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2024-2025
First Nations Launch Competition
Mars Handbook

REVISED: 10/13/2024

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https://spacegrant.carthage.edu/first-nations-launch/about-us/

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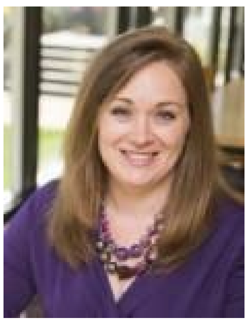

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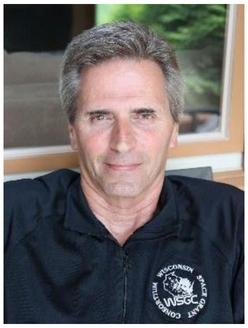

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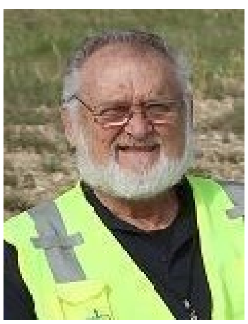
- Handbook questions



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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	**Preliminary Design Review (PDR) Milestone**
	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)
	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	Final Virtual Safety Inspection with Tripoli Rocketry Association (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) Milestone
PLAR Report Due* (Moon/Mars)
2-3 Team Project Photos Due* (Gateway/Moon/Mars)

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 2024-2025 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.

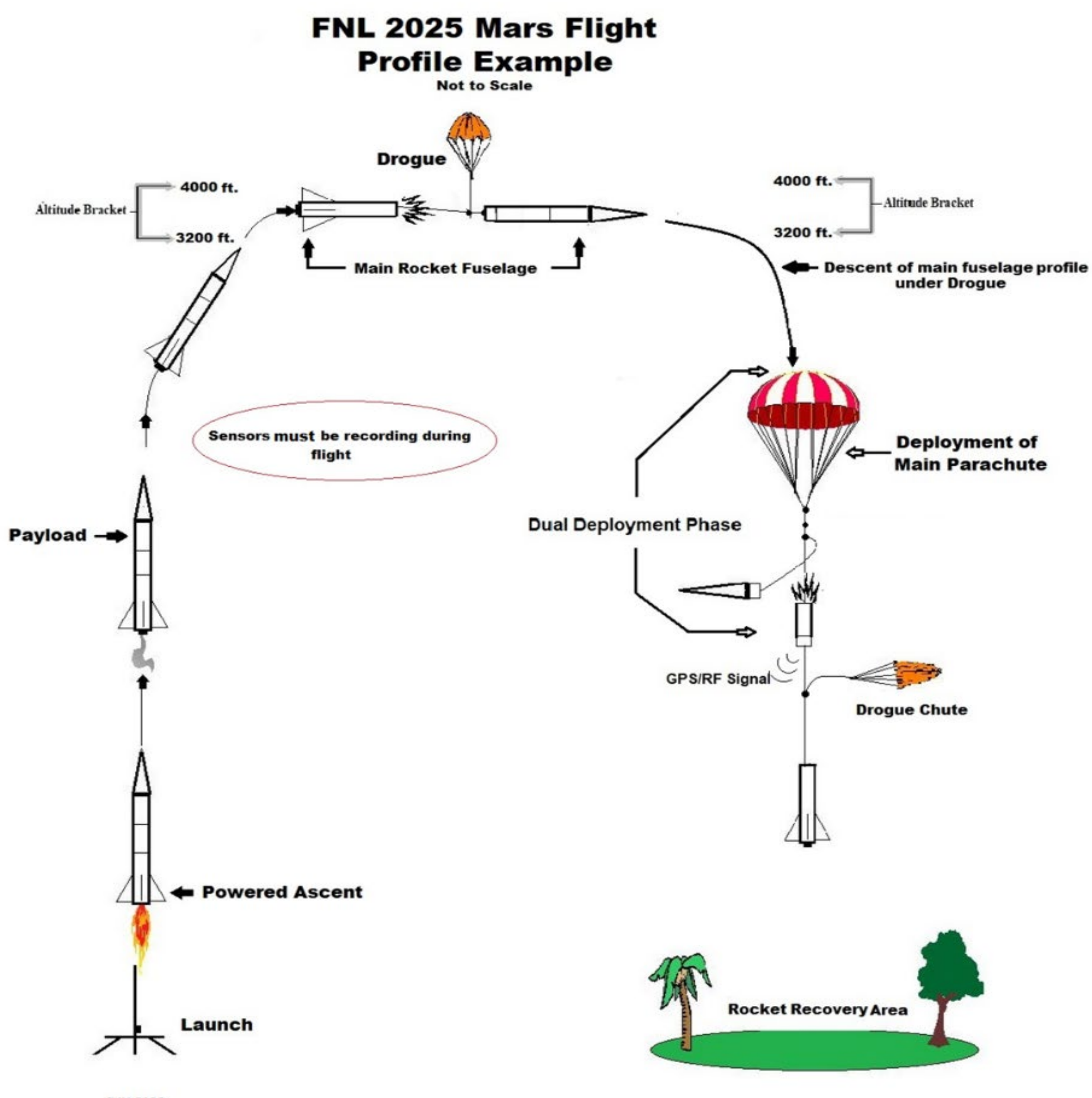
MARS Challenge Overview

Teams may choose to compete in any challenge. There are no restrictions or requirements for team eligibility. However, WSGC recommends 1) new teams or 2) teams with all new members or 3) non-engineering school teams enter the Gateway or Moon Challenges (see the MOON and GATEWAY Handbooks respectively), while experienced teams and engineering school teams enter the Mars Challenge.

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

Mars Engineering Challenge Overview:

Teams shall build a minimum 4” diameter rocket either from components, utilizing one of the competition motors and achieve an altitude of 3,200’ – 4,000’ AGL. The annual challenge will see the teams incorporate multiple sensors into a cohesive system to analyze the flight. The rocket must satisfy all other technical requirements as outlined in the requirements section of the competition handbook.



MARS Challenge Requirements

The 2025 MARS Challenge will focus on electronic sensors in the rocket. The following specific MARS challenge requirements must be satisfied:

1. Airspeed Sensor
    a. Sensor – select a suitable COTS pitot tube sensor
        i. Sensor will use captured pressure data to calculate airspeed
        ii. Sensor will require a corresponding flight computer (microcontroller)
    b. Data – collect airspeed data during the full competition rocket flight
        i. The flight computer (microcontroller) will be used to store the data
        ii. Power and memory should be considered in selection
    c. Post Flight - compare your collected data
        i. Pitot tube airspeed data versus COTS altimeter airspeed data
        ii. Discuss any discrepancies in your PLAR
2. Pressure Sensor
    a. Sensor – select a suitable COTS pressure sensor
        i. Sensor will measure the atmospheric pressure inside avionics bay
        ii. Sensor will require a corresponding flight computer (microcontroller)
    b. Data – collect pressure data during full competition rocket flight
        i. The flight computer (microcontroller) will be used to store the data
        ii. Power and memory should be considered in selection
    c. Post Flight – compare your collected data
        i. Atmospheric pressure data versus COTS altimeter pressure data
        ii. Discuss any discrepancies in your PLAR
3. Orientation Sensor
    a. Sensor – select a suitable COTS inertial measurement unit (IMU)
        i. Sensor will capture the 9-Degrees of Freedom orientation of the rocket
        ii. Sensor will require a corresponding microcontroller
    b. Data – collect the vehicle orientation data during the full competition rocket flight
        i. The microcontroller should store the data during the full rocket flight
        ii. Power and memory should be considered in selection
    c. Post Flight – compare your collected data
        i. IMU orientation data versus COTS altimeter / GPS orientation data
4. Acceleration Sensor
    a. Sensor – select a suitable load cell weight sensor (preferably wheatstone bridge)
        i. Sensor will capture the strain of a bar under deflection by the weight
        ii. Sensor will require an amplifier and corresponding microcontroller
    b. Data – collect the acceleration data during the full competition rocket flight
        i. Use a unit mass on the load cell (the increase / decrease in weight used to determine the max accelerations)
        ii. The microcontroller should store the data during the full rocket flight
        iii. Power and memory should be considered in selection
    c. Post Flight – compare your collected data
        i. Load Cell acceleration versus COTS altimeter acceleration
5. Deflection Sensor
    a. Sensor – select a suitable strain gauge for deflection measurement
        i. Sensor will measure any deflections (bending) of your fins in flight

        ii. Sensor may require multiple gauges, or amplification in the circuit
    b. Data – measure any deflection of your fin(s) during the full competition rocket flight
        i. The microcontroller should store the data during the full rocket flight
        ii. Power and memory should be considered in selection
    c. Post Flight – compare your collected data
        i. Deflections versus test results (or video of fin inflight)
        ii. Discuss results in your PLAR
6. The collection of all data shall be independent of (shall not use) rocketry electronics (aka the COTS altimeters or GPS).
    a. Data collected must be compared to COTS data collected, in post flight report.
7. The sensors can use the same flight computer / microcontroller for data collection, or each sensor can have an independent data collection.
    a. The sensors do not need to be co-located in the rocket (can be housed in different sections).
8. The Challenge hardware (sensors / electronics) shall not inhibit the safe flight of the rocket.
9. The Challenge hardware (sensors / electronics) is required to be flown – functioning or not.

Rocket Vehicle Requirements

1. Teams must construct a minimum 4-inch diameter rocket from COTS parts or fabricated parts or a combination of both.
2. Teams must select a motor from **Appendix A-1** such that the rocket with it's custom avionics will reach an apogee between 3,200' – 4,000' AGL and satisfy all other performance requirements.

Teams must ensure all other technical requirements from the remainder of the Requirements section are followed.

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 '**Advisor Handbook: 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 '**Advisor Handbook: 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 '**Advisor Handbook: 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 '**Advisor Handbook: 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 #9**).
    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 '**Advisor Handbook: 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 '**Advisor Handbook: 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 **Advisor Handbook: 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).
    a. Motors are provided by WSGC - Motors are limited to those listed in **Appendix A-1**.
    b. Final motor choices will be declared by the CDR milestone.
    c. Any motor change after CDR must be approved by the FNL Tech Team and will only be approved if the change is for the sole purpose of increasing the safety margin.
        i. When a motor change is made, a penalty against the team's overall score will be incurred, regardless of the reason.
2. The vehicle will carry, at a minimum, one commercially available, barometric altimeter.
    a. For triggering the required electronic deployment of ejection charges.
    b. For recording the official altitude.
        i. Used in determining the Altitude Award winner (see '**Appendix A-4**' for awards criteria)
3. Each altimeter (if redundant) will
    a. Have a dedicated power supply, on an independent circuit.
    b. Be armed by a dedicated mechanical arming switch, on an independent circuit, that is:
        i. Accessible from exterior of rocket when the rocket is on the launch pad.
        ii. Capable of being locked in the ON position for launch (i.e., cannot be accidentally disarmed due to flight forces).
4. The launch vehicle will have a minimum static stability margin of 1.0 at the point of rail exit (to be determined by simulations).
5. 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.'
6. The flight ready launch vehicle will have a thrust-to-weight ratio greater than 5:1.
7. The Center of Gravity (CG) and Center of Pressure (CP) must be indicated on the exterior of the rocket (from simulation), using the flight ready configuration prior to competition flight.
8. 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 can be used to alter flight performance and static stability.
    i. 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 (drogue parachute is deployed at apogee and a main parachute is deployed at a lower altitude).
    a. The apogee event may contain a delay of no more than 2 seconds past apogee.
    b. The main parachute event shall be deployed between 1000 – 300 ft AGL.
    c. Single deployment parachute release devices (tender descender, jolly logic parachute release etc.) are prohibited.
2. The descent rate after apogee (under drogue parachute) shall range between 45 – 65 feet per second.
3. The descent rate upon touchdown (under main parachute) shall range between 15 – 20 feet per second.
4. The recovery system electrical (COTS altimeter) circuits shall be completely independent of any payload/challenge electrical circuits.
5. The recovery system electronics (COTS altimeter) will be powered by commercially available batteries.
6. Recovery system electronic devices (COTS altimeters) must be used as your primary ejection events, at both apogee and main deployment.
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. The estimated time to apogee should be known (from simulations) to adjust the ejection charge delay fuse during motor prep.

    *Note this requirement implies the drogue parachute must sit in the booster section.
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

Project Deliverables required for successful participation and completion in Mars 2025 are listed here. Many of these deliverables coincide with the Project Milestones, as discussed in the next Section of this Handbook. Teams must provide to WSGC (or complete for WSGC) the following:

1. Prior to Proposal Submission (NOI)
    a. Team/students must participate in the virtual Kick-Off Meeting (see calendar).
    b. Team/students must procure, learn, utilize and provide a RockSim rocket simulation file:
        i. Of current design, uploaded to WSGC at each Milestone (Proposal, PDR, CDR, FRR)
        ii. Of the 'as-built' competition rocket, due the day before competition launch
    c. Team/students must fly a lower power Estes (or similar) rocket before PDR and upload a video of the flight prior to PDR (see calendar). The rocket will be provided by WSGC for all teams. A launchpad will be provided by WSGC for new teams.
2. During Milestones
    a. Mars/Moons team/students must complete and submit all required Written Reports (PDF) and Virtual Presentations (PowerPoint), to the WSGC FNL Grant Management site by the Team Lead on applicable due dates (see calendar).
    b. All teams must complete and submit all required Flysheets to the WSGC FNL Grant Management site by the Team Lead on applicable due dates (see calendar).
    c. Team/students must participate in Proposal, PDR, and CDR Virtual Reviews (Zoom teleconference) on the applicable dates (see calendar).
    d. Team/students must participate in one (1) Safety Review after CDR and one (1) Virtual Technical Inspection after FRR with Tripoli Wisconsin (Zoom teleconference).
3. During Launch Weekend
    a. Team/students must provide a reusable rocket with required payload/challenge system ready for competition launch and Launch Weekend (see calendar).
    b. Team/students must submit flight (altimeter) data on competition launch day via flash drive.
4. After Launch Weekend
    a. Mars/Moon team/students must complete and submit the Written Report (PDF) – Post Launch Assessment, to the WSGC FNL Grant Management site by the Team Lead on the applicable due date (see calendar).
    b. Team/students must provide 2 – 3 photos featuring team members designing, building, and flying the competition rocket to be submitted to the WSGC Grant Management page by the team lead by PLAR deadline.

Program Milestones: Criteria and Expectations

Proposal Requirements

NEW for 2024-2025, the proposing Mars team shall identify the following in a written Proposal due to WSGC as outlined in the FNL Calendar, at the time of NOI submission (please use the Proposal Template found at https://spacegrant.carthage.edu/first-nations-launch/rubric/)

Due to the competitive nature of this competition, this Proposal may be used to determine if your team will be selected and awarded a Grant for this division, so please fill ALL information as much as possible.

1. General Information
   a. Name of the college/university or secondary education institution.
   b. Name, school title for advisor and co-advisor (if applicable).
   c. Name, major, for the student Team Leader.
   d. Name, major, for the student Safety Officer.
   e. Name, title of the experienced rocketry mentor (certified L2 member or higher of NAR or TRA). If none, list 'in progress.'
   f. Name of the NAR/TRA section(s) the team is planning to work with for purposes of mentoring, review of designs and documentation, and local launch assistance. If none, list 'in progress.'
   g. Brief bio listing of student participants who will be committed to the project and their proposed duties. Include an outline of the project organization that identifies the key managers and technical personnel.
2. Facilities/Equipment
   a. This section includes description of facilities and hours of accessibility, necessary personnel, equipment, and supplies that are required to design and build the rocket and payload/challenge(s). Include images as necessary.
      i. Identify what shops (makerspace, student shops etc.) are available to students.
      ii. Identify the general tools / equipment available (woodworking, metal working etc.).
      iii. Identify the specific tools / equipment available for 3D printing (type of machines, number of machines).
      iv. Identify what training is needed to access the shops.
      v. Discuss plans to train team members (may include in the Project Management section).
      vi. Identify the dedicated workspace to store rocketry components and complete the build.
      vii. Identify the dedicated space for meetings on campus.
      viii. Identify the dedicated space for virtual presentations (camera and audio set) – may be the same as the meeting space.
   b. This section includes description of computing equipment available, for communication, design, development, simulation, and document development to support design reviews. The necessary equipment identified should include:
      i. Identify the computer hardware (computer lab space).
      ii. Identify the computer software (for report writing etc.), computer-aided drafting (CAD) and solid model software, FEM software, CFD software, internet access and email capability.
      iii. Identify filesharing capabilities (suggest you setup and use Google Drive to share information among the team members) or an alternative.

iv. Identify the number of simulation software licenses (RockSim mandatory) available (personal computers or school computers). See '**Advisor Handbook: Appendix D-3**' for assistance with how to acquire and learn RockSim.
    1. If none, provide a plan to procure the software.
    2. Note: free trial versions may be used until full license is procured.
    3. Note: the technical information discussed later in this Proposal should make use of RockSim so it should be procured and utilized at this point.

3. Safety
   Provide a written safety plan addressing the safety of the materials used, facilities involved, and student responsible, i.e., Safety Officer, for ensuring that the plan is followed.
   a. A risk assessment is suggested but not required.
   b. Provide a description of the procedures for NAR/TRA personnel (mentor) to perform. Ensure the following:
      i. Compliance with TRA High-Power Safety Code requirements (http://www.tripoli.org/SafetyCode).
      ii. Performance of all hazardous materials handling and hazardous operations.
   c. Describe the plan for briefing students on hazard recognition and accident avoidance as well as for pre-launch briefings.
   d. Describe methods to include necessary caution statements in plans, procedures, and other working documents including the use of proper Personal Protective Equipment (PPE).
   e. Each team shall provide a plan for complying with federal, state, and local laws regarding unmanned rocket launches and motor handling. Specifically, regarding the use of airspace, Federal Aviation Regulations 14 CFR, Subchapter F, Part 101, Subpart C; Amateur Rockets, Code of Federal Regulation 27 Part 55: Commerce in Explosives; and fire prevention, NFPA 1127 "Code for High-power Rocket Motors."
   f. Provide a plan for NRA/TRA personnel (mentor) purchase, storage, transportation, and use of rocket motors and energetic devices.
   g. Include a written statement that all team members understand and will abide by the following safety regulations:
      i. Range safety inspections will be conducted on each rocket before it is flown. Each team shall comply with the determination of the safety inspection or may be removed from the program.
      ii. The Range Safety Officer has the final say on all rocket safety issues. Therefore, the Range Safety Officer has the right to deny the launch of any rocket for safety reasons.
      iii. The team mentor is ultimately responsible for the safe flight and recovery of the team's rocket. Therefore, a team will not fly a rocket until the mentor has reviewed the design, examined the build, and is satisfied the rocket meets established amateur rocketry design and safety guidelines.
      iv. Any team that does not comply with the safety requirements will not be allowed to launch their rocket.

4. Technical Design
   Discuss your proposed and general approach to rocket and payload/challenge design for Mars 2025. Include alternatives (trade studies) to show you have examined various options as the WSGC Tech Team may prohibit your initial choices during Virtual Reviews. Your Proposal (use the Proposal Template found at ***Insert Link***) should include the following technical information:
   a. General Vehicle Dimensions.

    i. Material selection and justification (may fabricate airframe or purchase COTS).
    ii. Construction methods and experience (if fabricating).
    iii. Research various rocketry kit (or sizing) options and present your leading choices. Design drivers will include:
        1. Satisfying technical requirements (obtained via simulations).
        2. Dimensions of the rocket (diameter and length).
        3. Weight of kit / payload and motor combination to achieve expected altitude.
        4. Robustness of material to handle the expected loading.
        5. Capability of team / school to work with the material.
        6. Cost of rocket kit or applicable raw materials (suggest a spare airframe be purchased / fabricated, for testing, to cover for damage etc.).

b. Projected Recovery System Design.
    i. Research various rocketry recovery components and present your leading choices. This may include:
        1. Initial parachutes and hardware.
        2. Initial vehicle altimeters for parachute deployments.
        3. Initial electronic tracking systems.

c. Projected Motor Designation (Motors are restricted to Aerotech brand).
    i. Research the various motor performance parameters and use simulations to determine leading choices:
        1. Motors are restricted to those on the Approved Motor List (**Appendix A-1**)
        2. Motor should be selected to satisfy technical requirements (not an arbitrary selection).

d. Simulations.
    i. Initial RockSim simulations are expected at the Proposal phase including simulation data.
        1. Above parameters are inputs to simulations, to determine the best motor choice.

e. General Challenge Details.
    i. Research each of the Sensor Requirements in the previous Mars Challenge Requirements Section, and discuss an approach (trade studies) with leading choices here, listing for each sensor (include images):
        1. Initial sensor selection with general details
        2. Initial microcontroller or flight computer used with sensor with details
        3. Initial location of assembly in rocket
    ii. Consider other Mars Challenge Requirements such as rocket restrictions, integration goals, or vehicle performance targets, and show that you will meet those goals:
        1. This may include screenshots of RockSim simulation outputs.
        2. This may include 3D models showing possible integration.

f. Major technical challenges and solutions.
    i. Share any major technical concerns and identify the critical path.

5. Project Plan
    a. Test Plan - Provide an initial test plan for applicable vehicle, recovery, altimeters, and challenge components selected at this point (this will be refined / updated at each milestone). See '**Appendix C-2**' for support.
        i. Challenge tests should include the following at each milestone (component procurement should begin after Proposal Review):
            1. PDR – component tests to ensure each component works individually.

2. CDR – assembly tests to ensure all the components work as an assembly.
3. FRR – configured tests to ensure the assembly works in flight conditions (could be a full or scale test flight, or drone flight at a minimum).

ii. Vehicle tests should include the following at each milestone (airframe procurement should wait until after PDR Review, when Challenge components are more mature):
1. CDR – altimeters/GPS component tests to ensure each component works individually.
2. FRR – ejection tests to ensure parachute deployments are acceptable, and the safe use of black powder is understood

*a full-scale flight test is optional, but scale flight tests may prove beneficial to understanding or testing components (deployments) in flight

b. Requirements Verification – Provide an initial requirements verification matrix – this will be refined and updated at each milestone. This table will ensure that your team satisfies all of the requirements, and your design does not violate any requirements.
i. Create a spreadsheet that contains all of the Requirements from this Handbook.
ii. Include columns for Requirement – Verification Method - Status (Completed / In Work) – Person Responsible.
iii. Only the Requirement column needs to be filled at Proposal.

c. Schedule Plan - Provide an initial schedule/timeline covering all aspects necessary to successfully complete the project (this will be refined/updated at each milestone). Use Gantt chart format. See '**Appendix C-1**' for support.
i. Use the milestone dates (Proposal, PDR, CDR, FRR, Flight, PLAR) as guidance and create a general schedule for the successful completion of the project.
ii. Include items such as (start and end of):
1. Team training and recruitment timeline.
2. Challenge design and selection (material / methods research and simulations).
3. Procurement (equipment, raw materials) timeline.
4. Component build / fabrication timeline.
5. Component testing timeline.
6. Flight test timeline (if applicable).
7. Launch Weekend travel timeline.
8. Outreach events timeline.

d. Budget Plan - Provide an initial budget to cover all aspects necessary to complete the project successfully (this will be refined/updated at each milestone). Use spreadsheet format. See '**Appendix C-1**' for support.
i. Initially, breakdown your budget into groups such as:
1. Software costs
a. You are required to procure RockSim simulation software licenses (see '**Advisor Handbook: Appendix D-3**' for support).
2. Fabrication or testing equipment / supplies costs.
3. Rocket parts / payload materials costs.
4. Payload / challenge costs
5. Team travel on Launch Weekend costs.

ii. Provide a detailed funding plan.
iii. You may need to seek additional funds beyond the WSGC funding, for long term sustainability.

e. Sustainability Plan - Develop a clear plan for sustainability of the rocket project in the local area. This plan should include:
    i. How to provide and maintain established partnerships and regularly engage successive classes of students in rocketry.
    ii. Partners (industry/community/local state Space Grant consortium), recruitment of team members, funding sustainability, and STEM engagement/outreach activities.

Preliminary Design Review (PDR)

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

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

Preliminary Design Review Report

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

1. Team Summary
    a. Team name
    b. School name
    c. Name of team advisor (required) and co-advisor (if applicable)
    d. Name of student team lead and student safety lead
    e. Name of mentor, NAR/TRA number and certification level (required)
    f. Names and roles of team members
2. Summary of PDR report (2 pages maximum)
    a. Highlight any major changes since previous report
        i. Launch Vehicle Summary
            1. Preliminary size and mass
            2. Preliminary motor choice(s)
            3. Preliminary recovery system
        ii. Challenge Summary
            1. Summarize your approach to satisfying the Challenge Requirements
            2. Provide preliminary payload electronics list
3. Vehicle Criteria
    a. Selection and Design of Launch Vehicle.
        i. Provide an overview of all key components/systems, including alternatives.
            1. Present the pros and cons of each alternative.
        ii. After evaluating alternatives, present a vehicle design with the current leading alternatives, and explain why they are the leading choices.
            1. Describe each subsystem and the components within those subsystems.
        iii. Include images where applicable (manufacturer, simulation, CAD models etc.)
        iv. Provide estimated masses for each component.
    b. Recovery Subsystem
        i. Using the estimated mass of the launch vehicle, perform a preliminary analysis on parachute sizing and determine what size is required for a safe descent.

    ii. Choose leading components amongst the alternatives, present them, and explain why they are the current leaders.
  c. Avionics Subsystem
    i. Demonstrate that preliminary design has begun on the structure, sizing, and placement of the avionics bay, including the location and sizing of the vent holes.
    ii. Include overall position of the avionics bay within the vehicle, number of altimeters, layout of avionics sled, and type/location of switch(es) to be used to power on from outside of the vehicle, power/wiring of electronics.
    iii. Present the leading altimeter choices (the altimeters used for parachute deployments – the electronics used for payload should be described in Payload Criteria section below)
    iv. Include any diagrams, drawings, schematics, sketches, images
  d. Motor Selection
    i. Review different motor alternatives and present data on each alternative
      1. What drives motor change as the design progresses? How can this be controlled?
    ii. Present the motor retention device (which retains the motor after insertion)
  e. Mission Performance Predictions
    i. Show flight profile simulations (that simulations have been run), present altitude predictions with simulated vehicle data (from simulations).
    ii. Show stability margin and simulated Center of Pressure (CP)/Center of Gravity (CG) relationship and locations (using simulations).
    iii. Calculate the expected descent time (normally using simulations – can be hand calculation) for the rocket and any section that descends untethered.
    iv. Calculate the drift (normally using simulations – can be hand calculation) for each independent section of the launch vehicle from the launch pad for three different cases:
      1. No wind
      2. 10-mph wind
      3. 20-mph wind.

4. Payload / Challenge Criteria
  a. Selection and Design of Payload / Challenge Solution
    i. Present the preliminary commercial-off-the-shelf (COTS) electronics components for your sensor and data collection.
      1. Include alternatives examined, and justification for selection (cost, performance, size, integration, etc.)
    ii. Present the preliminary integration approach for all sensors.
      1. Discuss where in the rocket the sensors and controllers will sit.
      2. Discuss any special integration features as needed
    iii. Include 3D CAD renderings for your payload packages, which will aid in integration.

5. Safety
    a. Demonstrate an understanding of all components needed to complete the project, and how risks/delays impact the project
    b. Include data indicating that the hazards have been researched, especially personnel (if extensive, may be contained as an Appendix (e.g., NAR regulations, operator's manuals, MSDS, etc.)
6. Project Plan
    a. Test Plan
        i. Refine and update your fabrication component test plan (see '**Appendix C-2**' for guidance)
        ii. Include functional tests required to prove the integrity of design to your plan (if applicable at this stage):
            1. Vehicle component tests
                a. Altimeter ground tests
                b. GPS tracking ground tests
                c. Ground ejection tests
                d. Any flight tests, etc.
            2. Payload / Challenge component tests
                a. Electronics component tests
        iii. Update your schedule to incorporate these tests
    b. Requirements Verification
        i. Create a verification plan (see '**Appendix C-3**' for guidance) for every requirement from sections 1 – 5 of the project requirements listed in the Competition Handbook.
            1. Identify what is required to verify the requirement:
                a. i.e., test, analysis, demonstration, or inspection
            2. Include an associated plan / step needed for verification
            3. If the plan is extensive, may be contained as an Appendix to your report
    c. Project Budget
        i. Refine and update your initial budget. Provide a line-item budget with market values for individual components, material vendors, and applicable taxes or shipping/handling fees
        ii. Include travel estimates for Launch Weekend
        iii. Include TRA/NAR Membership fees
        iv. Provide a funding plan describing sources of funding, allocation of funds, and material acquisition plan

d. Project Timeline
    i. Refine and update your initial schedule. Provide a timeline including all team activities and expected activity durations. The schedule should be complete and encompass the full term of the project.
    ii. Deliverables should be defined with reasonable activity duration. GANTT charts are encouraged (see '**Appendix C-1**' for Gantt chart example).
    iii. Include parts procurement timeline, component test timeline, build timeline and flight test timeline.
    iv. Recall that the vehicle must be ready (95% complete) to fly two weeks prior to the competition launch date, so the build timeline should reflect this deliverable.

Preliminary Design Review Presentation

The presentation is a concise summary of the PDR report. It must include the following items (please use the latest PDR Virtual Presentation template from the WSGC website https://spacegrant.carthage.edu/first-nations-launch/rubric/):

1. Present preliminary vehicle dimensions and materials
    a. Include preliminary motor selection
2. Present preliminary vehicle performance
    a. Include static stability margin, CP/CG locations
    b. Include thrust-to-weight ratio, Rail exit velocity
    c. Include predicted altitude
3. Present preliminary avionics (vehicle only) subsystem
    a. Include location in vehicle
    b. Include type and number of altimeters
    c. Include power sources
4. Present preliminary recovery subsystem
    a. Include preliminary sizes, locations and descent rates
    b. Include preliminary recovery devices (GPS)
5. Present preliminary test plan
    a. Include any tests completed to date
6. Present preliminary payload / challenge approach
    a. Include electronics component selections
    b. Include integration approach
7. Present major technical challenges (the critical path)
8. Present brief budget (over / under) status and brief schedule (ahead / behind) status

The PDR will be presented to a panel of engineers and TRA personnel. The purpose of this review is to convince the WSGC FNL Review Panel that the preliminary design will:

1. Meet all requirements.
2. Have a high probability of meeting the mission objectives.
3. Can be safely: Constructed – Tested – Launched - Recovered

It is expected that the team participants will deliver the report and answer all questions. The mentor or advisor shall not participate in the presentation but can be present. The presentation of the PDR shall be well prepared with a professional overall appearance. This includes, but is not limited to, the following:

1. Having AV configured and tested prior to joining call.
2. Easy-to-read slides.
    a. Do not add slides, or rearrange order
    b. You may change or add formatting to slides to personalize
3. Appropriate placement of pictures / diagrams / images / plots, where appropriate.
4. Speaking clearly and loudly.
5. Referring to the slides rather than reading them.
6. Communicating to the panel in an appropriate and professional manner.

Critical Design Review (CDR)

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

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

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

Critical Design Review Report

1. Team Summary
    a. Team name
    b. School name
    c. Name of team advisor (required) and co-advisor (if applicable)
    d. Name of student team lead and student safety lead
    e. Name of mentor, NAR/TRA number and certification level (required)
    f. Names and roles of team members
2. Summary of CDR report (2 pages maximum)
    a. Highlight any major changes since the previous report
        i. Launch Vehicle Summary
            1. Final size and mass
            2. Final motor choice
            3. Final recovery system
            4. Rail button size
        ii. Payload / Challenge Summary
            1. Provide final payload electronics list
            2. Provide integration overview
3. Vehicle Criteria
    a. Design of Launch Vehicle
        i. Present which of the alternatives from PDR were chosen as the final components for the launch vehicle
            1. Provide justification for best choices (cost, weight, performance etc.)
            2. Present all major vehicle structural components
        ii. Demonstrate that the designs are complete and ready to manufacture / procure by:
            1. Listing ALL necessary components
            2. Showing that simulations include all components and weights (vehicle weight should not change after CDR, so ensure all weights are accurate in simulation, and all components are accounted for).

        iii. Include images where applicable (manufacturer, simulations, CAD models etc.)
        iv. If airframe build/manufacture has begun, include:
            1. Pictures of assembled components
            2. Manufacturing and joining steps (especially sealed components such as inner fin fillets, that can no longer be examined once joined)
        v. Update estimated masses for each component
    b. Recovery Subsystem
        i. Present which of the alternatives from PDR were chosen as the final components for the recovery subsystem.
            1. Provide justification for best choices (cost, weight, performance etc.)
            2. Present ALL components and attachment hardware
        ii. Include any diagrams, drawings, schematics, sketches, images
    c. Avionics Subsystem
        i. Present the final avionics bay structure overview (where is it located in the vehicle, what are the major structural components)
        ii. Present the final altimeter selections and the number of altimeters
        iii. Present the final avionics sled, material, sled layout
        iv. Present the final size/location and number of vent holes
        v. Present the final switch(es) selected for powering on the altimeters from the outside of the vehicle
        vi. Present the final recovery tracking electronics (GPS) selection and location
        vii. Include any diagrams, drawings, schematics, sketches, images
    d. Motor Selection
        i. Present the final motor selection (cannot be changed after CDR – design should be completely mature at this point)
        ii. Present the motor retention device (which retains the motor after insertion)
    e. Mission Performance Predictions
        i. Show flight profile simulations, present altitude predictions with simulated vehicle data (from simulations)
        ii. Show stability margin and simulated Center of Pressure (CP)/Center of Gravity (CG) relationship and locations (using simulations)
        iii. Calculate the expected descent time (normally using simulations – hand calculations accepted) for the rocket and any section that descends untethered
        iv. Calculate the drift (normally using simulations – hand calculations accepted) for each independent section of the launch vehicle from the launch pad for three different cases:
            1. No wind
            2. 10-mph wind
            3. 20-mph wind
4. Payload / Challenge Criteria
    a. Design of Payload / Challenge Approach
        i. Present the final commercial-off-the-shelf (COTS) electronics components
            1. Include justification for selection (cost, weight, performance etc.)
        ii. Discuss the final integration of the challenge components in the rocket
            1. Present where the electronics will sit and how they are accessed
        iii. Include 3D CAD renderings, which will aid in integration and fabrication
5. Safety

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

6. Project Plan
    a. Test Plan
        i. Refine and update your component test plan (see '**Appendix C-2**' for guidance).
        ii. Refine and update your functional tests required to prove the integrity of design.
        iii. Discuss the results of any tests and discuss any remaining critical tests.
    b. Requirements Compliance
        i. Update the verification plan for every requirement from Sections 1 - 5 of the Project Requirements listed in the Competition Handbook.
            1. Identify what is required to verify the requirement:
                a. I.e., test, analysis, demonstration, or inspection.
            2. Include an associated plan / step needed for verification.
            3. If the plan is extensive, may be contained as an Appendix to your report.
    c. Project Budget
        i. Refine and update your budget. Provide an updated line-item budget with market values for individual components. Please include:
            1. List all components, sorted by Vehicle or Payload or Supplies or Travel.
            2. Include columns for manufacturer and vendor, for all components.
            3. Include columns for procurement status (ordered, shipped, received etc.)
            4. Consider shipping / handling fees in your budget.
        ii. Provide an updated funding plan describing any additional sources of funding.
    d. Project Timeline
        i. Refine and update your schedule. The schedule should be complete and encompass the full term of the project.
        ii. Deliverables should be defined with reasonable activity duration. GANTT charts are encouraged.
        iii. Include parts procurement timeline, component test timeline, build timeline and flight test timeline.
        iv. Recall that the vehicle must be ready (95% complete) upon arrival for Launch Weekend.

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 final vehicle dimensions
    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 (Vehicle)
    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 final test plans
    a. Include results and tests remaining
6. Present final Payload / Challenge
    a. Include electronics component selections and status
    b. Include integration plan
7. Present remaining technical challenges (critical path).
8. 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 (including the payload/challenge) 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 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 (FRR)

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

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

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

Flight Readiness Review Report

1. Team Summary
    a. Team name.
    b. School name.
    c. Name of team advisor (required) and co-advisor (as applicable).
    d. Name of student team lead and student safety lead.
    e. Name of mentor, NAR/TRA number and certification level. (required)
    f. Names and roles of team members.
2. Summary of FRR report (1 page maximum).
    a. Highlight any major changes since the previous report.
        i. Launch Vehicle Summary
            1. Flight ready vehicle size and mass.
            2. Flight ready motor choice.
            3. Flight ready recovery details.
            4. Flight ready rail button size.
        ii. Challenge Summary
            1. Present flight ready payload electronics overview.
            2. Present flight ready payload integration.
3. Vehicle Criteria
    a. Design and Construction of Vehicle
        i. Present a launch vehicle overview that ensures the vehicle can be launched and recovered safely. Include overview of as-built components:
            1. Structural elements (i.e., airframe, fins, bulkheads, attachment hardware, etc.).
            2. Electrical elements (i.e., wiring, switches, battery retention, retention of avionics boards, etc.).
            3. Include pictures of critical hardware where relevant showing details (i.e., bulkhead joins/fillets, airframe tube fit/alignments, fin alignments, centering ring fillets, fin fillets, motor retention, eyebolt/shock cord attachment, avionics sled/switches/vent holes, rail button attachment/alignment).
        ii. Prove that the vehicle is fully constructed (component images) and fully document the construction process (assembly images).
            1. Identify any outstanding vehicle assembly or testing that is needed, if applicable.
        iii. Include summary of the AS-BUILT rocket dimensions (There is a good chance dimensions have changed slightly due to the construction process).

            1. Show the as-built dimensions match CAD or simulation vehicle.
            2. Discuss how / why the constructed rocket differs from design, if applicable.
        iv. Update and provide the final masses of all components, and ensure your simulations match the number and mass of components
    b. Recovery and Avionics Subsystem
        i. Present the as-built and as-tested recovery system – hardware and electronics. Include:
            1. Structural elements (such as bulkheads, harnesses, attachment hardware, etc.).
            2. Electrical elements (such as altimeters/computers, switches, connectors).
                a. Any redundancy features.
            3. Parachute sizes and descent rates.
            4. Rocket locating devices.
            5. Include relevant diagrams, schematics of the as-built electrical and structural assemblies.
        ii. Discuss any test results related to recovery (such as ejection charges and electronics).
        iii. Identify any outstanding recovery tests / selections that are needed, if applicable.
    c. Motor Selection
        i. Present the final motor selection.
        ii. Present the motor retention device (which retains the motor after insertion).
    d. Mission Performance Predictions
        i. Show flight profile simulations, present altitude predictions with simulated vehicle data (from simulations).
        ii. Show stability margin and simulated Center of Pressure (CP) / Center of Gravity (CG) relationship and locations (using simulations).
        iii. Calculate the expected descent time (normally using simulations – hand calculations accepted) for the rocket and any section that descends untethered.
        iv. Calculate the drift (normally using simulations – hand calculations accepted) for each independent section of the launch vehicle from the launch pad for three different cases:
            1. No wind.
            2. 10-mph wind.
            3. 20-mph wind.
4. Payload / Challenge Criteria
    a. Design and Testing of Challenge Components.
        i. Present the flight ready commercial-of-the-shelf (COTS) electronics components.
            1. Present each component individually, and as part of a sub-assembly.
            2. Identify any outstanding component testing or integration, if applicable.
        ii. Present the flight ready payload integration approach from the rocket.
            1. Present the integrated electronics systems in the rocket.
            2. Identify any outstanding component testing or integration, if applicable.
    b. Include 3D CAD renderings if possible and discuss how the as-built differs from the as-designed.
5. Safety and Procedures
    a. Launch Operations Procedures
        i. Provide detailed procedures and checklists for the following (at a minimum):
            1. Avionics preparation checklist.
            2. Recovery preparation checklist.
            3. Final assembly checklist.
            4. Setup on launch pad checklist.
            5. Troubleshooting checklist.
            6. Post-flight inspection checklist.

ii. These procedures and checklists should include specially demarcated steps related to safety. Examples include:
    1. Warnings of hazards that can result from missing a step.
    2. PPE required for a step in the procedure (identified BEFORE the step).
    3. Required personnel to complete a step or to witness and sign off verification of a step.

6. Project Plan
    a. Test Plan
        i. Show that all testing (component and functional) is complete and provide test methodology and discussion of results not covered in CDR.
            1. Discuss whether each test was successful or not.
            2. Discuss lessons learned from the tests conducted.
            3. Discuss differences between predicted and actual results of tests.
    b. Requirements Compliance
        i. Review and update the verification plan.
            1. Present how each Competition Handbook requirement was verified using testing, analysis, demonstration, or inspection.
    c. Project Budget
        i. Update final budget. Provide an updated line-item budget with market values for individual components, material vendors, and applicable taxes or shipping/handling fees.
        ii. Provide an updated funding plan describing any additional sources of funding.
    d. Project Timeline
        i. Update final schedule. Although the build should be near complete at this stage, include a timeline of any remaining or critical activities between now and Launch Weekend, if applicable.

Launch Weekend 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 a summary 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, dimensions, materials, motor selection (include any drawings, diagrams, images).
2. Present static stability margin, CP/CG locations, thrust-to-weight ratio, rail exit velocity, time to apogee, and predicted altitude.
3. Present vehicle altimeters, switch / power (include any drawings, diagrams, images).
4. Present vehicle parachute sizes, descent rates, vehicle tracking devices / locations (include any drawings, diagrams, images).
5. Present the final payload / challenge approach (include any drawings, diagrams, images).
    a. Payload electronics summary
6. Present major challenges/lessons learned (can be technical, programmatic etc.).

Note:
1. Your rocket will be on display during the presentation. Please feel free to disassemble or refer to the physical components as they are being discussed.
2. Use the oral presentation template, which consists of 8 slides.
3. You will have 8 minutes to give your presentation to the Judges.
4. Judges will follow with 2-3 minutes of questions prior to finalizing the presentation score.
5. Please practice your presentation, to not exceed allotted time.

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

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 (PLAR)

The PLAR is an assessment of system in-flight performance. The panel will be expecting a professional and polished report that follows the order of sections as they appear below.

Post Launch Assessment Report

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

1. Team Summary
    a. Team name.
    b. School name.
    c. Name of team advisor and co-advisor (as applicable).
    d. Name of student team lead and student safety lead.
    e. Name of mentor, NAR/TRA number and certification level.
    f. Names and roles of team members.
2. Summary of PLAR report (1 page maximum)
    a. Launch Vehicle Summary
        i. Launch day vehicle size and mass and launch day motor.
    b. Payload / Challenge Summary
        i. Summarize your payload.
3. Vehicle Criteria
    a. Vehicle Summary
        i. Discuss the overall vehicle performance.
        ii. Did all components (structure, recovery, altimeters, tracking etc.) perform as expected?
        iii. Were there any anomalies or unexpected behavior? If so, can they be explained?
    b. Data Analysis and Mission Performance
        i. Discuss the flight performance data.
            1. Compare predicted versus actual performance (speed, altitude, acceleration, stability, drift, etc.).
            2. Show and discuss plots of the flight data; compare them to simulation data.
4. Payload / Challenge Criteria
    a. Payload / Challenge Summary
        i. Discuss the overall payload performance.
        ii. Did all components (structure, recovery, altimeters, tracking etc.) perform as expected?
        iii. Were there any anomalies or unexpected behavior? If so, can they be explained?
5. Project Outcomes
    a. Lessons Learned
        i. Summarize lessons learned over the program (technical and/or project management).
    b. STEM Engagement
        i. Summarize any STEM Engagement that occurred in the community and outcomes.
    c. Overall Budget Summary
        i. Summarize the project budget summary – contrast predicted versus actual.

HPR Safety Overview

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

Virtual Tech Inspection – Tripoli Wisconsin

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

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 – First Nations Launch 2025 Motor Choices

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

Mars Challenge Motors

Manufacturer	Size	Type	Motor
Aerotech	54mm	DMS	K400C
Aerotech	54mm	DMS	K535W

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-3 – First Nations Launch 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 10, 2024 - November 3, 2024, March 9, 2025 - November 2, 2025)
Central Standard Time (November 3, 2024 - March 8, 2025)

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

APPENDIX A-4 – First Nations Launch 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 Division Award **Gateway Division Award

APPENDIX C-1 – Project Planning Guidance

Team Structure

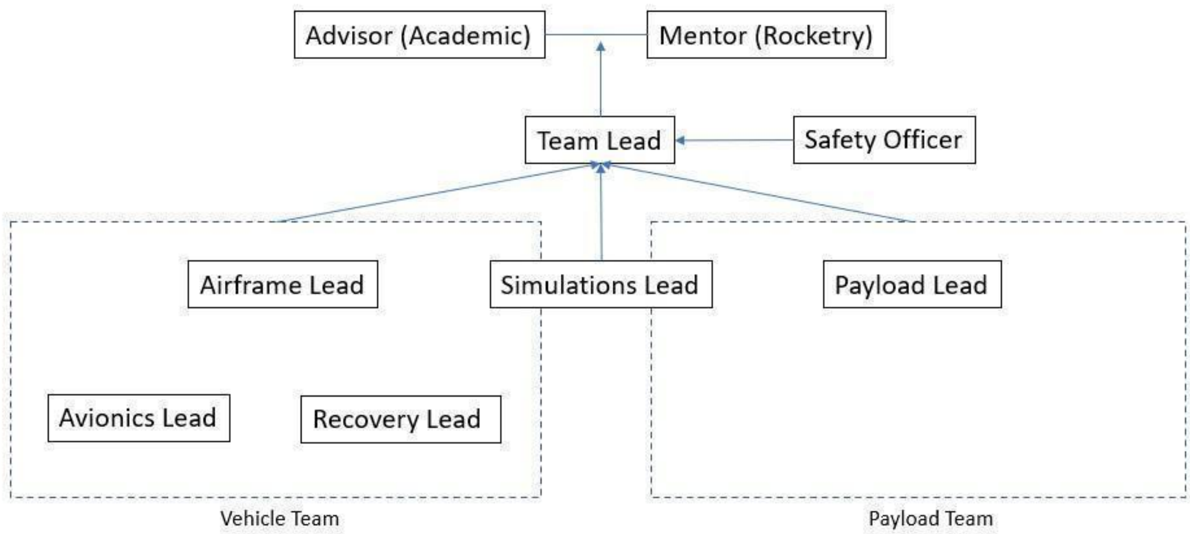


Figure C.1 GANTT Chart- Recommended team structure.

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

EXAMPLE

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).

Proposal Schedule

At the Proposal phase, you will need to start by understanding the Project Lifecycle. We use a gated process where your design progresses through ‘gates’ or milestones (Proposal -> Preliminary Design -> Critical Design -> Flight Readiness -> Launch -> Post Launch Assessment).

Each milestone you have a certain amount of time (and accomplishments) to complete. So, your team schedule should highlight these milestone dates. The time in-between these dates is where you will need to create daily or weekly tasks to get you to the milestone.

Tasks can be broken down into recruitment, training, design (brainstorming/researching/3D modeling), simulations, procurement, fabrication, component testing, flight testing, assembly, report writing, travel etc.

If you are new to rocketry, your initial schedule may not contain many details which is fine. Keep in mind, the schedule is for YOUR BENEFIT, not simply to satisfy an objective in the reports.

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

Milestone Schedule

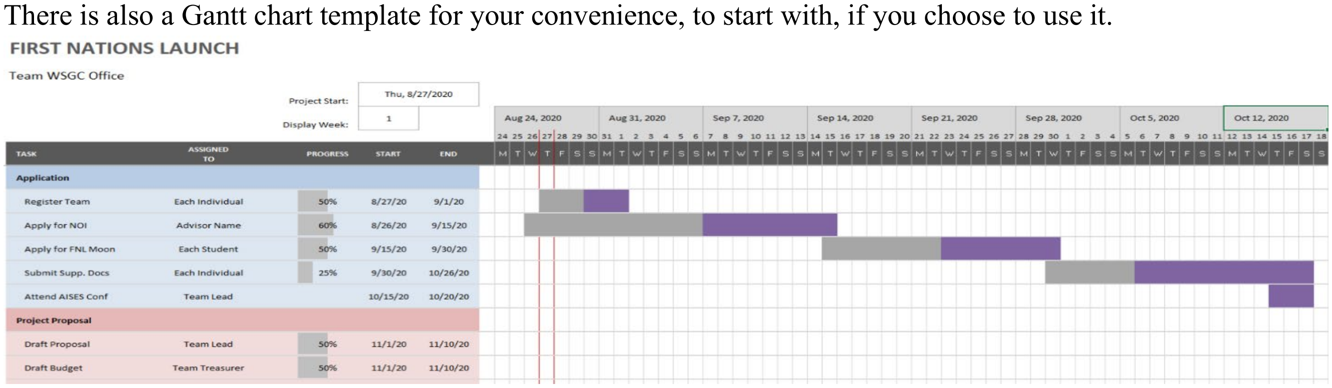
At each milestone, you will update your schedule as needed. You may find or eventually see a ‘critical path’ – an item or task that is critical to complete on time, so as not to jeopardize the success of your build and flight.

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

Mars Challenge Teams

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. **Structural Components**
    a. Airframe tests
    b. Fin tests
    c. Bulkhead tests
2. **Electrical Components**
    a. Altimeter testing
    b. Tracking testing
3. **Recovery System Tests**
    a. Parachute ejections tests
    b. Parachute deployment tests
4. **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.

Structural Testing

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

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

Altimeter Testing

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

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

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

Recovery Testing

It is encouraged that teams (with the help of a rocketry mentor) procure energetics and perform parachute ejection tests (on the ground) prior to flight, to understand how much 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.

Challenge Solution Tests

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

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

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

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

Design and testing are an iterative process – the results (or negative results) of a test may change the design, which in turn, will change the future tests etc.

Your Reports (Section 7.1) starting with PDR, through CDR and FRR, should include a table listing your tests (example shown here):

System	**Test**	**Objective**	**Timeframe**	**Outcome**
Structure	Hoop test	To verify the hoop strength of the structure	Nov-23	-
	Shear test	To verify the shear strength of the structure	Nov-23	-
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). Editable example safety checklists can be found on the Tools & Tips page or at: https://spacegrant.carthage.edu/live/files/6461-fnl-example-checklistsxlsx.

APPENDIX D-4 – How to Acquire and Use Ejection Charges

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

More experienced or advanced teams may wish to complete ejection tests prior to competition, or even a full scale test flight. This section provides guidance on how to acquire and properly handle ejection canisters and energetics.
Energetics used for ejection come in two types; Black Powder and Pyrodex

Black Powder
Black powder is a fine grain chemical explosive. https://en.wikipedia.org/wiki/Gunpowder

Figure D.4.1

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

1. FYI : When used for recovery system ejection charges in high-power rocketry, black powder substitutes such as pyrodex need a greater degree of confinement to ensure a complete burn and generation of sufficient ejection pressure. This can be achieved by wrapping 2–3 layers of electrical tape over the ejection charge canister.

Figure D.4.2

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

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

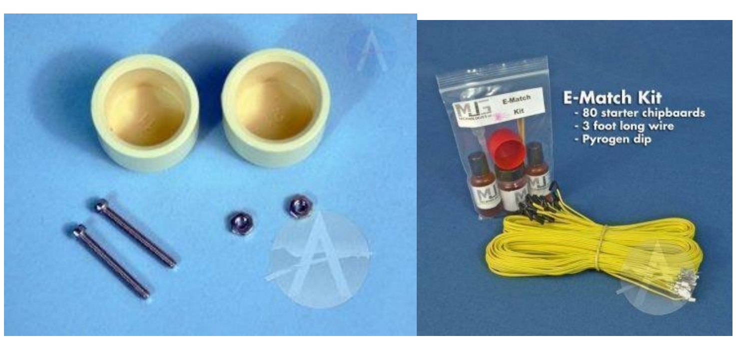


Figure D.4.3 PVC Ejection Canister (left) and E-match kit (right).

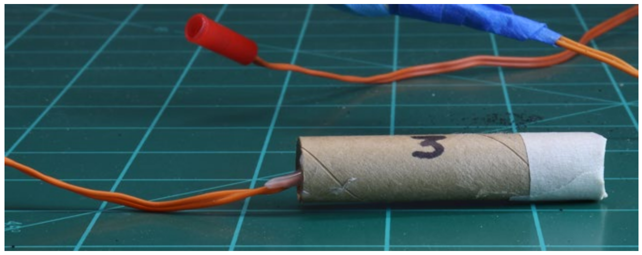


Figure D.4.4 Ejection canister (3 gram load) with e-match installed.

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

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

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

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

Compressed Gas Ejection

An alternative to chemical explosives for energetics, is a CO2 compressed gas ejection system (such as the Peregrine CO2 Ejection Device, shown in *Figure D.4.5* below). Here the canisters are disposable, but the energetic and the canisters are all provided as a kit (little fabrication required).

Figure D.4.5 Peregrine Compressed Gas Ejection System

APPENDIX D-5 – Personal Tripoli HPR Certification

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 are 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.

- BIG RED BEE; ARDF beacons and all-in-one trackers designed for rocketry, both ham and non-licensed
  http://www.bigredbee.com

- 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

- BYONICS: APRS, GPS, and transmitter modules, all-in-one trackers, and direction finding transmitters
  http://www.byonics.com

- ARGENT DATA SYSTEMS; APRS, GPS, and transmitter modules
  http://www.argentdata.com

- RPC ELECTRONICS; APRS modules
  http://www.rpc-electronics.com

- YAESU USA, hand held and mobile Amateur Radio equipment with built in APRS.
  http://yaesu.com/?cmd=DisplayProducts&DivisionID=65&ProdCatID=249

- KENWOOD USA, hand held and mobile Amateur Radio equipment with built in APRS
  https://www.kenwood.com/usa/com/amateur/

- DOPPLER DF INSTRUMENTS; Amateur Radio direction finding equipment
  http://www.silcom.com/~pelican2/PicoDopp/MICROHUNT.htm

- COMMUNICATION SPECIALISTS; Amateur Radio direction finding equipment
  http://www.com-spec.com/rocket/index.html

- MULTRONIX, Very full featured , non-licensed, GPS tracking system for high power rockets
  http://www.multronix.com

- REAL FLIGHT SYSTEMS, Non-licensed GPS Tracking, telemetry and data logging equipment designed for rocketry
  http://www.realflightsystems.com/

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 Link Coming Soon
FNL Preliminary Design Report (PDR) Template Link Coming Soon
FNL PDR Virtual Review PowerPoint Template Link Coming Soon
FNL Critical Design Report (CDR) Template Link Coming Soon
FNL CDR Virtual Review PowerPoint Template Link Coming Soon
FNL Flight Readiness Report (FRR) Template Link Coming Soon
FNL Flight Readiness Review PP Template (Oral Presentation) Link Coming Soon
FNL Post Launch Assessment Report Template Link Coming Soon

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/6462-fnl25aopdf
FNL Launch 2 Learn Rocketry Workshop https://spacegrant.carthage.edu/live/files/6471-fnl25l2l-workshop-flyerpdf
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
10/13/24	Corrected Motor Size listed in Appendix A-1 for division from 38mm to 54mm.