INTRODUCTION & OUTLINE

Both the parachute and streamer duration are easy and fun to fly events. However, the number of disqualified flights is surprisingly high and the performance of many models resembles the performance of sport-flying models. In this short presentation all the parts of the flight trajectory of PD/SD model will be discussed and a typical model and operations will be presented.

- PD/SD rules in plain English
- Flight trajectory of PD/SD model
- Phases of flight trajectory
  - Takeoff
  - Boost and coast
  - Ejection and deployment
  - Descend
  - Landing and return
- Thermals
- Additional tips
- Discussion

PD & SD RULES

Rocket: Single stage vehicles only. 2 models allowed.

Parachute: Multiple parachutes are allowed.

Streamer: Single streamer only. Streamer is a continuous (no holes) strip of material attached to the rocket at one point only (no yokes). Width to length ratio at least 1:5. Can be crumpled or pleated but cannot be cut or slit.

Wadding: the only part that can separate from the rocket.

Ejection plugs: considered to be a wadding.

Separation: if the rocket separates (shock cord breaks), flight is disqualified. Motor must stay with the rocket too.

Score: total duration of all qualified flights.

Multiround: each contestant can fly three times but can use only two models. If the contestant loses both two models in first two flights, third attempt is not possible.

Returns: one return is required. If all flights are qualified and no rocket is returned, contestant gets flight points only (cannot place in the event).

For exact wording of the rules for these events see the Pink Book (paragraph 30–31).

FLIGHT PHASES

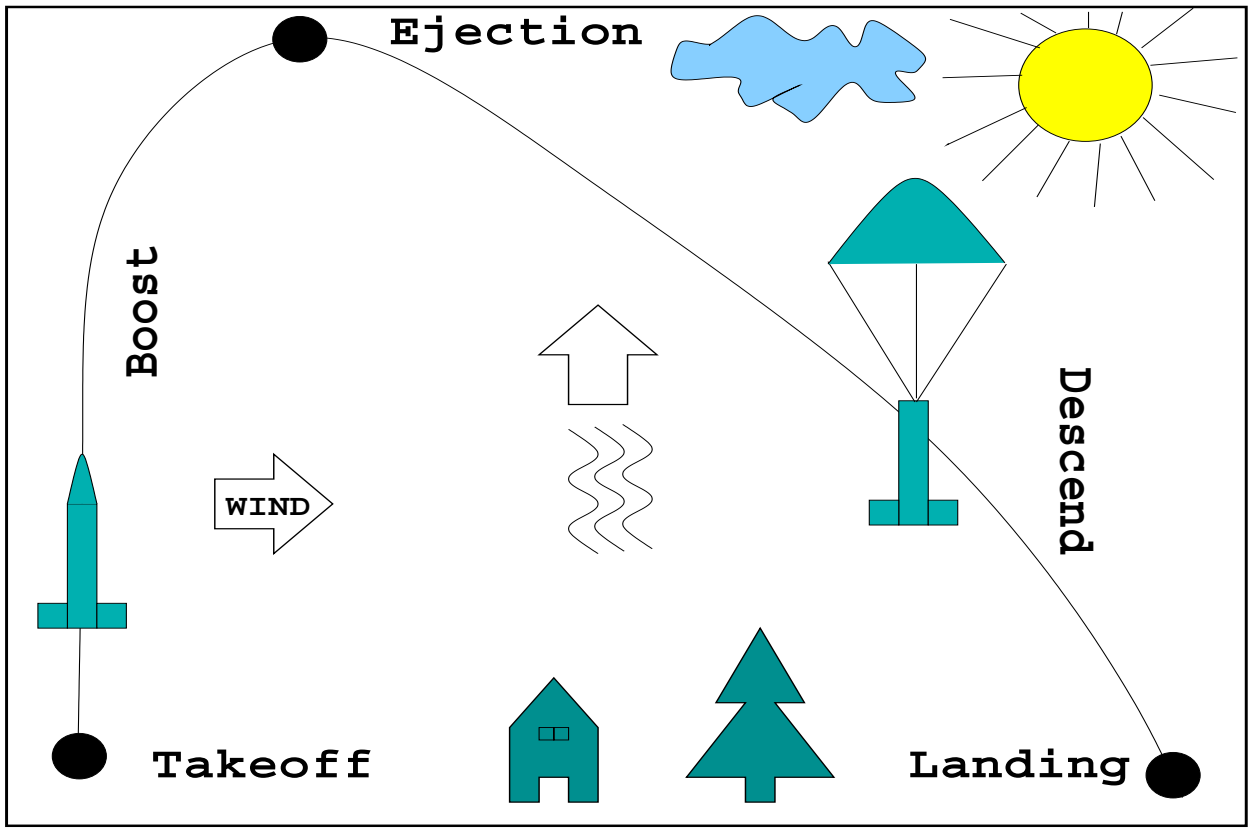
Takeoff: the rocket starts moving and leaves the launch pad.

Boost: the rocket flies under power and then unpowered until the ejection charge fires. (Coast is considered to be a part of boost for now.)

Ejection: Ejection charge fires, a recovery device is pushed out from the rocket and deployed.

Descend: Slowed by its recovery device, the rocket falls back to the ground.

Landing: Rocket touches the ground, is found and returned.



TAKEOFF

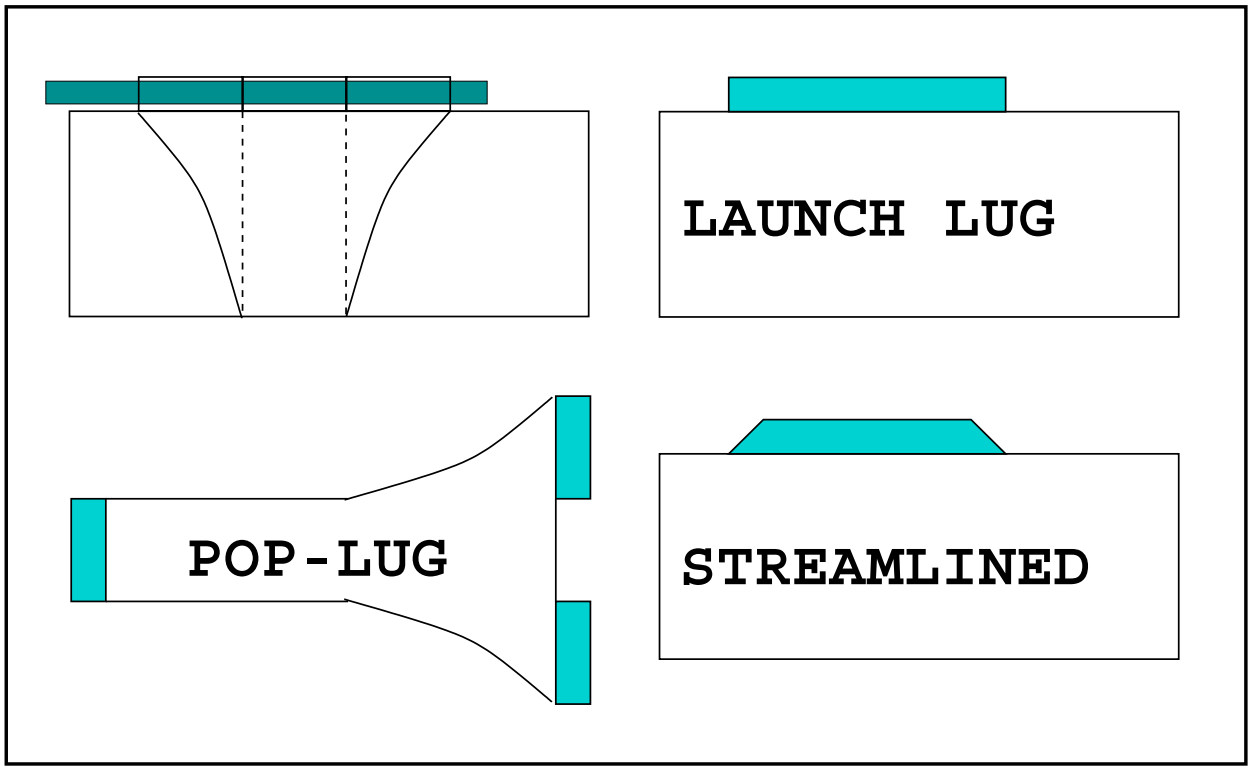
GOAL: *Get the rocket to the air, get a good start*

Launch lug: contributes to total drag by almost **35**%(!)

Launch tower: Eliminates launch lug. If not available:

- Streamline the launch lug and/or place it in the fin-body joint.
- Use a pop-lug (pop-lug falls off when the rocket leaves the launch rod).

Pistons: by the use of a piston you can increase the altitude achieved by 5%. However, pistons are seen more often in the altitude events.



BOOST

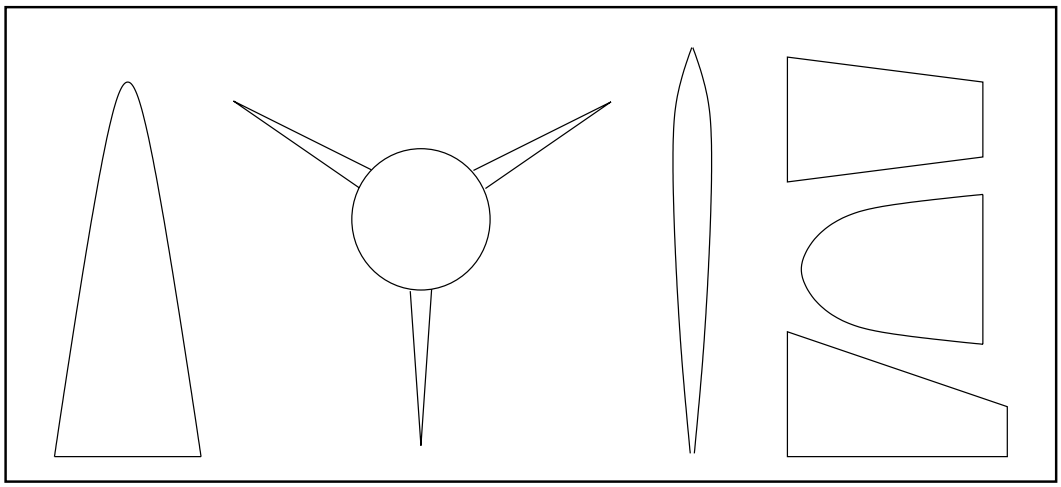
GOAL: *Gain a good altitude*

Fins: three fins are enough. Use elliptical, clipped delta or trapezoidal fins, with a symmetric airfoil profile. Sand the fins as smooth as you can, make sure they are glued straight.

Nosecone: use a balsa or lightweight plastic nosecone of parabolic shape. Sand the balsa nosecone as smooth as possible.

Motor: a low thrust motor will bring the rocket higher. In the case of windy weather, a high thrust motor will ensure a stable boost. Use your judgment.

Body tube: minimum diameter model for PD or SD, boat-tailed design for PD. Optional: vellum tube (ultralight).



EJECTION & DEPLOYMENT

GOAL: *Eject and deploy a recovery device*

Ejection: do not pack a chute or streamer too tight. You should be able to blow out the recovery device out of rocket. If not, repack or use smaller device.

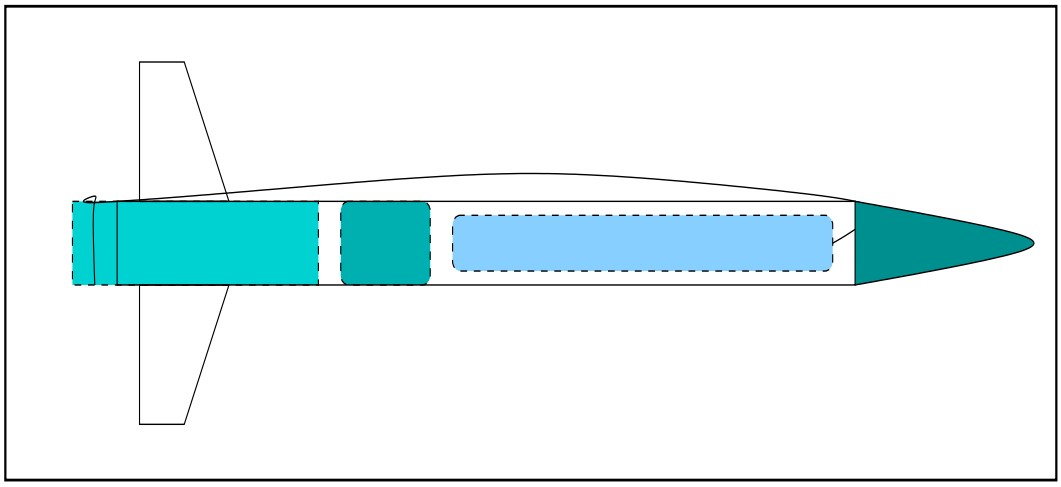
Protect chute or streamer: use enough wadding. Even better than wadding is an ejection plug.

No separation: use an external shock cord.

No spitting: use the "Apogee Lariat Loop" and masking tape to hold the motor inside the rocket.

Packing: roll the streamer, Z-fold the chute. NEVER WRAP SHROUD LINES AROUND CHUTE!

Deployment: dust the chute with talcum powder before packing. Powder will prevent the chute from sticking.



RECOVERY DEVICES

GOAL: *Equip rocket with working recovery device*

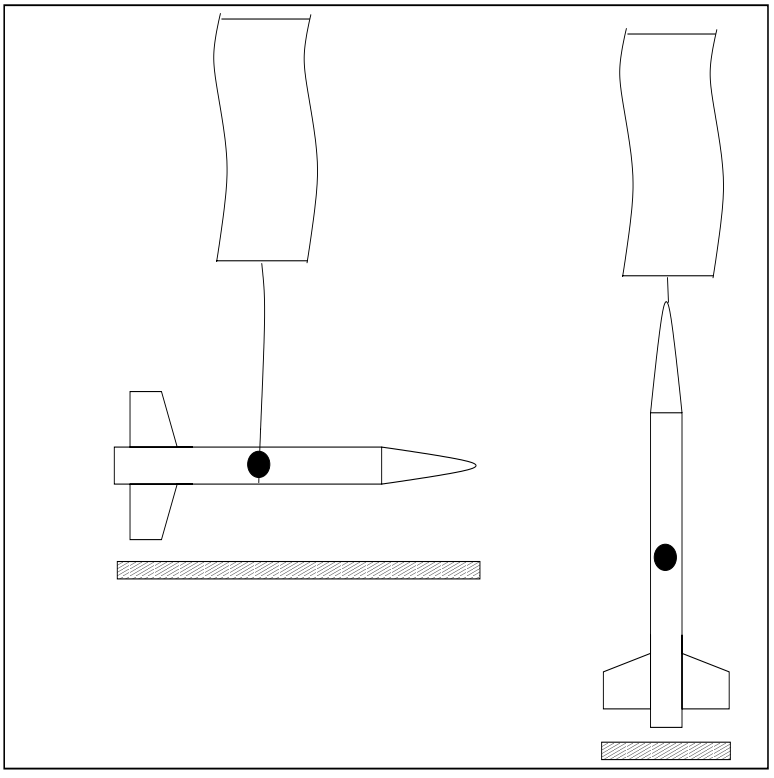
Color: dark color is the best. A large recovery device is much more easy to spot on the sky than a small rocket.

Chute materials: 0.25mm mylar, 0.35mm kitchen bags or 0.25mm paint drops (MENARDS, Paint Section).

Streamer material: crepe paper (high friction) or Mylar.

Shock cord: Kevlar. At least 200% of rocket length.

Rocket drag: mount the external shockcord at the CG of rocket.



DESCEND WITH A CHUTE

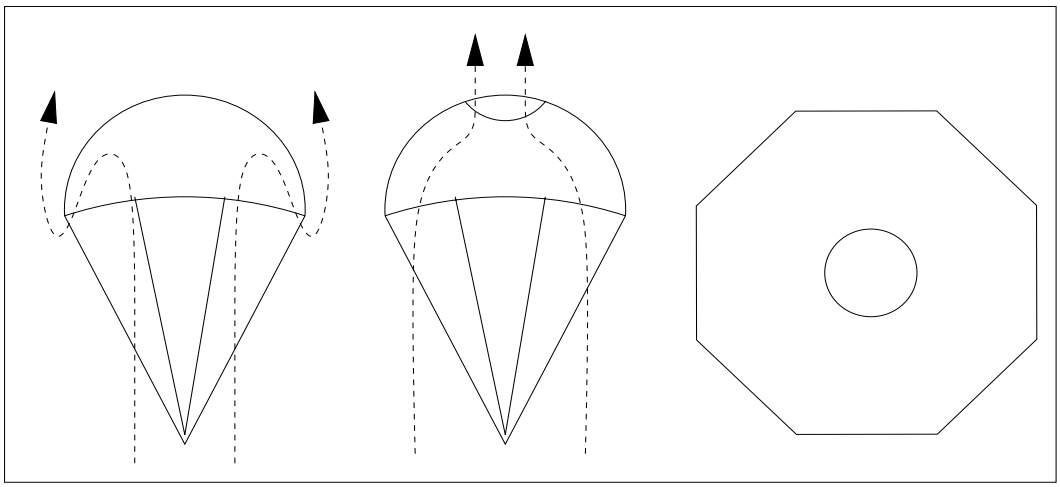
GOAL: *Keep aloft as long as possible*

Number of shroud lines: The drag coefficient of a chute grows with the number of shroud lines. However, a higher number of shroud line makes chute hard to pack and manage. 8 shroud lines seem to be an optimal number.

Length of shroud lines: 150%–200% of a chute diameter is an optimal length. Longer lines will not provide any improvement and are hard to manage.

Size and shape of chute: Use the size you can pack comfortably into tube. Octagonal chute is effective and easy to handle. Practice chute packing often.

Stabilizing vent: The circular hole in the top of chute provides a vent which makes the chute more stable.



DESCEND WITH A STREAMER

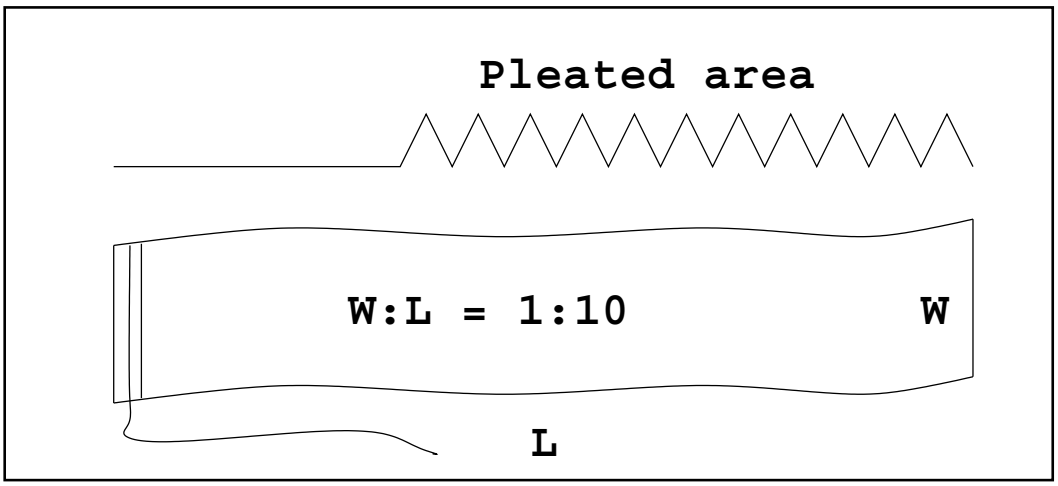
GOAL: *Keep a loft as long as possible*

Streamer dimensions: 10:1 length to width ratio seems to be an optimal ratio.

Pleating the streamer: At least half of the streamer should be folded in the strips about 3/8 of inch wide. This will add great amount of drag and will induce vigorous streamer flapping which will slow the descend.

Streamer material: Everybody believes in something else. Mylar seems to be a good choice.

Shock cord: Roll shock cord around the packed streamer. A large amount of energy is consumed for unrolling after the ejection, which helps to absorb the shock.



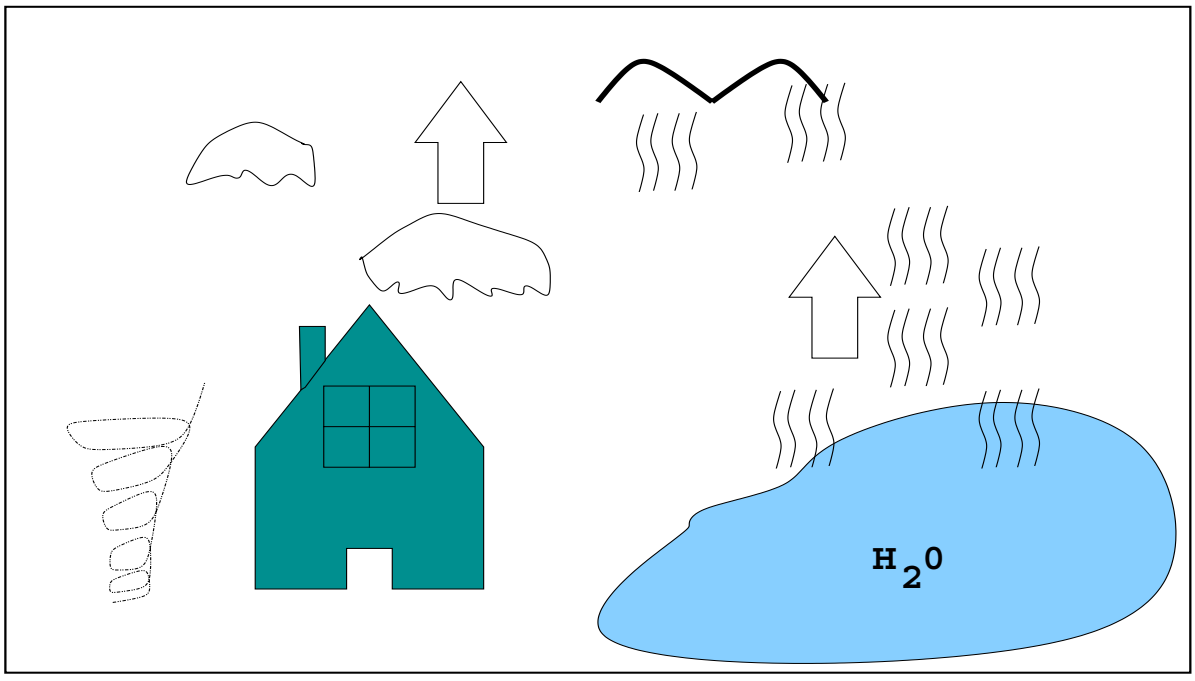
THERMALS

Thermals: are invisible, warm currents or bubbles in the air. They rise up and a rocket caught in the thermal may stay aloft much longer (or fly away completely).

Where to find them: above metal roofs, water surfaces (at the afternoon), above the dark areas of dry ground and anywhere else.

How to find them: look how the rockets of other competitors behave. The rocket in the thermal will "hang" in the air.

Other clues: air vortices may mean that thermal is around. Some birds like to "bathe" in the thermals. Look for birds hanging in the air without flapping their wings.



SOME MORE TIPS

Recovery device color: dark. This will make the rocket easy to spot once the recovery device is deployed.

Sunglasses: increase the contrast and protect eyes. Try different color to see which one works best for you, usually it's a green shade for sunny days and orange or yellow for cloudy weather.

Good shoes: tennis shoes or better. Sandals are a bad idea.

Forward retriever: it always pays off to get a helper positioned in downwind direction.

Landing spot: fix your eyes on a landing spot and walk directly to it. Do not look around. The best is to have somebody to watch the landing spot and navigate you. You can set a tripod mounted camera with a telelens to "remember" the landing spot.

Short range radio: good for team communication.

Literature: During long winter evenings read through the basic rocketry literature as well as the technical reports. You can find never drying well of information and inspiration there.

Compete: the best place where you can see a cutting edge competition rockets and learn is at the competition itself.

References

[1] G. Harry Stine, Handbook of Model Rocketry, sixth edition, 1994

[2] Timothy S. Van Milligan, Model Rocket Design and Construction, How to Create and Build Unique and Exciting Model Rockets that Work, first edition

[3] Dan Wolf, Competition Rocketry: Improve Your Reliability in Streamer Duration, *Sport Rocketry, March/April 1998*

[4] Trip Barber and Tom Milkie, Streamer Duration Optimization, *NARTS TR-101*

[5] MIT Rocket Society, Competition Design Book, 1977

[6] John Viggiano, Vellum Rocket Construction, *NARTS TR-8*, 1993

[7] Ed LaCroix, NAR Contest Strategies, *NARTS TR-8*, 1993

[8] Novaar, NOVAAR Model Rocket Competition Handbook, *NARTS*

[9] Jim Rea, Parachute Performance, *NARTS, TR-2*, 1974