NASA'S SPACE GRANT 2021-2022 MIDWEST HIGH-POWER ROCKETRY COMPETITION – THE "RETURN TO FLIGHT: FLEET CHALLENGE"

MAY 2022 COMPETITION LAUNCH NEAR NORTH BRANCH, MN

HOSTED BY THE MN SPACE GRANT CONSORTIUM AND BY THE TRIPOLI MN HIGH-POWER ROCKETRY CLUB

Informational telecon: Monday, September 20, 2021, 7 p.m. CST
Repeated: Thursday, January 13, 2022, 7 p.m. CST

Introductions

- MN Space Grant Organizer

  James Flaten, U of MN Twin Cities

  flate001@umn.edu

- Technical Advisor

  Gary Stroick, Tripoli MN

  president@offwegorocketry.com

- Round Robin Introductions

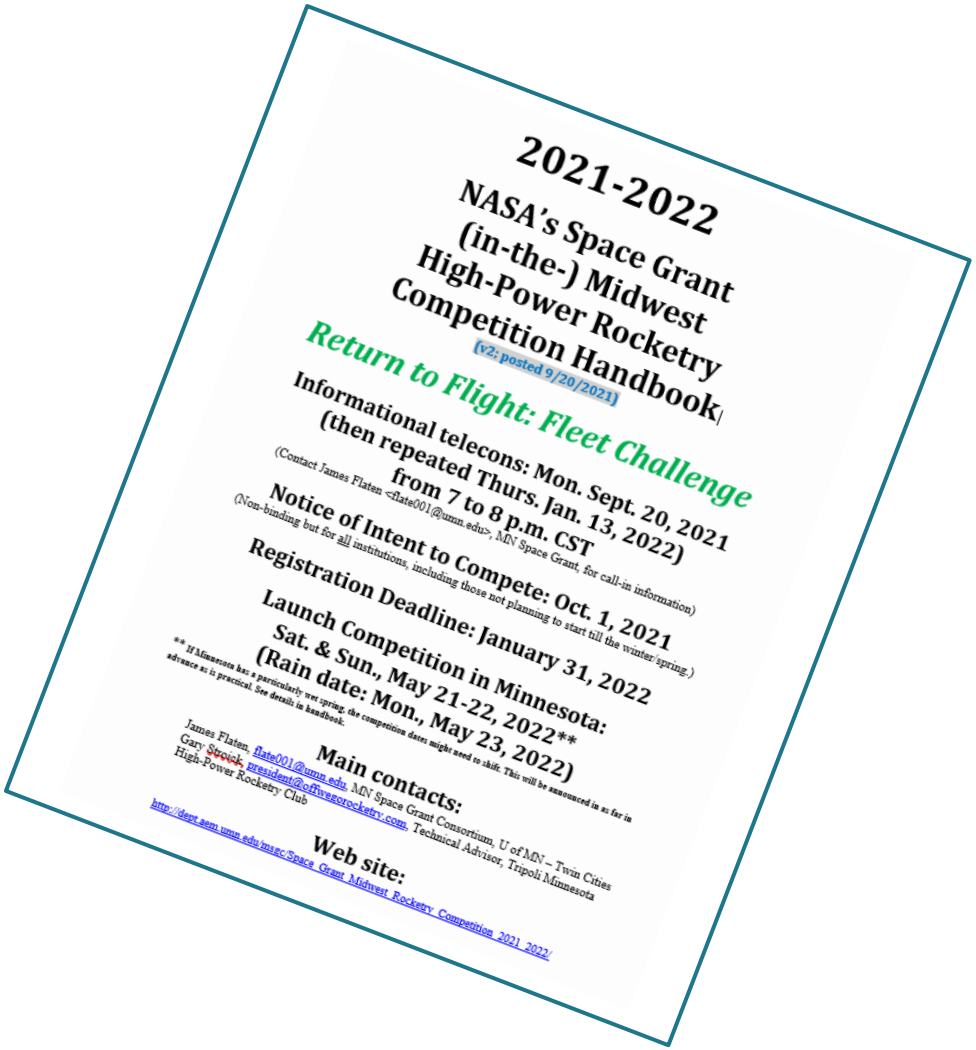
Number of Teams Participating

- Teams competing in 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
  - 17 teams made it to the fly-off. MN (5), WI (3), IL (3), AK (1), ND (1), NE (1), UT (1), VA (1), FOREIGN (1)
  - The other 3 teams made some progress, but ultimately had to withdraw before the fly-off in May 2019.
- In 2019-2020 we started a competition with about 20 teams, but had to cancel it due to COVID-19.
- This year we are hoping to attract over 20 teams to attempt the "Return to Flight: Fleet Challenge."

What you need to know

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

Competition Handbook & Website



2021-2022

NASA's Space Grant

(in-the-) Midwest

High-Power Rocketry

Competition Handbook

(v2: posted 9/20/2021)

Return to Flight: Fleet Challenge

Informational telecons: Mon. Sept. 20, 2021

(then repeated Thurs. Jan. 13, 2022)

from 7 to 8 p.m. CST

(Contact James Flaten <flate001@umn.edu>, MN Space Grant, for call-in information)

Notice of Intent to Compete: Oct. 1, 2021

(Non-binding but for all institutions, including those not planning to start till the winter/spring.)

Registration Deadline: January 31, 2022

Launch Competition in Minnesota:

Sat. & Sun., May 21-22, 2022**

(Rain date: Mon., May 23, 2022)

** If Minnesota has a particularly wet spring, the competition dates might need to shift. This will be announced in as far in advance as is practical. See details in handbook.

Main contacts:

James Flaten, flate001@umn.edu, MN Space Grant Consortium, U of MN – Twin Cities

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_2021_2022/

Website: http://www.aem.umn.edu/msgc/Space_Grant_Midwest_Rocketry_Competition_2021_2022/

Fees & Supplied Equipment

- Registration Fee: $400*† (due Friday, Jan. 31, 2022)
- 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 like peak altitude, velocity, and acceleration. (Note: An AltimeterThree, if you own one, is allowed instead.) However, remember that AltimeterTwo and AltimeterThree data loggers cannot fire ejection charges, so you will still need to fly a "genuine" (commercial) altimeter (or two, if not using motor eject for drogue back-up).
  - 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 set of competition motors costs more than $100 total – very likely)
  - Note: Teams are allowed to bring additional motors, or purchase more motors (to pick up at the competition), then try to fly some rockets more than once within the launch window (but only till ~4 p.m.). This should only be attempted after the entire fleet has flown once.

*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, 2021.

†Teams that paid $400 for the 2019-2020 competition which was called-off before the fly-off in the spring of 2020 due to COVID-19 are allowed to apply that fee to this competition (or else to next year's competition), so they do not need to not pay another registration fee.

**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, 2021.

Space Grant "Sponsorship"

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 specifying to Space Grants what "sponsorship" should 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 2022 (cost varies widely)
(c) building and instrumenting the rockets (cost will vary; about $600 to $1600)
(d) paying for motors (beyond the $100 provided) and casings and closures (cost will depend on the motors selected; about ~$150 to $500)
(e) buying motor(s) for at least one pre-competition test launch for the "core" rocket and, potentially, L1 certification flight(s) before attempting L2 cert flights at the fly-off itself (~$40 to $120)

2021-2022 Competition Description

The "Return to Flight: Fleet Challenge" (summary description)

In this competition, college-student teams will design and construct a set of (fairly-low-cost) high-power rockets (either five rockets (a "fleet") or else three rockets {a "flotilla"} or else eight rockets [an "armada"]). These rockets are to differ from one another in as many ways as possible, to illustrate the ability of the team to successfully demonstrate a wide variety of rocketry styles and build techniques. Every fleet (or flotilla) (or armada) must include one "core" team-built kit-rocket flown on a specific motor (see details in handbook) for "head-to-head" competition. This "core" rocket will be accompanied by four (or two) (or seven) additional rockets, some team-built and some individual-built (for certification). Every "flotilla" must include one individual-built rocket for a Level 1 certification attempt. Every "fleet" must include one individual-built rocket for a Level 1 certification attempt and one individual-built rocket by a different team member for a Level 2 certification attempt. Every "armada" must include two individual-built rockets by different team members for Level 2 certification attempts. To keep costs down, we encourage all rockets to be relatively low cost – perhaps in the $100 to $250 range (aside from motor, motor case and closure, and electronics). In addition to diversity of rocketry styles & building techniques, points will be awarded for "most effective use of (fleet) theme," so rocket names, paint jobs, etc. should be coordinated. Note that all fabrication work on the rockets, except for possibly machining of plastic and/or metal parts, must be performed by students.

2021-2022 Competition Constraints

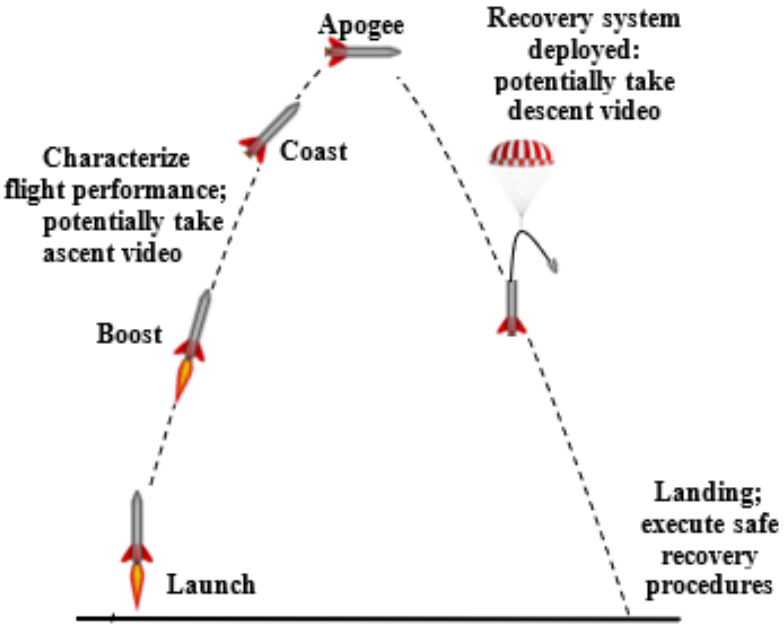


Figure 1: Generic single-deploy rocket flight profile.

RULES/CONSTRAINTS

- All teams are required to have a non-student Level 2 (or higher) certified mentor, a faculty adviser, and be "sponsored" by their state's Space Grant.
- All teams must build a "core" kit-rocket then supplement it with highly-diverse rockets up to a **"fleet"** of 5 rockets or a **"flotilla"** of 3 rockets or an **"armada"** of 8 rockets. Every team is required to have some individually-built rockets for Level 1 and/or Level 2 team member certification – see handbook for details.
- Receive feedback on a "Draft of Designs" before starting to build.
- All competition flights on H- or I- or J-class motor from Cesaroni or Aerotech. Consult Gary Stroick of Off We Go Rocketry about motor availability & cost.
- Do at least one test flight of a team-built rocket on a high-power motor prior to fly-off. L1 cert fights (to prep for L2) may also be required prior to fly-off.
- All rockets must have an "apogee parachute" deployed at apogee (or just after apogee). If any rocket is dual-deploy – the "core" rocket will be dual-deploy; optional, but possibly advantageous, for other rockets – the main parachute must be deployed no lower than 500 feet above ground level.
- All parts of recovery systems that are electronically deployed must use commercial altimeters. The motor eject must remain in place or a second independently-powered commercial altimeter must back-up parachute deployment at apogee.
- One competition data logger will be provided – a Jolly Logic "AltimeterTwo."
- Radio-tracking of rockets is required by Tripoli MN for some flights (and recommended by this competition for all flights) - see handbook for details.
- Rocket must have $1 \leq$ static margin ≤ 5 at launch and land with pieces all tied together, descending at less than 24 ft/sec for all flights.

Pre-Competition Requirements

Draft of Designs

- **Purpose**
  - To give your team's mentor and Gary Stroick an early look at your designs and specifications BEFORE YOU START TO BUILD.*
- **Due date**
  - Submit as early as possible – definitely before you start to build the rockets* (so this might need to be submitted well before the PDR is due)
  - If planning to build "late" (i.e. possibly even after getting feedback on your designs through the PDR process), still submit this Draft of Designs no later than 5 p.m. Central Time on Friday, Feb. 11, 2022 (4 weeks before the PDR is due)
- **Contents**
  - This document must include simulation files (OpenRocket or RockSim), as well as basic details about the dimensions and materials to be used for the fins, airframes, and nose cones, connections, commercial altimeter(s) planned for ejections, etc. for all rockets.
  - 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. 11, 2022: 20% Overall Score Reduction**

* You are allowed to build kit-rockets, but not scratch rockets, prior to getting this feedback. However, document all rockets in your Draft of Designs.

Pre-Competition Requirements

Model Rocket Demonstration Flight

- **Purpose**
  - Demonstrate a minimum knowledge of rocketry
- **How to do it**
  - Purchase a model rocket flight kit
  - Assemble it
  - 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 11, 2022 (the PDR due date)
- **Potential Waivers**
  - If your whole team has high-power rocketry experience, you may request a waiver from this requirement from Gary Stroick
  - 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 ones you will use to compete
- **Failure to complete by March 11, 2022: 10% Overall Score Reduction**

Pre-Competition Requirements

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 9, 2022 – also send a copy to the Technical Adviser, Gary Stroick
- Tell your state's Space Grant office to notify the Technical Advisor that they have received and validated the form
- **Failure to complete by May 9, 2022: 10% Overall Score Reduction**

5 Judged Aspects of the Competition

- 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 Designs, the Model Rocket Demonstration Flight, and/or 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 day (or 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, nor included with the team reports.

5 Judged Aspects of the Competition

Preliminary Design (Written) Report (30%)

- Communicate the engineering and design effort
  - Provide detailed designs and diagrams
  - Discuss diversity of techniques to be tried
  - Analysis of predicted performances
  - Analysis of non-"pre-qualified" components
  - Addresses issues raised from Draft of Designs submission, if any
- Estimated Budget
- 25 pages MAX {or 20} [or 30]
- Due by 5 p.m. Central Time on Friday, March 11, 2022

Also: Competition motors order due on this date. Send Gary Stroick a separate e-mail message by this due date explicitly listing the type and number of motors you want to order for the competition fly-off. NOTE: Rocketry vendors typically need 6 to 8 weeks lead time to receive motors, so you should order test-flight motor(s) even BEFORE this PDR due date (like by mid-February, for potential April test flights).

5 Judged Aspects of the Competition

Flight Readiness (Written) Report (15%)

- SHOW the construction and completed rockets
  - Construction pictures, diagrams, etc.
  - Discuss "core" rocket build and changes, if any, made from given instructions
  - Discuss diversity of techniques
- Test Flight(s) (at least 1 test flight of a team-built rocket on a high-power motor – perhaps some L1 cert flights (as L2 cert flight prep) too)
  - Flight Performance Analysis
  - Flight Results Discussion
  - Improvements planned, if any, prior to competition
- Actual Budget
- 25 pages MAX {or 20} [or 30] **(plus "Code Appendix" – no page limit)**
- Due by 5 p.m. on Monday, May 9, 2022

5 Judged Aspects of the Competition

Flight Readiness (Oral) Presentation (15%)

- Communicate the design and engineering effort
- Organization and presentation
- Rocket Construction (especially AV-bay(s))
- VISUAL AIDS
- 10 minutes for presentation for all teams, regardless of the number of rockets built, plus up to 3 minutes for Q & A
- Separate time for safety check and to show judges the inside of your AV-bay(s)
- Saturday afternoon into the evening, May 21, 2022

5 Judged Aspects of the Competition

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:
  - All rockets have successful flights (see above)
  - Timely prep of rockets, starting with cert flights (see details in handbook)
  - See handbook for normalization scoring formulas for teams flying different numbers of rockets
  - Flight disqualification decisions will be announced on the spot (based on observations, not logged data). Flight(s) may be re-tried, as long as the RSO agrees the rocket is safe and there is time in the launch window.

5 Judged Aspects of the Competition

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

- Flight Performance Comparison
  - Actual vs simulated flight performance analysis
  - Graphs, charts, links to posted videos or stills (if any), etc.
  - Performance results; discrepancy discussion; failure analysis, if needed
- 15 pages MAX {or 13} [or 18] **(plus "Code Appendix" – only include if code has changed since FRR – no page limit)**
- Due by 5 p.m. Central Time on Friday, June 3, 2022

Safety Reviews

- 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! If they won't allow a rocket to fly, they will explain why (and may be able to provide suggestions on changes that could be made to try to bring the rocket up to safety-par).**

Judging

- 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 <u>one</u> judge. (States fielding four or more teams may be asked to provide <u>two</u> 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 a member of the Tripoli MN club to serve as "your" judge. Typically judges' travel expenses are reimbursed (at least). Please select and confirm your judge(s) no later than Jan. 31, 2022.

Schedule Summary

- Oct. 1, 2021 – Notice of Intent to Compete (non-binding)
- DUE BEFORE YOU START TO BUILD – Draft of Designs (specs & sim)
- Jan. 31, 2022 – Team registration fee is due (pay $)
- Jan. 31, 2022 – All states' judges identified
- Feb. 11, 2022 – Declaration of Competition Attendance
- Feb. 11, 2022 – Last possible date to get credit for Draft of Designs (specs & sim)
- Mid-Feb. – Recommended latest time to order test motor(s) for April test flights
- March 11, 2022 – 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 before the end of April
- May 9, 2022 – Flight Readiness (Written) Report (FRR) along with Educational Outreach form
- May 21-22, 2022 – Competition (includes Oral FRR) – weather delay date: 5/23**

**Competition organizers reserve the right to shift the competition dates – see handbook p 17.

- June 3, 2022 – Post-Competition Flight Performance (Written) Report (PCFPR)
- June 15, 2022 – Competition Results Announced

$$v_x = v\cos\theta$$

$$v_y = v\sin\theta$$

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

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

Comments or Questions?