



NASA'S SPACE GRANT 2018-2019 MIDWEST HIGH-POWER ROCKET COMPETITION – THE “EFFICIENT SUPERSONIC” CHALLENGE

MAY 2019 COMPETITION LAUNCH
NEAR NORTH BRANCH, MN

HOSTED BY THE MN SPACE GRANT
CONSORTIUM AND BY TRIPOLI MN

Photo: Max Jetzer & Adrian Guither

Informational telecon: Tuesday, September 25, 2018, 7 p.m CST
Repeated: Thursday, January 17, 2019, 7 p.m. CST

Introductions

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- MN Space Grant Organizer

U of MN's Prof. James Flaten

<flate001@umn.edu>

- Technical Advisor

Tripoli MN's Gary Stroick

<president@offwegorocketry.com>

- Round Robin Introductions

Number of Teams Participating

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- Teams competing last year (2017-2018)
 - ▣ 19 teams, mostly from the Space Grant “Great (Lakes) Midwest” Region, but open to entire nation
 - ▣ MN (7), WI (5), IL (2), IA (1), NE (1), OH (1), VA (1), TN (1)
 - ▣ 5 of the teams made some progress but ultimately had to withdraw before the competition in May 2018
- This year we will continue to encourage teams from all across the country to participate and are hoping to attract over 20 teams.

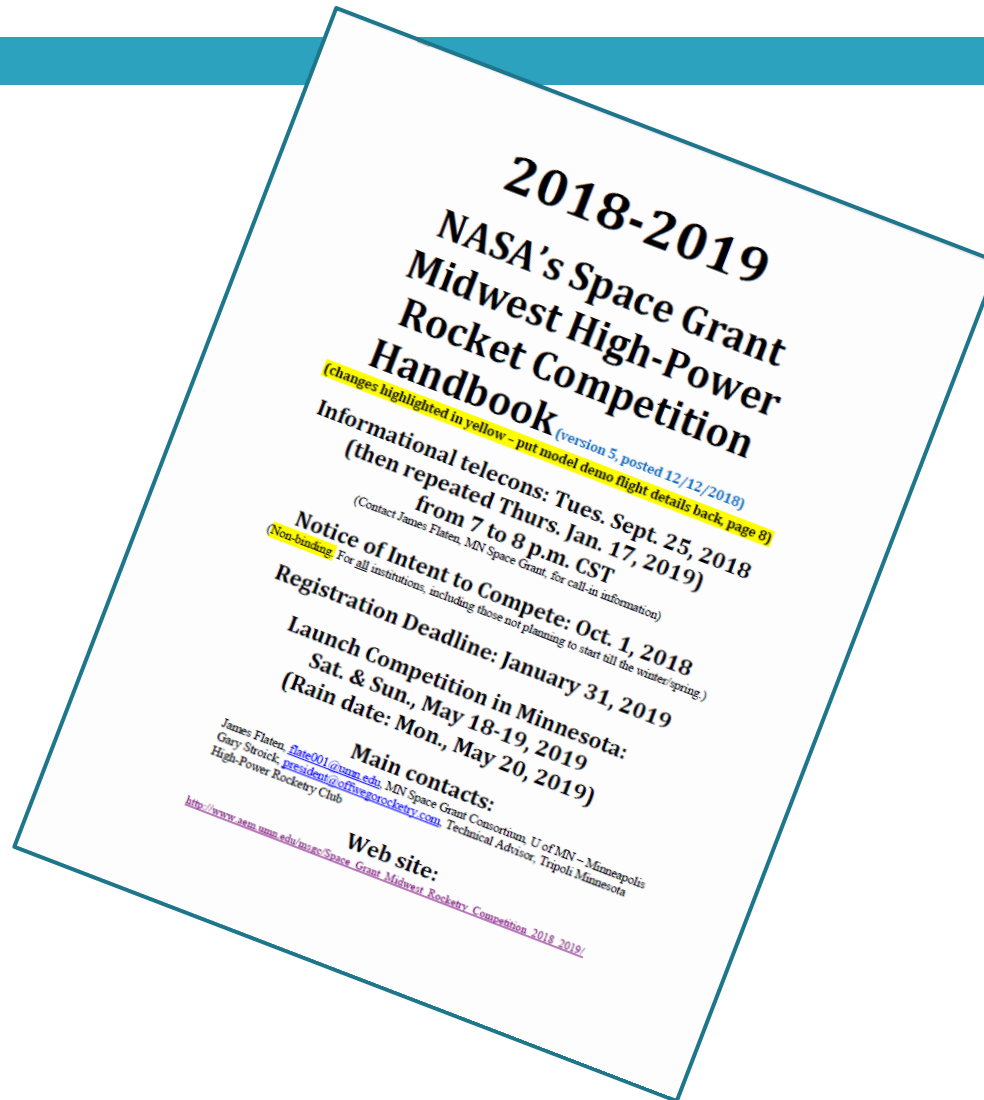
What you need to know

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- Competition Handbook
- Fees & Supplied Equipment
- Schedule
- Competition Parameters
- Pre-Competition Requirements
- Five Aspects of the Competition
- Flight Safety
- Judging
- Q & A

Competition Handbook & Website

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Fees & Supplied Equipment

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- Registration Fee: \$400* (due Thursday, Jan. 31, 2019)
- The Registration Fee Covers (on Launch Day):**
 - MODIFIED: One loaner commercial data logger (a Jolly Logic Altimeter Two) for non-supersonic flight attempts. (Note: An Altimeter Three, if you own one, is allowed instead.) But remember that Altimeter Two and Altimeter Three data loggers cannot fire ejection charges so you will still need to fly a “genuine” altimeter (or two, if not using motor eject).
 - NEW: You must use an accelerometer-based altimeter, such as a Raven3, for your supersonic flight attempt. We will lend Ravens to any teams that don't own one. You may use its functionality to fire ejection charges. (Note: You may elect to fly a Raven altimeter on all flights if desired, instead of ever using an Altimeter Two or Altimeter Three.)
 - Up to \$100 for Competition Motors from Off We Go Rocketry (Tripoli MN vendor)
 - first flight (unlikely to go supersonic, so just for head-to-head comparison of performance) on a Cesaroni 491-I-218-14A “White Thunder” 1-grain, 54 mm diameter motor
 - second flight on any AeroTech or Cesaroni I-class or J-class motor (team must pay the difference if their two competition motors cost more than \$100 total)
 - Note: Teams are allowed to bring additional motors, or purchase more motors (to pick up at the competition), then try to fly more than twice within the launch window (till ~ 5 p.m.)

**Tentative value – might possibly go up or down (a little) depending on the number of teams that sign up and our success in finding outside sponsors – changes to this fee, if any, will be announced by December 31, 2018.*

***If we garner enough outside sponsorship support we may be able to provide more things or possibly reduce the registration fee. Additional details, if any, announced no later than December 31, 2018.*

Space Grant “Sponsorship”

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To help us keep tabs on participants for Space Grant Reporting, we require that every team contact their state’s Space Grant for “sponsorship.” We are not suggesting to Space Grants what “sponsorship” might mean – this is to be negotiated on a case-by-case basis. For example, a Space Grant sponsorship doesn’t necessarily entail full (or even partial) financial support, so most teams will need to find other sources of funding.

However we hope that Space Grants will at least consider helping with some basic competition expenses such as:

- (a) registration fee (\$400)
- (b) travel to MN for the competition launch in May 2019 (cost varies widely)
- (c) building and instrumenting the rocket itself (cost varies; about \$500-1500)
- (d) paying for motor casings, with closures (depends on the motors selected, ~\$70 to \$150)
- (e) buying motor(s) for the at least one pre-competition test launch and, potentially, additional test launches (~\$50 to \$150)

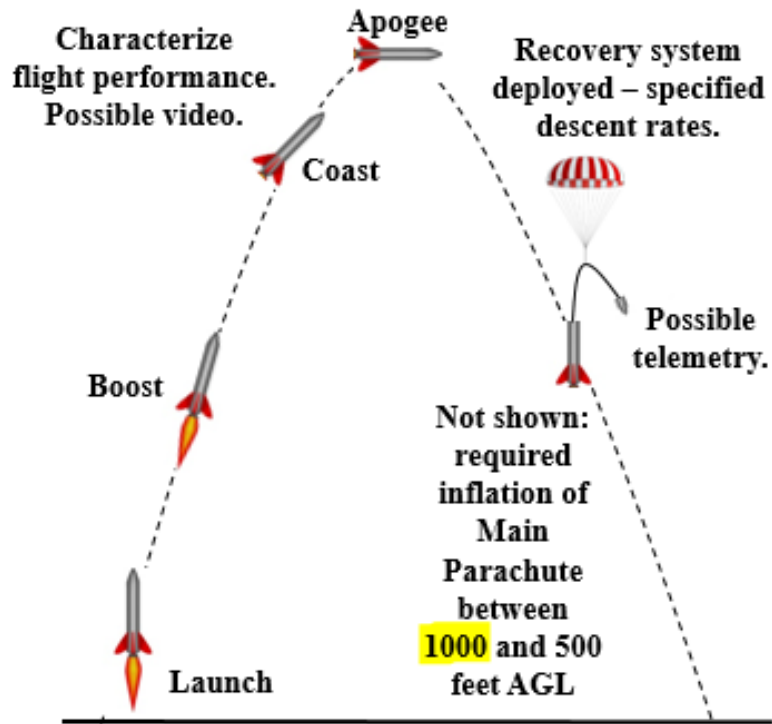
2018-2019 Competition Parameters

The “Efficient Supersonic” Challenge:

In this competition student teams will design and construct an “efficient supersonic” single stage, dual-deploy-required, high-power rocket that will fly twice in the competition. Rockets will fly first on a Cesaroni 491-I-218-14A “White Thunder” (1-grain, 54 mm diameter) motor – unlikely to go supersonic, but for head-to-head comparison of maximum altitude, speed, and acceleration. The second flight can be on any Cesaroni or AeroTech I-class or J-class motor and will be rated based on going supersonic but doing so as “efficiently” as possible – that is, using the lowest possible impulse motor and only going slightly faster than the speed of sound. The handbook will have a specific “figure of merit” to help define “efficient” in this context. The rocket must also carry a non-commercial data-logging sensor suite to characterize flight performance including (at least) axial acceleration, velocity, altitude, rotation about rocket axis (AKA “roll”), and ambient pressure in the av-bay. Extra points will be awarded to rockets with a camera system that can see launch, landing, plus the deployment/inflation of both parachutes and also to rockets that carry a radio telemetry system capable of sending flight performance data to the ground during the flight, to be relayed to the judges before the rocket lands. Note that all fabrication work on the rocket (except for possible machining of plastic and/or metal parts) must be performed by students.

2018-2019 Competition Parameters

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Supersonic rocket flight profile.

RULES/CONSTRAINTS

- All teams are required to have a non-student Level 2 (or higher) certified mentor, a faculty adviser, and get “sponsored” by their state’s Space Grant.
- **NEW: Receive feedback on a Draft of Design before starting to build.**
- At least one test flight on a high-power motor, H-class or above, with electronics activated. Test flights on both actual competition motors highly recommended.
- First fly on a Cesaroni 491-I-218-14A motor then attempt to go supersonic on any I-or-J-class motor from Cesaroni or Aerotech. Consult Gary Stroick of Off We Go Rocketry, the Tripoli MN vendor, about motor availability and cost.
- Teams must be able to prep their rocket for each flight within 1 hour.
- The rocket must be dual deploy (i.e. have two parachutes). The drogue parachute should be deployed at apogee (or just after apogee) and the main parachute must be inflated between 1000 and 500 feet above ground level.
- All parts of the recovery system must be electronically deployed using a commercial altimeter. The motor eject must remain in place or a second commercial altimeter must back-up the drogue deployment at apogee.
- One competition data logger will be provided – an “Altimeter Two.”
- Radio-tracking of the rocket is now required by Tripoli MN – see handbook.
- Also required – a non-commercial sensor suite that logs axial acceleration, roll rate, and av-bay pressure at 10 Hz (at least).
- Extra points for “thorough” (up & down, at least) video camera system.
- Extra points for ability to send performance data down by radio telemetry.
- Rocket must have $1 \leq \text{static margin} \leq 5$ at launch for both flights. Rocket body, including fins, must look identical (from the outside) for both flights (new: may change nose cone and/or boat-tail).
- See handbook for formula used to calculate flight score for both flights.

Pre-Competition Requirements

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NEW: Draft of Design

▣ Purpose

- To give your team's mentor and Gary Stroick an early look at your design and specifications BEFORE YOU START TO BUILD IT.

▣ Due date

- Submit as early as possible – definitely before you start to build the design (so this might need to be submitted well before the PDR is due)
- If planning to build “late” (i.e. after submitting and getting feedback on your design through the PDR process), still submit this draft of design no later than Friday, Feb. 15, 2019 (3 weeks before the PDR is due)

▣ Contents

- This document must include a simulation file (OpenRocket or RockSim) with supersonic motor selected, as well as basic details about the dimensions and materials to be used for the fins, airframe, and nose cone, connections, commercial altimeter(s) planned for ejections, etc.
- Gary Stroick will provide feedback within one week regarding any concerns he may have, especially regarding potential fin flutter and/or divergence issues and/or appropriateness of altimeter(s).

▣ Failure to complete by Feb. 15, 2019: 20% Overall Score Reduction

Pre-Competition Requirements

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Model Rocket Demonstration Flight

▣ Purpose

- Demonstrate a minimum knowledge of rocketry

▣ How to do it

- Purchase a model rocket flight kit
- Assemble
- Successfully fly and recover the rocket
- Document the flight with before and after photos of the rocket and the team “in the field”
- E-mail photos to the MN Space Grant along with flight date and location no later than Friday, March 8, 2019 (PDR due date)

▣ Potential Waivers

- If your whole team has high-power rocketry experience, you may request a waiver from this requirement from Gary Stoick
- If you prefer to build and fly a (non-competition) high-power rocket instead of a model rocket to fulfill this requirement, that is acceptable, but it must be a different rocket than the one you use to compete

▣ Failure to complete by March 8, 2019: 10% Overall Score Reduction

Pre-Competition Requirements

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Educational Outreach (see form at end of handbook)

- ❑ Collected/validated by each State's Space Grant Coordinator or Director (note – your team's faculty advisor can provide contact information for the Space Grant Coordinator or Director in your state)
- ❑ Form must be completed and submitted to your state's Space Grant no later than Monday, May 6, 2019 – also send a copy to the Technical Adviser, Gary Stroick
- ❑ Tell your state's Space Grant office to notify the Technical Adviser that they have received and validated the form
- ❑ **Failure to complete by May 6, 2019: 10% Overall Score Reduction**

5 Judged Aspects of the Competition

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- Preliminary Design (Written) Report (30%)
- Flight Readiness (Written) Report (15%)
- Flight Readiness (Oral) Presentation (15%)
- Competition Flight Performance (20%)
- Post-Competition Flight Performance Report (20%)

Note 1 – There are overall percentage reductions if you do not complete the Draft of Design, the Model Rocket Demonstration Flight, and the Educational Outreach component on time.

Note 2 – Written reports are due by e-mail (or by another mutually-agreed upon means) to the Technical Advisor by 5:00 p.m. Central Time on the dates specified in the schedule. Scores for late reports will be reduced by 20% for each portion of a day that they are late. If you are unsure about whether or not you can get documents the size of your reports to the Technical Advisor, you should practice by submitting comparably-sized sample documents in advance.

Note 3 – Mentors must submit report forms as well, by the same report dates specified in the schedule. Mentor reports can go directly to the Technical Advisor by e-mail – they do NOT need to be collected by teams and included with the team reports.

Note 4 – Points for optional activities (see p. 6 of handbook) will be awarded on top of the %'s listed above.

5 Judged Aspects of the Competition

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Preliminary Design (Written) Report (30%)

- ❑ Communicate the engineering and design effort
 - Provide detailed design and diagrams
 - Analysis of predicted performance
 - Analysis of non-“pre-qualified” components
 - Addresses issues raised from Draft of Design submission, if any
- ❑ Estimated Budget
- ❑ If doing any optional parts, discuss those as well
- ❑ 25 pages MAX
- ❑ Due Friday, March 8, 2019
- ❑ Competition motor(s) order due
- ❑ **NOTE: Rocketry vendors typically need up to 6 weeks lead time to provide motors so you should order test-flight motors BEFORE this due date (like by mid-February for April flights)**

5 Judged Aspects of the Competition

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Flight Readiness (Written) Report (15%)

- ▣ SHOW the construction and completed rocket
 - Construction pictures, diagrams, etc.
- ▣ Test Flight(s) (at least 1 test flight with a high-power motor – best to test fly on actual competition motors, if possible)
 - Flight Performance Analysis
 - Flight Results Discussion
 - Improvements planned, if any, prior to competition
- ▣ Actual Budget
- ▣ If doing any optional parts, discuss those as well
- ▣ 25 pages MAX
- ▣ Due Monday, May 6, 2019

5 Judged Aspects of the Competition

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Flight Readiness (Oral) Presentation (15%)

- ❑ Communicate the design and engineering effort
- ❑ Organization and presentation
- ❑ Rocket Construction (especially AV-bay)
- ❑ VISUAL AIDS
- ❑ If doing any optional parts, discuss those as well
- ❑ 10 minutes for presentation plus up to 3 minutes for Q & A
- ❑ Separate time for safety check and to show judges the inside of your AV-bay
- ❑ Saturday afternoon into the evening, May 18, 2019

5 Judged Aspects of the Competition

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Competition Flight (20%) (see handbook for more details)

- Each successful flight requires:
 - Rocket launches, flies vertically, flies stably all the way to apogee
 - Recovery system(s) successfully deployed at appropriate altitudes
 - Safely lands at < 24 ft/sec descent speed under drogue + main
 - Rocket is recovered in re-flyable condition

- Flight Scoring:
 - Two successful flights (see above)
 - Timely prep of rocket for both flights (no more than 1 hour prep each)
 - See handbook p. 25 for scoring formulas for both flights
 - Flight disqualification decisions will be announced on the spot (based on observations, not logged data). Flights may be re-tried as long as the RSO agrees they are safe.
 - Report on best Flight 1 and best Flight 2, regardless of re-flights.

5 Judged Aspects of the Competition

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Post-Flight Performance (Written) Report (20%)

- Flight Performance Comparison
 - Actual vs simulated flight performance analysis
 - Graphs, charts, links to posted videos, stills from videos, etc.
 - Performance results; discrepancy discussion; failure analysis, if needed
- If you did any optional parts, discuss those as well
- 15 pages MAX
- Due Friday, May 31, 2019

Safety Reviews

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- Each team must go through a safety review with their certified mentor in their home state prior to coming to the competition
- Each team will go through a safety review with Tripoli MN the evening of their oral presentation
- On the day of the launch:
 - Each rocket must be examined for flight safety by the Range Safety Officer (RSO)
 - **The Tripoli MN RSO has the final word on flight safety!**

Judging

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- Separate from safety checks by Tripoli MN, the written and oral reports and the performance in the competition flights will be evaluated according to the rubrics in the handbook by a panel of judges from industry and/or academia.
- **Each Space Grant sponsoring more than one rocket team will be expected to provide one judge. (States fielding four or more teams may be asked to provide two judges.)**
- If you don't have someone from your state you would like to send to MN for the competition dates, contact Gary Stroick about possibly retaining member of the Tripoli MN club to serve as "your" judge(s). Typically judges' travel expenses are reimbursed (at least). Please identify your judge(s) no later than Thursday, Jan. 31, 2019.

Schedule Summary

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- Oct. 1, 2018 – Notice of Intent to Compete (non-binding)
- **NEW: DUE BEFORE YOU START TO BUILD – Draft of Design (specs & sim)**
- Jan. 31, 2019 – Formal Team Registration (pay \$)
- Jan. 31, 2019 – All states' judges identified
- Feb. 8, 2019 – Declaration of Competition Attendance
- **Feb. 15, 2019 – Last possible date to get credit for Draft of Design (specs & sim)**
- Mid-Feb. – Recommended latest time to order test motor(s) for April test flights
- March 8, 2019 – Preliminary Design (Written) Report (PDR) along with Competition Motor Order and Model Rocket Flight documentation
- Early May – Test flight(s) done: better still, do these well before the end of April
- May 6, 2019 – Flight Readiness (Written) Report (FRR) along with Educational Outreach form
- May 18-19, 2019 – Competition (includes Oral FRR) – weather delay date: 5/20
- May 31, 2019 – Post-Competition Flight Performance (Written) Report (PCFPR)
- June 7, 2019 – Competition Results Announced

$$v_x = v \cos \theta$$

$$v_y = v \sin \theta$$

$$x = v \cos \theta \cdot t$$

$$y = \left(v \sin \theta - \frac{g}{2} t \right) \cdot t$$