2019-2020

First Nation Launch

Student Competition Handbook

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Acronym Dictionary

AGL = Above Ground Level
AISES = American Indian Science and Engineering Society
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
FNLI = 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
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
TCU = Tribal Colleges and Universities
TRA = Tripoli Rocketry Association
WSGC = Wisconsin Space Grant Consortium
**Glossary**

**Team Advisor** = usually an educator, responsible for many 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 First Nations Launch – does not need to have a STEM or technical background.

**Team Mentor** = not necessarily affiliated with the school, this person is typically Tripoli Rocketry Association or National Association of Rocketry certified and/or an industry subject matter expert, as well as experienced with building and flying high-powered rockets.

Team Advisor and Team Mentor may or may not be the same individual.

**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 control, or deployment or sampling are usually not a part of the Avionics (they would be referred to as Payload Electronics), even if they are housed in the same area as the Vehicle Avionics. Payload Electronics would have their own electrical circuit and power source.

**Payload** = is used to describe the ‘cargo’ that the rocket vehicle is designed to carry. A conventional payload would integrate inside of the rocket tube, usually behind the nose cone. An unconventional payload could consist of external hardware that is used to control the vehicle, or alter its appearance. The ‘payload’ is the team solution to the challenge posed by FNL.
Statement of Work (Engineering Parameters)

Design, Development, and Launch of a Reusable Rocket and Payload: Statement of Work

Activity Name: WSGC First Nation Launch

Governing Office: Carthage College, Wisconsin Space Grant Consortium

The Wisconsin Space Grant Consortium First Nations Launch competition offers Tribal Colleges and Universities (TCU), as well as active American Indian Science and Engineering Society (AISES) collegiate 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 unique aerospace experience for students that provides a great aerospace experience unique to the Native American communities.

Wisconsin Space Grant Consortium seeks proposals from TCUs, as well as, colleges and universities with active AISES chapters to conduct the WSGC First Nations Launch during the 2019-2020 academic year.

Proposals to participate will be accepted from any TCU 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.

The challenges are summarized as follows:

Moon Engineering Challenge:

Teams are required to design and construct a “Moon Capsule” stowed in/on a high - powered rocket. The Capsule will be designed to carry two (2) raw eggs to an altitude of 2389 ft AGL. The Flight Crew eggs must be undamaged upon recovery. A video camera must be mounted inside of the capsule, to observe the Flight Crew eggs over the duration of the flight. The Capsule does not need to separate from the rocket vehicle.

Mars Engineering Challenge:

Teams are required to design and construct a “Moon Lander Vehicle” stowed in/on a high-power rocket. The rocket shall deploy the Moon Lander at an apogee altitude of 2389 ft AGL or during descent. If Moon Lander is not tethered to the rocket during descent, the Moon Lander shall have its own recovery parachute system. The Moon Lander shall be designed to land in an upright configuration. Mounting cameras showing Moon Lander deploying from rocket are required. In addition, an onboard video camera on the lander capturing its descent and landing is required.

Teams may compete in either challenge. There are no restrictions or requirements for team eligibility. WSGC highly recommends new teams, teams with all new members, and non-engineering school teams enter the Moon Challenge, while experienced teams and engineering school teams enter the Mars Challenge.

The requirements to compete in FNL for 2019-2020 are as follows:

(*** Denotes requirement is optional for Moon Challenge)
General Requirements

1. The adult educator/advisor and the student team lead must register on the WSGC website prior to submitting a Notice of Intent (NOI) to compete (see ‘Appendix C-1’ for instructions on how to register). Once both individuals have registered, the advisor will complete the NOI application. 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 complete in order for the team to be considered eligible to compete.

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

3. The adult educator/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 attending launch week activities by the due date of the CDR. This is accomplished by ensuring each student is registered (as explained previously), and non-attendees are removed from the team roster. 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 mentor (see General Requirement #5).
   c. One adult educator/advisor. Teams may have no more than two adult educators/advisors.

5. Each team must identify a ‘local/state mentor’ (see ‘Appendix C-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.
      i. 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. 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).

7. The team will provide and maintain a project plan to include, but not limited to the following items: project milestones, budget and community support, checklists, personnel assignments, STEM engagement events, and risks and mitigations. Team advisor should provide guidance. See ‘Appendix B-1’ for example project plans.

8. Team leads will upload all deliverables to the WSGC grant management page (see ‘Appendix C-3’ for instructions on how to upload to WSGC website) by the deadline specified in this handbook for each milestone. All deliverables must be in PDF format.

9. Teams will utilize the provided templates (see ‘Report Templates and Scoring Rubrics’ on the WSGC website) for each report and virtual presentation. In every report, teams will:
   a. provide a table of contents including major sections and their respective sub-sections
   b. include the page number at the bottom of the page
10. The team will provide (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.

11. 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 airframe, couplers, bulkheads should be completely procured/manufactured to spec and permanently attached as designed.

12. 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 12 foot (12”) 1515 rails will be provided. 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.

13. All projects must have a documented flight stable simulation profile. Commercial high-powered rocketry software is highly recommended (i.e. Rocksim, OpenRocket). Teams are free to write their own code/software for flight simulations but this code needs to be validated, through documented test flights prior to submitting the FRR. See ‘Appendix C-4’ for information how to obtain Rocksim.

**Vehicle Requirements**

1. Moon Challenge: The vehicle will deliver the payload to an apogee altitude of 2,389 feet above ground level (AGL).

2. Mars Challenge: The vehicle will deliver the payload to an apogee altitude of 2,389 feet above ground level (AGL).

3. 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.

4. The total impulse provided by launch vehicle (both Moon and Mars Challenge) will be between a 480 Newton-seconds (I-J-class) – 38mm and 2,650 Newton-seconds (K-class) – 54mm. Motor provided by WSGC. See ‘Appendix A-4’ for detailed motor criteria.

5. 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).

6. Each altimeter will have a dedicated power supply.

7. Each altimeter will be armed by a dedicated mechanical arming switch that is accessible from the exterior of the rocket airframe when the rocket is in the launch configuration on the launch pad.

8. Each arming switch will be capable of being locked in the ON position for launch (i.e. cannot be disarmed due to flight forces).
9. 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.
   a. Coupler/airframe shoulders which are located at in-flight separation points will be at least 1 body diameter in length.
   b. Nosecone shoulders which are located at in-flight separation points will be at least \( \frac{1}{2} \) body diameter in length.

10. 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.

11. 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.

12. The launch vehicle will accelerate to a minimum velocity of 52 fps at rail exit.

13. 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.

14. 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.
   b. The team will record the Estes rocket flight, post the results to Facebook, and upload the URL to the Team Lead’s Grant Management page.

15. Mars Challenge teams are highly recommended to successfully launch and recover a subscale model of their rocket prior to CDR. Subscales are not required to be high-power rockets (Mars Challenge ONLY)**
   a. The subscale model should resemble and perform as similarly as possible to the full-scale model, however, the full-scale will not be used as the subscale model.
   b. The subscale model will carry an altimeter capable of recording the model’s apogee altitude.
   c. The subscale rocket must be a newly constructed rocket, designed and built specifically for this year’s project.
   d. Proof of a successful flight shall be supplied in the CDR report. Altimeter data output may be used to meet this requirement.

16. 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.

17. 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 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.

l. 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. 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 C-5’ for recommendations).

3. The recovery system electrical circuits will be completely independent of any payload electrical circuits.

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

5. The recovery system will contain at least one (although redundant is recommended), commercially available altimeter. The term “altimeters” includes both simple altimeters and more sophisticated flight computers. Neatness of wiring will affect scoring (and possibly performance).

6. Motor ejection is required backup deployment at apogee.

7. The recovery system electronics:
   a. Will not be adversely affected by any other on-board electronic devices during flight (from launch until landing).
   b. Will be physically located in a separate compartment within the vehicle from any other radio frequency transmitting device and/or magnetic wave producing device.
   c. Will be shielded from any other onboard devices which may adversely affect the proper operation of the recovery system electronics.

8. RECOMMENDED: Removable shear pins can be used for both the main parachute compartment and the drogue parachute compartment (optional).

9. RECOMMENDED: An electronic tracking device will be installed in the launch vehicle and will transmit the position of the tethered vehicle or any independent section to a ground receiver (optional).
   a. Any rocket section or payload 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.
Payload / Experiment Requirements

1. Moon Challenge – The following specific requirements must be satisfied:
   a. The rocket must be fin-stabilized with a static margin of one (1) or greater (in fully loaded preflight configuration)
   b. The rocket must fly with a minimum of one (1) on-board camera (to observe the payload).
   c. The payload must resemble a capsule: It can be the nosecone itself, contained within the nosecone, or contained within the upper airframe.
   d. The payload does not need to separate from the rocket vehicle – if the rocket design includes payload separation, this must be approved by WSGC team.
   e. Dual deployment is recommended but not mandatory.
   f. All airframe parts must be Commercial-Off-The-Shelf (COTS). Any custom fabricated parts must be approved by WSGC team.

2. Mars Challenge – The following requirements must be satisfied:
   a. The rocket must be fin-stabilized with a static margin of one (1) or greater (in fully loaded preflight configuration)
   b. The rocket must fly with a minimum of one (1) camera showing the deployment/separation of the payload from the vehicle.
   c. The rocket must fly with a minimum of one (1) camera in/on the payload for the duration of the flight.
   d. Dual deployment is recommended but not mandatory.
   e. All airframe parts must be Commercial-Off-The-Shelf (COTS). Any custom fabricated parts must be approved by WSGC team.

Safety Requirements

1. 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 B-2’ for checklist support).

2. 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
      2. Construction of vehicle and payload
      3. Assembly of vehicle and payload
      4. Ground testing of vehicle and payload
      5. Launch day
      6. Recovery activities
   b. Implement procedures developed by the team for construction, assembly, launch, and recovery activities.
   c. Document, manage and maintain current revisions of the team’s safety procedures, and MSDS/chemical inventory data. (Mars Challenge ONLY)**

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 payloads at WSGC FNL does not give explicit or implicit authority for teams to fly those vehicle configurations and/or payloads 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. Teams will abide by all rules set forth by the FAA.

5. For proof of construction and a safe flight, photographs/video must be made during the construction process (especially of sealed or hidden components) to ensure proper technique has been followed.
6. All projects must have a minimum of two (2) virtual inspections with the WSGC Technical Advisor, prior to (to coincide with) Flight Readiness Review.

7. 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, which must be included in the design reports.
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, mailing address, title of the project, and the date.

2. Name, title, and contact information (including phone number) for up to two adult educators (minimum of one 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 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(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, and how many licenses are available (OpenRocket, RockSim, etc.).

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.
   2.1. Provide a description of the procedures for NAR/TRA personnel (mentor) to perform. Ensure the following:
       2.1.2. Performance of all hazardous materials handling and hazardous operations.
   2.2. Describe the plan for briefing students on hazard recognition and accident avoidance as well as for conducting pre-launch briefings.
   2.3. Describe methods to include necessary caution statements in plans, procedures, and other working documents, including the use of proper Personal Protective Equipment (PPE).
   2.4. Each team shall provide a plan for complying with federal, state, and local laws regarding unmanned rocket launches and motor handling. Specifically, regarding the use of airspace, Federal Aviation Regulations 14

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

2.6. Include a written statement that all team members understand and will abide by the following safety regulations:

   2.6.1. 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.

   2.6.2. The Range Safety Officer has the final say on all rocket safety issues. Therefore, the Range Safety Officer has the right to deny the launch of any rocket for safety reasons.

   2.6.3. 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.

   2.6.4. Any team that does not comply with the safety requirements will not be allowed to launch their rocket.

Technical Design

1. A proposed and detailed approach to rocket and payload 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.
   e. Address the General, Vehicle, Recovery, Payload, and Safety requirements outlined on pages 5-11 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.

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), recruitment of team members, funding sustainability, and STEM engagement activities.
First Nations Launch 2020 Project Deliverables

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

1. Participation in the virtual Kick-off Meeting.
2. A reusable rocket with required payload system ready for competition launch.
3. A rocket simulation file of the as-built competition rocket, due the day before competition launch.
4. An Estes rocket must be flown before PDR and a video of the flight uploaded prior to PDR. The rocket will be provided by WSGC.
5. Reports (PDF format) and virtual presentations (PowerPoint format) completed and submitted to the WSGC FNL grant management team by the team lead on applicable due dates.
6. Participation in PDR and CDR virtual reviews through GoToMeeting conference call.
7. Participation in two (2) Virtual Technical Inspections with Tripoli Wisconsin.
8. Flight (avionics) data must be turned in on competition launch day.

WSGC FNL is responsible for providing to the teams:

1. Project / Travel Award of $3000.
2. Hotel accommodations (maximum three (3) rooms for three (3) nights per team at competition hotel), during Launch Weekend.
3. Select meals (Thursday dinner, Friday lunch, Saturday lunch and dinner), during Launch Weekend.
4. Low-power rocket for flight demo, 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, 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.
Program Milestones: Criteria and Expectations

Preliminary Design Review (PDR)

The PDR demonstrates that the overall preliminary design meets 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). Note that (***) items are optional for Moon Challenge teams.

I) Team Summary
   - Team name and mailing address
   - Name of school advisor
   - Name of mentor, NAR/TRA number and certification level, and contact information

II) Summary of PDR report (1 page maximum)

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

Payload Summary
   - Payload title
   - Summarize payload experiment

III) Changes made since Proposal (1-2 pages maximum)

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

IV) Vehicle Criteria

Selection, Design, and Rationale 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.
   - Provide dimensional drawings (perhaps using a solid modeler, or 2-D simulation images at the least) using the leading design. (Mars Challenge ONLY)***
   - Provide estimated masses for each subsystem. (Mars Challenge ONLY)***

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 Bay 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, type/location of switch(es) to be used to power on from outside of the vehicle, power/wiring of electronics.

**Motor Selection**
• Review different motor alternatives and present data on each alternative.
  o What would dictate the need to change motors as the design progresses? How can this be controlled?
  o 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 – hand calculation accepted) for the rocket and any section that descends untethered from the rest of the vehicle.
• Calculate the drift (normally using simulations – hand calculation accepted) for each independent section of the launch vehicle from the launch pad for three different cases: no wind, 10-mph wind, and 20-mph wind. The drift calculations should be performed with the assumption that apogee is reached directly above the launch pad. *(Mars Challenge ONLY)**

**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 Criteria**
Selection, Design, and Rationale of Payload/Challenge Solution
• Describe what the objective of the payload is and what specific purpose it will perform. What results will qualify as a successful experiment?
• 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 design with the current leading alternatives and explain why they are the leading choices.
• Describe the preliminary interfaces between the payload and launch vehicle.
• Include drawings and electrical schematics for all elements of the preliminary payload. *(Mars Challenge ONLY)**
• List estimated masses for components. *(Mars Challenge ONLY)**

**VII) Project Plan**
Requirements Verification *(Mars Challenge ONLY)**
• Create a verification plan (see ‘Appendix B-3’ for guidance) for every requirement from sections 1-5 of the project requirements listed in the Competition Handbook. Identify if test, analysis, demonstration, or inspection are required to verify the requirement. After identification, describe the associated plan needed for verification.
• If plan is extensive, may be contained as an Appendix to your report.
Budget

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

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.
- 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.


**Preliminary Design Review Presentation**

Please include the following in your presentation:

- 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
- Drawing and discussion of avionics subsystem
- Drawing and discussion of recovery subsystem
- Discussion of current Mission Performance Predictions
- Preliminary payload 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 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 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. Although there should be discussion of subscale models, the CDR documents are to primarily discuss the final design of the full-scale launch vehicle and subsystems.

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. Note that (**) items are optional for Moon Challenge teams.

I) Team Summary

• Team name and mailing address
• Name of school advisor
• Name of mentor, NAR/TRA number and certification level, and contact information

II) Summary of CDR report (1 page maximum)
Launch Vehicle Summary

• Size and mass
• Final motor choice
• Recovery system
• Rail size

Payload Summary

• Summarize payload experiment

III) Changes made since PDR (1-2 pages maximum)
Highlight all changes made since PDR and the reason for those changes.

• Changes made to vehicle criteria
• Changes made to payload criteria
• Changes made to project plan

IV) Vehicle Criteria
Design and Verification 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.
  o Estimate the final mass of launch vehicle as well as the individual subsystems.
• Provide justification for material selection, dimensioning, component placement, and other unique design aspects.
• Using the final designs, create dimensional and computer aided design (CAD) drawings to illustrate the final launch vehicle, its subsystems, and its components. (Mars Challenge ONLY)**

Subscale Flight Results (Mars Challenge ONLY)**
(This section only applies if there exists a test launch vehicle)
• At least one data gathering device must be onboard the launch vehicle during the test launch. At a minimum, this device must record the apogee of the rocket. If the device can record more than apogee, please include the actual flight data.
• Describe the scaling factors used when scaling the rocket. What variables were kept constant and why? What variables do not need to be constant and why?
• Describe launch day conditions and perform a simulation using those conditions.
• Perform an analysis of the subscale flight.
  o Compare the predicted flight model to the actual flight data. Discuss the results.
  o Discuss any error between actual and predicted flight data.
  o Estimate the drag coefficient of the full-scale rocket with subscale data.
• Discuss how the subscale flight data has impacted the design of the full-scale launch vehicle.

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 the parachutes, harnesses, bulkheads, and attachment hardware.
• Provide the operating frequency of the locating tracker(s), if equipped.
• Include drawings/sketches. (Mars Challenge ONLY)**

Avionics Bay Subsystem
• Describe the avionics bay 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 drawings/sketches, block diagrams, and electrical schematics. (Mars Challenge ONLY)**

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.
• Calculate the expected descent time for the rocket and any section that descends untethered from the rest of the vehicle.
• Calculate the drift for each independent section of the launch vehicle from the launch pad for three different cases: no wind, 10-mph wind, and 20-mph wind. The drift calculations should be performed with the assumption that apogee is reached directly above the launch pad (Mars Challenge ONLY)**

V) Safety
Launch Concerns and Operation Procedures
• Submit a draft of final assembly and launch procedures including:
  o Recovery preparation
  o Motor preparation
o Setup on the launch pad
o Igniter installation
o Troubleshooting
o Post-flight inspection

• 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 Criteria

Design of Payload / Challenge Experiment

• Identify which of the design alternatives from PDR was chosen for the payload. 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, as well as the entire payload assembly.
  o Include drawings/diagrams for major components/assemblies.
  o Describe how the payload components interact with each other.
  o Describe how the payload integrates within the launch vehicle.
• Demonstrate that the design is complete.
• Discuss the payload electronics with special attention given to safety switches and indicators. Include the following:
  o Drawings and schematics
  o Block diagrams
  o Batteries/power
  o Switch types and locations
• Provide justification for all unique aspects of your payload (materials, dimensions, placement, etc.)

VII) Project Plan

Testing (Mars Challenge ONLY)**

• For each test, present the test objective and success criteria, as well as testing variable and methodology.
• Justify why each test is necessary to validate the design of the launch vehicle and payload.
• Discuss how the results of a test can cause any necessary changes to the launch vehicle and payload.
• Present results of any completed tests.
  o Describe the test plan and whether or not the test was a success.
  o How do the results drive the design of the launch vehicle and/or payload?

Requirements Compliance (Mars Challenge ONLY)**

• Create a verification plan for every requirement from sections 1-5 of the Project Requirements listed in the Competition Handbook (if extensive, may be contained as an Appendix). Identify if test, analysis, demonstration, or inspection are required to verify the requirement. After identification, describe the associated plan needed for verification.

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.

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 include the following information in your presentation:

- Final launch vehicle and payload dimensions
- Discuss key design features
- 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
- Tests of the staged recovery system
- Discuss mission performance predictions
- Final payload design overview

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) 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 system. 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. Note that (***) items are optional for Moon Challenge teams.

I) Team Summary
- Team name and mailing address
- Name of school advisor
- Name of mentor, NAR/TRA number and certification level, and contact information

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

Payload Summary
- Summarize payload/challenge solution

III) Changes made since CDR (1-2 pages maximum)
Highlight all changes made since CDR and the reason for those changes.
- Changes made to vehicle criteria
- Changes made to payload 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.
  - Structural elements (such as airframe, fins, bulkheads, attachment hardware, etc.)
  - Electrical elements (wiring, switches, battery retention, retention of avionics boards, etc.)
- 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 and defend the robustness of the as-built and as-tested recovery system.
  - Structural elements (such as bulkheads, harnesses, attachment hardware, etc.)
  - Electrical elements (such as altimeters/computers, switches, connectors)
  - Redundancy features
As-built parachute sizes and descent rates
• Drawings** and schematics of the as-built electrical and structural assemblies
• Rocket-locating transmitters with a discussion of frequency, wattage, and range
• Discuss the suitable parachute sizes for mass, attachment scheme, deployment process, and discuss the test results with ejection charges and electronics

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.
• Calculate the expected descent time for the rocket and any section that descends untethered from the rest of the vehicle.
• Calculate the drift for each independent section of the launch vehicle from the launch pad for five different cases: no wind, 5-mph wind, 10-mph wind, 15-mph wind and 20-mph wind. The drift calculations should be performed with the assumption that apogee is reached directly above the launch pad. **(Mars Challenge ONLY)**

V) Safety and Procedures
Launch Operations Procedures
• Provide detailed procedures and checklists for the following (at a minimum):
  o Recovery preparation
  o Motor preparation
  o Setup on launch pad
  o Igniter installation
  o Launch procedure
  o Troubleshooting
  o Post-flight inspection
• 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 Criteria
Design and Testing of Payload
• Describe any changes in the payload design from CDR and explain why those changes are necessary.
• Describe unique features of the payload. Include the following:
  o Structural elements
  o Electrical elements
• Prove that the payload is fully constructed and fully document the construction process.
• Include schematics of the AS-BUILT payload. There is a good chance dimensions have changed slightly due to the construction process.
• Discuss how and why the constructed payload differs from earlier models.

VII) Project Plan
Testing **(Mars Challenge ONLY)**
• Prove that all testing is complete and provide test methodology and discussion of results.
• Discuss whether each test was successful or not.
• Discuss lessons learned from the tests conducted.
• Discuss any differences between predicted and actual results of the tests conducted.
Requirements Compliance (Mars Challenge ONLY)

- Review and update the verification plan. Describe how each Competition Handbook requirement was verified using testing, analysis, demonstration, or inspection.

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.
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. You will use your FRR Review Presentation as a starting point, but provide the most up-to-date details of your rocket vehicle, payload and mission performance predictions.

Please include the following information in your presentation:

- 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
- Avionics bay, altimeter(s), switch/power, vent holes
- Parachute sizes and descent rates, tracking devices
- Recovery system tests and ejection charge required
- Payload design and dimensions
- Key design features of the payload
- Challenges / Lessons Learned (technical challenges, programmatic challenges, key lessons during build)

The team is expected to present and defend the as-built launch vehicle (including the payload), 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; 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 and mailing address
- Name of school advisor
- Name of mentor, NAR/TRA number and certification level, and contact information

II) Summary of PLAR report (1 page maximum)

Launch Vehicle Summary

- Size and mass
- Launch day motor

Payload Summary

- Summarize payload/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 Criteria

Payload Summary

- Discuss the payload performance
  - Did the payload/challenge perform as desired?

Data Analysis and Payload Performance

- Discuss the flight data
  - 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 NAR [www.nar.org/safety-information/] 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 an initial and a final virtual Tech Inspection approximately seven and three weeks before the competition flights, respectively. 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.)
- Construction Techniques.
- Payload or Mechanical Operations.

The team will be given a go – no – go by the WSGC Technical Advisor. The 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 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, a 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>
<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>
<thead>
<tr>
<th>Motor Parameter</th>
<th>Certification Required</th>
<th>Certification Required</th>
<th>Certification Required</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>Level 1 HPR</td>
<td>Level 2 HPR</td>
</tr>
<tr>
<td>Total Combined Impulse</td>
<td>320 N-sec (2xG Class)</td>
<td>640 N-sec (H, I Class)</td>
<td>5120 N-sec (J, K, L Class)</td>
</tr>
<tr>
<td>Combined Propellant Mass</td>
<td>125 grams</td>
<td>No Limit</td>
<td></td>
</tr>
<tr>
<td>Single Motor Impulse</td>
<td>160 N-sec</td>
<td>No Limit</td>
<td></td>
</tr>
<tr>
<td>Single Motor Propellant Mass</td>
<td>62.5 grams</td>
<td>No Limit</td>
<td></td>
</tr>
<tr>
<td>Single Motor Avg Thrust</td>
<td>80 N</td>
<td>No Limit</td>
<td></td>
</tr>
<tr>
<td>Sparky Motors</td>
<td>Not Allowed</td>
<td>Allowed</td>
<td></td>
</tr>
<tr>
<td>Total Rocket Mass</td>
<td>1500 grams</td>
<td>No Limit</td>
<td></td>
</tr>
<tr>
<td>Field Distance Reqmts</td>
<td>Per Model Rocket Safety Code</td>
<td>Per HPR Safety Code</td>
<td></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 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) Payloads
   a) Do not install or incorporate in a high-power rocket a payload 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:
      i) Twice the complex distance for the total installed impulse. (Refer to V. Distance Tables)
      ii) 2000 ft. (610 m)
      iii) 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
### APPENDIX A-1 – First Nations Launch 2020 Awards

*(Based upon availability of funds)*

<table>
<thead>
<tr>
<th>Award Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Prize Award</td>
<td>$3000 w/invitation to a NASA Center</td>
</tr>
<tr>
<td>2nd Place</td>
<td>$2000</td>
</tr>
<tr>
<td>3rd Place</td>
<td>$1000</td>
</tr>
<tr>
<td>Aesthetic Award</td>
<td>Team whose rocket has the most innovative and professional appearance.</td>
</tr>
<tr>
<td>Team Spirit Award</td>
<td>Team chosen by their peers as the team that shows interactive spirit, helpfulness, and cooperation.</td>
</tr>
<tr>
<td>Altitude Award</td>
<td>Team whose actual apogee is closest to required apogee.</td>
</tr>
<tr>
<td>Judges Award</td>
<td>Team chosen by the judges as the team who met the goals of the program and exemplified hard work and determination.</td>
</tr>
<tr>
<td>Next Step Award</td>
<td>Up to $15000 Project/Team Travel Award w/invitation to Student Launch at Marshall Space Flight Center and/or RockOn! at Wallops Flight Facility.</td>
</tr>
<tr>
<td>Team Advisor/Mentor Stipend</td>
<td>Up to $1000 (Teams must meet the conditions of participation). See advisor handbook.</td>
</tr>
</tbody>
</table>
APPENDIX A-2 – First Nations Launch 2020 Outreach

The Wisconsin Space Grant Consortium (WSGC) and NASA would like to thank you for giving our 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 their competition score is based on their outreach activities and your willingness to let them assist you in the work you are doing is appreciated.

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 the WSGC is to promote science, technology, engineering, and math (STEM) fields through educational opportunities in the state of Wisconsin. 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 WSGC funding. If you have any questions about the competition or our organization, please visit our website at https://spacegrant.carthage.edu/

<table>
<thead>
<tr>
<th>Name of Organization</th>
<th>Supervisor Name</th>
<th>Phone or Email</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<table>
<thead>
<tr>
<th># of Hours</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
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<td></td>
</tr>
</tbody>
</table>

### Activity Performed

<table>
<thead>
<tr>
<th>Approx. # of Attendees</th>
<th>Brief Descrip. of Attendees</th>
<th>Brief Descrip. of Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Circle one:

- K-12
- Off-Campus Comm.
- University

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<td></td>
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</tr>
</tbody>
</table>

Circle one:

- K-12
- Off-Campus Comm.
- University
APPENDIX A-3 – First Nations Launch 2020 Overall Scoring Rubric

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

I. Design Reports (60% of total)
   a. **Competition Proposal** (10%)
   b. **Preliminary Design Review** (PDR) (10%)
      1. PDR Virtual Review (5%)
   c. **Critical Design Review** (CDR) (10%)
      1. CDR Virtual Review (5%)
   d. **Flight Readiness Review** (FRR) (10%)
   e. **Post Launch Assessment Report** (PLAR) (10%)

II. Launch Weekend Presentations (10% of total)
   a. **Flight Readiness Presentation** (10%)

III. Flight Performance (30% of total)
   a. Mission Performance (10%)
   b. Payload / Challenge (10%)
   c. Apogee (10%)

Reports submitted after 11:59 pm CST on the due date will receive a deduction of the overall report score:

<table>
<thead>
<tr>
<th>Late Days</th>
<th>Deduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Day Late</td>
<td>20% Deduction</td>
</tr>
<tr>
<td>2 Days Late</td>
<td>40% Deduction</td>
</tr>
<tr>
<td>3 Days Late</td>
<td>60% Deduction</td>
</tr>
<tr>
<td>4 Days Late</td>
<td>80% Deduction</td>
</tr>
<tr>
<td>5 Days Late</td>
<td>Zero</td>
</tr>
</tbody>
</table>
For the 2020 First Nations Launch Challenge, the motor selections are constrained to:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Size</th>
<th>Type</th>
<th>Impulse (N-s)</th>
<th>Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerotech</td>
<td>38mm - I</td>
<td>RMS</td>
<td>480 Newton-seconds</td>
<td>I285R, I300T, I211W</td>
</tr>
<tr>
<td>Aerotech</td>
<td>38mm - I</td>
<td>RMS</td>
<td>600 Newton-seconds</td>
<td>I366R, I435T</td>
</tr>
<tr>
<td>Aerotech</td>
<td>54mm - K</td>
<td>RMS</td>
<td>1706 Newton-seconds</td>
<td>K550W, K695R, K1100</td>
</tr>
<tr>
<td>Aerotech</td>
<td></td>
<td></td>
<td></td>
<td>Any DMS motor, not to exceed class impulse.</td>
</tr>
</tbody>
</table>
APPENDIX A-5 – First Nations Launch 2020 Program Calendar

October 2019
03 Informational Telecon @ 4:00 pm CDT (Telecon #: 262.551.2124)
15 Letter of Request to participate in Rocket Certification Workshop Due
15 Early Bird Non-binding Notice of Intent to Compete Due
25-27 Rocket Certification Workshop – Carthage College
31 Non-binding Notice of Intent to Compete Due

November 2019
01 Selection Announcement
07 Virtual Kick-off Meeting @ 4:00 pm CST** (Telecon #: 262.551.2124)
25 Award Acceptance Material* Due
25 Proposal* and Preliminary Budget* Due

December 2019
10 Design Report Informational Telecon @ 4:00 pm** (Telecon #: 262.551.2124)

January 2020
27 Preliminary Design Report* (PDR) Due
27 Flight Demo* Due

February 2020
03 Patch Design Due
03-07 PDR Virtual Presentations

March 2020
02 Critical Design Report* (CDR) Due
02 Final Motor Selection* Due
02 Official Team Roster* and Team Bio* Due
02 Team Photo* Due
   Upload team photo to Facebook and/or Twitter and to the team lead grant management page
09 Reimbursements Due (First payout)
09-13 Initial Virtual Safety Inspection with WSGC / CDR Virtual Presentations
30 Flight Readiness Report* (FRR) Due

April 2020
06-10 Final Virtual Safety Inspection with WSGC / FRR Virtual Presentations
16 Teams Arrive in Wisconsin
16 Team Workday @ 1:00-4:00 pm** (optional)
16 Safety Inspection @ 3:00-5:00 pm**
16 Welcome Dinner/Competition Kick-off @ 6:00 pm** – Carthage College
17 Oral Presentations @ 8:30 am – 12:00 pm**
17 Motor Build Workshop, Final Workday @ 1:30 – 4:00 pm**
18 Launch day @ Richard Bong Recreational Area in Kansasville, WI
18 Closing Banquet
19 Launch Rain Date

May 2020
04 Final Reimbursements Due
04 Post Launch Assessment Report (PLAR) Due
25 Notification of Winners

Summer 2020
Grand Prize Trip to a NASA Center
Rock-On

*Submission of these documents will be uploaded to the WSGC application website by the team lead. Submission received after 11:59 pm CST will be considered late.

**Central Standard Time
APPENDIX B-1 – Project Planning Guidance

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.

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.
APPENDIX B-2 – 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 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).
**APPENDIX B-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.’

Benefits to including Requirements Verification include:

For the FNL, we require the Mars Challenge teams to manage the requirements and show us this is being accomplished in the reports. The steps involved are:

1. **Step 1:** List Requirements. The requirements for FNL are explicitly listed in the Competition Handbook.
2. **Step 2:** Assign Requirement to Individual / Team (example, structures requirement, avionics requirement etc.)
3. **Step 3:** Identify how the requirement will be satisfied. Requirements can be satisfied by: test, analysis, demonstration, simulation or inspection.
4. **Step 4:** List outcomes / ensure requirements are satisfied, or explain why not.

The initial requirements plan needs to be completed by PDR, but work can begin in the Proposal phase, in order to create design goals and help to distribute responsibilities to sub-teams and individuals. Steps 2 and 3 will need to be updated as the team and plan evolves. The Requirements Verification should be reviewed again at CDR, and even at FRR to show that the design matches what is built and it achieves all it supposed to.

A basic example Requirement Verification spreadsheet would look like:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Assigned to</th>
<th>Method to Satisfy</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 Vehicle Rqmt</td>
<td>Airframe - Simulations</td>
<td>Simulation</td>
<td>Simulation shows 89 fps rail exit.</td>
</tr>
<tr>
<td>14 Vehicle Rqmt</td>
<td>Airframe</td>
<td>Inspection</td>
<td>-</td>
</tr>
<tr>
<td>15 Vehicle Rqmt</td>
<td>Team</td>
<td>Demonstration</td>
<td>-</td>
</tr>
</tbody>
</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-1 – How to Register with WSGC**

A faculty advisor must first register with WSGC, and the students must register next.

**Advisor Registration**

1. Register as faculty on the WSGC website (https://spacegrant.carthage.edu/about/login/). Applicants will be prompted to update personal information annually.

2. Submit the “Create Rocket Launch Team (NOI)” Grant Application Form (https://spacegrant.carthage.edu/forms/account/login/?next=/forms/application/first-nations-rocket-competition/).

3. Teams must only apply for either Moon Challenge or Mars Challenge; please indicate in the Rocket Launch Team NOI which competition is the school’s preference.

**Registration Page**

Once the faculty advisor completes the Notice of Intent (NOI), identifies the team name, lists the student participants, and chooses which competition the team will compete in, each student will need to:

5. Register as an undergraduate student on the WSGC website (https://spacegrant.carthage.edu/about/login/). Applicants will be prompted to update personal information annually.

6. Complete the First Nations Rocket Competition application (https://spacegrant.carthage.edu/forms/account/login/?next=/forms/application/first-nations-rocket-competition/).

7. Submit a media release form (https://spacegrant.carthage.edu/live/files/1746-nasaadultmediareleaseform2011pdf)
Account Manager

Sign In

You have signed out.

If you are not registered with WSOC, register here. Note: you must be affiliated with a member institution of the WSOC.

E-mail

Password

Remember Me

Submit

Have you forgotten your password?

Login Page
APPENDIX C-2 – How to Obtain a Local NAR or TRA Mentor

How to Acquire a Local Rocketry Mentor

WSGC recommends each team reach out to 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. Team can reach out to either or both of the national rocketry.

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 one of dozens of Tripoli prefectures around the country. If there is not a Tripoli Prefecture in your area, you can also address 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 straightforward. Most chapters will also have a launch site nearby, with an FAA waiver and monthly club launches (usually weekends). Local association launches are open to spectators, and there is no fee to attend and observe. Some of the larger local launches will have rocketry vendors and food vendors on-site, so you can make local connections for parts and supplies. Attending a local launch with your team, as spectators, is a great way to recruit new members and get them 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 /association 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.

WSGC expects FNL teams will take advantage of their local NAR or TRA chapters/prefectures, 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 with regard to what is acceptable to fly in FNL.
**APPENDIX C-3 – 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 C-4 – 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 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).

There are various and multiple resources on the World Wide Web, to help you properly understand how to work Rocksim. The Rocksim vendor website is a start: (https://www.apogeerockets.com/RockSim/RockSim_Information).

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 C-5 – 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 C-6 – Reimbursement Guide

All costs associated with this program must be necessary and reasonable for this award, following all applicable WSGC regulations.

1. **Make purchases(s)**
   1.1. 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.**
   2.1. We recommend saving receipts in an envelope or folder until time of reimbursement submission.
   2.2. Number each receipt. (ex. 2,3) (ex. 5,6,7,8,9,10)
   2.3. Circle date and total on receipt(s). (ex. 2,3) (ex. 5,6,7,8,9,10)
   2.4. If food or lodging receipts cover more than one person, list participant names on receipt(s). (ex. 10)
   2.5. Itemized restaurant receipts are required. If purchases are made on a credit card, a signature copy must be included. (ex. 2) (ex. 10)
   2.6. Tips over 20% will not be reimbursed.
   2.7. All purchase receipts must be itemized, detailing each item purchased. (ex. 2,3)

3. **Complete a Team Funded Program Expense Reimbursement Form and/or Travel Expense Summary Report** (see Tools and Tips on the WSGC website). Make sure to apply supply and travel expenses to the respective forms. Use a separate Travel Expense Summary Report 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. (ex. 1) (ex. 4)
   3.1. Carefully read and follow instructions before completing forms.
   3.2. List receipt(s) in numerical order on the appropriate form. (ex. 1) (ex. 4)
   3.3. Identify date from each receipt. (ex. 1) (ex. 4)
   3.4. List name of Vendor/Store from each receipt. (ex. 1) (ex. 4)
   3.5. Describe the purchase from each receipt. (ex. 1) (ex. 4)
   3.6. Provide the total expended amount from each receipt. (ex. 1) (ex. 4)
   3.7. Add all receipts together for a total reimbursement request. (ex. 1) (ex. 4)
   3.8. Secure all appropriate original signatures. (ex. 1) (ex. 4)
   3.9. Print out a Google map for verification of personal vehicle mileage ($.51 per mi). Circle the total miles. The mileage rate includes fuel costs. Gas receipts will only be reimbursed for rental vehicle travel. (ex. 5)
   3.10. **Attach (staple) receipts and Google map to the reimbursement form(s) in numerical order.**

4. **Submit the completed form(s), receipts and Google map(s) via USPS postmarked by the due date(s) to:**
   **ATTN: Lisa Crumble**
   **Wisconsin Space Grant Consortium**
   **Carthage College**
   **2001 Alford Park Drive**
   **Kenosha, WI 53140**
   4.1. Reimbursements will not be honored if postmarked after due date(s).

**Do Not:**

1. Submit unattached receipts.
2. Submit partially completed forms.
3. Submit forms without all required original signature.
4. Submit forms past due date(s).
APPENDIX C-7 – Rocket Shipping Procedure

Please follow the FNL Rocket Shipping Procedure when shipping rocket(s) to Wisconsin for the competition.

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 4 p.m. Thursday, April 16th. We recommend scheduling a package pickup from the hotel at the same time. **NOTE:** All rockets should be scheduled for pickup prior to your hotel checkout.
   1.1. Have package(s) shipped to:
   
   ATTN: (Guest Name)
   
   Wyndham Garden Kenosha Harborside
   
   5125 6th Avenue
   
   Kenosha, WI 53140
   
   1.2. 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.
   4.1. 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.
   4.2. 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.
APPENDIX C-8 – Personal HPR Certification

There exists an opportunity, while attending the Launch Weekend in Wisconsin, for students to attain their Tripoli High-Powered Rocketry Certification.

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

High-Power Level 1

“The Level 1 certification, is open to all team 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 FNL rocket certification 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 a donor however. The student must purchase and build their rocket independently, and transport their rocket to 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 a donor however. The student must purchase and build their rocket independently, and transport their rocket to Wisconsin for the certification flight.

Certification flights will be on Sunday morning of the Launch Weekend, 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 2020 FNL Calendar.

If you did not attend the workshop, and plan to certify, you must coordinate your motor choice with Tripoli Wisconsin Technical Advisor.