

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*

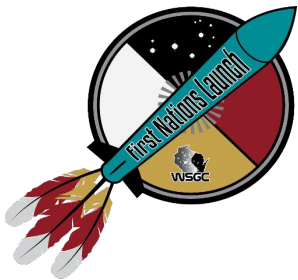
Connie Engberg, *WSGC/FNL Project Support Assistant*



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*



AIAA-Wisconsin Section

Adrian Guither, *WSGC CRL Alumni/Volunteer Support*

Faculty and 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

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

- Rob and Connie 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

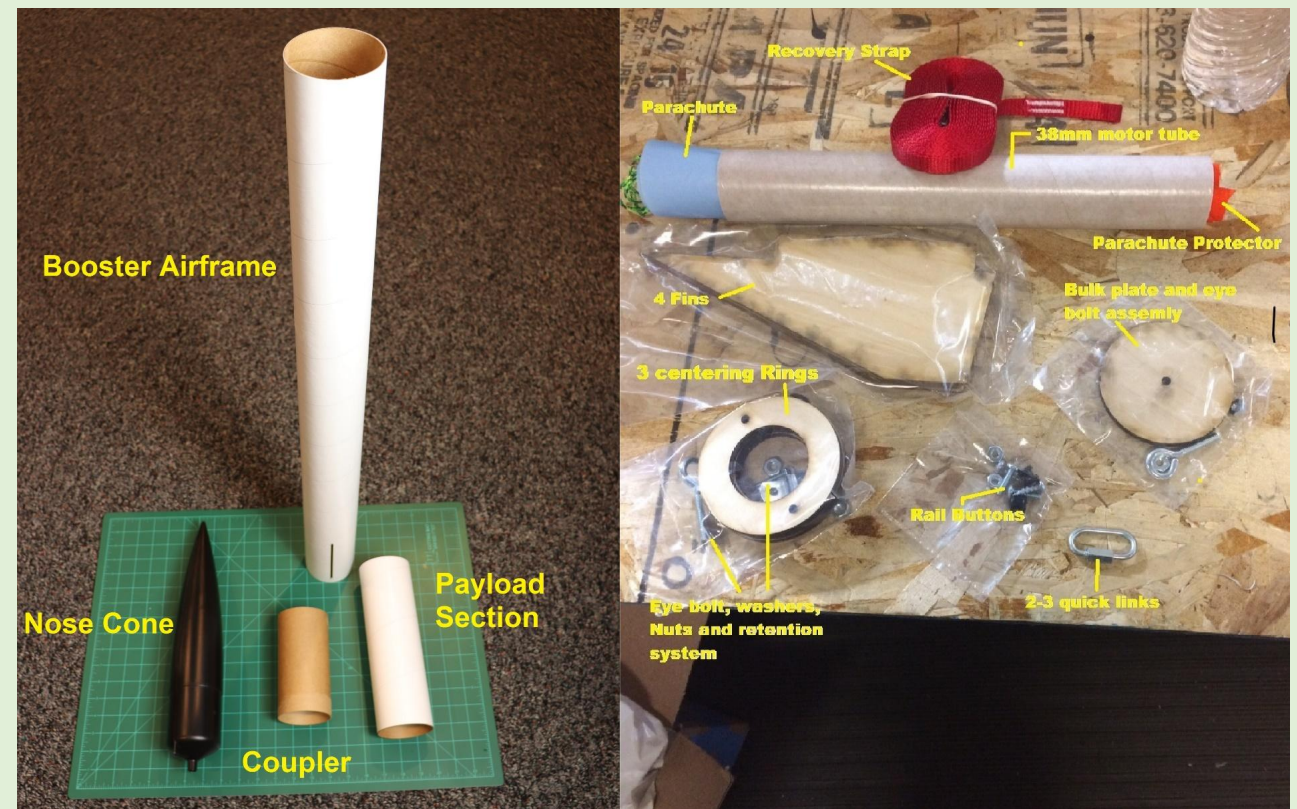


Figure 2-1: Parts included with the LOC Precision – 3.10" Caliber ISP Rocket Kit (not including parts supplied by WSGC)

Workshop Materials & Supplies

| ITEM DESCRIPTION: | QUANTITY: | RECEIVED: |
|---|-----------|-----------|
| LOC Precision – 3.10” Caliber ISP Rocket Kit*: | 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/

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

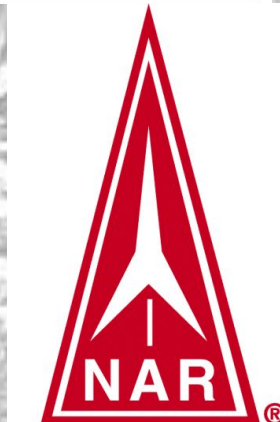
<https://spacegrant.carthage.edu/students/tools-and-tips/>



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

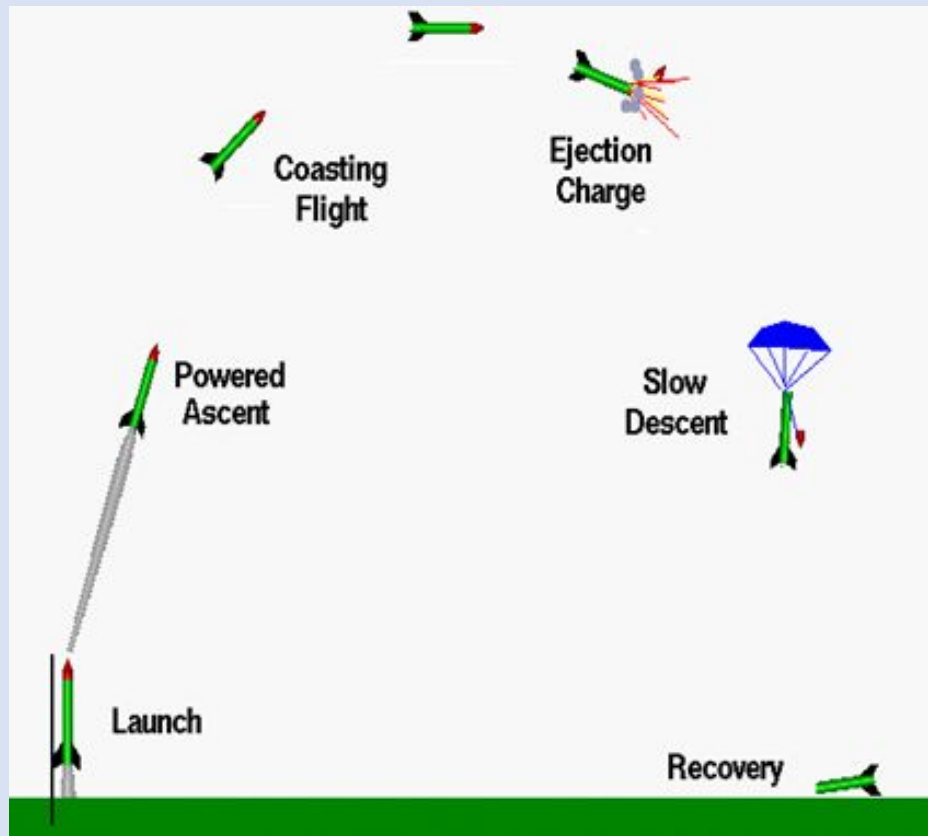


Figure 4-1: Single Deploy Flight Profile

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

Rocketry 101 – Dual Deploy Flight Profile

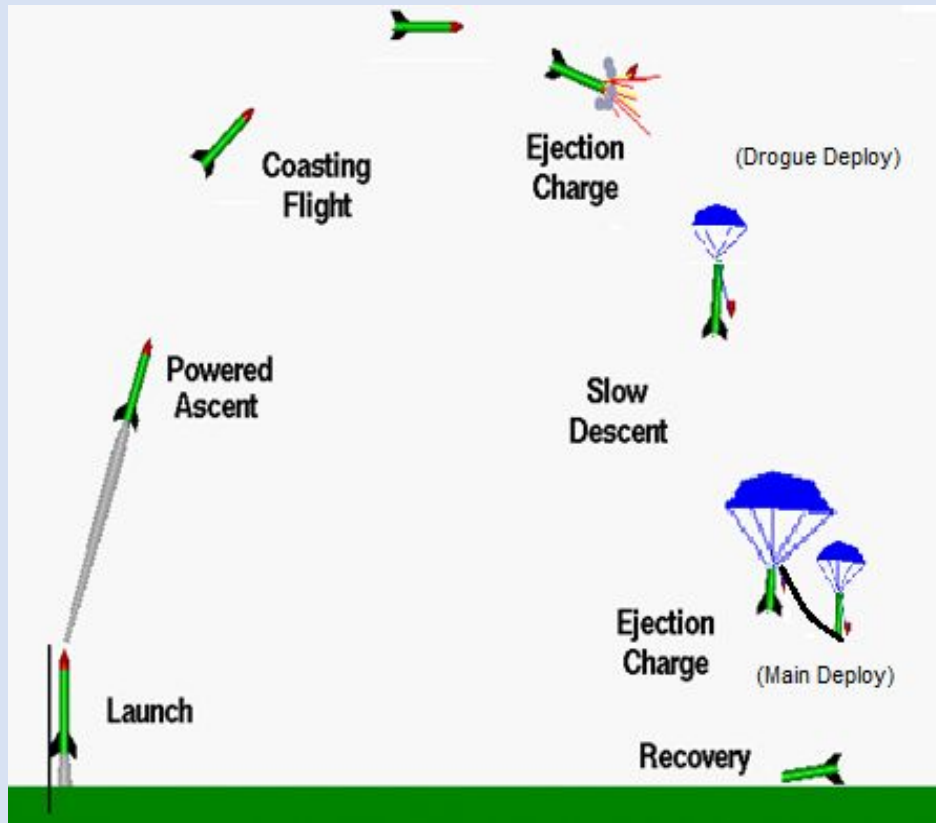


Figure 4-2: Dual Deploy Flight Profile

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

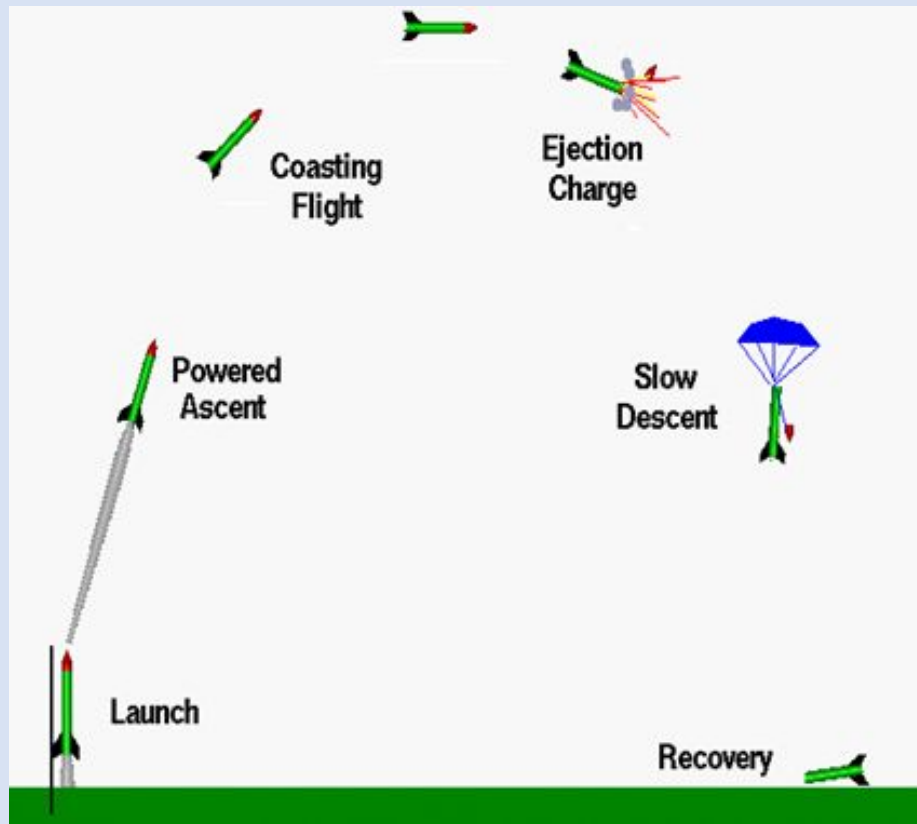


Figure 4-1: Single Deploy Flight Profile

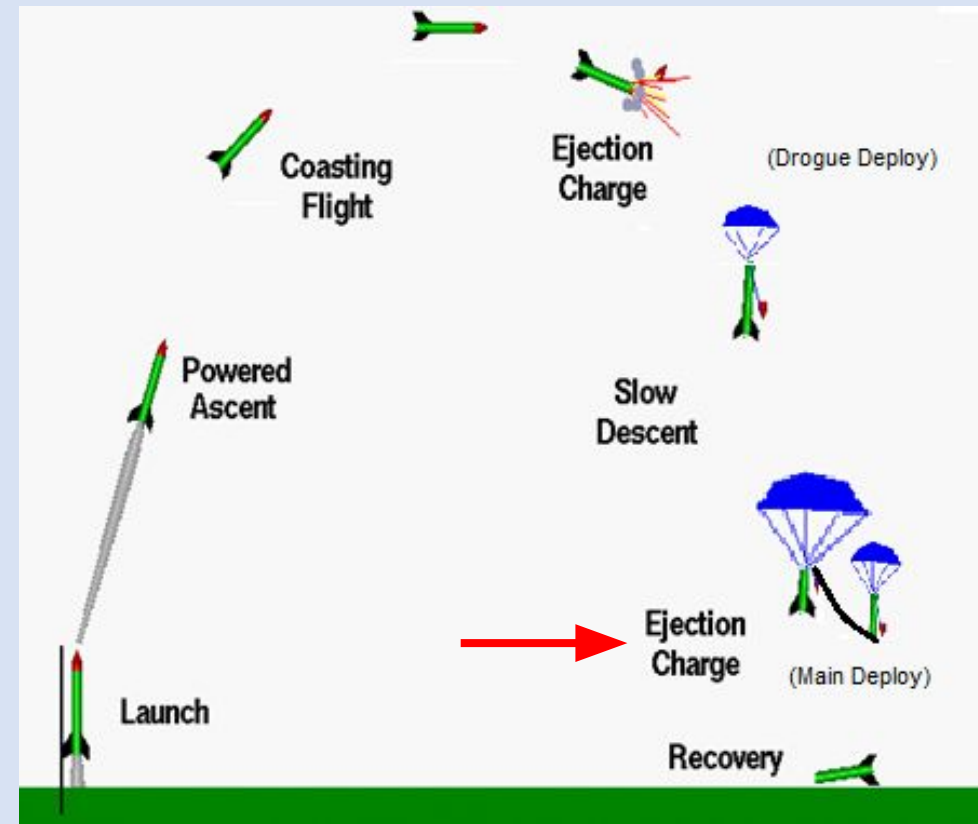


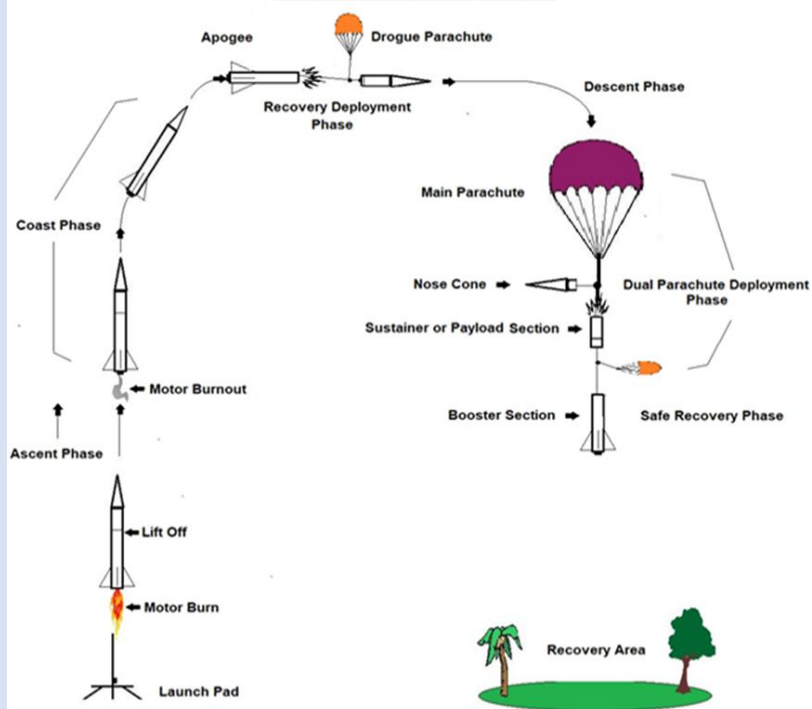
Figure 4-2: Dual Deploy Flight Profile

Rocketry 101 – Competition Flight Profile

FNL Gateway 2024

Flight Profile

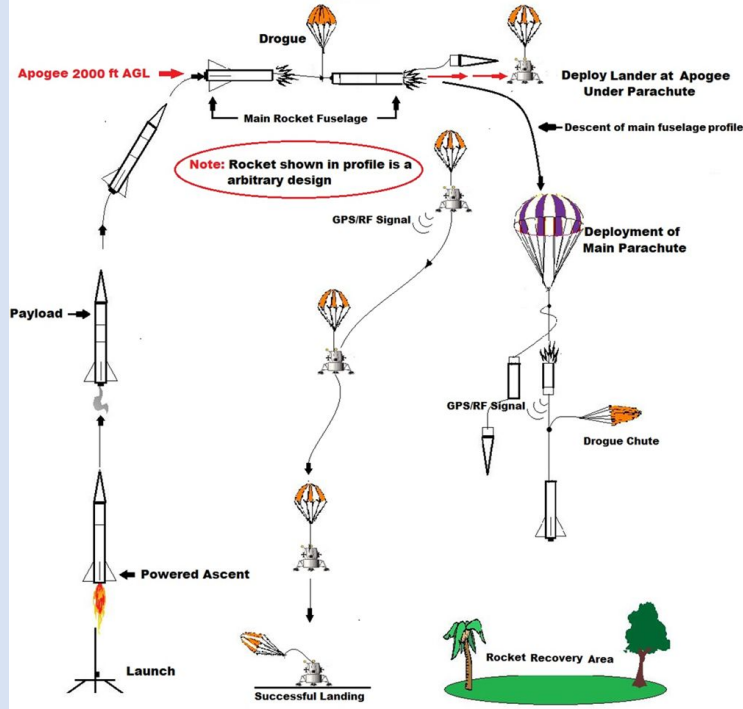
Altitude 2200' - 2800' AGL



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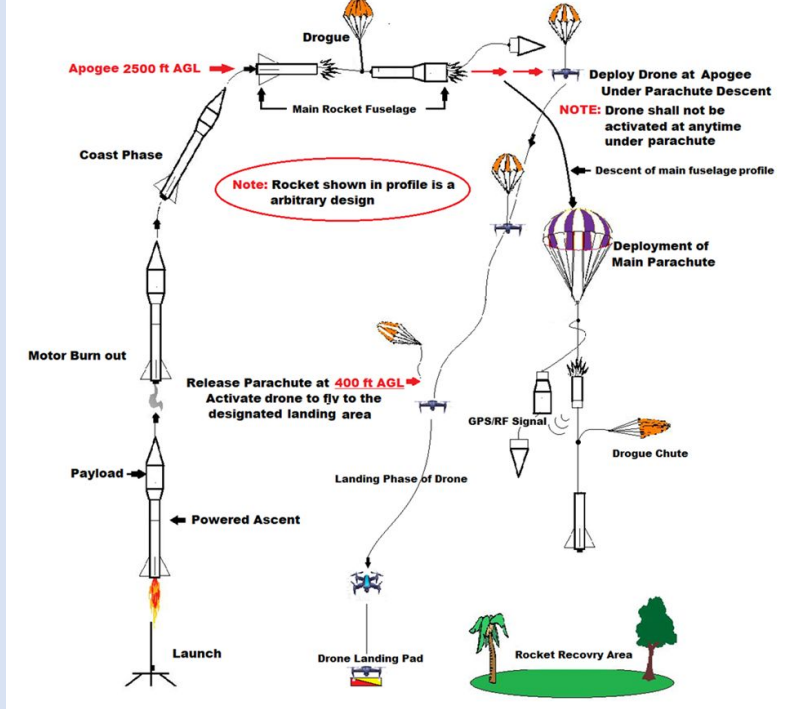
FNL 2024 Moon Flight Profile Example

Not to Scale



FNL 2024 Mars Flight Profile Example

Not to Scale



Rocketry 101 - Structures

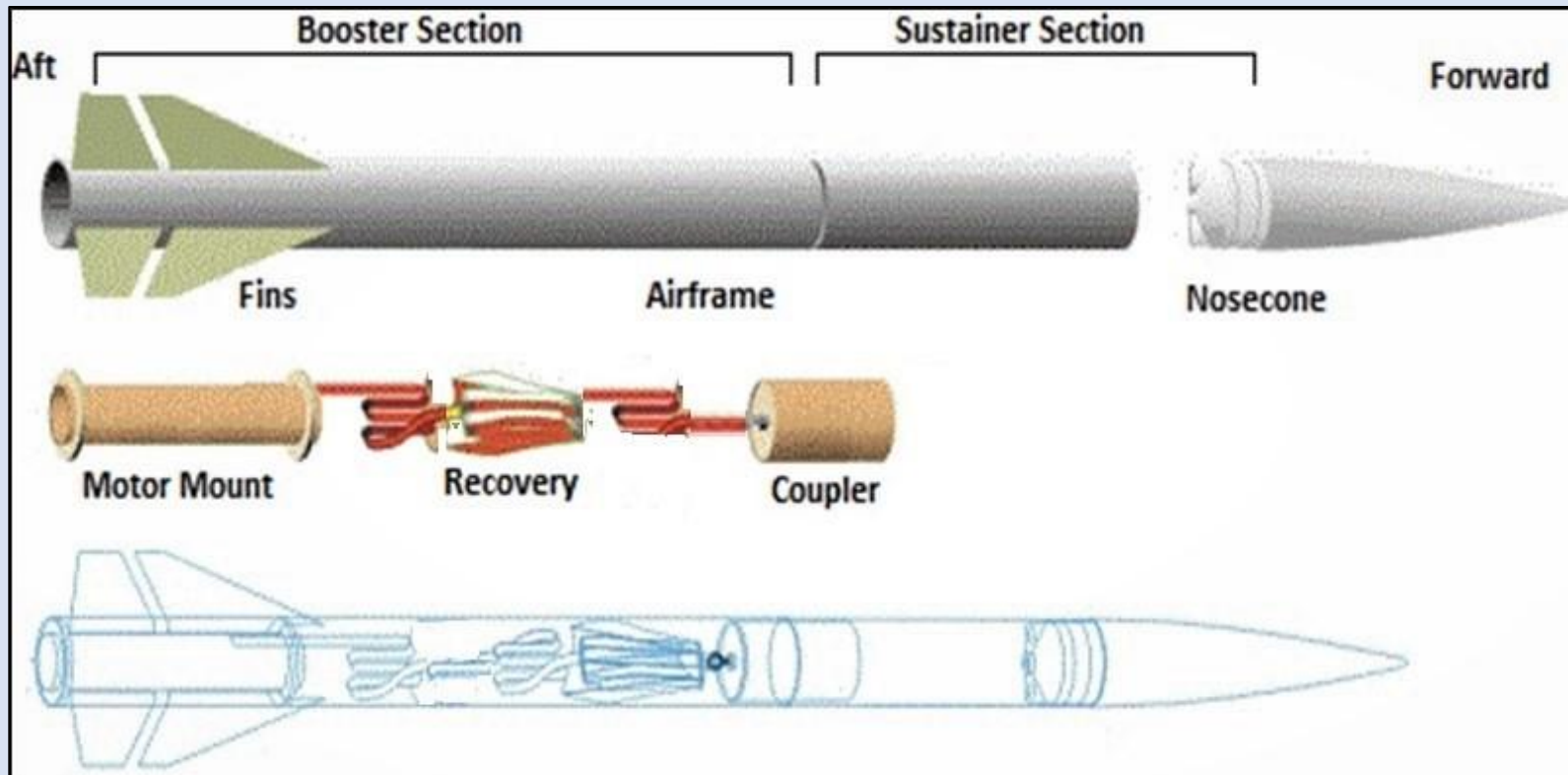


Figure 5-1: High-Power Rocket with Coupler

Rocketry 101 – RockSim Introduction

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

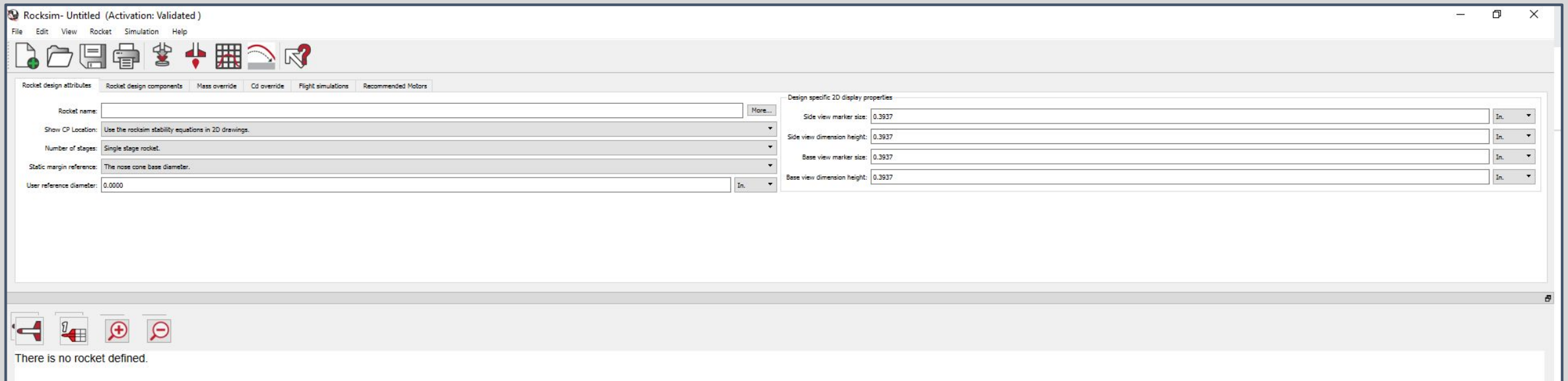


Figure 11-1: RockSim 10

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

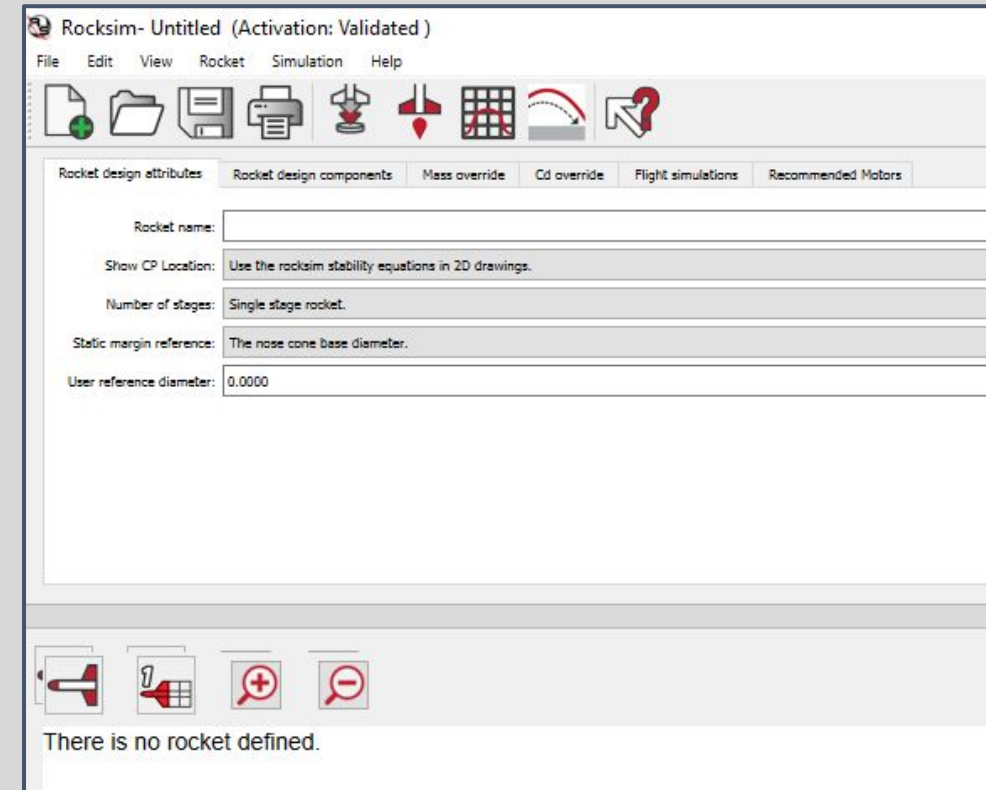


Figure 11-2: RockSim 10 Folders

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 Gyalatan | loc_gyalatan.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

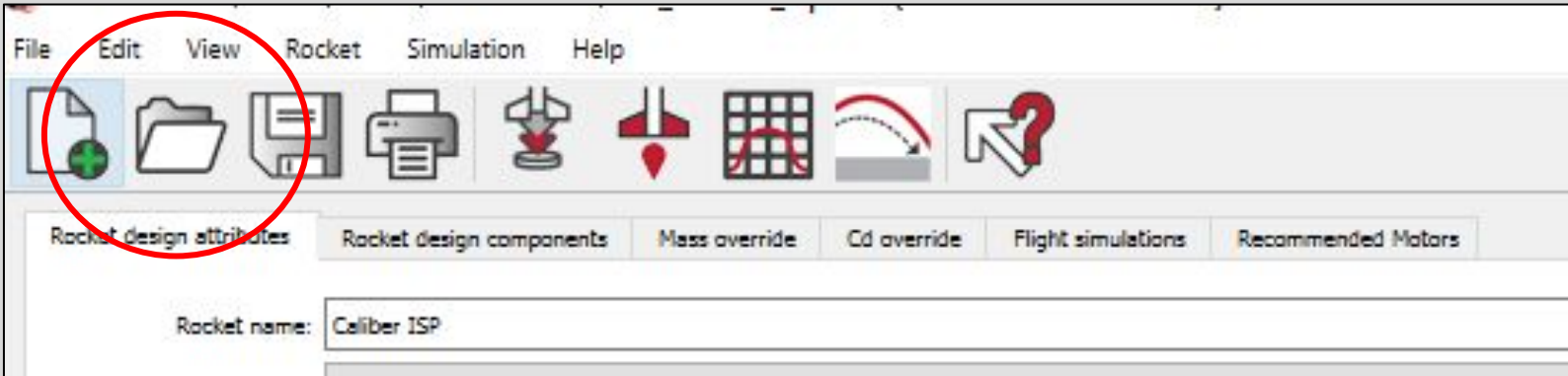


Figure 11-4: RockSim Import Folder

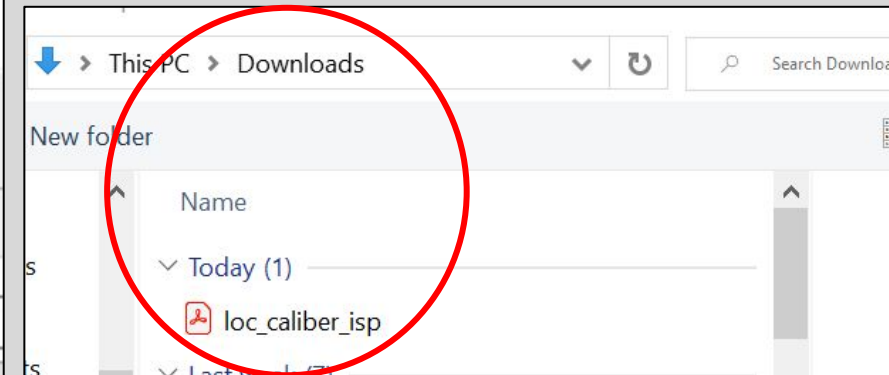


Figure 11-5: Select Rocket File from Download Folder on Computer

Rocketry 101 – RockSim Introduction

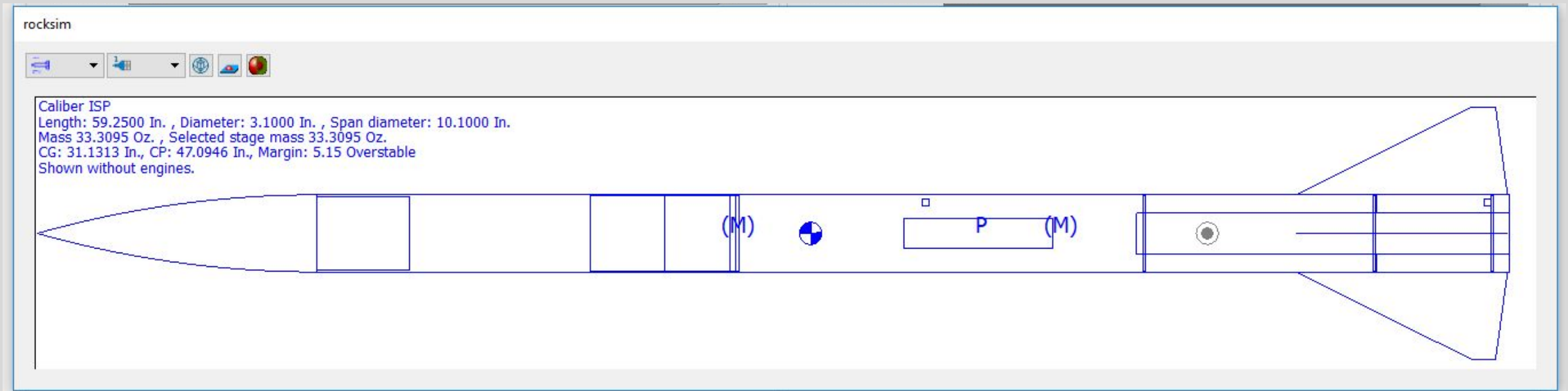


Figure 11-6: Caliber ISP Stock File

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

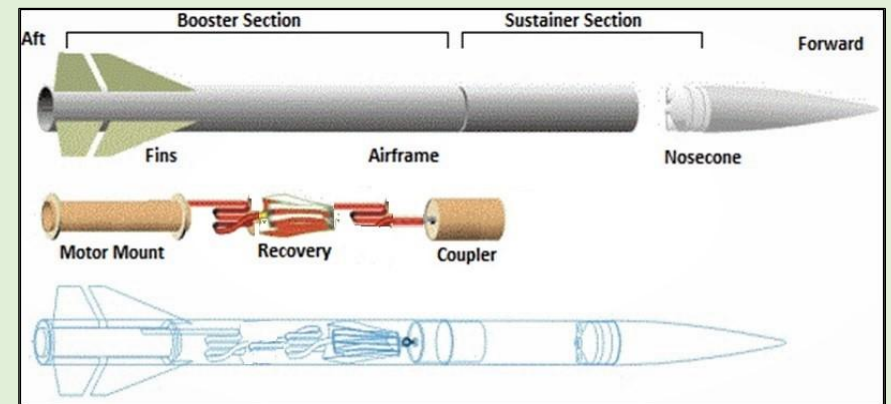


Figure 13-1: High-Power Rocket Diagram

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)
3. Sand outside of bulkplate for proper fit
4. 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
2. 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
4. Draw line at same distance on motor mount tube for center motor mount ring placement. NOTE: Measure from aft end of motor mount tube
5. 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)
2. 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

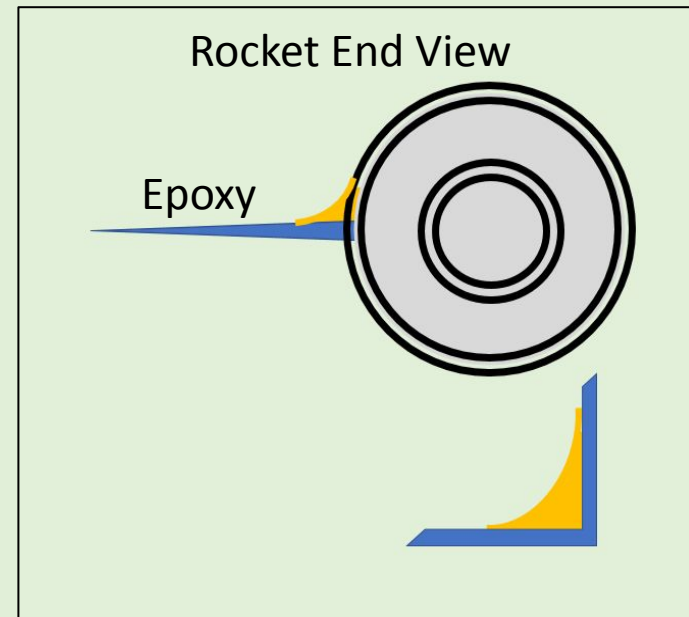


Figure 13-14: Epoxy Fillets

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

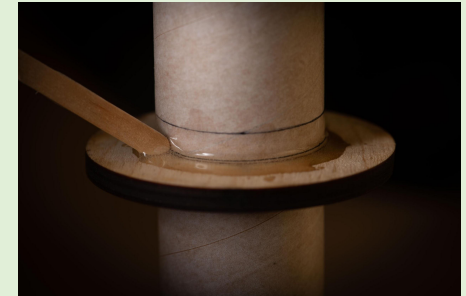


Figure 13-15: Motor Mount Placement with Line (Top); Applying Epoxy to the Mid-Centering Ring (Center); Completed Mid-Centering Ring (Bottom)

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

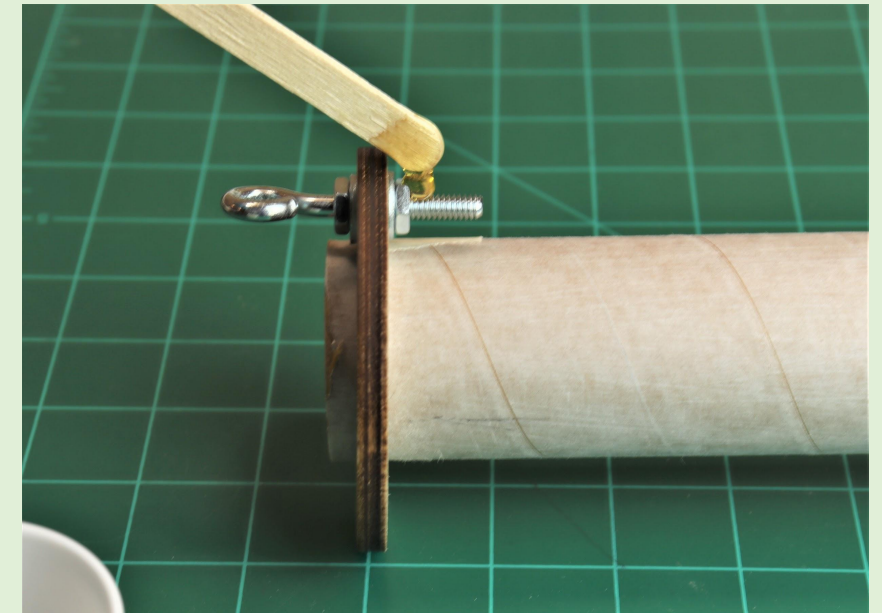
Rocket Build – Assembly

Motor Mount Assembly

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



Figure 13-16: Epoxy Eyebolt Thread



Rocket Build – Assembly

Coupler Assembly

1. Dry-fit Step: Fit bulkplate inside coupler, ensuring level fit ~1/4" from the edge
2. Remove bulkplate after ensuring fit
3. Put on gloves before preparing epoxy
4. Prepare small amount of epoxy
5. 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 few 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

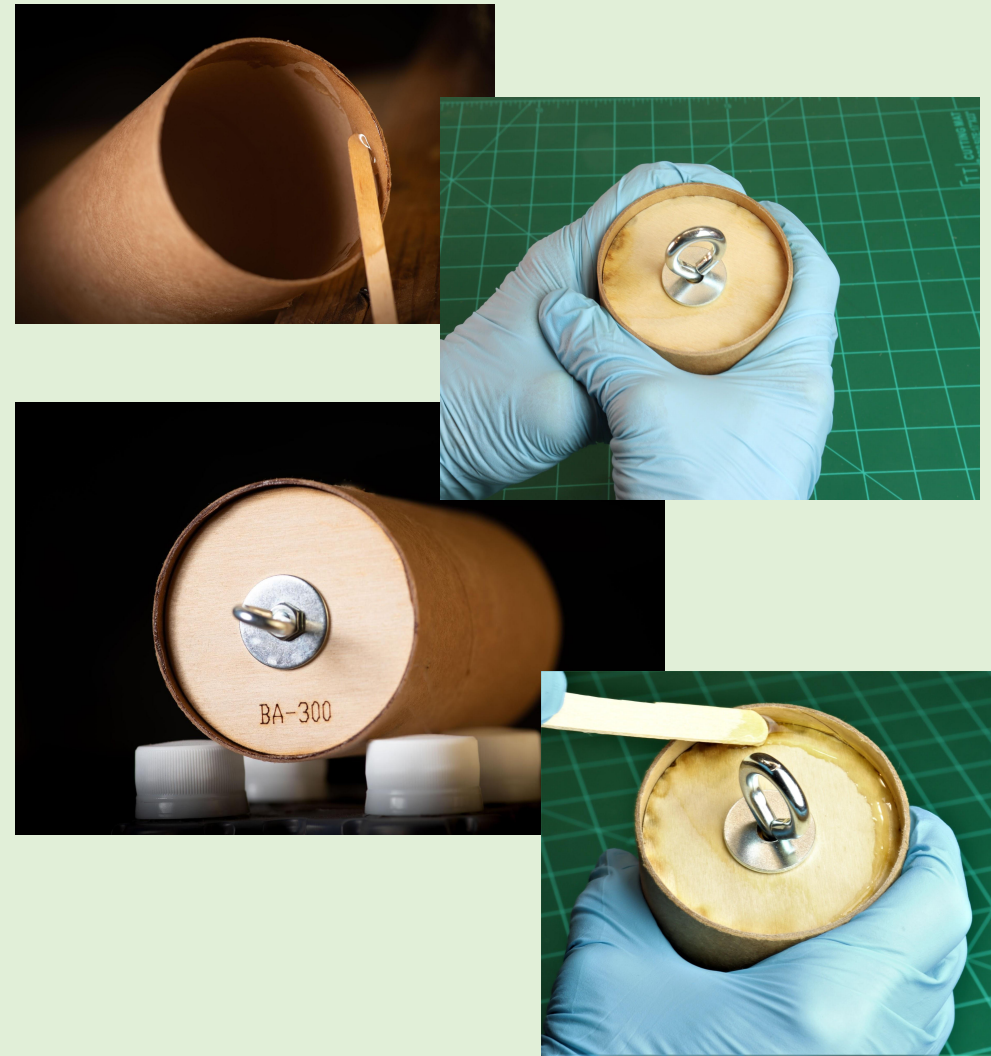


Figure 13-17: Applying Epoxy around Inside of Coupler (Top); Bulkplate Installed in Coupler (Bottom)

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!