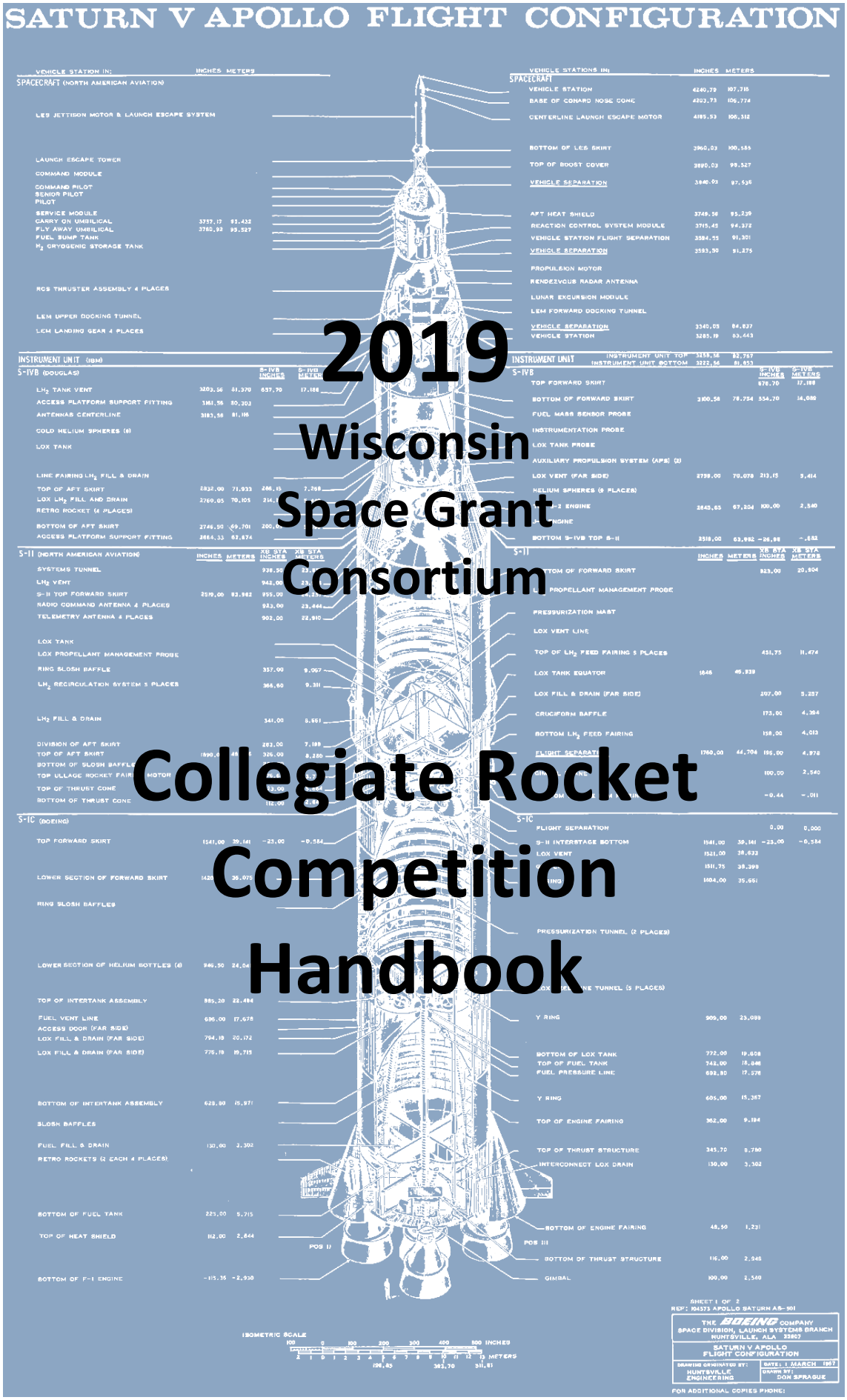
SATURN V APOLLO FLIGHT CONFIGURATION
2019
Wisconsin
Space Grant
Consortium
Collegiate Rocket
Competition
Handbook

Page
Intentionally
Left
Blank

Table of Contents

Competition Objective

The Wisconsin Space Grant Consortium's (WSGC) Collegiate Rocket Competition is intended to supply teams of affiliated university students with the opportunity to demonstrate engineering and design skills through direct application. It allows the teams to conceive, design, fabricate and compete with high powered rockets. The restrictions on rocket motors and dimensions are limited so that knowledge, creativity and imagination of the students are challenged. The end result is a great aerospace experience for students that would not otherwise be available in the region.

Rocket Design Objectives

The objective of the WSGC 2019 Collegiate Rocket Competition entries can be stated simply as:

> Student teams will be required to design, construct and fly a high-power, one-stage rocket that will, following apogee, land safely under an operating parachute(s) and deploy a Ground Excursion Module (GEM). In addition to being recovered safely and in flyable condition, its flight performance must be accurately predicted. All work on the rocket must be performed by students - no professional assistance is permitted.

Judging Categories

To truly evaluate the engineering behind the designs, the teams will be judged on the demonstration of their knowledge, the performance of their design, their ability to communicate effectively and the workmanship of the fabrication. This will be accomplished in six parts; a design report, a presentation to a selected group of judges, the flight of the rocket, an examination of predicted vs. actual performance for the rocket, project management, and an outreach activity.

The total score for each student team will be based on the following parameters:

Design Report	(Written)	20
Flight Readiness Presentation, and Quality of Fabrication	(Oral)	15
Competition Flight	(Flight)	30
Performance Post-Flight Performance Evaluation Report	(Written)	15
Project Management	(Form)	10
Educational Outreach	(Form)	10
	Total	100

Competition Engineering Parameters

Student teams will be required to design, construct and fly a high-power, one-stage rocket that will, following apogee, land safely under an operating parachute(s) and deploy a Ground Excursion Module (GEM) that will move under its own power, without external control. The rocket is required to use electronic deployment of the recovery parachute and motor deployment as a backup. A downed rocket location aid must be included in the design. All structural components and materials for the rocket must be obtained from reputable high powered rocketry vendors or an engineering analysis demonstrating their suitability must be included with the design. The winner of the flight portion of the competition will be the team whose rocket completes a safe, successful flight, achieves an apogee closest to their predicted altitude as reported in the team's Final Design Report (FDR) and whose GEM traverses the farthest distance in the allowed time.

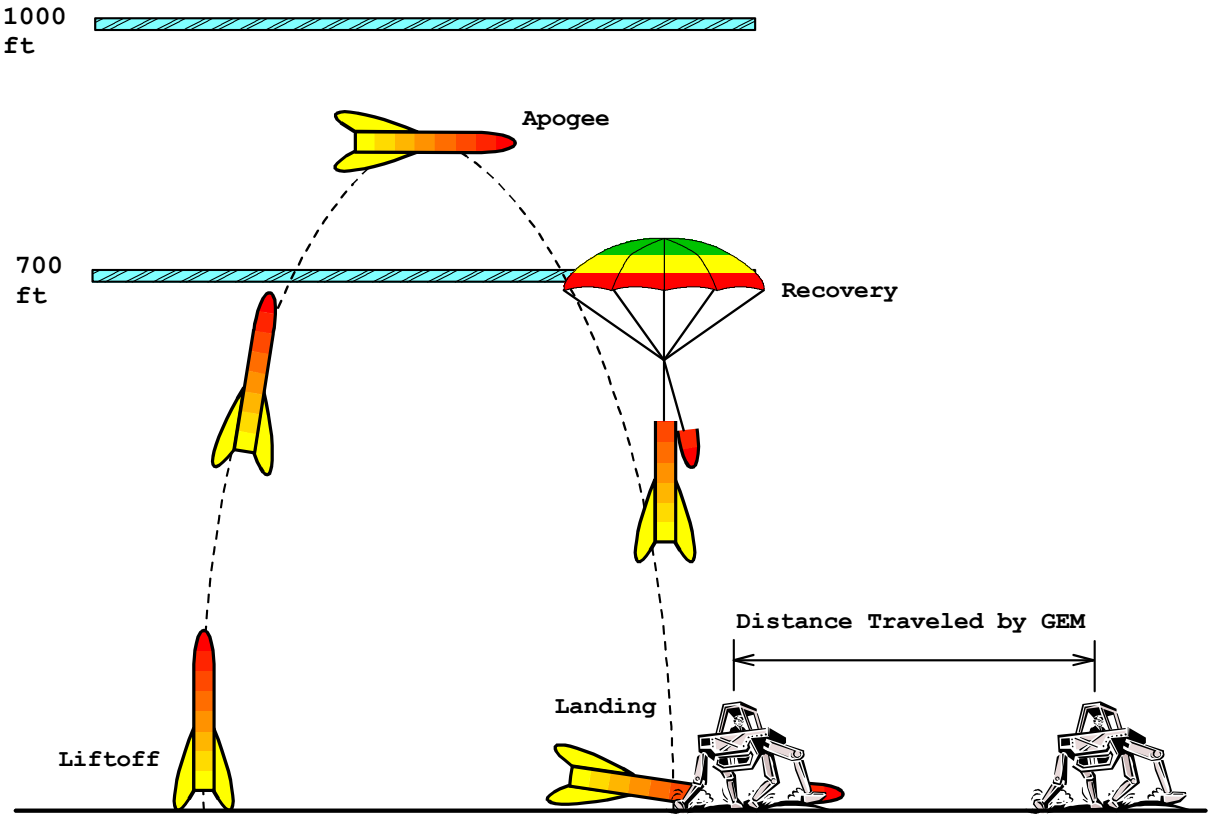

Figure 1 Flight Path of Rocket

Table 1 Competition Parameters

Flight Mission	⊢ Successful fly a high power, one-stage rocket that will, following apogee, land safely under an operating parachute(s) and deploy a GEM.
Altitude Window	⊢ Apogee, Maximum: 1000 ft ⊢ Apogee, Minimum: 700 ft
Target Altitude	⊢ Each team determines their own ⊢ Value must be presented in the FDR
GEM	⊢ Must operate without external control (autonomously). ⊢ May not contain anything/system that in normal operation could leak a contaminating fluid or create a fire hazard. ⊢ Must move under its own power.
Video evidence of GEM travel	⊢ A video recording device must be incorporated in either/both the rocket or the GEM that can document the travel of the GEM to show that no physical tampering of the GEM's position occurs during the time period it is allowed to travel.
Distance Traveled by GEM:	⊢ GEM tracking official will place a marker at the location they visually judge as the point the GEM first begins to move on the ground under its own power, once it is completely clear of the rocket. ⊢ GEM will be allowed a 10 minute time period, beginning at rocket launch, to travel autonomously. The GEM tracking official will place a marker at location reached by the GEM. ⊢ GEM distance traveled will be measured as the straight line segment that connects the marker where it first began to move under its own power to the marker at its location at the end of the allowed time period. ⊢ The GEM tracking official's judgment will become the official measurement.
Recovery	⊢ Electronic ejection (required as primary) ⊢ Motor ejection (required as backup) ⊢ Parachute (required) ⊢ Downed rocket location aid (required)
Rocket Constraints	⊢ Each team must prepare a mounting location for the competition flight recorder in their rocket

Low-power Rocket Demonstration Flight	➢ Each team must purchase, assemble, fly and successfully recover a "low-power" rocket. Pictures of the team at their launch site with the rocket, before and after their launch, must be posted to WSGC's Facebook page when the budget is submitted. ➢ Examples: Estes Alpha, Quest Astra or comparable model rocket kits.
Rocket Design and Safety Reviews	➢ Each team must work with the WSGC to identify a Rocketry Mentor. The mentor must hold a current High Power Level 2 certification and cannot be a member of the team. At minimum, 3 design reviews must be held with the mentor. ➢ Each team, with their rocket, must participate in the Design and Safety Review meeting approximately one month before the competition launch. o Rockets must be 90% of ready to fly – **Teams without rockets at this level of construction will not be allowed to continue in competition.** o Be prepared to explain the onboard electric power generation o Analysis of non "pre-qualified" components must accompany the rocket at the Design and Safety Review ➢ Each rocket must pass the Range Safety Officer's Inspection the day of the launch, before it will be allowed to fly.
Educational Outreach	➢ Each team must share information pertinent to aerospace with a group or audience. For purposes of the competition, teams will be scored as "completed" or "not completed".
Safe Flight	➢ Launch followed by stable ascent ➢ Electronic recovery system must successfully deploy ➢ The rocket must be recovered in flyable condition
Successful Flight	➢ Safe Flight ➢ Rocket must achieve an apogee between 700 ft and 1000 ft

In addition to the budget support, the WSGC will provide each team with the following equipment:

List of Rocket Motors for Competition	➢ One Cesaroni Technology Inc. Motor o CTI 38mm 5grain: J357-B, J285-C, J270-G, J335-R, J290-W o CTI 54mm 4grain: K630-B, K445-C, K400-G, K500-R, K520-W Thrust curves data can be found at: http://www.thrustcurve.org/searchpage.jsp

Competition	⇤ Raven III http://www.featherweightaltimeters.com/The_Raven.php
Flight Data	⇤ 1.80" long x 0.8" wide x 0.55" thick, ~ 0.25 oz.
Recorder	⇤ Powered by a 9 v battery, ~ 1.6 oz.

This recorder is separate from the team's electronic deployment system and will be inserted at time of launch to record acceleration & altitude vs. time.

Additional Comments:

Interested students with questions about the capabilities of the launch motors or seeking help in getting started are highly encouraged to contact **Frank Nobile** (Maxq3@aol.com) or **Bob Justus** (bob@mhbofni.com) of Tripoli Wisconsin Association (a high-power rocketry association); or a rocket association near them. Students interested in gaining information or experience by observing rocket launches are encouraged to contact these individuals, or to attend one of the regular rocket launches held by Tripoli at Bong Recreational Area. More information and launch schedules can be accessed at http://www.tripoliwisconsin.org.

Safety and Construction

Setting the Tone

It is understood that this experience may be the first time many of the competitors have designed, built and flown a high power rocket. To aid in making it a safe as well as educational aerospace opportunity attention to safety will be held paramount. All teams will therefore be held to Code for High Power Rocketry as laid out in NFPA 1127 and further enhanced by the Tripoli Rocketry Association and the National Association of Rocketry.

Design and Safety Review

Endeavoring to have all teams perform their flights in a safe and controlled manor, all teams are required to participate in the Design and Safety Review approximately 1 month before the competition flights. The teams must be prepared to discuss the design of their rocket and its systems. In addition the teams must display:

- Rockets must be 90% of ready to fly –
  - – **Teams without rockets at this level of construction will not be allowed to continue in the competition.**
- Explanation of the electric power generation system.
- A diagram of the rocket indicating the configuration of its main components
- Analysis of non "pre-qualified" components must accompany the rocket
- Flight simulation showing max altitude and launch guide velocity (speed at 10 ft.)
- Deployment altimeter user manual
- Preflight Checklist

- Launch Pad and Flight Arming checklist
    - must include the altimeter's ready/standby tones
- Recovery/Postflight Checklist
    - Must include procedure to "safe" deployment charges and payload

Table 2 **FAA Model Rocket Classification**

Limitation	**Class 1**	**Class 2**
Rocket weight	1500 grams (3.3lbs)	No limit
Motor limit	4.4 oz. of fuel (mid-size H motors)	40960 N-sec total thrust
Altitude limit	None - may be set by local agreement.	FAA limited
Other	Clear of clouds (all classes)	5 miles visibility, Clouds less than 5/10ths coverage (Clear of clouds) FAA Waiver required and Notice to Airmen (NOTAM) filed Between Sunrise and Sunset

Table 3 **NAR/Tripoli Certification Requirements and Limitations**

	Rocket / Motor Limitations			
Certification required	None	Level 1 HPR	Level 2 HPR	Level 3 HPR
Total Combined Impulse	320 N-sec (2 G Motors)	640 N-sec (H,I)	5120 N-sec (J,K,L)	40960 N-sec (M,N,O)
Combined propellant mass	125 grams (4.4 oz.)	No Limit		
Single Motor Impulse	160 N-sec (G motor)	No Limit		
Single Motor propellant mass	62.5 grams (2.2 oz.)	No Limit		
Single Motor Average Thrust	80 N	No Limit		
Sparky Motors	Not allowed	Allowed		
Total Rocket Mass	1500 grams (3.3 lbs)	No Limit		
Field distance requirements	Per Model rocket safety code	Per HPR safety code		

The purpose of NFPA 1127 the Tripoli Safety Code and the NAR Safety Code are to:

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

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

Tripoli Code for High Power Rocketry
Tripoli Rocketry Association
http://www.tripoli.org/LinkClick.aspx?fileticket=vF%2f34Qq57zg%3d&tabid=185

NAR High Power Rocket Safety Code
National Association of Rocketry
http://www.nar.org/NARhpsc.html

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 and the center of gravity of the high power rocket to the RSO if the RSO requests same.
   C. The member shall provide proof of membership and certification status by presenting their membership card to the LD or RSO upon request.
   D. A rocket with a predicted altitude in excess of 50,000 feet AGL requires review and approval by the TRA Class 3 Committee.
   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. Install only flame resistant recovery wadding if wadding is required by the design of the rocket.
      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. Payloads
      1. Do not install or incorporate in a high power rocket a payload that is intended to be flammable, explosive, or 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.

J. Install an ignition device in a high power rocket motor only at the launch pad.

K. 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. Tripoli Rocketry Association Safe Launch Practices
F. When three or more rockets (at least one high power) are launched simultaneously, the minimum distance for all involved rockets shall be the lesser of:
    1. Twice the complex distance for the total installed impulse. (refer to V. Distance Tables)
    2. 2000 ft (610 m)
    3. 1.5 times the highest altitude expected to be achieved by any of the rockets.
G. When more than one high power rocket is being launched simultaneously, a minimum of 10 ft (3m) shall exist between each rocket involved.

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

Note: A Complex rocket is one that is multi-staged or that is propelled by two or more rocket motors

Preflight Safety Inspection

On flight competition day, all teams must have their rockets inspected before they will be allowed to proceed to the launch pad. The teams must be prepared to discuss their rocket's design and its deployment systems. In addition the teams must display:

- Team's rocket readied for launch
    - Center of Gravity (CG) and Center of Pressure (CP) must be clearly marked on the rocket's exterior.
- Preflight Checklist (showing that all steps have been completed up to launch)
- Launch Pad and Flight Arming checklist
    - Must include the altimeter's ready/standby tones
- Recovery/Postflight Checklist
    - Must include procedure to "safe" deployment charges and payload

Postflight Check-in

Following the team's competition flight, the team must follow their Recovery/Postflight Checklist to insure a safe recovery. The team then proceeds to the recovery check-in with:

- The team's rocket
- Recovery/Postflight Checklist
    - Must show that all steps in the recovery procedure were completed before approaching the check-in station.

Flight Readiness Presentation (Oral)

Presentation Format

Team members will deliver the presentation to the judges in front of an audience. All team members who will deliver any part of the presentation, or who will respond to the judges' questions, must be in the podium area when the presentation starts and must be introduced to the judges. Team members who are part of this "presentation group" may answer the judge's questions even if they did not speak during the presentation itself.

Presentations are limited to a maximum of seven (7) minutes. The judges will stop any presentation exceeding ten minutes. The presentation itself will not be interrupted by questions. Immediately following the presentation there will be a question and answer session of up to three (3) minutes. Only judges may ask questions. Only team members who are part of the "presentation group" may answer the judges' questions. If time allows, there may be opportunity to take additional questions from the audience. If questions are taken from the audience, a designated presentation official will determine if the question is appropriate and if so then allow the team to answer.

Evaluation Criteria

Presentations will be evaluated on content, organization, visual aids, delivery and the team's response to the judges' questions. Rockets will be evaluated for the quality of their fabrication. The scoring criteria are detailed in Appendix A-1 "Presentation Judging". The criteria are applied only to the team's presentation itself. The team that makes the best presentation, regardless of the quality of their rocket, will score highest for the presentations.

Scoring Formula

The scoring of the Presentation is based on the average of the Presentation Judging forms. There is a maximum of 100 points on the Presentation Judging Form that will be scaled to meet the 15% of the competition total score.

Design Reports (Written)

Design Reports Objective

The concept of the design reports are to evaluate the process and effort that the team put into the design of the rocket and how the engineering meets the intent of the competition. The rocket that illustrates the best use of design to meet the design goals and the best understanding of the design by the team members will score the highest. There are three (3) design reports that must be submitted. The first is the Preliminary Design Report (PDR) which describes the design goals, constraints, proposed solution idea, preliminary project schedule and proposed budget. The second report is the Critical Design Report (CDR) that describes how the design was developed, the design of the solution, and predictions for its performance. The third report is the Final Design Report (FDR) which looks at how the design was altered following the CDR given the feedback from the Safety Review, as well as any payload performance testing and rocket flight tests.

Report Format

The design report can be no longer than twenty five (25) single-sided pages in length. It must be in a font not smaller than 12pt. The left margin must be no less than 1 inch and the remaining margins must be no less than 1 inch from the edge of the page. All pages (except for the cover page) must be numbered in the upper right hand corner. Each section of the report must be clearly delineated with a heading. All section headings must appear in a table of contents. Reports must be submitted electronically in *.pdf* format.

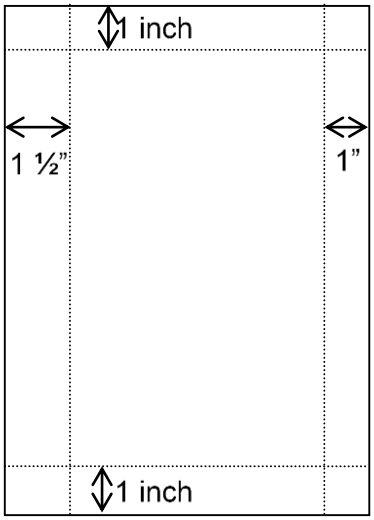

Figure 2 Design Report Page Layout

Preliminary Design Report (PDR) – short report, single-sided pages and must include, as a minimum:

- **Cover Page**
  - Team name
  - School
  - Team members
  - Faculty advisor
- **Table of Contents**
- **Design Goals**
  - List the design goals for the design of the rocket and the GEM payload
    - How is rocket/payload performance measured by competition?
    - Which will be designed first rocket, GEM or simultaneously?
    - What does the team define as most important
- **Design Constraints**
  - List limits on design
    - Limits imposed by competition
    - Limits team has chosen to include beyond those required by competition
  - List limits on resources
    - Budget
    - People
    - Skills/tools
    - Time
- **Description of Preliminary Solution Idea**
  - Briefly describe the solution the team has chosen to advance.
  - Include sketch of proposed payload and rocket.
- **Proposed Schedule**
  - Identify competition deliverable dates
  - Identify competition meeting dates
  - Identify school important dates (vacation, final exam days, etc.)
  - Show design, fabrication, documentation/reporting, subsystem and system tests
- **Proposed Budget**
  - All rocket components
  - All payload components
  - Travel expenses

Critical Design Report (CDR) - no longer than twenty five (25) single-sided pages in length and must be included, as a minimum:

- **Cover Page** *(not included in page total)*
- **Table of Contents** *(not included in page total)*
- **Executive Summary**
  - One or two paragraphs describing the rocket, payload and predicted performance
  - Image of the rocket
- **Design Features of Payload**
  - Background Information on possible methods for moving the GEM
  - Brief description of each method identified
  - Comparison of methods including the decision process for evaluation and selection of method employed
  - Design of GEM, its deployment and operation, and the video recording system
  - Image of the GEM
- **Design Features of Rocket**
  - Design compensations made to accommodate the GEM payload
  - Incorporated downed rocket location aid
- **Design Features of Recovery System**
  - Altimeter chosen and how it is mounted
  - How motor backup deployment is incorporated
  - Parachute selected
  - Shock-cord and mountings
- **Accurate Diagram of Rocket** Identifying the dimensioned locations for the:
  - CP (center of pressure)
  - CG_1 (center of mass with the fully loaded rocket motor) for rocket with GEM
  - CG_2 (center of mass after motor-burnout) for the rocket with GEM
- **Analysis of the Anticipated Performance** – including how each were estimated
  - Estimated Maximum Altitude
  - Estimated Peak Acceleration
  - Plot of Estimated Acceleration vs. Time (from start of flight)
- **Construction of Rocket and Payload** (include photos)
- **Conclusion**
- **Photographs of Completed Rocket** *(not included in page total)*
- **Budget** *(not included in page total)*

Final Design Report (FDR) - no longer than ten (10) single-sided pages in length and must be included, as a minimum:

- **Cover Page** *(not included in page total)*
- **Table of Contents** *(not included in page total)*
- **Executive Summary**
  - One or two paragraphs summarizing the adjustments made to the rocket, the payload and the predicted performance following the Safety Review, Payload performance tests and Rocket test flights.
  - Image of the rocket and payload
- **Adjustment to Design of Payload**
  - Document adjustments made to the design of the GEM during fabrication and payload performance tests
  - Image of the GEM
- **Adjustments to Design of Rocket**
  - Document adjustments made to the design of the rocket during fabrication and flight tests.
  - Image of final rocket
- **Accurate Diagram of Rocket** Identifying the dimensioned locations for the:
  - CP (center of pressure)
  - CG_1 (center of mass with the fully loaded rocket motor) for rocket with GEM
  - CG_2 (center of mass after motor-burnout) for the rocket with GEM
- **Adjustment to Anticipated Performance** – including how each were estimated
  - Estimated Maximum Altitude
  - Estimated Peak Acceleration
  - Plot of Estimated Acceleration vs. Time (from start of flight)
- **Conclusion**

Evaluation Criteria

Reports and design will be evaluated on content, organization, clarity, completeness and professionalism of the material. The PDR will be evaluated for completeness, but not scored. Both the CDR and FDR will be scored. The criteria are detailed in Appendix A-2 "Design Judging."

Scoring Formula

The scoring of the event is based on the average of the Design Report Judging forms. There is a maximum of 100 points from the Design Report Judging Form that will be scaled to meet the 20% of the competition total score.

Competition Flight

Launch and Flight Format

The launch will take place at a site determined by Tripoli Wisconsin Association. Each rocket must pass a safety inspection before launch and any additional equipment must be cleared by the Range Safety Officer (RSO) before entering the launch area. The official flight data recorder will be placed in the rocket by the altitude tracking official or designee. The RSO will have discretion over the number of team members that attend the rocket once it is in the launch area. Each team must assemble a recovery team that will follow the directions of the RSO or designee.

To be considered a safe and successful flight, the rocket must:

- Safe Flight:
  - Launch
  - Fly in a stable, near-vertical trajectory during ascent
  - Electronically-deployed recovery system must successfully deploy
  - Rocket must be recovered safely and in ready to fly condition
- Successful Flight:
  - Safe Flight
  - Apogee between 700 ft and 1000 ft

Flyable condition shall be considered condition that if the team were handed another motor, the rocket would pass RSO inspection and could be put on the pad and flow again safely (without repairs). The entire rocket must be returned to a designated location for post-flight inspection by the RSO or designee.

A flight performance report sheet will be filled out by a designated flight operations recorder. The flight operations recorder will record the data on the sheet during and following the flight. Upon completion, a team member must sign their initials of acceptance before a copy will be released to the team.

Evaluation Criteria

Finishing order for of the competition flight will based on:

- Safe flight and recovery
- Apogee within the acceptable window (zero for alt if outside the apogee window)
- Apogee closest to their predicted altitude (as presented in their FDR)
- GEM straight line distance traveled (zero points for GEM traveled if not clear of rocket)

Scoring Formula

Teams will score points based on the formula:

$$Score = 20 \text{ for safe flight} + 40\left(\frac{minimum\ alt\ diff\ (ft)}{team's\ alt\ diff\ (ft)}\right) + 20\left(\frac{team's GEM\ dist\ travled\ (in)}{maximum\ GEM\ dist\ travled\ (in)}\right)$$

No less than 20 points will be awarded to rockets that complete a safe flight. There is a maximum of 100 points from the Competition Flight that will be scaled to meet the 30% of the competition total score.

Post-Flight Performance Report

Performance

The performance of the team's rocket and payload are to be presented in the form of a brief report that will include:

- Cover page
    - Report title
    - WSGC CRL 2019
    - Team Name
    - School
    - Team member's names
- Assessment of the rocket's operation
- Performance of the payload
    - Images of the GEM's deployment and travel
        - Distance traveled by the GEM
    - Discussion of the performance of the payload and how it might have been improved
- Actual vs. predicted flight performance
    - A "Flight Performance Reporting Sheet" (see Table 4 sample on next page)
    - Plot: "Acceleration Performance Comparison of Predicted and Actual" (Figure 4)
    - Discussion of Results
        - Compare predicted and actual apogees, describe and defend possible reasons for differences
    - Discussion of how flight could have been improved
- Photographic documentation of the flight

Flight Performance Report Format

The performance comparison document should follow the same guidelines as the Design Report, be no more than eight (8) pages in length and must be submitted electronically in *.pdf* format.

Evaluation Criteria

Reports will be evaluated on how closely the predicted results compare to the actual results, how well the team explains any differences, clarity, completeness and professionalism of the material. The criteria are detailed in Appendix A-3 "Flight Performance Judging."

Scoring Formula

Flight Performance Report scoring is based on the average of the Post-Flight Performance Report Judging forms. There is a maximum of 100 points from the Post-Flight Performance Report Judging Form that will be scaled to meet the 15% of the competition total score.

SAMPLE: FLIGHT PERFORMANCE REPORTING SHEET

SCHOOL _____ **Team** _____

1 Operation (determined by RSO or designee)	✓
Launch	
Stable Ascent	
Recovery deployment - Electronic	
- Motor	
Recovered	
GEM Deployment	
Determined to be in flyable condition	

			Predicted (FDR)	**Actual**	
2	Maximum Altitude	(*ft.*)			
3	Distance traveled by GEM	(*in.*)			

Table 4 Example of Flight Performance Characteristics Table

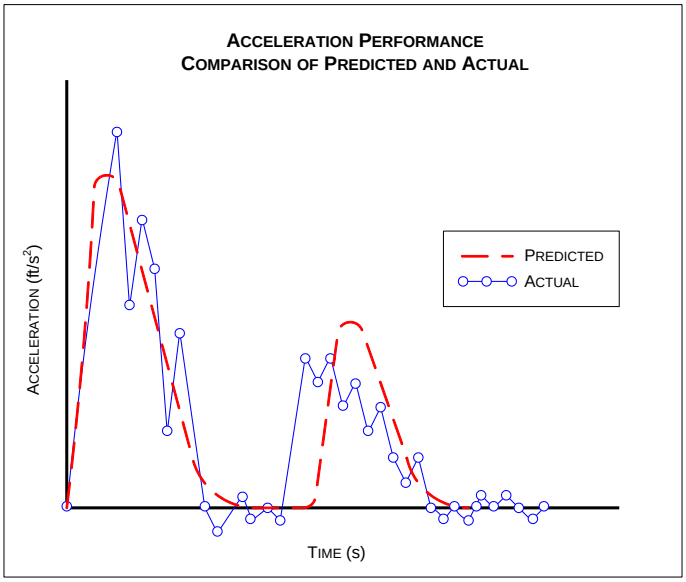

Figure 3 Example of Acceleration Performance Plot

Project Management

Project Management Performance

The ability of the team to meet the project targets will be assessed during this competition. Targets measured will include:

- Review and discussion of the team's design at three important phases with their rocketry mentor. There will be an online form for the team and mentor to fill out following each phase:
    - PDR – Preliminary Design Review
        - The PDR demonstrates that the preliminary design all system requirements have been accounted for and that the proposed design approach has sufficient maturity to ensure success of the final design
    - CDR – Critical Design Review
        - The CDR demonstrates that the design is ready for fabrication. Systems are fully accounted for and detailed hardware/software specifications can meet the functional requirements
    - FDR – Final Design Review
        - The FDR incorporates the adjustments to the design given feedback from the Safety Review as well as any payload performance testing and rocket flight tests.
    - FRR – Flight Readiness Review (presentation)
        - The FRR demonstrates that not only is the system ready to fly, but the procedures have been clearly defined for the pre-flight preparation, the operation and the post-flight safety and data-download.
- Team representation at all meetings either online or in person as required during the competition.
- Completion of online forms to track the team's progress.
- Completion and quality of team's documentation in addition to the reports that have been spelled out about. For example:
    - Team member and contact list
    - Project budget
    - Model rocket launch photos/videos

Evaluation Criteria

Timeliness, accuracy, quality and thoroughness will be the basis for the evaluation.

Scoring Formula

Project Management Performance will be documented throughout the competition for each team. The result of the Project Management Performance will be scaled to meet the 10% of the competition total score.

Page
Intentionally
Left
Blank

Educational Outreach

Educational Outreach Performance

An "Educational Outreach" element, in which each team shares information pertinent to aerospace with a group. For purposes of the competition, teams will be scored based on the audience reached. Outreach possibilities could include but are not limited to:

- Meet with a K-12 class or student organization to explain how rockets work.
- Make a presentation in the community or to a group on campus to describe the rocket competition and your team's design.
- Make a presentation to a group on campus describing opportunities at NASA or through the WSGC that are available to students before they graduate.

Evaluation Criteria

At the completion of the outreach event the team will need to have a representative at the event fill out and return to them an EPO (Education/Public Outreach) form that the team must then submit to the WSGC.

Scoring Formula

Teams that successfully complete the Educational Outreach and submit their EPO form will receive up to 10 points towards their total score.
Audience scoring:

- K-12 10 pts
- Community, off-campus 9 pts
- On-campus, university 7 pts

Page
Intentionally
Left
Blank

APPENDIX A-1

SCHOOL _____ **Team** _____

ORAL PRESENTATION JUDGING

_____ **ENGINEERING & DESIGN CONTENT: (30 pts)**

- Ground Excursion Module (GEM) (15 pts)
  - Selection of GEM system
  - Description of how it is deployed and operates
  - Estimate of distance it will travel in time allowed
  - Description of system video system on GEM
  - Diagrams/photos showing how it was implemented in rocket
- Addressed Competition Flight Objectives/Requirements (5 pts)
- Use of Analytical Data (5 pts)
- Description of Construction Techniques (5 pts)

_____ **ROCKET APPERANCE & DETAIL: (15pts)**

- Detail/realism of appearance (5 pts)
- Quality of Visual Appearance (5 pts)
- Quality of Construction (5 pts)

_____ **ORGANIZATION: (20 pts)**

- Logical Organization & Structure (5 pts)
- Presentation Clarity (5 pts)
- Use of Visual Aids as Support Material (5 pts)
- Balance & Transitions Among Presenters (5 pts)

_____ **VISUAL AIDS: (10 pts)**

- Appropriate Use of Text (2 pts)
- Informational Charts & Illustrations (2 pts)
- Appropriate Design and Use of Graphics (3 pts)
- Use of Supporting Physical Materials (3 pts)

_____ **COMMUNICATION SKILLS: (15 pts)**

- Articulation, Verbal Projection (5 pts)
- Body Language, Poise/Presence, Eye Contact (5 pts)
- Adherence to Time Constraints (5 pts)

_____ **QUESTION & ANSWER: (10 pts)**

- Active Listening Skills (4 pts)
- Answer Relevance (3 pts)
- Response Confidence/Persuasiveness (3 pts)

TOTAL = PRESENTATION POINTS (100 points maximum)

COMMENTS:

Page
Intentionally
Left
Blank

APPENDIX A-2

SCHOOL _____ **Team** _____

DESIGN REPORT JUDGING

0.0 = inadequate or no attempt
¼ Val = attempted but below expectation
½ Val = average or expected
¾ Val = above average but still lacking
Max Val = excellent, perfectly meets intent

_____ Ground Excursion Module System (0-25)

- Possible methods identified (10 pts)
  - brief description of each possible method identified
  - Comparison of methods identified
  - Describe the decision process used for the evaluation and selection of top method
  - Comparison of methods identified
  - Justification of method selected
- Design details of system to capture image (10 pts)
- Accommodations to rocket made for GEM system (5 pts)

_____ ROCKET MECHANICAL & ELECTRICAL DESIGN (0-30)

- Accurate diagrams of rocket (5 pts)
  - External appearance with overall dimensions
  - Internal organization identifying components
- Recovery System Design Specifications (5 pts)
- Avionics System Design Specifications (5 pts)
- Planned Construction Solutions & Techniques (5 pts)
- Structural Analysis of Custom-Fabricated Parts (5 pts)
- Downed rocket location aid (5 pts)

_____ FLIGHT PERFORMANCE MEASUREMENT PLAN (0-25)

- Rocket Parameters – describe how each were estimated (5 pts)
  - Dimensions and Weight
  - Motor Selection
  - Aerodynamic Drag estimates
- Over all Flight Analysis (5 pts)
- Modeling of Flight Profile (5 pts)
- Stability Analysis (5 pts)
- Environmental Conditions Analysis (5 pts)

_____ SAFETY (0-10)

- Designed for Safe Flight & Recovery (5 pts)
- Planned Pre & Post Launch Procedures and Checklists (5 pts)

_____ MISCELLANEOUS (0-10)

- Followed Specifications (3 pts)
- Correct Spelling and Grammar (3 pts)
- Documented Figures and Graphs; References and Labeling (4 pts)

_____ TOTAL = DESIGN REPORT POINTS (100 points maximum)

Page
Intentionally
Left
Blank

APPENDIX A-3

SCHOOL _____ **Team** _____

POST-FLIGHT PERFORMANCE REPORT JUDGING

0.0 = inadequate or no attempt
¼ Val = attempted but below expectation
½ Val = average or expected
¾ Val = above average but still lacking
Max Val = excellent, perfectly meets intent

_____ **ASSESSMENT OF ROCKET OPERATION (25)**

- Flight Anomalies Analysis (10 or 0 pts)
  {If no anomaly then points are distributed to remaining subsections}
- Propulsion System Assessment (3 or 5 pts)
- Flight Path Assessment (3 or 5 pts)
- Recovery System Analysis (3 or 5 pts)
- Rocket Location & Recovery Analysis (3 or 5 pts)
- Pre & Post Launch Procedure Assessment (3 or 5 pts)

_____ **PAYLOAD SYSTEM PERFORMANCE (30)**

- Distance traversed by GEM (5 pts)
- Description of quality of motion on the ground (10 pts)
- Still images from GEM video system (5 pts)
- Discussion of overall payload performance and possible improvements (10 pts)

_____ **ACTUAL VS PREDICTED PERFORMANCE (20)**

- Altitude Comparison (10 pts)
- Acceleration Comparison (10 pts)

_____ **PHOTOGRAPHIC DOCUMENTATION OF FLIGHT (15)**

- Launch pad and/or liftoff photo(s) (5 pts)
- In-flight photo(s) (5 pts)
- Landed on ground photo before collected (5 pts)
- Recovered rocket showing all intact or damage (5 pts)

_____ **REPORT AESTHETICS (10)**

- Followed Specifications (3 pts)
- Professionally Written (10 pts)
- Accurate Representation of Events (7 pts)

_____ **TOTAL = POST-FLIGHT PERFORMANCE REPORT POINTS (100 points maximum)**

COMMENTS:

Page Intentionally Left Blank

APPENDIX A-4

WSGC Collegiate Rocket Competition
Education/Public Outreach Documentation Form

The Wisconsin Space Grant Consortium (WSGC) and NASA would like to thank you for giving our collegiate rocket competition participants a chance to assist your organization. Please take a moment to fill in some information below to verify the students' participation. A portion of their competition score is based on their outreach activities and your willingness to let them assist you in the work you are doing is appreciated.

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

Name of Organization		Supervisor Name	Phone or Email
# of Hours		Signature	Date
Activity Performed			
Approx. # of Attendees	Brief Descrip. of Attendees		Brief Descrip. of Activity
	Circle one: K-12 Off-Campus Comm. University		

Name of Organization		Supervisor Name	Phone or Email
# of Hours		Signature	Date
Activity Performed			
Approx. # of Attendees	Brief Descrip. of Attendees		Brief Descrip. of Activity
	Circle one: K-12 Off-Campus Comm. University		

Page
Intentionally
Left
Blank

NASA WISCONSIN SPACE GRANT CONSORTIUM

Collegiate Rocket Launch Calendar 2019

07-Nov-2018 **Award Acceptance Material Due**

08-Nov-2018 **Kick-Off Meeting**

10-Dec-2018 **PDR*, Preliminary Budget*, and Demo Flight* Deadline**
Upload rocket demo flight video on Facebook and/or Twitter and demo flight link to *team lead grant management page*.

17-Jan-2019 **Design Update Virtual Meeting I**

12-Feb-2019 **Design Update Virtual Meeting II**

15-Feb-2019 **CDR* Deadline**

01-Mar-2019 **First Payout Deadline**
Please complete and mail the **Travel Summary Expense Form** and/or the **Team Funded Program Expense Reimbursement Form** (found in **Tools and Tips**) to the WSGC Program Office. Include original receipts. Allow 60 days for payment.

23-Mar-2019 **Design and Safety Review Meeting at EAA Museum**
Mandatory meeting with 90% ready-to-fly rocket

25-Mar-2019 **Final Team Roster* Deadline**

15-Apr-2019 **FDR* Deadline**

19-Apr-2019 **Education Outreach* Deadline**
Team will share information pertinent to aerospace with a group or audience.

23-Apr-2019 **Oral Design Presentation PowerPoint* Deadline**

26-Apr-2019 **Oral Design Presentation at Carthage College**
Present a 6-8 minute PowerPoint presentation discussing team's rocket

27-Apr-2019 **Launch Competition**
Attend the High-Powered Rocket Launch at Richard Bong Recreational Area in Kansasville, WI.

13-May-2019 **Post Flight Performance* Report**

13-May-2019 **Final Payout Deadline**
Please complete and mail the **Travel Summary Expense Form** and/or the **Team Funded Program Expense Reimbursement Form** (found in **Tools and Tips**) to the WSGC Program Office. Include original receipts. Allow 60 days for payment.

09-Aug-2019 **Annual Conference**
If your team places 1st-3rd in the competition, present the results of your studies associated with this program at the 29th Annual Wisconsin Space Conference at UW-Platteville

16-Sep-2019 **Proceeding Paper****
If your team places 1st-3rd in the competition, submit a Proceedings Paper for the 29th Annual Wisconsin Space Conference online journal.

Team Lead is responsible for uploading document(s) to
**grant management page and/or **online journal.*
