



**Wisconsin  
Space Grant  
Consortium**

**2010  
Collegiate Rocket  
Competition**

## Competition Objective

The Wisconsin Space Grant Consortium's (WSGC) Collegiate Rocket Competition is intended to supply teams of WSGC affiliated university students with the opportunity to demonstrate engineering and design skills through direct application. It allows the teams to conceive, design, fabricate and compete with high powered rockets. 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 the students that would not otherwise be available in the state of Wisconsin.

### ***Rocket Design Objectives***

The objective of the WSGC 2010 Collegiate Rocket Competition entries can be stated simply as:

Engineering teams will compete to design a single stage, heavy-lift rocket with the goal of reaching an altitude of at least 1500 ft. with the largest mass.

### ***Judging Categories***

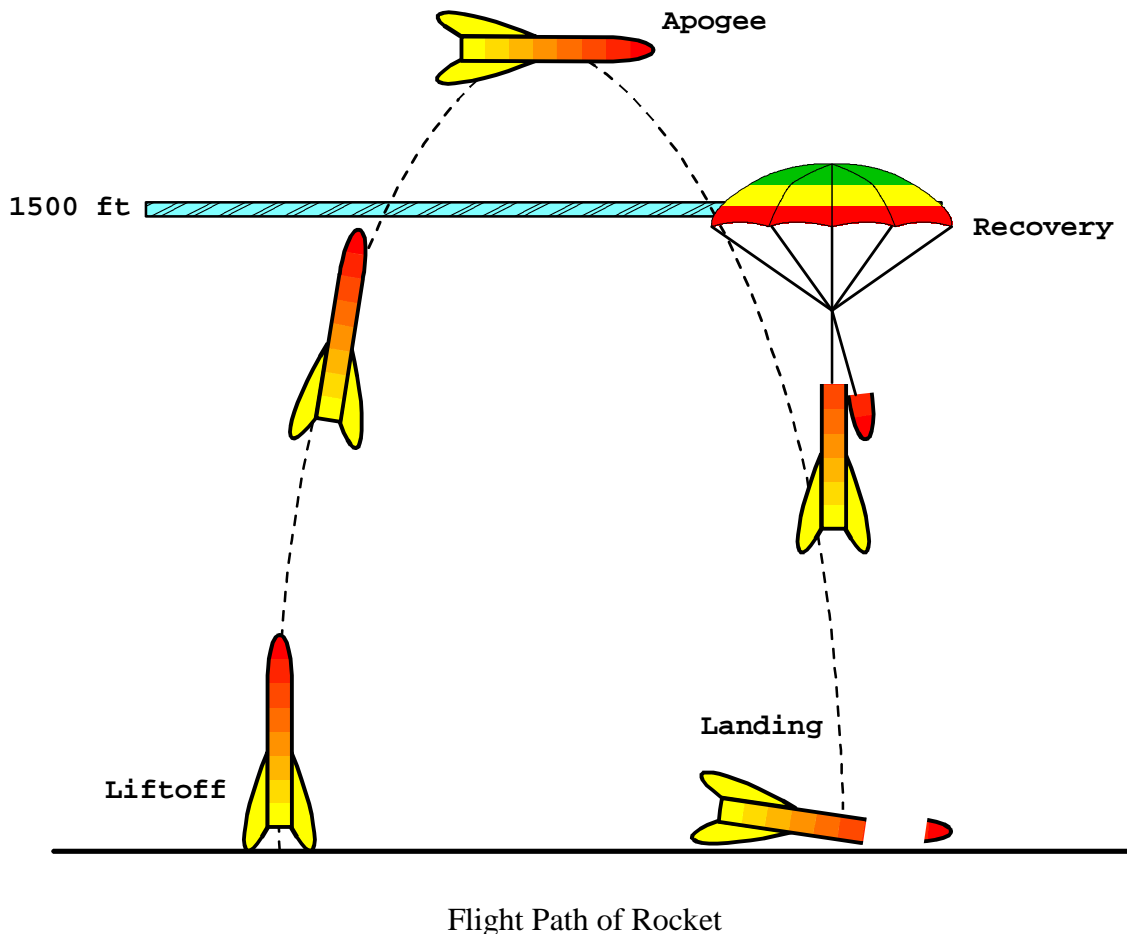
To truly evaluate the engineering behind the designs, the teams will be judged on the performance of their design, the demonstration of their knowledge and their ability to communicate effectively. This will be accomplished in four parts; a presentation to a selected group of judges, the flight of the rockets, an examination of predicted vs. actual performance for the acceleration of the rockets, and a design report.

The total score for each student team will be based on several parameters:

|                                          |            |
|------------------------------------------|------------|
| Presentation of design                   | 15         |
| Design report (provided prior to launch) | 25         |
| Competition Flight                       | 45         |
| Flight Performance Evaluation            | 15         |
|                                          | _____      |
| <b>Total</b>                             | <b>100</b> |

## Competition Engineering Parameters

Supplied with a K1100 rocket motor (provided by WSGC), student teams will be required to design and fabricate a suitable single-stage, heavy-lift rocket. The rocket must attain a minimum altitude of 1500 ft. and be recovered safely and in flyable condition. All parts of the rocket must be recovered together using an electronically deployed parachute recovery system.



The winner of the flight portion of the competition will be the team whose rocket completes a successful flight and has the largest total mass without the motor installed.

Other parameters include:

- |                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Model Rocket<br>Demonstration<br>Flight | <ul style="list-style-type: none"> <li>➤ 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 budget submittal.</li> <li>➤ Examples: Estes Alpha, Quest Astra or comparable model rocket kit.</li> </ul>                                                                                                                                   |
| Rocket<br>Construction                  | <ul style="list-style-type: none"> <li>➤ Materials for the construction of the rocket must be “pre-qualified” by obtaining it from a high-powered rocketry equipment supplier or an engineering analysis must be supplied showing the level of safety for each component of the rocket.</li> </ul>                                                                                                                                                                                         |
| Rocket Safety<br>Inspection             | <ul style="list-style-type: none"> <li>➤ Each team, with their rocket, must participate in the Safety Review meeting approximately one month before the competition launch.               <ul style="list-style-type: none"> <li>○ Analysis of non “pre-qualified” components must accompany the rocket at the Safety Review</li> </ul> </li> <li>➤ Each rocket <u>must</u> pass the Range Safety Officer’s Inspection the day of the launch, before it will be allowed to fly.</li> </ul> |
| Successful Flight                       | <ul style="list-style-type: none"> <li>➤ Launch</li> <li>➤ Minimum altitude of 1500 ft. must be attained before apogee</li> <li>➤ Parachute recovery must be deployed electronically</li> <li>➤ All parts of the rocket must be recovered together</li> <li>➤ Rocket must be recovered in flyable condition</li> </ul>                                                                                                                                                                     |

Equipment provided by WSGC:

- |                         |                                                                                                                                                                                                                                                                                        |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rocket Motor            | <ul style="list-style-type: none"> <li>➤ K1100 <a href="http://www.thrustcurve.org/motorsearch.jsp?id=358">http://www.thrustcurve.org/motorsearch.jsp?id=358</a></li> </ul>                                                                                                            |
| Flight Data<br>Recorder | <ul style="list-style-type: none"> <li>➤ R-DAS Tiny <a href="http://www.aedelectronics.nl/rdas/tiny.htm">http://www.aedelectronics.nl/rdas/tiny.htm</a></li> <li>➤ (inserted at time of launch to record acceleration &amp; altitude vs. time)</li> <li>➤ 1.1 in. x 3.5 in.</li> </ul> |

**Additional Comments:**

Interested students with questions about the capabilities of the launch motors or seeking help in getting started are highly encouraged to contact **Frank Nobile** ([Maxq3@aol.com](mailto:Maxq3@aol.com)) or **Bob Justus** ([bob@mhbofni.com](mailto:bob@mhbofni.com)) of Tripoli Wisconsin Association (a high-power rocketry association). Students interested in gaining information or experience by observing rocket launches are encouraged to contact these individuals, or to attend one of the regular rocket launches held by Tripoli at Bong Recreational Area. More information and launch schedules can be accessed at <http://www.tripoliwisconsin.org>.

**The official website for the competition information can be found at:**

<http://tinyurl.com/WSGC-Rockets>

## **Presentation**

### ***Presentation Format***

One or more team members will deliver the presentation to the 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. Team members who are part of this "presentation group" may answer the judge's questions even if they did not speak during the presentation itself.

Presentations are limited to a maximum of ten (10) minutes. The judges will stop any presentation exceeding ten 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 five (5) minutes. Only judges may ask questions. 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 taken from the audience, a designated presentation official will determine if the question is appropriate and if so then 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-1 "Presentation Judging". The criteria are applied only to the team's presentation itself. The team that makes the best presentation, regardless of the quality of their rocket, will win this event.

### ***Scoring Formula***

The scoring of the Presentation is based on the average of the Presentation Judging forms. There is a maximum of 60 points from the Presentation Judging Form that will be scaled to meet the 15% of the competition total score.

It is intended that the scores will range from near zero (0) to fifteen (15). In the event of multiple judging teams, the Presentation Event Captain may at his/her discretion normalize the scores of different judging teams.

$\text{PRESENTATION SCORE} = 15 \times P_{\text{your}}/P_{\text{max}}$ .

Where:

- "Pmax" is the highest score awarded to any team
- "Pyour" is the score awarded to your team

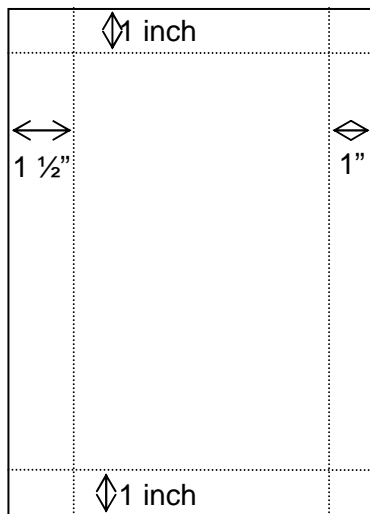
## Design Report

### ***Design Report Objective***

The concept of the design report is to evaluate the engineering effort that went into the design of the heavy-lift rocket and how the engineering meets the intent of the competition. The rocket that illustrates the best use of engineering 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 12pt in height. The left margin must be no less than 1 inch and the remaining 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.



Material that must be included, as a minimum:

- Cover Page
- Table of Contents
- Executive Summary
- Design Features of Rocket
- Diagram of Rocket Identifying the dimensioned locations for the:
  - CP (center of pressure)
  - $CG_1$  (center of mass with the fully loaded rocket motor)

- $CG_2$  (center of mass after motor-burnout)
- Analysis of the Anticipated Performance – including how each were estimated
  - Estimated Maximum Altitude for the Rocket
  - Estimated Peak Acceleration
  - Plot of Estimated Acceleration vs. Time
- Construction of Rocket (include photos)
- Photographs of Completed Rocket
- Conclusion
- Budget

### ***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-2 “Design Judging”.

### ***Scoring Formula***

The scoring of the event is based on the average of the report judging forms. There is a maximum of 100 points from the Design Judging Form that will be scaled to meet the 25% of the competition total score.

It is intended that the scores will range from near zero (0) to twenty five (25). In the event of multiple judging teams, the Presentation Event Captain may at his/her discretion, normalize the scores of different judging teams.

PRESENTATION SCORE =  $25 \times P_{\text{your}}/P_{\text{max}}$ .

Where:

- “ $P_{\text{max}}$ ” is the highest score awarded to any team
- “ $P_{\text{your}}$ ” is the score awarded to your team

## Competition Flight

### ***Launch and Flight Format***

The launch will take place at a site determined by Tripoli Wisconsin Association. Each rocket must pass a safety inspection before launch 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. The RSO will have discretion over the number of team members that attend 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.

To be considered a successful flight, the rocket must:

- launch
- attain an altitude of at least 1500ft before apogee
- electronically deploy a recovery parachute attached to all parts of the rocket
- safely land
- be recovered in flyable condition.

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 initial acceptance before a copy will be released to the team.

### ***Evaluation Criteria***

Finishing order for of the competition flight will based on:

- Successful flight and recovery
- Mass of rocket without rocket motor.

First in order will be the rocket with a successful flight, and the largest mass without rocket motor.

### ***Scoring Formula***

Teams will score points based on the formula:  $50 - 3 * (\text{Finish order} - 1)$ , but no more than 40 points will be awarded to unsuccessful flights and no less than 15 points will be awarded to rockets that safely launch.

## Flight Performance

### ***Performance Comparison***

The comparison of the flight 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 Design Report and be no more than four (4) pages in length.

Material that must be included, as a minimum:

- Cover Page
- Flight Performance Comparison Sheet
  - Table of performance characteristics (Table 1)
  - Plot: "Acceleration Performance Comparison of Predicted and Actual" (Figure 1)
- Discussion of Results
  - Separate headings for each characteristic discussed

### ***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-3 "Flight Performance Judging".

### ***Scoring Formula***

The scoring of the Flight Performance is based on the average of the Flight Performance Judging forms. There is a maximum of 100 points from the Design Judging Form.

It is intended that the scores will range from near zero (0) to fifteen (15). In the event of multiple judging teams, the Presentation Event Captain may at his/her discretion, normalize the scores of different judging teams.

PRESENTATION SCORE =  $15 \times P_{\text{your}}/P_{\text{max}}$ .

Where:

- "Pmax" is the highest score awarded to any team
- "Pyour" is the score awarded to your team



**APPENDIX A-1**

SCHOOL \_\_\_\_\_

Team \_\_\_\_\_

**PRESENTATION JUDGING**

Score the following categories on the basis of 0-10 points each according to the following scale (any number or fraction along this scale may be used).

- 0.0 = inadequate or no attempt
- 2.5 = attempted but below expectation
- 5 = average or expected
- 7.5 = above average but still lacking
- 10 = excellent, perfectly meets intent

\_\_\_\_\_ **CONTENT:** Were the concepts presented appropriate and adequate to explain how the boosted-dart rocket meets the intent of the contest? Were enough technical details presented without being boring?

\_\_\_\_\_ **ORGANIZATION:** Were the concepts presented in a logical order progressing from basic concept and showing how the engineering accomplished the concept? Was it clear to the audience what was to be presented and what was coming next? Were distinct introduction and overviews as well as summary and conclusions given?

\_\_\_\_\_ **VISUAL AIDS:** Were visual aids used or clear visual references made to the rocket? Were the illustrations visible for all of the audience?

\_\_\_\_\_ **ROCKET APPERANCE:** Does the rocket have the appearance of being well constructed? Were the illustrations visible for all of the audience?

\_\_\_\_\_ **DELIVERY:** Did the presenter speak in a clear voice? Did the presenter show enthusiasm and promote confidence in the technical aspects? Did he/she maintain eye contact?

\_\_\_\_\_ **QUESTIONS:** Did their answers illustrate that the team fully understood the questions? Is there doubt that the team understood their answers? Did the team promote complete confidence in their response to the questions?

**TOTAL = PRESENTATION POINTS (60 points maximum)**

COMMENTS:

## APPENDIX A-2

SCHOOL \_\_\_\_\_ Team \_\_\_\_\_

### DESIGN JUDGING

\_\_\_\_\_ **AESTHETICS (0-15)** - Does the rocket look attractive? Does it have a high performance appearance?

\_\_\_\_\_ **ROCKET MECHANICAL & ELECTRICAL DESIGN (0-20)** - Do components appear to have been sized properly for the loads? Does form follow function? Where all “pre-qualified” components (those purchased from recognized high-powered rocketry suppliers) indicated? Were the analysis included for components not pre-qualified?

\_\_\_\_\_ **ANTICIPATED PERFORMANCE (0-20)** – Do the anticipated performance values make sense? Is there enough evidence to verify the methods used and the resulting values?

\_\_\_\_\_ **INNOVATIVENESS (0-15)** - Are any of the components or systems unique? Do the innovations add to the rocket's functions?

\_\_\_\_\_ **SAFETY (0-10)** - Is the rocket designed to function in accordance with the safety guidelines supplied? Does the rocket require any “special” preparation that if not performed properly might compromise its safety?

\_\_\_\_\_ **MISCELLANEOUS (0-20)** – Is the report complete? Is it professional in its appearance and presentation of the information? Does it accurately represent the work that was done? Did the project meet the intent of the competition?

\_\_\_\_\_ **TOTAL = DESIGN POINTS (100 points maximum)**

COMMENTS:

### APPENDIX A-3

SCHOOL \_\_\_\_\_ Team \_\_\_\_\_

#### FLIGHT PERFORMANCE JUDGING

\_\_\_\_\_ **OPERATION of Rocket (0-30)** – Did the rocket function properly?  
Explain

\_\_\_\_\_ **MAXIMUM ALTITUDE (0-25)** – How closely does the anticipated altitude match the actual values? Was there a reasonable explanation for any difference?

\_\_\_\_\_ **PEAK ACCELERATION (0-20)** – How closely does the anticipated peak acceleration match the actual values? Was there a reasonable explanation for any difference?

\_\_\_\_\_ **MISCELLANEOUS (0-25)** – Is the report complete? Is it professional in its appearance and presentation of the information? Does it accurately represent the work that was done?

\_\_\_\_\_ **TOTAL = FLIGHT PERFORMANCE POINTS (100 points maximum)**

COMMENTS: