NASA
WISCONSIN SPACE GRANT CONSORTIUM
WSGC
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# 2024-2025 First Nations Launch Gateway Competition Handbook

REVISED: 1/14/2025

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- Advisor and Mentor support
- Technical and challenge/payload questions
- Handbook questions

# First Nations Launch 2024 - 2025 Program Calendar

***Zoom Presentations and Meetings:*** *https://zoom.us/j/99258659434*

*All times listed in Central Time*
*Central Daylight Savings Time (CDT): March 10, 2024 – November 3, 2024*
*Central Standard Time (CST): November 3, 2024 – March 8, 2025*
*Central Daylight Savings Time (CDT): March 9, 2025 – November 2, 2025*

**September 2024**

2 Announcement of Opportunity
17 Informational Meeting @ 4:00 pm CDT (Zoom)

**October 2024**

4 Visit FNL Booth #1437 at the AISES Conference
7 Launch 2 Learn Registration w/Non-Binding Notice of Intent (NOI) to Compete Due
(Level 1 Rocket Certification Workshop @ Carthage College, Nov. 2-3, 2024
8 Proposal Webinar @ 4:00 pm CDT (Zoom)
15 Informational Meeting @ 4:00 pm CDT (Zoom)
22 TRA/NAR Mentor Webinar @ 4:00 pm CDT (Zoom)
24 Non-binding Notice of Intent to Compete Due* (Moon/Mars)
Proposal Due* (Moon/Mars)
Early Bird Registration* (Gateway)
28 Award Announcement (Moon/Mars/Gateway)
29 Kick-off Meeting @ 4:00 pm CDT (Zoom) (Moon/Mars)
30-1 Proposal Virtual Discussions (Zoom) (Moon/Mars)

**November 2024**

02-03 L2L Level I Rocket Certification Workshop @ Carthage College (registration required)
05 Challenge Parameters Webinar @ 4:00 pm CDT (Zoom)
11 Award Acceptance Material Due* (Moon/Mars)
Preliminary Budget Due* (Moon/Mars)
12 Introduction to RockSim Webinar @ 4:00 pm CST (Zoom)
19 Project Management Webinar @ 4:00 pm CST (Zoom)

**December 2024**

**02 PDR Milestone (Moon/Mars)**
Report Due* (Moon/Mars)
Flysheet Due* (Moon/Mars)
RockSIM Due* (Moon/Mars)
03 Structures Webinar @ 4:00 pm CST (Zoom)
09 Notice of Intent to Compete Due* (Gateway)
Request for Virtual Rocketry Workshop Due*
09-13 PDR Virtual Presentations (Zoom) (Moon/Mars)
16 Award Announcement (Gateway)

**January 2025**

07 Kick-off Meeting @ 4:00 pm CST (Zoom) (Gateway)
08 Launch 2 Learn Kit Reveal @ 4:00 pm CST (Zoom)
13 Award Acceptance Material Due* (Gateway)
14 Gateway Project Management Webinar @ 4:00 pm CST (Zoom)
17-18 Launch 2 Learn Rocket Certification Virtual Workshop (Registration Required)
21 Avionics/Altimeters Webinar @ 4:00 pm CST (Zoom)
**27 Critical Design Review (CDR) Milestone**
CDR Report Due* (Moon/Mars)
Flysheet Due*(Gateway/Moon/Mars)
RockSim Due* (Gateway/Moon/Mars)
Budget Due* (Gateway/Moon/Mars)
Budget Due* (Gateway/Moon/Mars)
Flight Demo Due* - *Upload rocket demo flight video on Facebook and/or X and add link to Team Application*

**February 2025**

03 Final Requests to Change to Different Competition Challenge Due *
03-07 CDR Virtual Presentations Continued (Zoom) (Gateway/Moon/Mars)
11 Recovery Webinar @ 4:00 pm CST (Zoom)
17 Patch Design Entries Due*
Final Motor Selection Due* (Gateway/Moon/Mars)
Official Team Roster & Lodging List Due* (Gateway/Moon/Mars)
Team Bio Due* (Gateway/Moon/Mars)
Team Photo Due* (Gateway/Moon/Mars)
All Team Member Registration on WSGC Website & FNL Application Due* (Gateway/Moon/Mars)
18 Advisor/Mentor Meeting @ 4:00 pm CST (Zoom)
26-28 Gateway Interim Review (Zoom)

**March 2025**

03 Reimbursements Due* (First payout) (Gateway/Moon/Mars)
04 Build & Assembly Techniques Webinar @ 4:00 pm CST (Zoom)
**17 Flight Readiness Review (FRR) Milestone**
FRR Report Due* (Moon/Mars)
Flysheet, RockSim, Educational Outreach Forms Due* (Gateway/Moon/Mars)
TRA/NAR Team Membership Information Form Due - email to cengberg@carthage.edu
24-28 FRR Virtual Safety Inspection (Zoom) (Gateway/Moon/Mars)

**April 2025**

08 Launch Operations Webinar @ 4:00 pm CDT (Zoom)
09-11 Final Virtual Safety Inspections with Tripoli Rocketry Association (Zoom) (Gateway/Moon/Mars)
15 Advisor/Mentor Meeting @ 4:00 pm CDT (Zoom)
21 Oral Presentations PPT Due* (Gateway/Moon/Mars)
24 Teams Arrive in Kenosha, Wisconsin
25 Welcome Breakfast/Competition Kick-off @ 8:00 am CDT - Carthage College, Kenosha, WI
Team Workday, Motor Build Workshop, Breakout Sessions, Final Safety Inspections of Rocket, Oral Presentations
26 Launch Day @ 7:30 am – 3:00 pm CDT – Richard Bong Recreational Park, Kansasville, WI
Closing Banquet @ 6:30 pm CDT – Carthage College
27 Launch Rain Date
30-04 Student Launch Initiative (Next Step Award 2024)

**May 2025**

12 Final Reimbursements Due*
Post Launch Assessment Review (PLAR) Report Due* (Gateway/Moon/Mars)
2-3 Team Project Photos Due*

**June 2025**

02 Notification of Winners
TBD RockOn! 2025 @ Wallops Flight Facility (Next Step Award 2025)

**Summer 2025**

TBD Grand Prize Trip to a NASA Center (Moon/Mars Grand Prize Winners)

**April 2026**

TBD Student Launch 2025 (Next Step Award 2025)

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

***Schedule subject to change.***

## 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

COTS = Commercial off-the-Shelf (i.e., store bought)

CP = Center of Pressure

EIT = Electronics and Information Technology

FAA = Federal Aviation Administration

FNL = First Nations Launch

FPV = First Person View

FRR = Flight Readiness Review

GPS = Global Positioning System

HPR = High-Power Rocketry

LCO = Launch Control Officer

LRR = Launch Readiness Review

MSDS = Material Safety Data Sheet

NAR = National Association of Rocketry

NASA = National Aeronautics and Space Administration

NASNTI = Native American Serving Non-Tribal Institution

NFPA = National Fire Protection Association

PDR = Preliminary Design Review

PLAR = Post Launch Assessment Review

PPE = Personal Protective Equipment

RPM = Revolutions per Minute

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

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

**Wisconsin Space Grant Consortium (WSGC)**
The host Space Grant Consortium, located at Carthage College in Kenosha, WI. https://spacegrant.carthage.edu/

**First Nations Launch (FNL)**
One of many programs created and hosted by WSGC. It is the only high-power rocketry competition dedicated to support American Indian and Indigenous students. First Nations Launch is a NASA Artemis Student Challenge. https://spacegrant.carthage.edu/first-nations-launch/

**American Indian Science and Engineering Society (AISES)**
AISES is a national nonprofit organization focused on substantially increasing the representation of Indigenous peoples of North America and the Pacific Islands in science, technology, engineering, and math (STEM) studies and careers. https://www.aises.org/

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

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

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

**WSGC Technical Advisor**
The primary technical advisor of First Nations Launch (the Wisconsin Tripoli Prefect and Launch Weekend RSO).

**Team Advisor** (Faculty Advisor)
Usually an educator (faculty or staff at the institution), responsible for administrative duties for the team, providing support for the students (securing a workspace, securing financial support, keeping students on task, ensuring team meets deadlines), and liaising with FNL – does not need to have a STEM or technical background, but encouraged. The Team Advisor will also assist in coordinating team travel for Launch Weekend.

**Team Mentor**
Not necessarily affiliated with the school, this person is TRA or NAR certified and experienced with building and flying high-power rockets. The Team Mentor should be a local individual, who can visit the school and assist with and monitor the build. If a local mentor is unavailable, a Team Mentor may assist a team virtually. Team mentor may also facilitate any static testing, flight testing (at a local TRA or NAR field) and hazardous materials procurement and handling (motors, energetics). The Team Mentor is strictly a volunteer role. Mentors may apply for a $500 travel stipend to attend the First Nations Launch competition in Kenosha, WI.

**High-Power Rocketry**
A hobby similar to model rocketry. The major difference is that higher impulse range motors are used. The National Fire Protection Association (NFPA) definition of a high-power rocket is one that has a total weight of more than 1,500 grams (3.3 lb.) and contains a motor or motors containing more than 125 grams (4.4 oz) of propellant and/or rated at more than 160 Newton-seconds (40.47 lbf·s) of total impulse, or that uses a motor with an average thrust of 80 newtons (18 lbf) or more. https://en.wikipedia.org/wiki/High-power_rocketry

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

**Payload**
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.

**Challenge**
This term is used to describe all of the parameters of the particular challenge for the year. There are four (4) general challenge categories, which are rotated within a four-year cycle:

1. Avionics Challenge - the focus would be on an electronics payload/challenge integrated into the rocket.
2. Payload Challenge - the focus would be on a 'payload/challenge' contained within the rocket.
3. Stability Challenge - the focus would be on controlling or modifying the stability of the rocket.
4. Structure Challenge - the focus would be on the airframe and construction of the rocket.

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

**Rail Size and Rail Button Size**
There are various ways to attach a high-power rocket to a launch rail (and there are various launch rail types), which is dependent on the size and weight of the rocket. In FNL we require the use of rail buttons. These rail buttons come in two sizes – 1010 rail button (considered small, for use with a 6-foot, 1 $in^2$ rail) or a 1515 rail button (considered large, for use with a 10-foot, 1.5 $in^2$ rail). Ensure your simulations are configured correctly to account for the proper rail button size.

**Rail Exit Velocity** (Launch Guide Departure Velocity)
This parameter is important to monitor during simulations, as this value will affect the rocket stability in flight. There is a minimum value to be attained in order to maintain a stable flight (52 feet per second). Meeting the rail exit velocity requirement in simulations (and in flight) can be done by modifying the weight, shape, and features (such as rail buttons) of your rocket. Refer to Notes and Suggestions, Technical Note 2.g. for launch rail length.

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

**Time-to-Apogee**
This parameter is important to understand during simulations, as this will be used to set motor ejection delay during your flight. It also is an indicator that your simulations are working correctly, as time to apogee should be in the 10 – 15 second range.

# Statement of Work (Engineering Parameters)

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

Activity Name: WSGC First Nations Launch
Governing Office: Carthage College, Wisconsin Space Grant Consortium

## About the Program

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

## Purpose

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

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

## Eligibility

Wisconsin Space Grant Consortium seeks proposals from TCUs, NASNTIs, as well as colleges/universities with active collegiate AISES chapters to conduct the WSGC First Nation Launch (FNL) during the 2023-2024 academic year.

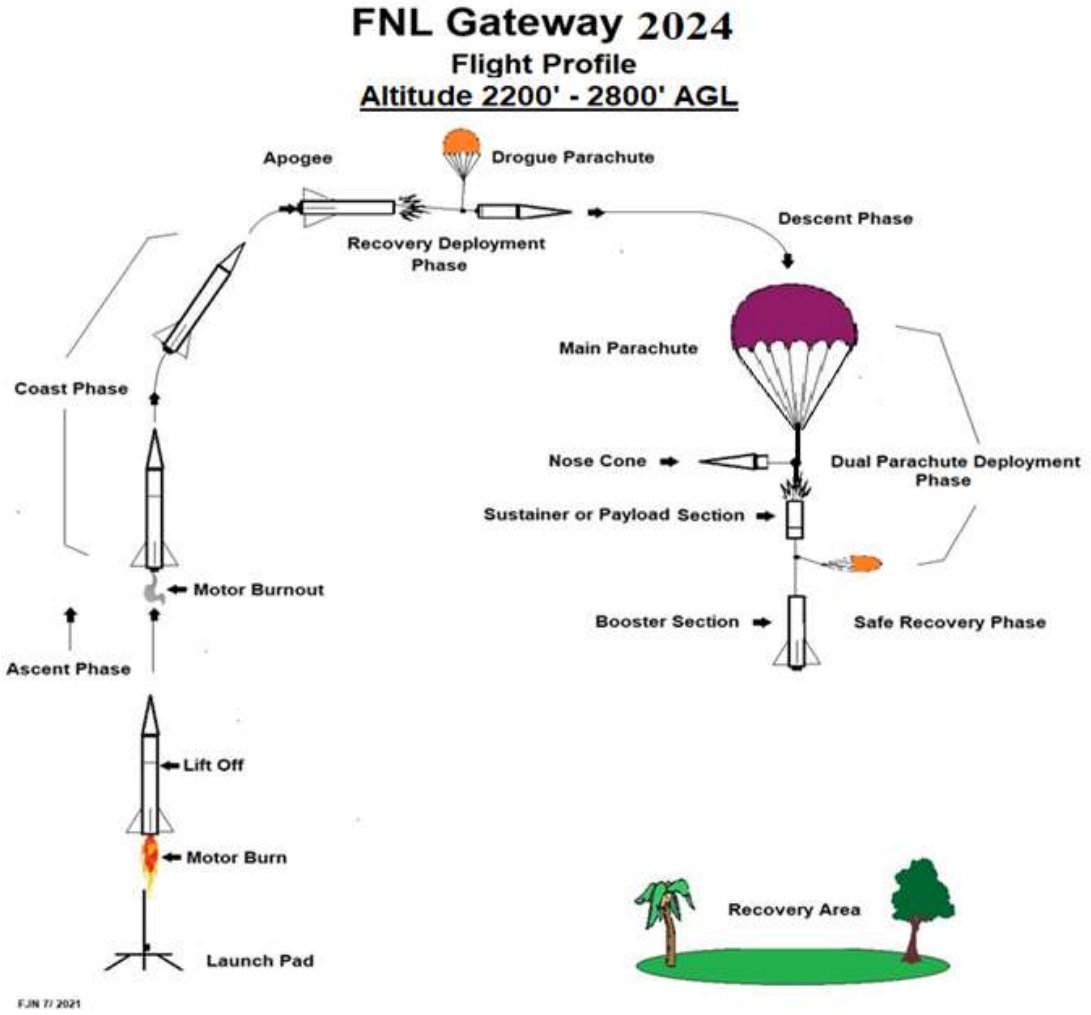
Notice of Intent (NOI) to participate will be accepted from any TCU, NASNTI, or collegiate AISES chapter. Following the proposal acceptance, teams will complete a series of design reviews, which are discussed further in the Program Milestones section of this handbook.

# GATEWAY Challenge Overview

The requirements to compete in FNL Gateway Challenge for 2024-2025 are as follows:

## Gateway Challenge

Teams shall design and construct a dual deploy high-power rocket from a list of possible kit combinations. There is no payload/challenge associated with this challenge, with focus being on the safe and complete selection, simulation, procurement, assembly/fabrication, and flight of the kit rocket. The flight shall be stable and reach an apogee between 2200’ - 2800’ AGL. The rocket should satisfy all other technical requirements as outlined in the following Requirements sections.



# GATEWAY Challenge Requirements

The following specific challenge requirements must be satisfied:

- Gateway Teams must select a suitable Kit from the proposed Kits in Appendix A-2
    - Teams must ensure to run and understand simulations for all kits
    - Teams must ensure to use the correct motors for each Kit, as outlines in Appendix A-1
    - The Kit / Motor combination selected must reach an altitude of 2,200-2,800 ft AGL

- Gateway Teams must make all component selections that will satisfy simulation performance parameters
    - Components will include altimeters, batteries, switches, GPS, parachutes, shock cords etc.
    - The following Requirements Sections outline the performance parameters

- Gateway Teams must submit a RockSim simulation file at each Milestone
    - Teams must select a final simulation from all 6 possible simulations by CDR
    - Teams can still change kits at or after CDR but only under extreme circumstances
    - Team will receive feedback on your simulations at Milestone Review

- Gateway Teams must fill and submit a Fly Sheet at each Milestone
    - Teams must understand where each parameter comes from and how to determine
    - Team will receive feedback on your Fly Sheet at Milestone Review

- Gateway Teams must create, track, update and submit a Gateway Budget / Schedule at each Milestone
    - Teams must use the Gateway Budget / Schedule Template on the Website
    - Team will receive feedback on your Budget / Schedule at Milestone Review

- Gateway Teams must create, submit and give a Virtual Presentation at each Milestone
    - Teams must use the Gateway PowerPoint Template on the Website
    - Team will receive feedback on your Presentation at Milestone Review

- Gateway Teams should not purchase any components / kits until after 1st Milestone Review
    - This ensures that the components are suitably selected for High Powered Rocketry
    - The FNL Tech Team will give feedback of your component selections at Milestone Review
        - This is why its important to present something, so we can give you feedback

## General Requirements

1. The **team lead, team advisor, and co-advisor** (if applicable) must **create a profile** in the NASA STEM Gateway system. If a profile already exists, it must be updated annually. See '**Appendix B-1**' for instructions on how to create a profile.
2. The **team lead, team advisor, and co-advisor** (if applicable) must then **register** with WSGC before students/team members register. See '**Appendix B-2**' for instructions on how to register.
3. Once the above listed have registered, the **team advisor** will complete and submit the "Rocket Launch Team (Create NOI)" Grant application form.
4. After the NOI application is submitted on the WSGC Grant Application Page, the **team lead** must **apply** to the First Nations Launch program. All steps must be completed in order for the team to be considered eligible to compete.
5. All student **team members** must register a profile on the NASA Gateway application. See '**Appendix B-1**' for instructions on how to create a profile.
6. All student **team members** must **register** on the WSGC website and **then apply** to the First Nations Launch program on the Grant Application page no later than the Critical Design Review (CDR) due date. See '**Appendix B-2**' for instructions on how to register and apply.
7. The **team 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.
8. The team must identify all **team members**, both those students attending and not attending the launch weekend activities, by the due date of the CDR. This is accomplished by ensuring each student is registered and applied (as explained previously), and attendees are listed on the lodging list. Rocketry (TRA/NAR) mentors do not need to register on the WSGC website unless they are attending the Launch Weekend activities. The term 'team member' will include:
    a. Students actively engaged or previously actively engaged in the project.
        i. WSGC recommends 4-6 students, but does not prohibit teams from competing who have fewer or greater number of team members.
        ii. First Nations Launch highly encourages teams to represent the indigenous community, being comprised of Native American, Alaska Native, and Native Hawaiian/Pacific Island team members.
    b. At a minimum, one team mentor (see **General Requirement #5**).
    c. At a minimum, one team advisor (a maximum of two co-advisors allowed).
9. Each team must identify a local/state experienced rocketry **team mentor** (see '**Appendix D-2**' for more information on how to obtain a local mentor and the benefits).
    a. A team mentor is defined as an adult, 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.
    b. 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.

10. **Team leads** will upload all deliverables to the WSGC Grant Management page (see '**Appendix B-3**' for instructions on how to upload to WSGC website) by the deadline specified in this handbook for each milestone. All report deliverables must be in PDF format.
11. **Teams** will utilize the provided templates (see '**Report Templates and Scoring Rubrics**' on the WSGC website) for each report and virtual presentation.
12. All **teams** will successfully launch and recover an Estes rocket provided by WSGC.
    a. The Estes rocket shall be built and launched by the team, prior to PDR.
    b. The team will record the Estes rocket flight and post the results to Facebook and upload the URL to the Team Lead's Grant Management page.
    c. Teams impacted by adverse weather conditions may request an exemption or extension.
13. **All projects must be completely constructed (at least 95%) ready to fly at least two (2) weeks prior to launch date**. Complete is defined as: all airframe, motor mount, fins, payload/challenge airframe, couplers, bulkheads should be completely procured/manufactured to spec and permanently attached as designed. A virtual inspection prior to Launch Weekend will be used to determine if satisfied.
14. All projects must have a documented flight stable simulation profile at each design review milestone. Commercial high-power rocketry software is required. **RockSim is the required simulation software, expected to be procured by teams**. OpenRocket may be used to verify/validate RockSim results. See **Appendix D-3** for information on how to obtain RockSim. Teams must submit their simulation files over the course of the project:
    a. At each design milestone (Proposal, PDR, CDR, FRR), upload a RockSim file to WSGC website.
    b. At Launch Weekend, submit a file on flash drive prior to flight day.

## General Vehicle Requirements

1. The launch vehicle will use a commercially available solid motor propulsion system using ammonium perchlorate composite propellant (APCP) which is approved and certified by the National Association of Rocketry (NAR), and/or Tripoli Rocketry Association (TRA). Motors are provided by WSGC. Motors are limited to those listed in **Appendix A-1.**
    a. Final motor choices will be declared by the 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.
    c. A penalty against the team's overall score will be incurred when a motor change is made after the CDR milestone, regardless of the reason.
2. The vehicle will carry, at a minimum, one commercially available, barometric altimeter for recording the official altitude used in determining the Altitude Award winner (see '**Appendix A-4**' for awards criteria) and is to be used for electronic deployment of ejection charges.
3. Each altimeter (if redundant) will have a dedicated power supply, on an independent circuit.
4. Each altimeter (if redundant) will be armed by a dedicated mechanical arming switch, on an independent circuit, that is:
    a. Accessible from the exterior of the rocket airframe when the rocket is in the launch configuration on the launch pad.
    b. Capable of being locked in the ON position for launch (i.e., cannot be disarmed due to flight forces).
5. The launch vehicle will have a minimum static stability margin of 1.0 at the point of rail exit (to be determined by simulations). Rail exit is defined at the point where the forward rail button loses contact with the rail.
6. The launch vehicle will accelerate to a minimum velocity of 52 feet per second (fps) at rail exit (to be determined by simulations). This parameter is also known as 'rail exit velocity' or 'velocity at launch guide departure.'
7. The launch vehicle and motor will have a thrust-to-weight ratio greater than 5:1.
8. 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, prior to competition flight.
9. Vehicle Prohibitions
    a. The launch vehicle will not utilize:
        i. 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
        ii. Forward firing motors
        iii. Motors that expel titanium sponges (*Sparky, Skidmark, MetalStorm, etc.)
        *Note: Wisconsin Tripoli Rocketry allows a sparky motor at the competition launch site, but they may not be allowed at other launch locations
        iv. Hybrid motors
        v. Multi-stage motors
        vi. A cluster of motors
        vii. Friction fitting for motors
        viii. Blue tube, or sonotube airframes
        ix. Plexiglass/acrylic (or any other non-rigid) fins
        x. Excessive and/or dense metal in the construction of the vehicle

1. 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

b. The launch vehicle will not exceed Mach 1 (767+ mph at NTP) at any point during flight.
c. 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 10 lbs. on the pad may contain a maximum of 1 lbs. of ballast).
d. 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 utilize a standard dual deployment recovery scheme, 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 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.
    c. Single deployment parachute release devices (tender descender, jolly logic parachute release etc.) are not allowed.
2. The recovery system electrical circuits shall be completely independent of any payload/challenge electrical circuits.
3. All recovery electronics will be powered by commercially available batteries.
4. Descent rate after apogee (under drogue parachute) shall range between 45 – 65 feet per second.
5. Descent rate upon touchdown (under main parachute) shall range between 15 – 20 feet per second.
6. Electronics (COTS altimeters) must be used as your primary ejection events, at both apogee and main deployment.
    a. Suggest utilization of two altimeters for ejection event redundancy, but not required.
7. The motor ejection charge is the required backup (redundant) deployment at apogee.
    a. Motor ejection cannot be used as your primary (or only) ejection event.
    b. Note this requires that the drogue parachute sits in the booster section.
    c. The estimated time to apogee should be known (from simulations) to adjust the ejection charge delay fuse during motor prep.
8. An electronic tracking device (i.e., GPS) will be installed in the launch vehicle and will transmit the position of the tethered vehicle or any independent section to a ground receiver.
    a. Any rocket section or payload/challenge component, which lands untethered to the launch vehicle, will contain an active electronic tracking device.
    b. The electronic tracking device(s) will be fully functional during the official flight on launch day.
    c. It is recommended to use an electronic tracking device that does not require licensing.
    d. A list of commonly used rocket tracking devices is available in **Appendix D-6**

## Safety Requirements

1. Each team must identify a 'student safety officer' who will be responsible for implementing the requirements in this section. The role and responsibilities of each safety officer will include, but are not limited to:
    a. Monitor team activities with an emphasis on Safety during:
        i. Design of vehicle and payload/challenge
        ii. Construction of vehicle and payload/challenge
        iii. Assembly of vehicle and payload/challenge
        iv. Ground testing of vehicle and payload/challenge
        v. Launch day
        vi. Recovery activities
    b. Implement procedures developed by the team for
        i. Construction
        ii. Assembly
        iii. Launch
        iv. Recovery activities
    c. Document, manage and maintain current revisions of the team's safety procedures, and MSDS/chemical inventory data. (*Mars Challenge ONLY*)**
2. Each team will use a launch and safety checklist. The final checklists will be included in the FRR report and used during any launch day operations (see '**Appendix C-4**' for checklist support).
3. During test flights (if applicable), teams will abide by the rules and guidance of the local rocketry club's RSO. The allowance of certain vehicle configurations and/or payload/challenges at WSGC FNL does not give explicit or implicit authority for teams to fly those vehicle configurations and/or payload/challenges at other club launches. Teams should communicate their intentions to the local club's President or Prefect and RSO before attending any NAR or TRA launch.
4. For proof of construction and a safe flight, photographs/video must be made during the construction process (especially of sealed or hidden components) to ensure proper technique has been followed. The Flight Readiness Report must contain the photos of the build of sealed/hidden components that can no longer be accessed.
5. All projects must have a virtual inspection with the WSGC Technical Advisor, prior to (to coincide with) Flight Readiness Review.
6. All components and materials must be obtained from a reputable high-power rocketry vendor or must undergo an engineering analysis (or test) demonstrating their suitability and integrity must be included in the design reports.

## Notes and Suggestions

1. Project Notes
    a. 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).
    b. The team should ensure they have any computer equipment necessary to perform a video teleconference with the review panel. This includes, but is not limited to, a computer system, video camera, speaker telephone, and a sufficient internet connection. Cellular phones should be used for speakerphone capability only as a last resort.
    c. **Note from Tripoli**: Without exception, university teams must involve an experienced team mentor, preferably a TAP or L3CC, during the design and construction phases of their rocketry projects if they expect to fly the competition rocket at Tripoli events. The mentor must be certified at or above the level of motor the team wishes to fly AND is experienced in the type of construction, propulsion, and recovery the team uses. Although it is ultimately up to the judgment of the RSO and Launch Director, teams who build a rocket that requires a motor higher than their team member/mentor certification levels may not be allowed to launch the rocket at local club events as recommended by NAR/TRA.
2. Technical Notes
    a. The launch vehicle will have a maximum of four (4) independent sections. An independent section is defined as a section that is either tethered to the main vehicle or is recovered separately from the main vehicle using its own parachute. Coupler shoulders shall be one body diameter length at a minimum.
    b. 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.
    c. To aid in recovery of rockets, the team's name and launch day contact information shall be in or on the rocket airframe as well as in or on any section of the vehicle that separates during flight and is not tethered to the main airframe. This information shall be included in a manner that allows the information to be retrieved without the need to open or separate the vehicle.
    d. Competition ejection charges will be provided by Tripoli Wisconsin at the event. For ground ejection tests or pre-competition flight test (recommended) purposes, it is suggested to use ejection charges of the same size and type as those provided at competition (see '**Appendix D-4**' for recommendations).
    e. Removable shear pins can be used for both the main parachute compartment and the drogue parachute compartment.
    f. Avoid touching or handling electronic components when not grounded or in a static environment such as walking on carpeted floors, cloth upholstery furniture and in vehicles. Sporadic constant on/off power up connections may cause brownouts, causing altimeter to indicate an error. Always store your electronics in an approved static proof bag that comes with the device. When in doubt, always reset and test.
    g. All teams will be required to use the launch pads provided by Tripoli Wisconsin. No custom pads will be permitted on the launch field. Six-foot (6') 1010 rails and ten-foot (10') 1515 rails will be provided. Please ensure you have the correct rail button for the respective rail. The launch rails will be canted 5 to 10 degrees away from the crowd on launch day. The exact cant will depend on launch day wind conditions, to be determined by Tripoli Wisconsin.

# First Nations Launch 2025 Project Deliverables

1. Deliverables required for successful participation are listed below. More details are provided in the Project Milestones: Criteria and Expectations section.
    a. Team/students must participate in the virtual Kick-Off Meeting.
    b. Team/students must provide a reusable rocket ready for competition launch.
    c. Team/students must provide a RockSim rocket simulation file:
        i. Of the designed rocket, uploaded to WSGC website at each design phase (CDR, FRR)
        ii. Of the 'as-built' competition rocket, due the day before competition launch
    d. Team/students must fly a lower power Estes (or similar) rocket before CDR and upload a video of the flight prior to CDR. The rocket will be provided by WSGC for all teams. A launchpad will be provided by WSGC for new teams.
    e. All teams must complete and submit all required Flysheets to the WSGC FNL Grant Management site by the Team Lead on applicable due dates.
    f. Team/students must participate in PDR and CDR Virtual Reviews (Zoom teleconference).
    g. Team/students must participate in one (1) Safety Review after CDR and one (1) Virtual Technical Inspection after FRR with Tripoli Wisconsin (Zoom teleconference).
    h. Team/students must submit flight (avionics) data on competition launch day via flash drive.
    i. Team/students must provide 2 – 3 photos featuring the team designing, building, and flying the competition rocket to be submitted to the WSGC Grant Management page by the team lead by PLAR deadline.
2. WSGC FNL is responsible for providing to the teams:
    a. Project/Travel Award of $4000.
        i. Teams traveling from Mountain, Pacific, Hawaiian, or Alaskan time zones may request additional travel funds.
    b. Hotel accommodations @ FNL selected location (maximum three (3) rooms for three (3) nights per team at competition hotel) during Launch Weekend.
    c. Select meals (Friday breakfast, lunch, and light dinner, Saturday breakfast, lunch, and dinner) during Launch Weekend.
    d. Low-power rocket (Estes) for flight demo (and launch pad if applicable), shipped to school prior to CDR.
    e. Two (2) Rocketry Reference Books (for schools that are new to the competition).
    f. Ejection charges for competition flight, provided on Launch Day.
    g. One (1) motor maximum for competition flight, prepped on Launch Weekend, provided on Launch Day.
    h. One (1) motor casing for competition flight, provided on Launch Day. Motor casings shall be returned to FNL on Launch Day after final competition flight.

# Program Milestones: Criteria and Expectations

## Critical Design Review Presentation

Your presentation is a concise summary of your CDR report. It must include the following items (please use CDR Virtual Template from the WSGC website: (https://spacegrant.carthage.edu/first-nations-launch/rubric/)

1. Present initial Vehicle
    a. Include vehicle dimensions, materials
    b. Include initial motor selection
2. Present initial vehicle performance
    a. Include static stability margin, CP / CG location
    b. Include thrust-to-weight ratio, rail exit velocity
    c. Include predicted altitude
3. Present initial Avionics Subsystem
    a. Include avionics bay
    b. Include type / number of altimeters, switches, vent holes.
4. Present initial Recovery Subsystem
    a. Include parachute sizes, shock cords, descent rates.
    b. Include tracking devices and locations.
5. Present technical / resource challenges (critical path).
6. Present budget status and schedule status.

The CDR will be presented to a panel of engineers and TRA personnel. The team is expected to present and defend the final design of the launch vehicle that proves the design meets the mission objectives and requirements and can be safely 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 will 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:

1. Easy-to-read slides made with dark text on a light background.
2. Appropriate placement of pictures.
3. Graphs and videos.
4. Professional appearance of the presenters.
5. Speaking clearly and loudly.
6. Looking into the camera.
7. Referring to the slides rather than reading them.
8. Communicating to the panel in an appropriate and professional manner.

## Flight Readiness Review Presentation

Your presentation is a concise summary of your FRR report. It must include the following items (please use FRR Virtual Template from the WSGC website: (https://spacegrant.carthage.edu/first-nations-launch/rubric/)

1. Present final Vehicle
    a. Include vehicle dimensions, materials
    b. Include final motor selection
2. Present final vehicle performance
    a. Include static stability margin, CP / CG location
    b. Include thrust-to-weight ratio, rail exit velocity
    c. Include predicted altitude
3. Present final Avionics Subsystem
    a. Include avionics bay
    b. Include type / number of altimeters, switches, vent holes.
4. Present final Recovery Subsystem
    a. Include parachute sizes, shock cords, descent rates.
    b. Include tracking devices and locations.
5. Present technical / resource challenges (critical path).
6. Present budget status and schedule status.

The FRR will be presented to a panel of engineers and TRA personnel. The team is expected to present and defend the final design of the launch vehicle that proves the design meets the mission objectives and requirements and can be safely constructed, tested, launched, and recovered.

Upon successful completion of the FRR, the team is given the authority to proceed into the construction and verification phase of the life cycle that will culminate in a Launch Weekend Inspection.

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

The presentation of the FRR shall be well prepared with a professional overall appearance. This includes, but is not limited to, the following:

1. Easy-to-read slides made with dark text on a light background.
2. Appropriate placement of pictures.
3. Graphs and videos.
4. Professional appearance of the presenters.
5. Speaking clearly and loudly.
6. Looking into the camera.
7. Referring to the slides rather than reading them.
8. Communicating to the panel in an appropriate and professional manner.

## Launch Weekend Presentation

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

Your presentation is an update of your FRR. Your presentation must include the following items at a minimum (please use the Launch Weekend Presentation template from the WSGC website https://spacegrant.carthage.edu/first-nations-launch/rubric/):

1. Present vehicle design.
    a. Kit / motor overview.
2. Present expected vehicle performance.
    a. Static stability margin, CP/CG locations, thrust-to-weight ratio, rail exit velocity, time to apogee, and predicted altitude.
3. Present vehicle avionics.
    a. Altimeters, switch / power.
4. Present vehicle recovery.
    a. Parachute sizes, descent rates, vehicle tracking devices / locations.
5. Present major challenges/lessons learned (can be technical, programmatic etc.).

Note:

1. Your rocket will be on display during the presentation - refer to the components as they are discussed.
2. You will have 8 minutes to give your presentation to the Judges (5 slides – try not to add slides).
3. Judges will follow with 2-3 minutes of questions prior to finalizing the presentation score.
4. Please practice your presentation, to not exceed allotted time.

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

The Oral Presentation shall be well prepared. This includes, but is not limited to:

1. Professional overall appearance.
2. Easy to see slides with dark text on a light background (use the templates).
    a. Do not add slides, do not change order of slides.
3. Appropriate placement of pictures, graphs, and videos.
4. Professional appearance of the presenters.
5. Speaking clearly and loudly.
6. Looking into the camera.
7. Referring to the slides, not reading them.
8. Communicating to the panel in an appropriate and professional manner.

## Post Launch Assessment Review

This is a new requirement for Gateway teams within the 2024-2025 Competition. This review is still being adjusted but will follow the pattern of prior milestones of filling in a PPT template but this would focus on the results of your competition flight.

More information will be provided as we get closer to Launch Weekend.

# HPR Safety Overview

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

## Virtual Tech Inspection – Tripoli Wisconsin

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

1. The team's rocket should be 95% + constructed.
2. A diagram of the rocket indicating the configuration of its main components.
3. Flight simulation showing max altitude and launch guide velocity.
4. Knowledge of their altimeter operation.
5. Type of hardware used (eye bolts, recovery harnesses, adhesives, etc.).
6. Discuss construction techniques.
7. Payload/challenge or mechanical operations.

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

## Overview of Safety Regulations

High-power 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:

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

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

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

Tripoli Rocketry Association
Tripoli Code for High-power Rocketry
Safety Information - Tripoli Rocketry Association

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

HPR Launch Sites

Contact a local NAR or Tripoli Club who have an FAA Waiver, a designated launch site and club launch dates in place where you can safely fly your rocket for test flights, etc.

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

Table 1: FAA Rocket Classification

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

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

Table 2: Certification Requirements

| | Certification Required | | | |
|---|---|---|---|---|
| Motor Parameter | None | Level 1 HPR | Level 2 HPR | Level 3 HPR |
| Total Combined Impulse | 320 N-sec (2xG Class) | 640 N-sec (H, I Class) | 5120 N-sec (J, K, L Class) | 40960 N-sec (M,N,O Class) |
| Combined Propellant Mass | 125 grams | No Limit | | |
| Single Motor Impulse | 160 N-sec | No Limit | | |
| Single Motor Propellant Mass | 62.5 grams | No Limit | | |
| Single Motor Avg Thrust | 80 N | No Limit | | |
| Sparky Motors | Not Allowed | Allowed | | |
| Total Rocket Mass | 1500 grams | No Limit | | |
| Field Distance Reqmts | Per Model Rocket Safety Code | Per HPR Safety Code | | |

## High-power Rocketry Safety Code

1. **Certification.** I will only fly high-power rockets or possess high-power rocket motors that are within the scope of my user certification and required licensing.
2. **Materials.** I will use only lightweight materials such as paper, wood, rubber, plastic, fiberglass, or when necessary ductile metal, for the construction of my rocket.
3. **Motors.** I will use only certified, commercially made rocket motors, and will not tamper with these motors or use them for any purposes except those recommended by the manufacturer. I will not allow smoking, open flames, nor heat sources within 25 feet of these motors.
4. **Ignition System.** I will launch my rockets with an electrical launch system, and with electrical motor igniters that are installed in the motor only after my rocket is at the launch pad or in a designated prepping area. My launch system will have a safety interlock that is in series with the launch switch that is not installed until my rocket is ready for launch, and will use a launch switch that returns to the "off" position when released. The function of onboard energetics and firing circuits will be inhibited except when my rocket is in the launching position.
5. **Misfires.** If my rocket does not launch when I press the button of my electrical launch system, I will remove the launcher's safety interlock or disconnect its battery, and will wait 60 seconds after the last launch attempt before allowing anyone to approach the rocket.
6. **Launch Safety.** I will use a 5-second countdown before launch. I will ensure that a means is available to warn participants and spectators in the event of a problem. I will ensure that no person is closer to the launch pad than allowed by the accompanying Minimum Distance Table. When arming onboard energetics and firing circuits I will ensure that no person is at the pad except safety personnel and those required for arming and disarming operations. I will check the stability of my rocket before flight and will not fly it if it cannot be determined to be stable. When conducting a simultaneous launch of more than one high-power rocket I will observe the additional requirements of NFPA 1127.
7. **Launcher.** I will launch my rocket from a stable device that provides rigid guidance until the rocket has attained a speed that ensures a stable flight, and that is pointed to within 20 degrees of vertical. If the wind speed exceeds 5 miles per hour, I will use a launcher length that permits the rocket to attain a safe velocity before separation from the launcher. I will use a blast deflector to prevent the motor's exhaust from hitting the ground. I will ensure that dry grass is cleared around each launch pad in accordance with the accompanying Minimum Distance table, and will increase this distance by a factor of 1.5 and clear that area of all combustible material if the rocket motor being launched uses titanium sponge in the propellant.
8. **Size.** My rocket will not contain any combination of motors that total more than 40,960 N-sec (9208 pound-seconds) of total impulse. My rocket will not weigh more at liftoff than one-third of the certified average thrust of the high-power rocket motor(s) intended to be ignited at launch.
9. **Flight Safety.** I will not launch my rocket at targets, into clouds, near airplanes, nor on trajectories that take it directly over the heads of spectators or beyond the boundaries of the launch site, and will not put any flammable or explosive payload/challenge in my rocket. I will not launch my rockets if wind speeds exceed 20 miles per hour. I will comply with Federal Aviation Administration airspace regulations when flying, and will ensure that my rocket will not exceed any applicable altitude limit in effect at that launch site.
10. **Launch Site.** I will launch my rocket outdoors, in an open area where trees, power lines, occupied buildings, and persons not involved in the launch do not present a hazard, and that is at least as large on its smallest dimension as one-half of the maximum altitude to which rockets are allowed to be flown at that site or 1500 feet, whichever is greater, or 1000 feet for rockets with a combined total impulse of less

than 160 N-sec, a total liftoff weight of less than 1500 grams, and a maximum expected altitude of less than 610 meters (2000 feet).

11. **Launcher Location.** My launcher will be 1500 feet from any occupied building or from any public highway on which traffic flow exceeds 10 vehicles per hour, not including traffic flow related to the launch. It will also be no closer than the appropriate Minimum Personnel Distance from the accompanying table from any boundary of the launch site.
12. **Recovery System.** I will use a recovery system such as a parachute in my rocket so that all parts of my rocket return safely and undamaged and can be flown again, and I will use only flame-resistant or fireproof recovery system wadding in my rocket.
13. **Recovery Safety.** I will not attempt to recover my rocket from power lines, tall trees, or other dangerous places, fly it under conditions where it is likely to recover in spectator areas or outside the launch site, nor attempt to catch it as it approaches the ground.

## Safe Launch Practices

I. **All Launches:**

A. Must comply with United States Code 1348, "Airspace Control and Facilities," Federal Aviation Act of 1958 and other applicable federal, state, and local laws, rules, regulations, statutes, and ordinances.

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 (CP) and the center of gravity (CG) of the high-power rocket to the RSO if the RSO requests the same.

C. The member shall provide proof of membership and certification status by presenting their membership card to the Launch Director 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.

E. Recovery

1. 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.
2. Ensure that adequate protection is in place to prevent hot ejection gasses from causing burn damage to retaining cords, parachutes, and other vital components.
3. Do not attempt to catch a high-power rocket as it approaches the ground.
4. Do not attempt to retrieve a rocket from a power line or other place that would be hazardous to people attempting to recover it.

F. Payload/challenges

1. Do not install or incorporate in a high-power rocket a payload/challenge that is intended to be flammable, explosive or debris that can cause harm.
2. Do not fly a vertebrate animal in a high-power rocket.

G. Weight Limits

1. 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.

H. Launching Devices

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

I. Ignition Systems

1. Use an ignition system that is remotely controlled, electrically operated, and contains a launching switch that will return to "off" when released.
2. The ignition system shall contain a removable safety interlock device in series with the launch switch.
3. 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.

4. A rocket motor shall not be ignited by a mercury switch or roller switch.
    a) Install an ignition device in a high-power rocket motor only at the launch pad.

J. Launch Operations
1. Do not launch with surface winds greater than 20 mph (32 km/h) or launch a rocket at an angle more than 20 degrees from vertical.
2. Do not ignite and launch a 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).
3. A rocket shall be pointed away from the spectator area and other groups of people during and after installation of the ignition device(s).
4. Firing circuits and onboard energetics shall be inhibited until the rocket is in the launching position.
5. Firing circuits and onboard energetics shall be inhibited prior to removing the rocket from the launching position.
6. When firing circuits for pyrotechnic components are armed, no person shall be allowed at the pad area except those required for safely arming/disarming.
7. Do not approach a high-power rocket that has misfired until the RSO/LCO has given permission.
8. Conduct a five second countdown prior to launch that is audible throughout the launching, spectator, and parking areas.
9. All launches shall be within the Flyer's certification level, except those for certification attempts.
10. The RSO/LCO may refuse to allow the launch or static testing of any rocket motor or rocket that he/she deems to be unsafe.

II. 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.
F. When three or more rockets (at least one high-power) are launched simultaneously, the minimum distance for all involved rockets shall be the lesser of:
    1. Twice the complex distance for the total installed impulse. (Refer to V. Distance Tables)
    2. 2000 ft. (610 m)
    3. 1.5 times the highest altitude expected to be achieved by any of the rockets.
        (1) 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

| Installed Total Impulse (Newton-Seconds) | Equivalent High Power Motor Type | Minimum Diameter of Cleared Area (ft.) | Minimum Personnel Distance (ft.) | Minimum Personnel Distance (Complex Rocket) (ft.) |
|---|---|---|---|---|
| 0 – 320.00 | H or smaller | 50 | 100 | 200 |
| 320.01 – 640.00 | I | 50 | 100 | 200 |
| 640.01 – 1,280.00 | J | 50 | 100 | 200 |
| 1,280.01 – 2,560.00 | K | 75 | 200 | 300 |
| 2,560.01 – 5,120.00 | L | 100 | 300 | 500 |
| 5,120.01 – 10,240.00 | M | 125 | 500 | 1000 |
| 10,240.01 – 20,480.00 | N | 125 | 1000 | 1500 |
| 20,480.01 – 40,960.00 | O | 125 | 1500 | 2000 |

# APPENDIXES

## APPENDIX A-1 – 2025 Motor Choices

For the 2025 First Nations Launch Challenge, the motor selections are constrained to:

### Gateway Challenge Motors

**Kit: FANTOM 438**

| Manufacturer | Size | Type | Motor |
|---|---|---|---|
| Aerotech | 38mm | DMS | I175WS |
| Aerotech | 38mm | RMS | I285R |


**Kits: Patriot and LOC IV -X2**

| Manufacturer | Size | Type | Motor |
|---|---|---|---|
| Aerotech | 38mm | RMS | I366R |
| Aerotech | 38mm | RMS | I284W |


**Motor Types**

DMS = "Disposable Motor System"
RMS = "Reloadable Motor System"

**Important Notes about Motors:**

1. Final motor selection is due by February 17, 2025. No changes can be made without approval from Frank Nobile, TRA.
2. Motors (and hardware) will be purchased by WSGC after the CDR report.
3. Motors (and hardware) will be provided to teams at Launch Weekend.
4. Motor prep will be taught during Launch Weekend (motor workshop), prior to Launch Day.

## APPENDIX A-2 – First Nations Launch 2025 Gateway Competition Kits

The Gateway category must select a kit from the following list:

1. Loc Precision - 4" diameter "FANTOM 438" EXL variant
    a. https://locprecision.com/products/fantom-438?variant=39778638528703
    b. When ordering, remember to include the following additional components from the order page:
        i. "E-bay and Alti-package (EXL)"
    c. RockSim file is available from the manufacturer
        i. https://cdn.shopify.com/s/files/1/0568/7489/3503/files/loc_pk_51_fantom438_exl.rkt?v=1673214533
    d. Motor Options
        i. Aerotech – DMS I175WS
        ii. Aerotech – RMS I285W


2. Loc Precision - 4" diameter "Patriot"
    a. https://locprecision.com/products/4-patriot?_pos=1&_sid=e919eabe1&_ss=r
    b. When ordering, remember to include the following additional components:
        i. "Loc Style Ebay"
    c. RockSim file is available from the manufacturer:
        i. https://cdn.shopify.com/s/files/1/0568/7489/3503/files/YPAT438.zip?v=1623859293
    d. Item to note, the kit is offered in two different "trims"
        i. LOC Cardboard Airframe with birch ply fins
            1. Standard building materials for a rocket and is suggested for most teams
        ii. PML Quantum Airframe with G10 fiberglass fins
            1. Advanced airframe and fin materials. While the finished rocket may look great, the airframe is prone to cracking when handling or dropping and is known for temperature related expansion/shrinkage issues.
    e. Motor Options
        i. Aerotech – RMS I366R
        ii. Aerotech – RMS I284W


3. Loc Precision - 4" diameter "LOC IV X2"
    a. https://locprecision.com/products/loc-iv-x2?_pos=1&_sid=2c3bbffa6&_ss=r
    b. RockSim file is available from the manufacturer
        i. https://cdn.shopify.com/s/files/1/0568/7489/3503/files/LOC-IV-X2.rkt?v=1717091317
    c. Motor Options
        i. Aerotech – RMS I366R
        ii. Aerotech – RMS I284W

Some hardware/component variance may be present between kit/hardware vendors and may include/exclude features including avionics bays, sleds, shock cord, and parachutes. There are some general hardware items that teams may need to also consider that could include items such as: quick links, swivel eyes, motor retaining clips, e-bay switches, and other items.

## APPENDIX A-3 – 2025 Overall Scoring

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

Note that reports make up most of the overall score – this is in part, because a large amount of time is spent on the reports. Completing the reports, forces your team to address every component of the design. Do not skip the reports. It is crucial that you follow the design sequence properly, in order to have a successful flight. Also note that bonus points can be earned by completing outreach events. This 10% may put your team considerably ahead of the competition for overall grand prize.

| | |
|---|---|
| 1. Design Reports | 75% of Total |
| a. Competition Proposal/Flysheet | (5%) |
| b. Preliminary Design Review (PDR) Report/Flysheet | (15%) |
| c. Preliminary Design Review (PDR) Presentation | (5%) |
| d. Critical Design Review (CDR) Report/Flysheet | (15%) |
| e. Critical Design Review (CDR) Presentation | (5%) |
| f. Flight Readiness Review (FRR) Report/Flysheet | (15%) |
| g. Flight Readiness Review - Virtual Inspection | (5%) |
| h. Post Launch Assessment Review (PLAR) Report | (10%) |
| 2. Launch Weekend Presentation | 5% of Total |
| a. Flight Readiness Presentation | (5%) |
| 3. Flight Performance | 20% of Total |
| a. Mission Performance (including Apogee) | (10%) |
| b. Challenge Performance | (10%) |
| 4. Bonus Points | (Up to 10%) |
| a. Plan and conduct an Education Outreach Project | |
| b. Submit Education/Public Outreach Form (**Appendix A-2**) | |

Reports submitted after 11:59 pm Central time on the due date will receive a reduction of the overall score.
Central Daylight Savings Time (March 12, 2023 - November 11, 2023, March 10, 2024 - November 3, 2024)
Central Standard Time (November 12, 2023 - March 09, 2024)

| | |
|---|---|
| 1 Day Late | 20% Deduction |
| 2 Days Late | 40% Deduction |
| 3 Days Late | 60% Deduction |
| 4 Days Late | 80% Deduction |
| 5 Days Late | Zero |

## APPENDIX A-4 – 2025 Awards List

*(Based upon availability of funds)*

| Title | Description | Award |
|---|---|---|
| **Grand Prize Award*** | Team with most overall points. | $3000 with invitation to a NASA Center. |
| **2nd Place Award*** | Team with 2nd most overall points. | $2000 |
| **3rd Place Award*** | Team with 3rd most overall points. | $1000 |
| **Golden Gateway Team***** | Top performing Gold status Gateway Team | $500 |
| **Aesthetic Award** | Team whose rocket has the most innovative and professional appearance as determined by peers. | Industry sponsored gift |
| **Team Spirit Award** | Team that shows interactive spirit, helpfulness, and cooperation as determined by peers. | Industry sponsored gift |
| **Rookie Team Award** | New team that completes all phases of the rocket competition with determination and perseverance. | Industry sponsored gift |
| **Advisor Award** | Advisor or co-advisor that equips, encourages, and empowers their team to compete with confidence and capabilities that lead to next step opportunities. | Industry sponsored gift |
| **Team Lead Award** | Awarded to a team lead that fulfills their role with excellence. | Industry sponsored gift |
| **Altitude Award** | Team whose actual apogee is closest to required/predicted apogee in the Flight Readiness report. | Industry sponsored gift |
| **Judges Award** | Team who best met the goals of the program and exemplified hard work and determination as determined by the judges. | Industry sponsored gift |
| **Next Step Award** | Team best deemed to compete at the next level of competition as determined by the WSGC team. | Up to $15000 team sponsorship with invitation to Student Launch at Marshall Space Flight Center and/or RockOn! at Wallops Flight Facility |
| **Outreach Award** | Team who completes one or more outreach events that can be continued or scaled. | $500 |
| **Patch Contest Award** | Individual that submits the winning patch submission. | $100 |
| **Team Advisor Stipend** | Stipend if team meets the conditions of participation. | Up to $1000 |

*Moon/Mars Challenge Levels

## APPENDIX A-5 – First Nations Launch 2025 Outreach Form

May be found on the First Nations Launch Tools and Tips webpage:
https://spacegrant.carthage.edu/live/files/4953-outreach-form

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

*Education/Public Outreach*
*Documentation Form*

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

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

| Your Team Information | | |
|---|---|---|
| **Team Lead's Name** | **Advisor's Name** | **Academic Institution** |
| | | |
| **Team Lead Signature** | **Advisor's Signature** | **Today's Date** |
| | | |

| Event Information | | |
|---|---|---|
| **Date of Event** | **Approximate # of Attendees** | **List Each City, State, & Zip Code Where the Event Took Place** |
| | | |
| **Brief Description of Attendees (Click all that apply)** | | **List All Organizations Involved With the Event** |
| ☐ PreK: ☐ Students ☐ Teachers<br>☐ K-5 Grade: ☐ Students ☐ Teachers<br>☐ 6-8th Grade: ☐ Students ☐ Teachers<br>☐ High School: ☐ Students ☐ Teachers<br>☐ University/Campus: ☐ Undergrads ☐ Graduate<br>☐ Administrator ☐ Faculty<br>☐ Public at Large<br>☐ Informal Education Setting (Museum, etc.) | | |

| Event Information Continued | |
|---|---|
| **Brief Description of Activity** | |
| | |
| **Is this a new or existing event? (Select one)** | **What was the duration of the event? (Select one)** |
| ◯ New ◯ Existing | ◯ < 2 days ◯ = 2 days ◯ > 2 days |
| **How many exhibits were supported/developed by this event?** | **How many student hands-on activities were supported/developed by this event?** |
| | |
| **How many public at large activities were supported by this event?** | **If other activities were supported by this event, please explain:** |
| | |
| **Please provide links to any media coverage (via your institution, local, or regional news outlets) received for this event:** | |
| | |
| **Please provide the title, presenter, and venue for any presentations directly attributed to this activity.** | |
| | |
| **Describe how your team plans to build upon this outreach event:** | |
| | |
| **Please use this space to provide WSGC with any additional information about this outreach event:** | |
| | |

# APPENDIX C-1 – Project Planning Guidance

## Team Structure

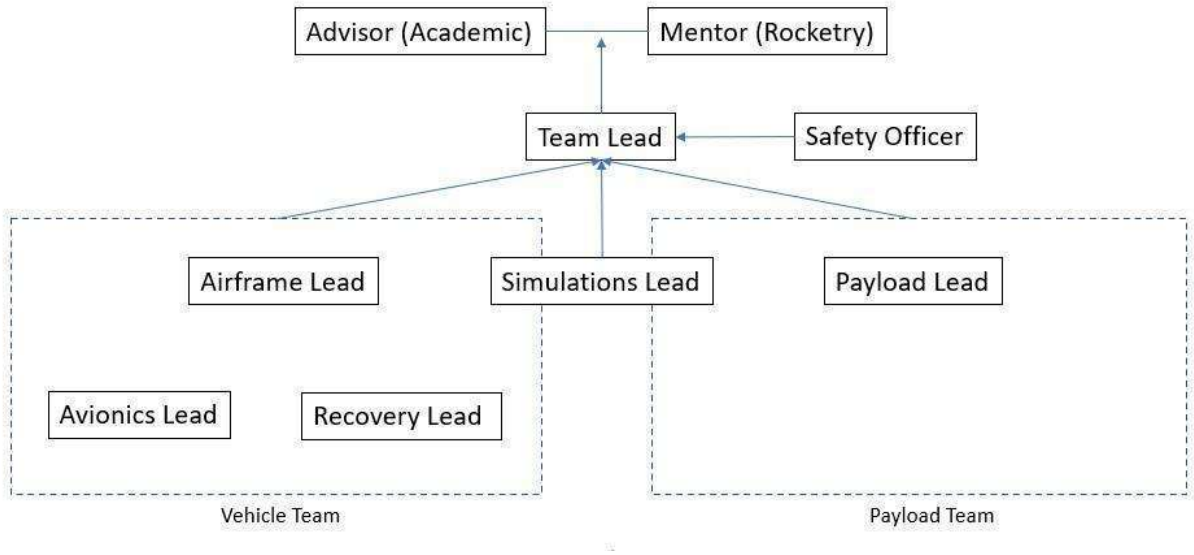



*Figure C.1 GANTT Chart- Recommended team structure.*

## Role Descriptions

*Figure C.1* shows the recommended breakdown for a typical Rocket Competition team. This breakdown works best for 5-6 team members. If you do not have 5-6 team members, ensure that you are dividing the work evenly.

a. Team Lead
   i. Organizes meetings, delegate tasks, keeps the team on track and integrated.
   ii. Support other team member's roles as needed.
   iii. Bring issues to advisor and/or TRA mentor.
   iv. Bring issues/questions to the WSGC team.
   v. Assists and organizes parts/supplies procurement.
   vi. Compiles and proofs reports and presentations.

b. Team Safety Officer
   i. Organizes the safety procedures of the team.
   ii. Responsible for the Safety section of the reports.
   iii. Creates and maintains all hazard analysis and risk assessment.

c. *S*imulations Lead (can be combined with Airframe)
   i. Responsible for running/updating simulations and motor selection.
   ii. Responsible for the Mission Performance section of reports.

d. Avionics Lead
   i. Responsible for design/layout/fabrication of avionics bay.
   ii. Responsible for altimeter selection/operation.
   iii. Responsible for the Avionics section of reports.

e. Recovery Lead

i. Responsible for all recovery hardware and its integration
ii. Responsible for proper parachute selection/sizing (simulation).
iii. Responsible for the Recovery section of report.

f. Sub-Teams

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

i. Airframe Team
    1. Responsible for vehicle modification and assembly/construction.
    2. Responsible for subsystem integration.
    3. Responsible for the Vehicle Criteria section of reports.

ii. Payload/challenge Team (the Challenge)
    1. Responsible for payload/challenge design (hardware and software).
    2. Responsible for integration.
    3. Responsible for the Payload/challenge Criteria section of reports.

g. Additional Team Resources

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

i. Team Role Test
ii. Stages of Team Formation
iii. Positive Team Building: Bruce Tuckman's Proven Formation
iv. The Unique Characteristics of an Effective Team
v. Understanding the Stages of Team Formation
vi. Team Charters
vii. Sample Team Charter
viii. So, You're Going to be a Member of a Team

## 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. The Team Lead should be responsible for creating and maintaining the budget, with assistance from the Advisor.

There are many Project Management tools available for use. We do not limit which one you prefer. The simplest approach is to use an Excel Spreadsheet. Your initial budget at the Proposal phase will not contain many details. Instead, it will contain a breakdown to the primary functions of your Project.

1. Proposal Budget
    a. Teams receive a $4000 funded project. You will need to decide how much you will allocate to:
        i. Simulation Software
        ii. Vehicle Parts
        iii. Payload Parts
        iv. Testing or Mockup of Components and Ideas
        v. Rocketry Building Supplies
        vi. Tooling or Special Tools
        vii. Personal Protective Equipment
        viii. Travel and Accommodations

The budget should not be an afterthought – monitor and update the budget weekly or as needed. You may find that your generous allowance slowly fades, as the budget creeps. You may also need to reallocate funds from one source to another, or even seek out additional funds from your school or community.

> If you create and maintain your budget in Excel spreadsheet, it is a simple matter to copy the table over to your report when necessary (if it is large, you may add it as an Appendix – do not shrink the table so small that the reader struggles to read it).

## Milestone Phases

At each milestone, you will need to update the budget spreadsheet with new details as the team makes design choices. All the remaining reports (PDR, CDR, FRR) require you to submit the updated budget. The WSGC team can also verify you are on track if certain items are in your budget at certain milestones – or conversely, if you are missing key items, we will ask if you have considered them, and help get you back on track.

**Bonus:** You can also use the budget spreadsheet to track items (create a column for 'status' – purchased, shipped, on-hand etc.). You can also use the budget spreadsheet to verify and maintain the parts mass balance (create a column for 'weight' – weigh each item as it arrives and update the simulations accordingly).

## Example Budget

There is an example budget (slightly detailed, perhaps at PDR phase) found on the WSGC website resource page.

WSGC (Collegiate, First Nations, Great Midwest) Rocket Competition 20xx
Team ABC
School Name

Proposed Budget

| Component Description | Quantity | Cost Per Unit | Total |
|---|---|---|---|
| BODY FRAME CONSTRUCTION | | | |
| Body Tube 3.9" ID 4.0" OD 34 inch length | 2 | $10.45 | $20.90 |
| Centering Rings 3.9" OD 38 mm ID 0.5" thickness will be made in house | 2 | $8.10 | $16.20 |
| Nose Cone 3.9" outer diameter | 1 | $21.95 | $21.95 |
| Construction Supplies Epoxy/Paint/Battery/Hardware/Etc. - | - | $100.00 | $100.00 |
| PAYLOAD DESIGN | | | |
| GoPro Camera | 1 | $199.99 | $199.99 |
| AVIONICS | | | |
| Altimeters For systematic parachute deployment (Already have 2) | - | - | - |
| Altimeter Bay Payload bay to hold altimeters | 1 | $28.56 | $28.56 |
| Pitot tube Used to calculate velocity of rocket | 1 | $350.00 | $350.00 |
| Key switches Used to turn on altimeters at the launch pad | 2 | $6.00 | $12.00 |
| GPS Garmin GTU 10 have | - | - | - |
| MOTOR/PROPULSION | | | |
| Motor Mount Tube 38 mm fits I, and J motors; to mount motor in rocket | 1 | $7.35 | $7.35 |
| Motor Retainer 38 mm retainer; secures motor in motor mount tube | 1 | $31.03 | $31.03 |
| Terminal Block 12 Position terminal strip for wiring ejection charges | 1 | $3.49 | $3.49 |
| Rail Buttons For launch; to connect rocket to launch rail | 2 | $1.54 | $3.08 |
| RECOVERY | | | |
| Parachute 60" SkyAngle (10.2-22.1 lbf) (Already have 1) | - | - | - |
| Parachute Protector Reusable fire resistant cloth to protect parachute (Already have 4) | - | - | - |
| Rip Cord 1500lb Kevlar Shock Cord (Cost per foot) | 60 | $0.92 | $55.32 |
| GENERAL MATERIALS & SUPPLIES | | | |
| Toolbox Storage of tools and components (Already have) | - | | - |
| Dremel Rotary tool kit General purpose tool (used for cutting fin slots, sanding, etc.) have Drogue Parachute To eject before main parachute; have one, but will buy spare have Fins Approximate price for G-10; size and shape to be determined | 4 | $15.95 | $63.80 |
| TRAVEL EXPENSES | | | |
| Air fare | 5 | $200.00 | $1,000.00 |
| Baggage fees | 2 | $50.00 | $100.00 |
| Shipping fees | - | $100.00 | $100.00 |
| Rental car | - | $500.00 | $500.00 |
| Mileage (based on Google map, reimbursement rate of $0.575 per mile) | 90 | $0.58 | $51.75 |
| Tolls & parking | - | $25.00 | $25.00 |
| Food ($30/day/person) | 5 | $30.00 | $150.00 |
| TOTAL | | | $2,840.42 |



## 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.

The Team Lead should be responsible for creating and maintaining the schedule, with assistance from the Advisor. There are many Project Management tools available for use. We do not limit which one you prefer. One of the more dedicated tools to assist with scheduling is Microsoft Project. (https://www.microsoft.com/en-us/microsoft-365/project/project-management-software). If you have access to this software via your school computers or licenses you may use it (it is simple to learn the basics on your own). However, creating and tracking a schedule can be accomplished using Excel. We suggest you use the Gantt chart template (this is a simplified version of MS Project).

## Milestone Schedule

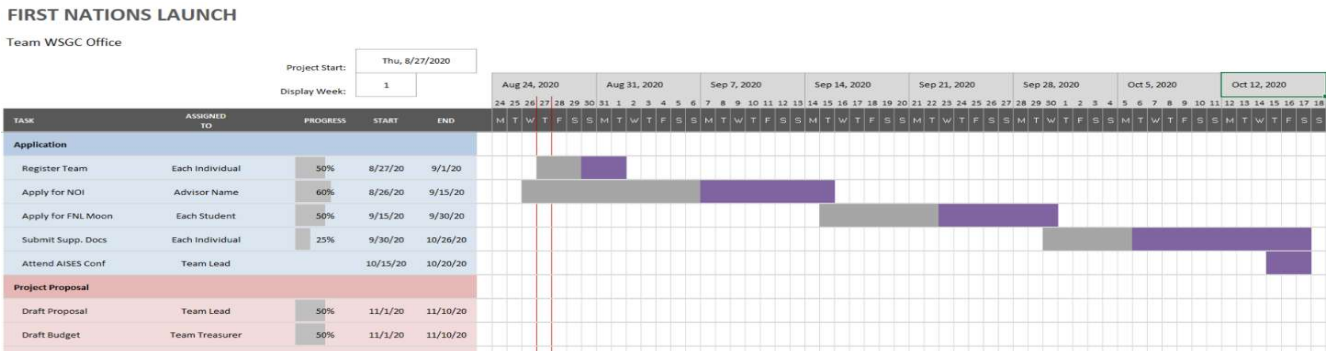
At each milestone, you will update your schedule as needed. You may find or eventually see a 'critical path' – an item or task that is critical to complete on time, so as not to jeopardize the success of your build and flight.

Procurement is an essential item to monitor in your schedule. You do not want to procure the large items too early in the design and constrain your choices (do not procure major items until the entire design is near completion at end of PDR phase or beginning of CDR phase). You also do not want to procure too late (some items have long 'lead times' or are custom order). Depending on where you are located relative to the vendor, shipping times may also be important.

## Example Schedule

There is an example schedule section (Gantt chart format – the initial few months of the competition) found on the WSGC website resource page (Tools and Tips).

There is also a Gantt chart template for your convenience, to start with, if you choose to use it.



## APPENDIX C-2 – Testing Plan Overview

At each phase of this project, you will be expected to create and update a test plan. It is suggested that you use an Excel spreadsheet to maintain the information of your test plan, and copy necessary information at each design phase into your Report (perhaps as an Appendix).

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

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

1. **Electrical Components**
    a. Altimeter testing
    b. Tracking testing
2. **Recovery System Tests**
    a. Parachute ejections tests
    b. Parachute deployment tests
3. **Scale Tests**
    a. Small scale rocket tests can be used to test any new components in flight
    b. Wind tunnel tests can determine drag

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

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

### Altimeter Testing

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

Some advanced altimeters can be controlled wirelessly or via Bluetooth. Make sure to test these connections, and the range of these connections in the field. Make sure to understand the conditions of the field in Wisconsin, it may not be the same as where you test. Ensure multiple people (or even all team members) are proficient in programming and retrieving information from the altimeters.

Tracking devices should also be tested and understood in the field (perhaps not a literal field, but somewhere outside opposed to bench testing in the lab). Understand your battery life, how long you will have power for. Ensure multiple people (or even all team members) are proficient in using the tracking devices.

### Recovery Testing

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

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

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

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

### Scale Testing

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

| System | Test | Objective | Timeframe | Outcome |
|---|---|---|---|---|
| Altimeter | Pressure test | To verify the pressure sensor operates correctly. | Dec-23 | - |
| | Accelerometer test | To verify the accelerometer operates correctly. | Dec-23 | - |
| Recovery | Ejection test | To verify the amount of energetic needed for satisfactory ejection. | Jan-24 | - |
| | Tracking test | To verify the GPS tracking system functions properly, and determine limitations. | Jan-24 | - |

At each design cycle, update the list of tests, adding any new ones that may arise or removing unnecessary ones. You may also need to update the time frame and add the outcomes as tests are completed.

## APPENDIX C-3 – Requirements Verification Overview

In any engineering project, a major component of project management is requirements management (also known as Verification and Validation - https://en.wikipedia.org/wiki/Verification_and_validation). 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."

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. List Requirements. The requirements for FNL are explicitly listed in the Competition Handbook.
2. Assign Requirement to Individual/Team (example, structures requirement, avionics requirement etc.)
3. Identify how the requirement will be satisfied. Requirements can be satisfied by:
    a. Test, analysis
    b. Demonstration
    c. Simulation
    d. Inspection
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 is supposed to achieve.

A basic example Requirement Verification spreadsheet would look like the example below. The Requirements Spreadsheet is found in the 'Tools and Tips' page of the WSGC website: https://spacegrant.carthage.edu/first-nations-launch/tools-and-tips/

| | | Requirement | Assigned to | Method to Satisfy | Outcome |
|---|---|---|---|---|---|
| 13 | Vehicle Rqmt | The launch vehicle will accelerate to a minimum velocty of 52 fps at rail exit. | Airframe - Simulations | Simulation | Simulation shows 89 fps rail exit. |
| 14 | Vehicle Rqmt | The center of gravity and center of pressure must be indicated on the exterior of the rocket, from simulation, using the fully loaded | Airframe | Inspection | - |
| 15 | Vehicle Rqmt | All teams must successfully launch and recover an Estes rocket provided by WSGC. | Team | Demonstration | - |

Remember to complete and list ALL requirements. Monitoring these requirements will help to ensure a successful build and flight, and ensure nothing is missed during the design.

## APPENDIX C-4 – Safety Checklists

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

Checklists can be used for **inventory**. Examples include:

1. Weekly shop checks to ensure that there are always adequate supplies on hand
2. 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:

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

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

1. Avionics programming steps
2. Avionics bay assembly
3. Payload/challenge assembly and installation/integration with vehicle

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

These include:

1. Avionics Prep
2. Recovery Prep
3. Final Assembly
4. Launch Pad Setup
5. Post Flight Inspection

# APPENDIX D-3 – How to Acquire RockSim and Simulation Resources

## *RockSim – What Is It?*

There are various tools for the amateur rocketeer to assist with creating and simulating a high-power rocketry flight. A few of these are:

1. RockSim https://www.apogeerockets.com/RockSim/RockSim_Information
2. OpenRocket https://openrocket.info/
3. RASAero http://www.rasaero.com/

For First Nations Launch, **RockSim** is the required simulation tool.

RockSim is a computer program (simulation tool) that allows you to design any size rocket then simulate its flight to see how high and fast it will fly! Even before you start buying components and building your design, you'll find out if it will be stable and safe to launch, as well as meet any weight, speed or height criteria you might want. Instead of wasting money on incorrect components and numerous test motors, imagine how much money you'll save by doing all your test flights on the computer!

You can also use it to find the best motor and delay combinations for your existing kits. Because nearly every rocket manufacturer uses this software, nearly all available rocket kits have a RockSim design file that you can open. RockSim is available for both Mac and Windows.

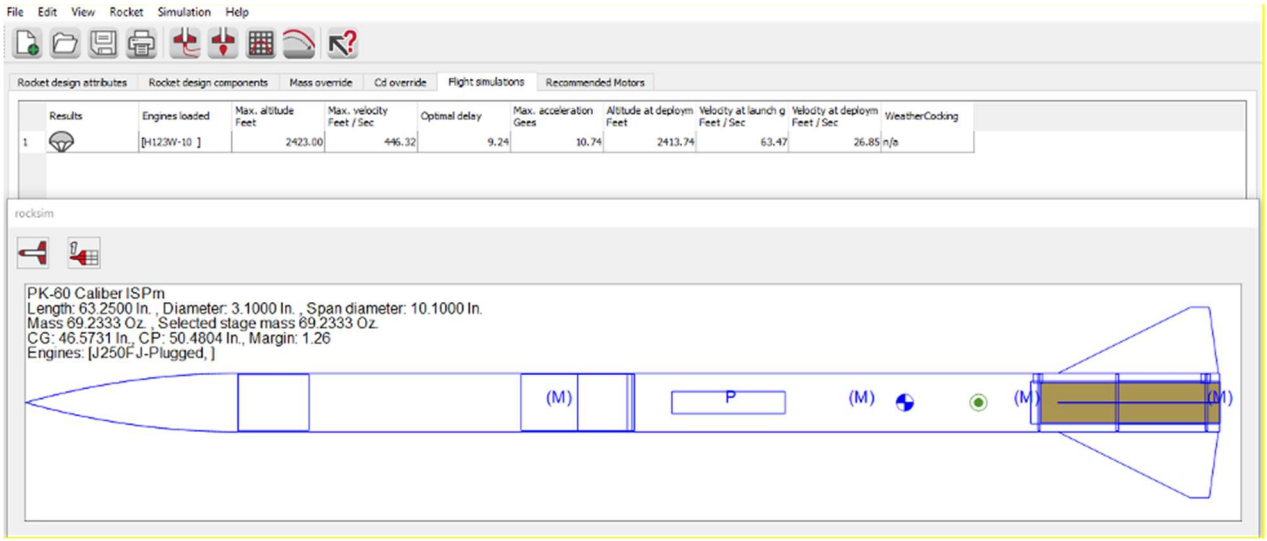



*Figure 1 – Image of RockSim user interface.*

### *RockSim - Why Do I Need It?*

RockSim is the required primary simulation tool. Many other competitions also require teams to learn and use RockSim as their primary simulation tool:

1. The American Rocketry Challenge (TARC) https://rocketcontest.org/)
2. NASA Student Launch Initiative (SLI) https://www.nasa.gov/stem/studentlaunch/home/index.html)
3. Spaceport America Cup (SAC) https://spaceportamericacup.com/)

Like any industry engineering project, the high-power rocketry challenge begins with concepts, which need to be examined using simulations, to aid in design, prior to procurement, manufacture, test and flight. You will use RockSim, beginning at Proposal phase to:

1. Research and examine various dual deployment rocket kits
2. Ensure the rocket kit can accommodate the payload/challenge solution
3. Select a corresponding motor that allows the rocket and payload to achieve all performance requirements

As the design progresses, you will refine your simulation models to:

1. Ensure every component of the model has an accurate mass (matches on hand part).
2. Select proper parachutes to meet recovery requirements.
3. Ensure all component masses are accounted for in the simulation (hardware, electronics etc.).
4. Ensure all internal components are in the correct location, to obtain an accurate center of gravity.
5. Ensure drag components are accounted for:
    a. Surface finish
    b. Rail buttons
    c. Any protuberance
6. Ensure all performance requirements are satisfied

Your team is required to submit a RockSim file at each Milestone, for our inspection, to ensure that your simulations and design are progressing on track, and that your rocket will have a safe, stable flight.

Some flight parameters needed from RockSim at each milestone (in your report or flysheet) include:

1. Fully loaded rocket weight
2. Rocket length and diameter
3. Center of Gravity (CG) and Center of Pressure (CP) location
4. Stability margin
5. Velocity at launch guide departure (rail exit velocity)
6. Descent rate
7. Maximum altitude
8. Time to apogee

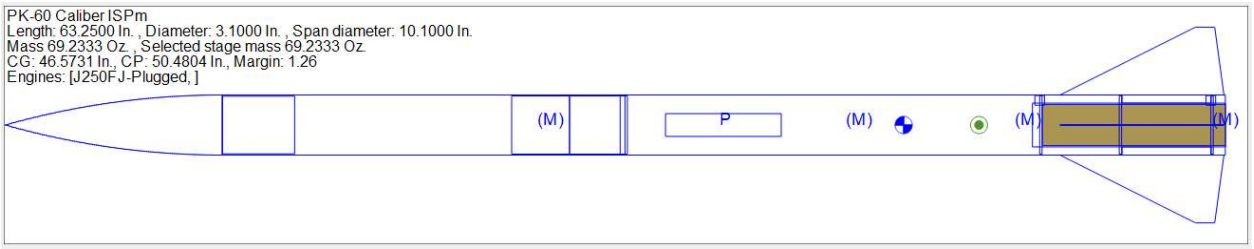



*Figure 2 – Image of RockSim user interface, showing rocket inset.*

### *RockSim – How Do I Get It?*

RockSim is distributed by Apogee Components. https://www.apogeerockets.com/

Suggested Approach

1. It is suggested that students of interested teams request the trial version of RockSim by filling out the 'RockSim Trial' form (see links below). This trial version is good for 30 days, it is a limited version. Students can begin learning RockSim using online tutorials (see links below).
2. Once the team (Advisor) receives the Acceptance Letter from WSGC, it is suggested that the Advisor procure multiple licenses to distribute to the team (prior to the trial versions expiring).
    a. To get the discounted rate ($20 per license), you must procure the 'Educational License – TARC Temporary License' (see links below).
        i. You must provide the 'Team ID / Team Number' while ordering.
        ii. You will get a 'Team ID / Team Number' from WSGC FNL in your Acceptance Letter.
            1. Note the license is 'temporary' – it will deactivate on August 31 of the following year.
3. The Advisor will distribute the activation keys to the necessary team members.

Note: L2L participants will receive a free temporary RockSim license as part of their L2L participation

Alternative Approach

1. The trial version is not required or necessary to install RockSim – you may install and activate the full version (once you have been given an activation key from your Advisor) by following the instructions on 'Download/Registration' (see links below).
2. This assumes the Advisor has completed the steps above to procure licenses for the team
3. Alternatively, students may procure RockSim on their own as well (full permanent version at full price, or discounted rate, using the 'Team Award #' FNL<YR>_<Award #>)

There are various license versions, so please ensure you procure the correct one (use the links below). Of course, you may also procure any of the various full licenses as you wish – explore the options on Apogee Components website (single user - permanent, school site licenses - multiple).

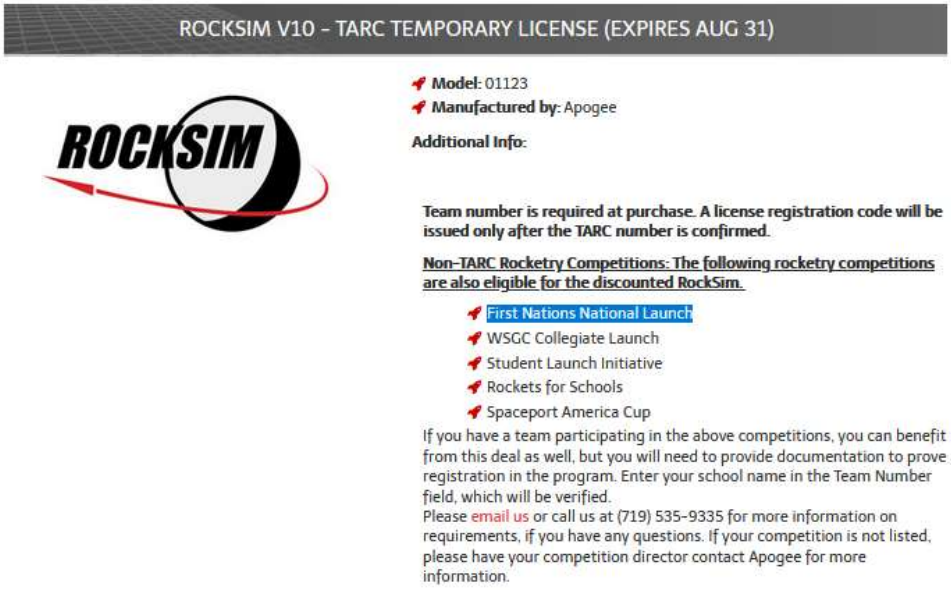



*Figure 3 – RockSim TARC Temporary (Discounted) License*

### *RockSim – When Do I Need It?*

Students interested in FNL, should request a trial version of RockSim **immediately** (September). RockSim will be needed to begin the Proposal phase, once the NOI is submitted (October). The trial version is valid for 30 days from the installation date. It has reduced capability relative to the licensed version but is still capable of providing all the necessary information to complete the Proposal.

Advisors should procure RockSim licenses as soon as they receive the WSGC FNL Acceptance letter (October), and distribute the activation keys to the necessary team members.

Students should begin to learn RockSim by following the online tutorials provided by Apogee Components (see links below) as soon as possible.

### *RockSim – How Do I Use It?*

Apogee Components provides many online and self-directed learning resources to learn to use RockSim. See the Video Tutorial section of the Apogee Components website (see links below).

WSGC FNL will also conduct a Virtual Webinar – "Introduction to RockSim" after NOIs and prior to Proposal submission which will highlight simulation tips pertaining to FNL.

### *RockSim – Important Links*

Overview / Information: https://www.apogeerockets.com/RockSim/RockSim_Information

1. Trial Version Sign-Up: https://www.apogeerockets.com/RockSim/Rocksim_Trial
2. Educational License: https://www.apogeerockets.com/Rocket_Software/RockSim_Educational_TARC
3. TARC Temporary License: https://www.apogeerockets.com/index.php?main_page=product_software_info&cPath=13_207&products_id=204
4. Download / Registration: https://www.apogeerockets.com/RockSim/Rocksim-Registration
5. Video Tutorials: https://www.apogeerockets.com/RockSim/RockSim_Video_Tutorials

### *Other Related Resources*

Another resource to mention is the User Database of RockSim rocket files (**RockSim Library**), found at RocketReview.com (see link below). Although RockSim comes with an extensive library of rocket files to open and examine, it is not a complete set. As you research rocket kit choices online, there is typically a corresponding rocket simulation file in the pre-loaded database – if not, you may find a rocket simulation file in the RockSim Library (or on the vendor's website for you to download).

1. Design Files: https://www.rocketreviews.com/rocksim-library.html

A final resource to mention is the Motor database at **ThrustCurve.org** (see link below). The RockSim library contains most motors from most manufacturers (Aerotech, Cesaroni etc.) However, there may be times when the RockSim database does not contain the motor you wish to simulate – or you simply want more information about a motor to add to your Milestone report. You can search motors at Thrustcurve.org and download/import motor files into the RockSim Library as needed.

1. Motor Files: https://www.thrustcurve.org/

## APPENDIX D-5 – Personal Tripoli HPR Certification (Optional)

**Tripoli Certification Overview** (**http://www.tripoli.org/Certification**). There exists an opportunity for advisors and students to obtain their Tripoli High-power Rocketry Certification, either at a Launch 2 Learn (L2L) rocket certification workshop or at the First Nations Launch competition.

L2L Certifications are subject to the L2L workshop. If the workshop is conducted at Carthage College in Kenosha, WI, attendees will complete the certification process within the workshop. If the workshop is conducted at a different location or virtually, the certification flight may take place at a later date.

Launch weekend certification flights may take place during the competition after the team has flown their competition rocket. Flight time will also be available on Sunday from 10:00 am – 2:00 pm (2:00 pm - 4:00 pm during L2L certification launches in October) so plan your travel accordingly. In order to certify, you must sign up with WSGC (express your intention to certify) by the deadline announced in the FNL Calendar, in order that we may procure and provide motors as needed. If you did not attend the in person L2L Workshop (‘**Appendix D-6’)**, and plan to certify, you must coordinate your motor choice with Tripoli Wisconsin Technical Advisor.

### *High-power Level 1 Rocket Certification*

The Level 1 certification is open to individuals 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 L2L 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 purchased and paid for by WSGC at the time of certification.

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

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

### *High-power Level 2 Rocket Certification*

The Level 2 certification is open to all individuals 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. The written test must be passed prior to the flight attempt. Tripoli Rocketry Association will administer the test during the competition weekend.

The costs of the rocket and the motor must be borne by the student. The Tripoli membership fee will be covered by an FNL donor. The student must purchase and build their rocket independently, and transport their rocket to and from Wisconsin for the certification flight. The L2L workshop does not offer Level 2 certification.

### *High-power Level 3 Rocket Certification*

No Level 3 launch certifications will be conducted through the First Nations Launch program.

## APPENDIX D-6 - Common Rocketry Tracking Devices

Here is a list of rocket tracking devices commonly used in High-Power Rocketry. This list is not inclusive of all products available on the market.

Please visit their websites to view the tracker.  Some devices may require FCC licensing as indicated.

- EGG TIMER ROCKETRY; non-licensed and ham band GPS tracker and altimeter kits
  http://eggtimerrocketry.com
- FEATHERWEIGHT: non-licensed GPS tracking system and altimeters.
  https://www.featherweightaltimeters.com/featherweight-gps-tracker.html
- MISSILEWORKS, non-licensed GPS tracking system and altimeters
  https://www.missileworks.com/menu
- APOGEE COMPONENTS: non-licensed GPS tracking system
  https://www.apogeerockets.com/Electronics_Payloads/Rocket_Locators
- ALTUS METRUM: licensed GPS tracking systems and altimeters
  https://altusmetrum.org/

## APPENDIX E-3 – WSGC Resource Page

**Wisconsin Space Grant Consortium (WSGC) Resources:**
WSGC Website https://spacegrant.carthage.edu/
WSGC Website Registration Page (Login/Registration) https://spacegrant.carthage.edu/about/login/

**First Nations Launch (FNL) Resources:**
FNL Website https://spacegrant.carthage.edu/first-nations-launch/
FNL Zoom Meetings https://zoom.us/j/99258659434
FNL Calendar https://spacegrant.carthage.edu/first-nations-launch/calendar/
FNL FAQ https://spacegrant.carthage.edu/first-nations-launch/faq/
FNL Patch Contest https://spacegrant.carthage.edu/first-nations-launch/patch-contest/
FNL About Us https://spacegrant.carthage.edu/first-nations-launch/about-us/
FNL History https://spacegrant.carthage.edu/first-nations-launch/history/
FNL Awards https://spacegrant.carthage.edu/first-nations-launch/awards/

**FNL Report Templates:**
FNL Report Templates and Scoring Rubric https://spacegrant.carthage.edu/first-nations-launch/rubric/
FNL Proposal Template https://spacegrant.carthage.edu/live/files/6238-fnl24proposaltemplatedocx.docx
FNL Preliminary Design Report (PDR) Template https://spacegrant.carthage.edu/live/files/6238-fnl24proposaltemplatedocx.docx
FNL PDR Virtual Review PowerPoint Template https://spacegrant.carthage.edu/live/files/6220-fnl24pdrpresentation-templatepptx.pptx
FNL Critical Design Report (CDR) Template https://spacegrant.carthage.edu/live/files/6240-fnl24cdrtemplatedocx.docx
FNL CDR Virtual Review PowerPoint Template https://spacegrant.carthage.edu/live/files/6221-fnl24cdrpresentation-templatepptx.pptx
FNL Flight Readiness Report (FRR) Template https://spacegrant.carthage.edu/live/files/6241-fnl24frrtemplatedocx.docx
FNL Flight Readiness Review PP Template (Oral Presentation) https://spacegrant.carthage.edu/live/files/6222-fnl24launch-weekendpresentation-templatepptx.pptx
FNL Post Launch Assessment Report Template https://spacegrant.carthage.edu/live/files/6242-fnl24plartemplatedocx.docx

**FNL Tools & Tips Resources:**
*The following documents can be found on the* FNL Tools and Tips *webpage* or the URL may be copied and pasted into your search field https://spacegrant.carthage.edu/first-nations-launch/tools-and-tips/
FNL Announcement of Opportunity https://spacegrant.carthage.edu/live/files/6214-first-nations-launch-fnl-announcement-of.pdf
FNL Launch 2 Learn Rocketry Workshop https://spacegrant.carthage.edu/live/files/6191-fnl24l2l-workshop-flyerpdf.pdf
Adult Media Release https://spacegrant.carthage.edu/live/files/4575-media-release-form-adult.pdf
FNL Outreach Form https://spacegrant.carthage.edu/live/files/4953-outreach-form.pdf
FNL Team Bio Form https://spacegrant.carthage.edu/live/files/4974-team-bio-form.pdf
FNL Team Roster & Lodging Form https://spacegrant.carthage.edu/live/files/5021-team-roster-and-lodging-list-formfillable.pdf
FNL Proposed Budget Example https://spacegrant.carthage.edu/live/files/4955-proposed-budget-example.pdf
FNL Project Expense Form Instructions https://spacegrant.carthage.edu/live/files/4564-project-expense-form-instructions-and-example.pdf

FNL Project Expense Forms https://spacegrant.carthage.edu/live/files/4563-project-expense-form.pdf
FNL Travel Expense Form Instructions https://spacegrant.carthage.edu/live/files/5403-travel-expense-formeditable-instructionsfinal.pdf
FNL Travel Expense Form https://spacegrant.carthage.edu/live/files/5405-travel-expense-form.pdf
FNL Shipping Procedure https://spacegrant.carthage.edu/live/files/4827-fnl-rocket-shipping-procedure.pdf

**Additional FNL Resources:**
FNL Team Building Resources https://spacegrant.carthage.edu/first-nations-launch/tools-and-tips/
FNL Example Safety Checklists https://spacegrant.carthage.edu/live/files/5296-safety-checklist-examples.pdf
W9 https://www.irs.gov/pub/irs-pdf/fw9.pdf

**AISES Resources:**
American Indian Science and Engineering Society Website https://www.aises.org/

**Apogee Resources:**
Apogee Rockets – RockSim Information https://www.apogeerockets.com/RockSim/RockSim_Information
Apogee Rockets – RockSim Quick Start Guide
https://www.apogeerockets.com/RockSim_Quick_Start_Guide?pg=quickside
Apogee Rockets – RockSim Discounted Temp License
https://www.apogeerockets.com/Rocket_Software/RockSim_Educational_TARC

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

**Tripoli (TRA) Resources:**
TRA Website http://www.tripoli.org/
TRA Membership http://www.tripoli.org/Membership
TRA Certification Overview http://www.tripoli.org/Certification
TRA Prefectures http://www.tripoli.org/Prefectures

**National Association of Rocketry (NAR) Resources:**
NAR Website https://www.nar.org/
NAR Membership https://www.nar.org/my-membership/
FAA Waiver on NAR Website
http://www.nar.org/high-power-rocketry-info/filing-for-faa-launch-authorization/filing-for-faa-waiver/

## APPENDIX E-4 – Handbook Change Log

| Date | Change |
|---|---|
| **1/27/25** | Corrected Appendix A-1 motor designation for one motor available to Fantom kits and one motor available to Patriot/Loc IV-X2 kits |
| | |
| | |