

**Getting Started: a quick introduction to hobby rocketry**  
brought to you by  
**Tripoli Central Virginia Prefecture**

**Too many options...**

The AIAA YP competition rules are intentionally loose to allow teams the maximum flexibility in achieving the contest goals. But it does mean that the myriad options for reaching the goals can be a bit bewildering. This document will attempt to offer some solutions to help your team get started. Please keep in mind that these are not the recommend, or necessarily even optimal, way to design an entry for the competition. But if your team needs some guidance in getting started then this is for you.

**Reference Material**

Estes Industries has a number of documents for download on their <http://www2.estesrockets.com/cgi-bin/wedu001P.pgm?p=publicat> page. The third item "Model Rocketry Technical Model [sic]" is an excellent overview "manual" for smaller rockets.

Stine's "Handbook of Model Rocketry" (<http://www.questaerospace.com/itemdesc.asp?ic=9502>) is the official handbook of the National Association of Rocketry.

The book "Modern High Power Rocketry" is available through <http://modernhpr.com/> and is a good starter guide to larger hobby rockets.

<http://www.rocketryforum.com/> is a good online forum.

**Find a Mentor**

It is important to find local mentors and a local club flying field. You will find it much easier to get started if you don't have to deal with locating a safe flying field and maintaining your own launch equipment. <http://www.nar.org/> and <http://www.tripoli.org/> are the national model rocket organizations in the USA. Their web sites include listing of local clubs. Contact your local club and start attending launches as soon as possible.

**Start Flying Early**

If your team has little experience with hobby rocketry then you should plan to start flying some introductory models as soon as possible. Try to pick a "skill level 1" model from any of the kit manufacturers. The Estes "Big Bertha" (<http://www.estesrockets.com/store/001948-big-berthar.html>) is only one of many possibilities.

There are also several introductory "egg loft" kits. The Quest "Courier" (<http://www.questaerospace.com/itemdesc.asp?ic=2011>) or Estes "Eggscalibur"

(<http://www.estesrockets.com/store/002123-eggscalibertm.html>) will give you valuable experience in flying a chicken egg.

The simplest altimeter that meets the requirements for the competition is one the products from the <http://jollylogic.com/> company. A rocket such as the Quest “Gamma Ray” (<http://www.questaerospace.com/itemdesc.asp?ic=2004>) might make a good test vehicle.

All these examples are primarily design for smaller (18mm and 24mm diameter) black powder motors. <http://www.valuerockets.com/> is one source for 18 and 24mm “composite propellant” motors that provide a significant increase in total impulse over the black powder motors. These come as “single use” motors that are disposed of after a single flight and “reloadable” motors where a reusable aluminum casing is purchased and propellant kits can then be bought. Aerotech’s catalog at <http://aerotech-rocketry.com/products.aspx> provides a nice overview to reloadable motor technology.

### **Sometimes larger is easier...**

Those smaller rockets have significant advantages due to their low cost to build and low cost to fly. But sometimes it can be a challenge to “miniaturize” your rocket and it might be easier to fly something a bit larger. Or, perhaps, your team already has significant hobby rocket experience and wants to fly a larger rocket for the challenge. And, of course, larger rockets mean more real estate for displaying sponsor logos!

The “Excel” series of rockets from <http://binderdesign.com/> might be a good starting place.

Be warned that use of 38mm and larger motors will require at least one team member to be a member of NAR or Tripoli and to complete a “high power certification” process. More details are available at the <http://nar.org/hpcert/NARhprintro.html> pages and from your local rocket club.

### **Advanced Altimeter Usage**

The StratoLogger (<http://perfectflite.com/>), Raven (<http://www.featherweightaltimeters.com/>), and ARTS2 (<http://www.ozarkaerospace.com/>) altimeters can all control the deployment of your rocket’s recovery system. While this is an advanced technique, it is fun, and can be very useful for reducing the wind drift of your rocket during landing.

You will need extra airframe parts for your rocket and <http://binderdesign.com/> sells a “Dual Deploy kit for 3.9” diameter rockets” that is a nice complement to their 4” diameter “Excel” series of rockets. Or the “Excel 38mm with Dual Deploy kit” or that package with a 54mm motor mount would make a great platform for electronic parachute recovery.

Electronic recovery requires the use of a low current electrical initiator and a small amount of pyrogen to deploy the parachute. The <http://www.questaerospace.com/items.asp?Cc=igniter> Q2G2 igniters could be a good choice of initiator. Aerotech sells “ejection charge kits” at [http://www.valuerockets.com/product\\_details.aspx?pid=14&itemid=67](http://www.valuerockets.com/product_details.aspx?pid=14&itemid=67) that are a source for the required parachute deployment pyrogen. When using advanced recovery techniques such as altimeters it is imperative that your team ground test the function of all electronics and the deployment charges as thoroughly as practical. Be careful with pyrotechnic products! Eye protection is a good idea and be careful of ignition sources such as cigarettes, cellphones, and loose batteries. Store all flammable products in a safe, secure, place. And follow all regulations about motors and accessories.

And for larger rocket motors it is important that the motor be securely retained inside the rocket. For smaller rockets and motors it is acceptable to use some form of tape to either friction fit or wrap the end of the motor and the end of the rocket together. Binder Design sells “Kaplow Clips” that will fit over the end of your motor to hold it into the rocket. Or the products from [http://www.aeropack.net/motor\\_retainers.html](http://www.aeropack.net/motor_retainers.html) are very nice.

### **Understanding flight characteristics**

The behavior of your rocket is very important from both a flight safety as well as a performance perspective. Even a small rocket with an unstable flight profile can be dangerous. And understanding the altitude your rocket will reach is fundamental to both contest performance and to staying within FAA mandated altitude limitations.

One major safety contributor is the velocity that your rocket reaches before departing the guidance launch rail. The second is having a reasonable relationship between the Center of Gravity (Cg) and the Center of Pressure (Cp) of your rocket. These, to a large extent, will determine if you have a stable or unstable flight profile.

In general the Cg (or fully loaded balance point) of your rocket should be one body diameter (caliber) ahead of the Cp. Your team is required to supply a safety summary package and one of the required reports is a calculated Cp from one of the

- RASAero (<http://www.rasaero.com/>)
- RockSim (<http://www.apogeerockets.com/rocksim.asp>)
- SpaceCAD (<http://spacecad.com/>)

software packages. These packages will also help you pick motors and rocket weights to optimize your rocket’s altitude.

When you have much more than one caliber of stability, the rocket will tend to tilt into the wind when it departs the launch rail. This can adversely affect safety as well as affect your final altitude. When the Cg is less than one caliber ahead of the Cp the fins will not have much restorative affect on the flight profile. And a Cg

behind the  $C_p$  will result in a rocket going unstable as soon as it departs the launch rail.

The rule of thumb is that a rocket should be moving at least 45 feet per second when it departs the launch rail for the fins to be effective. This is an estimate for relatively low (perhaps five MPH) wind speeds. As the rocket's Angle of Attack increases (i.e. as the wind increases at launch) the  $C_p$  of the rocket will move forward, decreasing the stability of the rocket. Increasing the speed at which the rocket departs the rail will help mitigate this as the AoA will be decreased by an increased rocket velocity relative to the wind.

The software packages mentioned are very good at calculating  $C_p$ . It is useful to mark your rocket with its  $C_p$  so that you can visually compare that to the balance point of your rocket before each flight.

These packages are not so good at calculating final weight and  $C_g$  or at estimating the Coefficient of Drag ( $C_d$ ) which is critical to estimating the rocket's final altitude. Always measure the final, as built, weight of your rocket and use those numbers in your simulations. And always measure the final, as built,  $C_g$  of your rocket and use that number in your simulations as well. Estimating a  $C_d$  of 0.75 is not unreasonable. Compare the results of your simulations with the results reported by your on board altimeters and refine your rocket's  $C_d$  from there.

This is an incredibly brief summary of a fascinating subject. Stine's *Handbook of Model Rocketry* should be your next stop.

### **In Summary**

There are lots of ways to solve the challenges presented by the AIAA Region I competition. It is unclear whether smaller, highly optimized, rockets will carry the day over larger, potentially more robust, vehicles. What is clear is that sensible engineering followed by lots of flight practice is critical. An experienced mentor from your local rocket club will help you.

Please feel free to contact us with any questions, for more guidance in getting started, or in finding a local mentor. Have fun!

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## **Resources**

Find a launch or mentor:

- [www.nar.org](http://www.nar.org)
- [www.tripoli.org](http://www.tripoli.org)

Launch site sponsor: <http://battlepark.org/>

[www.rocketryforum.com](http://www.rocketryforum.com) particularly the “getting started information” in <http://www.rocketryforum.com/forumdisplay.php?f=41> and the list of vendors in <http://www.rocketryforum.com/showthread.php?t=110>

[www.rocketryonline.com](http://www.rocketryonline.com)  
[www.rocketryplanet.com](http://www.rocketryplanet.com)  
[www.jcrocket.com](http://www.jcrocket.com)

### **Rocket simulation software:**

RASAero: <http://www.rasaero.com/>  
RockSim: <http://www.apogeerockets.com/rocksim.asp>  
SpaceCAD: <http://spacecad.com/>

### **Altimeter Suppliers:**

<http://www.perfectflite.com/>  
<http://www.featherweightaltimeters.com/>  
<http://www.ozarkaerospace.com/>  
<http://www.jollylogic.com/>

### ***Invited* Finals competition on site motor vendors:**

<http://performancehobbies.com/>  
<http://www.thedragonshoard.com/>