2016-2017

NASA's Space Grant Midwest High-Power Rocket Competition Handbook (version 2 – posted 1/4/2017)

Informational telecons: Tues. Sept. 27, 2016 (then repeated Thurs. Jan. 19, 2017) from 7 to 8 p.m. CST

(Contact James Flaten, MN Space Grant, for call-in information)

Notice of Intent to Compete: Oct. 3, 2016

(For all institutions, including those not planning to start till the winter/spring.)

Registration Deadline: January 27, 2017

Launch Competition in Minnesota: Sat. & Sun., May 20-21, 2017 (Rain date: Mon., May 22, 2017)

Main contacts:

James Flaten, flate001@umn.edu, MN Space Grant Consortium, U of MN – Minneapolis
Gary Stroick, president@offwegorocketry.com, Technical Advisor, Tripoli MN (High-Power Rocketry Club)

Web site:

http://www.aem.umn.edu/mnsgc/Space_Grant_Midwest_Rocketry_Competition_2016_2017

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Competition Objective

The Space Grant Midwest High-Power Rocket Competition is intended to supply student teams from colleges and universities around the nation with the opportunity to demonstrate engineering and design skills through practical application. Teams will conceive, design, document, fabricate, and fly custom high-power rockets to accomplish specific goals. 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 college/university students that would not otherwise be available in the region.

Rocket Design Objectives

The general objective of this year's "adaptable rocket challenge" is as follows:

> *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 extration 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.*

Judging Categories

Teams will be judged on their engineering acumen including, but not limited to, their design documentation, performance simulation, project construction and aesthetics, test plans and execution, launch and recovery operations including safety, as well as the demonstration of their rocketry knowledge and ability to communicate effectively. Teams will be evaluated based on their design reports, test flight results, presentations, competition flight, post-flight reports, as well as outreach activities.

The total score for each student team will be based on the following parameters. Note: Outreach (described later) is also expected and there will be a 10% overall deduction if not performed before the Flight Readiness (Written) Report due date.

Preliminary Design (Written) Report & Model Rocket Flight Documentation	30%
Flight Readiness (Written) Report	15%
Flight Readiness (Oral) Presentation	15%
Competition Flight Performance	20%

Post-Flight Performance Evaluation and Data Collection (Written) Report	20%
Total	100%

Competition Engineering Parameters

Student teams will be required to design and fabricate a deployment verification system for a high-power rocket. Such a system employs a mechanism to detect that the rocket has separated, the parachute has been extracted from the rocket, and the parachute has successfully opened without the use of any parts that detach from the rocket. Furthermore, the rocket must be designed to fly on two consecutive-class ~~Cesaroni~~[1] motors (one I-class and one J-class, or one J-class and one K-class) while attaining the same altitude with the motor from each class. The rocket must be fin-stabilized with a static margin of one or greater but less than or equal to five during the entire flight and designed to land safely. The rocket must use electronic deployment of a drogue parachute, ejected at or after apogee, and a main parachute, deployed between 1500 and 500 feet above the ground, using a commercial rocketry altimeter. The recovery system must safely land the vehicle at a descent speed not to exceed 24 ft/sec. The motor ejection charge must remain in place, as a back-up to the electronic deployment of the drogue parachute. All structural components and materials 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 minimum of two safe and successful flights under the following conditions (see more details later in the handbook):

1. The external geometry of the rocket may not change between flights and must be identical at launch and apogee (so if anything is deployed to adjust drag, it must be retracted prior to apogee),
2. The initial flight with the I-class or J-class motor establishes the baseline altitude which must be 3,000 ft or greater,

and whose rocket comes closest to achieving the same apogee altitude for both motors, as recorded by a competition-provided flight recorder. Please note that teams may make multiple attempts at each type of flight (smaller and/or larger class motor system) and may select which two flights are to be judged. However rockets must fly with the smaller class motor first, to establish an apogee target to aim for on the larger motor flight(s). Bear in mind that rocket motors may vary ±10% from the manufacturer, so consider designs that can actively compensate for variation in motor impulse from nominal values.

Teams must also construct a non-commercial data collection package for the rocket to directly verify the rocket's velocity versus time (at least), for comparison to the data collected by the commercial altimeter that is controlling the dual deploy ejection charge firings, and to sense and log drogue and main parachute deployment stages in each flight: rocket separation and parachute extraction. Additionally, a video system with up and down views external to the rocket airframe must be used to document the status of the rocket at all times, including seeing the drogue ejection event and inflated drogue parachute followed by the main ejection event and inflated main parachute. Note that in

[1] 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 registration payment is due). – See "Motor Announcement" on next page and posted separately on January 4, 2017.

Inserted page on January 4, 2017:

Motor announcement for the 2016-2017 Midwest High-Power Rocket Competition

As a result of a fire at the Cesaroni plant in March, 2016, subsequent production issues have forced us to modify the requirement to use only Cesaroni motors for the 2016-2017 Space Grant Midwest High Power Rocket Competition. We are relaxing the competition motor requirements and will now allow the use of solid fuel reloadable and single use motors from other manufacturers besides Cesaroni, including AeroTech, Loki Research, and Gorilla Rocket Motors. Note that any combination of motors may be selected from the same or different manufacturers for the I-and-J or the J-and-K motor combination your team decides to use in the competition.

However you should be aware that the use of motors from each manufacturer requires the use of that manufacturer's hardware (such as motor casings and closures), since the hardware is not compatible between them. The one exception is that the 54mm and 75mm diameter Loki Research and Gorilla Rocket Motors hardware is interchangeable, which means that the 54mm and 75mm reloads from either manufacturer will work in the appropriate length case from both manufacturers. Be aware that motors from different companies need to be assembled in different ways and are (typically) more complicated than Cesaroni motors. (Work with your mentor to learn how to assemble the motors you select – motor assembly errors often lead to motor cato events!)

Note that AeroTech "single use" motors (AKA "the AeroTech disposable motor system") don't require external motor cases – they slide directly into the motor-mount tube and have a lip to keep them from going in too far (but they still require motor retention to keep them from coming out). Although such motors are easier to use, the selection of single use motors is more limited than reloadables in the sizes expected for this competition.

Please contact me with any questions. Remember that motor orders for the competition itself must be placed with me (and paid for, if the total cost exceeds the $100 that the registration will cover) no later than March 10, 2017, in conjunction with submitting your PDR. Motors for test flights should be ordered even earlier – from a high-power rocketry vendor such as one who serves high-power launches in your part of the country.

Gary Stroick
Tripoli MN Technical Advisor for the Space Grant Midwest High Power Rocket Competition
phone: 952.201.3002
e-mail: president@OffWeGoRocketry.com

this context "direct" measurement of the velocity precludes calculating velocity from pressure data, accelerometer data, and/or gps data (if available). The commercial altimeter against which the velocity data is to be compared, on the other hand, will probably calculate the velocity indirectly. Be sure to select a commercial altimeter that records velocity versus time for the entire ascent (at least), not just peak values for velocity, accerleration, and altitude.

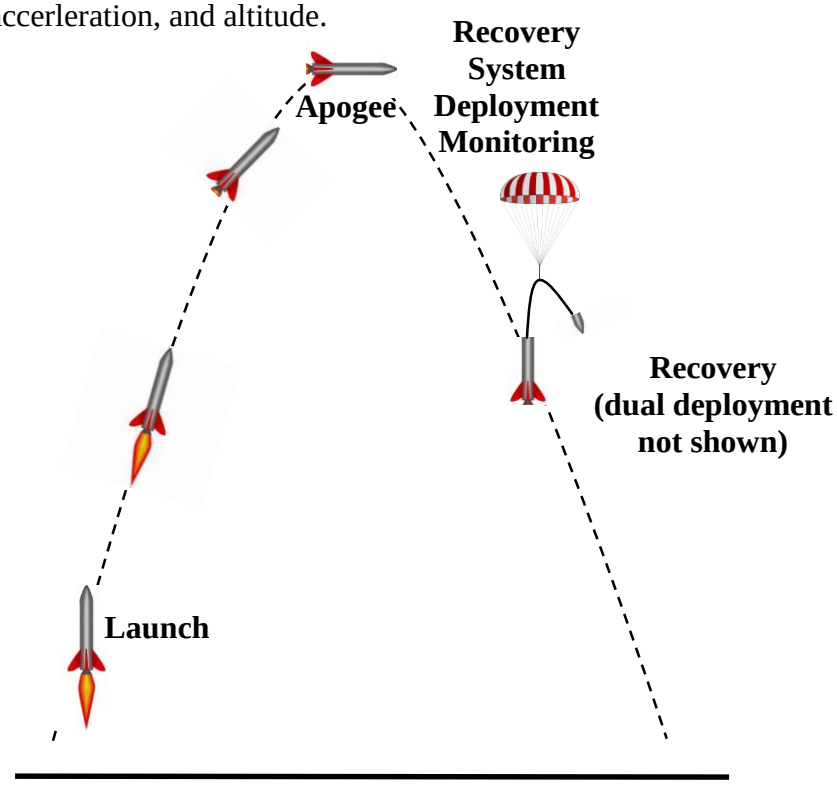


Table 1. Competition Parameters

Flight Mission	Use an adaptable motor system to attain the same altitude on each flight with one I-class and one J-class, or one J-class and one K-class motor. Document the state of the deployment system with your on-board logging system and up and down video. Collect sensor data to measure velocity versus time directly.
Rocket Recovery	⊢ Electronic ejection of a recovery system no earlier than apogee using a commercial rocketry altimeter is required ⊢ Dual deployment recovery system is required ⊢ Motor ejection backup (post-apogee) is required ⊢ Use of Drogue parachute (deployed no earlier than apogee) and Main parachute (deployed between 1500 and 500 feet above the ground) is required ⊢ Landing speed $\leq$ 24 ft/sec.
Rocket Constraints	⊢ Each team must prepare a mounting location for a competition-provided "Altimeter Two" data recorder – make it accessible! ⊢ Each team must be able to fully prepare their rocket for

	flight within **one hour** and fly at least twice during the launch window, which will run from 9 a.m. to 5 p.m. Wait-time in the RSO line will not count against the one hour limit. All rockets are expected to be ready for RSO inspection within one hour of the range opening in the morning. The second one-hour period will begin after the rocket has been recovered, passes a post-flight inspection, and competition flight data has been extracted. Modest point deductions will be made for taking longer than one hour to prep a rocket but DO NOT JEOPARDIZE SAFETY FOR TIME. The way to make this work is to have checklists, assigned roles, and to practice. Be organized and efficient, but don't rush, lest you make mistakes! The last flights of the day need to be in the RSO line no later than 4 p.m. - The static margin of the rocket must be greater than or equal to 1 and less than or equal to 5 during the entire ascent, with deployable drag system (if any) both deployed and stowed. - The thrust to weight ratio for each flight must be no less than 3 to 1 at launch (i.e. at maximum weight). - No deployment of drag devices (if any) until after boost.
Model Rocket Demonstration Flight	- Each team must purchase, assemble, fly, and successfully recover a "model" rocket. Pictures of the team at their launch site with the rocket, before and after their launch, must be included with the Preliminary Design Report. Teams whose members all have previous high-power rocket experience may request a waiver of this requirement from the competition Technical Advisor. Teams may satisfy this requirement by building and flying and successfully recovering a (non-competition) high-power rocket rather than a model rocket if they wish.
Required Pre-Competition Test Flight	- Each team must assemble, fly, and successfully recover their fully-functional competition rocket at least once (on either an I-class or a J-class motor) prior to attending the competition. (Note – teams that do not satisfy this requirement may still compete, but will lose a set amount of points in the Flight Readiness report and oral presentation.) Here "fully-functional" means that the rocket at least has the adaptable motor system and the dual deploy recovery system fully operational and utilized in flight. If you elect not to fly all of your other electronics (e.g., deployment system monitoring video, non-commercial data logger, etc.), replace them with

	dummy weights so the vehicle performance is as realistic as possible. It is recommended, although not required, that the rocket be test-flown on both the planned competition motors. Note: Teams planning to use motors of different diameters might consider using a motor mount tube adapter in their design. Teams are strongly encouraged to fly an Altimeter Two data recorder (the competition organizers will lend you one in advance, upon request) on the test flight(s), to become familiar with how they work.
Rocket Design and Safety Reviews	⇤ Each team, with their rocket, must participate in the Safety Review the day before the competition launch. In addition to a faculty adviser, every team is <u>required</u> to have a non-student mentor with high power rocket experience (a Tripoli or NAR member with a Level 2 or higher certification). This mentor must evaluate the safety of your design both prior to and during the build process, preferably more than once, using a competition-provided checklist. The faculty adviser and rocketry mentor (this potentially could be the same person) are strongly encouraged, though not required, to attend the competition itself in Minnesota in May of 2017. o Analysis of non-"pre-qualified" components must accompany the rocket at the Design Safety Review. ⇤ Each rocket <u>must</u> 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 their competition rocket design/build/fly experience with at least one non-rocketry group of 10 or more. For purposes of this competition, Outreach will be scored simply as "completed" or "not completed". Teams that do not complete the Outreach task and submit the requisite documentation by the scheduled due date, as verified by their state's Space Grant, will receive a 10% deduction from their final score.
Successful Flights	⇤ Launch (at least two flights – first with smaller motor (to establish the base apogee) then with larger motor (to achieve the equivalent-apogee goal)) ⇤ Rocket flies vertically ⇤ Rocket is stable throughout the flight ⇤ Landing descent rate is deemed reasonable (≤ 24 ft/sec) ⇤ All rocket components remain attached together

throughout the flight (e.g. no disassembly or shedding of components)
- Rocket must be recovered in flyable condition

Equipment provided by Competition:

Competition Rocket Motors (two provided; pay more if total cost exceeds $100)	- Teams may select one Cesaroni I-class and one Cesaroni J-class, or one Cesaroni J-class and one Cesaroni K-class motor for competition use. Thrust curve data can be found at: http://www.thrustcurve.org/searchpage.jsp
Radio Tracking	- Optional (but **strongly recommended**) Communication Specialties R-300 (ground) Tracking Receivers will be available to lend out, but teams will need to provide their own on-board radio transmitters. Even though the launch field is on a sod farm, there are woods and fields of deeper crops (corn and soybeans) nearby that rockets sometimes drift into, making them hard to find without radio tracking. See http://www.com-spec.com/rocket/index.html
Competition Flight Data Recorder	- Jolly Logic "Altimeter Two" (just a data logger – not capable of firing ejection charges; has an internal battery) - 1.93" long x 0.64" wide x 0.47" high - 0.24 ounces (6.7 grams) This data recorder will be separate from the team's own required commercial rocketry altimeter that is controlling the electronic deployment system(s). The data logger will be inserted just prior to each launch to record altitude (and other data).

Additional Comments:

Interested students with questions about the capabilities of the launch motors or seeking help in getting started are highly encouraged to contact the competition's Technical Advisor **Gary Stroick** (president@OffWeGoRocketry.com) of Tripoli Minnesota Association (a high-power rocketry association); or a high-power rocket association near them. Students interested in gaining information or experience by observing high-power rocket launches are encouraged to contact Gary or to attend one of the regular high-power rocket launches held in North Branch, MN, by Tripoli MN, or a comparable launch in their state. More information and launch schedules can be accessed at http://www.tripolimn.org and comparable websites.

Competition Schedule

Teams will be required to adhere to the following schedule:

- Late August, 2016 – Announcement of rules
- September 27, 2016, 7 to 8 p.m. CST – Informational telecon (for teams starting in the fall and faculty advisers (at least) who expect to form teams later in the year)
- October 3, 2016 – (Non-binding) Notice of Intent to Compete and "sponsorship" by a Space Grant required of all teams, including those starting later in the school year
- January 19, 2017, 7 to 8 p.m. CST – Repeat of informational telecon (for teams starting in the spring)
- January 27, 2017 – Formal Team Registration and payment of $400* registration fee due (*tentative value – might possibly go up or down (a little) depending on the number of teams that sign up and depending on our success in raising funding from outside sponsors)
- February 10, 2017 – Declaration of Competition Attendance due
    - Specify Number of Team Members Attending Launch
    - Specify Number of Hotel Rooms and Dates Required
- March 10, 2017 – Preliminary Design (Written) Report due (see rubric below)
    - Must include the type and number of motors desired – the registration fee covers the cost of two competition motor reloads for the competition flights costing up to $100 – teams whose two competition motors cost more than $100 total and/or who want to purchase additional motors from Off We Go Rocketry (the vendor that serves Tripoli MN launches) for test flights and/or to try to fly more than twice at the competition must submit the extra funds with this report. Generally speaking, purchasing additional motors are the responsibility of the team and must be purchased from a high-power rocketry vendor and paid for in advance. This report will also include Model Rocket Demonstration Flight documentation
- March and April 2017 – likely times for test flight(s), at least one of a "fully-functional" rocket. However it is strongly recommended that teams conduct test flight(s) **well in advance of the end of April 2017**, early enough to reschedule if weather is not cooperative and also early enough to have time to repair and re-fly the rocket prior to the FRR due date (see below) if things don't go as planned.
- May 5, 2017 – Flight Readiness (Written) Report and Educational Outreach form due
- May 20-21, 2017 – Competition
    - Saturday, May 20 – Mid-afternoon into the evening: Flight Readiness (Oral) Presentations and Safety Checks
    - Sunday, May 21 – Competition launch all day (North Branch, MN) and evening social event with announcement of partial results[2]

[2] At this event we expect to announce, and celebrate, the top team in select categories which may include highest figure of merit (see definition below) and closest-to-identical apogees along with (peer-judged) milestones like "Best Adaptable Design" and "Coolest-Looking Rocket". All teams are strongly encouraged to stay into the evening following the primary launch day so they can attend this event and just in case we need to launch on the alternate/rain date.

    - Monday, May 22 – Alternative competition launch (Rain Date)
- May 31, 2017 – Post-Flight Performance Evaluation and Data Collection Report due
- Final competition results will be reported on or before June 9, 2017.

Note that reports, motor requirements, forms, etc. are due to the Technical Advisor by e-mail at 5:00 p.m. Central Time on the dates specified above. Scores for late reports will be reduced by 20% for each portion of a day that they are late so DON'T BE LATE!

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.

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.	No Limit FAA Waiver Required
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 filed (NOTAM) Between Sunrise and Sunset

Table 3. 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-sec	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

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 (3 m) 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 -- 160.00	G or smaller	N/A	30	30
160.01 -- 320.00	H	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

Design and Safety Review

Endeavoring to have all teams perform their flights in a safe and controlled manner, each team must have a non-student mentor that reviews the design and construction of their rocket in advance of the competition flight by a person holding at least a High-Power Rocket Level 2 Certification with Tripoli or NAR. If you need assistance in finding a rocketry mentor, please contact the competition Technical Advisor and they will help you with this task. A Safety Review Meeting will occur the evening before the competition launch date that will be mandatory for all teams.

The teams must be prepared to discuss the design of their rocket and its systems. In addition, the teams must be able to demonstrate:

- Their rocket in various state of assembly
- A diagram of the rocket indicating the configuration of its main components
- Flight simulation showing max altitude and launch rail departure velocity (speed at 8 ft – should exceed 45 ft/s)
- Commercial rocketry altimeter for ejection charge deployment 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" unexploded deployment charges (if any) and turn off payload (if needed for safety reasons)

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) for each flight 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" unexploded deployment charges (if any) and turn off payload (if needed for safety reasons)

Postflight Check-in

Following the team's competition flights the team must follow their Recover/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

At this check-in the rocket will be inspected and the competition flight data will be downloaded before the rocket is released to be prepped for additional flight(s). The one-hour prep timer (for successful flights only) will start when the rocket is released from this postflight check-in. If a rocket has an unsuccessful flight but is reparable and re-flyable, the timer will begin after the rocket has been repaired – don't rush that!

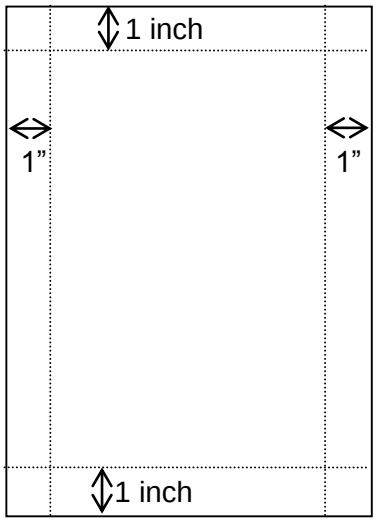
Preliminary Design (Written) Report

Design Report Objective

The purpose of this design report is to evaluate the engineering effort that went into the design of the rocket and how the engineering meets the intent of the competition. The document that illustrates the best use of engineering principles to meet the design goals and the best understanding of the design by the team members will score the highest.

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 12 pt and no less than single-spaced. All 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.



Material that must be included, as a minimum:

- Separate Cover Page (counts toward page limit)
- Team Name, School Name, Team Mentor, Team Faculty Adviser (with contact information including both e-mail and cell phone), Student Team Lead (with contact information including both e-mail and cell phone), and a listing of all Student Team Members – this information can all go on the Cover Page
- Separate Table of Contents page (counts toward page limit)
- Separate Executive Summary page (1 page max, counts toward page limit)
- Design Features of Rocket Airframe including mounting of up/down-looking video
- Design Features of Electronics/Payload (i.e. commercial altimeter, non-commercial system to measure velocity and monitor recovery deployment state, etc.)
- Diagram of Rocket Identifying the dimensioned locations for the:

    - CP (center of pressure)
    - CG (center of gravity with the fully loaded rocket motors)
- Analysis of the Anticipated Performance (for both motors) – including how each were estimated
    - Estimated Maximum Altitude
    - Estimated Peak Velocity
    - Estimated Peak Acceleration
    - Plot of Estimated Velocity vs. Time
- Budget (planned, including (value of) Registration fee and Competition Travel)

Evaluation Criteria

Reports and design will be evaluated on content, organization, clarity, completeness, and professionalism of the material. The criteria are detailed in Appendix A-1 "Preliminary Design Report Judging."

Scoring Formula

The scoring of the Preliminary Design Report is based on the average of the Preliminary Design Report Judging forms. There is a maximum of 100 points from the Preliminary Design Report Judging form that will be scaled for the final competition weighting.

Flight Readiness (Written) Report

Flight Performance

The team will report on the success of the test flight(s) including, but not limited to, the deployment system monitoring (if on-board) plus the recovery system operation (as viewed from the ground, at least). Comparison of the fight performance to the predicted performance shall also be included, to demonstrate the team's knowledge and understanding of the physics involved. This will be presented in the form of a brief report which shall include a discussion of the results, especially any differences between the actual and the predicted values.

Test Flight Format

The test flight document should follow the same formatting guidelines as the Preliminary Design Report, no more than twenty five (25) pages in length, and must be submitted electronically in *.pdf* format.

Material that must be included, as a minimum:

- Separate Cover Page with information requested for PDR (updated, if need be) (counts toward page limit)
- Separate Table of Contents page (counts toward page limit)
- Summary of Design (keep this to 5 pages or less)
- Budget (actual; with comments about changes since planned budget)
- Construction of Rocket (include photos)
- Explicit discussion of the parachute deployment monitoring system. Explain how it works, show photos of it "in action" (in lab), describe the logic used to when certain stages are achieved during a flight.
- Photographs of Completed Rocket and Test Flight(s)
- Test Flight(s) Report
  - Flight Performance
  - Recovery System Performance
  - Table of Flight Characteristics (mass, motor, max altitude, max velocity, …)
  - Plot of Altitude, Velocity, and Acceleration vs. Time – both estimated and actual (from your commercial altimeter, at least, and as many as possible from your own non-commercial sensor system, if flown)
- Discussion of Results
  - Compare predicted and actual apogees, describe and defend possible reasons for differences
  - Compare predicted and actual peak velocities (from the commercial altimeter and the non-commercial system, if flown) and peak accelerations, describe and defend possible reasons for differences
  - Performance of the on-board up/down video and deployment state monitoring system (optional, but encouraged – test flight(s) without up/down video and/or the deployment state monitoring are allowed, but only as long as the dual deployment recovery system is fully operational)
- Planned changes/improvements (if any) prior to the competition flights

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-2 "Flight Readiness Written Report Judging."

Scoring Formula

The scoring of the Flight Readiness Written Report is based on the average of the Flight Readiness Written Report Judging forms. There is a maximum of 100 points from the Flight Readiness Written Report Judging form that will be scaled for the final competition weighting.

Educational Outreach

Educational Outreach Performance

An “Educational Outreach” element, in which each team presents information related to their work on this competition with a non-rocketry group of at least 10 people, is expected. For purposes of this competition, outreach will be scored as "completed" or "not completed." Outreach possibilities could include, but are not limited to:

- Meet with a K-12 class or student organization to explain how rockets work (including your rocket design).
- Make a presentation in the community or to a group on campus to describe this rocket competition and your team’s design.

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 (located on the last page of this document) that the team must then submit to their state’s Space Grant and to the competition organizers.

Scoring Formula

Teams that do not complete the Educational Outreach and submit their EPO form by the due date will receive a 10% decrease in their team’s overall score.

Flight Readiness (Oral) Presentation

Presentation Format

In the late afternoon or evening of the first day of the competition one or more team members will deliver the oral presentation to a panel of judges. 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. All team members who are part of this "presentation group" may answer the judge's questions, even if they did not present material during the presentation itself.

Presentations are limited to a maximum of ten (10) minutes. The judges will stop any presentation exceeding eleven (11) 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 (at first). 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 asked by the audience, a designated official will determine if the question is appropriate and, if so, 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. The scoring criteria are detailed in Appendix A-3 "Flight Readiness Oral Presentation Judging." The criteria are applied only to the team's presentation itself. The team that delivers the best oral presentation, regardless of the quality of their actual rocket, will score highest for the oral presentations.

Scoring Formula

The scoring of the Oral Presentation is based on the average of the Oral Presentation Judging forms. There is a maximum of 100 points from the Oral Presentation Judging form that will be scaled to meet the final competition weighting.

Competition Flight

Launch and Flight Format

The launch will take place at a site determined by Tripoli Minnesota (near North Branch, MN, which is about a one hour drive north of Minneapolis and St. Paul). Each rocket must pass a safety inspection before each flight 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 or, minimally, proper placement and arming will be verified by such officials. Since Altimeter Twos can time out if they don't detect a launch soon enough after they are armed, be sure to design your rocket so the Altimeter Two can be armed and inserted easily just before launch (and is accessible enough to be re-armed easily, if need be). No more than five team members per Tripoli member may attend to 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.

All rockets must be designed so that they can be prepared for flight within one hour. Therefore, the following additional requirements are in effect:

- All teams must present their rockets in ready to fly condition to the RSO within one hour of the end of the on-site launch briefing. The specific time will be announced on site but this will be approximately 10:15 a.m. on flight day.
- Upon completion of providing flight data with the flight operations recorder, the time will be recorded and the team must again present their rocket in ready to fly condition to the RSO within one hour of that time.
- Teams that do not meet these pre-time requirements will be allowed to fly but will be subjected to modest late-flight penalties.
- Wait time in the RSO line does not count against the 60 minutes.

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

- Launch
- Rocket flies vertically (launch rail vertical at launch)
- Rocket is stable throughout the ascent
- Recovery system (both drogue and main) is successfully deployed
- Descent rate is deemed reasonable (≤ 24 ft/sec)
- All rocket components remain attached throughout the flight (e.g., no disassembly or shedding of components)
- Rocket must be recovered in flyable condition
- Note: Failure to log data and/or collect video will <u>not</u> in and of itself constitute a failed flight if the conditions above are met. For example, there will not be an explicit deduction or disqualification if any part of the recovery system is ejected successfully by the motor back-up or an electronic back-up rather than by the primary electronic system. A dual-deploy rocket that lands safely, even if the parachutes didn't deploy exactly as planned, will <u>not</u> be subject to immediate disqualification, but will sustain a point deduction.

The stability condition (i.e. "static margin of one or greater but less than or equal to five") is a <u>safety</u> rule and applies from launch to apogee. Safety decisions (associated with

stability among others) will be made by the launch-site judges. If need be, the judges may use "instant replay" (i.e. ground video footage of the launch and/or on-board footage from the rocket itself) to assist them in making their decision. Rockets (or parts thereof) that go unstable during ascent, even unintentionally, will be subject to disqualification on safety grounds, even if they aren't actually damaged.

Flyable condition is defined to be that if the flyer were handed another motor, the rocket would pass RSO inspection and could be put on the pad and flow again safely.

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 flights will based on:

- Having safe flights
- Having successful flights and recoveries, as defined above
- Minimizing the separation apogee between your smaller and larger motor system flights, as described below

Scoring Formula

Teams will score points based on the following formulas:

$$\text{Figure of Merit (FM)} = Apogee_{avg} * \frac{\left(\frac{Total\ Impulse_{max}}{Total\ Impulse_{min}}\right) * \left(\frac{Avg\ Thrust_{max}}{Avg\ Thrust_{min}}\right)}{\left(\frac{Apogee_{max}}{Apogee_{min}}\right)^2 * \left(\frac{Initial\ mass_{max}}{Initial\ mass_{min}}\right)}$$

Flight Score = 0 (AKA disqualification) if rocket is not recovered in flyable condition or if the flight is deemed "unsafe" or in violation of competition rules, even if the rocket is undamaged. This is at the judges' discretion. Rockets may be disqualified for events like unstable ascent, too-fast descent, not deploying recovery systems, etc. Rockets that are disqualified may be launched again later in the day if the disqualification issue can be resolved to the RSO's satisfaction.

Flight Score (if not disqualified) = 10 points for timely flights (loss of 2 points per 15 minutes over 60 minutes of prep time for either flight)

PLUS

20 points (10 points each for completing two safe flights)

PLUS

$$70 * \left(\frac{FM_{your\ rocket}}{FM_{competition\ max}}\right)$$

POTENTIAL PLUS

Bonus points (up to 10) for lower power launch apogee over 3000 ft (see below)

POTENTIAL MINUS

Deducted points (up to 100, so this can even carve into points awarded for safe and timely flights) for lower power launch apogee below 3000 ft (see below)

This means that rockets will benefit from having motors that differ as much as possible in both total impulse and average thrust and rockets will also benefit from going as high as possible (definitely at least 3000 feet for each flight). But there is a penalty for not having the two flights go to the same altitude (and notice that this ratio is squared!) and also for changing the mass between flights (i.e. just using extra internal mass (which is allowed) to slow the rocket down on the second flight).

Notice that no less than 30 points will be awarded to rockets that are prepped in a timely manner and safely complete at least two flights (to at least 2000 feet – see below) and are recovered in flyable condition. There is a maximum of 100 points (plus potential bonus points) from the Competition Flight that will be scaled for the final competition weighting. If a rocket is flown more than twice during the competition, the best flights will count (even if one or more flights are disqualified). However there is a finite launch window and the Tripoli MN members running the launch might not allow launching a rocket that appears to them (in advance) to be fundamentally unsafe, so don't expect to bend the safety limits nor bet too heavily on the prospect of flying more than twice.

Any team reaching an apogee on their lower-power motor higher than 3,000 feet above ground level will have a one point bonus added to their score for every 200 feet, up to a maximum of 10 bonus points. Any team reaching an apogee on their lower-power motor less than 3,000 feet above ground level will receive a one point deduction from their score for every ten feet below 3,000 feet, up to a maximum of 100 deducted points (i.e. disqualification if the rocket does not reach at least 2000 feet above ground level).

Post-Flight Performance Report

Performance Comparison

The comparison of the fight performance to the predicted performance will help to demonstrate the team's knowledge and understanding of the physics involved. It will be presented in the form of a brief report that will include a "Flight Performance Comparison Sheet" and discussion of the results, especially any differences between the actual and the predicted values.

Performance Comparison Format

The performance comparison document should follow the same guidelines as the Preliminary Design Report, no more than fifteen (15) pages in length, and must be submitted electronically in *.pdf* format.

Material that must be included, as a minimum:

- Separate Cover Page with information requested for PDR (updated, if need be) (counts toward page limit)
- Flight Performance Comparison Sheet
  - Table of Flight Characteristics (mass, motor, max altitude, max velocity, max acceleration, etc.)
  - Plots of Velocity vs Time from commercial and non-commercial systems
  - Deployment System State vs Time
  - Screenshots (at least a few) from up/down video system and link to where full videos can be viewed on-line (e.g. posted to YouTube)
- Discussion of Results
  - Compare predicted and actual apogees, describe and defend possible reasons for differences
  - Compare predicted and actual peak accelerations and peak velocities. (Note: the Altimeter Twos will give peak acceleration and peak velocity, and other performance characteristics), describe and defend possible reasons for differences
  - Compare predicted and actual velocity vs time graphs from all sources
  - Optional – discuss other (optional) sensor data that was collected during the flight

Evaluation Criteria

Reports will be evaluated on how closely the predicted results compare to the actual results and how well actual values from various sources agree with one another, how well the team explains any differences, as well as clarity, completeness, and professionalism of the material. The criteria are detailed in Appendix A-4 "Post-Flight Performance Report Judging."

Scoring Formula

The scoring of the Post-Flight Performance Report 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 for the final competition weighting.

APPENDIX A-1

PRELIMINARY DESIGN REPORT JUDGING

Score the following categories according to the following scale (any number or fraction along this scale may be used).

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

_____ **OVERALL TEXT RELEVANCE (15 pts)**

- Executive Summary (5 pts)
- Overall description of rocket functions (5 pts)
- Design fit to competition objectives (5 pts)

_____ **ROCKET MECHANICAL & ELECTRICAL DESIGN (25 pts)**

- Airframe and Propulsion System Specifications (with dimension) (5 pts)
- Recovery System Design Specifications (5 pts)
- Avionics/Payload System Design Specifications (5 pts)
- Planned Construction Solutions & Techniques (5 pts)
- Structural Analysis of Scratch-Built Parts and Overall Risk Mitigation Analysis (5 pts)

_____ **PREDICTED PERFORMANCE (25 pts)**

- Launch Analysis (5 pts)
- Flight Analysis (peak altitude, peak velocity, peak acceleration, etc.) (5 pts)
- Recovery Analysis (5 pts)
- Stability Analysis (5 pts)
- Environmental Conditions Analysis (5 pts)

_____ **SAFETY (20 pts)**

- Designed for Safe Flight & Recovery (5 pts)
- Documented Material-Handling Procedures (5 pts)
- Planned Assembly Procedures (5 pts)
- Planned Pre- & Post-Launch Procedures (5 pts)

_____ **REPORT AESTHETICS (15 pts)**

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

_____ **TOTAL PRELIMINARY DESIGN REPORT POINTS (100 points maximum)**

COMMENTS:

APPENDIX A-2

FLIGHT READINESS WRITTEN REPORT JUDGING

Score the following categories according to the following scale (any number or fraction along this scale may be used).

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

_____ **RECAP OF ROCKET DESIGN (25 pts)**

- Design and Dimensions (5 pts)
- Construction Techniques (5 pts)
- Stability Analysis (5 pts)
- Constructed for Safe Flight & Recovery (5 pts)
- Discussion of Changes Since Preliminary Design Report (5 pts)

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

- Launch and Boost Phase Analysis (4 pts)
- Coast Phase Analysis (including drag modification attempts, if any) (8 pts)
- Recovery System and Descent Phase Analysis (8 pts)
- Pre- & Post-Launch Procedure Assessment (5 pts)

_____ **TEST LAUNCH ACTUAL VS PRED. PERFORMANCE (35 pts)**

- Peak Altitude Comparison to Expectations (10 pts)
- Peak Velocity and Peak Acceleration Comparison to Expectations (5 pts)
- Velocity versus Time Comparison to Expectations (10 pts)
- Video and Data Logging of Rocket State – Performance and Comparison to Expectations (10 pts) (if intentionally not flown, discuss ground testing instead)

_____ **FINDINGS AND FUTURE WORK (10 pts)**

- Key Findings (5 pts)
- Potential Design Improvements (5 pts)

_____ **REPORT AESTHETICS (5 pts)**

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

COMMENTS:

APPENDIX A-3

FLIGHT READINESS ORAL PRESENTATION JUDGING

Score the following categories according to the following scale (any number or fraction along this scale may be used).

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

_____ **ENGINEERING & DESIGN CONTENT (35 pts)**

- Discussion of Engineering Methodology (5 pts)
- Use of Design Tools (5 pts)
- Thorough Presentation of Custom Rocket Design and How It Addresses Competition Objectives/Requirements (15 pts)
  Note – team must discuss all their rocket's hardware but is allowed not to divulge their engage/disengage logic (if any) orally – that is covered in their written FRR
- Use of Analytical Data – Comparison of Test Flight(s) Performance to Expectations (5 pts)
- Description of Construction Techniques (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 (2 pts)
- Use of Supporting Physical Materials (2 pts)
- Appropriate Use and Formatting of Slides (2 pts)

_____ **ROCKET APPEARANCE (5 pts)**

- Visual Appearance (2 pts)
- Quality of Construction (3 pts)

_____ **COMMUNICATION SKILLS (20 pts)**

- Articulation (4 pts)
- Eye Contact (4 pts)
- Verbal Projection (4 pts)
- Body Language/Poise/Presence (4 pts)
- Adherence to Time Constraints (4 pts)

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

- Active Listening Skills (3 pts)
- Answer Relevance/Correctness (5 pts)
- Response Confidence/Persuasiveness (2 pts)

TOTAL ORAL PRESENTATION POINTS (100 points maximum)

COMMENTS:

APPENDIX A-4

POST-FLIGHT PERFORMANCE REPORT JUDGING

Score the following categories according to the following scale (any number or fraction along this scale may be used).

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

_____ **ROCKET OPERATION ASSESSMENT (30 pts)**

- Flight Anomalies Analysis (10 or 0 pts)
  {If no anomalies, then points are distributed to remaining subsections}
- Propulsion System Assessment (4 or 6 pts)
- Flight Trajectory (Mostly Coast Phase) Assessment (4 or 6 pts)
- (In-flight) Recovery System Assessment (4 or 6 pts)
- Ground Recovery Assessment (4 or 6 pts)
- Pre- & Post-Launch Procedure Assessment (4 or 6 pts)

_____ **ACTUAL VS PREDICTED PERFORMANCE (35 pts)**

- Peak Altitude Comparison to Expectations (10 pts)
- Peak Velocity and Peak Acceleration Comparison to Expectations (10 pts)
- Velocity vs Time Data Collection and Comparison to Expectations (15 pts)

_____ **DEPLOYMENT/RECOVERY SYSTEM DATA COLLECTION AND ANALYSIS (20 pts)**

- Deployment Monitoring Data Presentation (5 pts) (other sensors too, optional)
- Up/Down Video Images and Links to Posted Flight Videos (5 pts)
- Data Interpretation and Comparison to Expectations (10 pts)

_____ **REPORT AESTHETICS (15 pts)**

- Followed Specifications (3 pts)
- Professionally Written (6 pts)
- Accurate Representation of Events (6 pts)

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

COMMENTS:

2016-2017 NASA's Space Grant
Midwest High-Power Rocket Competition
Education/Public Outreach Documentation Form

The Minnesota Space Grant Consortium (MnSGC), on behalf of NASA, would like to thank you for giving our Midwest High-Power Rocket Competition participants a chance to provide educational outreach to 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, so your willingness to let them present to you is appreciated.

One main goal of Space Grant activities nationwide 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."[1] Space Grant Consortia in every state promote science, technology, engineering, and math (STEM) fields through educational opportunities for college/university students, such as this rocket competition. We are also grateful for your involvement in this mission. If you have any questions about the Midwest High-Power Rocket Competition or about NASA's Space Grant program, please contact the MN Space Grant Consortium (MnSGC), which is running this competition, by writing to mnsgc@umn.edu, or else contact your state's Space Grant Consortium directly. Web sites can be found at:

http://www.nasa.gov/offices/education/programs/national/spacegrant/home/Space_Grant_Consortium_Websites.html

Activity 1 (required)

Name of Organization	Supervisor Name	Phone or e-mail
Duration of Activity (hrs)	Signature	Date
Approx. # of Attendees	Brief descrip. of attendees	Brief decrip. of activity

Activity 2 (optional)

Name of Organization	Supervisor Name	Phone or e-mail
Duration of Activity (hrs)	Signature	Date
Approx. # of Attendees	Brief descrip. of attendees	Brief decrip. of activity

1 – Source: *Explanatory Guide to the NASA Science Mission Directorate Education & Public Outreach Evaluation Factors*, Version 3.0, April 2008