

Recovery

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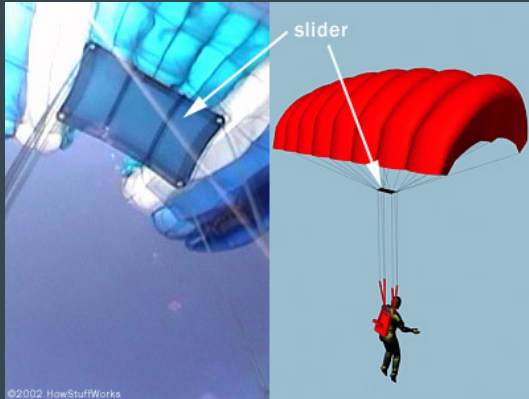
Recovery relies heavily on electronics and structures designs.

Goals/Objectives:

- Safely descend
- Rocket must be reusable
 - Important for points!
- Design a guidance system
 - Land in close proximity of launch zone
- Deployment stages
- Completely dumbfound the judges and spectators with our awesome recovery skills!!!

Chutes

- Addition of slider
- Guidance properties of the ram-air chute
 - Motor setup and programming
 - Rigorous testing
- Chute design



Slider addition



Guidance!

Parachute Configuration

- Cord strength
 - Withstand deployment tension
- Line material
 - Usually made from braided strands of nylon or synthetic fibers
 - Cord types
- Packing

Type I

Type I paracord holds 95 lbs and is has 1 core strand.

Type II

Type II paracord holds 400 lbs and has 4-7 core strands.

Type III

Type III cord holds 550 lbs and has 7-9 core strands.

Type IV


Type IV paracord holds 750 lbs and has 11 core strands.

(Right) Chute packing, (Above) Cord types.



Drag Coefficient

- Dependent on chute radius
 - Average drag coefficient for round parachutes is 1.75
- Testing

 **Velocity During Recovery** Glenn Research Center

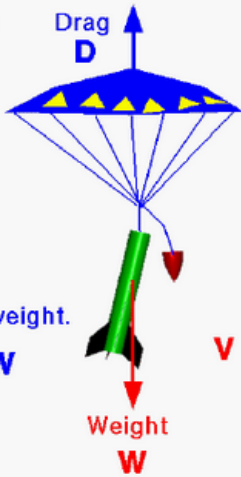
C_d = drag coefficient of parachute
 $C_d = 1.75$ (typical)

r = air density
 $r = 1.229 \text{ kg / cu m}$
 A = parachute area
 V = velocity

Drag Equation:
$$D = C_d \frac{r V^2}{2} A$$

During recovery, drag=weight.
$$D = C_d \frac{r V^2}{2} A = W$$

Solve for Velocity:
$$V = \text{sqrt} \left(\frac{2 W}{C_d r A} \right)$$



Governing drag equation

Ejection Considerations/Variables

- Ejection charge mass
- Ejection force on nosecone
- Length for pressurization chamber
- Wind pressure
- Projection area
- Drag coefficient



Ideal separation

Additional Considerations

- Initial calculations do not include shear pin forces
- Electronics integration
- Student-built chutes!
- Outside resources



Yes!



NO!