

Staging and Clustering From Mongoose to N1

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- I. Basic Clustering
 - A. Safe distances

Use the distance for the class of motor that is one step greater than the total impulse class of the cluster you are flying.
 - B. Motor positioning

Motors in the cluster should be grouped as close to the center axis of the rocket as possible. This keeps the thrust close to the center line and prevents uneven thrust if a motor fails to ignite. Recommended method for people new to clustering.
 - C. Number of motors

Two or three are recommended to start. Black powder (Estes) motors easiest to cluster. Keep it simple in the beginning.
 - D. Thrust-to-weight

When starting, use a rocket that will fly safely in the event of a motor failing to ignite. If using two motors, allow a minimum of 4:1 thrust to weight with one motor.
 - E. Ignition
 1. Adequate launch equipment

The launch platform needs to be able to support the weight and liftoff force of the clustered rocket. Use a launch rod longer than normal. This allows the rocket to build up speed in the event that a motor is slow to ignite or come up to pressure. Use launch leads that are long enough to reach close to the top of the launch rod, but not past the top of the rod. This will prevent the rocket from dragging the leads with it past the end of the rod, altering the flight direction.
 2. Whip clips

Whip clips should be constructed from Teflon wires. Teflon insulation melts at a much higher temperature and holds up far better than PVC insulation in the thrust stream. Stainless steel clips are best but very hard to find and expensive. Nickel plated (Chrome) are good also. The hard chrome finish holds up well and cleans up easily. Copper are worst for durability. Hard to clean and they oxidize heavily after being exposed to the thrust. Solder the clips and the junction of the wires. Protect the clips with boots. Clean the whip clip after each use.
 3. Flash pan

Not a wise idea for reliable ignition. This can burn the airframe and is very likely to fail. Do not over-do the powder, you want to light the motor, not blow the pad up.
 4. Thermolite / Canon fuse

Fairly reliable. A great and simple system for doing airstarts of black powder motors. Hold the fuse into the nozzle with a small piece of tissue paper. Check the burn rate of the fuse prior to using it.
 - F. Ejection system

Make sure you light the motor that is responsible for ejection on the ground
- II. Motor types
 - A. Black Powder Motors
 1. Igniter installation
 2. Igniter plugs
 3. Ignition lead connection
 - B. Composite Motors
 1. Aerotech
 2. Pro 38

- C. Igniter selection
 - 1. Continuity and resistance check
 - 2. Total current calculation
- D. Igniter installation
 - 1. Multiple igniters
 - 2. Embedding igniters into the grains
 - 3. Pyrogen the grain surface

III. Advanced Clustering

- A. Clusters and staging, getting them all lit
 - 1. Low current igniters
 - 2. Onboard battery / relay system
- B. Wide spaced clustering
 - 1. Ignition a must
 - 2. Safety "hold down" thread
- C. Vectored Thrust
 - 1. Thrust-to-weight considerations
 - 2. Choosing a thrust angle
- D. Canted / Spin thrust
 - A little angle gets you a LOT of spin

IV. Basic Staging

- A. Impulse – got enough?
- B. CG/CP considerations
- C. More than one stage?
- D. Black powder to black powder
 - Chad staging
 - 1. Retaining motors together
 - 2. Distance between motors – good ignition
- E. Composite to black powder
 - 1. Motor delay – selecting the right timing
 - 2. Ejection / ignition charge

V. Advanced Staging

Composite to Composite

- A. Motor selection
- B. Igniter selection
 - Making sure the second stage lights
 - 1. Electronics
 - 2. Explosive staging
 - 3. Recovery systems