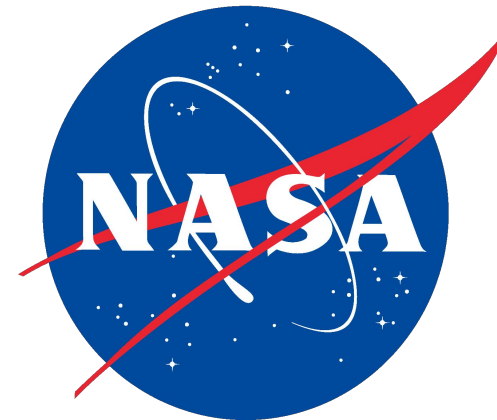


# Launch 2 Learn



## Introductory Rocket Workshop

First Nations Launch - November 4-5, 2023

Collegiate Rocket Launch - November 10-11, 2023

First Nations Launch - January 19-20, 2024

*Brought to you by Wisconsin Space Grant Consortium and Tripoli Rocketry Association*

This session  
will be recorded

# Introductions



## Wisconsin Space Grant Consortium

**Christine Bolz**, *WSGC Assistant Director, FNL Program Director*

**Rob Cannon**, *FNL Program Manager*

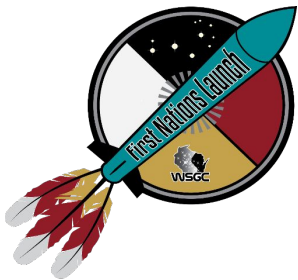
**Connie Engberg**, *WSGC/FNL Project Support Assistant*



## Tripoli Rocketry Association

**Frank Nobile**, *CRL & FNL Technical Advisor*

**Bob Justus**, *IL Tripoli Assistant*



## First Nations Launch

**Sean Osurman**, *FNL Alumni/Volunteer Assistant*

**Aaron Ashley**, *FNL Alumni/Volunteer Assistant*

## Faculty and Student Introductions

*Name*

*Area of instruction/study*

*Rocket experience*

*Goals/expectations for the workshop*

# Introductions



## **Wisconsin Space Grant Consortium**

**Christine Bolz**, *WSGC Assistant Director*

**Connie Engberg**, *WSGC Project Support Assistant Director*

## **Collegiate Rocket Launch**

**William Farrow**, *WSGC Student Satellite Initiatives Associate Director*



## **Tripoli Rocketry Association**

**Frank Nobile**, *CRL Technical Advisor*

**Bob Justus**, *IL Tripoli Assistant*

## **AIAA-Wisconsin Section**



**Trent Cybela**, *WSGC CRL Alumni/Vice President/Volunteer Support*

**Adrian Guither**, *WSGC CRL Alumni/Volunteer Support*

## **Faculty, Student Introductions**

*Name*

*Area of instruction/study*

*Rocket experience*

*Goals/expectations for the workshop*

# Workshop Presentation – Formatting Note

## Rocketry Overview & Fundamentals

- Colored / Highlighted blue

## Rocket Workshop Build

- Colored / Highlighted green

## Rocketry Simulations

- Colored / Highlighted grey

## Competition Support

- Colored / Highlighted yellow

## Additional Information Not Found in Handbook

- Colored red

# Weekend Workshop Schedule

## Saturday Morning (Pre-Break)

- Introduction & Overview
- Rocket Build - First Level 1 Kit
- RockSim Intro
- Epoxy & Pre-Fit Check Overview
- Pre-Fit Check Overview & Build
- Motor Mount Assembly & Build

**\*\*BREAK\*\***

## Saturday Morning (Post Break)

- Coupler Assembly & Build
- Motor Mount Assembly & Build
- Propulsion, Coupler, & Sustainer Overview
- RockSim Overview
- Nosecone Installation & Build
- Rail Button Alignment, Vent Hole Installation, & Build

**\*LUNCH BREAK\***

## Saturday Afternoon

- Inner Fin Installation Overview & Build
- Stability Overview
- Outer Fin Installation Overview & Build
- RockSim Update

**\*\*BREAK\*\***

- Aft Centering Ring Installation Overview & Build
- Rail Button Installation Overview & Build
- RockSim Update
- Recovery Installation & Build
- Parachute Preparation & Build
- Recovery Electronics
- Choosing a Dual Deploy Rocket
- Certification Launch Guidelines
- Workshop Review, Survey, Q&A

# Weekend Workshop Schedule

## Friday Evening

- Introduction & Overview
- Workshop Supply List/Level 1 Kit
- RockSim Intro
- Pre-Fit Check Overview & Build
- Epoxy & Pre-Fit Check Overview
- Motor Mount Assembly & Build
- Review/Prep for Saturday

## Saturday Morning

- Introduction
- Coupler Assembly & Build
- Motor Mount Assembly & Build
- Propulsion Overview
- RockSim Overview
- Nosecone Installation & Build
- Rail Button Alignment, Vent Hole Installation, & Build
- Morning Session Review

\*LUNCH BREAK\*

## Saturday Afternoon

- Inner Fin Installation Overview & Build
- Stability Overview
- Outer Fin Installation Overview & Build
- RockSim Update

\*\*BREAK\*\*

- Aft Centering Ring Installation Overview & Build
- Rail Button Installation Overview & Build
- RockSim Update
- Recovery Installation & Build
- Parachute Preparation & Build
- Launch Preparation Overview
- Recovery, Motor, Launch Pad, Rocket Retrieval
- Certification Launch Requirements
- Certification Flight, Rocket Transport
- Workshop Review, Survey, Q&A

# Workshop Expectations

## Zoom Platform

- Dr. Farrow/Christine will be our workshop moderators, helping you with technical difficulties
- Profile should include First and Last Name, School
- Keep your camera/video on - we MUST see you/your work space/rocket
  - Allows you to actively participate and ask for help
  - If you need to step away for a break, turn off camera
  - Raise hand feature, use of chat, and verbal questions are all encouraged
- Keep your audio muted during overviews, unmuted during build activities
- Breakout rooms may be used for additional support
- View Options
  - Spotighting - Moderator will spotlight build camera
  - Pinning - Allows you to focus on key individuals
  - Gallery vs. Speaker option

# Workshop Expectations

## Launch 2 Learn Handbook

- Handbook reference on bottom left-hand corner of slide
- Take notes
- Overview (sections 1-12), build (section 13), launch preparation (section 14), certification (section 15), page references (section 16) and evaluation questionnaire (section 17)

## RockSim

- RockSim should be already installed and activated with the “key” provided by WSGC
- The instructors will walk you through RockSim during sections of the build – You will walk through each step with them

## Rocket Build

- Instructors will walk you through each build section
- You will complete your build in real time with the instructors

# Workshop Objectives

- Introduce design, build, fly concepts of high-powered rocket
  - Remember this is only an introductory workshop, there is not enough time to cover all aspects in greater detail
- Build a Level 1 high-powered single deploy kit rocket
  - We will build the LOC Precision Caliber-ISP kit
- Develop basic understanding of rocket flight simulation
  - Import the Caliber kit rocket into RockSim and analyze a flight
- Understand Tripoli Level 1 certification
  - Certification process and how to complete your launch

# Workshop Materials & Supplies

ITEM DESCRIPTION:	QUANTITY:	RECEIVED:
Launch 2 Learn Handbook*	1	
Alcohol Wipes	15	
Awl, drill and bits	1	
Craft Sticks, Wooden	15	
Cups, Plastic	15	
18" Wooden Dowel	1	
Epoxy	1	
Nitrile Gloves	6 pr.	
Masking Tape	1	
Paper Plates	2	
Paper Towels	bundle	
Pencil	1	
Ruler	1	
Sandpaper	1	
Screwdriver set	1	
Table Covering	1	
Utility Knife	1	



## Launch 2 Learn Introductory Rocket Workshop Handbook

Brought to you by Wisconsin Space Grant Consortium, Tripoli Rocketry Association and AIAA  
Funded through NASA Cooperative Agreement #80NSSC20M0123

# Rocket Build – Your First Level 1 Kit

## Loc Precision Caliber – ISP

### Single Deploy Rocket

38 mm H219T - DMS/ H100W -DMS

#### Kit Features Include:

- Heavy Duty Airframe Tubing
- Precision Cut Plywood Fins & Rings
- Pre-slotted Airframe
- Plastic Nose Cone
- Payload Section
- Nylon Parachute Recovery
- Shock Cord Mount

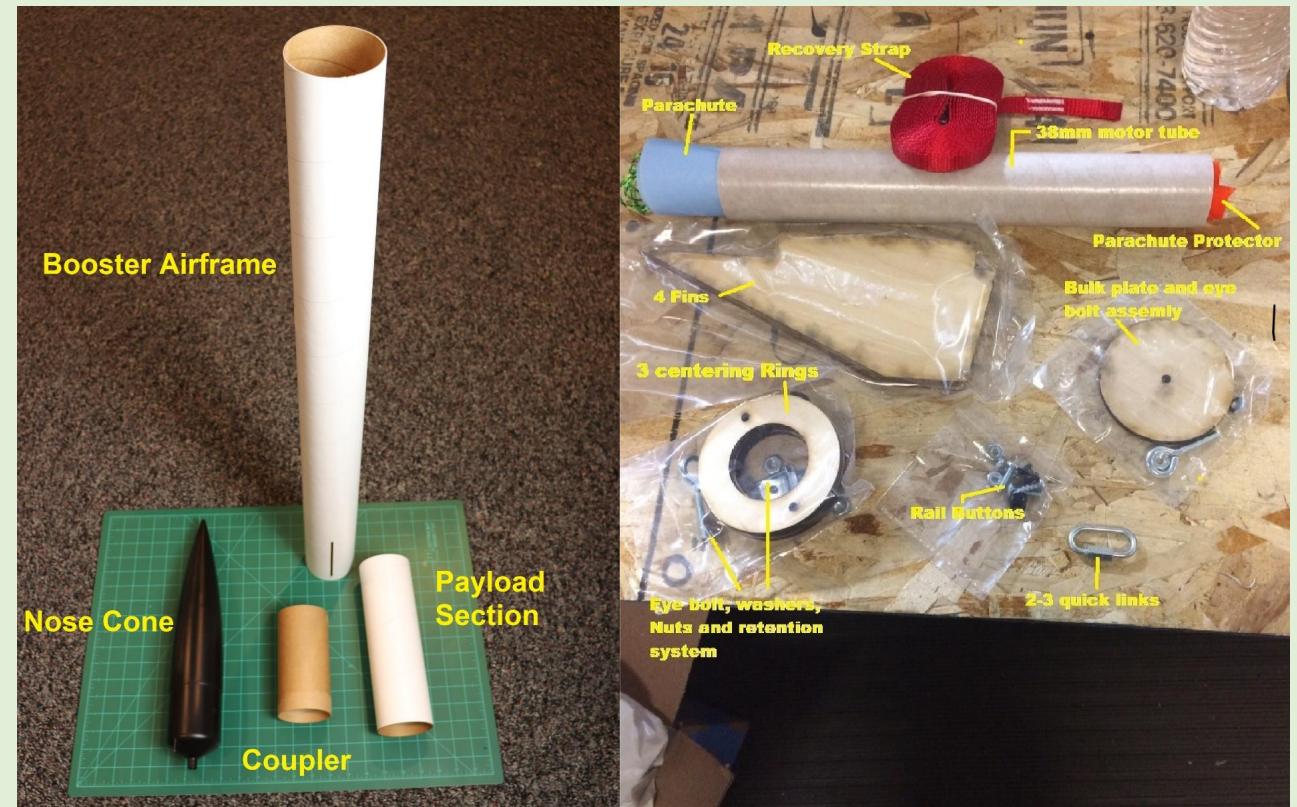


Figure 2-1: Parts included with the LOC Precision – 3.10" Caliber ISP Rocket Kit (not including parts supplied by WSGC)

# Workshop Materials & Supplies

ITEM DESCRIPTION:	QUANTITY:	RECEIVED:
<b>LOC Precision – 3.10” Caliber ISP Rocket Kit*:</b>	1	
Booster Airframe	1	
Nose Cone	1	
Coupler	1	
Payload Section	1	
38mm Motor Mount Tube	1	
Recovery Strap	1	
Parachute	1	
Parachute Protector	1	
Fin	4	
Quick Link	2	



<i>Centering Ring Bag:</i>		
Centering Ring with 2 Small Holes	1	
Centering Ring with 1 Small Hole	1	
Centering Ring with 0 Small Holes	1	
Eyebolt	1	
Washer	2	
#8 Wood Screws	2	
Machine Screw	2	
Motor Retention Cap	1	
<i>Rail Button Bag:</i>		
Rail Button	2	
Nut	2	
Machine Screw	2	
Wood Screw	2	
<i>Bulk Plate Bag:</i>		
Bulk Plate	1	
Eyebolt	1	
Nut	2	



# FNL - Tools & Tips

[spacegrant.carthage.edu/first-nations-launch/tools-and-tips/](https://spacegrant.carthage.edu/first-nations-launch/tools-and-tips/)

## WSGC Launch 2 Learn Workshop 2023

Launch 2 Learn Fin Alignment Guide

Launch 2 Learn Virtual Handbook 

Launch 2 Learn Virtual Presentation

Launch 2 Learn Virtual Schedule 

## Local Contacts

- State Space Grant Consortia
- American Indian Science and Engineering Society (AISES)
- Federal Aviation Administration
- National Association of Rocketry
- Tripoli Rocketry Association/Contacts

## Reimbursement Request Forms

- Project Expense Form 
- Project Expense Form – Instructions and Example 
- Travel Expense Form 
- Travel Expense Form Instructions 
- Travel Guidelines 

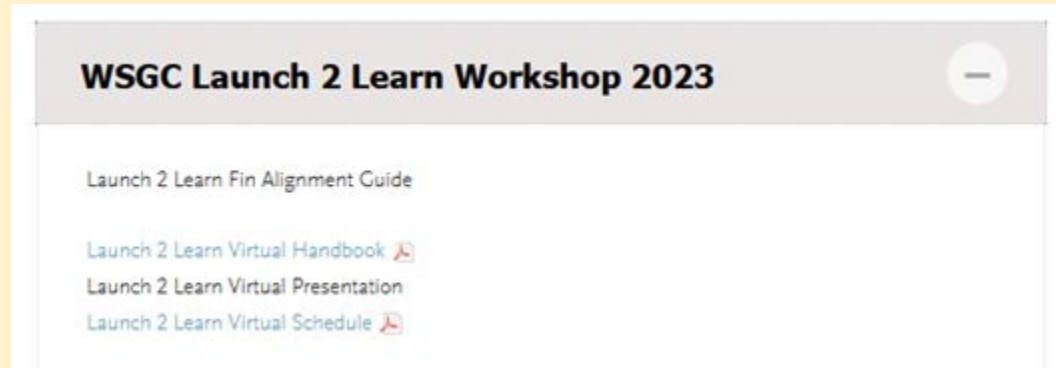
## Travel & Accommodations

- FNL Rocket Shipping Procedure 

- Reimbursement Request Forms
- WSGC Launch 2 Learn Workshop 2024
- Local Contacts
- Travel & Accommodations

# Students - Tools & Tips

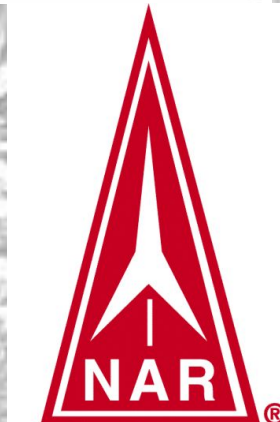
<https://spacegrant.carthage.edu/students/tools-and-tips/>



# High-Power Rocketry History



- *Scientific American Article (1957)*
  - Design, propellant formulations, and launching techniques
- *Rocket Manual for Amateurs (1960)*
- Homer Hickam - *Rocket Boys*(1998) <https://homerhickam.com/>
- National Organizations and Regulation
  - National Association of Rocketry (NAR) <https://www.nar.org>
  - Tripoli Rocketry Association (TRA) <http://www.tripoli.org>
- [First amateur high-powered rocket into space](#) (2004) @ 72 miles
- University of Southern California sets world record (2017)
  - Highest altitude a student built and designed rocket reaches: [144,000' apogee](#)





# Rocketry 101 – Single Deploy Flight Profile

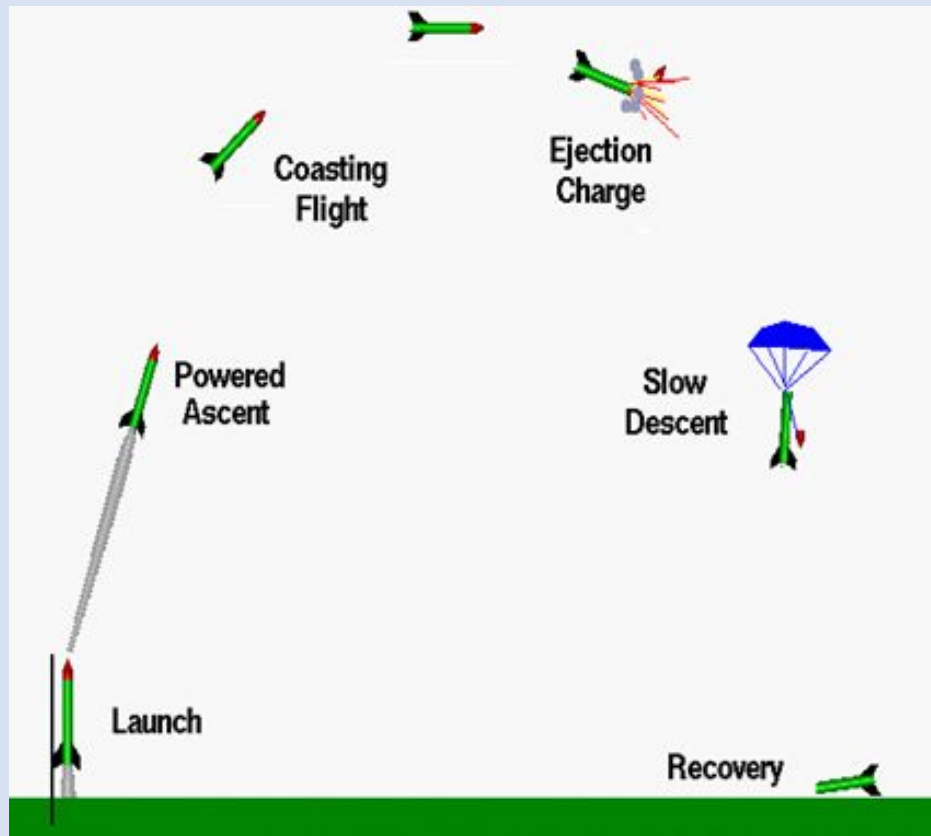


Figure 4-1: Single Deploy Flight Profile

1. Launch
2. Powered Ascent
3. Coasting Flight
4. Ejection Charge
5. Slow Descent
6. Recovery

# Rocketry 101 – Dual Deploy Flight Profile

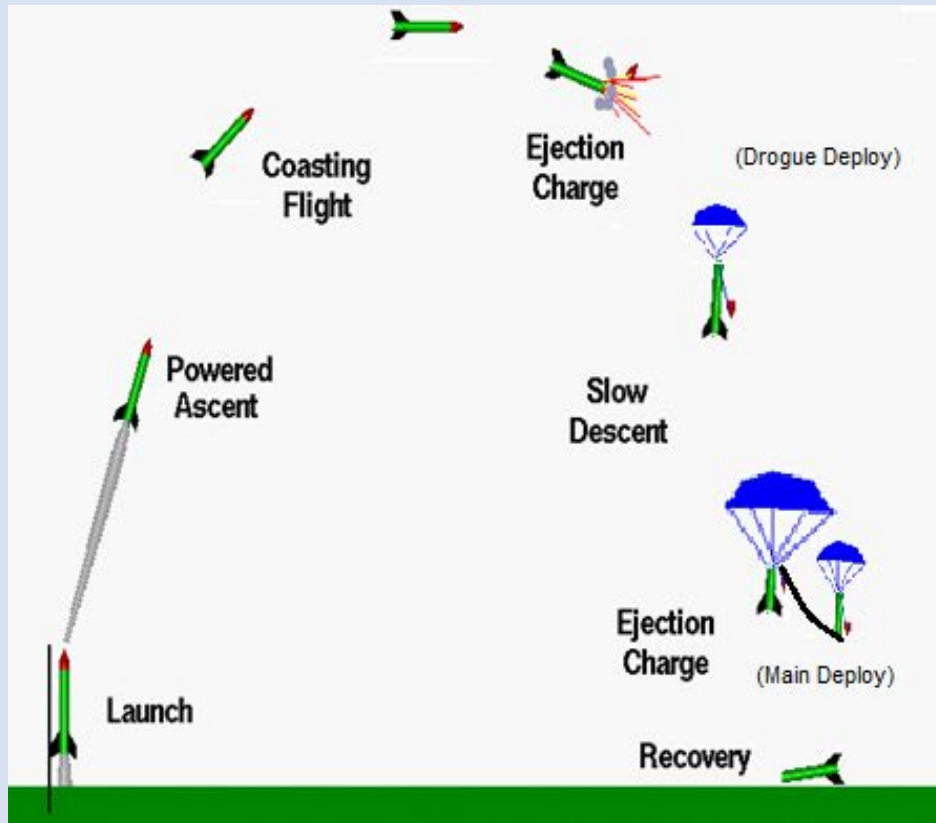


Figure 4-2: Dual Deploy Flight Profile

1. Launch
2. Powered Ascent
3. Coasting Flight
4. Ejection Charge / Drogue Deploy
5. Slow Descent
6. **Ejection Charge / Main Deploy**
7. Recovery

# Rocketry 101 – Flight Profile Differences

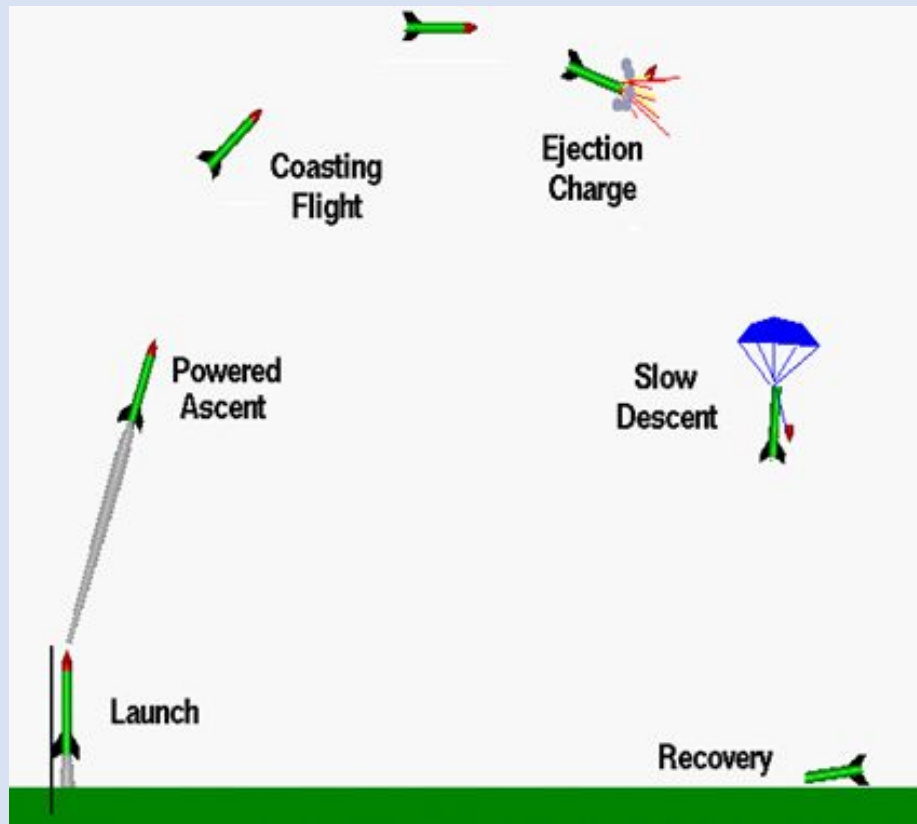


Figure 4-1: Single Deploy Flight Profile

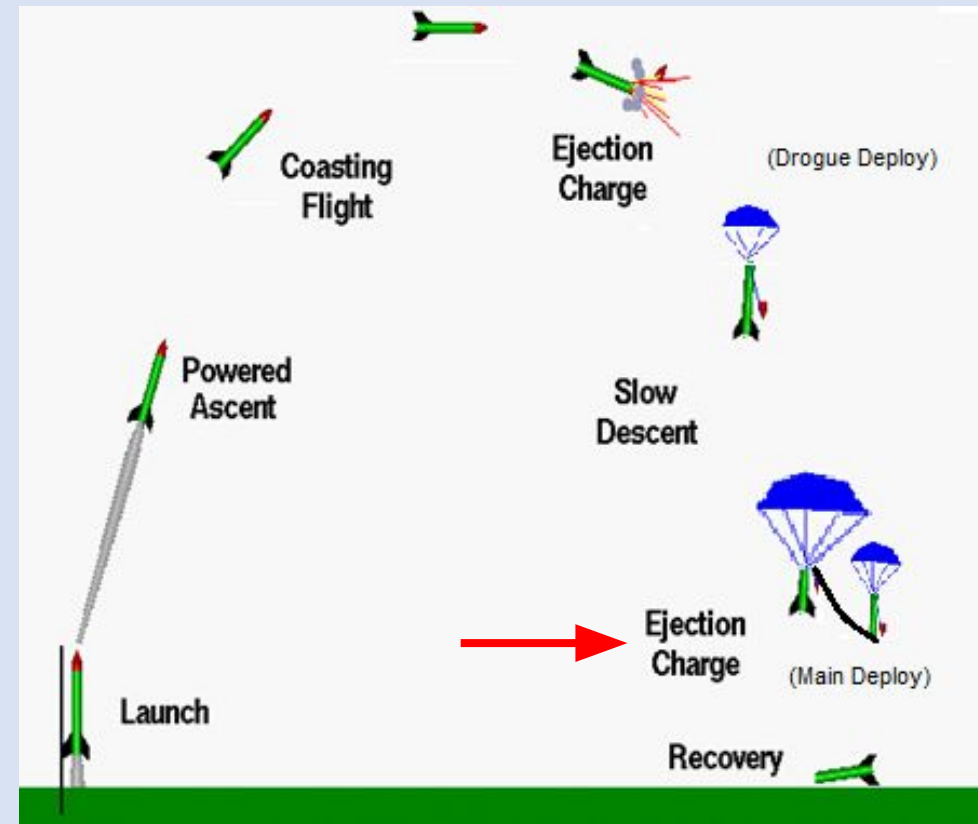
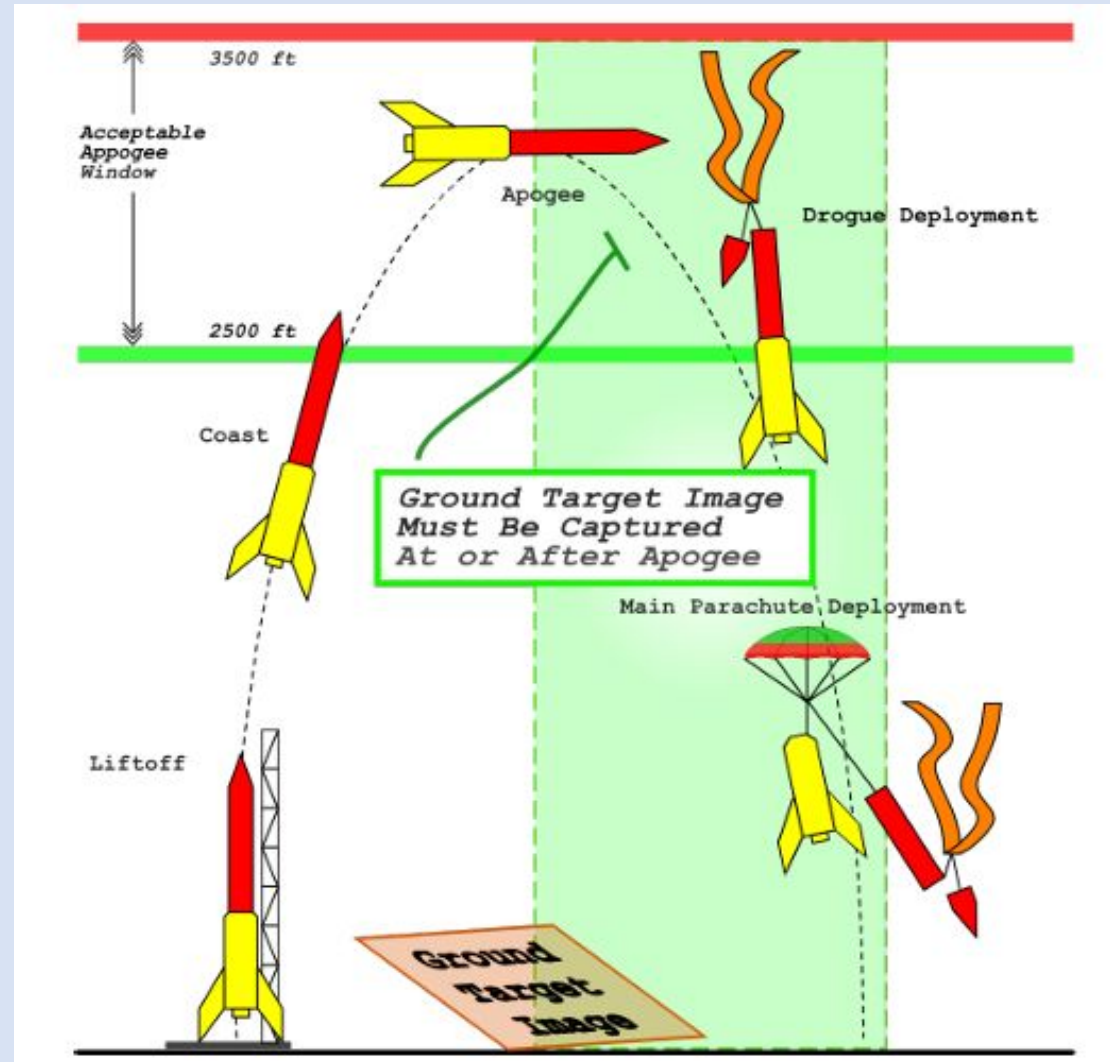


Figure 4-2: Dual Deploy Flight Profile

# Rocketry 101 – Competition Flight Profile



# Rocketry 101 - Structures

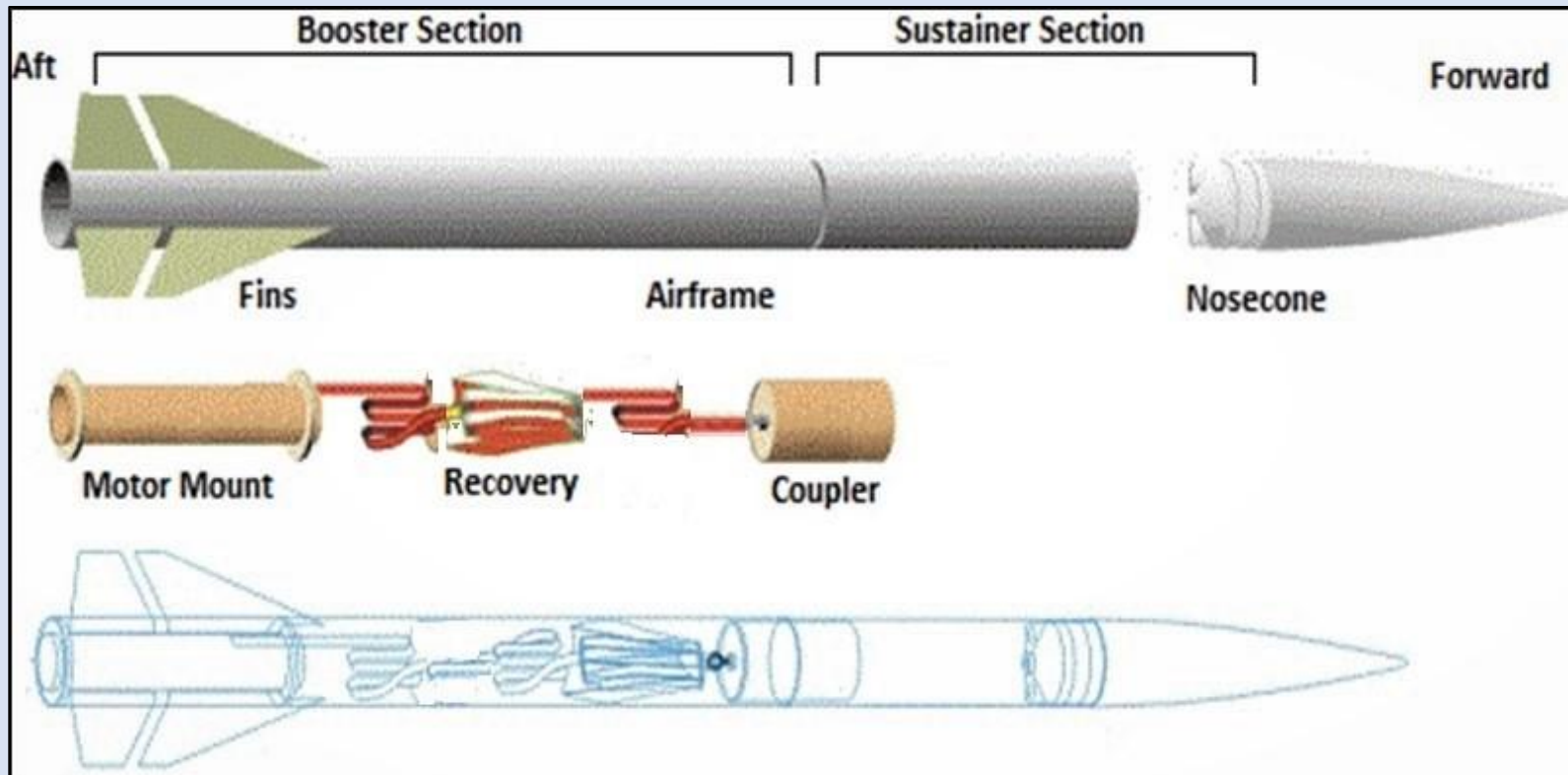


Figure 5-1: High-Power Rocket with Coupler

# Rocketry 101 – RockSim Introduction

- Creating a Model in RockSim 10
  - RockSim: <http://www.apogeerockets.com/rocksim.asp>

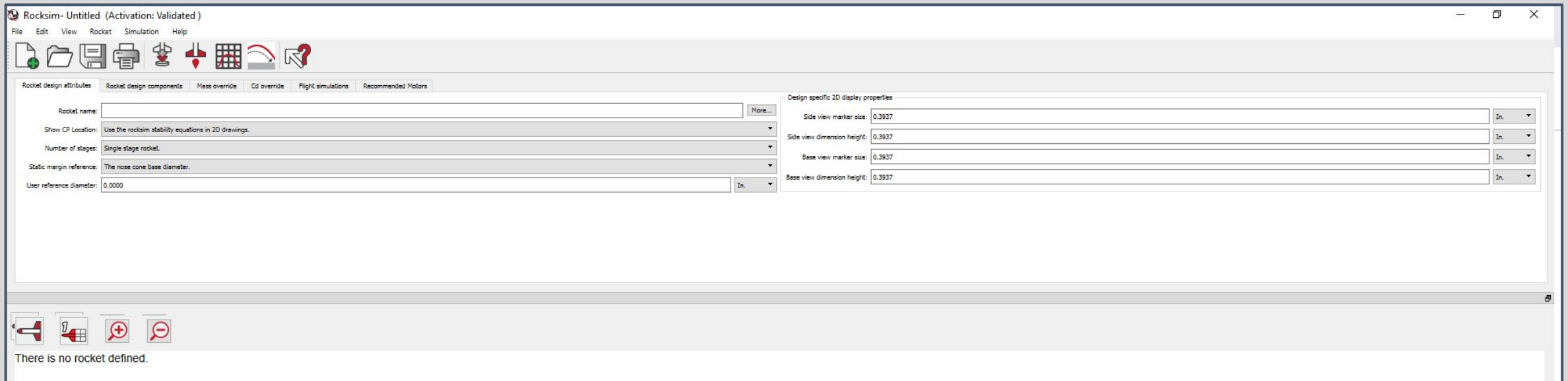


Figure 11-1: RockSim 10

# Rocketry 101 – RockSim Introduction

- Simulations are THE key component to high powered rocket design
  - Rocket Design Attributes
  - Rocket Design Components
  - Mass Override
  - CD Override
  - Flight Simulations
  - Recommended Motors

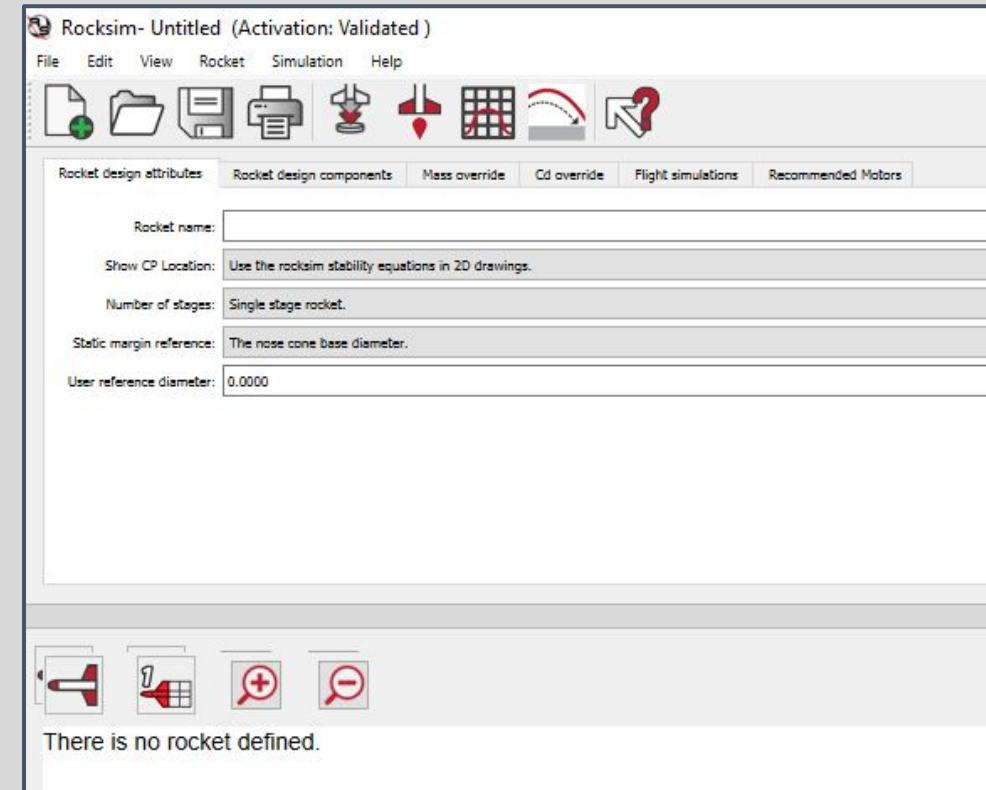


Figure 11-2: RockSim 10 Folders

# Rocketry 101 – RockSim Introduction

1. Download a pre-existing model of a LOC Precision-Caliber ISP kit
  - a. <https://www.rocketreviews.com/rocksim-library.html>
  - b. Sort by Manufacturer
  - c. Display RockSim files for LOC/Precision
  - d. Download Caliber ISP file

Uploaded	Manufacturer	Design Name	File Name
2010-11-23	LOC/Precision	LOC/Precision 4" V2 ...	loc_4_inch_v2_preproduction.rkt
1999-01-01	LOC/Precision	loc_29-4ss_stock.rkt	loc_29-4ss_stock.rkt
2019-07-02	LOC/Precision	LOC/Precision Athena3	LOC-Athena-3-PK37.rkt
2010-11-23	LOC/Precision	LOC/Precision Aura	loc_locaura.rkt
1999-01-01	LOC/Precision	Aura	loc_aura.rkt
1999-01-01	LOC/Precision	LOC Aura modified	mod_loc_aura_level1.rkt
2010-11-23	LOC/Precision	LOC/Precision Big Nuke	loc_bignukre.rkt
2010-11-23	LOC/Precision	LOC/Precision Big Nuke	mods_loc_big_nuke_shaffer.rkt
2010-11-23	LOC/Precision	LOC/Precision Big Nuke Rod's ...	mods_loc_kevs_bignukelp.rkt
1999-01-01	LOC/Precision	Loc/Precision PK-82-3E Big ...	loc_big_nuke-3e.rkt
2010-11-23	LOC/Precision	LOC/Precision Bruiser	loc_bruiserstart.rkt
2010-11-23	LOC/Precision	LOC/Precision Bruiser EXP3	loc_bruiserexp3.rkt
1999-01-01	LOC/Precision	Caliber ISP	loc_caliber_isp.rkt
2010-11-23	LOC/Precision	LOC/Precision GANCAT 2HP	mod_loc_gancat_2h.rkt
2010-11-23	LOC/Precision	LOC/Precision Gyaltra	loc_gyaltra.rkt

Figure 11-3: Rocket Reviews RockSim Library, Caliber ISP

# Rocketry 101 – RockSim Introduction

2. Import rocket file into RockSim 10
  - a. Open the existing design file folder (Import Folder)
  - b. Select loc\_caliber\_isp file from download folder

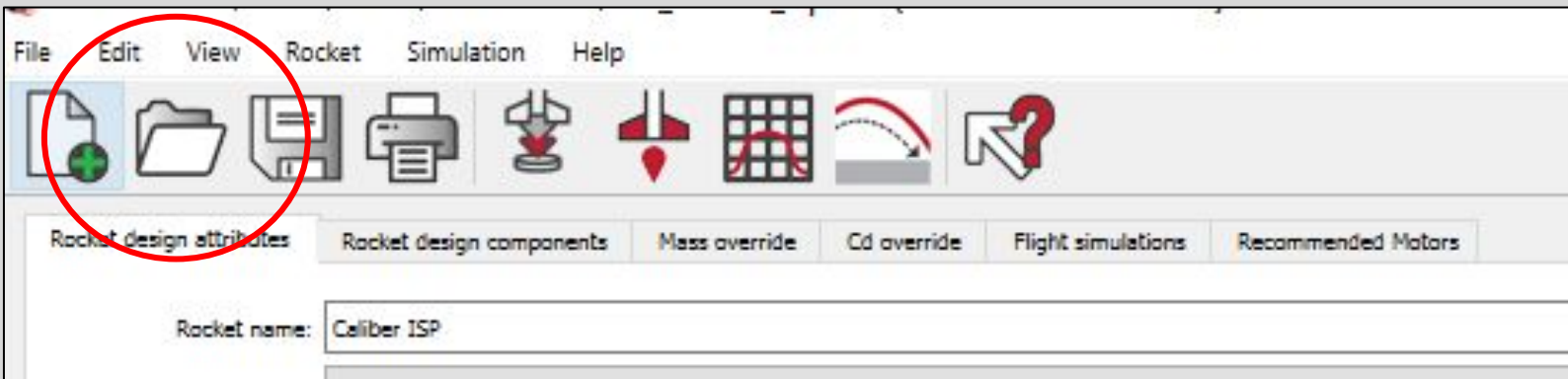


Figure 11-4: RockSim Import Folder

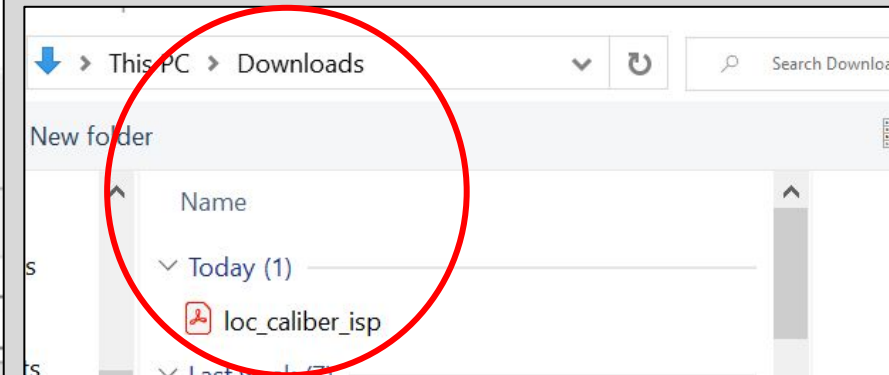


Figure 11-5: Select Rocket File from Download Folder on Computer

# Rocketry 101 – RockSim Introduction

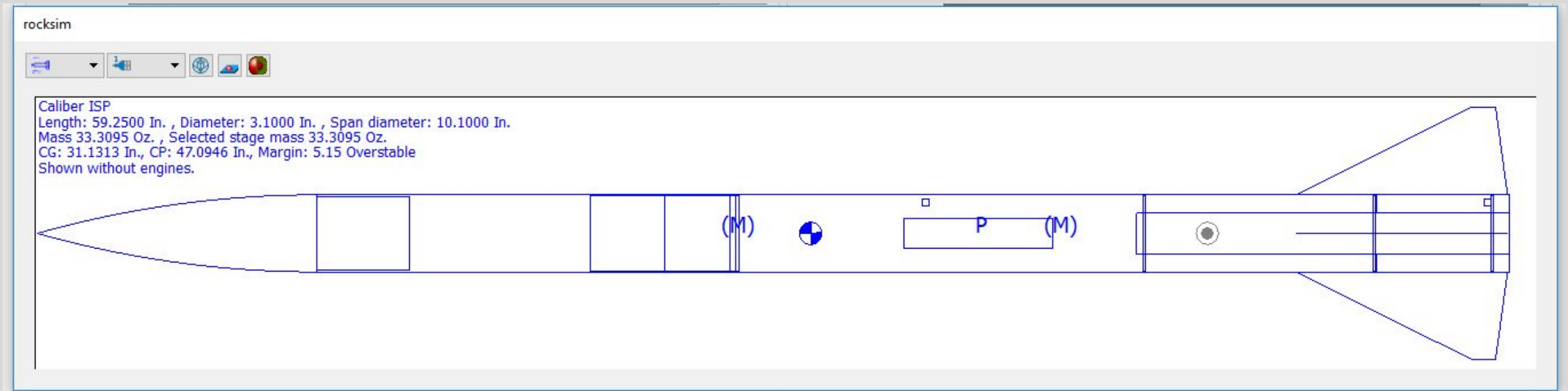


Figure 11-6: Caliber ISP Stock File

# Rocket Build – Pre-Fit Check

Key to proper fit and adhesion is to **DRY-FIT** all rocket parts **BEFORE** applying any epoxy to parts.

Do not over-sand your parts, a snug fit is required.

## Parts to dry-fit:

- Centering Rings
- Coupler and Bulkplate
- Motor Mount Tube (MMT)
- Airframe
- Fins
- Nosecone

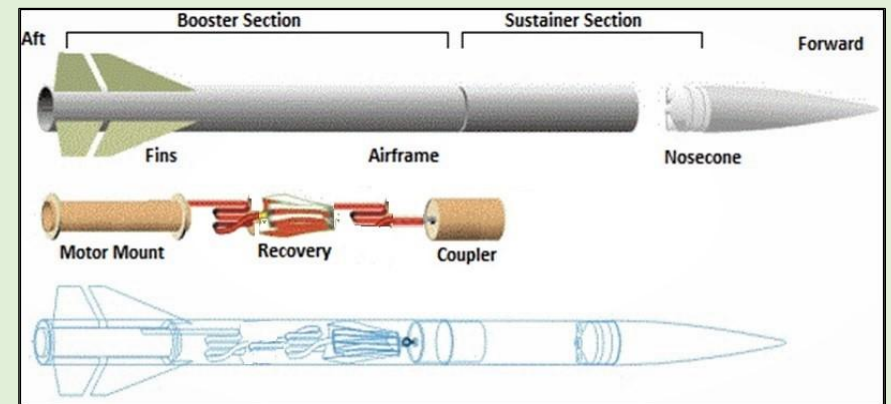


Figure 13-1: High-Power Rocket Diagram

# Rocket Build – Pre-Fit Check

## *Centering Rings*

1. Identify and label centering rings
  - a. Add the word 'forward' to the ring with one (1) hole
  - b. Add the word 'mid' to the ring with zero (0) holes
  - c. Add the word 'aft' to the ring with two (2) holes
    - Add the word 'out' to one side of the Aft Centering Ring
    - Add the word 'in' to the other side of the Aft Centering Ring
2. Rough sand MMT just enough to remove glassine
3. Sand inside of centering rings so they fit into MMT
  - a. May use a dremmel tool for sanding



Figure 13-2: Aligned Centering Rings

# Rocket Build – Pre-Fit Check

## *Centering Rings*

4. Install small eyebolt into the Forward centering ring
  - a. Place one nut and small washer on the eyebolt side of the centering ring
  - b. Place one small washer and one nut on the back end of the centering ring
  - c. **NOTE: (If you only have one washer, the washer should be placed on the back side of the bulkplate)**



*Figure 13-3: Forward Centering Ring with Eyebolt Installed*

# Rocket Build – Pre-Fit Check

## *Bulkplate*

1. Install an eyebolt into the bulkplate
  - a. Place one large washer and one nut on the eyebolt side of the centering ring
  - b. Place one large washer and one nut on the back side of the bulkplate (*If you only have one washer, the washer should be placed on the back side of the bulkplate*)



Figure 13-5: Bulkplate and Eyebolt



Figure 13-6: Eyebolt Installed in Bulkplate

# Rocket Build – Pre-Fit Check

## *Bulkplate*

2. Dry-fit bulkplate into coupler tube (using eyebolt as handle)
2. Sand outside of bulkplate for proper fit
2. Place the **Coupler Bulkplate** 1/4" from end of the coupler
  - NOTE: When using a 12" ruler, make sure you start the measurement at 0" vs. the end of the ruler



Figure 13-7: Eyebolt installed in Bulkplate



# Rocket Build – Pre-Fit Check

## *Centering Ring Alignment*

1. Centering rings should fit on motor mount tube
1. Mark the forward end of motor mount tube at  $1/8''$ - $3/16''$  for forward centering ring placement



Figure 13-8: Centering Rings Fitted on Motor Mount Tube



Figure 13-9: Center Motor Mount Ring Distance from End of Motor Mount Tube

# Rocket Build – Pre-Fit Check

## *Centering Ring Alignment*

3. Measure distance from aft end of airframe to the forward fin slot for center motor mount ring placement
3. Draw line at same distance on motor mount tube for center motor mount ring placement. NOTE: Measure from aft end of motor mount tube
3. Mark the middle of motor mount tube at 5-1/4" from aft end for mid-centering ring placement



Figure 13-10: Center Motor Mount Ring Located above Fin Slot (Left); Measure the Length of the Fin Slot for Accuracy (Center); Draw a Line on the Motor Mount Tube around the Center Motor Mount Ring (Right)

# Rocket Build – Pre-fit Check

*Additional Steps: Airframe, Fins, Nose Cone*

1. Rough sand around fin slots of airframe tube (for adhesion)
1. Fit fins into airframe tube slots – sand as needed to fit



*Figure 13-11: Fin Slot (Top); Relation to Motor Mount Tube and Mid/Aft Centering Rings (Center); Fin Sanding Technique (Bottom)*

# Rocket Build – Assembly

## *Epoxy Overview*

- Normally a two-part chemical mixture
  - A resin
  - A hardener
  - Usually mixed in a 1:1 ratio
- Various Types Based on Material and Strength
  - Time, Strength
  - JB Weld – metallic bonding
  - Silica additive can be used for fin fillets
- Epoxy Usage
  - 5-minute epoxy sets quickly
  - Mix quarter-size amount of resin/hardener - no more



Figure 13-12: Epoxy Resin and Hardener

# Rocket Build – Assembly

## *Epoxy Overview*

- Epoxy Fillets
  - Creates a strong bond between two surfaces
  - Applied with a craft stick in single smooth line to create a valley between two surfaces
- Safety
  - Always wear gloves prior to mixing and applying epoxy
  - Work quickly and with small amounts of epoxy at each step
  - If you get epoxy on skin or unwanted surfaces, use rubbing alcohol to remove residue

Learn more about epoxy:

<https://www.apogeerockets.com/education/downloads/Newsletter186.pdf>

Or see the NASA Handbook for construction tips



Figure 13-13: Epoxy Application

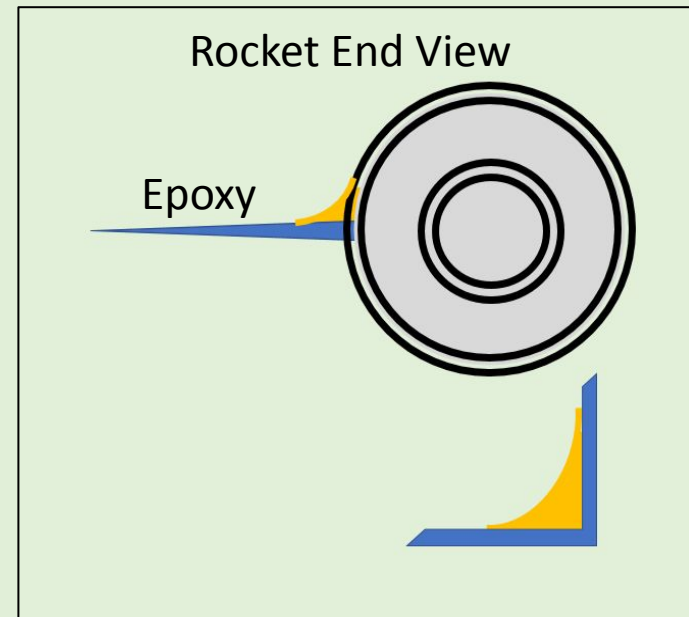
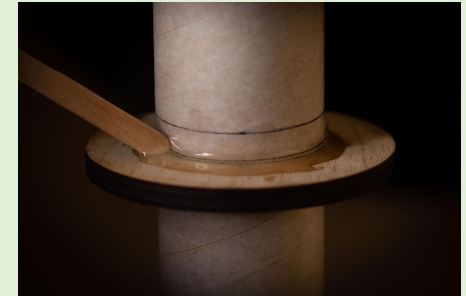


Figure 13-14: Epoxy Fillets

# Rocket Build – Assembly

## *Motor Mount Assembly – Mid Centering Ring*

1. Dry-fit Step: Fit the **mid-centering ring** at the measurement marked in previous steps
  - a. Slide ring down below lines
  - b. Put on gloves before preparing epoxy
  - c. Prepare small amount of epoxy 1:1 ratio
    - i. Open new bottles
    - ii. Remove nozzle
    - iii. Remove internal cap from the bottle
    - iv. Replace the nozzle
  - d. Apply epoxy to the motor tube on the lines drawn for mid-centering ring
  - e. Slide the mid-centering ring just ahead of the forward fin slot on the marked line, using twisting motion



*Figure 13-15: Motor Mount Placement with Line (Top); Applying Epoxy to the Mid-Centering Ring (Center); Completed Mid-Centering Ring (Bottom)*

# Rocket Build – Assembly

## *Motor Mount Assembly – Forward Centering Ring*

2. Dry-fit Step: Fit the **forward centering ring** at the measurement marked in previous step
  - a. Slide ring down below lines
  - b. Put on gloves before preparing epoxy
  - c. Prepare small amount of epoxy 1:1 ratio
  - d. Apply epoxy to the motor tube on the lines drawn for forward centering ring
  - e. Slide the forward centering ring to the marked line(s), using twisting motion



Figure 13-16: Motor Mount Assembly

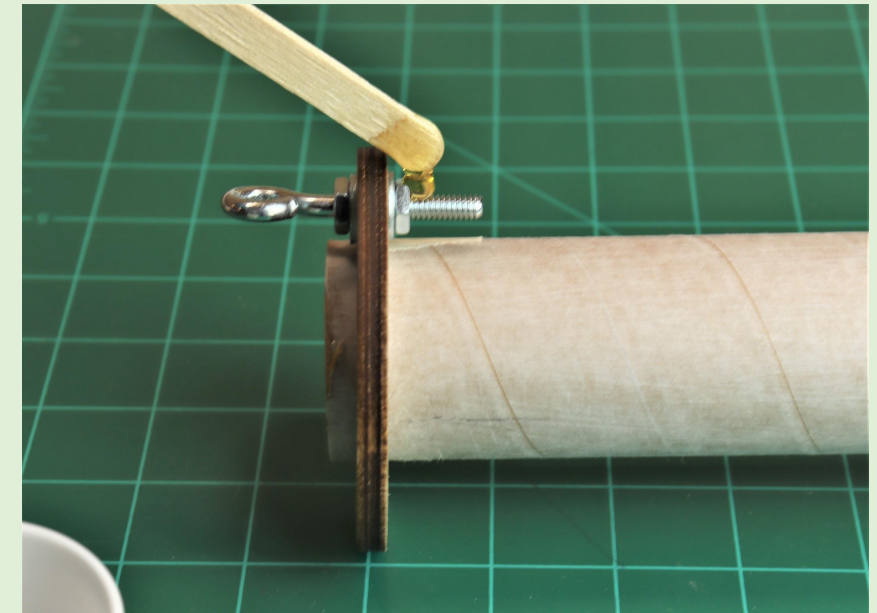
# Rocket Build – Assembly

## *Motor Mount Assembly*

3. Apply fillet on **aft** side of **forward**  
**centering ring**
3. Apply small dabs of epoxy to eyebolt threads
  - Do not get epoxy on the outside of the motor mount tube
3. Set motor mount assembly aside, allow epoxy to dry



Figure 13-16: Epoxy Eyebolt Thread



# FRIDAY NIGHT BREAK

*Remember...to be early is to be on time and to be on time is to be late. Saturday's presentation is being condensed by 3 hours.*

*We will start exactly at 10:00 am CST.*

*We have lots to cover in a short period of time!*

# SATURDAY MORNING

*Welcome Back!!!*

*Make sure your workstation is ready to go...table covered,  
handbook open, pen/pencil ready, gloves available, camera on,  
sound ready, water and snack nearby.*

This session  
will be recorded

# Workshop Day 1 - Morning Review

1. What are the two professional rocketry associations?
2. What are the two types of flight profiles?
3. Name the 6 phases of the single deploy flight profile.
4. What is the difference between single and dual deploy?
5. Who is the manufacturer of the kit?
6. Where is the mid centering located on the motor mount tube?
7. What is the purpose of sanding all of the rocket components?

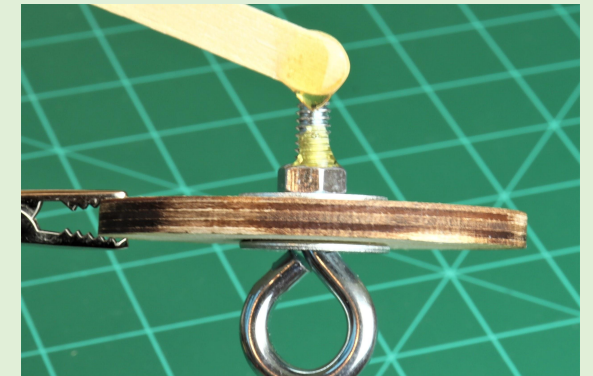
# Rocket Build – Assembly

## *Coupler Assembly*

1. Dry-fit Step: Fit bulkplate inside coupler, ensuring level fit ~1/4" from the edge
1. Remove bulkplate after ensuring fit
1. Put on gloves before preparing epoxy
1. Prepare small amount of epoxy
1. Dab the threads and nut of eyebolt with epoxy



*Figure 13-17: Bulkplate Installed in Coupler*

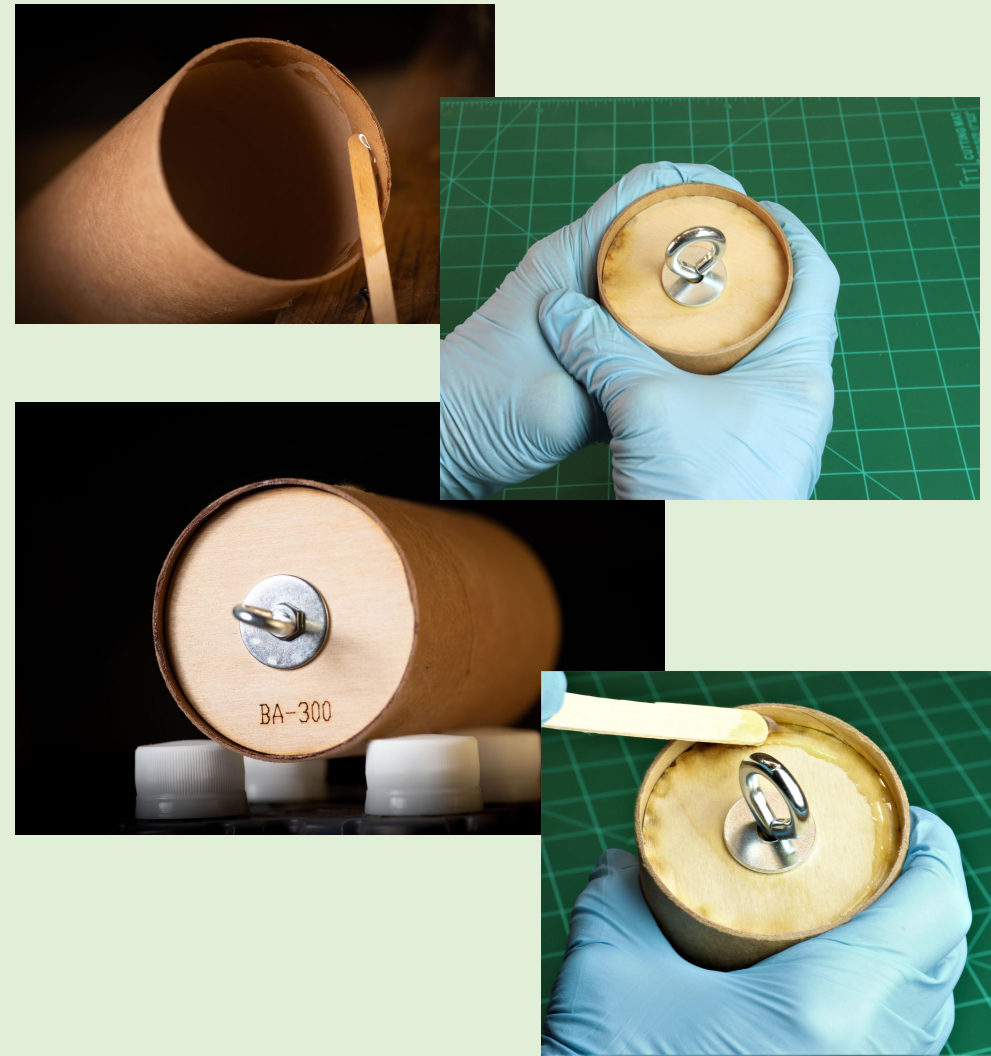


*Figure 13-17: Dabbing epoxy on threads and nut of eyebolt*

# Rocket Build – Assembly

## *Coupler Assembly*

6. Apply epoxy around inside coupler ~ ¼” from the end
7. Twist the bulkplate into the coupler leaving ¼” gap from the edge of the coupler, brace the coupler to avoid bulkplate shifting
8. Hold in place for a few minutes to allow epoxy to start setting
9. Set coupler assembly aside, allow epoxy to dry
10. Add fillet of epoxy to edges of bulkplate



*Figure 13-17: Applying Epoxy around Inside of Coupler (Top); Bulkplate Installed in Coupler (Bottom)*

# Rocketry 101 - Propulsion Overview

## Qualifying definitions for High Powered Rockets:

- A motor using an engine with more than 160 Newton-seconds of total impulse (and 'H' motor or larger) or motors that all together exceed 320 Newton-seconds; or
- Uses a motor with more than 80 Newtons average thrust (see rocket motor coding); or
- Exceeds 125 grams of propellant; or
- Weighs more than 1,500 grams including motor(s); or
- Includes any airframe parts of ductile metal

Impulse Class		Category
H	160.01Ns to 320.01Ns	Level 1
I	320.01Ns to 640.00Ns	
J	640.01Ns to 1280.00Ns	Level 2
K	1280.01Ns to 2560.00Ns	
L	2560.01Ns to 5120.00Ns	
M	5120.01Ns to 10240.00Ns	Level 3
N	10240.01Ns to 20480.00Ns	
O	20480.00Ns to 40960.00Ns	

Table 6-1: HPR Motor Impulse Class and Category

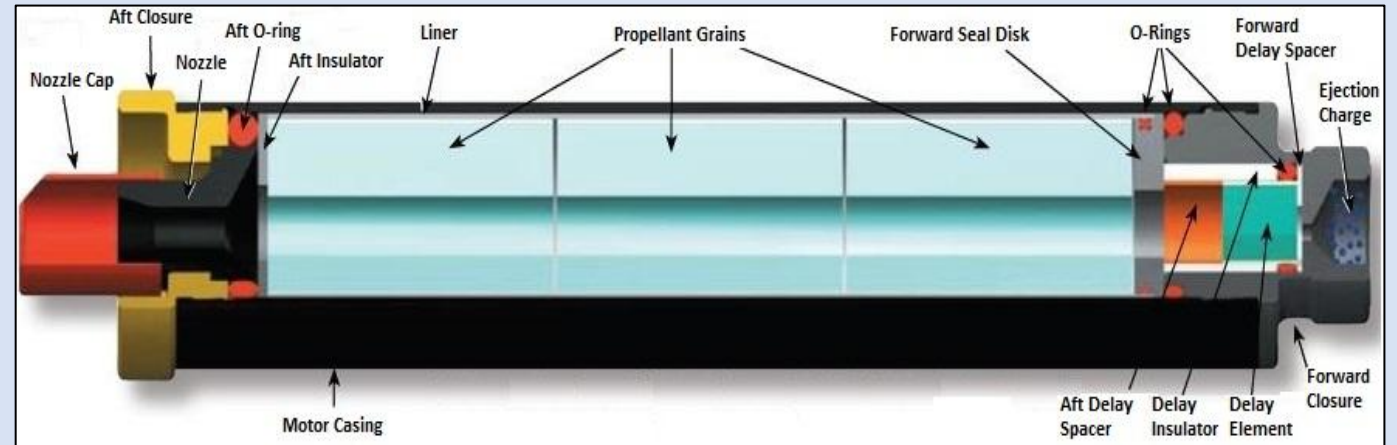
## HPR motors cannot be purchased over the counter

- Must be certified either by NAR or TRA to the appropriate level to purchase motor
- FNL teams - Approved Rocketry Mentor can purchase motor for local launch
- CRL teams - Frank Nobile will purchase certification motors

# Rocketry 101 – Propulsion Overview



Figure 6-1: Motor Kit Example



*Figure 6-3: Cutaway Drawing of Typical Assembled RMS-Plus Motor*



*Figure 6-6: Motor assembly and example of burn*



Figure 6-4: Aerotech Single Use Motor with Ignitor 2

# Rocketry 101 - Propulsion Overview

## Thrust to Weight Ratio

- At a minimum this is 5:1 (you need 5 times the amount of thrust per weight)
- If your rocket weighs 10 lbs, your motor needs to produce at least 50 lbs of (average) thrust

## Thrust Curves

- Burn time
- Max thrust
- Average thrust
- Either Newtons or pounds

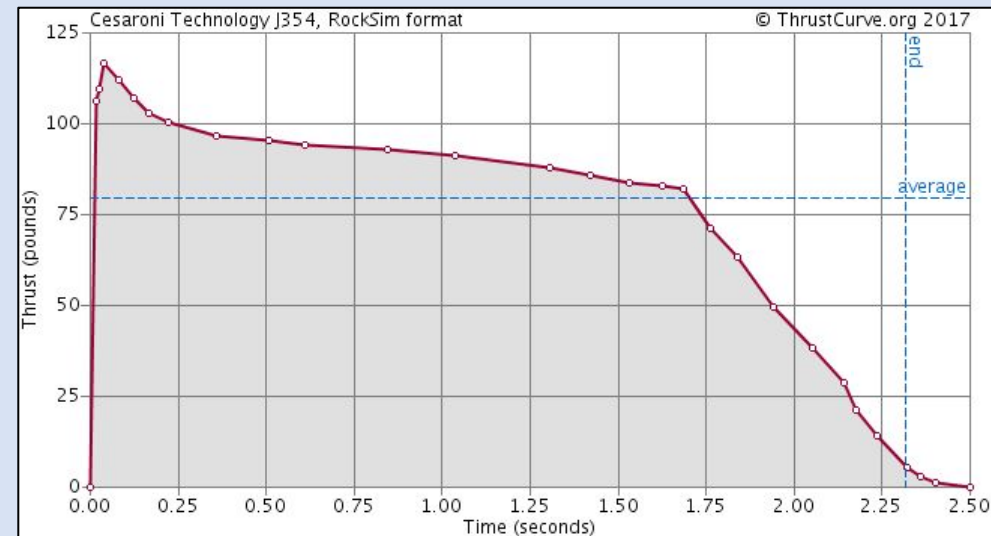
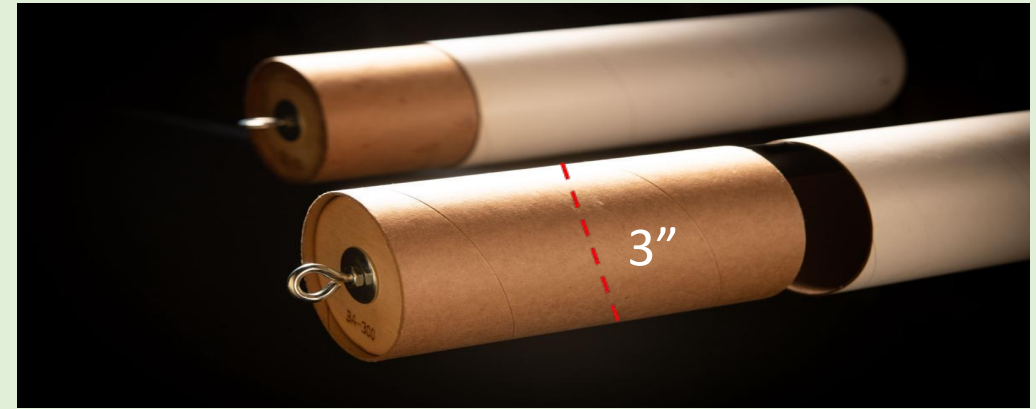


Figure 6-5: Thrust Curve Example

# Rocket Build – Assembly

## *Coupler/Sustainer*

1. Dry-fit coupler to upper airframe (sustainer)
2. Draw a line/mark around the center of the coupler
  - ~Approximately 3" on this kit
3. Put on gloves before preparing epoxy
4. Prepare small amount of epoxy



*Figure 13-18: Example of Where to Draw Line on Coupler*

# Rocket Build – Assembly

## *Coupler/Sustainer*

5. Apply epoxy around inside of the sustainer (about 1" from edge)
6. Place coupler into sustainer section aligning aft section of the sustainer with the center line drawn on the coupler
7. Use a twisting motion, to evenly distribute the epoxy
8. Clean off excess epoxy on exposed section of coupler
9. Set aside, let epoxy dry

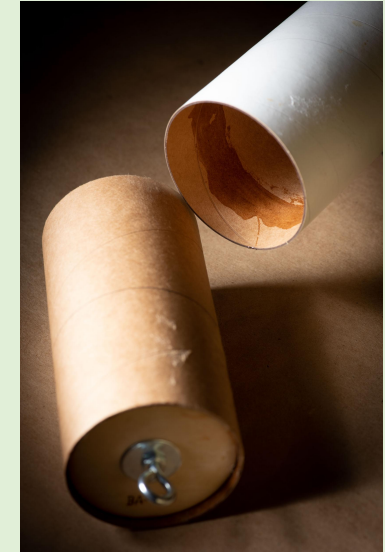


Figure 13-18: Epoxy Application (Top));Coupler Placement (Bottom)

# Rocket Build – Assembly

## *Motor Mount*

1. Attach the shock cord to the forward centering ring eyebolt using a quicklink in the shock cord loop and the eyebolt
  - a. A [double slip square knot](#) can be used if a loop is not on the shock cord OR if you do not have 2-3 quicklinks
    - i. Attach shock cord by feeding the cord through the eyebolt
    - ii. Feed the opposite end of the shock cord through the sewn loop
    - iii. Pull shock cord tight

**NOTE:** Step by step information on how to do this knot can be found on the next slide

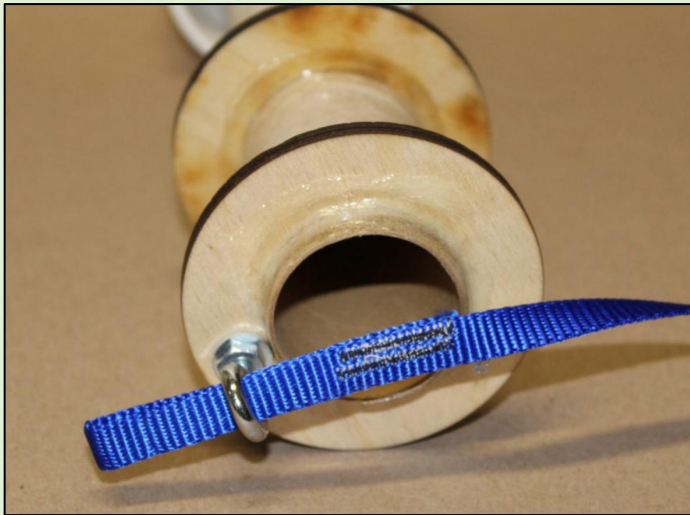


*Figure 13-19: Shock Cord and Quicklink*

# Rocket Build – Assembly

## *Motor Mount Knot Overview – Shock Cord*

### [Slip Knots for Beginners!](#)



1. Attach shock cord by feeding the cord through the eyebolt



2. Feed the opposite end of the shock cord through the sewn loop



3. Pull shock cord tight

# Rocket Build – Assembly

## *Motor Mount*

2. Re-coil shock cord, securing with masking tape when done

3. Leave enough length on the eyebolt end of the shock cord such that it will come out the end of the forward opening on the air frame



*Figure 13-20: Shock Cord  
Attached to Eyebolt*

# Rocket Build – Assembly

## *Motor Mount*

4. Stuff the bundle of cord inside the motor mount tube



*Figure 13-21: Shock Cord Installed Inside Motor Mount Tube Using Eyebolt (Left) and Quicklink and Eyebolt (Right)*

# Rocket Build – Assembly

## *Motor Mount*

5. Dry-Fit Step: Make sure motor mount tube fits into air frame properly, sand outer edge of centering rings as needed
  - a. Avoid making burrs on the inner edge of the airframe
  - b. If a burr occurs, gently sand the inner edge of the airframe
6. Slide motor mount tube into air frame forward the mid-centering location
7. Remove MMT after ensuring proper fit

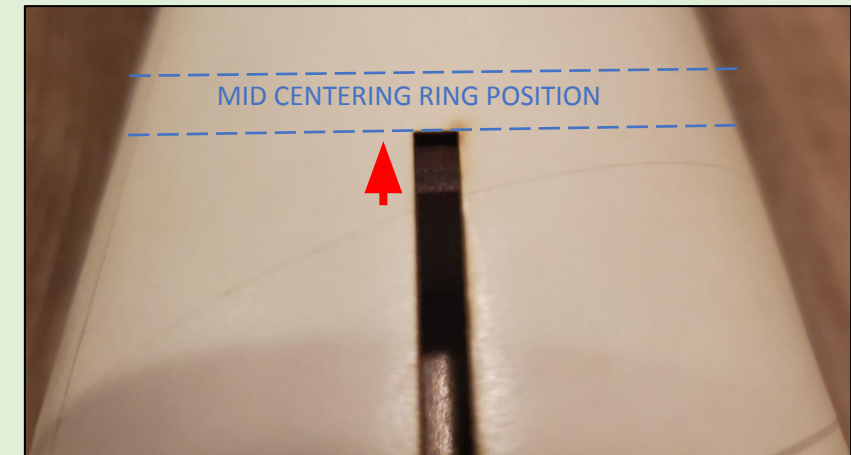


Figure 13-22: Relative Position of MMT Assembly Once Installed in Airframe (Top); Mid Centering Ring Should Sit Forward of Fin Slots (Bottom)

# Rocket Build – Assembly

## *Motor Mount*

8. Tape craft stick to the dowel rod - wrap 4-5 times minimum
9. Measure the distance from the top of the MMT to the forward centering ring using the craft stick/dowel rod
  - Make a mark on the dowel rod to indicate distance from aft end of the airframe to the forward centering ring
10. Put on gloves before preparing epoxy
11. Prepare small amount of epoxy



# Rocket Build – Assembly

## *Motor Mount*

12. Epoxy inside parameter of the aft air frame about a  $\frac{1}{4}$ " before the forward center ring location using craft stick taped onto dowel rod
13. Slide the motor mount tube into position
  - The Mid-Centering Ring must be just forward of the forward fin slot. If the mid-centering ring does not clear the slot, fins may not fit into the slots properly
  - The Motor Mount Tube should be flush with the aft side of the air frame
14. Stand airframe up with AFT down. Allow epoxy to dry

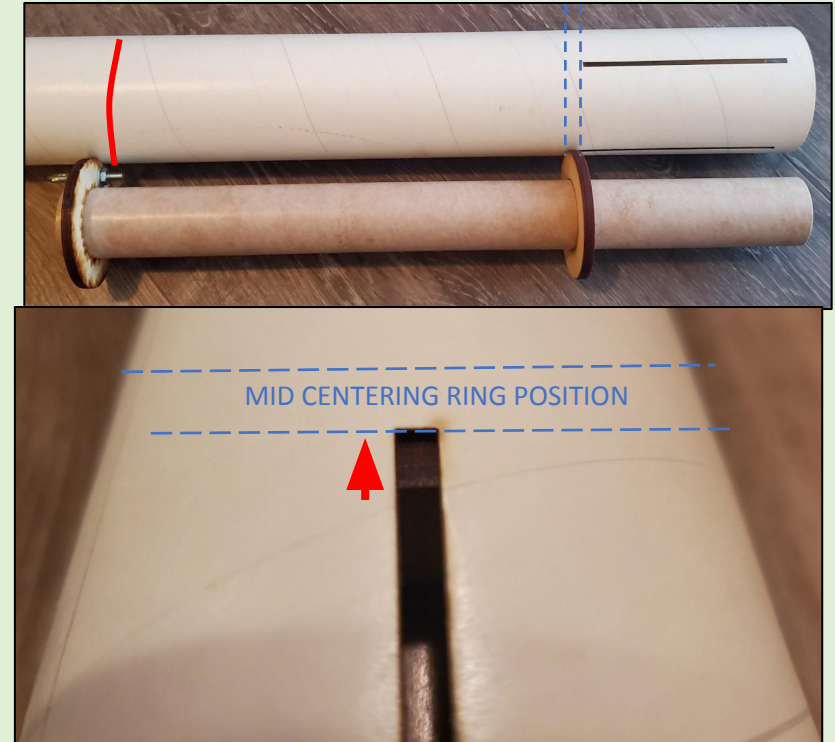


Figure 13-22: Relative Position of MMT Assembly Once Installed in Airframe (Top); Mid Centering Ring Should Sit Forward of Fin Slots (Bottom)

# Rocketry 101 - RockSim Motors

Motor – Aerotech 38mm H219T  
- DMS/ H100W -DMS

- <http://www.thrustcurve.org/>

What to do when there isn't an exact match

- <https://www.youtube.com/watch?v=QIXN5jGysQg&feature=youtu.be>



# Rocketry 101 - RockSim Motors

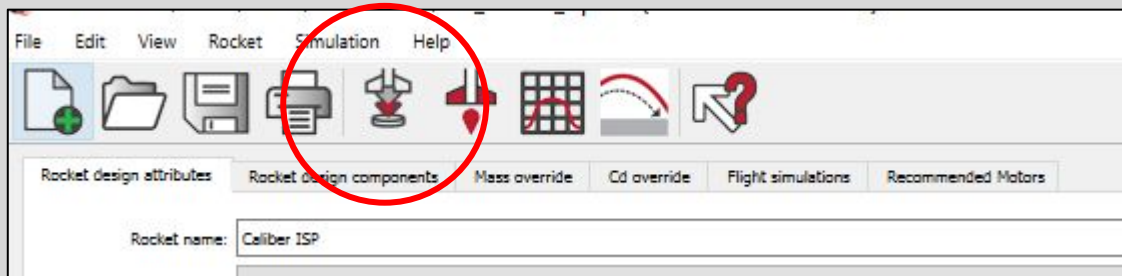


Figure 11-7: Prepare for Launch Icon

1. Select the 'Prepare for Launch' icon

1. Select the 'Choose Engine' tab

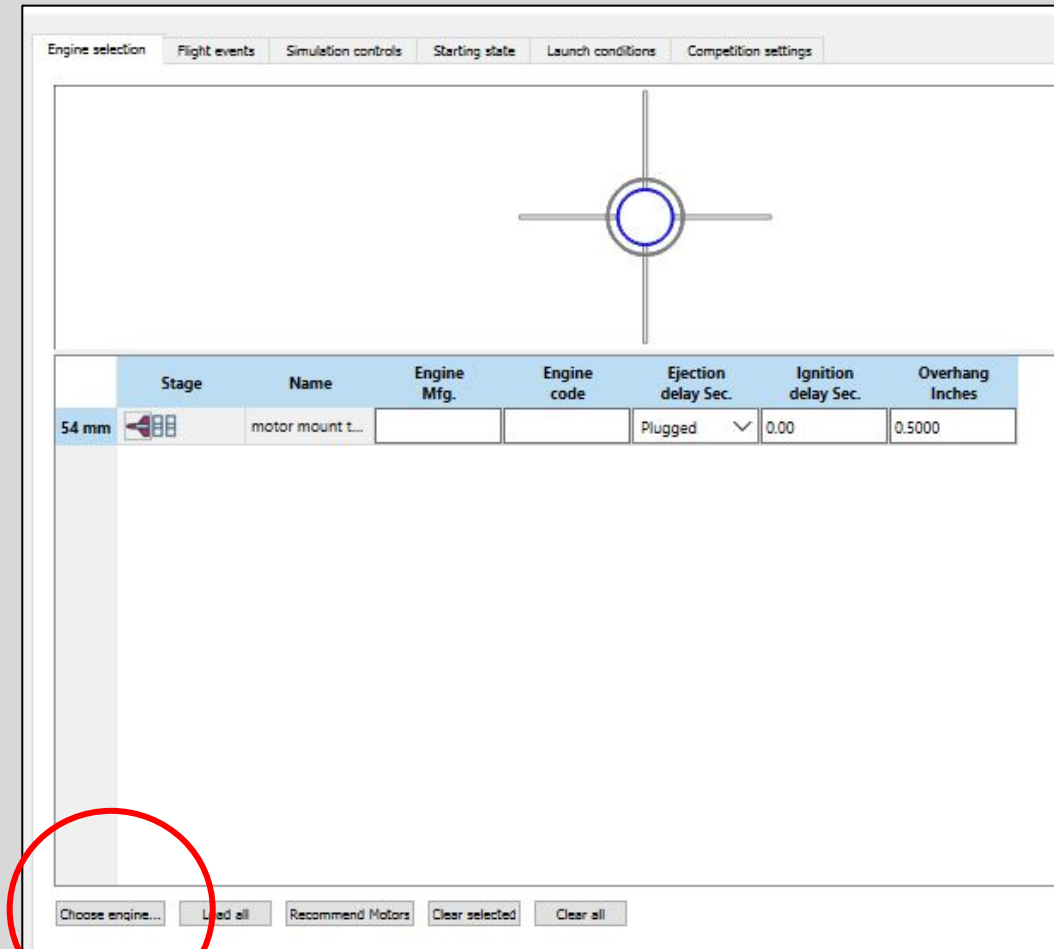


Figure 11-8: Choose Engine Tab

# Rocketry 101 - RockSim Motors

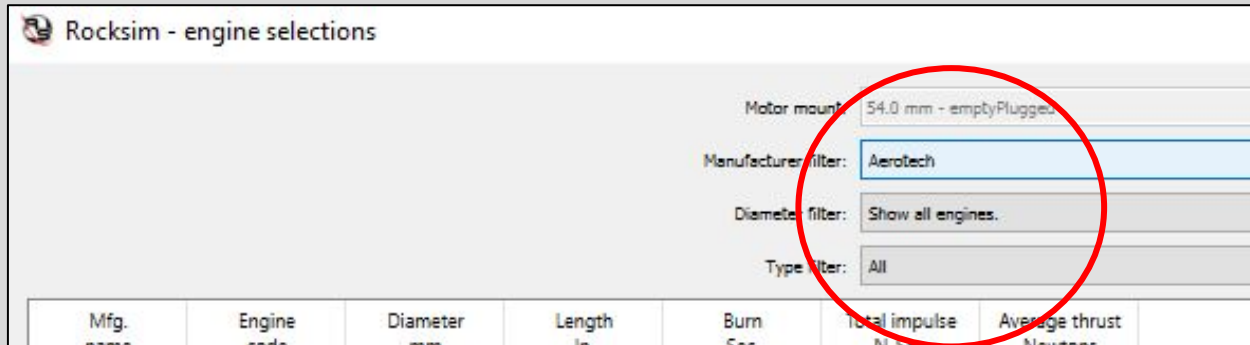


Figure 11-9: Manufacturer Field and Diameter Filter

3. Select 'Aerotech' in the Manufacturer Filter field
3. Select the 'Show all engines' in the Type Filter field
3. Double click on the H219T/ H100W -DMS motor

Mfg. name	Engine code	Diameter mm	Length in.	Burn Sec.	Total impulse N-Sec.	Average thrust Newtons
Aerotech	M1780NT	75.00	26.1811	3.04	5341.079	1759.828
Aerotech	M1800FJ	98.00	29.5669	4.95	8212.700	1658.461
Aerotech	M1845NT	98.00	23.5039	4.73	8093.458	1711.452
Aerotech	M4500ST	98.00	23.5039	1.69	7307.365	4321.328
AT	M6000ST	98.00	29.5669	1.74	9606.003	5533.412
Aerotech	N1000W	98.00	41.1811	16.14	14138.407	876.235
Aerotech	N2000W	98.00	41.1811	7.68	13263.435	1727.235
Aerotech	N3300R	98.00	41.7323	4.52	14035.152	3105.809
Aerotech	N4800T	98.00	47.2835	5.21	19273.861	3702.240
Aerotech	O5280X	98.00	59.0157	4.52	22223.946	4920.068
Aerotech	H283ST	38.00	6.1024	0.74	199.083	269.031
Aerotech	I175WS	38.00	8.4252	1.97	333.196	169.135
Aerotech	G80T	29.00	4.8819	1.50	116.252	77.501
Aerotech	D22W	24.00	3.4252	1.01	19.243	19.053
Aerotech	E26W	24.00	3.4646	1.22	27.619	22.583
Aerotech	F52C	29.00	4.3701	1.33	66.311	49.895
Aerotech	G12ST	29.00	6.1417	12.60	145.847	11.574
Aerotech	H13ST	29.00	8.3858	15.43	214.935	13.928
Aerotech	G85T	29.00	6.1417	19.96	129.868	6.505
Aerotech	K400C	54.00	14.1339	3.26	1307.257	401.122
Aerotech	H219T	38.00	6.1024	1.08	234.561	216.985
Aerotech	F52C	29.00	4.3701	1.33	66.311	49.895
Aerotech	I130-300CC080	51.00	20.5118	4.00	477.075	119.269

Figure 11-10: Aerotech H219T Motor Selection

# Rocketry 101 - RockSim Motors

The Aerotech H219T/H100W will automatically load into the RockSim software

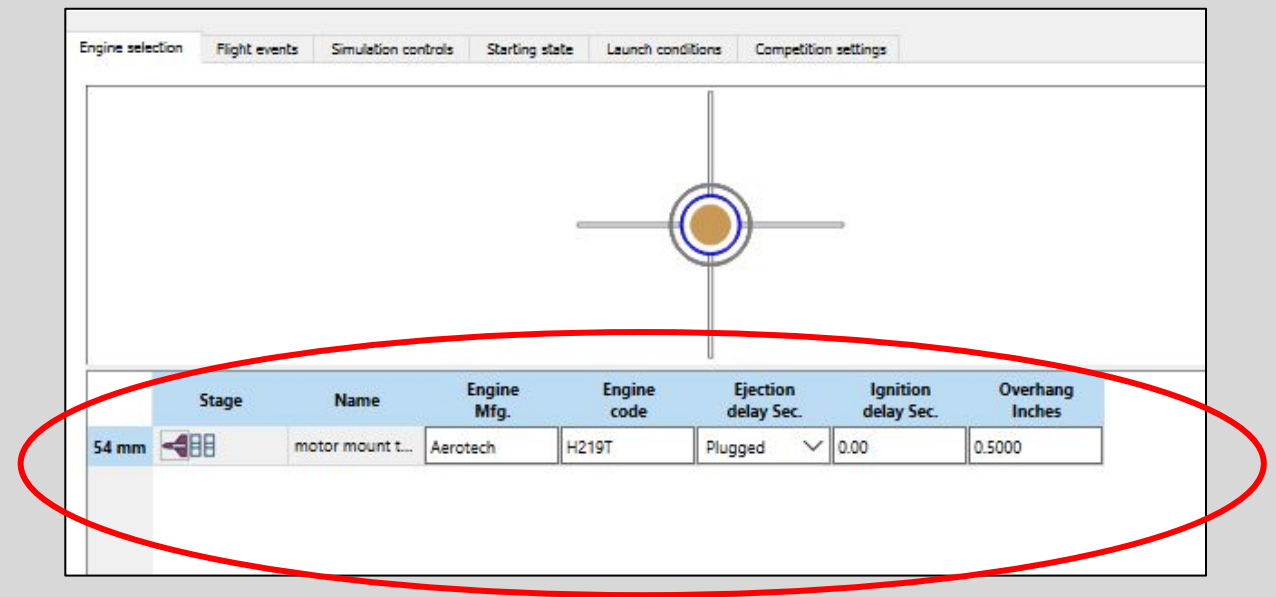


Figure 11-11: Motor Uploaded to RockSim

# Rocket Build – Assembly

## *Nose Cone*

1. Fit the nose cone to the sustainer
  - a. Should not require sanding
2. Drill a single hole at location shown, through both airframe and nose cone with an awl or  $\frac{1}{8}$ " drill bit
3. Attach the nose cone to the airframe with a **#8  $\frac{1}{2}$ " wood screw** (pointed screw) to keep the nose cone from separating in flight (but allow for removal of nose cone)



Figure 13-23: Drilling the Airframe and Nose Cone (Left); Figure 13-24: Nose Cone Fitted on Sustainer, Red Dot Indicates Drill Mark

# Rocket Build – Assembly

## *Rail Button Alignment*

### Rail Guide System

- 1010 rail guide (it's a 1.0" x 1.0" rail)
- 6' (or 72 inches) in length



*Figure 5-6: Rail Guide*

# Rocket Build – Assembly

## *Rail Button Alignment*

1. Temporarily position a 4"- 5" length of tape between the fin slots. Place a mark on tape, just inside of both fin slots.
2. Remove the masking tape
3. Fold masking tape in half on non-stick side, matching the two fin slot reference marks
4. Make a crease at the middle location

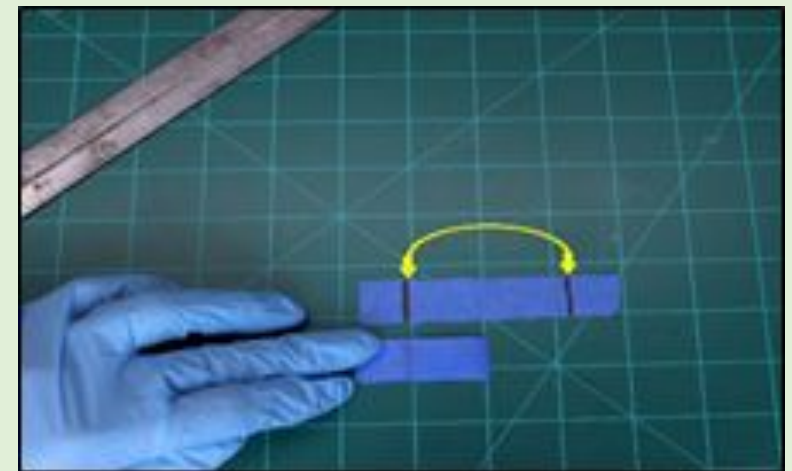
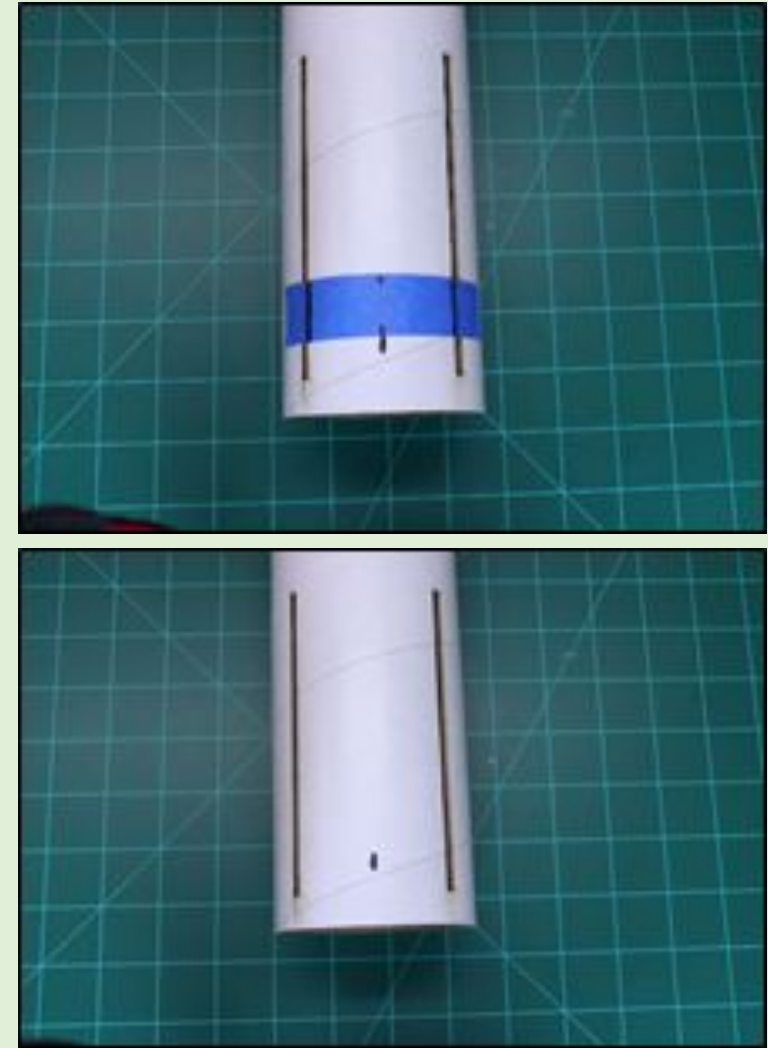


Figure 13-25: Measuring Fin Slots (Top); Measuring Half Way between Two Fin Slots (Bottom)

# Rocket Build – Assembly

## *Rail Button Alignment*

5. Place the strip of masking tape back on the airframe matching lines to the fin slots
6. Mark the center point at the crease line, making a line half way between the two fin slots on the aft portion of the booster section

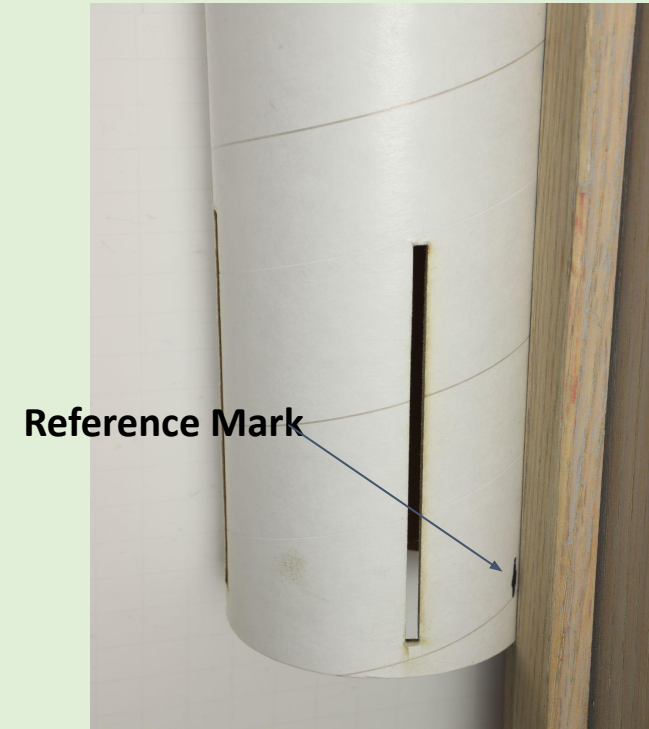


*Figure 13-25: Drawing a Line at the Half Way Mark on Tape(Top); Drawing the Half Way Mark on the Air Frame (Bottom)*

# Rocket Build – Assembly

## *Rail Button Alignment*

7. Draw a line halfway up the air frame
  - a. Use door frame, window frame or table/counter edge to draw line
8. This is the line the rail buttons will be installed on after the fins have been installed



*Figure 13-25: Markers to Indicate Rail Button Placement/Alignment (Bottom)*

# Rocket Build – Assembly

## *Vent Holes*

- Vent (pressure relief) holes allow the pressure inside the rocket to equalize to the external atmosphere.
- Usually 1/8"-1/4" in diameter

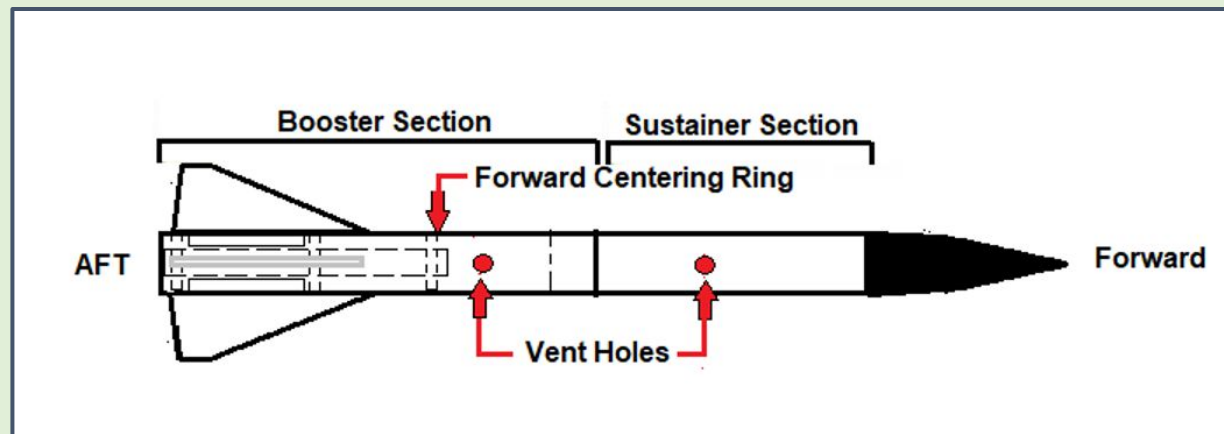
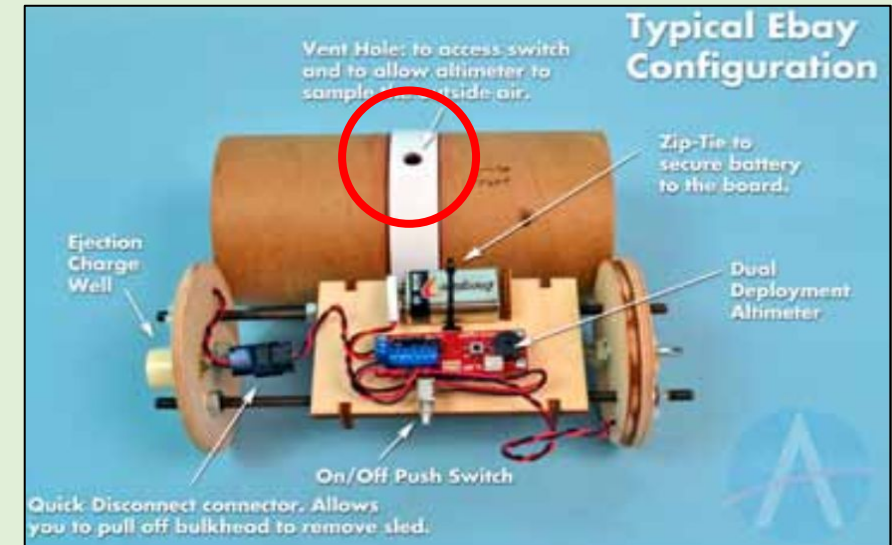


Figure 13-27: Vent Holes Indicated in Red on Rocket Airframe

# Rocket Build – Assembly

## *Vent Holes*

1. Drill first hole with an awl or  $\frac{1}{8}$ " drill bit in the middle region of the sustainer
  -
2. Drill second hole with an awl or  $\frac{1}{8}$ " drill bit in the booster region above the motor mount tube/fins

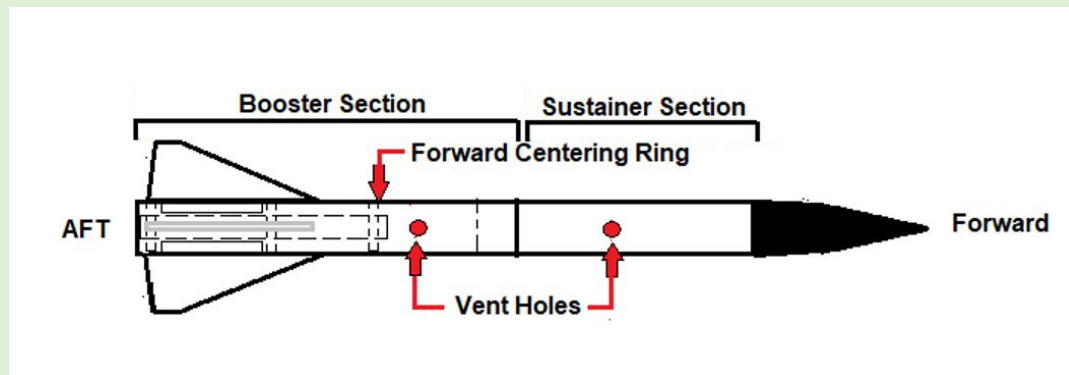


Figure 13-27: Vent Holes Indicated in Red on Rocket Airframe

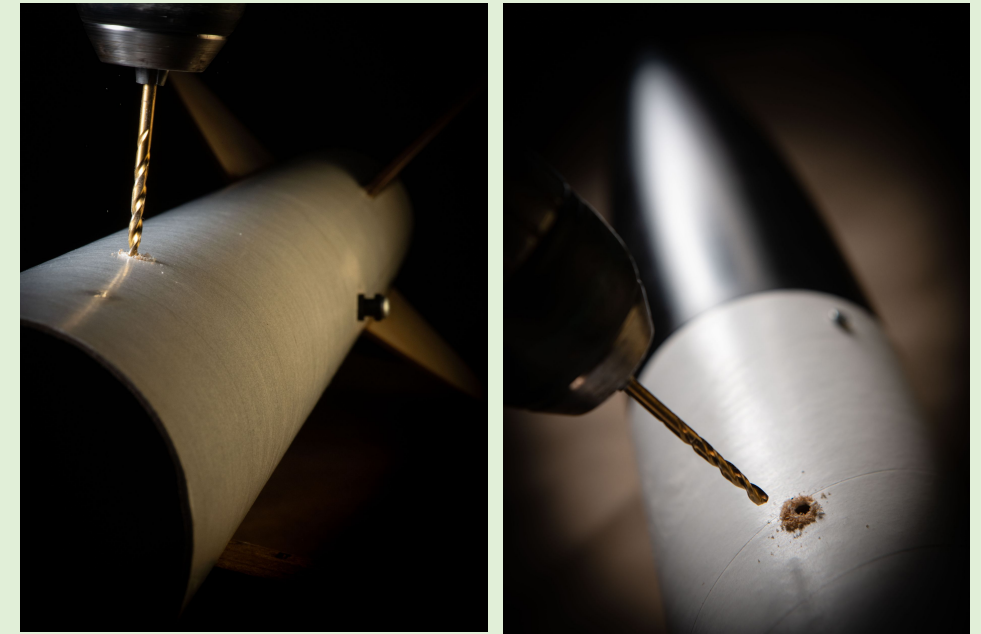


Figure 13-28: Drilling Vent Hole in Booster Section to Not Interfere with Rail Buttons Alignment (Left); Drilling Vent Hole in Sustainer Section (Right)



# LUNCH BREAK

*Remember...to be early is to be on time and to be on time is to be late. Saturday's presentation is being condensed by 3 hours.  
We have lots to cover in a short period of time!*

# Workshop Morning - Review

1. Name the parts of the rocket.
2. Where should the mid centering ring be installed inside the airframe?
3. What makes up the aft portion of the rocket?
4. What is the minimum thrust to weight ratio required?

# Rocket Build – Assembly

## *Fin Installation*

### Dry-fit and Tack

1. Dry-fit fins into slots
2. Retrieve fin installation guide from binder, and place guide on floor
3. Set air frame on the center circle on the guide
4. Align each fin to the crosshair lines
5. Remove fin and sand to ensure fin when inserted flush to motor mount
6. Remove fins before preparing epoxy

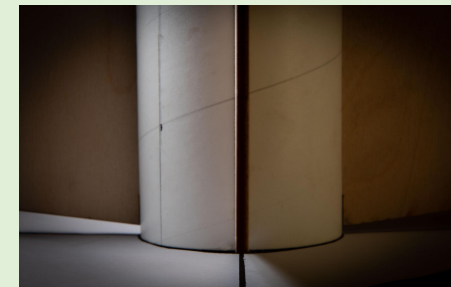
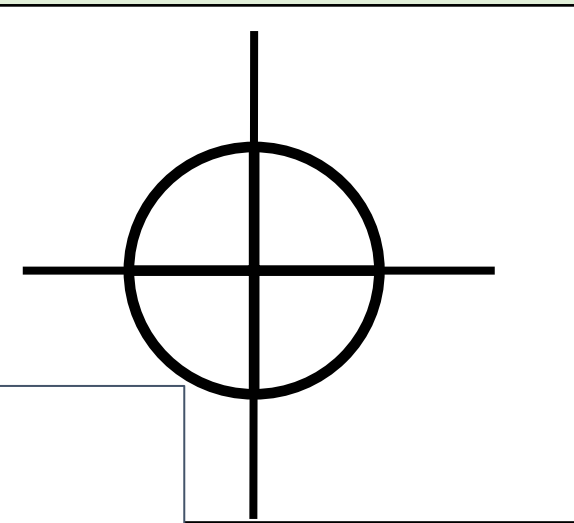
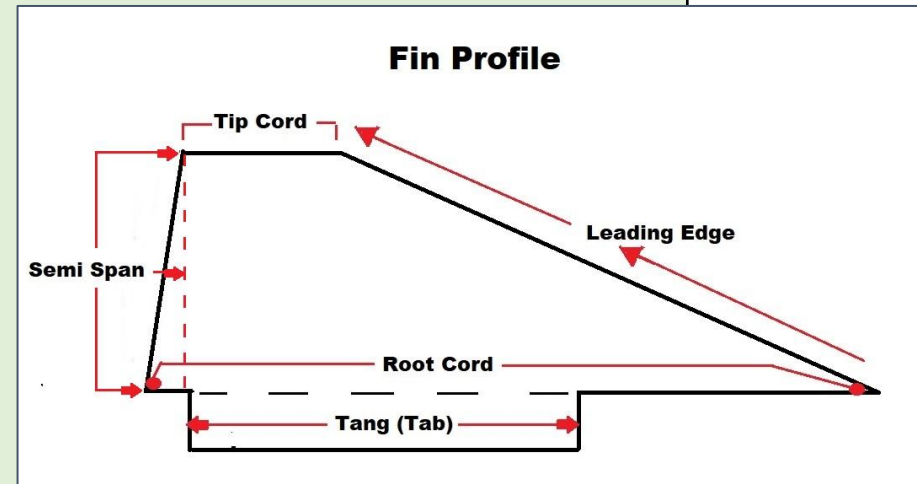


Figure 13-29: Align Each Fin to Crosshair Lines

# Rocket Build – Assembly

## *Fin Installation*

7. Put on gloves before preparing epoxy
8. Prepare small amount of epoxy
9. Apply epoxy to “Tang” side of fin #1 (light tack)
10. The span (b) is placed at the aft end of the airframe
11. Insert fin into fin slot – repeat for each fin
  - a. Ensure the tang touches the motor mount tube

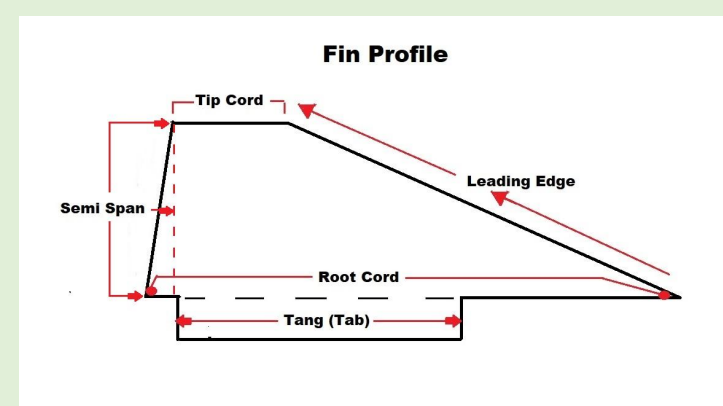


Figure 13-30: Tang Example (Top); Apply Epoxy to Tang (Center); Insert Tang in Fin Slot (Bottom)

# Rocket Build – Assembly

## *Fin Installation*

12. Place assembly on fin installation guide, and align fins - tape fins to the airframe as needed
13. **Do these steps quickly to get all fins tacked/aligned before the first fin cures - approximately 3-5 minutes from when epoxy mixed**

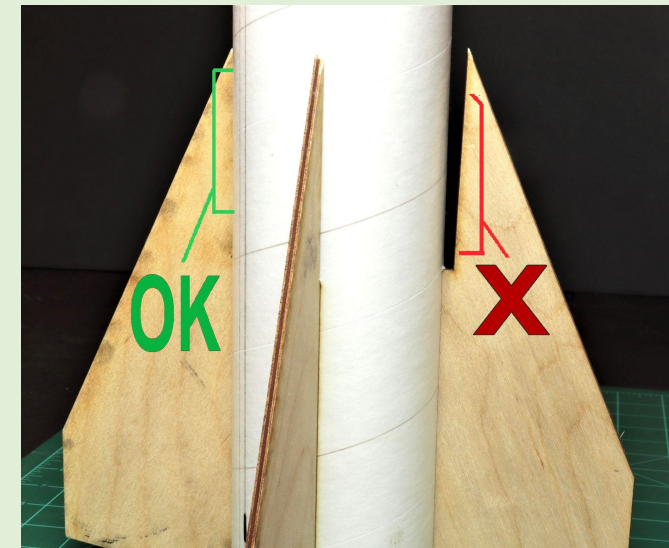
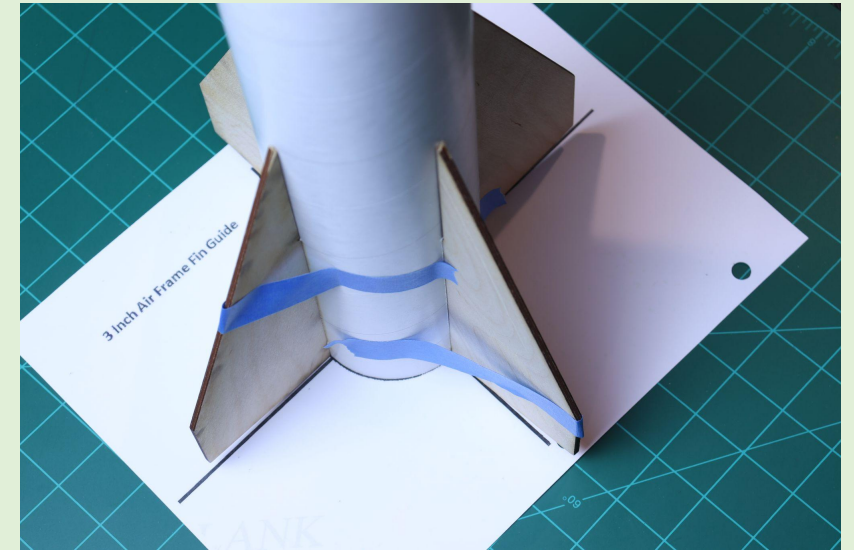


Figure 13-30: Tang Example (Top); Apply Epoxy to Tang (Center); Insert Tang in Fin Slot (Bottom)

# Rocketry 101 - Stability Overview

## Center of Gravity (CG)

- What is it? Where is it?

## Center of Pressure (CP)

- What is it? Where is it?

## Stability Margin (SM)

- How do you determine the SM?

Remember: simulated CG and CP are not actual CG and CP (although they should be close!)

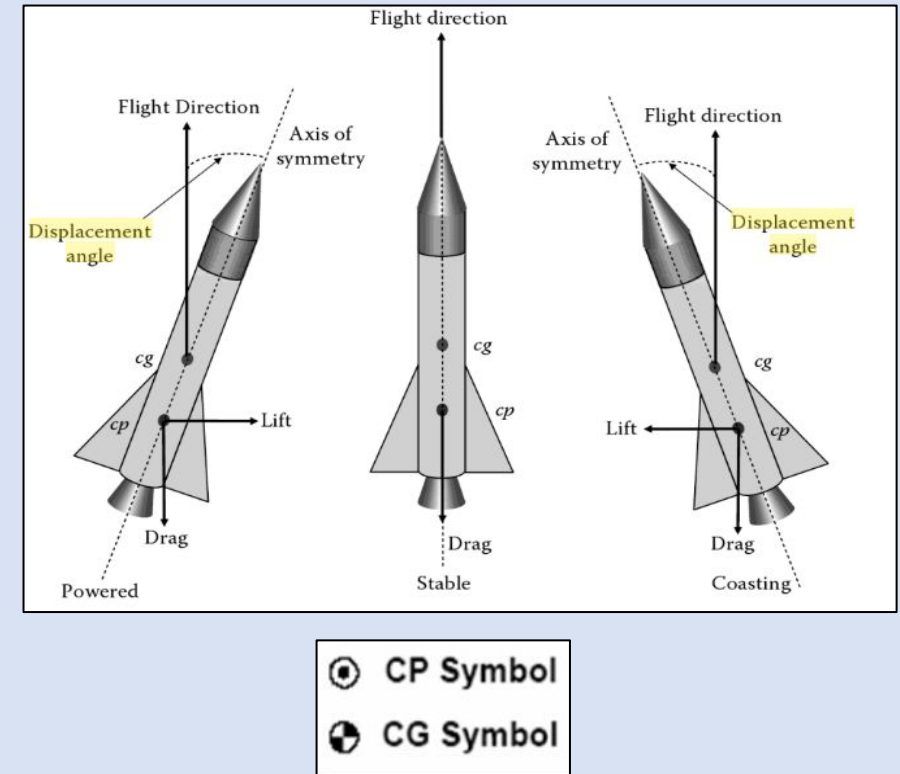


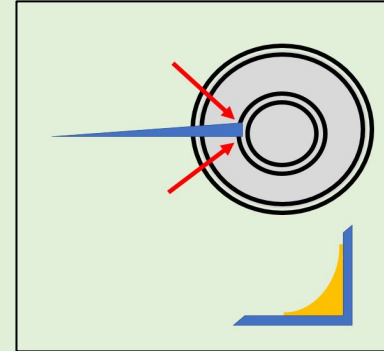
Figure 7-1: Rocket Stability Diagram

# Rocket Build – Assembly

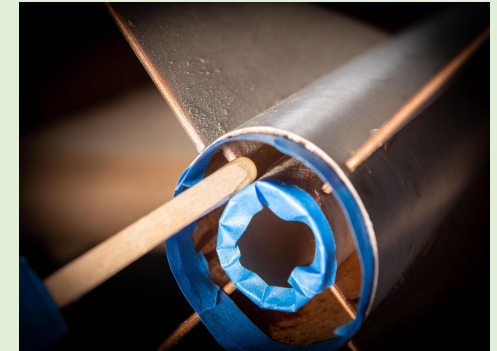
## *Fin Installation*

### Inner Fin Fillets

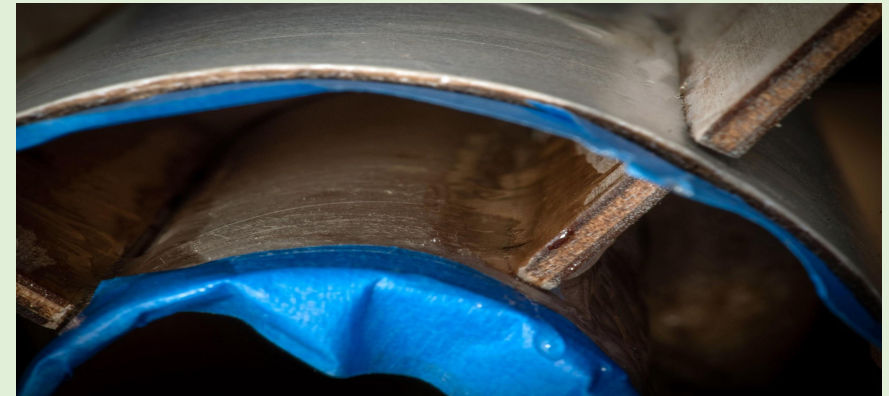
1. Preparation: Apply masking tape to outside diameter of motor mount tube and airframe (up to fin tab)
2. Put on gloves before preparing epoxy
3. Prepare small amount of epoxy
4. Apply epoxy fillet to seam between motor mount tube and “tang” side of the fin
5. Use long dowel to apply along full length
6. Apply quickly with large dollops
7. Apply a total of 8 fillets (on each side of 4 fins)
8. Allow epoxy to set, remove tape while wet (within 15 minutes)



*Figure 13-31: Epoxy Fillet to Seam Motor Mount and Tang*

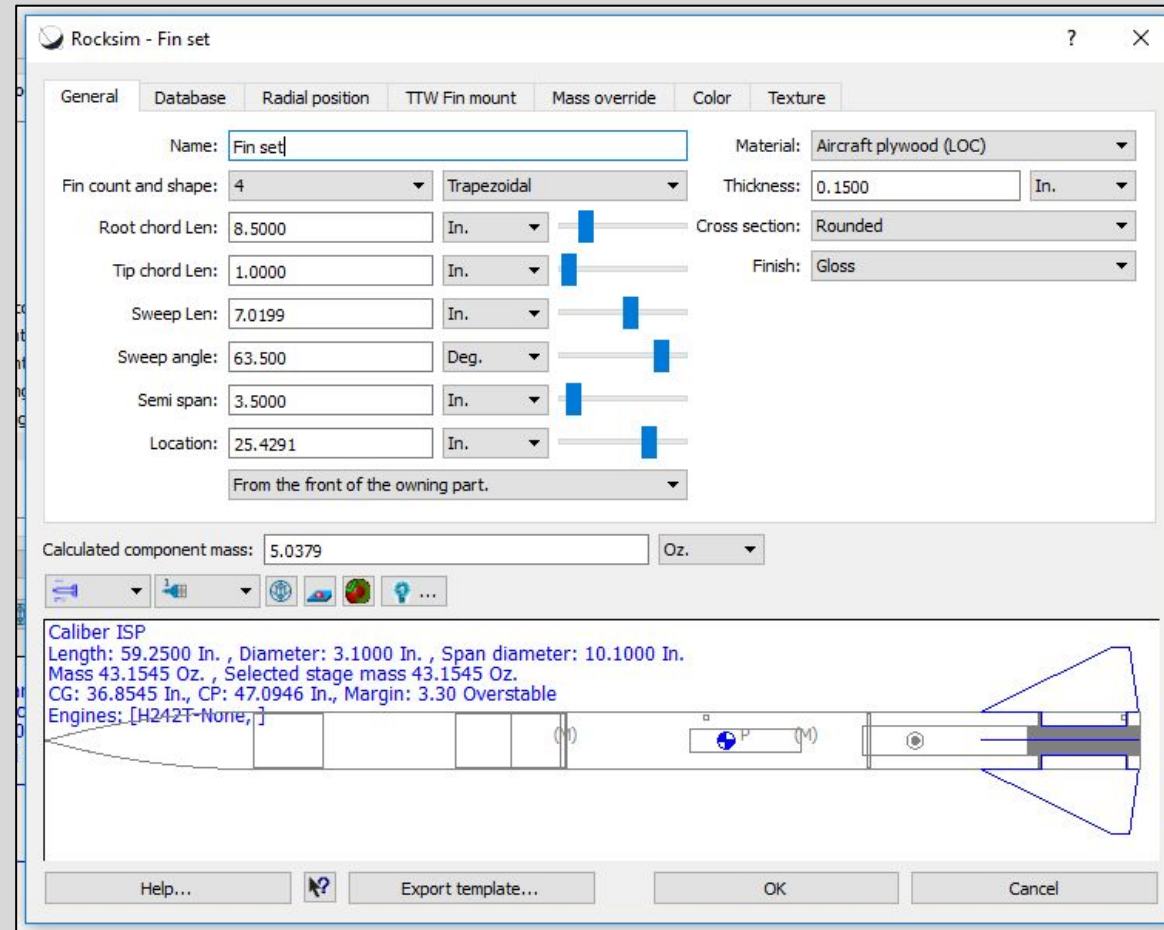
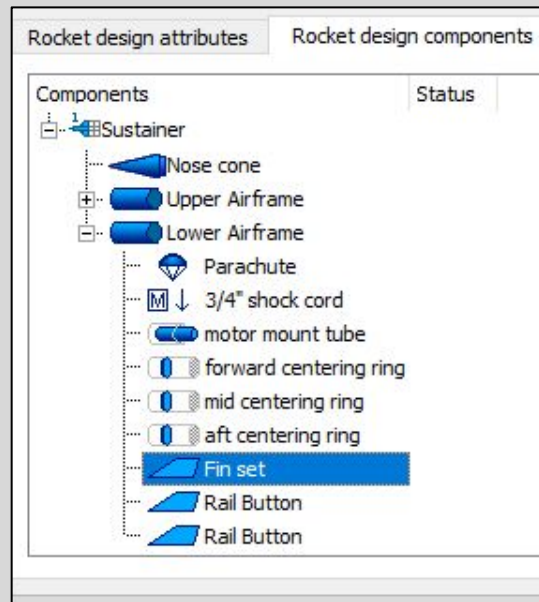


*Figure 13-32: Use Craft Stick or Long Dowel to Apply Epoxy Fillet between Motor Mount and Fin*



*Figure 13-33: Fully Applied Epoxy Fillet between Motor Mount and Fin*

# Rocketry 101 - RockSim Update

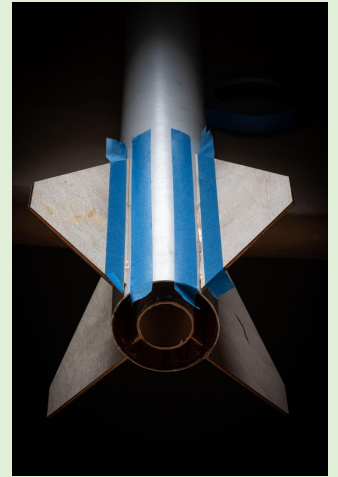
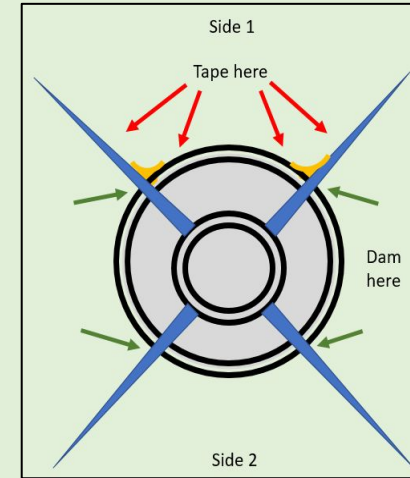


# Rocket Build – Assembly

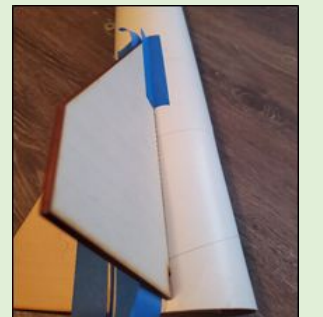
## *Fin Installation*

### Outer Fin Fillets (Prep)

1. Fillet tape must be installed parallel to fin, along the full length about 1/4" away from corner
  - a. On both fin and tube (red arrows)
2. Repeat fillet tape for all four fins
  - a. Will be 16 strips of tape for entire rocket for fillets
3. With the rocket positioned as shown, place 4 pieces of tape to create 4 dams to fill in the small gap between the fin and tube, on top of fillet tape
4. Place tape under fin long enough to cover gap
  - a. Must be tight in corner, so epoxy does not leak through (green arrows)

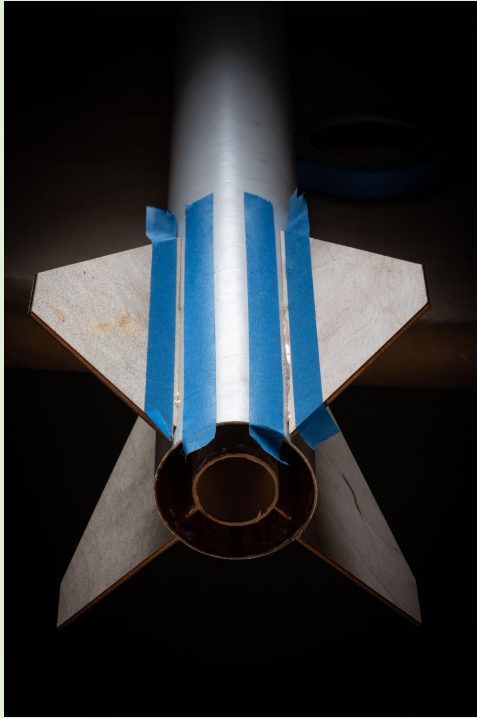


Figures 13-34, 13-35: Tape and Dam Diagram; (Top Left); Tape Locations for Epoxy Fillets (Top Right, Center); Dam Locations (Bottom Right)



# Rocket Build – Assembly

## *Fin Installation*



*Figure 13-35: Tape Locations for Epoxy Fillets (Left, Center); Dam Locations (Right)*

# Rocket Build – Assembly

## *Fin Installation*

### Outer Fin Fillets (Epoxy)

5. For Side 1 (as shown):
  - a. Put on gloves before preparing epoxy
  - b. Prepare the right amount of epoxy (not a lot, you can mix more if needed)
  - c. Fill in gap with epoxy (both fins) – let set few minutes, ensure epoxy is not leaking past dam on underside near the leading edge and AFT end near the semi span.
  - d. Epoxy along entire length of fin root, create smooth fillets with craft stick (both fins)
  - e. Remove dam tape from underside after 10 minutes
  - f. Immediately remove both fillet tapes from Side 1 (tube and fins)
  - g. Let set up for 10 – 12 minutes
6. Rotate rocket 180 degrees, and repeat for Side 2
7. Sides 3 and 4 do not require a dam step, fillet only

### Fin failure (1:00)

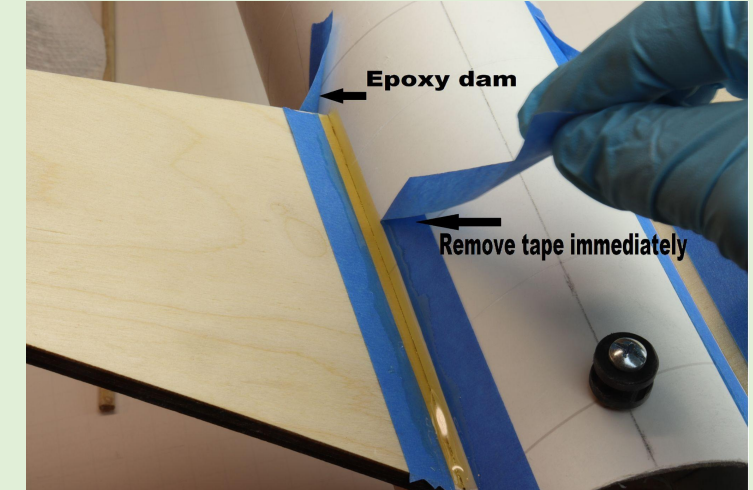
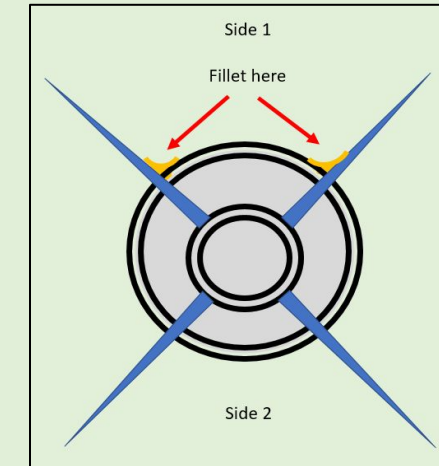


Figure 13-36: Fillet Diagram (Top); Fin Fillet Fill (Bottom)

# AFTERNOON BREAK

*Remember...to be early is to be on time and to be on time is to be late. Saturday's presentation is being condensed by 3 hours.  
We have lots to cover in a short period of time!*

# Workshop Afternoon - Review

1. What can result from improper fin installation?
2. Describe the rocket CP?
3. Describe the rocket CG?
4. What is the optimal stability margin/caliber?
5. What type of knot is used to connect the shock cord for the motor mount assembly?

# Rocket Build – Assembly

## *Aft Centering Ring Installation*

1. Install #8 wood screws halfway into Aft centering ring for use as handle. **Do not push down on these screws. Use them to pull out AFT ring only. Push down on ring only to install.**
  - a. Dry-fit Step: Ensure the aft end of booster is free of epoxy, for ease of fit (sand or wipe with alcohol)
  - b. Dry-fit Step: Ensure CR fits in tube, all the way until contact with fin tabs (will be an edge as shown) – sand as needed
  - c. Remove aft CR after dry-fit
2. Put on gloves before preparing epoxy
3. Prepare a small amount of epoxy
4. Apply a band of epoxy around outside of MMT and inside of airframe

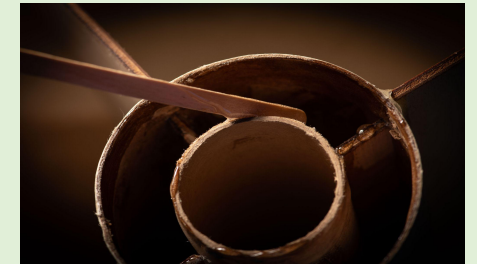
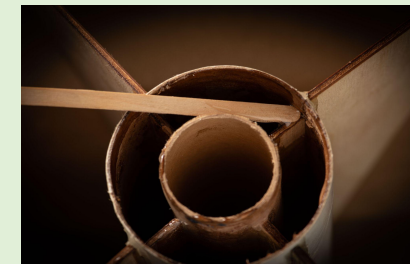
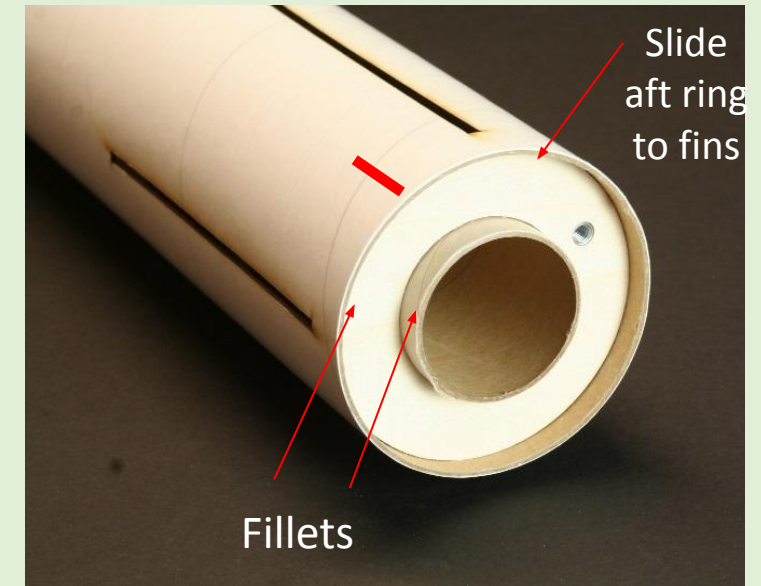
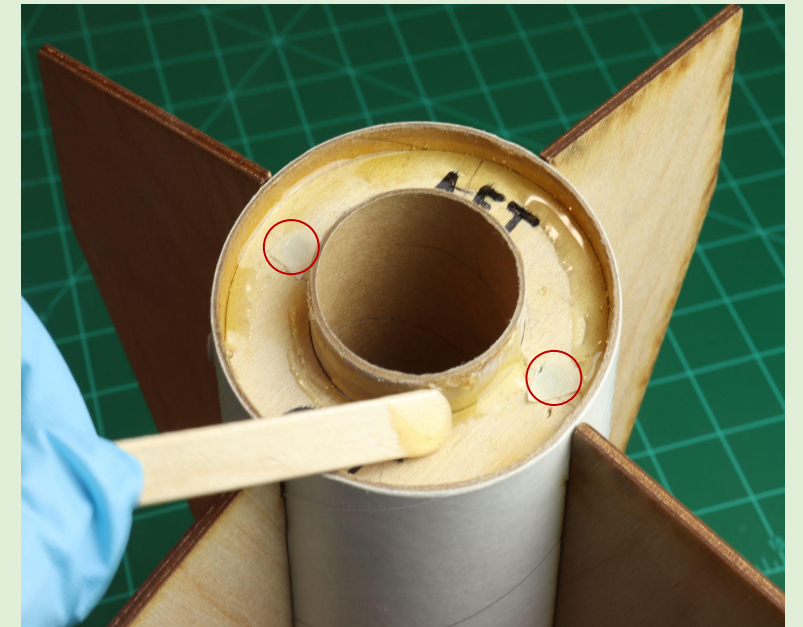


Figure 13-37: Slide Aft Ring to Fins (Top); Epoxy Outside of MMT (Left Middle); Epoxy Inside of Airframe (Right Middle)

# Rocket Build – Assembly

## *Aft Centering Ring Installation*

5. Twist centering ring into place, pushing in all the way until it stops against fin tabs
6. **Ensure wood screw is offset from rail button mark and fin tangs**
7. Apply fillet on aft end of aft CR
  - a. Avoid getting epoxy in MMT and in pre-drilled motor retainer holes
  - b. (Optional) Tape MMT to avoid getting epoxy in MMT
  - c. (Optional) Add screw into hole



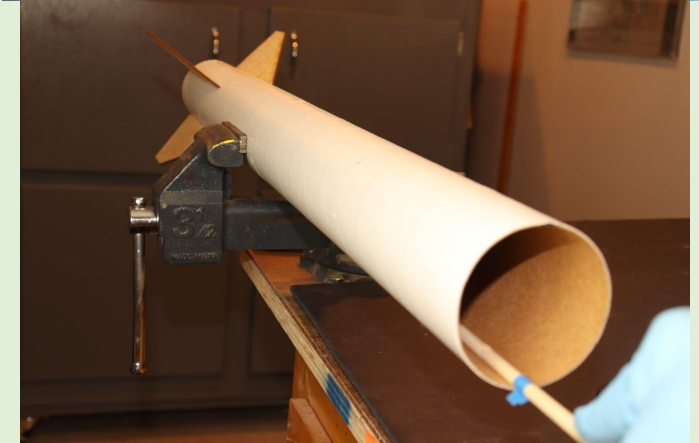
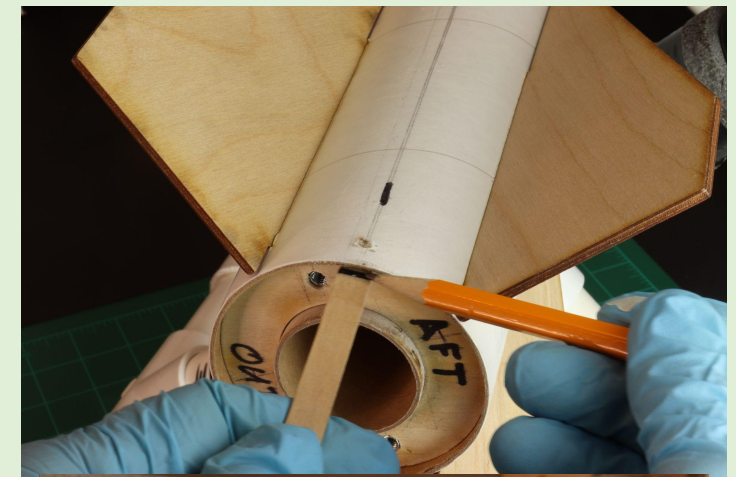
# Rocket Build – Assembly

## *Rail Button Installation*

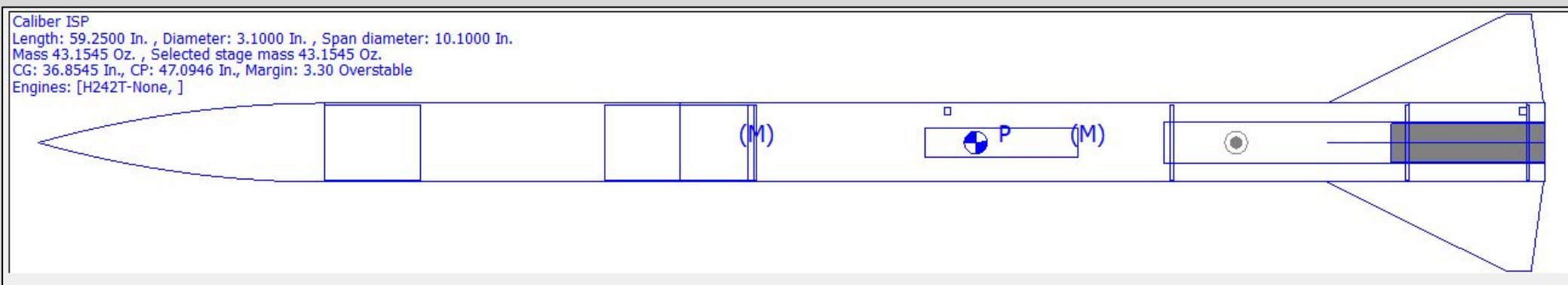
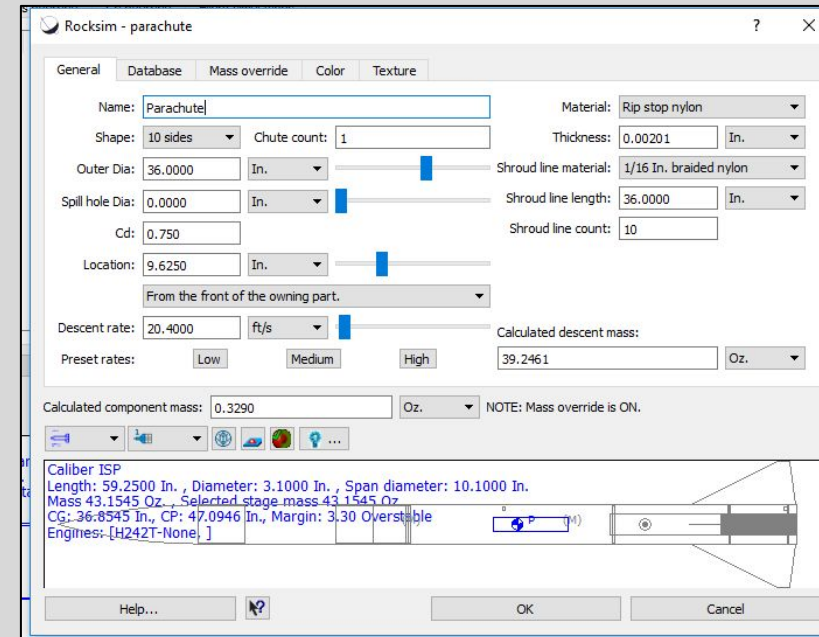
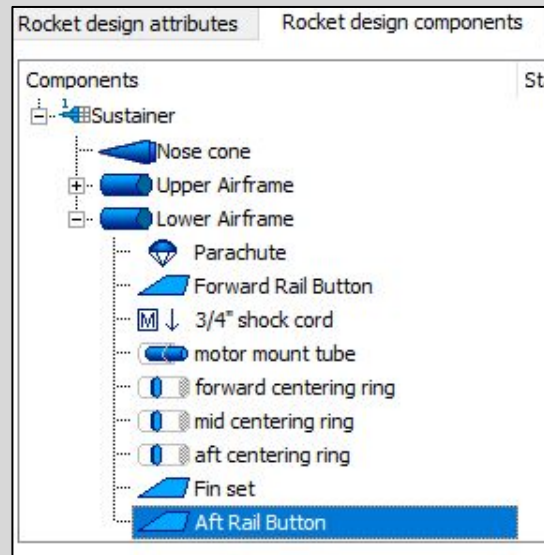
Rail Buttons are installed so that your rocket can be fit to a standard launch rail. Tape a craft stick to the end of your 18" dowel.

The bottom rail button will be installed into the aft centering ring, while the top rail button will be installed into the airframe (with backing nut – or into forward centering ring)

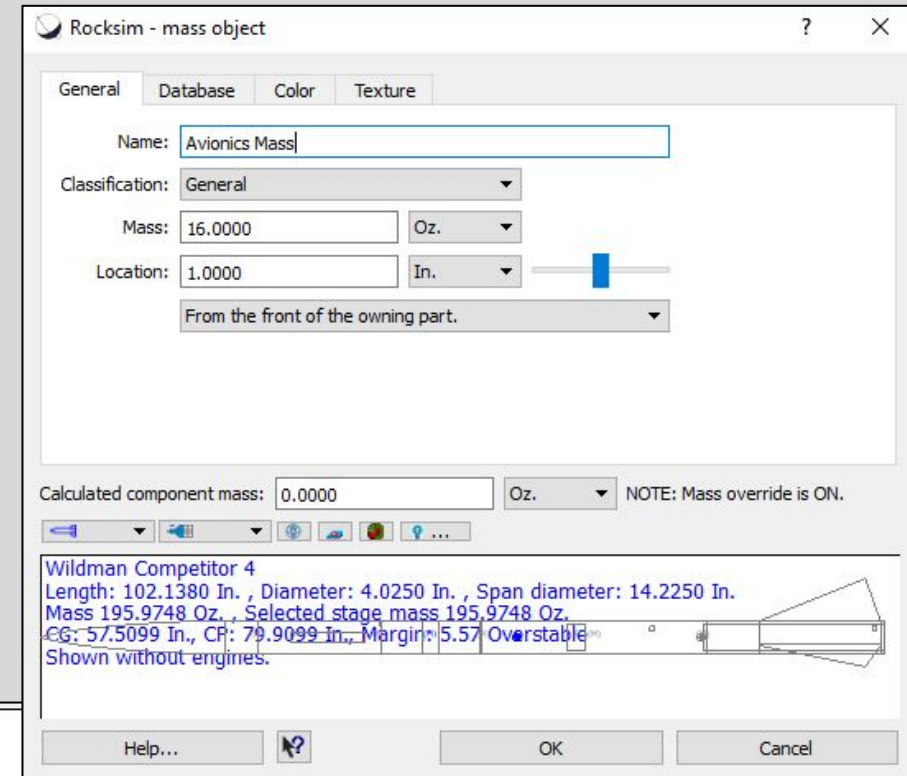
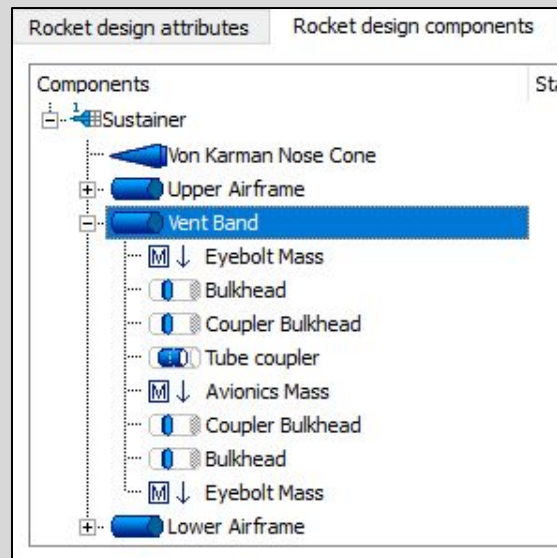
1. Mark an 'X' on the vertical line where it intersects the aft CR
  - a. Use a craft stick to gauge the depth of the aft CR. (add  $\frac{1}{8}$ " )
2. Mark an 'X' on the vertical line near the forward CR
  - a. Insert into forward end of airframe until it touches the forward CR. Beware dowel must be in contact with CR not the eyebolt.
  - b. Mark line on dowel indicating end of airframe, remove and place on top of airframe to use as "measuring gauge" (add  $\frac{1}{8}$ " )
3. Drill holes using a  $\frac{1}{8}$ " drill bit – ensure hole is perpendicular to surface
4. Dab epoxy in hole
5. Attach rail buttons and pointed wood screws into place



# Rocketry 101 - RockSim Update



# Rocketry 101 - RockSim Update



Wildman Competitor 4  
Length: 102.1380 In. , Diameter: 4.0250 In. , Span diameter: 14.2250 In.  
Mass 195.9748 Oz. , Selected stage mass 195.9748 Oz.  
CG: 57.5099 In., CP: 79.9099 In., Margin: 5.57 Overstable  
Shown without engines.



# Rocketry 101 - Parachute Selection

There are two requirements to assist with parachute selection

- Descent Velocity – a safe rule of thumb to adhere to is a descent velocity (or descent rate) of approximately 20 ft/s
- **NOTE: TRA recently changed the descent rate to 30 ft/s**

Most rocket simulators will determine the descent velocity for you

- The weight of the model must be as accurate as possible however
- Descent rate will also be affected by the motor selection (weight)

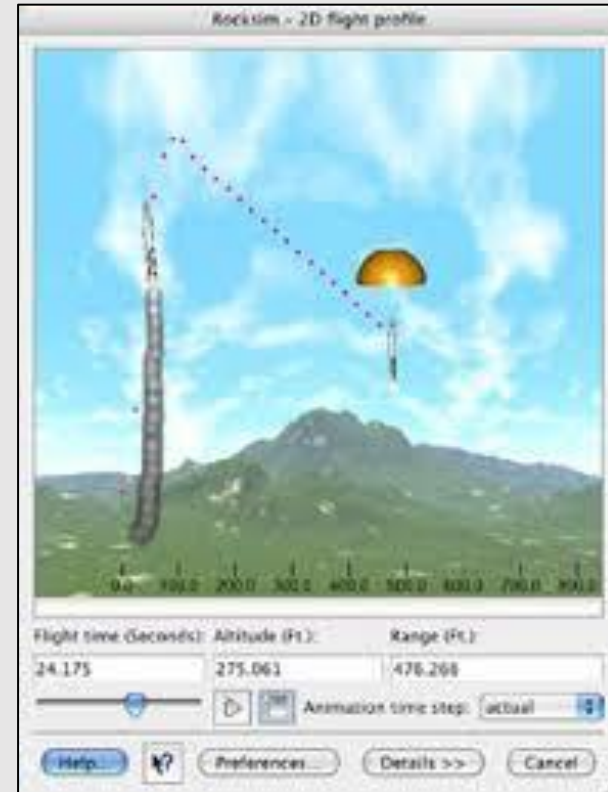
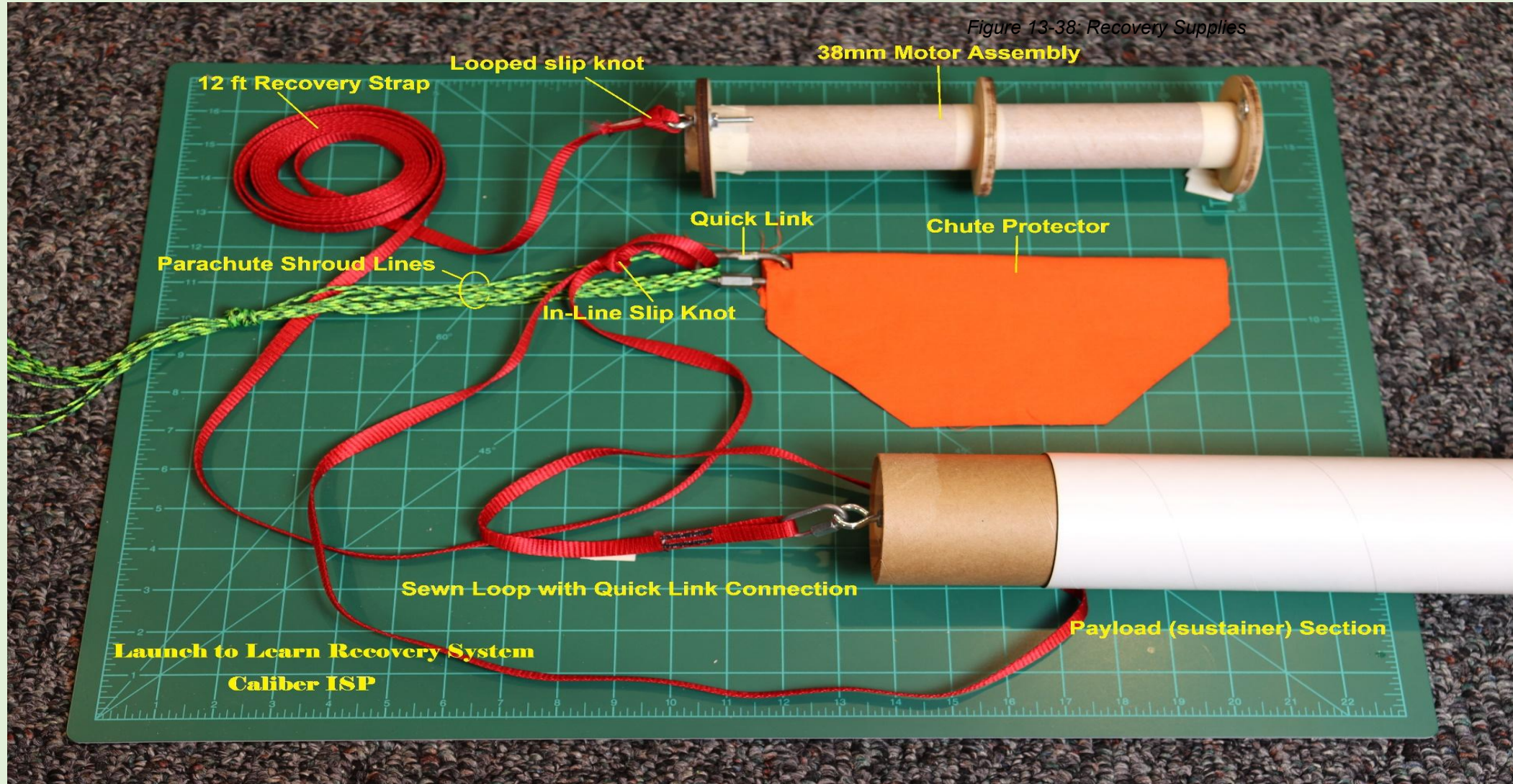


Figure 8-6: Example Recovery Simulation

# Rocket Build – Assembly

## *Recovery Installation*



# Rocket Build – Assembly

## *Recovery Installation*

### Failed parachute deployment

1. Push shock cord out through forward end of airframe, remove masking tape
2. Tie a knot in the shock cord (at 1/3 total distance from end)
  - A quick-link may be used at this step as an alternate method
3. Untangle parachute shroud lines
4. Place arm through the shroud lines



Figure 13-40: Masking Tape and Shock Cord (Top); Knot Location on Shock Cord (Bottom)

# Rocket Build – Assembly

## *Knot Overview - Parachute*

5. Attach the parachute to the parachute protector with a knot (step-by-step procedure next slide)



a. Feed shroud lines through sewn loop in shock cord end



b. Pass parachute through shroud lines

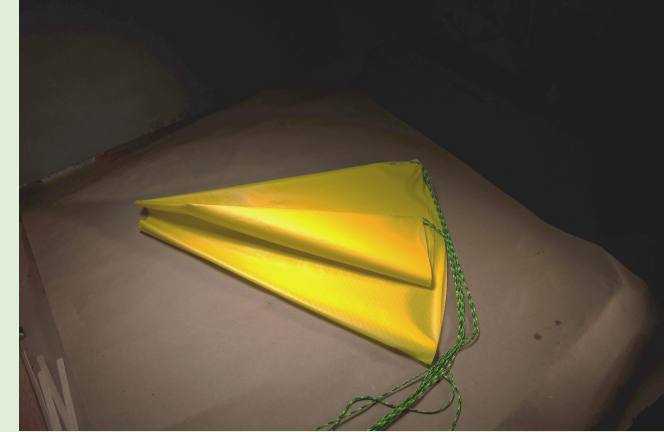


c. Pull parachute tight

# Rocket Build – Assembly

## *Parachute Preparation*

1. Make sure the parachute shroud lines are untangled, then lay it flat on the table
2. Position one shroud line nearest you, then start folding the parachute gores into angular sections by bringing each consecutive shroud line over the first and evening out the fold up to the tip



*Figure 13-44: Step 1 of Parachute Prep*



*Figure 13-45: Step 2 of Parachute Prep*

# Rocket Build – Assembly

## *Parachute Preparation*

3. Once all gores are folded with all shroud lines together, it should appear like this
4. Fold the parachute like a zig-zag



Figure 13-46: Step 3 of Parachute Prep

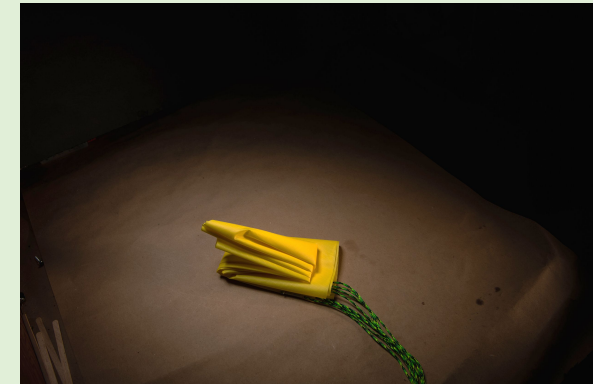


Figure 13-47: Step 4 of Parachute Prep

# Rocket Build – Assembly

## *Parachute Preparation*

5. Tightly roll the parachute into a cylinder. Ensure all shroud lines are still untangled and together.
5. Neatly bring the shroud lines together in a zig-zag fashion and place them next to the parachute at one corner of the parachute protector or Nomex cloth
  - a. Watch demo of alternate method with small Nomex cloth



Figure 13-48: Step 5 of Parachute Prep



Figure 13-49 Step 6 of Parachute Prep

# Rocket Build – Assembly

## *Parachute Preparation*

7. Start rolling the Nomex over the parachute and shroud lines. Keep it snug. Then place the shock cord onto the Nomex using the same method as the shroud lines.
8. Fold the left and right corners of the Nomex inward, then continue rolling the bundle tightly, keeping all of the shroud line inside the Nomex cloth



Figure 13-50: Step 7 of Parachute Prep



Figure 13-51: Step 8 of Parachute Prep

# Rocket Build – Assembly

## *Parachute Preparation*

9. Place the newly-wrapped parachute bundle into the booster section of the rocket



*Figure 13-52: Step 9 of Parachute Prep*

# Certification Launch Requirements

## *Safety Overview - Key Personnel*

*Tripoli Safety Code, NFPA 1127, etc.*

### HPR Launch Operations Overview

1. Range Safety Officer (RSO)
  - a. The goal of the RSO is to minimize the risks to personnel and property involved in the handling, preparation, and launch operations of model and high-power rocket launches.
2. Launchpad Safety Officer (LSO)
  - a. The LSO is responsible for determining the status of range operations: site, airspace, and weather.
3. Launch Pad Manager
  - a. The Launch Pad Manager will assist you with the launch prep
4. Rocketry Mentor
  - a. TRA/NAR certified at a level equal to or above the motor you will use to certify
  - b. May guide, direct, and assist you as you prepare your rocket and go to the launch pad

### [Launch Failure](#)

# Launch Preparation

## *Launch Preparation Overview*

### Launch Site Materials & Supplies

- Drill
- Screwdriver
- Dog Barf
- Epoxy
- Masking Tape
- Screw
- Washer
- Nut
- Etc.



Figure 14:1 Launch Site Preparation Area

# Certification Launch Overview

## *Certification Launch Requirements*

1. When arriving at the launch site, you are expected to abide by the presiding organizations safety procedures
2. Requirements at the certification launch
  - a. Review pre-launch checklist
  - b. Complete launch card and submit to TRA/NAR
  - c. After rocket recovery, return to HPR Launch Operations area
  - d. Properly dispose motor
  - e. Sign and submit TRA Membership Application to Frank Nobile (Wisconsin only)
  - f. Pack rocket for return home

# Certification Launch Overview

## *Certification Launch Requirements*

### 3. Fees associated with certification launch

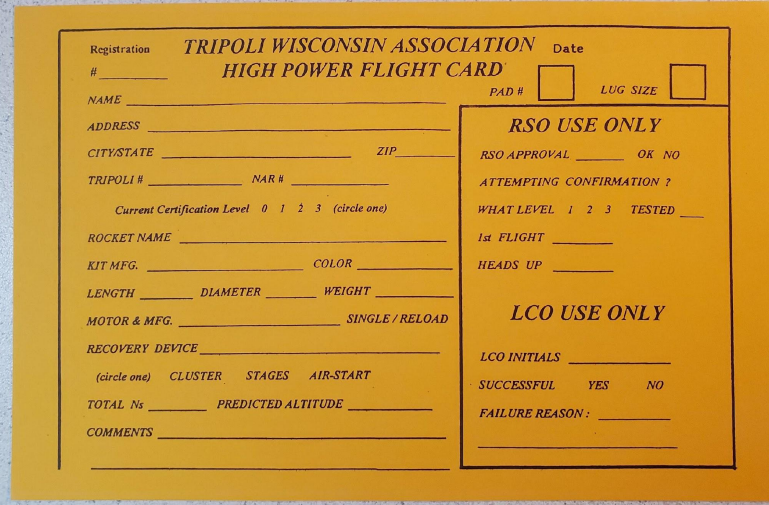
- a. FNL reimbursable by WSGC using reimbursement form or coordinated with local TRA/NAR
  - i. Flight/Ground Transportation/Meals
    - \$45 maximum meal allowance per day
    - Ground transportation: When personal vehicles are utilized, either gas or miles can be reimbursed, but not both
  - ii. Original receipts with names of individuals on each receipt
- b. CRL certification launches will take place during launch competition weekend
  - i. Special arrangements may be made to conduct certification launch on a regularly scheduled launch event through Frank Nobile [maxq3@aol.com](mailto:maxq3@aol.com)
- c. Complete and submit a reimbursement request to **Megan Goller** [wsgc.accounts@carthage.edu](mailto:wsgc.accounts@carthage.edu) no later than 30 days after certification launch

# Certification Pre-Flight

## *Pre-Flight Overview*

When you arrive at the launch site on launch day, you will need to:

1. Obtain a launch card from the club organizer table - each site
2. Prepare your rocket for flight
3. Ensure all of your bonds / fillets are intact
  - a. Ensure all your parts fit - no excess epoxy
4. Prepare your parachute as instructed in the workshop



The image shows a yellow launch card for the Tripoli Wisconsin Association. The card is titled "TRIPOLI WISCONSIN ASSOCIATION HIGH POWER FLIGHT CARD". It contains various fields for registration information, including name, address, city/state, zip, tripoli number, and NAR number. It also has fields for rocket details like name, kit manufacturer, color, length, diameter, weight, motor, and recovery device. There are checkboxes for "Current Certification Level" (0, 1, 2, 3) and "Air-Start". The card is divided into sections for "RSO USE ONLY" (Right of Safety Officer) and "LCO USE ONLY" (Launch Control Officer). The RSO section includes fields for approval, attempting confirmation, what level, and 1st flight. The LCO section includes fields for initials, successful status, and failure reason.

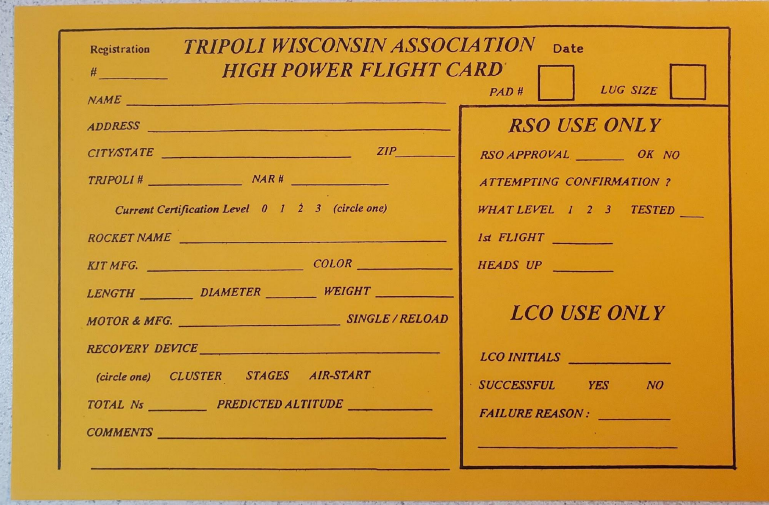
TRIPOLI WISCONSIN ASSOCIATION HIGH POWER FLIGHT CARD		Date
Registration # _____	PAD # <input type="checkbox"/>	LUG SIZE <input type="checkbox"/>
NAME _____		
ADDRESS _____		
CITY/STATE _____	ZIP _____	
TRIPOLI # _____	NAR # _____	
Current Certification Level 0 1 2 3 (circle one)		
ROCKET NAME _____		
KIT MFG. _____	COLOR _____	
LENGTH _____	DIAMETER _____	WEIGHT _____
MOTOR & MFG. _____ SINGLE / RELOAD _____		
RECOVERY DEVICE _____		
(circle one) CLUSTER STAGES AIR-START		
TOTAL Ns _____	PREDICTED ALTITUDE _____	
COMMENTS _____		
<b>RSO USE ONLY</b>		
RSO APPROVAL _____ OK NO		
ATTEMPTING CONFIRMATION ?		
WHAT LEVEL 1 2 3 TESTED _____		
1st FLIGHT _____		
HEADS UP _____		
<b>LCO USE ONLY</b>		
LCO INITIALS _____		
SUCCESSFUL YES NO		
FAILURE REASON : _____		

Figure 15-1: Tripoli Wisconsin Launch Card

# Certification Pre-Flight

## *Pre-Flight Overview*

5. Ensure your nose cone is attached
  - a. You may fly a 'payload' if you wish
6. Ensure you have a piece of tape with you (for friction fit & igniter)
7. Prepare you motor (see the RSO/Mentor for motors)
8. Ensure you have your motor retainer with you and tools to tighten it



The image shows a yellow launch card for the Tripoli Wisconsin Association. The card is titled "TRIPOLI WISCONSIN ASSOCIATION HIGH POWER FLIGHT CARD". It contains fields for registration information, personal details, rocket specifications, and launch status. The card is divided into sections for "RSO USE ONLY" and "LCO USE ONLY".

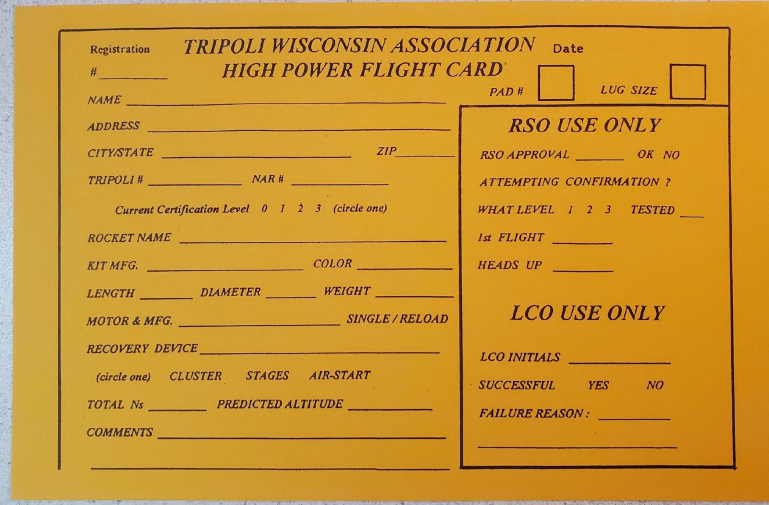
TRIPOLI WISCONSIN ASSOCIATION HIGH POWER FLIGHT CARD		Date
Registration # _____	PAD # <input type="checkbox"/>	LUG SIZE <input type="checkbox"/>
NAME _____		
ADDRESS _____		
CITY/STATE _____	ZIP _____	
TRIPOLI # _____	NAR # _____	
Current Certification Level 0 1 2 3 (circle one)		
ROCKET NAME _____		
KIT MFG. _____	COLOR _____	
LENGTH _____	DIAMETER _____	WEIGHT _____
MOTOR & MFG. _____ SINGLE / RELOAD _____		
RECOVERY DEVICE _____		
(circle one) CLUSTER STAGES AIR-START		
TOTAL Ns _____	PREDICTED ALTITUDE _____	
COMMENTS _____		
<b>RSO USE ONLY</b>		
RSO APPROVAL _____ OK NO		
ATTEMPTING CONFIRMATION ?		
WHAT LEVEL 1 2 3 TESTED _____		
1st FLIGHT _____		
HEADS UP _____		
<b>LCO USE ONLY</b>		
LCO INITIALS _____		
SUCCESSFUL YES NO		
FAILURE REASON : _____		

Figure 15-1: Tripoli Wisconsin Launch Card

# Certification Pre-Flight

## *Pre-Flight Overview*

9. Fill out / turn in your launch card to the LCO when you are ready to fly.
  - a. LCO will assign you a launch pad (numbered)
10. Proceed to launch pad when range is open
  - a. Usually, a Launch Pad manager (or mentor) will assist you with launch prep
11. Return to pit area to watch your launch!
12. Observe and recover your rocket
13. Return rocket to RSO for inspection and sign off



The image shows a yellow launch card for the Tripoli Wisconsin Association. The card is titled "TRIPOLI WISCONSIN ASSOCIATION HIGH POWER FLIGHT CARD". It contains various fields for registration information, including name, address, city/state, zip, tripoli number, and NAR number. It also has sections for "RSO USE ONLY" and "LCO USE ONLY". The "RSO USE ONLY" section includes fields for RSO approval, attempting confirmation, what level, and tested. The "LCO USE ONLY" section includes fields for LCO initials, successful status, and failure reason. The card is designed to be filled out by the participant and then signed off by the Range Safety Officer (RSO) and Launch Control Officer (LCO).

Registration		Date
#		
NAME		
ADDRESS		
CITY/STATE	ZIP	
TRIPOLI #	NAR #	
Current Certification Level 0 1 2 3 (circle one)		
ROCKET NAME		
KIT MFG.	COLOR	
LENGTH	DIAMETER	WEIGHT
MOTOR & MFG.	SINGLE / RELOAD	
RECOVERY DEVICE		
(circle one) CLUSTER STAGES AIR-START		
TOTAL Ns	PREDICTED ALTITUDE	
COMMENTS		

RSO USE ONLY	
RSO APPROVAL	OK NO
ATTEMPTING CONFIRMATION ?	
WHAT LEVEL	1 2 3 TESTED
1st FLIGHT	
HEADS UP	

LCO USE ONLY	
LCO INITIALS	
SUCCESSFUL	YES NO
FAILURE REASON :	


Figure 15-1: Tripoli Wisconsin Launch Card

# Certification Pre-Flight

## *Pre-Flight Inspection*

Prepare the following information for the LCO:

1. TRA/NAR Membership #
2. Kit Manufacturer
3. Center of Gravity (CG) and Center of Pressure (CP) – Mark the CG and CP on the rocket
4. Motor Type and Manufacturer
5. Type of Recovery Device
6. Length, Diameter, and Weight of Rocket
7. Predicted Altitude (Remember to conduct a simulation in RockSim)



The image shows a yellow "HIGH POWER FLIGHT CARD" from the Tripoli Wisconsin Association. The card is divided into several sections for recording flight information. The top section includes fields for Registration #, Name, Address, City/State, ZIP, Tripoli #, NAR #, Date, PAD #, and LUG SIZE. Below this is a section for "Current Certification Level" with options 0, 1, 2, and 3, and a note to "circle one". The next section is for "ROCKET NAME", "KIT MFG.", "COLOR", "LENGTH", "DIAMETER", "WEIGHT", "MOTOR & MFG.", "SINGLE / RELOAD", and "RECOVERY DEVICE". The bottom section includes fields for "TOTAL Ns", "PREDICTED ALTITUDE", and "COMMENTS". On the right side, there are two distinct sections: "RSO USE ONLY" and "LCO USE ONLY". The "RSO USE ONLY" section includes fields for "RSO APPROVAL", "ATTEMPTING CONFIRMATION?", "WHAT LEVEL", "TESTED", "1st FLIGHT", and "HEADS UP". The "LCO USE ONLY" section includes fields for "LCO INITIALS", "SUCCESSFUL", "FAILURE REASON", and a line for additional notes.

Registration		Date	
#			
NAME			
ADDRESS			
CITY/STATE		ZIP	
TRIPOLI #		NAR #	
Current Certification Level 0 1 2 3 (circle one)			
ROCKET NAME			
KIT MFG.		COLOR	
LENGTH		DIAMETER	
WEIGHT			
MOTOR & MFG.		SINGLE / RELOAD	
RECOVERY DEVICE			
(circle one) CLUSTER STAGES AIR-START			
TOTAL Ns		PREDICTED ALTITUDE	
COMMENTS			

RSO USE ONLY	
RSO APPROVAL	OK NO
ATTEMPTING CONFIRMATION ?	
WHAT LEVEL	1 2 3 TESTED
1st FLIGHT	
HEADS UP	

LCO USE ONLY	
LCO INITIALS	
SUCCESSFUL	YES NO
FAILURE REASON :	

# Certification Rocket Overview

## *Pre-Launch Rocket Preparation*

1. Airframe
  - a. Must be built by flyer
  - b. Display Center of Pressure
2. Recovery
  - a. Standard parachute recovery is required.
3. Motor
  - a. Single certified H or I motor (tested total impulse between 160.01 and 640.00 n-sec)
    - i. Local Certification Launch
      1. Coordinate Motor Purchase with TRA/NAR Mentor (Reimbursable cost)
      2. Contact TRA/NAR Launch organizer(s) to have a motor available if a vendor is on site (Reimbursable cost)
      3. Order motor through Wildman Rocketry (most reliable, but an additional hazmat fee (~\$50) charged) WSGC billed
    - ii. Richard Bong Recreational Park Certification Launch
      1. Motor available competition weekend through WSGC
  - b. Flyer shall be observed by certifying member during assembly and preparation of motor
4. Electronics
  - a. Not required

# Certification Launch Preparation

## *Motor Preparation*

1. Obtain your motor from the RSO
  - a. WSGC provides one certification motor
2. Perform your own motor prep
  - a. Remove certification motor from protective cardboard tube
  - b. Delay Adjustment
  - c. Black Powder
  - d. Motor Installation
3. RSO will observe your motor prep
  - a. It is not a test, it is a hands-on learning experience
  - b. If you don't understand something, ask questions
4. Insert your motor in rocket and install motor retainer
5. Suggest you tape the ignitor to the outside of the rocket for later



Figure 14-2 Certification Motor and Packaging

# Certification Launch Preparation

## *Motor Preparation*

The certification motor will come in a protective cardboard tube when shipped. The motor may be sealed in a plastic bag.

Remove contents from carton and plastic bag. The motor will have a parts contained within:

1. Motor
2. Ignitor Leads
3. Pyrogen
4. Vial of Black Powder
5. Red Forward Plug
6. Baffle Washer

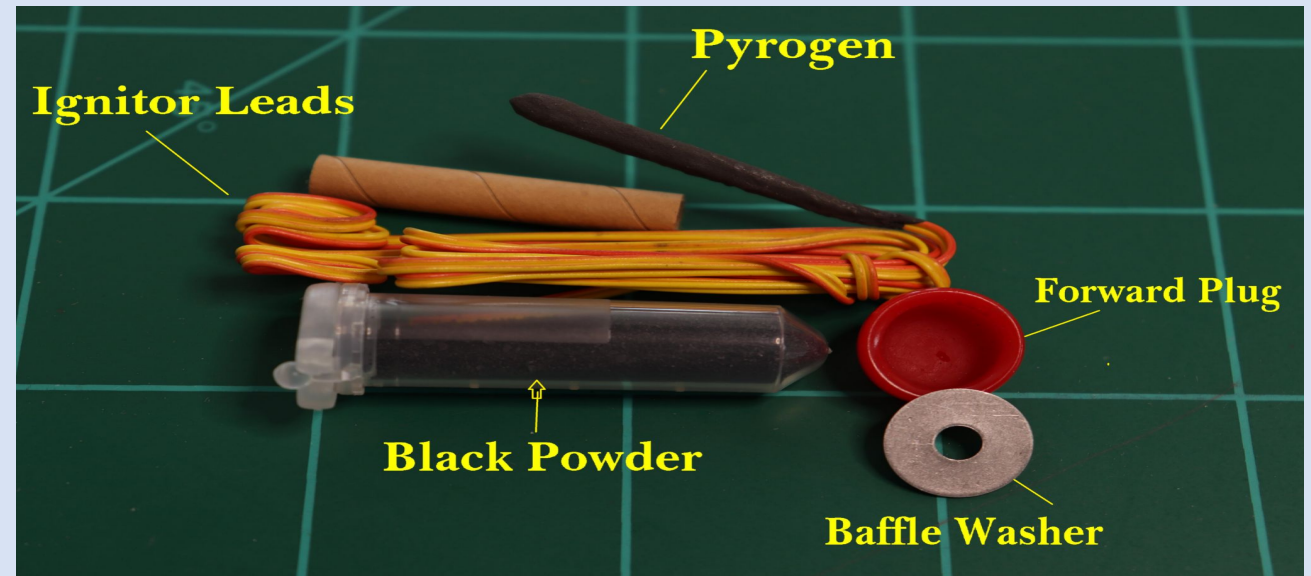


Figure 14-3: Certification Motor Parts

# Certification Launch Preparation

## *Motor Preparation*

1. Adjust the motor ejection charge delay
  - a. Use the delay adjust tool to remove seconds from delay
    - i. Adjust the tool for proper amount
    - ii. Screw the tool into the end
  - b. Shake flakes out – discard
  - c. Install Baffle Washer



Figure 14-4: Delay Tool

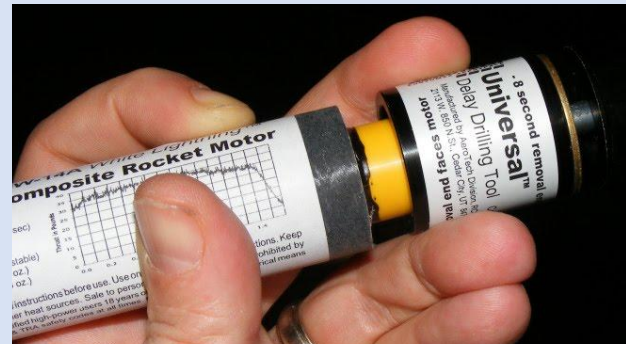


Figure 14-5 Removing seconds from delay



Figure 14-6: Install Baffle Washer

# Certification Launch Preparation

## *Motor Preparation*

- d. Pour black powder into end
- e. Place plug cap on end

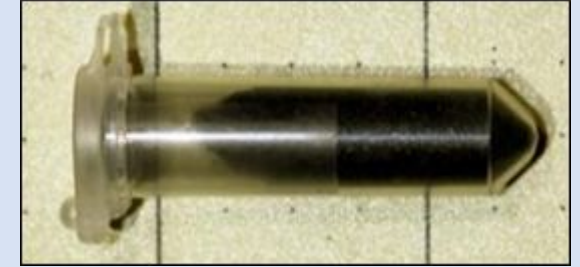


Figure 14-7: Black Powder Vial



Figure 14-8: Pour Black Powder into Deployment Well



Figure 14-9: Pour Black Powder into Deployment Well

# Certification Launch Preparation

## *Motor Preparation*

1. Insert your motor into your rocket (narrow end first – red cap inside)
1. If motor is difficult to insert
  - a. May need to clean epoxy from inside of MMT
1. Attach motor retention to keep motor in place
1. Secure ignitor with tape to exterior of rocket for later

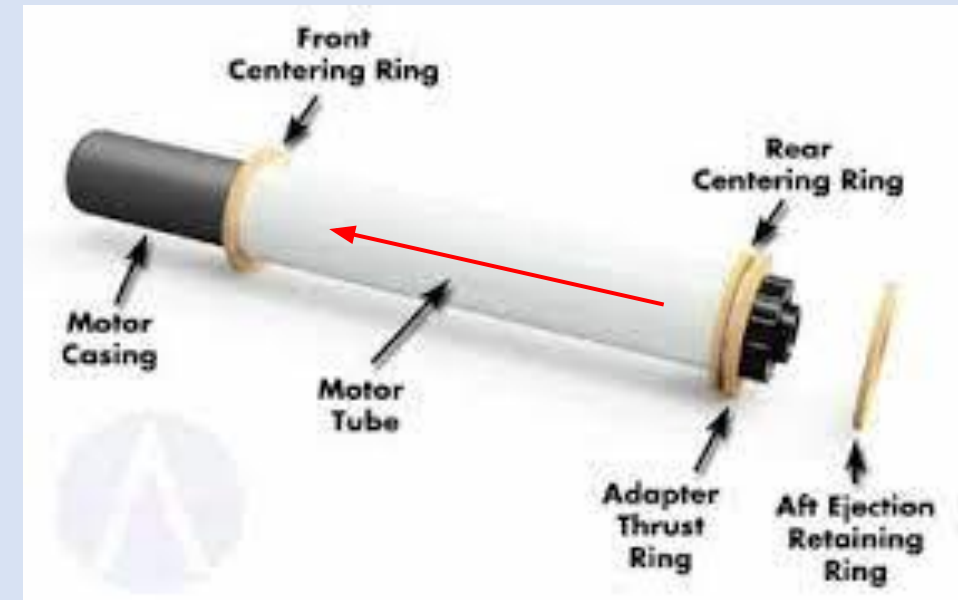
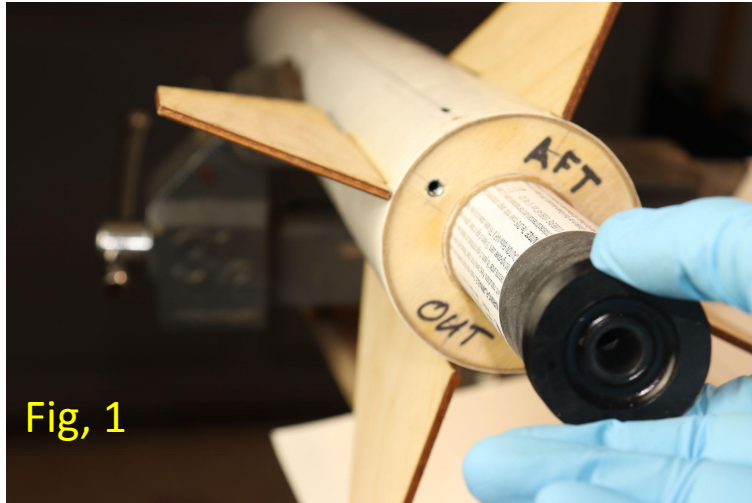


Figure 14-10: Motor Installation

# Motor Retention Installation

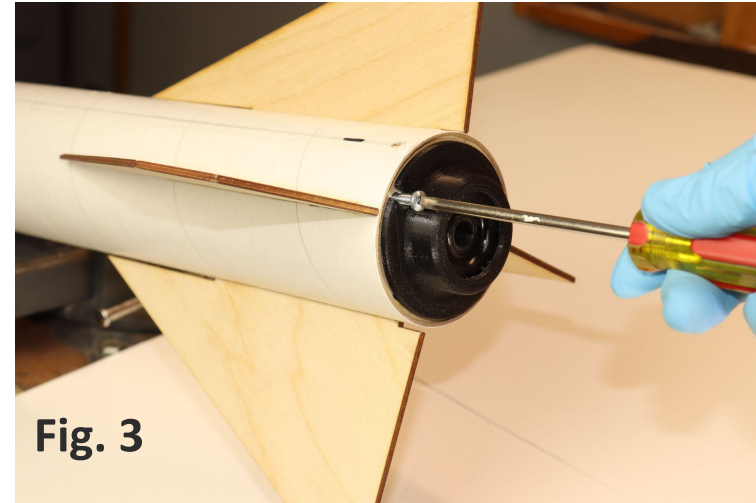


**Motor Retention cap**



**Fig, 1**

**Insert your prepared L 1 Motor into motor tube until it stops**



**Fig. 3**

**Install 2 machine screws to secure retention system do not over tighten**



**Fig. 2**



**Fig. 4**

# Certification Launch Preparation

## *Recovery*

1. Know how to fold / install your parachute into your rocket (as previous demo)
  - a. Ensure parachute and protectors are **attached** inside of quick-links
  - b. Ensure your quick-links are attached to rocket and **closed**
  - c. Ensure to use parachute protectors and/or 'dog barf' to protect your nylon parachute from the hot ejection charge gases
    - i. Ensure parachute protection is on bottom (where ejection charge is) and parachute on top

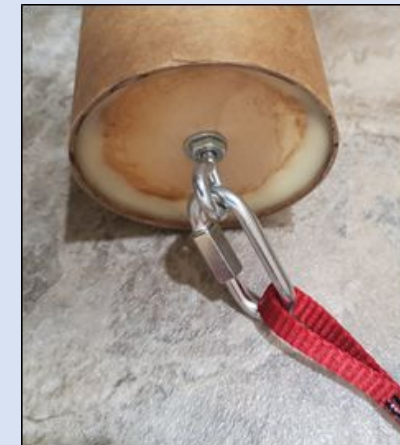


Figure 14:11: Parachute and Protectors Attached Inside of Quicklinks (Top); Quicklink Attached to Rocket and Closed (Bottom)

# Certification Launch Preparation

## *Recovery*

2. If your certification flight occurs in adverse conditions
  - a. Consider using a smaller parachute than the stock parachute provided, to prevent drift
    - i. Your Rocketry Mentor may be able to assist you
  - b. You may 'reef' your shroud lines using tape (or by tying a knot part way up the shroud lines)
    - i. This will decrease the parachute open diameter
    - ii. This will increase descent rate (decrease drift)
  - c. Ensure your mentor or RSO is aware of any adjustments you have made prior to flight



Figure 14-12: "Reef" the Shroud Lines Using Tape

# Certification Launch Preparation

## *Recovery*

3. At Tripoli Wisconsin (only) - additional recovery techniques are used for certification flights (when flying in adverse conditions)
  - a. Jolly Logic Parachute Release
    - i. This device will be loaned to flyers
    - ii. This device will not open the parachute until a much lower altitude
      1. AKA streamer (or tumble) recovery from apogee
  - b. RF Tracker and Antenna
    - i. This device will be loaned to flyers
    - ii. This device will emit an RF signal that allows you to track on ground
      1. It can be flown in your sustainer section or taped to shock cord

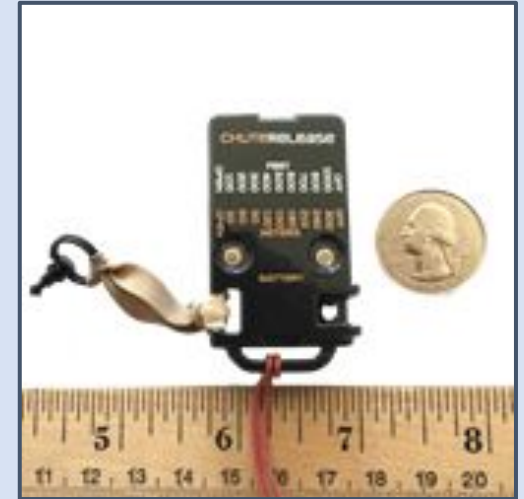


Figure 14-13: Jolly Logic Parachute Release



Figure 14-14: RF Tracking Device (Left); Yagi Antenna (Right)

# Certification Launch Preparation

## *Recovery*

4. These devices ARE NOT REQUIRED for certification flight
  - a. If you plan to use a device be familiar with its operation prior to flight
  - b. Ensure your mentor or RSO is aware of any devices used in flight

<https://jollylogic.com/products/chuterelease/>

<https://www.com-spec.com/rcplane/index.html>

# Certification Launch Preparation

## *Launch Pad Preparation*

Once you are prepared your rocket for the certification launch and have completed the pre-launch checklist:

1. Check in with the LCO for your pad assignment
2. Turn in the launch card
3. Proceed to the Launch pad when the “Range is Open.”



# Certification Launch Preparation

## *Launch Pad Preparation*

The Launch Pad Manager (or Mentor) will assist you with the launch prep. This is a time for learning not for quizzing:

1. The rail is tilted over for loading
  - a. Slide your rocket on rail, aligning your rail buttons in the grooves in the rail
2. Your rocket should be on top – your rail buttons down
  - a. Slide all the way down until it hits the stops

# Certification Launch Preparation

## *Rocket Retrieval*

1. Carefully observe the descent of your rocket for retrieval
2. Use the landmarks (trees / field / roads / water) to remember where you last saw it
3. You may want to go out in pairs and assist each other
  - a. This is for safety as well – look for one, then the other
4. Do not enter a hazardous situation to retrieve your rocket
  - a. Do not enter water
  - b. Do not climb trees
5. Check-in if you have been searching for awhile

# Launch Preparation

## *Rocket Retrieval*

- 1. Note the Hazards
- 1. Note the Landmarks
- 1. Note the Distances

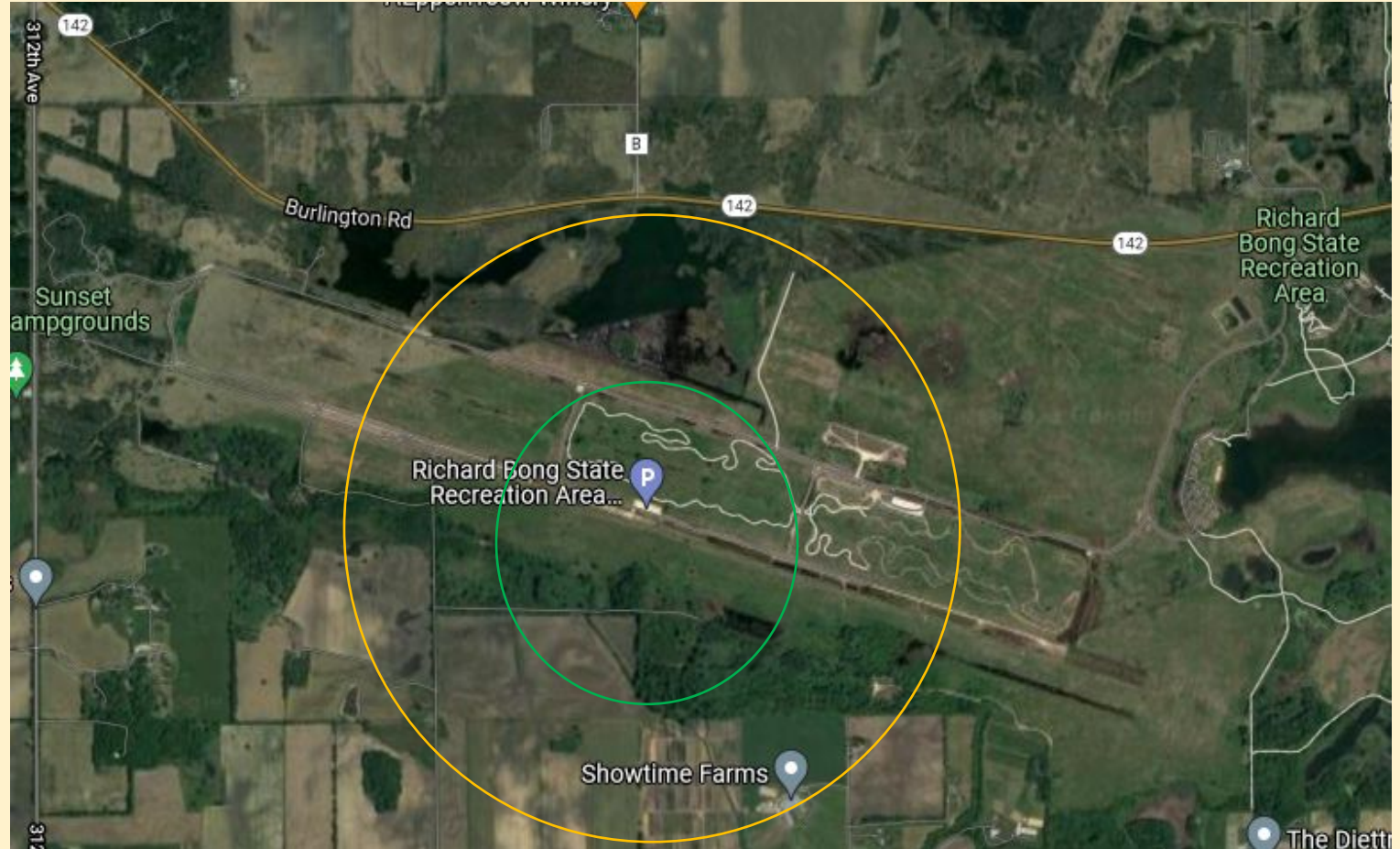


Figure 14-16: Richard Bong State Recreation Area Aerial Map

# Certification Launch Requirements

## *Certificaton Post-Flight*

Upon a successful flight and retrieval of your rocket, the following steps will take place:

1. The RSO will inspect your certification rocket
2. The RSO will sign your certification form
  - a. WSGC will reimburse L2L participants for the first year of TRA or NAR membership
3. WSGC will pay L2L participants TRA or NAR membership for Certification flights conducted at Richard Bong Recreation Area
4. Tripoli Membership cards will be mailed to participants address provided on form
  - a. Membership is valid for one year
  - b. Membership must be renewed by participant annually
  - c. TRA Certification is valid at NAR launches
  - d. Level II Certification may be obtained by participants, however, WSGC does not cover the cost of certification.

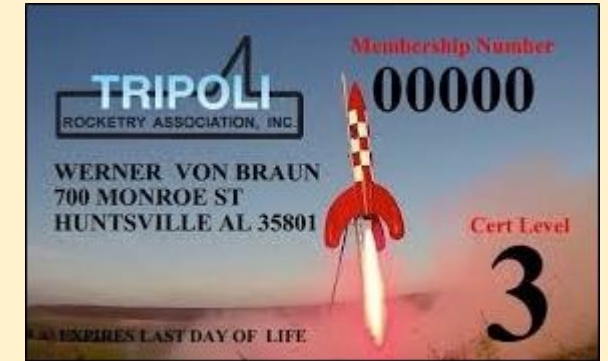


Figure 15-2: Tripoli Membership Card Example

# Certification Flight

## *Post-Flight Inspection - Non-Certification*

Any of the following will result in non-certification for a certification flight:

1. Motor CATO (Catastrophic Take Off)
2. Excessive damage
3. No recovery system deployment or tangled recovery system deployment
4. Rocket drifting outside the specified launch range
5. Components coming down not attached to the recovery system.
6. Any other violation of TRA safety code associated with this particular flight.
7. Any other legitimate reason the certifying member deems merits non-certification

# Certification Launch Requirements

## *Rocket Transport*

When preparing to bring your certification rocket home, you will need to take the necessary steps to clean your rocket and prepare for the transport.

1. Cleaning and packaging rocket for transport
  - a. Remove / dispose of the motor
  - b. Wipe out any black powder residue
  - c. Disassemble any components
2. Transporting rocket from Kenosha, WI
  - a. Checked bag for airline flights
  - b. Ship from hotel (confirm this option with the hotel)
    - i. Boxes, bubble wrap and labels will be available for shipping for certification launches conducted at Richard Bong Recreation Area. If you ship your rocket to the hotel during competition weekend, keep original packaging material for return shipment.
1. Shipping costs may be submitted with Launch 2 Learn travel expenses

# Certification Launch Requirements

## *Tripoli Requirements/WSGC Information*

NAR Level 1 Certification at Richard Bong  
Recreational Area

<https://www.youtube.com/watch?v=EFm5sG7qdm0>



# Workshop Closing - Review

1. Where can rocket supply equipment files be downloaded from?
2. What checkbox is critical to check or uncheck in RockSim?
3. What is the “Key Enemy” of your rocket build?
4. What does an altimeter do?
5. What is a reasonable rocket descent rate?
6. What must you do to become level one certified?
7. Who are the key personnel at the rocket launch?

# Workshop Objectives Review

- Introduce design, build, fly stages of high-power rocketry
  - Remember this is only an introductory workshop, there is not enough time to cover all aspects in greater detail
- Build a Level 1 high-power rocket
  - We will build the LOC Precision Caliber-ISP kit
- Develop basic understanding of RockSim
  - Import the Caliber kit rocket into RockSim and analyze a flight
- Understand Tripoli Level 1 certification

# SURVEY TIME

Help us hit a [home run](#) with our program. Tell us what is good (80%) and tell us ways to get better (20%)

If you make "this change," you'll be hitting a home run



This is what I LOVED about your workshop!!!



Please fill out the workshop evaluation  
questionnaire for The Everett Group:

Please fill out the workshop evaluation  
questionnaire here:

<https://forms.gle/HfyoLWQUru2uq85c6>

# QUESTIONS?