



NASA'S SPACE GRANT 2019-2020 MIDWEST HIGH-POWER ROCKET COMPETITION – THE “PHOTOGRAPHY/ALTITUDE” CHALLENGE

MAY 2020 COMPETITION LAUNCH
NEAR NORTH BRANCH, MN

HOSTED BY THE MN SPACE GRANT
CONSORTIUM AND BY TRIPOLI MN

Informational telecon: Tuesday, September 24, 2019, 7 p.m CST
Repeated: Thursday, January 16, 2020, 7 p.m. CST

Introductions

2

- 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

3

- Teams competing last year (2018-2019)
 - 20 teams registered, mostly from the Space Grant “Great (Lakes) Midwest” Region, but this competition is open to colleges/universities across the entire nation
 - MN (5), WI (3), IL (3), AK (1), ND (1), NE (1), UT (1), VA (1), FOREIGN (1)
 - 3 additional teams made some progress but ultimately had to withdraw before the competition in May 2019
- 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

4

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

Competition Handbook & Website

5

2019-2020
NASA's Space Grant Midwest
High-Power Rocket Competition
Handbook (version 1, posted 9/24/2019)
Photography/Altitude Challenge

Informational telecons: Tues. Sept. 24, 2019
(then repeated Thurs. Jan. 16, 2020)
(Contact James Flaten <flaten001@umn.edu>, MN Space Grant, for call-in information)
from 7 to 8 p.m. CST

Notice of Intent to Compete: Oct. 1, 2019
(Non-binding but for all institutions, including those not planning to start till the winter/spring.)

Registration Deadline: January 31, 2020

Launch Competition in Minnesota:
Sat. & Sun., May 16-17, 2020**
(Rain date: Mon., May 18, 2020)
** If Minnesota has a particularly wet spring, the competition dates might shift - see details in handbook.

Main contacts:
James Flaten, flaten001@umn.edu, MN Space Grant Consortium, U of MN - Minneapolis
Gary Stroick, president@offwegorocketry.com, Technical Advisor, Tripoli Minnesota
High-Power Rocketry Club

Web site:
http://dept.aem.umn.edu/msgc/Space_Grant_Midwest_Rocketry_Competition_2019_2020/

Fees & Supplied Equipment

6

- ❑ Registration Fee: \$400* (due Friday, Jan. 31, 2020)
- ❑ The Registration Fee Covers (on Launch Day):**
 - (LOANER) Competition Flight Data Recorder (A Jolly Logic “AltimeterTwo” data logger) to monitor altitude and other basic parameters (but not pressure nor roll rate)
 - Up to \$100 for Competition Motors from Off We Go Rocketry (Tripoli MN vendor)
 - 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 ~ 4 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, 2019.*

***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, 2019.*

Space Grant “Sponsorship”

7

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 2020 (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)

2019-2020 Competition Parameters

8

The “Photography/Altitude” Challenge:

*In this competition college/university student teams will design and construct a single stage (dual-deploy optional) high-power rocket that will fly twice in the competition. The target altitude for the first flight will be 2345 ft above ground level and the target altitude for the second flight will be 3456 feet above ground level. The flights can be on any Cesaroni or AeroTech I-class or J-class motor. The rocket must carry two low-cost cameras that interface with a non-commercial sensor suite described below (see handbook for cost limits on camera system). The cameras are to be mounted on parts of the rocket that separate from one another in flight. Photography points during ascent (post-burnout) will be awarded for quality of footage and minimum rotation. (Active roll-control mechanisms encouraged, but not required.) Photography points during recovery will be for having each camera keep the other part of the rocket in view, especially during separation and during landing. Photography points post-landing will be awarded for the best 360° horizon panorama (video or a set of still photo(s)) from just one camera from an elevation as far off the ground as possible **within 5 minutes of landing**. The rocket must also carry a non-commercial data-logging sensor suite to characterize flight performance including (at least) axial acceleration, roll rate about vertical axis, av-bay ambient pressure plus forward-facing (stagnation) pressure (from which velocity can be determined). Sensor values must be logged at 10 Hz (minimum) and also text-overlaid on one video in real time (not post-processing). Computer/camera system likely to be Raspberry-Pi-based with Pi cameras, or something similar. All fabrication work on the rocket (except for possible machining of plastic and/or metal parts) must be performed by students.*

2019-2020 Competition Parameters

9

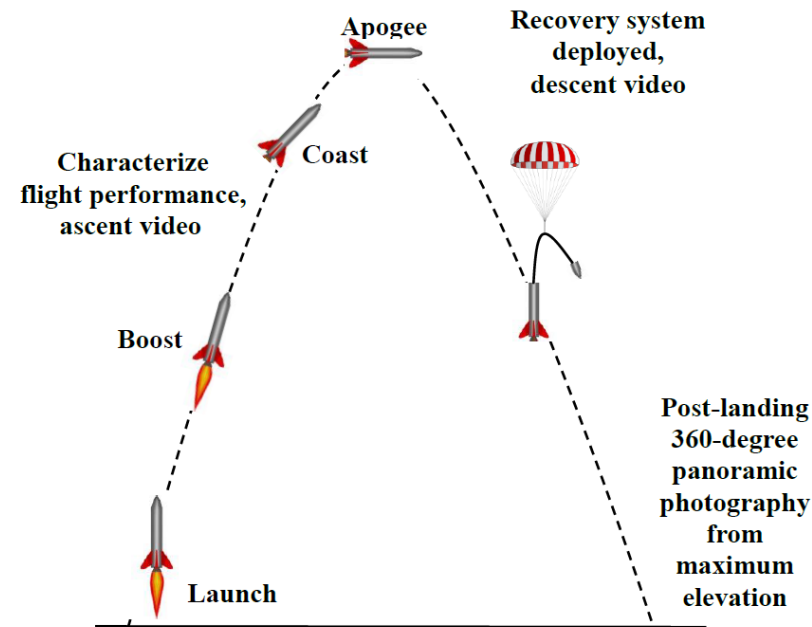


Figure 1: Generic rocket flight profile.

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. Test flights on both actual competition motors highly recommended.
- Both flights 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 have an “apogee parachute” deployed at apogee (or just after apogee). If the rocket is dual-deploy – optional, but possibly advantageous – the main parachute must be deployed no lower than 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 independent commercial altimeter system must back-up parachute 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, av-bay ambient pressure, and stagnation pressure at 10 Hz (at least).
- Active anti-roll (and active altitude targeting) encouraged, but not required. See handbook for details about video ascent, descent, post-landing tasks.
- Rocket must have $1 \leq \text{static margin} \leq 5$ at launch for both flights.
- See handbook for formula used to calculate flight score for both flights.

Pre-Competition Requirements

10

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 **5 p.m. Central Time on** Friday, Feb. 14, 2020 (4 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. 14, 2020: 20% Overall Score Reduction

Pre-Competition Requirements

11

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 **5 p.m. Central Time on** Friday, March 13, 2020 (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 13, 2020: 10% Overall Score Reduction

Pre-Competition Requirements

12

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 **5 p.m. Central Time on Monday, May 4 ~~May 11~~**, 2020 – 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 4 ~~May 11~~**, 2020: 10% Overall Score Reduction**

5 Judged Aspects of the Competition

13

- 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.

5 Judged Aspects of the Competition

14

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
- ▣ 25 pages MAX
- ▣ Due **by 5 p.m. Central Time on** Friday, March 13, 2020
- ▣ 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

15

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
- ▣ 25 pages MAX (plus “Code Appendix” – no page limit)
- ▣ Due **by 5 p.m. Central Time on Monday, May 4 ~~May 11~~, 2020**

5 Judged Aspects of the Competition

16

Flight Readiness (Oral) Presentation (15%)

- ▣ Communicate the design and engineering effort
- ▣ Organization and presentation
- ▣ Rocket Construction (especially AV-bay)
- ▣ VISUAL AIDS
- ▣ 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 16, 2020

5 Judged Aspects of the Competition

17

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
 - 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 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

18

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
- ▣ 15 pages MAX (plus “Code Appendix” (if code has changed since FRR) – no page limit)
- ▣ Due by 5 p.m. Central Time on Sunday, May 31, 2020

Safety Reviews

19

- 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

20

- 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 Friday, Jan. 31, 2020.

Schedule Summary

21

- Oct. 1, 2019 – Notice of Intent to Compete (non-binding)
- **NEW: DUE BEFORE YOU START TO BUILD – Draft of Design (specs & sim)**
- Jan. 31, 2020 – Formal Team Registration (pay \$)
- Jan. 31, 2020 – All states' judges identified
- Feb. 7, 2020 – Declaration of Competition Attendance
- **Feb. 14, 2020 – 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 13, 2020 – 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 4, 2020 – Flight Readiness (Written) Report (FRR) along with Educational Outreach form (CHANGED FROM MAY 11, AFTER FIRST KICK-OFF TELECON)**
- May 16-17, 2020 – Competition (includes Oral FRR) – weather delay date: 5/18**
*** Competition organizers reserve the right to shift the competition dates – see handbook p. 14.*
- May 31, 2020 – Post-Competition Flight Performance (Written) Report (PCFPR)
- June 12, 2020 – Competition Results Announced

$$v_x = v \cos \theta$$

$$v_y = v \sin \theta$$

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

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