

NASA'S SPACE GRANT 2016-2017 MIDWEST HIGH-POWER ROCKET COMPETITION – THE “ADAPTABLE ROCKET” CHALLENGE

(SPRING 2017 COMPETITION LAUNCH
HOSTED BY THE MN SPACE GRANT
CONSORTIUM AND BY TRIPOLI MN)

Informational telecon slides: September 27, 2016
Repeated: January 19, 2017

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 (2015-2016)
 - 18 teams, mostly from the Space Grant “Great (Lakes) Midwest” Region, but open to entire nation
 - MN (4), WI (4), IL (4), IA (2), KS (1), OH (1), NE (1), VA (1)
 - 4 of the teams made progress but ultimately had to withdraw before the competition in May 2016
- 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 January 27, 2017)
- The Registration Fee Covers (on Launch Day):**
 - Competition Flight Data Recorder (one Altimeter Two per rocket) to monitor altitude and other basic parameters
 - Two Competition Motor Reloads & Igniters – Cesaroni*** one I and one J or else one J and one K motor (teams must pay the difference if the two motors chosen cost more than \$100 total)
 - Note: Teams are allowed to bring additional motors, or purchase more at the competition, and fly more than twice

*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, if any, will be announced by December 31, 2016.

**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, 2016.

***The motor vendor might change due to current production issues at Cesaroni. If this occurs the change will be announced no later than December 31, 2016 (i.e. before the registration payment is due).

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 to “get sponsorship.” We are not suggesting to Space Grants what “sponsorship” might mean for them – this is to be negotiated on a case-by-case basis. For example, such 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, 2017 (\$ varies widely)
- (c) building and instrumenting the rocket itself (will vary; perhaps ~\$500-1500)
- (d) paying for motor casings, with closures (depends on the motors selected, ~\$70 to \$150)
- (e) buying motor(s) for the required practice launch and, potentially, additional test launches (~\$50 to \$150).

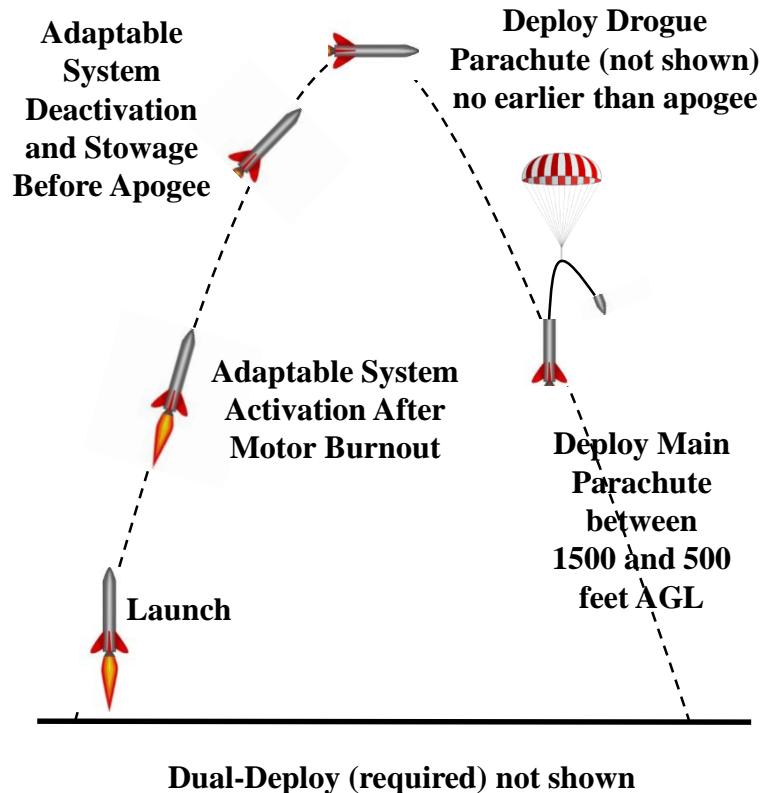
2016-2017 Competition Parameters

The “Adaptable Rocket” Challenge:

Student teams will design and construct an “adaptable” single stage, dual deploy high-power rocket system that will fly to the same highest possible altitude on two motors (one I-class and one J-class, or else one J-class and one K-class) that are as different as possible from one another. The rocket must be recovered safely and in flyable condition. The students must predict the rocket’s flight performance (with each selected motor) and construct a non-commercial on-board data collection package for the rocket that will directly measure velocity versus time, for comparison with data collected by a commercial rocketry altimeter, as well as sense and log airframe separation and parachute extraction from the airframe for both drogue and main parachute deployments, and also collect up and down video from outside the airframe to certify expected (i.e. primary, not backup) drogue and main parachute full deployment. Note that all fabrication work on the rocket (except for possible machining of plastic and/or metal parts) must be performed by students. Modest bonus for going above 3000 feet but stiff penalties for not reaching 3000 feet above ground level on the flight with the lower-power motor.

2016-2017 Competition Parameters

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RULES/CONSTRAINTS

- Two team-selected competition motors that differ in class (and in other ways). Consult with Gary Stroick about motor availability and cost.
- Level 2 or higher certified mentor and faculty adviser both required.
- At least one test flight on at least an I-class motor with adaptable system activated. Additional test flights are highly recommended.
- The adaptable system must be activated after motor burnout and deactivated (and stowed, if anything was deployed) prior to apogee (i.e. prior to the first recovery event).
- Teams must be able to prep their rocket for flight within 1 hour.
- The rocket must be dual deploy (i.e. have two parachutes). The drogue parachute must be fully-inflated post-apogee (but near apogee) – the main parachute must be fully inflated between 1500 and 500 feet above ground level during descent.
- All parts of the recovery system must be electronically deployed using a commercially-available altimeter. However the motor eject must also remain in place as a back-up to the drogue (apogee) deployment.
- One competition altimeter will be provided – an "Altimeter Two."
- Radio-tracking of rocket is optional, but highly recommended.
- Required – non-commercial direct measurement and logging of velocity.
- Required up & down video and logging of parachute deployment state.
- Rocket must have $1 \leq \text{static margin} \leq 5$ at all times on ascent.
- See handbook for formula used to calculate flight score – most important factor is for apogees on the two flights to be as similar as possible.

Pre-Competition Requirements

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Educational Outreach

- ❑ Validated by each State's Space Grant
- ❑ State Space Grant Notifies Technical Advisor
- ❑ Must be completed and submitted no later than May 5, 2017
- ❑ Failure to Complete on time: 10% 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 March 10, 2017 (PDR due date)

▣ Potential Waivers

- If your whole team has high-power rocketry experience, you may request of Gary Stroick a waiver from this requirement
- If you prefer to build and fly a standard (non-competition) high-power rocket instead of a model rocket, that is acceptable

Graded Aspects of the Competition

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

Note 1 – There is a 10% overall reduction if you do not complete the Educational Outreach component of this program.

Note 2 – Written reports are due by e-mail 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.

Five Aspects to 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
- Estimated Budget
- 25 pages MAX
- Due March 10, 2017

Five Aspects to 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 an I-class motor or higher)
 - Flight Performance Analysis
 - Flight Results Discussion
 - Improvements planned prior to competition
- ▣ Actual Budget
- ▣ 25 pages MAX
- ▣ Due May 5, 2017

Five Aspects to the Competition

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Flight Readiness (Oral) Presentation (15%)

- ▣ Communicate the design and engineering effort
- ▣ Organization and presentation
- ▣ Rocket Construction
- ▣ VISUAL AIDS
- ▣ 10 minutes for presentation plus 3 for Q&A
- ▣ Saturday afternoon or evening before the launch
(May 20, 2017)

Five Aspects to the Competition

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Competition Flight (20%)

■ Each successful flight requires:

- Rocket launches, flies vertically, and flies stably all the way to apogee
- Recovery system(s) successfully deployed
- Safely land all parts of rocket under 24 ft/sec
- Recover in re-flyable condition

■ Flight Scoring:

- Successful flight (see above)
- Timely prep of rocket for both flights (no more than 1 hour each time)
- See handbook p. 23 for the detailed scoring formula – points for matching apogees despite having different total impulses (required) and different average thrusts (optional) – penalty for having different launch masses
- Modest bonus for going over 3000 ft and stiff deductions for not going as high as 3000 ft on the lower-impulse motor

Five Aspects to the Competition

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

- Flight Performance Comparison
 - Actual vs simulated flight performance analysis
 - Graphs, charts, stills from up/down videos, etc.
 - Results and discrepancy discussion
- 15 pages MAX
- Due May 31, 2017

Safety Reviews

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- Each team must go through a safety review in their home state prior to coming to the competition launch
- 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 flight itself 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 will be expected to provide one judge.** If you don't have someone from your state you'd like to send to MN for the competition dates, contact Gary Stroick about possibly retaining someone from Tripoli MN to serve as "your" judge. Typically judges' travel expenses are reimbursed (at least). Please identify your judge no later than January 31, 2017.

Schedule Summary

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- Oct 3, 2016 – Notice of Intent to Compete (non-binding)
- Jan 27, 2017 – Formal Team Registration (pay \$)
- Jan 31, 2017 – All states' judges identified
- Feb 10, 2017 – Declaration of Comp. Attendance
- Mar 10, 2017 – Preliminary Design (Written) Report (PDR)
- April 30, 2017 – Test Flight(s) done no later than this date (preferably done well in advance of the end of April)
- May 5, 2017 – Flight Readiness (Written) Report (FRR)
- May 20-21, 2017 – Competition (incl. Oral FRR)
- May 31, 2017 – Post Flight Performance Report (PCPR)
- June 9, 2017 – Competition Results Announced

$$v_x = v \cos \theta$$

$$v_y = v \sin \theta$$

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

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