL = Above Ground Level
APCP = Ammonium Perchlorate Composite Propellant
CDR = Critical Design Review
CG = Center of Gravity
CP = Center of Pressure
EIT = Electronics and Information Technology
FAA = Federal Aviation Administration
FNL = First Nations Launch
FRR = Flight Readiness Review
HPR = High-powered Rocketry
LCO = Launch Control Officer
LRR = Launch Readiness Review
MSDS = Material Safety Data Sheet
NAR = National Association of Rocketry
NASA = National Aeronautics and Space Administration
PDR = Preliminary Design Review
PLAR = Post Launch Assessment Review
PPE = Personal Protective Equipment
RSO = Range Safety Officer
SME = Subject Matter Expert
SOW = Statement of Work
STEM = Science, Technology, Engineering, and Mathematics
TRA = Tripoli Rocketry Association
WSGC = Wisconsin Space Grant Consortium
Glossary

**NASA Space Grant Consortium(s)** = The mission of the NASA Space Grant Consortium is to enhance higher education opportunities for students seeking to pursue careers in the fields of science, technology, engineering and math (STEM); to enrich and improve STEM Education at diverse pre-college, college, university and community learning centers; and to provide public outreach for NASA missions, and thereby strengthen the future workforce for NASA and our nation. Each state has a Space Grant Office – to find your state’s host institution and specific programs (or funding support), see https://www.nasa.gov/stem/spacegrant/home/Space_Grant_Consortium_Websites.html

**Wisconsin Space Grant Consortium (WSGC)** = this is the host Space Grant Consortium, located at Carthage College, Kenosha, WI. https://spacegrant.carthage.edu/

**First Nations Launch (FNL)** = this is one of many programs created and hosted by WSGC. It is the only high-powered rocketry competition dedicated to support American Indian students. First Nations Launch is a NASA Artemis Student Challenge. https://www.nasa.gov/stem/artemis.html

**Tripoli Rocketry Association (TRA)** = this is a national non-profit organization (similar to AISES) who’s mission is to promote the sport of high-powered rocketry and ensure its continued safety and success. TRA usually promotes larger high-powered rocket launches. Local chapters or ‘prefectures’ exist across the country, who hold monthly meetings and launches when permissible. http://www.tripoli.org/

**National Association of Rocketry (NAR)** = this is a national non-profit organization (similar to AISES) who’s mission is to promote the sport of high-powered rocketry and ensure its continued safety and success. NAR usually promotes smaller low-powered rocket launches. Local chapters exist across the country, who hold monthly meetings and launches when permissible. https://www.nar.org/

**Federal Aviation Association (FAA)** = this is the organization that regulates the airspace above the United States, and determines the laws that govern safe high-powered rocketry among other things (such as private and commercial airplanes, rockets, drones, rotorcraft etc.). TRA and NAR organizations must understand and adhere to the regulations set forth by the FAA. TRA and NAR can also petition changes to those regulations.

**Technical Advisor** = the primary technical advisor of most high-powered rocket competitions is usually the local club/prefecture president or local club/prefecture Range Safety Officer (may or may not be the same individual). This individual may or may not have an engineering degree but will usually have many years of high-powered rocketry experience.

**Faculty Advisor** = usually an educator, responsible for administrative duties for the team, providing support for the students (securing a workspace, securing financial support, keeping students on task, ensuring team meets deadlines), and liaising with FNL – does not need to have a STEM or technical background, but encouraged. Faculty Advisor will also assist in coordinating team travel for Launch Weekend. Advisors can refer to the Advisor Handbook for guidance.

**Team Mentor** = not necessarily affiliated with the school, this person is TRA or NAR certified and experienced with building and flying high-powered rockets. Team mentor should be a local individual, who can visit the school and assist with and monitor the build. Team mentor may also facilitate any static testing, flight testing (at a local TRA or NAR field) and hazardous materials procurement and handling (motors, energetics).

*NOTE: Your Faculty Advisor and Team Mentor may or may not be the same individual.*
High-Powered Rocketry = is a hobby similar to model rocketry. The major difference is that higher impulse range motors are used. The National Fire Protection Association (NFPA) definition of a high-power rocket is one that has a total weight of more than 1,500 grams (3.3 lb) and contains a motor or motors containing more than 125 grams (4.4 oz) of propellant and/or rated at more than 160 Newton-seconds (40.47 lbf·s) of total impulse, or that uses a motor with an average thrust of 80 newtons (18 lbf) or more. [https://en.wikipedia.org/wiki/High-power_rocketry](https://en.wikipedia.org/wiki/High-power_rocketry)

Avionics Bay = is usually the section of the rocket that houses the altimeters (or electrical devices) that control the recovery subsystem for the vehicle. Electronics that are used for tracking may also be housed in the avionics bay. Electronics that are used for payload/challenge control, or deployment or sampling are usually not a part of the avionics (they would be referred to as payload/challenge electronics), even if they are housed in the same area as the vehicle avionics. Payload/challenge electronics would have their own electrical circuit and power source.

Payload/challenge = is used to describe the ‘cargo’ that the rocket vehicle is designed to carry. A conventional payload/challenge would integrate inside of the rocket tube, usually behind the nose cone. An unconventional payload/challenge could consist of external hardware that is used to control the vehicle, or alter its appearance.

Challenge = this term is used to describe all of the parameters for the particular challenge for the year. There exist four (4) general challenge categories, which are rotated within a four-year cycle;
- Avionics Challenge = the focus would be on an electronics payload/challenge integrated into the rocket
- Payload Challenge = the focus would be on a ‘payload/challenge’ contained within the rocket
- Stability Challenge = the focus would be on controlling or modifying the stability of the rocket
- Structure Challenge = the focus would be on the airframe and construction of the rocket

See the Challenge Requirements Section of this Handbook for Challenge details for current competition.

Rail Size and Rail Button Size = there are various ways to attach a high-powered rocket to a launch rail (and there are various launch rail types), which is dependent on the size and weight of the rocket. In FNL we will restrain these to the use of standard rail button. These rail buttons come in two sizes – 1010 rail button (considered small, for use with a 6-foot rail) or a 1515 rail button (considered large, for use with a 10-foot rail). Ensure your simulations are configured correctly to account for the proper rail button size.

Rail Exit Velocity = this parameter is important to monitor during simulations, as this value will affect the rocket stability in flight. There is a minimum value to be attained in order to maintain a stable flight (52 feet per second). Meeting this parameter in simulations (and in flight) is accomplished by selecting the proper rail button/rail length, and varying the weight and motor selection. RockSim refers to this parameter as ‘velocity at launch rail departure.’

Thrust-to-Weight Ratio = this parameter is important to monitor during simulations, as this value will affect the rocket stability in flight. The standard minimum thrust-to-weight ratio is 5-to-1 (written 5:1). This means the motor selected should provide 5 times the amount of average thrust than the weight of the fully loaded rocket. It is easiest to use the (average) motor thrust in pounds to determine your estimated thrust-to-weight ratio.

Time-to-Apogee = this parameter is important to understand during simulations, as this will be used to set motor ejection delay during your flight. It also is an indicator that your simulations are working correctly, as time to apogee should be in the 10 – 15 second range.
Statement of Work (Engineering Parameters)
Design, Development and Launch of a Reusable Rocket and Payload/challenge:
Statement of Work

Activity Name: WSGC First Nations Launch

Governing Office: Carthage College, Wisconsin Space Grant Consortium

About the Program

NASA Wisconsin Space Grant Consortium’s First Nations Launch (FNL) National High-Power Rocket Competition is a NASA Artemis Student Challenge that provides an opportunity for students attending a Tribal College or University, a Native American-Serving Nontribal Institution (NASNTI), or who are members of an active American Indian Science and Engineering Society (AISES) collegiate chapter to design, build, and fly a high-powered rocket to be launched at a competition at the Richard Bong State Recreational Area in Kansasville, WI.

Purpose

The Wisconsin Space Grant Consortium (WSGC) First Nations Launch (FNL) competition offers Tribal Colleges and Universities (TCU), Native American Non-Tribal Institutions (NASNTI) as well as active American Indian Science and Engineering Society (AISES) college chapters the opportunity to demonstrate engineering and design skills through direct application in high-power rocketry. The competition requires teams of undergraduate students to conceive, design, fabricate and compete with high-power rockets. FNL is a ‘First Step’ experience designed for students with no prior experience working with high-powered rockets. Rocket motors and dimensions are restricted by competition parameters so that knowledge, creativity, and imagination of the students are challenged. The end result is a great aerospace learning experience unique to the Native American communities.

The purpose of First Nations Launch is to support the innovative, visionary projects that are student-led and designed to fully realize WSGC’s goal of assisting in training the next generation of aerospace professionals.

Wisconsin Space Grant Consortium seeks proposals from TCUs, NASNTIs, as well as colleges/universities with active AISES chapters to conduct the WSGC First Nation Launch (FNL) during the 2020-2021 academic year.

Proposals to participate will be accepted from any TCU, NASNTI, or collegiate AISES chapter. Following the proposal acceptance, teams will complete a series of design reviews, which are discussed further in the Program Milestones section of this handbook.
Moon Challenge:

This year, all teams will participate in the Moon Challenge. Each team is required to design and construct a warning sensor system (flight recorder) mounted inside a high-power rocket. The rocket shall reach an apogee of 3,500-4,000 ft AGL, and the warning sensor system will be designed to record two flight events aboard the rocket during its ascent, including one nominal separation event and one airframe anomaly. Both events must be recorded on the flight recording system, and a video showing one event is required.
General Requirements

1. The faculty advisor must first register with WSGC before students/team members register. One exception to the order of registration exists. If the student team lead has never registered with WSGC, he/she must register before the advisor begins the Notice of Intent (NOI). (See ‘Appendix B-1’ for instructions). Once both individuals have registered, the faculty advisor will complete and submit the “Rocket Launch Team (Create NOI)” Grant application form. After the NOI application is submitted on the WSGC Grant Application Page, the team lead must apply to the First Nations Launch program. All steps must be completed in order for the team to be considered eligible to compete.

2. All student team members must register on the WSGC website and then apply to the First Nations Launch program on the Grant Application page no later than the Critical Design Review (CDR) due date. See ‘Appendix B-1’ for instructions how to register and apply.

3. The faculty advisor and the team lead must submit a signed copy of the Award Acceptance letter to their Grant Management page in order for the team to be eligible to receive reimbursements.

4. The team must identify all team members, both those students attending and not attending the launch weekend activities, by the due date of the CDR. This is accomplished by ensuring each student is registered and applied (as explained previously), and attendees are listed on the lodging list. Industry members do not need to register on the WSGC website and apply to the program unless they are attending the launch week activities. The term ‘team member’ will include:
   a. Students actively engaged in the project throughout the entire year. WSGC recommends 4-6 students, but does not prohibit teams from competing who have fewer or greater number of team members.
   b. One industry mentor (see General Requirement #5).
   c. One faculty advisor.
   d. One co-advisor.

5. Each team must identify a ‘local/state experienced rocketry mentor’ (see ‘Appendix D-2’ for more information on how to obtain a local mentor and the benefits).
   a. A mentor is defined as an adult who is included as a team member, who will be supporting the team (or multiple teams) throughout the project year, and may or may not be affiliated with the school, institution, or organization.
      1) The mentor must maintain a current certification, and be in good standing, through the National Association of Rocketry (NAR) or Tripoli Rocketry Association (TRA) for the motor impulse of the launch vehicle and must have flown and successfully recovered (using electronic, staged recovery) a minimum of 2 flights in this or a higher impulse class, prior to PDR. An industry subject matter expert may serve as a mentor as well.

6. Team leads will upload all deliverables to the WSGC Grant Management page (see ‘Appendix B-2’ for instructions on how to upload to WSGC website) by the deadline specified in this handbook for each milestone. All Report deliverables must be in PDF format.

7. Teams will utilize the provided templates (see ‘Report Templates and Scoring Rubrics’ on the WSGC website) for each report and virtual presentation.

8. All teams will successfully launch and recover an Estes rocket provided by WSGC.
   a. The Estes rocket shall be built and launched by the team, prior to PDR.
   b. The team will record the Estes rocket flight and post the results to Facebook and upload the URL to the Team Lead’s Grant Management page.
9. All projects must be completely constructed (at least 90%) ready to fly at least two (2) weeks prior to launch date. Complete is defined as: all airframe, motor mount, fins, payload/challenge airframe, couplers, bulkheads should be completely procured/manufactured to spec and permanently attached as designed. A Virtual Inspection prior to Launch Weekend will be used to determine if satisfied.

10. All projects must have a documented flight stable simulation profile. Commercial high-powered rocketry software is required. RockSim is the required simulation software, expected to be procured by teams. OpenRocket may be used to verify/validate RockSim results. See ‘Appendix D-3’ for information how to obtain RockSim. Teams must submit their simulation files over the course of the project:
   a. At each design milestone (Proposal, PDR, CDR, FRR), upload file to WSGC website
   b. At Launch Weekend, submit file on flash drive prior to flight day

11. For 2021, all teams will be required to include a COVID-19 safety plan to comply with academic institution, local, and state requirements.
Vehicle Requirements

1. The launch vehicle will use a commercially available solid motor propulsion system using ammonium perchlorate composite propellant (APCP) which is approved and certified by the National Association of Rocketry (NAR), and/or Tripoli Rocketry Association (TRA).
   a. Final motor choices will be declared by the Critical Design Review (CDR) milestone.
   b. Any motor change after CDR must be approved by the Tripoli Wisconsin Range Safety Officer (RSO) and will only be approved if the change is for the sole purpose of increasing the safety margin. A penalty against the team’s overall score will be incurred when a motor change is made after the CDR milestone, regardless of the reason.

2. The vehicle will carry, at a minimum, one commercially available, barometric altimeter for recording the official altitude used in determining the Altitude Award winner (see 'Appendix A-1' for awards criteria).

3. Each altimeter will have a dedicated power supply.

4. Each altimeter will be armed by a dedicated mechanical arming switch that is:
   a. accessible from the exterior of the rocket airframe when the rocket is in the launch configuration on the launch pad.
   b. capable of being locked in the ON position for launch (i.e. cannot be disarmed due to flight forces).

5. The launch vehicle will have a minimum static stability margin of 1.0 at the point of rail exit. Rail exit is defined at the point where the forward rail button loses contact with the rail.

6. The launch vehicle will accelerate to a minimum velocity of 52 feet per second (fps) at rail exit.

7. The Center of Gravity (CG) and Center of Pressure (CP) must be indicated on the exterior of the rocket, from simulation, using the fully loaded configuration prior to flight.

8. All teams will be required to use the launch pads provided by Tripoli Wisconsin. No custom pads will be permitted on the launch field. Six foot (6’) 1010 rails and ten foot (10’) 1515 rails will be provided. Please ensure you have the correct rail button for the respective rail. The launch rails will be canted 5 to 10 degrees away from the crowd on launch day. The exact cant will depend on launch day wind conditions, to be determined by Tripoli Wisconsin.

9. Vehicle Prohibitions
   a. The launch vehicle shall not have any structural protuberance forward of the motor burnout CG.
   b. The launch vehicle will not utilize forward canards. Camera housings will be exempted, provided the team can show that the housing(s) causes minimal aerodynamic effect on the rocket’s stability.
   c. The launch vehicle will not utilize forward firing motors.
   d. The launch vehicle will not utilize motors that expel titanium sponges (Sparky, Skidmark, MetalStorm, etc.)
   e. The launch vehicle will not utilize hybrid motors.
   f. The launch vehicle will not utilize multi-stage motors.
   g. The launch vehicle will not utilize a cluster of motors.
   h. The launch vehicle will not utilize friction fitting for motors.
   i. The launch vehicle will not exceed Mach 1 (767+ mph at NTP) at any point during flight.
   j. Vehicle ballast will not exceed 10% of the total unballasted weight of the rocket as it would sit on the pad (i.e. a rocket with an unballasted weight of 40 lbs. on the pad may contain a maximum of 4 lbs. of ballast).
   k. Transmissions from onboard transmitters will not exceed 250 mW of power.
1. Excessive and/or dense metal will not be utilized in the construction of the vehicle. Use of lightweight metal will be permitted but limited to the amount necessary to ensure structural integrity of the airframe under the expected operating stresses.

m. The launch vehicle will not utilize blue tube, or sonotube airframes.

n. The launch vehicle will not utilize plexiglass/acrylic (or any other non-rigid) fins.

o. The launch vehicle shall consist of an aerodynamic design; no odd rockets (i.e. flying pyramids, saucers, spools, etc.)
Recovery System Requirements

1. The launch vehicle will stage the deployment of its recovery devices, where a drogue parachute is deployed at apogee and a main parachute is deployed at a lower altitude. Tumble or streamer recovery from apogee to main parachute deployment is also permissible, provided that kinetic energy during drogue-stage descent is reasonable, as deemed by the RSO.
   a. The main parachute shall be deployed no lower than 300 feet.
   b. The apogee event may contain a delay of no more than 2 seconds past apogee.

2. The recovery system electrical circuits will be completely independent of any payload/challenge electrical circuits.

3. All recovery electronics will be powered by commercially available batteries.

4. The recovery system will contain at least one (although redundant system is recommended), commercially available altimeter. Neatness of wiring will affect scoring (and possibly, performance).

5. Motor ejection is required backup deployment at apogee. The estimated time to apogee needs to be known in order to adjust the ejection charge delay fuse.

6. An electronic tracking device (i.e. GPS) will be installed in the launch vehicle and will transmit the position of the tethered vehicle or any independent section to a ground receiver.
   a. Any rocket section or payload/challenge component, which lands untethered to the launch vehicle, will contain an active electronic tracking device.
   b. The electronic tracking device(s) will be fully functional during the official flight on launch day.
Challenge Requirements

Moon Challenge – The following specific requirements must be satisfied:

1) Vehicle Parameters
   a) Rocket must perform a stable flight profile.
   b) Rocket must achieve an apogee altitude of 3,500-4,500 ft AGL.
   c) Launch rod will be pointed in a direction away from all attending spectators and vehicles.
   d) Rocket shall be recovered safely and in flyable condition.
   e) At least one commercial off-the-shelf (COTS) altimeter must be used to deploy the rocket’s parachute(s).
   f) The rocket must be designed to function safely and to accommodate motor ejection back-up recovery.
   g) Additional rocket parameters including altitude requirements, specific motor propulsion and dual-deployment recovery with motor-charge backup will be mentioned in the Vehicle Requirements and Recovery System Requirements sections.
   h) Motors are limited to those in ‘Appendix A-4.’

2) Challenge Parameters
   a) The flight recorder must record data for one event from each category (two total). A camera must record video of one event from either category (one total).
      i. Nominal Operations – Confirmation of booster/sustainer or nose cone separation during its nominal flight profile. Video coverage should include the separation of the booster/sustainer or nose cone.
      ii. Flight Anomalies – Loose, ajar, or open hatch door warning indications on the structural rocket airframe during the ascent. Video coverage should include the structural area and the initiated anomalies occurring during ascent.
   b) Anomalies and nominal events must be recorded in a normal state during pad prep and powered ascent (motor burn) as a baseline.
   c) Anomalies and nominal events will be planned to occur after motor burnout and recorded on flight recorder.
   d) Sensors and measurements for the flight recorder should be chosen such that the data is able to confirm that each flight event occurred.
   e) Designing to deploy or initiate an anomaly event must be approved by the designated safety design committee so that all active anomalies do not interfere with aerodynamics during flight performance.

Moon Challenge Judging and Scoring Notes

- Flight data and flight video will be collected from the team after their successful flight.
- Flight data should be presented in an Excel spreadsheet, showing performance of recorded flight events.
- Scoring will be based on predicted altitude, accurate recording of nominal/anomalies performance, video evidence of recorded indications, and flight profile performance.
- Teams may reduce their challenge scope by taking a point loss and only record one flight event from either category, instead of recording two events.
Safety Requirements

1. Each team must identify a ‘student safety officer’ who will be responsible for implementing the requirements in this Section. The role and responsibilities of each safety officer will include, but are not limited to:
   a. Monitor team activities with an emphasis on Safety during:
      1) Design of vehicle and payload/challenge/challenge
      2) Construction of vehicle and payload/challenge/challenge
      3) Assembly of vehicle and payload/challenge/challenge
      4) Ground testing of vehicle and payload/challenge/challenge
      5) Launch day
      6) Recovery activities
   b. Implement procedures developed by the team for construction, assembly, launch, and recovery activities.

2. Each team will use a launch and safety checklist. The final checklists will be included in the FRR report and used during any launch day operations (see ‘Appendix C-4’ for checklist support).

3. During test flights, teams will abide by the rules and guidance of the local rocketry club’s RSO. The allowance of certain vehicle configurations and/or payload/challenge/challenges at WSGC FNL does not give explicit or implicit authority for teams to fly those vehicle configurations and/or payload/challenge/challenges at other club launches. Teams should communicate their intentions to the local club’s President or Prefect and RSO before attending any NAR or TRA launch.

4. For proof of construction and a safe flight, photographs/video should be made during the construction process (especially of sealed or hidden components) to ensure proper technique has been followed. The Flight Readiness Report should contain the photos of the build of sealed/hidden components that can no longer be accessed.

5. All projects must have a virtual inspection with the WSGC Technical Advisor, prior to (to coincide with) Flight Readiness Review.

6. All components and materials must be obtained from a reputable high-powered rocketry vendor, or must undergo an engineering analysis (or test) demonstrating their suitability and integrity must be included in the design reports.
Notes and Suggestions

1. Students on the team will do 100% of the project, including design, construction, written reports, presentations, and flight preparation with the exception of assembling the motors and handling black powder or any variant of ejection charges, or preparing and installing electric matches (to be done by the team’s mentor).

2. The team should ensure they have any computer equipment necessary to perform a video teleconference with the review panel. This includes, but is not limited to, a computer system, video camera, speaker telephone, and a sufficient Internet connection. Cellular phones should be used for speakerphone capability only as a last resort.

3. The launch vehicle will have a maximum of four (4) independent sections. An independent section is defined as a section that is either tethered to the main vehicle or is recovered separately from the main vehicle using its own parachute. Coupler shoulders shall be one body diameter length at a minimum.

4. The launch vehicle will be designed to be recoverable and reusable. Reusable is defined as being able to launch again on the same day without repairs or modifications.

5. In order to aid in recovery of rockets, the team’s name and launch day contact information shall be in or on the rocket airframe as well as in or on any section of the vehicle that separates during flight and is not tethered to the main airframe. This information shall be included in a manner that allows the information to be retrieved without the need to open or separate the vehicle.

6. Competition ejection charges will be provided by Tripoli Wisconsin at the event. For ground ejection tests or pre-competition flight test (recommended) purposes, it is suggested to use ejection charges of the same size and type as those provided at competition (see ‘Appendix D-4’ for recommendations).

7. Removable shear pins can be used for both the main parachute compartment and the drogue parachute compartment.

8. Avoid touching or handling electronic components when not grounded or in a static environment such as walking on carpeted floors, cloth upholstery furniture and in vehicles. Sporadic constant on/off power up connections may cause brown outs, causing altimeter to indicate an error. Always store your electronic in an approved static proof bag that comes with the device. When in doubt always reset and test.

9. **Note from Tripoli:** Without exception, university teams must involve an experienced mentor, preferably a TAP or L3CC, during the design and construction phases of their rocketry projects if they expect to fly them at Tripoli events. The mentor must be certified at or above the level of motor the team wishes to fly AND experienced in the type of construction, propulsion, and recovery the team uses. Although it is ultimately up to the judgment of the RSO and Launch Director, University teams who build a rocket that requires a motor higher than their member cert levels, and then as an afterthought contact a club hoping to fly (without ever involving an experienced mentor) should be told no.
**First Nations Launch 2021 Project Deliverables**

 Deliverables required for successful participation are listed below. More details are provided in the Project Milestones: Criteria and Expectations section.

  1. Team/students must participate in the virtual Kick-Off Meeting.
  2. Team/students must provide a reusable rocket with required payload/challenge/challenge system ready for competition launch.
  3. Team/students must provide a rocket simulation file:
     a. Of the designed rocket, uploaded to the WSGC website at each design phase
     b. Of the ‘as-built’ competition rocket, due the day before competition launch.
  4. Team/students must fly a lower power Estes (or similar) rocket before PDR and upload a video of the flight prior to PDR. The rocket will be provided by WSGC for all teams. A launchpad will be provided by WSGC for new teams.
  5. Team/students must complete and submit all required Written Reports (PDF) and Virtual Presentations (PowerPoint), to the WSGC FNL Grant Management site by the Team Lead on applicable due dates.
  6. Team/students must participate in PDR and CDR Virtual Reviews (Zoom teleconference).
  7. Team/students must participate in one (1) Virtual Technical Inspections with Tripoli Wisconsin (Zoom teleconference).
  8. Team/students must submit flight (avionics) data on competition launch day, via flash drive.
  9. Team/students must provide 2 – 3 photos featuring the team designing, building and flying the competition rocket to be submitted to the WSGC Grant Management page by the team lead by PLAR deadline.

WSGC FNL is responsible for providing to the teams:

  1. Project/Travel Award of $4000.
  2. Hotel accommodations (maximum three (3) rooms for three (3) nights per team at competition hotel) during Launch Weekend.
  3. Select meals (Friday breakfast and lunch, Saturday lunch and dinner) during Launch Weekend.
  4. Low-power rocket (Estes) for flight demo (and launch pad if applicable), shipped to school prior to PDR.
  5. Two (2) Rocketry Reference Books (for schools that are new to the competition).
  6. Ejection charges for competition flight, provided on Launch Day.
  7. Two (2) motor(s) maximum for competition flight, prepped on Launch Weekend, provided on Launch Day.
  8. One (1) motor casing for competition flight, provided on Launch Day.
  9. Feedback on reports submitted, a minimum of one (1) week prior to submission of next report.
Proposal Requirements

The proposing team shall identify the following in a written proposal due to WSGC as outlined in the FNL Calendar.

General Information

1. A cover page that includes the name of the college/university or secondary education institution, title of the project, and the date.

2. Name, title, and contact information (including email, phone number, and academic institution mailing address) for advisor and co-advisor (advisor required)

3. Name, title, and contact information for the student team leader.

4. Name and title of the student team member who will take responsibility for implementation of the safety plan. (Safety Officer)

5. Approximate number of student participants who will be committed to the project and their proposed duties. Include an outline of the project organization that identifies the key managers and technical personnel.

6. Name of the NAR/TRA section(s) the team is planning to work with for purposes of mentoring, review of designs and documentation, and launch assistance.

7. Name, title and contact information (including email and phone number) of team mentor.

Facilities/Equipment

1. Description of facilities and hours of accessibility, necessary personnel, equipment, and supplies that are required to design and build the rocket and payload/challenge/challenge(s).

2. Computing equipment available, for communication, design, development, simulation and document development to support design reviews. The information technology identified could include computer hardware, software, computer-aided drafting (CAD) and solid model capability, internet access and email capability.

3. Simulation software to be utilized (RockSim mandatory) and how many licenses are available.

Safety

1. Provide a written safety plan addressing the safety of the materials used, facilities involved, and student responsible, i.e. Safety Officer, for ensuring that the plan is followed.

2. A risk assessment is suggested but not required.
   a. Provide a description of the procedures for NAR/TRA personnel (mentor) to perform. Ensure the following:
      2) Performance of all hazardous materials handling and hazardous operations.
   b. Describe the plan for briefing students on hazard recognition and accident avoidance as well as for conducting pre-launch briefings.
   c. Describe methods to include necessary caution statements in plans, procedures, and other working documents, including the use of proper Personal Protective Equipment (PPE).

e. Provide a plan for NRA/TRA personnel (mentor) purchase, storage, transportation, and use of rocket motors and energetic devices.

f. Include a written statement that all team members understand and will abide by the following safety regulations:
   1) Range safety inspections will be conducted on each rocket before it is flown. Each team shall comply with the determination of the safety inspection or may be removed from the program.
   2) The Range Safety Officer has the final say on all rocket safety issues. Therefore, the Range Safety Officer has the right to deny the launch of any rocket for safety reasons.
   3) The team mentor is ultimately responsible for the safe flight and recovery of the team’s rocket. Therefore, a team will not fly a rocket until the mentor has reviewed the design, examined the build and is satisfied the rocket meets established amateur rocketry design and safety guidelines.
   4) Any team that does not comply with the safety requirements will not be allowed to launch their rocket.

g. Provide a plan for implementing a COVID-19 safety plan to comply with academic institution, local and state safety requirements.

Technical Design

1. A proposed and detailed approach to rocket and payload/challenge/challenge design.
   a. Include general vehicle dimensions, material selection and justification, and construction methods.
   b. Include projected recovery system design.
   c. Include projected motor brand and designation.
   d. Include detailed description of the team’s projected payload/challenge/challenge.
   e. Address the General, Vehicle, Recovery, Payload/challenge, and Safety requirements outlined on pages 9-16 of this handbook.
   f. Address major technical challenges and solutions.

Project Plan

1. Provide a detailed development schedule/timeline covering all aspects necessary to successfully complete the project.

2. Provide a detailed budget to cover all aspects necessary to successfully complete the project, including team travel to launch competition, and procuring RockSim simulation software/license(s).

3. Provide a detailed funding plan.

4. Develop a clear plan for sustainability of the rocket project in the local area. This plan should include how to provide and maintain established partnerships and regularly engage successive classes of students in rocketry. It should also include partners (industry/community/local state Space Grant consortium), recruitment of team members, funding sustainability, and STEM engagement/outreach activities.
Program Milestones: Criteria and Expectations

Preliminary Design Review (PDR)

The PDR demonstrates that the overall preliminary design meets at a minimum all requirements with acceptable risk, within the cost and schedule constraints, and establishes the basis for proceeding with detailed design. It shows that the correct design options have been selected, interfaces have been identified, and verification methods have been described. Full baseline cost and schedules, as well as all risk assessment, management systems, and metrics, are presented.

The panel will be expecting a professional and polished report that follows the order of sections as they appear below.

Preliminary Design Review Report

All information contained in the general information section of the Project Proposal shall also be included in the PDR Report. Page Limit: PDRs will only be scored using the first 40 pages of the report (not including title page or appendixes).

I) Team Summary
   • Team name
   • School name
   • Name of faculty advisor and co-advisor (if applicable)
   • Name of student team lead and student safety lead
   • Name of mentor, NAR/TRA number and certification level

II) Summary of PDR report (2 pages maximum)

Launch Vehicle Summary
   • Preliminary size and mass
   • Preliminary motor choice(s)
   • Preliminary recovery system

Payload/challenge Summary
   • Summarize payload/challenge experiment

III) Changes made since Proposal (2 pages maximum)

Highlight all changes made since the proposal and the reason for those changes.
   • Changes made to vehicle criteria
   • Changes made to payload/challenge criteria
   • Changes made to project plan

IV) Vehicle Criteria

Selection and Design of Launch Vehicle
   • Provide an overview of all key components/systems, including any and all alternatives. Evaluate the pros and cons of each alternative.
   • After evaluating all alternatives, present a vehicle design with the current leading alternatives, and explain why they are the leading choices. Describe each subsystem and the components within those subsystems.
Recovery Subsystem
- Using the estimated mass of the launch vehicle, perform a preliminary analysis on parachute sizing and determine what size is required for a safe descent.
- Choose leading components amongst the alternatives, present them, and explain why they are the current leaders.

Avionics Subsystem
- Demonstrate that preliminary design has begun on the structure, sizing and placement of the avionics bay, including the location and sizing of the vent holes.
- Include overall position of the avionics bay within the vehicle, number of altimeters, layout of avionics sled, and type/location of switch(es) to be used to power on from outside of the vehicle, power/wiring of electronics.
- Include any diagrams, drawings, schematics, sketches, images.

Motor Selection
- Review different motor alternatives and present data on each alternative.
  - What would dictate the need to change motors as the design progresses? How can this be controlled?
  - Discuss plan for motor retention.

Mission Performance Predictions
- Show flight profile simulations, altitude predictions with simulated vehicle data, component weights, and simulated motor thrust curve.
- Show stability margin and simulated Center of Pressure (CP)/Center of Gravity (CG) relationship and locations (using simulations).
- Calculate the expected descent time (normally using simulations – can be hand calculation) for the rocket and any section that descends untethered from the rest of the vehicle.

V) Safety
- Demonstrate an understanding of all components needed to complete the project, and how risks/delays impact the project.
- Include data indicating that the hazards have been researched, especially personnel (if extensive, may be contained as an Appendix). Examples: NAR regulations, operator’s manuals, MSDS, etc.

VI) Payload/challenge/challenge Criteria
Selection and Design of Payload/challenge/challenge Solution
- Describe what the objective of the payload/challenge/challenge is and what specific purpose it will perform.
- Review the design at a system level, going through each system’s alternative designs, and evaluating the pros and cons of each alternative.
- After evaluating all alternatives, present a payload/challenge/challenge design with the current leading alternatives and explain why they are the leading choices.
- Describe the preliminary interfaces between the payload/challenge/challenge and launch vehicle.

Project Budget
- Provide a line item budget with market values for individual components, material vendors, and applicable taxes or shipping/handling fees.
- Include travel estimates for Launch Weekend.
- Provide a funding plan describing sources of funding, allocation of funds, and material acquisition plan.

Project Timeline
- Provide a timeline including all team activities and expected activity durations. The schedule should be complete and encompass the full term of the project. Deliverables should be defined with reasonable activity duration. GANTT charts are encouraged (see ‘Appendix C-1’ for Gantt Chart example).
• Include parts procurement timeline, component test timeline, build timeline and flight test timeline.
• Recall that vehicle must be ready (90% complete) to fly two weeks prior to competition launch date, so the build timeline should reflect this deliverable.
Preliminary Design Review Presentation

Please use the Template located on the website; your presentation must include:

- Vehicle dimensions, materials, and justifications
- Preliminary motor selection and justification
- Static stability margin and CP/CG locations
- Thrust-to-weight ratio and rail exit velocity
- Discussion of avionics subsystem (include any drawings, diagrams)
- Discussion of recovery subsystem (include any drawings, diagrams)
- Discussion of current Mission Performance Predictions
- Preliminary payload/challenge/challenge design

The PDR will be presented to a panel. The purpose of this review is to convince the WSGC FNL Review Panel that the preliminary design will meet all requirements, has a high probability of meeting the mission objectives, and can be safely constructed, tested, launched, and recovered. Upon successful completion of the PDR, the team is given the authority to proceed into the final design phase of the life cycle that will culminate in the Critical Design Review.

It is expected that the team participants deliver the report and answer all questions. The mentor shall not participate in the presentation.

The presentation of the PDR shall be well prepared with a professional overall appearance. This includes, but is not limited to, the following: easy-to-read slides; appropriate placement of pictures, graphs, and videos; professional appearance of the presenters; speaking clearly and loudly; looking into the camera; referring to the slides rather than reading them; and communicating to the panel in an appropriate and professional manner. The slides should use dark text on a light background.
Critical Design Review (CDR)

The CDR demonstrates that the maturity of the design is appropriate to support proceeding to full-scale fabrication, assembly, and integration; showing at a minimum that the technical effort is on track to complete the flight and ground system development and mission operations in order to meet overall performance requirements within the identified cost schedule constraints. Progress against management plans, budget, and schedule, as well as risk assessment, are presented. The CDR is a review of the final design of the launch vehicle and payload/challenge/challenge system.

All analyses should be complete and some critical testing should be complete. The CDR Report and Presentation should be independent of the PDR Report and Presentation. However, the CDR Report and Presentation may have the same basic content and structure as the PDR documents, but with final design information that may or may not have changed since PDR.

The panel expects a professional and polished report that follows the order of sections as they appear below.

Critical Design Review Report

Page Limit: CDRs will only be scored using the first 40 pages of the report (not including title page or appendixes). Any additional content will not be considered while scoring.

I) Team Summary

- Team name
- School name
- Name of faculty advisor and co-advisor (if applicable)
- Name of student team lead and student safety lead
- Name of mentor, NAR/TRA number and certification level

II) Summary of CDR Report (2 pages maximum)

Launch Vehicle Summary

- Size and mass
- Final motor choice
- Recovery system
- Rail button size

Payload/challenge/Challenge Summary

- Summarize payload/challenge/challenge solution

III) Changes made since PDR (2 pages maximum)

Highlight all changes made since PDR and the reason for those changes.

- Changes made to vehicle criteria
- Changes made to payload/challenge/challenge criteria
- Changes made to project plan

IV) Vehicle Criteria

Design of Launch Vehicle

- Identify which of the design alternatives from PDR were chosen as the final components for the launch vehicle. Describe why those alternatives are the best choices.
- Demonstrate that the designs are complete and ready to manufacture/procure.
• Discuss the integrity of design.
  o Suitability of shape and fin style for mission.
  o Proper use of materials in fins, bulkheads, and structural elements.
  o Sufficient motor mounting and retention.
• If airframe build/manufacture has begun, include pictures of assembly, manufacturing and joining steps (especially sealed components that can no longer be examined once joined).

Recovery Subsystem
• Identify which of the design alternatives from PDR were chosen as the final components for the recovery subsystem. Describe why those alternatives are the best choices.
• Describe all components and attachment hardware.
• Include any diagrams, drawings, schematics, sketches, images

Avionics Subsystem
• Describe the avionics bay structure that will be used to deploy the recovery system.
• Discuss the number of altimeters (is the system redundant), and include a description of the altimeters.
• Describe the avionics sled material, avionics bay layout, the size/location and number of vent holes.
• Describe the switch to be used to power on the electronics from the outside of the vehicle.
• Include any diagrams, drawings, schematics, sketches, images.

Motor Selection
• Describe final motor selection.
• Describe motor retention system.

Mission Performance Predictions
• Show flight profile simulations, altitude predictions with simulated vehicle data, component weights, and simulated motor thrust curve. Verify that the vehicle design is robust enough to withstand the expected loads.
• Show stability margin and simulated Center of Pressure (CP)/Center of Gravity (CG) relationship and locations (using simulations).
• Calculate the expected descent time (normally using simulations – hand calculations accepted) for the rocket and any section that descends untethered from the rest of the vehicle.

V) Safety
Launch Concerns and Operation Procedures
• Submit a draft of final assembly and launch procedures including (see ‘Appendix C-4’ for guidance):
  o Avionics preparation checklist
  o Recovery preparation checklist
  o Final assembly checklist
  o Setup on launch pad checklist
  o Troubleshooting checklist
  o Post-flight inspection checklist
• These procedures/checklists should include specially demarcated steps related to safety. Examples include:
  o Warnings of hazards that can result from missing a step.
  o PPE required for a step in the procedure (identified BEFORE the step).
  o Required personnel to complete a step or to witness and sign off verification of a step.

VI) Payload/challenge/Challenge Criteria

Design of Payload/challenge/Challenge Experiment

• Identify which of the design alternatives from PDR was chosen for the payload/challenge/challenge. Describe why that alternative and its components were chosen.
• Review the design at a system level.
  o Include specifications for each component of the payload/challenge/challenge, as well as the entire payload/challenge/challenge assembly.
  o Describe how the payload/challenge/challenge components interact with each other.
• Demonstrate that the design is complete.
• If applicable, discuss the payload/challenge/challenge electronics with special attention given to safety switches and indicators. Include the following:
  o Drawings, diagrams, schematics, images
  o Batteries/power
  o Switch types and locations
• Provide justification for all unique aspects of your payload/challenge/challenge (materials, dimensions, placement, etc.).
• Describe the interfaces between the payload/challenge/challenge and the launch vehicle.
  o Discuss the integration of the payload/challenge/challenge.
  o Describe the deployment of the payload/challenge/challenge in detail (if applicable).
  o Include any drawings, diagrams, schematics, images.
• If payload/challenge/challenge build/manufacture has begun include pictures of assembly, manufacture and joining steps.

VII) Project Plan

Project Budget

• Provide an updated line item budget with market values for individual components, material vendors, and applicable taxes or shipping/handling fees.
• Provide an updated funding plan describing sources of funding, allocation of funds, and material acquisition plan.

Project Timeline

• Provide an updated timeline including all team activities and expected activity durations. The schedule should be complete and encompass the full term of the project. Deliverables should be defined with reasonable activity duration. GANTT charts are encouraged.
Critical Design Review Presentation

Please use the Template located on the website; your presentation must include:

- Final launch vehicle and payload/challenge/challenge dimensions
- Final motor choice
- Rocket flight stability in static margin diagram
- Thrust-to-weight ratio and rail exit velocity
- Avionics bay, altimeters and vent holes
- Parachute sizes, recovery harness type, size, length, and descent rates
- Discuss results of any critical tests
- Discuss mission performance predictions
- Discuss final payload/challenge/challenge design overview
- Discuss project schedule and any concerns
- Discuss project budget and any concerns
- Discuss any remaining technical challenges (the critical path)

*It is beneficial to have any built/acquired components and subassemblies on hand to show the judges during presentation or during question period

The CDR will be presented to a panel. The team is expected to present and defend the final design of the launch vehicle (including the payload/challenge/challenge) that proves the design meets the mission objectives and requirements and can be safety constructed, tested, launched, and recovered. Upon successful completion of the CDR, the team is given the authority to proceed into the construction and verification phase of the life cycle that will culminate in a Flight Readiness Review.

It is expected that the team participants deliver the report and answer all questions. The mentor shall not participate in the presentation.

The presentation of the CDR shall be well prepared with a professional overall appearance. This includes, but is not limited to, the following: easy-to-read slides; appropriate placement of pictures, graphs, and videos; professional appearance of the presenters; speaking clearly and loudly; looking into the camera; referring to the slides rather than reading them; and communicating to the panel in an appropriate and professional manner. The slides should be made with dark text on a light background.
Flight Readiness Review (FRR)

The FRR examines tests, demonstrations, analyses, and audits that determine the overall system (all projects working together) readiness for a safe and successful flight/launch and for subsequent flight operations of the as-built rocket and payload/challenge/challenge system at a minimum. It also ensures that all flight hardware, software, personnel, and procedures are operationally ready.

The panel will be expecting a professional and polished report that follows the order of sections as they appear below.

Flight Readiness Review Report

Page Limit: FRRs will only be scored using the first 40 pages of the report (not including title page or appendixes). Any additional content will not be considered while scoring.

I) Team Summary
   - Team name
   - School name
   - Name of faculty advisor and co-advisor (as applicable)
   - Name of student team lead and student safety lead
   - Name of mentor, NAR/TRA number and certification level

II) Summary of FRR report (1 page maximum)
   Launch Vehicle Summary
   - Size and mass
   - Launch day motor
   - Recovery system
   - Rail selection size

Payload/challenge/Challenge Summary
   - Summarize payload/challenge/challenge solution

III) Changes made since CDR (2 pages maximum)
   Highlight all changes made since CDR and the reason for those changes.
   - Changes made to vehicle criteria
   - Changes made to payload/challenge criteria
   - Changes made to project plan

IV) Vehicle Criteria
   Design and Construction of Vehicle
   - Describe any changes in the launch vehicle design from CDR and explain why those changes are necessary.
   - Describe features that will enable the vehicle to be launched and recovered safely.
     o Structural elements (such as airframe, fins, bulkheads, attachment hardware, etc.).
     o Electrical elements (wiring, switches, battery retention, retention of avionics boards, etc.).
     o Include pictures of critical hardware where relevant – show details such as bulkhead joins/fillets, airframe tube fit/alignments, fin alignments, centering ring fillets, fin fillets, motor retention, eyebolt/shock cord attachment, avionics sled/switches/vent holes, rail button attachment/alignment.
   - Prove that the vehicle is fully constructed and fully document the construction process.
   - Include schematics of the AS-BUILT rocket. There is a good chance dimensions have changed slightly due to the construction process.
   - Discuss how and why the constructed rocket differs from earlier models.

Recovery and Avionics Subsystem
• Describe the as-built and as-tested recovery system.
  o Structural elements (such as bulkheads, harnesses, attachment hardware, etc.).
  o Electrical elements (such as altimeters/computers, switches, connectors).
  o Redundancy features.
  o Parachute sizes and descent rates.
  o Include any diagrams, schematics of the as-built electrical and structural assemblies.
  o Rocket-locating tracking devices (if any).
• Discuss the suitable parachute sizes for mass, attachment scheme, deployment process
  o Discuss the test results with ejection charges and electronics (if completed).

Motor Selection
• Describe the final motor selection
• Describe the motor retention

Mission Performance Predictions
• Show flight profile simulations, altitude predictions with simulated vehicle data, component weights, and simulated motor thrust curve. Verify that the vehicle is robust enough to withstand the expected loads.
• Show stability margin and as-built Center of Pressure (CP)/Center of Gravity (CG) relationship and locations (using simulations).
• Calculate the expected descent time (normally using simulations – hand calculations accepted) for the rocket and any section that descends untethered from the rest of the vehicle.

V) Safety and Procedures
Launch Operations Procedures
• Provide detailed procedures and check lists for the following (at a minimum):
  o Avionics preparation checklist
  o Recovery preparation checklist
  o Final assembly checklist
  o Setup on launch pad checklist
  o Troubleshooting checklist
  o Post-flight inspection checklist
• These procedures and checklists should include specially demarcated steps related to safety. Examples include:
  o Warnings of hazards that can result from missing a step.
  o PPE required for a step in the procedure (identified BEFORE the step).
  o Required personnel to complete a step or to witness and sign off verification of a step.

VI) Payload/challenge Criteria
Design and Testing of Payload/challenge
• Describe any changes in the payload/challenge design from CDR and explain why those changes are necessary.
• Describe unique features of the payload/challenge. Include the following:
  o Structural elements
  o Electrical elements
  o Include pictures of critical hardware where relevant
• Prove that the payload/challenge is fully constructed and fully document the construction process.
• Include schematics of the AS-BUILT payload/challenge. There is a good chance dimensions have changed slightly due to the construction process.
• Discuss how and why the constructed payload/challenge differs from earlier models.

VII) Project Plan

Project Budget
• Provide an updated line item budget with market values for individual components, material vendors, and applicable taxes or shipping/handling fees.
• Provide an updated funding plan describing sources of funding, allocation of funds, and a material acquisition plan for any items that have not yet been obtained.

Project Timeline
• Although build should be near complete at this stage, include a timeline of any remaining or critical activities between now and Launch Weekend, if applicable.
Launch Weekend Oral Presentation

The Launch Weekend Oral Presentations will be your chance to practice your presentation skills, and present the culmination of your work to the panel of judges, the WSGC team and your fellow competitors. Provide the most up-to-date details of your rocket vehicle, payload/challenge and mission performance predictions.

Please use the Template from the website; your presentation must include the following at a minimum:

- Launch vehicle design and dimensions
- Discuss key design features of the launch vehicle
- Motor description
- Discuss mission performance predictions, and simulations used
- Rocket flight stability in static margin diagram
- Launch thrust-to-weight ratio and rail exit velocity
- Time to apogee, official predicted altitude (ft)
- Avionics bay, altimeter(s), switch/power, vent holes
- Parachute sizes and descent rates, tracking devices
- Recovery system tests and ejection charge required
- Payload/challenge design and dimensions
- Key design features of the payload/challenge
- Challenges/Lessons Learned (technical challenges, programmatic challenges, key lessons during build)

*Your rocket will be on display during the presentation. Please feel free to disassemble or refer to the physical components as they are being discussed.

The team is expected to present and defend the as-built launch vehicle (including the payload/challenge), showing that the launch vehicle meets all requirements and mission objectives and that the design can be safely launched and recovered.

It is expected that the team participants deliver the report and answer all questions. The mentor shall not participate in the presentation.

The Oral Presentation shall be well prepared with a professional overall appearance. This includes, but is not limited to, the following: easy to see slides; appropriate placement of pictures, graphs, and videos; professional appearance of the presenters; speaking clearly and loudly; looking into the camera; referring to the slides, not reading them; and communicating to the panel in an appropriate and professional manner. The slides should be made with dark text on a light background.
Post-Launch Assessment Review (PLAR)
The PLAR is an assessment of system in-flight performance. The panel will be expecting a professional and polished report that follows the order of sections as they appear below.

Post Launch Assessment Report
Page Limit: PLARs will only be scored using the first 25 pages of the report (not including title page or appendixes). Any additional content will not be considered while scoring.

I) Team Summary
• Team name
• School name
• Name of faculty advisor and co-advisor (as applicable)
• Name of student team lead and student safety lead
• Name of mentor, NAR/TRA number and certification level

II) Summary of PLAR report (1 page maximum)
Launch Vehicle Summary
• Size and mass
• Launch day motor

Payload/challenge Summary
• Summarize payload/challenge/challenge solution

III) Vehicle Criteria
Vehicle Summary
• Discuss the vehicle performance
  ○ Did all components perform as expected?
  ○ Where there any anomalies or unexpected behavior? If so, can they be explained?

Data Analysis and Mission Performance
• Discuss the flight performance data
  ○ Compare predicted versus actual performance (speed, altitude, acceleration, stability, drift, etc.).
  ○ Show and discuss plots of the flight data; compare to simulation data.

IV) Payload/challenge Criteria
Payload/challenge Summary
• Discuss the payload/challenge performance
  ○ Did the payload/challenge/challenge perform as desired?

Data Analysis and Payload/challenge Performance
• Discuss the flight data (if applicable)
  ○ Discuss what data was collected and if it was expected.

V) Project Outcomes
Lessons Learned
• Summarize any lessons learned over the course of the program (technical and/or project management).

STEM Engagement
• Summarize any STEM Engagement that occurred in the community and outcomes.

Overall Budget Summary
• Summarize the project budget summary – contrast predicted versus actual.
HPR Safety Overview

The Federal Aviation Administration (FAA) (www.faa.gov) has specific laws governing the use of airspace. A demonstration of the understanding and intent to abide by the applicable federal laws (especially as related to the use of airspace at the launch sites and the use of combustible/flammable material), safety codes, guidelines, and procedures for building, testing, and flying large model rockets is crucial. The procedures and safety regulations of the TRA (http://www.tripoli.org/SafetyCode/) shall be used for flight design and operations. The NAR/TRA mentor and Safety Officer shall oversee launch operations and motor handling.

Virtual Tech Inspection – Tripoli Wisconsin

All teams are required to participate in a Virtual Tech Inspection approximately two weeks before Launch Weekend. The teams must be prepared to discuss the design of their rocket and its systems. In addition, the teams must display:

- The team’s rocket in whatever state of assembly.
- A diagram of the rocket indicating the configuration of its main components.
- Flight simulation showing max altitude and launch guide velocity.
- Knowledge of their altimeter operation.
- Type of hardware used (eye bolts, recovery harnesses, adhesives, etc.).
- Discuss construction techniques.
- Payload/challenge or mechanical operations.

The team will be given a go/no – go by the WSGC Technical Advisor. The Technical Advisor must be satisfied with the state of build to proceed to competition weekend. The schedule will be posted at a later date.

Overview of Safety Regulations

High-powered rocketry is federally regulated by the National Fire Protection Association (NFPA). National rocketry organizations, Tripoli Rocketry Association – TRA (http://www.tripoli.org) and the National Association of Rocketry – NAR (http://www.nar.org) also have safety guidelines and regulations to follow. The purpose of NFPA 1127, the Tripoli Safety Code and the NAR Safety Code are to:

- Provide safe and reliable motors, establish flight operations guidelines and prevent injury.
- Promote experimentation with rocket designs and payload/challenge systems.
- Prevent beginning high-power hobbyists from making mistakes.

Detailed NFPA, TRA and NAR Safety Regulations may be found at the following links:

NFPA 1127 Code for High-power Rocketry
National Fire Protection Association
http://www.nfpa.org/1127

Tripoli Code for High-power Rocketry
Tripoli Rocketry Association

NAR High-power Rocket Safety Code
National Association of Rocketry
http://www.nar.org/safety-information/high-power-rocket-safety-code

HPR Launch Sites

In order to safely fly high-powered rockets, an FAA Waiver must be obtained, details of which can be found on the NAR website: http://www.nar.org/high-power-rocketry-info/filing-for-faa-launch-authorization/filing-for-faa-waiver/
For all intents and purposes however, it is simpler to contact a local NAR or Tripoli Club who will already have an FAA Waiver, a designated launch site and club launch dates in place where you can safely fly your rocket.

The Federal Aviation Administration (FAA) regulates and classifies model rockets according to FAR 101 Subpart C, which is summarized in Table 1. See the FARs for more details.

### Table 1: FAA Rocket Classification

<table>
<thead>
<tr>
<th>Limitation</th>
<th>Class 1</th>
<th>Class 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocket Weight</td>
<td>No more than 1500 grams</td>
<td>No limit</td>
</tr>
<tr>
<td>Motor Size Limit</td>
<td>No more than 125 grams</td>
<td>No more than 40960 N-sec total thrust</td>
</tr>
<tr>
<td>Altitude Limit</td>
<td>None – may be set by local agreement</td>
<td>FAA limited</td>
</tr>
<tr>
<td>Other</td>
<td>Clear of clouds</td>
<td>Must have 5 miles horizontal visibility, clouds less than 5/10ths coverage, FAA Waiver and NOTAM filed between sunrise and sunset</td>
</tr>
</tbody>
</table>

NAR and Tripoli certification requirements and limitation can be seen in Table 2.

### Table 2: Certification Requirements

<table>
<thead>
<tr>
<th>Motor Parameter</th>
<th>Certification Required</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Level 1 HPR</td>
</tr>
<tr>
<td></td>
<td>Level 2 HPR</td>
</tr>
<tr>
<td></td>
<td>Level 3 HPR</td>
</tr>
<tr>
<td>Total Combined Impulse</td>
<td>320 N-sec (2xG Class)</td>
</tr>
<tr>
<td>Combined Propellant Mass</td>
<td>125 grams</td>
</tr>
<tr>
<td>Single Motor Impulse</td>
<td>160 N-sec</td>
</tr>
<tr>
<td>Single Motor Propellant Mass</td>
<td>62.5 grams</td>
</tr>
<tr>
<td>Single Motor Avg Thrust</td>
<td>80 N</td>
</tr>
<tr>
<td>Sparky Motors</td>
<td>Not Allowed</td>
</tr>
<tr>
<td>Total Rocket Mass</td>
<td>1500 grams</td>
</tr>
<tr>
<td>Field Distance Reqmts</td>
<td>Per Model Rocket Safety Code</td>
</tr>
<tr>
<td></td>
<td>Per HPR Safety Code</td>
</tr>
</tbody>
</table>

### High-powered Rocketry Safety Code

1. **Certification.** I will only fly high-power rockets or possess high-power rocket motors that are within the scope of my user certification and required licensing.

2. **Materials.** I will use only lightweight materials such as paper, wood, rubber, plastic, fiberglass, or when necessary ductile metal, for the construction of my rocket.

3. **Motors.** I will use only certified, commercially made rocket motors, and will not tamper with these motors or use them for any purposes except those recommended by the manufacturer. I will not allow smoking, open flames, nor heat sources within 25 feet of these motors.
4. **Ignition System.** I will launch my rockets with an electrical launch system, and with electrical motor igniters that are installed in the motor only after my rocket is at the launch pad or in a designated prepping area. My launch system will have a safety interlock that is in series with the launch switch that is not installed until my rocket is ready for launch, and will use a launch switch that returns to the “off” position when released. The function of onboard energetics and firing circuits will be inhibited except when my rocket is in the launching position.

5. **Misfires.** If my rocket does not launch when I press the button of my electrical launch system, I will remove the launcher’s safety interlock or disconnect its battery, and will wait 60 seconds after the last launch attempt before allowing anyone to approach the rocket.

6. **Launch Safety.** I will use a 5-second countdown before launch. I will ensure that a means is available to warn participants and spectators in the event of a problem. I will ensure that no person is closer to the launch pad than allowed by the accompanying Minimum Distance Table. When arming onboard energetics and firing circuits I will ensure that no person is at the pad except safety personnel and those required for arming and disarming operations. I will check the stability of my rocket before flight and will not fly it if it cannot be determined to be stable. When conducting a simultaneous launch of more than one high-power rocket I will observe the additional requirements of NFPA 1127.

7. **Launcher.** I will launch my rocket from a stable device that provides rigid guidance until the rocket has attained a speed that ensures a stable flight, and that is pointed to within 20 degrees of vertical. If the wind speed exceeds 5 miles per hour, I will use a launcher length that permits the rocket to attain a safe velocity before separation from the launcher. I will use a blast deflector to prevent the motor’s exhaust from hitting the ground. I will ensure that dry grass is cleared around each launch pad in accordance with the accompanying Minimum Distance table, and will increase this distance by a factor of 1.5 and clear that area of all combustible material if the rocket motor being launched uses titanium sponge in the propellant.

8. **Size.** My rocket will not contain any combination of motors that total more than 40,960 N-sec (9208 pound-seconds) of total impulse. My rocket will not weigh more at liftoff than one-third of the certified average thrust of the high-power rocket motor(s) intended to be ignited at launch.

9. **Flight Safety.** I will not launch my rocket at targets, into clouds, near airplanes, nor on trajectories that take it directly over the heads of spectators or beyond the boundaries of the launch site, and will not put any flammable or explosive payload/challenge in my rocket. I will not launch my rockets if wind speeds exceed 20 miles per hour. I will comply with Federal Aviation Administration airspace regulations when flying, and will ensure that my rocket will not exceed any applicable altitude limit in effect at that launch site.

10. **Launch Site.** I will launch my rocket outdoors, in an open area where trees, power lines, occupied buildings, and persons not involved in the launch do not present a hazard, and that is at least as large on its smallest dimension as one-half of the maximum altitude to which rockets are allowed to be flown at that site or 1500 feet, whichever is greater, or 1000 feet for rockets with a combined total impulse of less than 160 N-sec, a total liftoff weight of less than 1500 grams, and a maximum expected altitude of less than 610 meters (2000 feet).

11. **Launcher Location.** My launcher will be 1500 feet from any occupied building or from any public highway on which traffic flow exceeds 10 vehicles per hour, not including traffic flow related to the launch. It will also be no closer than the appropriate Minimum Personnel Distance from the accompanying table from any boundary of the launch site.

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

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

1. All Launches:
   b. A person shall fly a rocket only if it has been inspected and approved for flight by the RSO. The flier shall provide documentation of the location of the center of pressure and the center of gravity of the high-power rocket to the RSO if the RSO requests same.
   c. The member shall provide proof of membership and certification status by presenting their membership card to the LD or RSO upon request.
   d. A rocket with a predicted altitude in excess of 50,000 feet AGL requires review and approval by the TRA Class 3 Committee.

2. Recovery
   a. Fly a rocket only if it contains a recovery system that will return all parts of it safely to the ground so that it may be flown again.
   b. Install only flame-resistant recovery wadding if wadding is required by the design of the rocket.
   c. Do not attempt to catch a high-power rocket as it approaches the ground.
   d. Do not attempt to retrieve a rocket from a power line or other place that would be hazardous to people attempting to recover it.

3. Payload/challenges
   a. Do not install or incorporate in a high-power rocket a payload/challenge that is intended to be flammable, explosive, or cause harm.
   b. Do not fly a vertebrate animal in a high-power rocket.

4. Weight Limits
   a. The maximum lift-off weight of a rocket shall not exceed one-third (1/3) of the average thrust on the motor(s) intended to be ignited at launch.

5. Launching Devices
   a. Launch from a stable device that provides rigid guidance until the rocket has reached a speed adequate to ensure a safe flight path.
   b. Incorporate a jet/blast deflector device if necessary to prevent the rocket motor exhaust from impinging directly on flammable materials.

6. Ignition Systems
   a. Use an ignition system that is remotely controlled, electrically operated, and contains a launching switch that will return to "off" when released.
   b. The ignition system shall contain a removable safety interlock device in series with the launch switch.
   c. The launch system and igniter combination shall be designed, installed, and operated so the liftoff of the rocket shall occur as quickly as possible after actuation of the launch system. If the rocket is propelled by a cluster of rocket motors designed to be ignited simultaneously, install an ignition scheme that has either been previously tested or has a demonstrated capability of igniting all rocket motors intended for launch ignition within one second following ignition system activation.
   d. A rocket motor shall not be ignited by a mercury switch or roller switch.
      1) Install an ignition device in a high-power rocket motor only at the launch pad.

7. Launch Operations
   a. Do not launch with surface winds greater than 20 mph (32 km/h) or launch a rocket at an angle more than 20 degrees from vertical.
   b. Do not ignite and launch a high-power rocket horizontally, at a target, in a manner that is hazardous to aircraft, or so the rocket's flight path goes into clouds or beyond the boundaries of the flying field (launch site).
   c. A rocket shall be pointed away from the spectator area and other groups of people during and after installation of the ignition device(s).
   d. Firing circuits and onboard energetics shall be inhibited until the rocket is in the launching position.
   e. Firing circuits and onboard energetics shall be inhibited prior to removing the rocket from the launching position.
f. When firing circuits for pyrotechnic components are armed, no person shall be allowed at the pad area except those required for safely arming/disarming.

g. Do not approach a high-power rocket that has misfired until the RSO/LCO has given permission.

h. Conduct a five second countdown prior to launch that is audible throughout the launching, spectator, and parking areas.

i. All launches shall be within the Flyer's certification level, except those for certification attempts.

j. The RSO/LCO may refuse to allow the launch or static testing of any rocket motor or rocket that he/she deems to be unsafe.

8. Commercial Launches

a. Use only certified rocket motors.

b. Do not dismantle, reload, or alter a disposable or expendable rocket motor, nor alter the components of a reloadable rocket motor or use the contents of a reloadable rocket motor reloading kit for a purpose other than that specified by the manufacture in the rocket motor or reloading kit instructions.

c. Do not install a rocket motor or combination of rocket motors that will produce more than 40,960 N-s of total impulse.

d. Rockets with more than 2560 N-s of total impulse must use electronically actuated recovery mechanisms.

e. When more than 10 model rockets are being launched simultaneously, the minimum spectator distance shall be set to 1.5 times the highest altitude expected to be reached by any of the rockets. Tripoli Rocketry Association Safe Launch Practices

f. When three or more rockets (at least one high-power) are launched simultaneously, the minimum distance for all involved rockets shall be the lesser of:

1) Twice the complex distance for the total installed impulse. (Refer to V. Distance Tables)

2) 2000 ft. (610 m)

3) 1.5 times the highest altitude expected to be achieved by any of the rockets.

a) When more than one high-power rocket is being launched simultaneously, a minimum of 10 ft. (3m) shall exist between each rocket involved.

Table 3: Minimum Distance Table

<table>
<thead>
<tr>
<th>Installed Total Impulse (Newton-Seconds)</th>
<th>Equivalent High Power Motor Type</th>
<th>Minimum Diameter of Cleared Area (ft.)</th>
<th>Minimum Personnel Distance (ft.)</th>
<th>Minimum Personnel Distance (Complex Rocket) (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 320.00</td>
<td>H or smaller</td>
<td>50</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>320.01 – 640.00</td>
<td>I</td>
<td>50</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>640.01 – 1,280.00</td>
<td>J</td>
<td>50</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>1,280.01 – 2,560.00</td>
<td>K</td>
<td>75</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>2,560.01 – 5,120.00</td>
<td>L</td>
<td>100</td>
<td>300</td>
<td>500</td>
</tr>
<tr>
<td>5,120.01 – 10,240.00</td>
<td>M</td>
<td>125</td>
<td>500</td>
<td>1000</td>
</tr>
<tr>
<td>10,240.01 – 20,480.00</td>
<td>N</td>
<td>125</td>
<td>1000</td>
<td>1500</td>
</tr>
<tr>
<td>20,480.01 – 40,960.00</td>
<td>O</td>
<td>125</td>
<td>1500</td>
<td>2000</td>
</tr>
</tbody>
</table>
# APPENDIX A-1 – First Nations Launch 2021 Awards List

*(Based upon availability of funds)*

<table>
<thead>
<tr>
<th>Title</th>
<th>Description</th>
<th>Award</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Prize Award</td>
<td>Team with most overall points</td>
<td>$3000 with invitation to a NASA Center</td>
</tr>
<tr>
<td>2nd Place Award</td>
<td>Team with 2nd most overall points</td>
<td>$2000</td>
</tr>
<tr>
<td>3rd Place Award</td>
<td>Team with 3rd most overall points</td>
<td>$1000</td>
</tr>
<tr>
<td>Aesthetic Award</td>
<td>Team whose rocket has the most innovative and professional appearance</td>
<td>Industry sponsored gift.</td>
</tr>
<tr>
<td>Team Spirit Award</td>
<td>Team that shows interactive spirit, helpfulness, and cooperation as determined by peers.</td>
<td>Industry sponsored gift.</td>
</tr>
<tr>
<td>Altitude Award</td>
<td>Team whose actual apogee is closest to required/predicted apogee in the Flight Readiness report.</td>
<td>Industry sponsored gift.</td>
</tr>
<tr>
<td>Judges Award</td>
<td>Team who best met the goals of the program and exemplified hard work and determination as determined by the judges.</td>
<td>Industry sponsored gift.</td>
</tr>
<tr>
<td>Next Step Award</td>
<td>Team best deemed to compete at the next level of competition as determined by the WSGC team.</td>
<td>Up to $15000 team sponsorship with invitation to Student Launch at Marshall Space Flight Center and/or RockOn! at Wallops Flight Facility</td>
</tr>
<tr>
<td>Outreach Award</td>
<td>Team who completes one or more Outreach events that can be continued or scaled.</td>
<td>$500</td>
</tr>
<tr>
<td>Patch Contest Award</td>
<td>Individual that submits the winning patch submission.</td>
<td>$100</td>
</tr>
<tr>
<td>Faculty Advisor Stipend</td>
<td>Stipend if team meets the conditions of participation.</td>
<td>Up to $1000</td>
</tr>
</tbody>
</table>
APPENDIX A-2 – First Nations Launch 2021 Outreach Form

First Nations Launch
High-Power Rocket Competition
Artemis Student Challenge
Hosted by Wisconsin Space Grant Consortium

Education/Public Outreach
Documentation Form

The Wisconsin Space Grant Consortium (WSGC) and NASA would like to thank you for giving our high-power rocket competition participants a chance to assist your organization. Please take a moment to fill in some information below to verify the students’ participation. A portion of your team’s competition score is based on their outreach activities. **Fill out one form for each outreach event you conduct.**

The goal of this activity is to “raise awareness of, or interest in, NASA, its goals, missions and/or programs, and to develop an appreciation for and exposure to science, technology, research and exploration.” One of the goals of First Nations Launch is to promote science, technology, engineering, and math (STEM) fields through educational opportunities throughout the United States. We are grateful for your involvement in this mission and we encourage you to be a part of additional projects that are taking place through NASA funding. If you have any questions about the competition or our organization, please visit our website at [https://spacegrant.carthage.edu/](https://spacegrant.carthage.edu/)

<table>
<thead>
<tr>
<th>Your Team Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Lead’s Name</td>
</tr>
<tr>
<td>Team Lead Signature</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Event Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Event</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Brief Description of Attendees</th>
<th>List All Organizations Involved With the Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Circle all that apply)</td>
<td></td>
</tr>
<tr>
<td>PreK: Students</td>
<td>Teachers</td>
</tr>
<tr>
<td>K-5 Grade: Students</td>
<td>Teachers</td>
</tr>
<tr>
<td>6-8th Grade: Students</td>
<td>Teachers</td>
</tr>
<tr>
<td>High School: Students</td>
<td>Teachers</td>
</tr>
<tr>
<td>University/ Campus: Undergrads</td>
<td>Graduate Administrator</td>
</tr>
<tr>
<td>Public at Large</td>
<td></td>
</tr>
<tr>
<td>Informal Education Setting (Museum, etc.)</td>
<td></td>
</tr>
<tr>
<td>Event Information Continued</td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td></td>
</tr>
<tr>
<td>Brief Description of Activity</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is this a new or existing event? (Circle one)</th>
<th>What was the duration of the event? (Circle one)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New     Existing</td>
<td>&lt; 2 days     = 2 days     &gt; 2 days</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How many exhibits were supported/developed by this event?</th>
<th>How many student hands-on activities were supported/developed by this event?</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>How many public at large activities were supported by this event?</th>
<th>If other activities were supported by this event, please explain:</th>
</tr>
</thead>
</table>

Please provide links to any media coverage (via your institution, local, or regional news outlets) received for this event:

Please provide the title, presenter, and venue for any presentations directly attributed to this activity.

Describe how your team plans to build upon this outreach event:

Please use this space to provide WSGC with any additional information about this outreach event:
**APPENDIX A-3 – First Nations Launch 2021 Overall Scoring**

The competition components will be judged according to the following rubric. Report and presentation templates can be found on the First Nation Launch Competition Rubric webpage: [https://spacegrant.carthage.edu/first-nations-launch/rubric/].

1. **Design Reports** 75% of Total
   a. Competition Proposal (5%)
   b. Preliminary Design Review (PDR) Report (15%)
      1) Preliminary Design Review (PDR) Presentation (5%)
   c. Critical Design Review (CDR) Report (15%)
      1) Critical Design Review (CDR) Presentation (5%)
   d. Flight Readiness Review (FRR) Report (15%)
      1) Virtual Inspection (5%)
   e. Post Launch Assessment Report (PLAR) Report (10%)

2. **Launch Weekend Presentation** 5% of Total
   a. Flight Readiness Presentation (5%)

3. **Flight Performance** 20% of Total
   a. Mission Performance (including Apogee) (10%)
   b. Challenge Performance (10%)

4. **Bonus Points** (Up to 10%)
   a. Plan and conduct an Education Outreach Project
   b. Submit Education/Public Outreach Form (Appendix A-2)

Reports submitted after 11:59 pm Central time on the due date will receive a reduction of the overall score.

Central Daylight Savings Time (March 8 - November 1, 2020, March 14, 2021 - November 7, 2021)
Central Standard Time (November 1, 2020 - March 14, 2021)

| 1 Day Late | 20% Deduction |
| 2 Days Late | 40% Deduction |
| 3 Days Late | 60% Deduction |
| 4 Days Late | 80% Deduction |
| 5 Days Late | Zero |
APPENDIX A-4 – First Nations Launch 2021 Motor Choices

For the 2021 First Nations Launch Challenge, the motor selections are constrained to:

Moon Challenge Motors

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Size</th>
<th>Type</th>
<th>Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerotech</td>
<td>38mm</td>
<td>RMS</td>
<td>I364FJ, I600R, J420R, J500G, J350W</td>
</tr>
<tr>
<td>Aerotech</td>
<td>38mm</td>
<td>DMS</td>
<td>I500T, J425R</td>
</tr>
<tr>
<td>Aerotech</td>
<td>54mm</td>
<td>RMS</td>
<td>K550W, K513FJ, K695R, K1100T</td>
</tr>
<tr>
<td>Aerotech</td>
<td>54mm</td>
<td>DMS</td>
<td>K535W, K400C</td>
</tr>
</tbody>
</table>

*Note: All motors have ejection charges to be used at apogee for backup.*
**APPENDIX A-5 – First Nations Launch 2021 Program Calendar**

**Zoom Presentations and Meetings:** [https://zoom.us/j/99258659434](https://zoom.us/j/99258659434)

**Teleconference Meetings:** 262.551.6272

*Document submissions shall be uploaded to the WSGC application website by the team lead. Submissions received after 11:59 pm CST/CDT will be considered late.*

Central Daylight Savings Time (March 8 - November 1, 2020, March 14, 2021 - November 7, 2021)

Central Standard Time (November 1, 2020 - March 14, 2021)

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**September 2020**
- 01 Announce of Opportunity
- 28 Zoom Informational Telecon @ 4:00 pm

**October 2020**
- 12 Early Bird Non-binding Notice of Intent to Compete and Request for Rocketry Workshop Due*
- 15-17 Visit FNL at the AISES Conference
- 20 Zoom Informational Telecon @ 4:00 pm
- 26 Non-binding Notice of Intent to Compete and Request for Rocketry Workshop Due*
- 30 Selection Announcement

**November 2020**
- TBD Rocket Certification Workshop(s)
- 03 Zoom Kick-off Meeting @ 4:00 pm
- 09 Zoom Proposal and Budget Development Webinar @ 6:00 pm
- 16 Zoom Project Management Webinar @ 5:00 pm
- 23 Award Acceptance Material*, Proposal*, and Preliminary Budget* Due (Note: Thanksgiving week)

**December 2020**
- 03 Zoom Design Review Process Informational Webinar @ 4:00 pm
- 10 **Avionics/RockSim Webinar @ 2:00 pm**

**January 2021**
- TBD Rocket Certification Workshop(s)
- 12 **Altimeter Webinar @ TBD**
- 25 Preliminary Design Review* (PDR) Report, Flight Demo* Due
  
  Upload rocket demo flight video on Facebook and/or Twitter, submit demo flight link to team lead grant management page
- 28 Recovery Webinar @ TBD
February 2021
01-04 Zoom PDR Virtual Presentations
08 Structures Webinar @ TBD
11 Telecon Advisor Meeting @ 2:00 pm
15 Critical Design Review Development Webinar @ 4:00 pm (TBC)
18 Official Team Roster* and Lodging List Form*, Team Members Registrations* and Applications*, Team Bio*, Team Photo* Due

March 2021
01 Critical Design Review* (CDR) Report, Final Motor Selection,* Patch Design,* Intent to Launch Certification Rocket* Due
05 Reimbursements Due (First payout)
08-11 Zoom CDR Virtual Presentations /Initial Virtual Safety Inspection with WSGC (as needed)
22 Zoom Flight Readiness Review Development Webinar @ 4:00 pm

April 2021
05 Flight Readiness Review* (FRR) Report, Outreach Forms Due
06 Telecon Advisor Meeting @ 2:00 pm
07-11 Student Launch Initiative (Mars Next Step Award 2020)
12-15 Final Virtual Safety Inspection with WSGC/TRA
19 Oral Presentations PPT Due*
22 Teams Arrive in Wisconsin
23 Welcome Breakfast/Competition Kick-off @ 8:00 am - Carthage College
23 Team Workday, Motor Build Workshop, Breakout Sessions, Final Safety Inspection @ 9:30 am – 3:00 pm – Carthage College
23 Oral Presentations @ 6:00 – 9:00 pm – Carthage College
24 Launch Day @ Richard Bong Recreational Area in Kansasville, WI @ 7:30 am – 3:00 pm – Richard Bong Recreational Park
24 Closing Banquet @ 6:30 pm – Carthage College
25 Launch Rain Date, Certification Launches @ 9:00 am – 12:00 pm – Richard Bong

May 2021
10 Final Reimbursements, Post Launch Assessment Report (PLAR)*, 2-3 Team Project Photos Due

June 2021
01 Notification of Winners
TBD RockOn! 2021 @ Wallops Flight Facility (Moon Next Step Award 2021)

Summer 2021
TBD Grand Prize Trip to a NASA Center (Moon Challenge Grand Prize Winners)
APPENDIX B-1 – How to Register with WSGC and Apply to FNL Competition

The faculty advisor must first register with WSGC and apply to the “Rocket Launch Team (Create an NOI)” before students/team members can apply to the First Nations Launch program.

One exception to the order of registration exists. If the student team lead has never registered with WSGC, he/she must register before the advisor begins the Notice of Intent (NOI) application.

Advisor Application Process

STEP 1: First-time users must register as faculty on the WSGC website. The registration and sign-in tab can be found on the upper right-hand corner of the website.

STEP 2: Sign in to your WSGC account. Applicants will be prompted to update personal information annually (if previously registered).

STEP 3: Select Manage Applications.

STEP 4: Under Grant Application Forms, select Rocket Launch Team (Create an NOI).

STEP 5: Complete and submit the Rocket Launch Team (Create NOI) Grant Application Form. The following information/documents will be submitted during this step:
- Other WSGC funding received
- Team Name
- Co-Advisor (if applicable)
- Student Team Lead
- Grants Officer (if applicable)
- Industry, Tripoli, National Rocketry Association Mentor Name and Email
- Competition (Collegiate, First Nations Moon Challenge for 2021)
- Team Members List

**Team Application Process**

*After* the faculty advisor completes the Notice of Intent (NOI), each team member (including any co-advisor) will need to:

**STEP 1:** Register as an undergraduate student on the WSGC website. The [registration](#) and [sign-in](#) tab can be found on the upper right-hand corner of the website.

**STEP 2:** Sign in to your WSGC account. Applicants will be prompted to update personal information annually (if previously registered).

**STEP 3:** Select Manage Applications.

**STEP 4:** Under Grant Application Forms, select the appropriate program (Collegiate Rocket Launch Competition or First Nations Rocket Launch Competition). The following information/documents will be submitted during this step:

- Other WSGC funding received
- Team Name submitted by the Faculty Advisor
- Resume *(Collegiate Rocket Launch Only)*
- Prior Rocket Experience
- Media Release
- Individual W9 *(First Nations Launch Co-advisors and Collegiate Rocket Launch Competition Team Members Only)*
**APPENDIX B-2 – How to Upload Documents to WSGC**

All of your reports, documentation, etc. will be submitted to WSGC via the website. Depending on what documents are being submitted, either the Advisor or the Team Lead will be required to login to the team profile, and upload the respective document, before the due date.

Click the ‘Select File’ below the document that needs to be uploaded, and then search for the file in the folder dialog box on your computer. Please ensure it is in the proper format and labeled appropriately. Do not forget to include the document submission deadlines in your master schedule, so as not to miss a deadline (or document).
APPENDIX B-3 – Reimbursement Guide

Project Expense Form Reimbursement Instructions

1. Make purchases.
   a. Teams should select one team member to oversee the budget, ensuring collective purchases/expenses do not exceed award amount.

2. Save all original digital and hard copy receipts.
   a. We recommend saving receipts in a folder until time of reimbursement submission.
   b. Number each receipt.
   c. Circle date and total on receipt(s).
   d. All purchase receipts must be itemized, detailing each item purchased.

3. Complete a Project Expense Form (see Tools and Tips on the WSGC website). If your expenses exceed the allotted space on the form(s), print off a second form to add the remaining expenses. Do not list both supply and travel expenses on one form.
   a. Carefully read and follow instructions before completing form(s).
   b. List receipt(s) in numerical order.
   c. Identify date from each receipt.
   d. List name of Vendor/Store from each receipt.
   e. Describe the purchase from each receipt.
   f. Provide the total expended amount from each receipt.
   g. The "Total" box will automatically sum all receipts together - this is your total reimbursement being requested.
   h. Initial and date each receipt with date of reimbursement submission.
   i. Sign, date, and enter your phone number.
   j. Have your team lead and advisor complete their required signatures.

4. Submit the completed form(s) and receipts in one email by the due date(s) to:

   Connie Engberg
   cengberg@carthage.edu
   (262) 551-6548

Do Not:
1. Submit partially completed forms.
2. Submit forms without all required signatures.
3. Submit forms past due date(s).
4. Submit “flat” per diem rate requests.
# PROJECT EXPENSE FORM

To receive reimbursement, this form must be submitted by each team member who made a purchase.

**NOTE:** The team leader cannot be reimbursed for purchases made by team members and then distribute the money.

Email Form and Receipts To:
Connie Engberg
cengberg@carthage.edu
(262) 551-6548

Please Make Check Payable To:
Name:
Address line 1:
Address line 2:
City, State, Zip:

Team Institution:

<table>
<thead>
<tr>
<th>Rcpt #</th>
<th>Date</th>
<th>Vendor/Store</th>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL**

0

**REQUISITIONER STATEMENT:** I declare (under penalties of perjury) that this account of expenses is accurate and conforms to all applicable WSGC regulations. The expenses are actual, reasonable and were personally incurred in accordance to my award letter criteria.

---

Team Member Signature   Phone #       Date
Team Leader Signature    Phone #       Date
Team Advisor Signature   Phone #       Date
# PROJECT EXPENSE FORM

To receive reimbursement, this form must be submitted by each team member who made a purchase.

**NOTE:** The team leader cannot be reimbursed for purchases made by team members and then distribute the money.

<table>
<thead>
<tr>
<th>Email Form and Receipts To:</th>
<th>Please Make Check Payable To:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connie Engberg</td>
<td><strong>Name:</strong> Jane Doe</td>
</tr>
<tr>
<td><strong><a href="mailto:cengberg@carthage.edu">cengberg@carthage.edu</a></strong></td>
<td><strong>Address line 1:</strong> 1234 Instruction Way</td>
</tr>
<tr>
<td>(262) 551-6548</td>
<td><strong>Address line 2:</strong> Apt 401</td>
</tr>
<tr>
<td></td>
<td><strong>City, State, Zip:</strong> Kenosha, WI 53140</td>
</tr>
</tbody>
</table>

Team Institution: 

<table>
<thead>
<tr>
<th>Rcpt #:</th>
<th>Date</th>
<th>Vendor/Store</th>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2/15/16</td>
<td>Menards</td>
<td>5 min. Epoxy, Coolflow Valve, Isoprop. Alcohol</td>
<td>57.21</td>
</tr>
<tr>
<td>2</td>
<td>11/17/15</td>
<td>Walmart</td>
<td>Masks, Wood Sticks</td>
<td>18.12</td>
</tr>
<tr>
<td>3</td>
<td>4/5/16</td>
<td>Wildman Hobbies</td>
<td>Parachute, etc</td>
<td>61.14</td>
</tr>
</tbody>
</table>

**TOTAL** 136.47

**REQUISITIONER STATEMENT:** I declare (under penalties of perjury) that this account of expenses is accurate and conforms to all applicable WSGC regulations. The expenses are actual, reasonable and were personally incurred in accordance to my award letter criteria.

---

**Team Member Signature**

Jane Doe

123-456-7890

5/17/16

**Team Leader Signature**

Susan Smith

234-567-8901

6/01/16

**Team Advisor Signature**

John Doe

345-678-9102

6/01/16
Travel Expense Form Reimbursement Instructions

1. Make purchases(s).
   a. Teams should select one team member to oversee the budget, ensuring collective purchases/expenses do not exceed award amount.

2. Save all original digital and hard copy receipts.
   a. We recommend saving receipts in a folder until time of reimbursement submission.
   b. Circle date and total on receipt(s).
   c. If food or lodging receipts cover more than one person, list participant’s name on receipt(s).
   d. Itemized restaurant receipts are required. If purchases are made on a credit card, a signature copy must be included. There is a $30 per diem per person for food.
   e. Alcohol and tips over 20% will not be reimbursed.
   f. All purchase receipts must be itemized, detailing each item purchased.

3. Complete a Travel Expense Form (see Tools and Tips on the WSGC website). Use a separate Travel Expense Form for each event. If your expenses exceed the allotted space on form(s), print off a second form to add the remaining expenses. Do not list both supply and travel expenses on one form.
   a. Carefully read and follow instructions before completing forms.
   b. Print out a Google map for verification of personal vehicle mileage ($.575 per mi). Circle the total miles. The mileage rate includes fuel costs. Gas receipts will only be reimbursed for rental vehicle travel.
   c. Organize your receipts to align with the Travel Expense Form (by receipt category and day of the week). Label each receipt with the coinciding row and column information (i.e. Receipt 1-Fri, 3-Mon, 11-Mon, etc).
   d. Provide the total expended amount from each receipt in the coinciding box on the expense form.
   e. The "Total" box will automatically sum all receipts together - this is your total reimbursement being requested.
   f. Initial and date each receipt with date of reimbursement submission.
   g. Sign, date, and enter your phone number.
   h. Have your team lead and advisor complete their required signatures.

4. Submit the completed form(s) and receipts in one email by the due date(s) to:

   Connie Engberg
   cengberg@carthage.edu
   (262) 551-6548

Do Not:
1. Submit partially completed forms.
2. Submit forms without all required signatures.
3. Submit forms past due date(s).
4. Submit “flat” per diem requests.
# TRAVEL EXPENSE FORM

To receive reimbursement, this form must be submitted by each team member who made a purchase.

**NOTE:** The team leader cannot be reimbursed for purchases made by team members and then distribute the money.

<table>
<thead>
<tr>
<th>Email Form and Receipts To:</th>
<th>Please Make Check Payable To:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connie Engberg</td>
<td></td>
</tr>
<tr>
<td><a href="mailto:cengberg@carthage.edu">cengberg@carthage.edu</a></td>
<td>Name:</td>
</tr>
<tr>
<td>(252) 551-6548</td>
<td>Address line 1:</td>
</tr>
<tr>
<td></td>
<td>Address line 2:</td>
</tr>
<tr>
<td></td>
<td>City, State, Zip:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Travel Start Date:</th>
<th>Travel End Date:</th>
<th>Team Institution:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Receipt Category</th>
<th>Description</th>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
<th>Line Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mileage Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$ 0.00</td>
</tr>
<tr>
<td></td>
<td>miles x 0.575</td>
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<td></td>
<td></td>
<td>$ 0.00</td>
</tr>
<tr>
<td>2</td>
<td>Air/Rail Fare</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$ 0.00</td>
</tr>
<tr>
<td>3</td>
<td>Baggage Fee(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$ 0.00</td>
</tr>
<tr>
<td>4</td>
<td>Rental Car</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>$ 0.00</td>
</tr>
<tr>
<td>5</td>
<td>Uber/Lyft/Taxi/Metro</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td>$ 0.00</td>
</tr>
<tr>
<td>6</td>
<td>Parking/Tolls</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>$ 0.00</td>
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<tr>
<td>7</td>
<td>Misc. Ground Transport</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$ 0.00</td>
</tr>
<tr>
<td>8</td>
<td>Lodging</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$ 0.00</td>
</tr>
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<td>9</td>
<td>Meals ($30 per diem)</td>
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<td></td>
<td></td>
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<tr>
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<td>$ 0.00</td>
</tr>
</tbody>
</table>

**TOTAL** $ 0.00

**REQUISITIONER STATEMENT:** I declare (under penalties of perjury) that this account of expenses is accurate and conforms to all applicable WSGC regulations. The expenses are actual, reasonable and were personally incurred in accordance to my award letter criteria.

<table>
<thead>
<tr>
<th>Team Member Signature</th>
<th>Phone #</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
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<table>
<thead>
<tr>
<th>Team Leader Signature</th>
<th>Phone #</th>
<th>Date</th>
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<tr>
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</table>

<table>
<thead>
<tr>
<th>Team Advisor Signature</th>
<th>Phone #</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# TRAVEL EXPENSE FORM

To receive reimbursement, this form must be submitted by each team member who made a purchase.

**NOTE:** The team leader cannot be reimbursed for purchases made by team members and then distribute the money.

<table>
<thead>
<tr>
<th>Receipt Category</th>
<th>Description</th>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
<th>Line Total</th>
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<tr>
<td>7</td>
<td>Misc. Ground Transport</td>
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<td></td>
<td>404.93</td>
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<td>Breakfast</td>
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<tr>
<td>14</td>
<td>Miscellaneous 1</td>
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<td></td>
<td>0.00</td>
</tr>
<tr>
<td>15</td>
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<td></td>
<td><strong>1,213.30</strong></td>
</tr>
</tbody>
</table>

**REQUISITIONER STATEMENT:** I declare (under penalties of perjury) that this account of expenses is accurate and conforms to all applicable WSGC regulations. The expenses are actual, reasonable and were personally incurred in accordance to my award letter criteria.

---

**Team Member Signature:** Jane Doe

**Phone #:** 123-456-7890

**Date:** 08/23/16

---

**Team Leader Signature:** Susan Smith

**Phone #:** 234-567-8901

**Date:** 08/24/16

---

**Team Advisor Signature:** John Doe

**Phone #:** 345-678-9012

**Date:** 08/24/16
Google Maps 2001 Alford Park Dr, Kenosha, WI 53140 to International Parking (Lot D) Drive 57.6 miles, 59 min

We don't have the most recent timetables for this area.

via I-94 E
57 min without traffic
⚠️ This route has tolls.

57.6 x 2 = 115.2
Rounded= 115 x $5.75 = $662.4

1:58 PM–5:41 PM
4 UP-N X9 Blue Line Van Galder
3 h 43 min

1:58 PM–5:41 PM
4 UP-N S1 Blue Line Van Galder
3 h 43 min

Receipt 1-Mon and 1-Sat

fd 8/27/16
<table>
<thead>
<tr>
<th>Charges</th>
<th>No</th>
<th>Unit</th>
<th>Price/Unit</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIME &amp; DISTANCE</td>
<td>1</td>
<td>Hours</td>
<td>234.00</td>
<td>234.00</td>
</tr>
<tr>
<td>FREE MILEAGE - TIME &amp; DISTANCE</td>
<td>2000</td>
<td>Days</td>
<td>2.50</td>
<td>5.00</td>
</tr>
<tr>
<td>CUST FACILITY CHG</td>
<td>5</td>
<td>Days</td>
<td>20.00</td>
<td>100.00</td>
</tr>
<tr>
<td>MVT FEE EXC EMISSIONS CHG</td>
<td>6</td>
<td>Days</td>
<td>0.62</td>
<td>3.72</td>
</tr>
<tr>
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<td>6</td>
<td>Days</td>
<td>2.60</td>
<td>15.60</td>
</tr>
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<td>VLP REC</td>
<td>6</td>
<td>Days</td>
<td>0.70</td>
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<tr>
<td>PL STATE SALES TAX #4,500 B</td>
<td></td>
<td></td>
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<td>367.37</td>
</tr>
</tbody>
</table>

**Total Charges**

**USD 284.75**

**Receipt 4-Mon**

**For Reservation: 1-800-RENT-A-CAR**

**Receipt 7-Sat**
<table>
<thead>
<tr>
<th>Date</th>
<th>Code</th>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/15/2016</td>
<td>2264568</td>
<td>GUEST ROOM</td>
<td>$109.00</td>
</tr>
<tr>
<td>8/15/2016</td>
<td>2264568</td>
<td>STATE TAX</td>
<td>$7.09</td>
</tr>
<tr>
<td>8/15/2016</td>
<td>2264568</td>
<td>CITY TAX</td>
<td>$5.45</td>
</tr>
<tr>
<td>8/19/2016</td>
<td>2264818</td>
<td>GUEST ROOM</td>
<td>$109.00</td>
</tr>
<tr>
<td>8/16/2016</td>
<td>2264818</td>
<td>STATE TAX</td>
<td>$7.09</td>
</tr>
<tr>
<td>8/16/2016</td>
<td>2264818</td>
<td>CITY TAX</td>
<td>$5.45</td>
</tr>
<tr>
<td>8/17/2016</td>
<td>2265114</td>
<td>GUEST ROOM</td>
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<td>8/17/2016</td>
<td>2265114</td>
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</tr>
<tr>
<td>8/17/2016</td>
<td>2265114</td>
<td>CITY TAX</td>
<td>$5.45</td>
</tr>
<tr>
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<td>2265312</td>
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<td>2265434</td>
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<td>2265434</td>
<td>CITY TAX</td>
<td>$5.45</td>
</tr>
<tr>
<td>8/19/2016</td>
<td>2265434</td>
<td>SERVICE RECOVERY, REVENUE</td>
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<tr>
<td>8/19/2016</td>
<td>2265434</td>
<td>STATE TAX</td>
<td>($7.09)</td>
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<td>8/19/2016</td>
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<td>8/19/2016</td>
<td>2266671</td>
<td><strong>BALANCE</strong></td>
<td>($404.93)</td>
</tr>
</tbody>
</table>

You have earned approximately 4,350 Hilton HHonors points for this stay. Hilton HHonors(R) stays are posted within 72 hours of checkout. To check your earnings or book your next stay at more than 3,900

Hilton hotels are all over the world. Find us in Canada, Costa Rica, Ecuador, Germany, India, Mexico, Poland, Turkey, United Kingdom, and United States of America. Coming soon in Italy and Romania.
FRESH MARKET ON THE GO
O'Hare Int'l Airport
Terminal 1
708-531-1694

Toll #: 878-502
Date/Time: 8/15/2016 8:11 AM
Operator: STELLA
Receipt #: 5001180193

Banana
$1.20
Shawarma into Masala
$3.99
Water 24oz
$2.89

Sub Total
$14.17
FL State & Expo Tax
$1.12
FL & Expo Tax
$0.14
$0.05 bottled water tax
$0.01
Sub Total incl Tax
$15.63

Master/Visa

Charge
$0.00

GO 8/17/16

Receipt 9-Mon

63
<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Diet Coke</td>
<td></td>
<td>5.00</td>
</tr>
<tr>
<td>1 Coke</td>
<td></td>
<td>2.50</td>
</tr>
<tr>
<td>2 Iced Tea</td>
<td></td>
<td>5.00</td>
</tr>
<tr>
<td>1 Coconut Creme,  in glass</td>
<td></td>
<td>16.45</td>
</tr>
<tr>
<td>3 Coconut Creme, 1 regular</td>
<td></td>
<td>18.00</td>
</tr>
<tr>
<td>1 Mango Berry, regular</td>
<td></td>
<td>6.00</td>
</tr>
<tr>
<td>1 Strawberry Explosion, regular</td>
<td></td>
<td>6.00</td>
</tr>
<tr>
<td>4 Chips &amp; Salsa,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 add lg guacamole,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 add lg guacamole,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 add lg guacamole,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 add lg guacamole,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Shrimp Tacos, with fruit</td>
<td></td>
<td>24.00</td>
</tr>
<tr>
<td>1 Patty Melt</td>
<td></td>
<td>12.50</td>
</tr>
<tr>
<td>3 Black &amp; Blue Burger</td>
<td></td>
<td>37.50</td>
</tr>
<tr>
<td>1 Mandarin Orange Salad, Carib Vingret</td>
<td></td>
<td>13.00</td>
</tr>
<tr>
<td>1 Fried Shrimp Basket</td>
<td></td>
<td>11.00</td>
</tr>
<tr>
<td>2 Top Sirloin</td>
<td></td>
<td>32.00</td>
</tr>
<tr>
<td>1 Chicken Alfredo</td>
<td></td>
<td>16.00</td>
</tr>
<tr>
<td>2 Scallops/Shrimp, 1 plain</td>
<td></td>
<td>36.00</td>
</tr>
<tr>
<td>1 Bourbon Glazed Salmon</td>
<td></td>
<td>19.50</td>
</tr>
<tr>
<td>1 Add Dinner Salad, honey mustard</td>
<td></td>
<td>2.00</td>
</tr>
<tr>
<td>1 Side Dressing</td>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td>4 Layer Chocolate Cake</td>
<td></td>
<td>24.00</td>
</tr>
<tr>
<td>2 Key Lime Pie</td>
<td></td>
<td>10.00</td>
</tr>
<tr>
<td>2 Coconut Meringue Pie</td>
<td></td>
<td>12.00</td>
</tr>
<tr>
<td>1 Milk</td>
<td></td>
<td>3.00</td>
</tr>
<tr>
<td>2 Coffee</td>
<td></td>
<td>5.00</td>
</tr>
<tr>
<td>1 Decaf Coffee</td>
<td></td>
<td>2.50</td>
</tr>
</tbody>
</table>

Sub Total: 334.45
Tax: 18.72
Sub Total: 353.17

08/17 19:43 TOTAL: 353.17

Suggested Gratuity
GRAT-18%  59.65
GRAT-20%  66.28

GRAVITUDE NOT INCLUDED
HAPPY HOUR M-F 4-7
FREE SHUTTLE AFTER 3
321 917-0100 917-6977

08/17 08:16 08/17/16

Owen for our group: John Doe, Julia Doe, Emily Doe, Tim Doe, Jim Doe
John Doe, Julia Doe, Emily Doe, Tim Doe, Jim Doe
John Doe, Julia Doe, Emily Doe, Tim Doe, Jim Doe

08/16/16
APPENDIX B-4 – Rocket Shipping Procedure

ROCKET SHIPPING PROCEDURE

Please follow the FNL Rocket Shipping Procedure when shipping rocket(s) to Wisconsin for the competition. It is the team’s responsibility to ensure your rocket makes it to Wisconsin in time for the Launch Weekend.

1. Call a carrier of your choice (FedEx, UPS, etc.), to schedule a package shipment. The delivery date to the hotel should coincide with your arrival. **NOTE:** All rockets should be delivered to the hotel prior to the team’s arrival at the hotel. We recommend scheduling a return package pickup from the hotel at the same time. **NOTE:** All rockets should be scheduled for pickup prior to your hotel checkout.
   a. Have package(s) shipped to:
      - ATTN: (Guest Name)
      - Wyndham Garden Kenosha Harborside
      - 5125 6th Avenue
      - Kenosha, WI 53140
   b. The hotel will put an alert on your reservation once the shipment arrives.

2. Upon check-in, notify the front desk that you shipped a package to the hotel. The hotel will verify the package’s arrival and give you the package(s). **NOTE:** Packages should include the name of the person picking up the package in the return address.

3. Rockets will be shipped from the hotel in the original packing material. It’s important that you keep boxes, etc. in your rooms to properly package your rocket. **NOTE:** WSGC and the hotel do not have packing materials available for return shipping.

4. If you did not pre-set up a return shipment with the carrier of your choice when making arrangements to ship your rocket to Wisconsin, do so upon your arrival.
   a. A ‘guest use’ computer is available in the hotel lobby which will allow you to set up your return shipment and to print your label.
   b. Take prepared package(s) to the hotel front desk and inform them of the scheduled pick-up date and time. The hotel will hold the package(s) until carrier pick-up.

ROCKET SHIPPING AIRLINE PROCEDURE

**Note When Transporting Rocket as a Checked Bag**

Information to consider when Checking a Box/Bag with an airline.

Most airlines will allow you to check one bag. There is normally a maximum weight limit of 50 pounds per checked bag as well as a size restriction. The most common maximum size bag allowed is 62 linear (total) inches. For example: a 38” x 12” x 12” (62” total) box would be allowed. Be sure to check with your specific airline carrier as overage fees can be quite costly.

Also be aware that black residue and motors are not allowed. Batteries are only allowed in carry-on bags.
**APPENDIX B-5 – Team Roster and Lodging List Form**

**First Nations Launch**

**Official Team Roster and Lodging List Form**

Complete and submit the **Official Team Roster and Lodging List form** to the advisor’s grant management page in the Lodging List field by the due date listed on the FNL Calendar.

(Note: All team members listed on the form should have registered on the WSGC website and applied to the FNL Competition.)

<table>
<thead>
<tr>
<th>Name of Academic Institution:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OFFICIAL TEAM ROSTER</strong></td>
<td><strong>LODGING LIST</strong></td>
</tr>
<tr>
<td>Advisor</td>
<td>Room 1 – WSGC Sponsored</td>
</tr>
<tr>
<td>Name:</td>
<td>e.g. 4/22</td>
</tr>
<tr>
<td>Co-Advisor</td>
<td>1.</td>
</tr>
<tr>
<td>Name:</td>
<td>2.</td>
</tr>
<tr>
<td>Team Lead</td>
<td>3.</td>
</tr>
<tr>
<td>Name:</td>
<td>4.</td>
</tr>
</tbody>
</table>

| **FINAL ROSTER**             |  |
| (Please include participants unable to attend the launch) |  |
| 1.                           |  |
| 2.                           |  |
| 3.                           |  |
| 4.                           |  |
| 5.                           |  |
| 6.                           |  |
| 7.                           |  |
| 8.                           | Room 2 – WSGC Sponsored | Arrival Date | Departure Date |
| 9.                           | e.g. 4/22 | e.g. 4/25 |
| 10.                          | 1. | |
| 11.                          | 2. | |
| 12.                          | 3. | |
| 13.                          | 4. | |
| 14.                          | Room 3 – WSGC Sponsored | Arrival Date | Departure Date |
| 15.                          | e.g. 4/22 | e.g. 4/25 |
| 16.                          | 1. | |
| 17.                          | 2. | |
| 18.                          | 3. | |
| 19.                          | 4. | |
| 20.                          | Room 4 – Team Budget | Arrival Date | Departure Date |
| 21.                          | e.g. 4/22 | e.g. 4/25 |
| 22.                          | 1. | |
| 23.                          | 2. | |
| 24.                          | 3. | |
| 25.                          | 4. | |
| 26.                          | Room 5 – Team Budget | Arrival Date | Departure Date |
| 27.                          | e.g. 4/22 | e.g. 4/25 |
| 28.                          | 1. | |
| 29.                          | 2. | |
| 30.                          | 3. | |
| 31.                          | 4. | |
| 32.                          | Room 6 – Team Budget | Arrival Date | Departure Date |
| 33.                          | e.g. 4/22 | e.g. 4/25 |
| 34.                          | 1. | |
| 35.                          | 2. | |
| 36.                          | 3. | |
| 37.                          | 4. | |

For office use only

Notes: Submission Date:

1. 2.
2. 3.
3. 4.
APPENDIX C-1 – Project Planning Guidance

1. Team Structure

![Recommended team structure diagram]

**Figure C.1 Recommended team structure.**

**Role Descriptions:**
*Figure C.2 shows the recommended breakdown for a typical Rocket Competition team. This breakdown works best for 5-6 team members. If you do not have 5-6 team members, ensure that you are dividing the work evenly.*

**Team Lead**
- Organizes meetings, delegate tasks, keeps team on track and integrated
- Support other team members roles as needed
- Bring issues to advisor and/or TRA mentor
- Bring issues/questions to WSGC team
- Assists and organizes parts/supplies procurement
- Compiles and proofs reports and presentations

**Team Safety Officer**
- Organizes the safety procedures of the team
- Creates and maintains all hazard analysis, risk assessment
- Responsible for Safety section of the reports

**Simulations Lead** (can be combined with Airframe)
- Responsible for running/ updating simulations and motor selection
- Responsible for Mission Performance section of reports

**Avionics Lead**
- Responsible for design/layout/fabrication of avionics bay
- Responsible for altimeter selection/operation
- Responsible for Avionics section of reports
Recovery Lead

- Responsible for all recovery hardware and its integration
- Responsible for proper parachute selection/sizing (simulation)
- Responsible for Recovery section of reports

Sub-Teams

It is important that all members of the overall team are communicating and working together where necessary. This is where your Team Schedule or Gantt Chart will help with workflow. The sub-teams shown in Figure C.1 are recommended for efficient breakdown of responsibility.

Airframe Team

- Responsible for vehicle modification and assembly/construction
- Responsible for subsystem integration
- Responsible for Vehicle Criteria section of reports

Payload/challenge Team (the Challenge)

- Responsible for payload/challenge design (hardware and software)
- Responsible for integration
- Responsible for Payload/challenge Criteria section of reports

Additional Team Resources

Additional team resources can be found under “Tools & Tips” on the First Nations Launch website at https://spacegrant.carthage.edu/first-nations-launch/tools-and-tips/

Resources include:

- Team Roles test
- Stages of Team Formation
- Positive Team Building: Bruce Tuckman’s Proven Formation
- The Unique Characteristics of an Effective Team
- Understanding the Stages of Team Formation
- Team Charters
- Sample Team Charter
- So, You’re Going to be a Member of a Team
2. **Budgets**

It is important to create and maintain a budget over the course of your project. Many projects struggle or fail due to mismanagement of funds or not anticipating the unexpected.

One tool to use to help with budgeting is a simple Excel spreadsheet.

---

<table>
<thead>
<tr>
<th>Component Description</th>
<th>Quantity</th>
<th>Cost Per Unit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BODY FRAME CONSTRUCTION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body Tube 3.9” ID 4.0” OD 34 inch length</td>
<td>2</td>
<td>$10.45</td>
<td>$20.90</td>
</tr>
<tr>
<td>Centering Rings 3.9” OD 33 mm ID 0.5” thickness will be made in house</td>
<td>2</td>
<td>$8.10</td>
<td>$16.20</td>
</tr>
<tr>
<td>Nose Cone 3.9” outer diameter</td>
<td>1</td>
<td>$11.95</td>
<td>$21.95</td>
</tr>
<tr>
<td>Construction Supplies Epoxy/Paint/Battery/Hardware/Etc. -</td>
<td>-</td>
<td>$100.00</td>
<td>$100.00</td>
</tr>
<tr>
<td><strong>PAYLOAD DESIGN</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GoPro Camera</td>
<td>1</td>
<td>$199.99</td>
<td>$199.99</td>
</tr>
<tr>
<td><strong>AVIONICS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Altimeters For systematic parachute deployment (Already have 2)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Altimeter Bay Payload bay to hold altimeters</td>
<td>1</td>
<td>$18.56</td>
<td>$28.56</td>
</tr>
<tr>
<td>Pitot tube Used to calculate velocity of rocket</td>
<td>1</td>
<td>$350.00</td>
<td>$350.00</td>
</tr>
<tr>
<td>Key switches Used to turn on altimeters at the launch pad</td>
<td>2</td>
<td>$6.00</td>
<td>$12.00</td>
</tr>
<tr>
<td>GPS Garmin GTU 10 have</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>MOTOR/PROPULSION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Mount Tube 38 mm fits L and J motors; to mount motor in rocket</td>
<td>1</td>
<td>$7.35</td>
<td>$7.35</td>
</tr>
<tr>
<td>Motor Retainer 38 mm retainer; secures motor in motor mount tube</td>
<td>1</td>
<td>$31.03</td>
<td>$31.03</td>
</tr>
<tr>
<td>Terminal Block 12 Position terminal strip for wiring ejection charges</td>
<td>1</td>
<td>$3.49</td>
<td>$3.49</td>
</tr>
<tr>
<td>Rail Buttons for launch; to connect rocket to launch rail</td>
<td>2</td>
<td>$1.54</td>
<td>$3.08</td>
</tr>
<tr>
<td><strong>RECOVERY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parachute 60” SkyAngle (10.2-21.1 lb) (Already have 1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Parachute Protector Reusable fire resistant cloth to protect parachute (Already have 4)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rip Cord 1500lb Kevlar Shock Cord (Cost per foot)</td>
<td>60</td>
<td>$0.92</td>
<td>$55.32</td>
</tr>
<tr>
<td><strong>GENERAL MATERIALS &amp; SUPPLIES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toolbox Storage of tools and components (Already have)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Drill Rotary tool kit General purpose tool (used for cutting fin slots, sanding, etc.) have Drogue Parachute To eject before main parachute; have one, but will buy spare have Fins Approximate price for 0-10; size and shape to be determined</td>
<td>4</td>
<td>$15.95</td>
<td>$63.00</td>
</tr>
<tr>
<td><strong>TRAVEL EXPENSES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air fare</td>
<td>5</td>
<td>$200.00</td>
<td>$1,000.00</td>
</tr>
<tr>
<td>Baggage fees</td>
<td>2</td>
<td>$50.00</td>
<td>$100.00</td>
</tr>
<tr>
<td>Shipping fees</td>
<td>-</td>
<td>$100.00</td>
<td>$100.00</td>
</tr>
<tr>
<td>Rental car</td>
<td>-</td>
<td>$500.00</td>
<td>$500.00</td>
</tr>
<tr>
<td>Mileage (based on Google map, reimbursement rate of $0.575 per mile)</td>
<td>90</td>
<td>$0.58</td>
<td>$51.75</td>
</tr>
<tr>
<td>Tolls &amp; parking</td>
<td>-</td>
<td>$15.00</td>
<td>$25.00</td>
</tr>
<tr>
<td>Food ($30/day/person)</td>
<td>5</td>
<td>$150.00</td>
<td>$150.00</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>$2,840.42</td>
</tr>
</tbody>
</table>
3. Timelines (Schedules)

It is important to create and maintain schedules over the course of your project. Many projects struggle or fail due to poor scheduling or no scheduling at all.

One tool to use to help with scheduling is the Gantt Chart, an example is provided below.
APPENDIX C-2 – Testing Plan Overview

Testing is a major part of any successful engineering program. Testing is used to validate concepts, and test unknown components and subassemblies, etc. Ensuring that each component will function as expected (on its own) will ensure that the entire collection of components (the vehicle or the payload/challenge) also function together successfully, and reduce the chance of failure.

In the proposal and concept phase, plans should be made to test various items such as:

Structural Components
- Airframe tests
- Fin tests
- Bulkhead tests

Electrical Components
- Altimeter testing
- Tracking testing

Recovery System Tests
- Parachute ejections tests
- Parachute deployment tests

Scale Tests
- Small scale rocket tests can be used to test any new components in flight
- Wind tunnel tests can determine drag

This is not an exhaustive list; you may test whatever you think is crucial for your design to work. In the critical and flight ready phase, the tests should be executed.

These plans can be shown in the form of a spreadsheet (or table in Word) listing the tests to be completed, what the results are (any anomalies or unexpected behavior) and when the test will be completed. The scale and number of tests that your team chooses to complete depends entirely on the size of your team and your school’s resources.

Structural Testing

Early on, your team must decide what material is suitable for your competition rocket kit (there are a few common rocket kit materials – phenolic, fiberglass wrapped phenolic, G10 fiberglass, G12 fiberglass or carbon fiber). If you are uncertain what these materials are, and the pros and cons of each, you may purchase a small sample or section of airframe of each, to conduct testing on.

Advanced teams may perhaps build their airframe from scratch – if this is the case, then testing is a must on this material. It helps to understand what tools are needed to work the material (is your school/shop capable of working with this material) – this may help with airframe selection.

Altimeter Testing

Understanding the full capability of your altimeters and how to program them and what the output (and data) means is crucial to the success of your flight. You can test them in various ways; in a vacuum chamber to test the pressure sensors, in a moving vehicle or elevator to test the accelerometers, or in a small-scale rocket flight or drone flight. Opposed to using the altimeters to ignite black powder charges in a test, use a small diode that lights up when the circuit is completed. Make sure you understand how to wire them properly and how to use the interface.

Some advanced altimeters can be controlled wirelessly or via Bluetooth. Make sure to test these connections, and the range of these connections in the field. Make sure to understand the conditions of the field in Wisconsin, it may not be the same as where you test. Ensure multiple people (or even all team members) are proficient in programming and retrieving information from the altimeters.
Tracking devices should also be tested and understood in the field (perhaps not a literal field, but somewhere outside opposed to bench testing in the lab). Understand your battery life, how long you will have power for. Ensure multiple people (or even all team members) are proficient in using the tracking devices.

**Recovery Testing**

It is encouraged that teams (with the help of a rocketry mentor) procure energetics and perform parachute ejection tests (on the ground) prior to flight, to understand how much energetic is required to successfully separate sections of the rocket and experience the event in order to understand the forces involved.

Ejection tests will also help to understand the need for parachute protection (such as Nomex cloth wrap or cellulose wadding aka ‘dog barf’) to protect the parachutes from damage from the energetic event.

Ejection tests can also reveal any structural weaknesses (perhaps don’t use your competition rocket the first time around, if you are new to recovery testing) or if the sections jam and don’t release. You can also test your remote electronics to test (if capable) to ignite the energetic for the test. If not, you can run a long set of lead wires to a safe distance away.

Ensure to follow all safe procedures and use the proper personal protection equipment (PPE). Do not attempt recovery testing without an experienced mentor/advisor on hand.

**Scale Testing**

Some advanced/experienced teams may be able to quickly scale up designs or concepts to a flight ready vehicle during the design phase of the project. This is not expected, but simulating the real conditions is the best test of the component undergoing the test. Please share the results of these test in reports/presentations.

**Challenge Solution Tests**

In the proposal phase, there may exist various solutions to the challenge proposed that year. One way to reduce the number of solutions (conversely, to solidify the best solution) is to mock-up or create a test that will show the solution is viable. Usually, if the solution is not viable, or too complex or difficult to construct, this will become evident during the test. The best solution is usually the simplest solution – complexity doesn’t gain you extra points, if the solution does not work in the end.

PDR - Develop a test plan by identifying all tests required to prove the integrity of design (you may have already completed some tests at this point, so include those and the results in the ‘plan’).

CDR - Update the test plan, with results for completed tests or any additional tests required (as the design evolves, the need for certain tests changes, so update as needed).

FRR - Show that all testing is complete and provide test methodology and discussion of results (perhaps all of the tests aren’t complete at this point, so will need to decide if tests continue or are eliminated).

Design and testing are an iterative process – the results (or negative results) of a test may change the design, which in turn, will change the future tests etc.
Your Reports (Section 7.1) starting with PDR, through CDR and FRR, should include a table listing your tests (example shown here):

<table>
<thead>
<tr>
<th>System</th>
<th>Test</th>
<th>Objective</th>
<th>Timeframe</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td>Hoop test</td>
<td>To verify the hoop strength of the structure</td>
<td>Nov-20</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Shear test</td>
<td>To verify the shear strength of the structure</td>
<td>Nov-20</td>
<td>-</td>
</tr>
<tr>
<td>Altimeter</td>
<td>Pressure test</td>
<td>To verify the pressure sensor operates correctly.</td>
<td>Dec-20</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Accelerometer test</td>
<td>To verify the accelerometer operates correctly.</td>
<td>Dec-20</td>
<td>-</td>
</tr>
<tr>
<td>Recovery</td>
<td>Ejection test</td>
<td>To verify the amount of energetic needed for satisfactory ejection.</td>
<td>Jan-21</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Tracking test</td>
<td>To verify the GPS tracking system functions properly, and determine limitations.</td>
<td>Jan-21</td>
<td>-</td>
</tr>
</tbody>
</table>

At each design cycle, update the list of tests, adding any new ones that may arise or removing unnecessary ones. You may also need to update the timeframe and add the outcomes as tests are completed.
**APPENDIX C-3 – Requirements Verification Overview**

In any engineering project, a major component of project management is requirements management (also known as Verification and Validation - [https://en.wikipedia.org/wiki/Verification_and_validation](https://en.wikipedia.org/wiki/Verification_and_validation)). NASA has many in-depth resources pertaining to Systems Engineering and Project Management.

For a successful project design, it is imperative to understand what the product is supposed to do (its requirements) versus what is nice to have, but not required. The same principles are applied to the project; what is required to complete the project and what is not required.

A simple way to manage this is to create a spreadsheet of all of the requirements, list who is responsible for satisfying the requirement, and list how the requirement will be satisfied. For large scale projects (space shuttle, commercial airplane, aircraft carrier etc.) the requirements are daunting, and it’s absolutely essential to manage the requirements. If not, the end product may not meet some of its expectations or goals, and may gain a few characteristics that were not initially requested. This is known as ‘scope creep.’

A basic example Requirement Verification spreadsheet would look like (a Requirements Spreadsheet is found in the ‘Tools and Tips’ page of the WSGC website):

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Assigned to</th>
<th>Method to Satisfy</th>
<th>Outcome</th>
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<td>Airframe - Simulations</td>
<td>Simulation</td>
<td>Simulation shows 89 fps rail exit.</td>
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<td>14 Vehicle Rqmt</td>
<td>Airframe</td>
<td>Inspection</td>
<td>-</td>
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<tr>
<td>15 Vehicle Rqmt</td>
<td>Team</td>
<td>Demonstration</td>
<td>-</td>
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</table>

Remember to complete and list ALL requirements. Monitoring these requirements will help to ensure a successful build and flight, and ensure nothing is missed during the design.
APPENDIX C-4 – Safety Checklists

Over the course of your project, it is suggested (and a part of the required report content) that your team develop checklists. Checklists can be very useful if designed properly, adhered to and enforced.

Checklists can be used for inventory. Examples include:

- Weekly shop checks to ensure that there are always adequate supplies on hand.
- Parts checks, to ensure all of the required parts/tools are brought when transporting the rocket.

Checklists can be used for a complicated build procedure, that requires consistency and accuracy (that requires many different people to repeat multiple times). Examples include:

- Building/laying up a carbon fiber cloth tube or part.
- The order and timing of steps to epoxy fins to the motor mount tube and body.

Checklists can be used rocket launch preparation (again, where repeatability by various members is required). Examples include:

- Avionics programming steps.
- Avionics bay assembly.
- Payload/challenge assembly and installation/integration with vehicle.

This list is not exhaustive. Brainstorm with your team to determine when best to develop checklists. Checklists will likely change over time as the process changes. Ensure they are up to date, and ensure everyone is using them (they are accessible). Safety checklists can be found on the Tools & Tips page [https://spacegrant.carthage.edu/live/files/5419-fnl21safety-checklistsxlsx](https://spacegrant.carthage.edu/live/files/5419-fnl21safety-checklistsxlsx).
1. Avionics Preparation Checklist Example

Example Avionics Preparation Checklist
Altimeter Prep can be completed night before Launch

Altimeters
- Ensure altimeter(s) are programmed correctly
  - Plug altimeter into interface (computer or display)
  - Power up altimeter (using switch if possible)
  - Ensure altimeter is reading local conditions (if equipped)
  - Ensure drogue parachute deployment is set properly
  - Ensure main parachute deployment is set properly
  - Power down altimeter and then power up
  - Ensure audible sequence is indicating correctly
  - Ensure sufficient storage bank is available
  - Power down altimeter (using switch if possible)
- If redundant system, repeat steps with second altimeter

Avionics Bay
- Ensure all hardware is attached correctly and firmly
- Ensure fresh power sources are installed and attached correctly and firmly
- Ensure ejection lead wires are attached to respective bulkplates
- Ensure switch wires are attached correctly and firmly
- Close avionics bay by securing bulkplates
- Ensure nothing is loose inside of avionics bay after closing
- Ensure switch still operates correctly
  - Altimeters power on
  - Altimeters produce correct sequence
- If redundant, repeat steps with second altimeter

Ejection Charges (Energetics)
- Ensure altimeters are powered off
- Attach all ejection charges to leads on outside of bulkplates
- Ensure correct charge size goes to correct bulkplate
- Do not power on altimeters after ejection charges are installed

Other
- Ensure any other electronics are powered up and functioning properly
- Install and seal all other electronics accordingly
  - Cameras
  - Tracking devices
Example Recovery Preparation Checklist

Avionics Prep should be completed prior to start of Recovery Prep

Drogue Parachute / Lower Airframe

- Attach shock cord to eyebolt on motor centering ring
  Use quicklink - ensure tightened
- Attach parachute shroud lines to shock cord at 1/3rd point
  Use quicklink - ensure tightened
- Attach shock cord to eyebolt on avionics aft bulkplate
  Use quicklink - ensure tightened
- Roll / fold parachute in parachute protector (if used)
- Daisy chain or coil shock cord
- Insert cellulose wadding (if used) into tube
- Insert shock cord and parachute into lower airframe tube
  Ensure parachute protection is pointed sideways
  (As charges will come from both sides)
  Ensure shock cord / parachutes are as far into tube as possible
- Close section by securing avionics bay with lower airframe
  Ensure energetics are still attached properly when closing
  Insert shear pins if used
- Ensure proper snug fit - lift entire lower assembly by avionics bay only
  Sections should not slide apart

Main Parachute / Upper Airframe

- Attach shock cord to eyebolt on nosecone or forward bulkplate
  Use quicklink - ensure tightened
- Attach parachute shroud lines to shock cord at 2/3rd point
  Use quicklink - ensure tightened
- Attach shock cord to eyebolt on avionics forward bulkplate
  Use quicklink - ensure tightened
- Roll / fold parachute in parachute protector (if used)
- Daisy chain or coil shock cord
- Insert cellulose wadding (if used) into tube
- Insert shock cord and parachute into upper airframe tube
  Ensure parachute protection is pointed towards charges
  Ensure shock cord / parachutes are as far into tube as possible
- Close section by securing avionics bay with upper airframe
  Ensure energetics are still attached properly when closing
  Insert shear pins if used
- Ensure proper snug fit - lift entire vehicle by nosecone only
  Sections should not slide apart

*ensure avionics bay is aligned in proper direction (not reversed)
**ensure shock cords / parachutes are not ‘jammed’ into airframe tubes / free to release
***can use talcum powder to provide lubrication inside of tube as needed
3. Flight Assembly Checklist Example

Example Final Assembly Checklist

Avionics
- Ensure avionics prep checklist is complete
- Ensure avionics bay is fully assembled
- Ensure ejection charges are connected

Recovery
- Ensure recovery prep checklist is complete
- Ensure all sections are joined after checklists are complete

Payload / Challenge
- Ensure payload / challenge components / system are installed properly
- Ensure payload / challenge components are functioning properly

Motor
- Install motor into rocket
- Ensure motor retainer is tight after installation
- Ensure motor ignitor wire remains with rocket
  - Can tape to lower airframe until needed on Launch Pad

Rocket should now be flight ready, and ready for RSO inspection
- Physically verify the CG of the flight ready rocket by balancing about CG
  - Mark the CG with marker
  - Mark the simulated CP with marker

RSO Inspection
- Fill out flight card with proper details
- Proceed to RSO table / tent for final checkout
- After RSO inspection, turn in flight card to Launch Director for next salvo
4. Launch Pad Setup Checklist

Example Launch Pad Setup
*following RSO approval

- Wait for Range Open call from Launch Director
  Proceed to assigned launch rail (if assigned one)
  *Tripoli members will assist / monitor launch prep

- Unlock and tilt rail horizontal
- Slide lower rail button into rail (rocket on top side of rail)
- Slide down until upper rail button is into rail
- Ensure to hold rocket entire time, do not put full weight onto rail
- Slide rocket entire way down the rail (holding rocket)
- Tilt rail (while holding rocket) back to vertical and lock into place

- Power up altimeters
  Ensure altimeters are beeping correct sequence
- Power up any other electronics (Tracking, cameras, etc.)

- Prep motor/ignitor lead wire
  Separate 5 - 6 inches of lead wires (so they won't touch)
  Strip 1 - 2 inches of each end of lead wire (for joining to power)
  Insert motor ignitor (coated end) into motor until stops
  Ensure tip of ignitor is all the way to the top of the motor
- Kink the ignitor wire at the edge of motor when inserted
- Secure the ignitor in position by either:
  - Tape the ignitor to the motor retainer at the kink
  - Use the plastic motor cap to hold the ignitor in place at kink

- Locate power leads on ground (alligator clips)
- Ensure power / continuity is off by touching leads together (sparking)
  - If sparking, inform Tripoli member
- Wrap one ignitor lead wire around alligator clip
  - Position alligator clip / wire such that it is not pulling on ignitor in motor
- Wrap other ignitor lead wire around alligator clip
  - Position alligator clip / wire such that it is not pulling on ignitor in motor
  *Clips may be taped to launch rail base
  *Ensure alligator clip is not touching metal
  *Ensure alligator clips are not close to each other (accidental contact)

- Take rocket pictures / setup any ground cameras
- Proceed back to pit area
5. Post Flight Checklist Example

Example Post Flight Checklist

- Proceed to general area of last sighting of rocket impact
- Power up GPS and ensure lock
  - Proceed to rocket location
  - Listen for PA if other rockets are in the air

- Take photos of landing site prior to disturbing rocket components
  - *this can be used in post launch assessment
- Listen to / record audible sequence from altimeters (prior to disturbing)
  - *this can be used to verify apogee altitude
- Disable / power off electronics (try not to disturb)
- Verify that ejection charges have gone off (canisters are empty)
  - If not, cut wires to disable charges

- Ensure all components are accounted for (in the area)
- Inspect airframe components for any structural damage
  - If damage, photograph (for post launch assessment)
- Inspect parachutes and recovery hardware for any damage
  - If damage, photograph (for post launch assessment)
- Inspect payload for any damage
  - If damage, photograph (for post launch assessment)

- Once inspection is complete, return to pit area with all rocket components
  - Listen for PA while walking if other rockets are in the air

- Remove motor casing
- Dispose of any spent grains.
- Clean motor casing with cleaning wipes.

- Disassemble avionics subsystem
- Power up altimeters and extract flight data.
- Turn in flight data
  - Transfer flight data to flash drive.
**APPENDIX D-1 – How to Join NAR or TRA**

Although not necessary to be a NAR or TRA member to compete in FNL, there are benefits to being a member in your local chapter or prefecture. Many students continue to design, build and fly high-powered rockets after the competition as a personal hobby – in this case, you must be a member to continue flying. It is not necessary to join both organizations.

You must first be a National member (by joining the National Organization), to join a local club (which is optional - you do not need to join a local club to be a national member, but each has its own benefits). You can search for local clubs near you on each National website.

**TRA membership includes:**

- Tripoli is the premier high-power rocketry organization! If high-power flying is your primary interest, Tripoli is the organization you want.
- Tripoli's annual launch, LDRS, is by far the best-attended high-power launch in the world! It's what you saw on the Discovery Channel!!
- Tripoli flyers are taken seriously by the commercial rocket community. TRA members were the first civilians to put a rocket into space (CSXT), and Tripoli members have been invited to assist NASA on rocketry research projects.
- Tripoli is an international organization, with prefectures worldwide. At TRA launches in the US, you may meet some of our members from Canada, Australia, the U.K., Sweden, Germany, Switzerland, and many more.
- Tripoli has its own private, active forums so that members can ask rocket-related question and get answers (sometimes too many answers!), without the spam and noise that accompanies some other forums.
- Tripoli-sanctioned launches are insured for up to $3,000,000 with primary insurance coverage. That means that in the highly-unlikely event of an accident, TRA insurance kicks in first
- Tripoli is an organization where there is no "little guy". At TRA launches you'll meet both novices and experienced rocketeers, all open and friendly to newcomers, all eager to share knowledge.
- In Tripoli you can advance into the exciting world of rocketry — designing, constructing and flying your own rocket motors!
- Tripoli is a group of serious rocketeers that is open to new generations and new members.
- Last but not least, Tripoli launches are just plain FUN!!

**NAR membership includes:**

- Six issues of Sport Rocketry magazine.
- The NAR Member Guidebook—a 64-page how-to book on all aspects of rocketry.
- $5 million rocket flight liability insurance.
- Access to the, “Member Resources” website.
- Access to NAR technical reports, high-power certification, and clubs.

**Membership Links**

Tripoli Rocketry Association membership can be found at:  [http://www.tripoli.org/Membership](http://www.tripoli.org/Membership)

National Association of Rocketry membership can be found at:  [https://www.nar.org/my-membership/](https://www.nar.org/my-membership/)

**Annual Membership Fees**

<table>
<thead>
<tr>
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<th>TRA membership fees are:</th>
<th>NAR membership fees are:</th>
</tr>
</thead>
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<td>$25</td>
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<tr>
<td>Adult</td>
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APPENDIX D-2 – How to Obtain a Local NAR or TRA Mentor

How to Acquire a Local Rocketry Mentor

It is recommended that your team reach out to the local rocketry clubs in your area, to obtain a volunteer rocketry mentor. This is equally beneficial to new teams - who are just learning the sport and rules - as well as to veteran teams, who may want to take their experience to another level. There are two national organizations you can appeal to for mentorship.

The primary national rocketry organization that would be able to support high-powered rocketry teams:
- Tripoli Rocketry Association (TRA) - http://www.tripoli.org/
- Prefecture (Chapter) Search - http://www.tripoli.org/Prefectures

Note that the host of the FNL competition, Tripoli Wisconsin, is among many Tripoli prefectures around the country.

If there is not a Tripoli Prefecture in your area, you can also contact the low powered national rocketry organization:
- National Association of Rocketry (NAR) - https://www.nar.org/
- Chapter Search - https://www.nar.org/find-a-local-club/nar-club-locator/

Once you find a local chapter, there are many ways to ask for support, or learn from the experience in your own backyard. Most chapters will have monthly club meetings, of which you can attend. Explaining to the club what your team is trying to do, and asking for a club member (or a set of members, depending on time commitments) to be on call for your questions is fairly straight forward.

Most chapters will also have a launch site nearby, with an FAA waiver and monthly club launches (usually weekends). Club launches are open to spectators, and there is no fee to attend and observe. Some of the larger club launches will have rocketry vendors and food vendors on-site, so you can make local connections for parts and supplies. Attending a club launch with your team as spectators is a great way to recruit new members and get your team excited to design and build a high-powered rocket, as well as to network with veteran rocketeers in your area.

Benefits to Acquiring a Local Rocketry Mentor

There are many benefits to obtaining a local rocketry mentor:

1. A local mentor can provide technical advice to save your team from making common mistakes during the design and build process.
2. A local mentor can come to your campus in person, and physically inspect the rocket or address any concerns or provide build advice from the beginning of the project.
3. A local mentor can help students get high-powered rocket certified, by explaining the process and utilizing the local club to observe and approve your certification flight.
4. A local mentor/club involvement will allow your team to perform test flights prior to competition.
5. A local mentor can provide advice on how to obtain and handle energetics properly (black powder or pyrodex, motors etc.).
6. A local mentor can provide advice on where to obtain rocketry supplies, parts and materials locally.
7. A local mentor can also work with your school, to provide advice and inform the school about regulations, to support the safe handling of hazardous materials and processes that are involved with building and testing high-powered rockets.

It is WSGC FNL expectation that teams will take advantage of their local NAR or TRA clubs, and increase the team skills, experience, resourcefulness and autonomy. It is likely that the local NAR or TRA would also be interested in gaining more young members in their clubs, and having a connection to academia is always beneficial for outreach.

Note: Tripoli Wisconsin is still the final authority pertaining to what is acceptable to fly in FNL.
APPENDIX D-3 – How to Acquire RockSim and Simulation Resources

Early in the course of your design, your team is expected to select a simulation tool, in order to help simulate the performance of your designed vehicle, and in order to help make design choices (such as overall weight, diameter, motor selection, payload/challenge location etc.).

There are various rocket simulation tools in existence. One in particular that provides the most flexibility and ease of use is RockSim (https://www.apogeerockets.com/RockSim_Quick_Start_Guide?pg=quickside). Each team is required to submit all simulations as a RockSim file. Other simulation resources, such as OpenRocket, may be used as a second verification source.

To receive a discounted temporary license for rocketry competition team members, select the RockSim – Education & TARC option: https://www.apogeerockets.com/Rocket_Software/RockSim_Educational_TARC. Select the RockSim – TARC Temporary License (Expires Aug 31) option.
APPENDIX D-4 – How to Acquire and Use Ejection Charges

During the Launch Weekend, with regards to safe and proper handling of energetics, Tripoli Wisconsin will provide and distribute ejection charges for your competition rocket. These will be a scratch-built canister type, with a minimum of 6 inches of lead wire (that you will connect to your altimeters, either directly through a hole in the bulkhead, or indirectly to a terminal block on the bulkhead).

More experienced or advanced teams may wish to complete ejection tests prior to competition, or even a full scale test flight. This section provides guidance on how to acquire and properly handle ejection canisters and energetics.

Energetics used for ejection come in two types; Black Powder and Pyrodex

Black Powder

Black powder is a fine grain chemical explosive. [https://en.wikipedia.org/wiki/Gunpowder](https://en.wikipedia.org/wiki/Gunpowder)

Pyrodex

Pyrodex (a trade name) is a black powder substitute. [https://en.wikipedia.org/wiki/Black_powder_substitute](https://en.wikipedia.org/wiki/Black_powder_substitute)

Ejection canisters used for containing the energetics come in various forms; all scratch-built.

Scratch-Built Ejection Canister

A proper ejection canister will need; a canister (or container to hold the energetic) and an igniter (a lead wire containing a filament tip that will ignite the energetic).

PVC Ejection Canister (left) and E-match kit (right).
Ejection canister with e-match installed.

Ejection canisters with energetics contained (e-match not installed).

Containers may be PVC caps or even small balloons. The igniters (sometimes called e-matches – although e-matches are federally regulated) are usually purchased through a reputable manufacturer/source.

Many outdoor sporting stores will sell Black Powder and Pyrodex. It should be stored in a secure and dry place (see the attached MSDS sheet, or search for a proper MSDS sheet for storing and handling information). Canisters (of various types) can be purchased online at various rocketry vendors.

You may want to experiment with various types of canisters and energetics to determine what works best for your team and rocket. Keep in mind however, that the competition charges will be a canister type, with black powder energetics.

**Compressed Gas Ejection**

An alternative to chemical explosives for energetics, is a CO2 compressed gas ejection system (such as the Peregrine CO2 Ejection Device, shown in the image below). Here the canisters are disposable, but the energetic and the canisters are all provided as a kit (little fabrication required).
**APPENDIX D-5 – Personal Tripoli HPR Certification**

There exists an opportunity for advisors and students to attain their Tripoli High-powered Rocketry Certification, either at a Launch 2 Learn rocket certification workshop or at the First Nations Launch competition.

Launch 2 Learn Certifications are subject to the Launch 2 Learn workshop. If the workshop is conducted at Carthage College in Kenosha, WI, attendees will complete the certification process within the workshop. If the workshop is conducted at a different location or virtually, the certification flight may take place at a later date.

Launch weekend certification flights will take place on Sunday from 10:00 am – 2:00 pm, so plan your travel accordingly. In order to certify, you must sign up with WSGC (express your intention to certify) by the deadline announced in the FNL Calendar, in order that we may procure and provide motors as needed. If you did not attend the Launch 2 Learn Workshop (‘Appendix D-6’), and plan to certify, you must coordinate your motor choice with Tripoli Wisconsin Technical Advisor.

**Tripoli Certification Overview** ([http://www.tripoli.org/Certification](http://www.tripoli.org/Certification))

**High-power Level 1**

“The Level 1 certification, is open to all senior members 18 years and older. The candidate needs to build, launch and successfully recover a rocket using a certified HPR motor in the H to I impulse range.”

All workshop attendees may attempt a certification flight, while in Wisconsin. In order to successfully attain the certification, the student must be a registered Tripoli member (fee will be paid by WSGC). All motors will also be covered by WSGC at the time of certification.

Those students who did not attend the workshop, may also attempt a certification during the Launch Weekend. However, the costs of the rocket, and the motor must be borne by the student. The Tripoli membership fee will be covered by an FNL sponsor. The student must purchase and build their rocket independently, and transport their rocket to and from Wisconsin for the certification flight.

The Tripoli Wisconsin Technical Advisor has a list of motors to choose from, in order to attempt a certification flight.

**High-power Level 2**

“The Level 2 certification is open to all senior members who hold a current Level 1 certification. The candidate needs to successfully pass the Level 2 written examination and then build, fly and recover successfully a rocket using a certified HPR motor in the J to L impulse range.”

Written Test – Only members certified L1 may take the L2 written examination. The written examination for level 2 shall be passed PRIOR to a level 2 certification flight.

Any student who has already obtained their Level 1 certification, may attempt a Level 2 certification during the Launch Weekend in Wisconsin. There will be a written test that must be passed prior to flight attempt. The costs of the rocket and the motor must be borne by the student. The Tripoli membership fee will be covered by an FNL donor. The student must purchase and build their rocket independently, and transport their rocket to and from Wisconsin for the certification flight. Launch 2 Learn does not offer Level 2 certification.
APPENDIX D-6 –Launch 2 Learn Rocket Certification Workshop

First Nations Launch offers an exciting opportunity for teams to participate in an Introductory Rocket Certification Workshop referred to as Launch 2 Learn. Each year, WSGC sponsors three (3) schools participating in the program for the first time, to attend the Launch 2 Learn workshop. All attendees receive a Level 1 Loc Precision Caliber-ISP Single Deploy Rocket Kit and Level 1 Tripoli Rocketry Association Certification upon a successful flight recovery.

The workshop will introduce design, build, and fly concepts. Participants will build a high-powered single deploy rocket and be presented with the difference between single and dual deploy rockets. They will be introduced to a basic understanding of rocket flight simulation and be given an overview of NAR and TRA certification.

First Nations Launch has offered workshops at Carthage College and at local campuses. The workshop may be offered virtually beginning in 2020. Up to ten (10) individuals will be sponsored through the program. Other FNL participants may attend a workshop but will be responsible for all expenses. The basic kit build is $200 plus any travel and FNL per diems associated with the workshop.

This unique opportunity is available for all teams who have submitted a Notice of Intent to compete in FNL. In order to be eligible to attend, teams must submit a letter of request as stated in the FNL Calendar of Opportunities.
APPENDIX D-7 – WSGC Resource Page

Wisconsin Space Grant Consortium (WSGC) https://spacegrant.carthage.edu/
WSGC Website Registration Page (Login/Registration) https://spacegrant.carthage.edu/about/login/
First Nation Launch (FNL) Web Page https://spacegrant.carthage.edu/first-nations-launch/
FNL Zoom Meetings https://zoom.us/j/99258659434
FNL Calendar https://spacegrant.carthage.edu/first-nations-launch/calendar/
FNL FAQ https://spacegrant.carthage.edu/first-nations-launch/faq/
FNL Patch Contest https://spacegrant.carthage.edu/first-nations-launch/patch-contest/
FNL About Us https://spacegrant.carthage.edu/first-nations-launch/about-us/
FNL History https://spacegrant.carthage.edu/first-nations-launch/history/
FNL Awards https://spacegrant.carthage.edu/first-nations-launch/awards/

FNL Report Templates and Scoring Rubric https://spacegrant.carthage.edu/first-nations-launch/rubric/
FNL Flight Readiness Review PP Template (Oral Presentation) Flight Readiness Presentation

FNL Team Building Resources https://spacegrant.carthage.edu/first-nations-launch/tools-and-tips/

AISES – American Indian Science and Engineering Society https://www.aises.org/
Apogee Rockets – RockSim Information  https://www.apogeerockets.com/RockSim/RockSim_Information

Apogee Rockets – RockSim Quick Start Guide  

Apogee Rockets – RockSim Discounted Temp License  
https://www.apogeerockets.com/Rocket_Software/RockSim_Educational_TARC

NASA Space Grant Consortium(s)  
https://www.nasa.gov/stem/spacegrant/home/Space_Grant_Consortium_Websites.html

NASA Systems Engineering and Project Management Resources  
https://en.wikipedia.org/wiki/Verification_and_validation

Tripoli Rocketry Association (TRA)  http://www.tripoli.org/  
TRA Membership  http://www.tripoli.org/Membership

TRA Certification Overview  http://www.tripoli.org/Certification

TRA Prefectures  http://www.tripoli.org/Prefectures

National Association of Rocketry (NAR)  https://www.nar.org/

NAR Membership  https://www.nar.org/my-membership/

FAA Waiver on NAR Website  
http://www.nar.org/high-power-rocketry-info/filing-for-faa-launch-authorization/filing-for-faa-waiver/

The following documents can be found on the FNL Tools and Tips webpage or the URL may be copied and pasted into your search field  https://spacegrant.carthage.edu/first-nations-launch/tools-and-tips/  


FNL Launch 2 Learn Rocketry Workshop  https://spacegrant.carthage.edu/first-nations-launch/launch-2-learn-rocket-certification-workshop


FNL Team Roster & Lodging Form  https://spacegrant.carthage.edu/live/files/5553-fnl21official-team-roster-and-loding-list-fillable

FNL Proposed Budget Example  https://spacegrant.carthage.edu/live/files/5381-fnl21appendix-c-1budget-examplepdf

FNL Project Expense Form Instructions  https://spacegrant.carthage.edu/live/files/5378-bec21project-expense-forminstructions-and-example

FNL Project Expense Forms  https://spacegrant.carthage.edu/live/files/5377-bec21project-expense-formfillable-for-webfinalpdf
FNL Travel Expense Form Instructions https://spacegrant.carthage.edu/live/files/5403-travel-expense-formeditable-instructionsfinalpdf

FNL Travel Expense Form https://spacegrant.carthage.edu/live/files/5402-travel-expense-forminstructions-and-example-for

FNL Shipping Procedure https://spacegrant.carthage.edu/live/files/5397-fnl-appendix-b-4-rocket-shipping-procedurespdf