

Central New York Rocket Team Challenge 2018

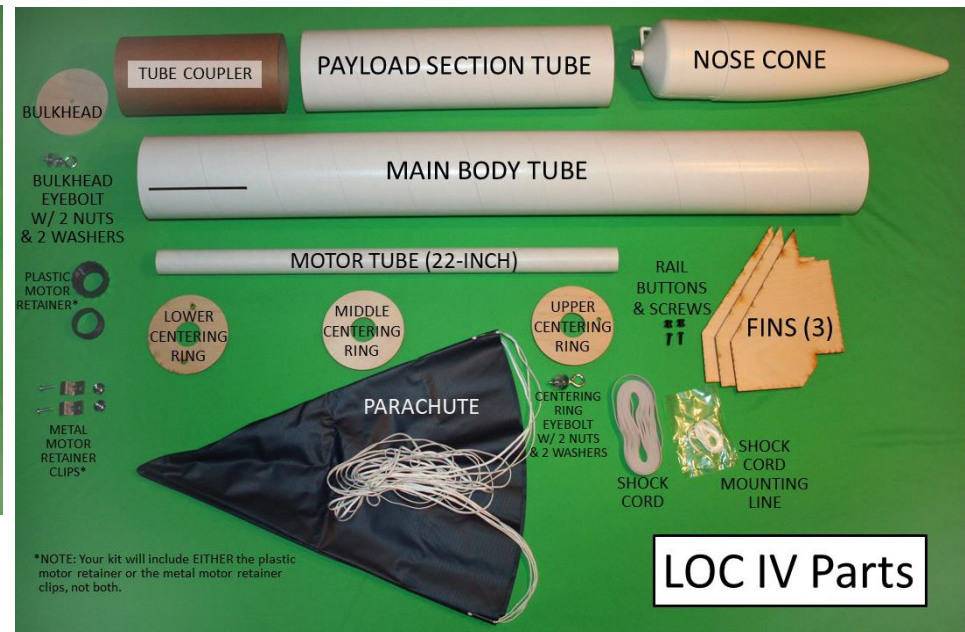
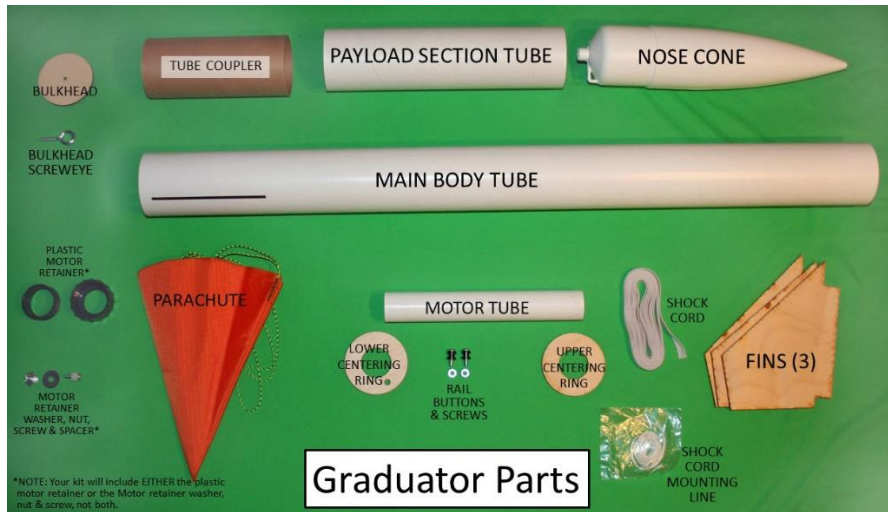
Rocket Assembly Instructions

Note: These instructions vary from those provided by the manufacturer of the rocket kits. There is also considerable varying discussion that can be found on rocket web sites on construction methods. While the teams are allowed to assembly kits in a manner they see fit, these assembly instructions and methods are those recommended to complete a rocket to compete at the Central New York Rocket Team Challenge.



Getting Started

First, make sure you have all the parts you need to build the rocket. The following pictures will help you identify the components of the LOC IV and Graduator kits as you work through these instructions.



Other items needed during assembly:

Ruler, glue (we recommend Titebond II), cyanoacrylate (super glue), 5 minute epoxy, masking tape, sandpaper, two types of wood sticks (for glue application), rubber gloves, pen, modeling knife, and paper.

NOTE: Your school gets to keep the rocket for future launching!

Motor Mount Sub-Assembly

The motor mount holds the rocket motor during flight and must be built to transfer the forces to the rest of the rocket. It is very important to follow the next two sections carefully!

If you are building the LOC IV attach the eye bolt to the front centering ring.

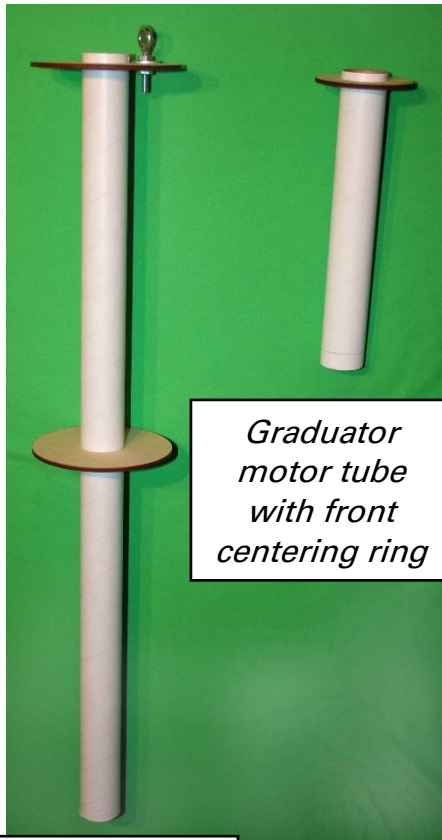


Top view of LOC IV front centering ring.



Bottom view of LOC IV front centering ring.

Tighten the nuts on the eyebolt, then put a layer of blue over the washer and nut on both sides of the eye bolt.



Graduator motor tube with front centering ring

1) Sand the outer surface of the motor tube. This will help the glue adhere to the surface.

2) Test-fit all centering rings on the end of the motor tube. They should fit snugly but not crimp or tear the end of the tube. If they are too tight, use coarse sandpaper to remove some material from the inside of each centering ring until a good fit is obtained. Set aside the rear centering ring for a later step.

3) Place the front centering ring 1/8-inch from the front of the motor tube. For the LOC IV, also place the middle centering ring at the mid-point of the motor tube (11 inches from the front of the tube).

4) Apply a line of glue at the joint of the tube and front ring. Smooth out the glue around the joint using a gloved finger. You may want to wear disposable gloves when applying carpenters wood glue. ALWAYS wear gloves when working with epoxy glue.

LOC IV motor tube with front and middle centering rings

5) Repeat step #4 on the other side of this ring for added strength.

6) For the LOC IV place a ring of glue on both sides of the middle centering ring.

7) Allow the glue on the centering rings to dry before proceeding.

Glue Hints:

A light amount of glue will dry more quickly!

The type of glue is "Titebond II" carpenters glue.

Keep in mind that this glue will stain clothing!

Two-part epoxy is stronger but requires greater care. Gloves must be worn when applying epoxy.



Installing the Motor Mount

In this section, you will glue the motor-tube/ring sub-assembly into place inside the main rocket body tube. The kit comes with a 29 mm motor tube.



1a) If you are using a plastic motor retainer ring, mark a line $7/16$ " inch from the aft end of the tube (the end without the centering ring). You will use this mark to know how far to let the motor tube stick out beyond the bottom centering ring.

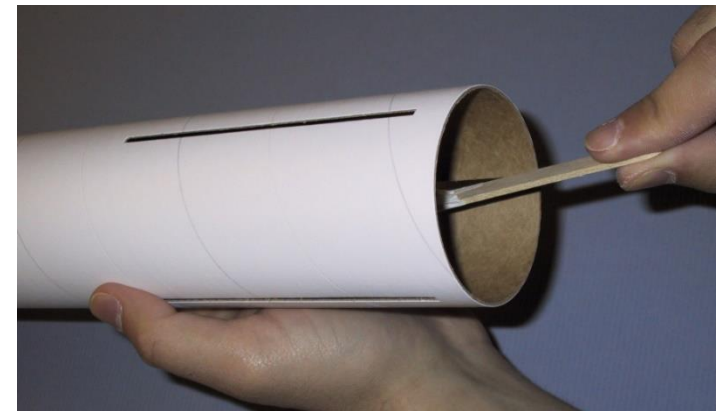
1b) If you are building a LOC IV and are using the metal motor retainer clips, mark a line $1/4$ " inch from the aft end of the tube (the end without the

centering ring). You will use this mark to know how far to let the motor tube stick out beyond the bottom centering ring.

1c) If you are building a Graduator and are using the washer motor retainer clip, mark a line $3/16$ " inch from the aft end of the tube (the end without the centering ring). You will use this mark to know how far to let the motor tube stick out beyond the bottom centering ring.

2) Test-fit the tube/ring sub-assembly into the end of the main tube that has the fin slots. The ring goes in first. It may be easier to initially slide it in a little off center, and then set straight. If the centering ring fits too tightly, sand around the outer edge of the ring.

3) Apply a ring of glue inside the main body tube just above the forward edge of the fin slots. Spread the glue using popsicle sticks (tape two of them together to make a longer stick). Keep the main tube horizontal to prevent the glue from running down the inside length of the tube.



Fin Slots & Tabs:

The fins are made with tabs that glue directly to the motor tube instead of the outside of the main tube. This method is stronger during launch & landing.

4a) **If you are using a plastic motor retainer ring**, slide the motor-tube/ring sub-assembly into the end of the main tube (ring first) until it hits the glued area. Continue pushing the tube in until the end of the motor tube is exactly even with the end of the bod tube.

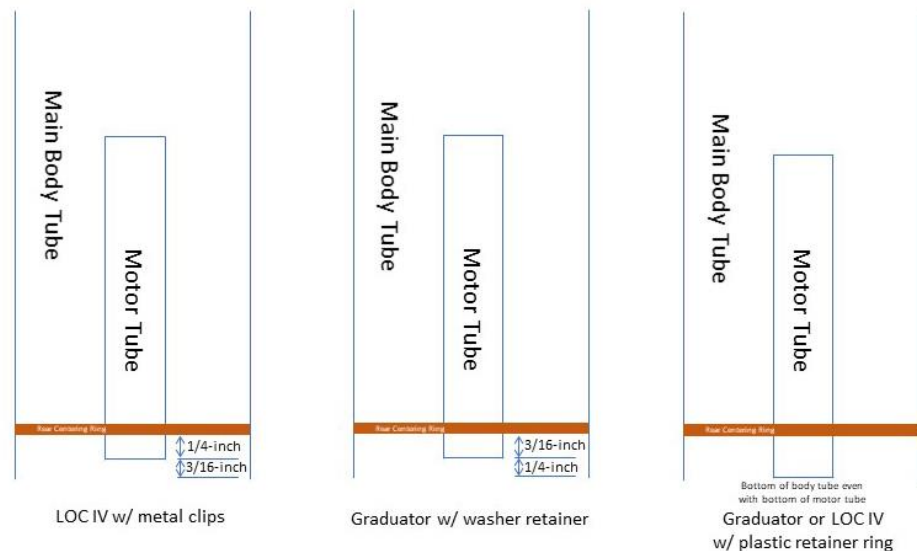
4b) **If you are building a LOC IV and are using the metal motor retainer clips**, slide the motor-tube/ring assembly into the end of the main tube. Continue pushing the tube until the motor tube is exactly 3/16-inch forward of the end of the body tube.

4c) **If you are building a Graduator and are using the washer motor retainer clip**, slide the motor-tube/ring assembly into the end of the main tube. Continue pushing the tube until the motor tube is exactly 1/4-inch forward of the end of the body tube.

5) If you are building the Graduator, you can use the 3 fins temporarily to center the motor tube within the main tube. Each fin has a tab that goes through a slot in the main tube and presses against the motor tube. With all three fins inserted, the motor tube will be centered. Tape the fins in place temporarily with a small amount of tape.

6) Set the rocket on its fins and wait 15 minutes or more to let the glue set into the upper ring.

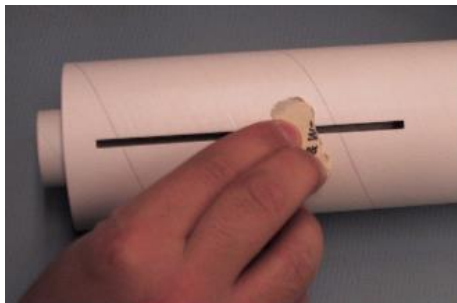
7) Place a fillet of glue on the bottom side of the top centering ring (Graduator) or middle centering ring (LOC IV) and allow to set.



Attaching the Fins

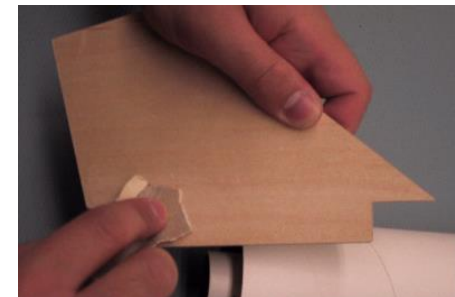
The three plywood fins will be glued in three places to guarantee a strong attachment to the rocket. Remember to use a light amount of glue and try to keep it from running while it sets.

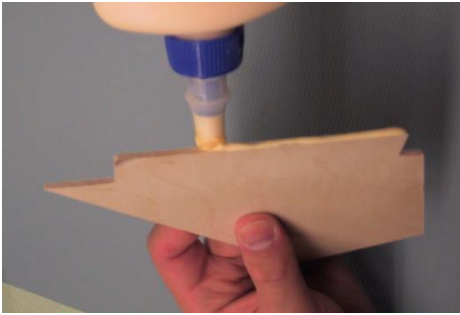
1) Remove the fins from the slots after allowing the ring to set in place from the previous section.



2) Lightly sand the outer surface of the main tube around the fin slots.

3) Sand the surface of the fins where they will meet the inside and outside edges of the fin slot. This will help the glue adhere to the fins.



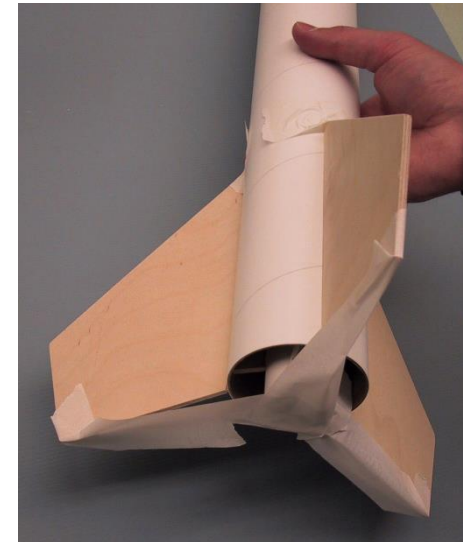


4) Apply a light amount of glue to the inner edge of the fin where it will meet the motor tube. Remember, a small amount of glue will dry faster and you will be adding more later.

5) Insert the fin through the slot, being careful not get much of the glue on the slot area. Hold the fin against the motor tube and align the fin as straight as possible. Tape the fin in place to hold it straight while the glue sets.

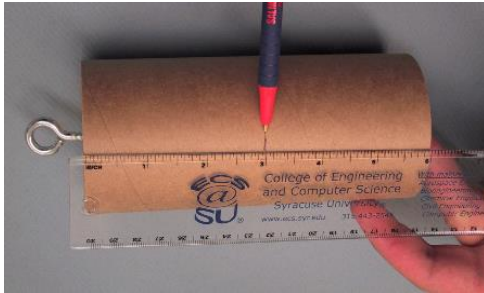
6) Repeat for each of the three fins. Add tape across the back edge of each fin and onto the motor tube. This will help keep the fins aligned while the glue dries. Double check the alignment of all the fins.

7) Set the rocket on its fins and go on to the next section while the glue sets.



Payload Sub-Assembly

This section describes how to attach the tube coupler to the payload section. This section will slide onto the main body and hold your payload items (the altimeter and the egg!). The steps shown here will give you a basic structure.



1) Mark the coupler at its half-way point (3" for the Graduator, 4" for the LOC IV).

2) Apply some glue inside one end of the payload tube. Spread the glue evenly for a thin layer up to 3 inches inside the tube. Use a thin

stick to spread the glue.



3) Insert the coupler into the end of the tube up to the half-way mark on the coupler. Make sure you do this quickly because the glue will set almost immediately!

4) For the Graduator apply some glue to the hole in the bulkhead and screw the screw eye into the bulkhead. Apply a small amount of glue where the screw eye meets the bulkhead. For the LOC IV, attach the eye bolt to the bulkhead with the supplied washers and nut. Apply a small amount of glue around the washers and nut. Let the glue set.

Payload Design:

Your team is responsible for the design and construction of an inner structure of the payload section that will safely hold and protect the egg during flight and landing.



5) Apply a line of glue inside the end of the coupler. Insert the bulkhead ring into the coupler against the glue. Leave about 1/8-inch of the coupler showing at the back of the bulkhead ring. Allow glue to set.

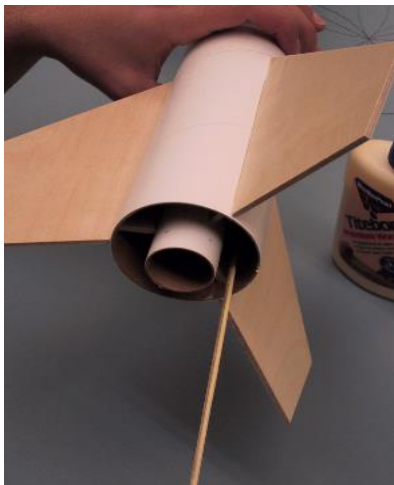
6) Apply a fillet of glue between the bottom of the bulkhead and the coupler. Allow glue to set.



Fin Reinforcement

After the initial glue has set, the fins are ready for some reinforcement. This step is essential for higher-power model rockets like this one.

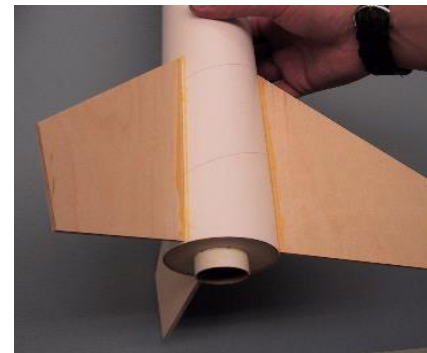
1) Remove the temporary tape that was holding the fins in place while the initial glue was drying. Make sure the glue is set and fins are secure before removing the tape!



2) Add a line of glue where each fin meets the motor tube and where each fin meets the inside of the main tube. You may find it useful to let the glue run down the joint and spread it out with a stick. Keep the rocket horizontal during these steps!

3) On the outside of each main tube/fin joint, add a thin layer of glue. Spread it out with your finger in one motion to make a uniform layer at the joint. Make sure you are wearing gloves if you are using epoxy. (This may

be repeated later on and allowed to dry before you paint your rocket.)



4) You may find it easiest to do the reinforcement gluing in thirds. Place the rocket horizontally with one fin pointing down. Reinforce with glue all joints that are facing up. Let the glue set. Rotate the rocket one-third and then reinforce the next group of joints facing up. Repeat reinforcement for the last third.

5) The inner fin/tube joints can be additionally strengthened by laminating lengths of 1/8" wood strips – balsa or basswood works well and both are light weight.

6) Set the rocket horizontally while the glue dries.

Always wait for the glue to completely set before attempting any step that applies pressure.

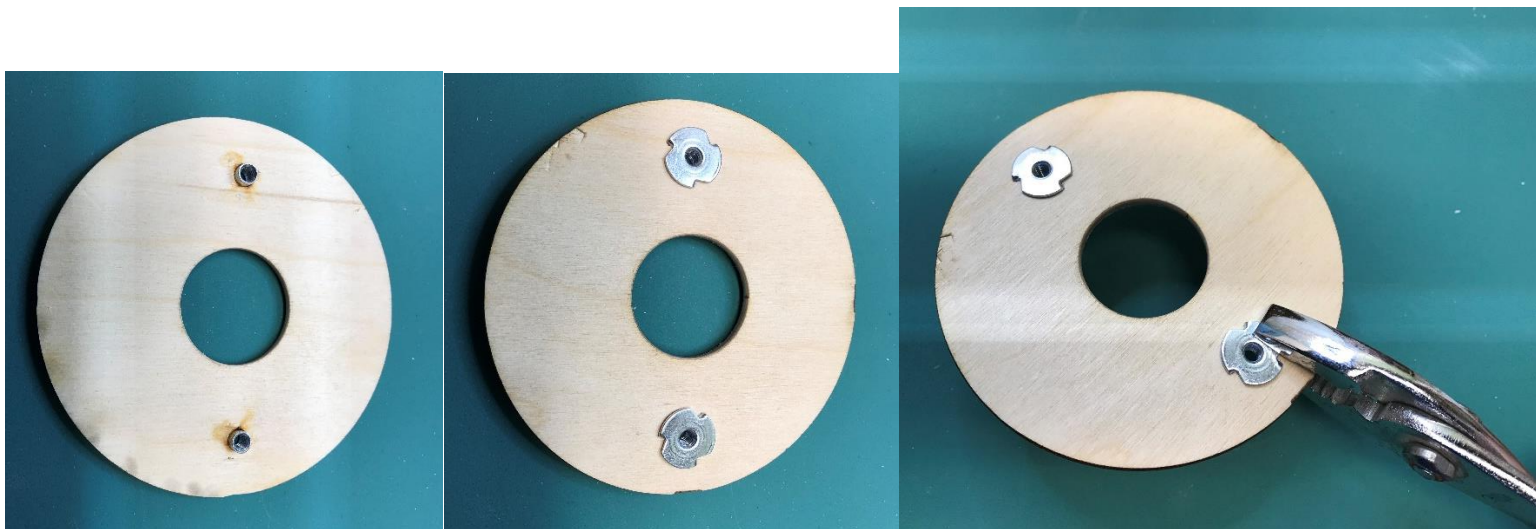
Another glue tip:

Remember to use the minimum amount of glue needed to fill the joints. Excessive use of glue will cause runs and drips, plus it will take forever to dry!

Rear Centering Ring

The next step on the motor-mount assembly is to add the rear centering ring.

- 1) The rear ring may fit too tightly if there is any extra glue remaining from the previous steps. Test fit it into the back end of the rocket's main tube, **but be careful. The rear ring may fit so tightly during the test fit, that you may not be able to remove it for gluing.** Sand or scrape the glue residue from the inside back end of the main tube. Or, you may have to sand the outside edge of the ring.
- 2) If your rocket has a metal clip or washer motor retainer, install the T-nuts in the rear centering ring. The LOC IV has two T-nuts. The Graduator has one T-nut. You can use a pair of pliers to squeeze the prongs on the T-nuts into the wooden ring. Place glue around the flange of the T-nut, but be careful not to get any glue in the threads of the nut.



- 2) Apply a layer of glue just inside the rear of the main rocket tube. Spread this out in an even layer.
- 3) Insert the ring over the motor tube and slide it into the end of the main tube. Make sure the flanges of the T-nuts are up(inside the rocket). Make sure a T-nut is not directly over a fin tab as this will make the tab interfere with the mounting screw. Do this quickly before the glue takes hold! Push the ring in until it fits up against the fin tabs that are on the inside of the back of the rocket.

- 3) Add a light ring of glue at the joint of the ring and the rear of main body tube. Spread this out with your finger, leaving a thin smooth layer at the joint. Be careful not to get any glue in the treads of the T-nuts.
- 4) The rear centering ring will look like this:



Graduator



LOC IV

Plastic Motor Retainer

If you are using the plastic motor retainer, the last step on the motor-mount assembly is to glue the retainer to the motor tube.



1) Lightly sand the outside of the 29 mm motor mount tube that protrudes from the aft end of the rocket. This will help the glue adhere to the tube.

2) Sand the inside surface of the motor retainer ring that will be glued to the motor tube. This is critical to achieve a strong joint.

3) Spread a thin layer of two-part 5-minute epoxy over the outside of the motor mount tube that protrudes from the aft end of the rocket. **YOU MUST USE EPOXY FOR THIS STEP.** Always wear

gloves when working with epoxy.



4) Press the motor retainer ring over the motor mount tube until it seats firmly on the motor tube. Wipe away any excess glue. Be careful not to get any glue on the retainer threads or inside the motor tube. The picture to the left shows the retainer ring installed on the LOC IV.

Shock Cord Anchor - Graduator

The main rocket body is connected to the shock cord and parachute during the recovery portion of the flight. To keep the shock cord attached to the rocket, a piece of nylon cord is used as an anchor.

- 1) Tie a knot in each end of the shock cord mounting line.
- 2) Fold the line in half and tie a knot in the doubled-over end to make about a 1" loop.
- 3) Use a 2" x ¼" piece of tape just above the knots to temporarily hold the line in place inside the front end of the main rocket tube. **The tape must be at least 4" from the opening of the tube to allow the payload coupler to slide freely into the main tube.** Glue the cord in place using 5-minute two-part epoxy ([ask your teacher to help](#)). The epoxy should cover the ends of the nylon cord, and the cord should lay flat against the body tube leaving no projections that would catch on the parachute. Always use gloves when working with epoxy.



Shock Cord Anchor – LOC IV

The shock cord anchor for the LOC IV is the eye bolt that you attached to the top centering ring. You will tie one end of the shock cord to that eye bolt.

Shock Cord Attachment

The main body of the rocket is connected to the payload section by 8 feet of thick elastic cord.

- 1) One end of the shock cord is attached to the loop in the shock cord anchor (made in the previous section) for the Graduator or the eyebolt for the LOC IV. Slide one end of the shock cord through the loop and tie a double knot in the shock cord.
- 2) The other end is attached to the eye bolt on the bottom end of the payload section. Loop the end of the shock cord through the eye bolt and make a double knot in the cord.

Parachute Attachment

The parachute that comes with the kit is sufficient to recover the rocket safely under most circumstances.

Make a 3" loop in the shock cord about two feet from the payload section. Tie a knot in the cord to hold the loop in place. Tie the parachute to this knot, keeping all of the parachute lines even.

Attaching the Nosecone

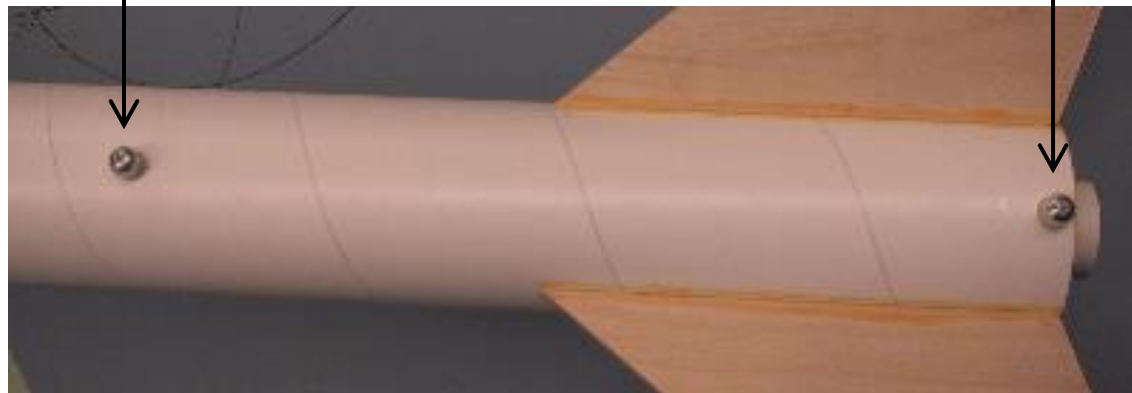
The nose cone of your rocket needs to be secured to the top of your payload bay to prevent it from coming off during the flight and releasing the payload. It is recommended that a small hole be drilled through the payload section's tube (air frame) and into the part of the nose cone that inserts into the airframe (the shoulder). Screw into the hole a #6 x 1/2 Inch Pan Head Sheet Metal screw to hold the nose cone securely in place. Do not over-tighten this screw as it is easy to strip the threads in the plastic nosecone hole.

Launch Guides

Rockets need initial guidance during the boost. At the Central New York Rocket Team Challenge, rockets are guided by a 6 foot grooved rail.

Two launch rail guides (rail buttons) need to be secured into the main (lower) airframe of the rocket vertically aligned between two fins.

They are attached by drilling 1/8" holes, applying some cyanoacrylate (super glue), and screwing them into place. The holes must be aligned along the body tube, with one of them into the rear ring, and the other about one foot above. They may be added after painting the rocket. For maximum strength (and multiple launches), it is best if the screws are anchored into the wood centering rings or supplemental backing material added (easier to do on the 4" diameter rocket).



Payload Section Preparation

There are a few important payload section design specifications that must be met in order for your team's rocket to be allowed to compete at the Central New York Rocket Team Challenge. These features should be added after the team has applied the finish coat of paint.

Reserve Spacing in the Top of the Payload Section for Altimeter

To allow for the placement of the altimeter in the payload section, a portion from the top of the payload section airframe down must be available.

The space needed from the top of the payload's airframe by kit is as follows:

Graduator	5.875 inches
LOC IV	7.125 inches

The variation in the reserve space by kit is due to differences in the nose cone shoulder length (the part of the nose cone that inserts into the tube.)

Pressure Equalization Hole

A 1/8-inch diameter pressure equalization hole should be drilled through the wall of the payload section in the middle of the reserve space described above. The hole should be located on the side of the payload section opposite the screw securing the nose cone. This hole allows the air pressure in the payload reserve space to equalize with the atmospheric pressure outside the rocket. The altimeter uses the sensed pressure to determine the rocket's altitude. The pressure equalization hole should have clean smooth edges. This is best accomplished in the following steps:

1. Drill a 1/8-inch hole.
2. Sand the body tube with 150 grit sandpaper on the outside face and inside face of the tube to remove any excess material left after drilling.
3. Apply a drop of thin cyanoacrylate glue (super glue) with a toothpick to the inside edge of the hole and allow to dry completely.
4. Run the 1/8-inch drill through the hole one more time to remove any roughness left from the glue application.

Securing the Altimeter

At the launch, the altimeter will need to be secured to the inside of the payload section within the reserved space. The MOST will provide an encapsulated altimeter at the launch. These capsules will be secured within your payload section with Velcro. A $\frac{3}{4}$ -inch wide strip, 2- $\frac{1}{2}$ inches long of hook side (the rough part) of the Velcro will be provided on the day of the launch, and must be placed vertically inside the reserve space of the payload section. Be sure to place the strip far enough down so that it does not interfere with the insertion of the nose cone and high enough that it does not interfere with your egg container.

Securing the Video Camera

At the launch, a video camera will be secured to the outside of the main body tube section. The MOST will provide launch video cameras ready to go on the day of the launch. The camera will be secured to the outside of your main body tube section with Velcro. A $\frac{3}{4}$ -inch wide strip, 4- $\frac{1}{2}$ inches long of the loop side (the felt-like part) of the Velcro will be provided on the day of the launch, and must be placed $\frac{3}{4}$ -inch below the top of the main body tube section. Be sure you do NOT place the Velcro in line with the rail buttons.

Stowing Egg

The egg should be secured in the payload section in the area below the reserved space.

Finishing Up!

Your rocket is almost ready to launch, but you will want to paint it first. Standard spray paints (such as Krylon) are low-cost and readily available at department stores and home improvement stores.

All surfaces should be sanded lightly before applying a primer coat. "Sandable primer" is recommended. Repeat the sanding and priming until you get a fairly smooth surface.

Apply the final paint in light coats to prevent running. Your team may want to choose your school colors, and add lettering or decals of your own design. Laser printer decals are available at office supply stores. Airbrush painting is great for unique designs. Be creative!

Keep in mind that a rough finish (or other added stuff on the rocket!) will add “drag”. The drag forces will act against the thrust of the rocket motor, limiting the altitude of the rocket.

PLEASE NOTE!

Be careful handling and storing your rocket!

The tube could be damaged easily if leaned against, or bounced around in your car!