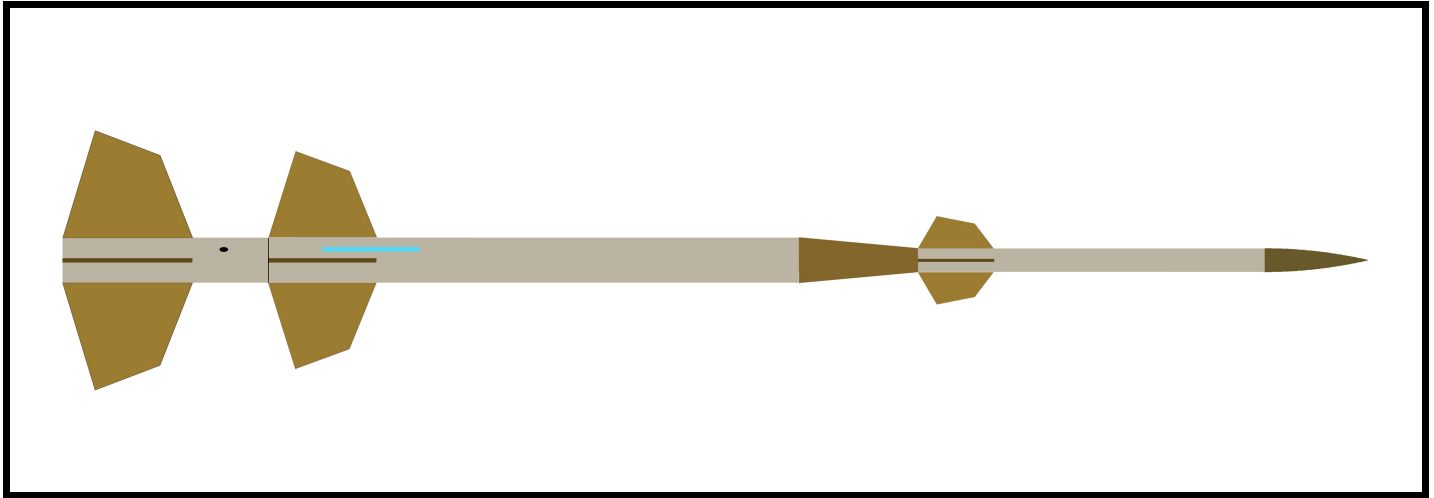




Skill Level 3

# Tempest

Created by C. P. McGraw



Length	30.15"
Diameter	1.040"
Fin Span	5.97"
Weight	1.6 oz

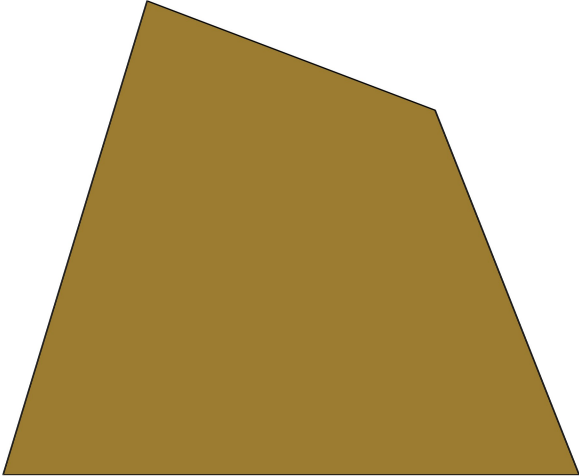
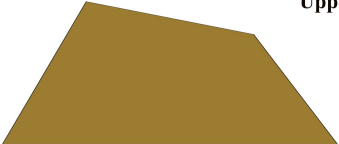
### Parts List

Nose Cone.....	BC-524
Upper Body Tube.....	ST-5120
Sustainer Body Tube.....	ST-10120
Booster Body Tube.....	ST-1050
Engine Mounts.....	(2) EM-710
Inner Body Tube.....	ST-720
Centering Rings.....	(2) CR-710
Centering Rings.....	(2) TB-7
Coupler.....	(2) CPL-10
Balsa Bulkhead.....	BH-5
Launch Lug.....	LL-18
Screw Eye.....	1"
Snap Links.....	(3) #10
Upper Fin Stock.....	1/16" x 3" x 4"
Sustainer Fin Stock.....	3/32" x 3" x 6"
Booster Fin Stock.....	3/32" x 3" x 8"
Shock Chord.....	SC-24
Kevlar Shock Chord Mount.....	SCK-24
Parachutes.....	(2) CPK-12

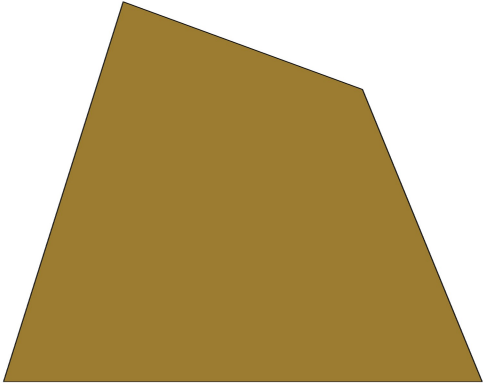
## **Additional Materials Required**

Small bottle of yellow carpenter's glue  
Small, soft-bristle hobby brushes  
Pencil, 0.05mm mechanical  
Steel ruler  
Sheets of 220-, 400-, and 600-grit sanding papers  
Tack rag  
Sprayable primers, paints, and gloss Acrylic clearcoat  
Sharp hobby knife  
Various clamps and weights  
Sheets of cardstock to print patterns on  
Copy of ***The Model Rocketry Handbook, Seventh Edition***, by  
G. Harry Stine and Bill Stine

Upper Body Fins -- 1/16" Sheet



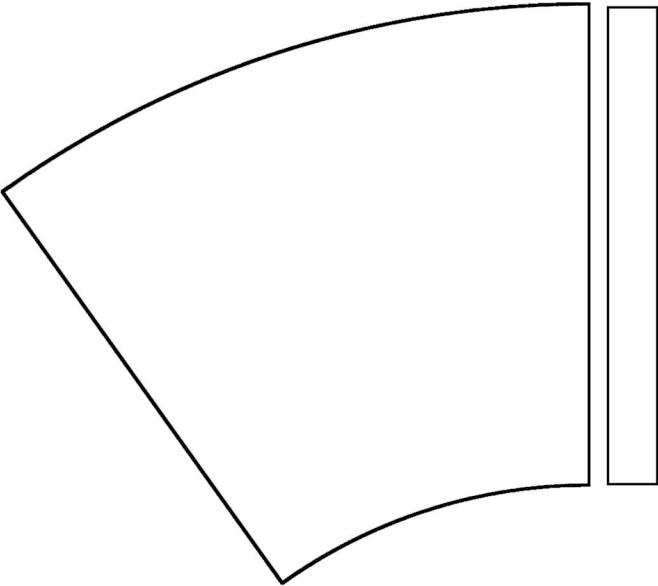
Booster Fins -- 3/32" Sheet



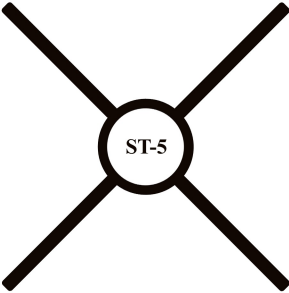
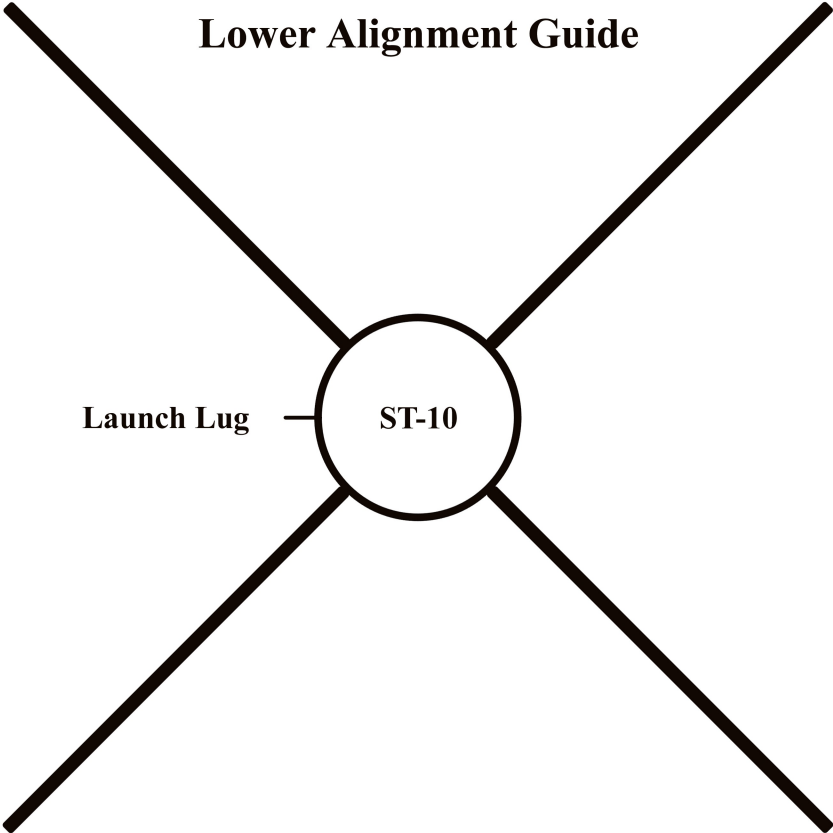
Sustainer Fins -- 3/32" Sheet

*Tempest Master Fin Pattern*

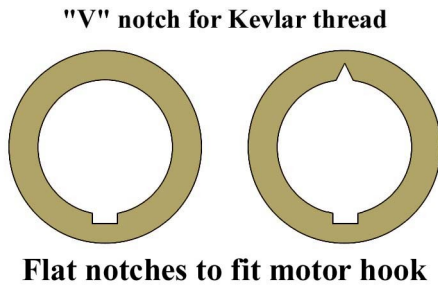
**Tempest Reduction Shroud**



**Lower Alignment Guide**

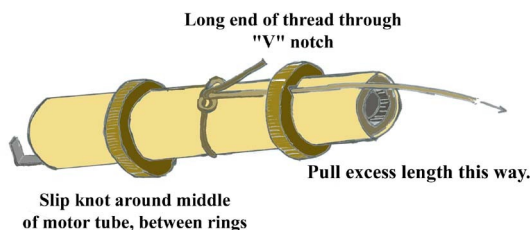


**Upper Alignment Guide**



*Figure 1*

- **Step 1** Modify the four CR-710 rings found in the EM-710 packages with a flat notch, as seen in the left-hand image of Figure 1. This notch should only be as wide as the engine hook, and only as deep as the thickness of the hook. Modify one of these four rings with a “V” notch, as shown in the right-hand image of Figure 1.
- **Step 2** Assemble the two EM-710 packages according to the Semroc instructions, using the ring with the “V” notch as the **forward-most** ring of the **sustainer** engine mount. The flat notches should be aligned over the engine hooks. Do not allow glue to block the “V” notch. Clean out any glue that fills this notch completely with a soft hobby brush, moistened. Allow both subassemblies to dry.

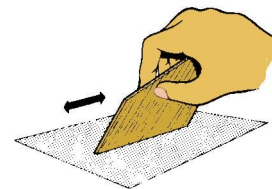


*Figure 2*

- **Step 3** Tie a slip knot around the

middle of the **sustainer** engine mount using the Kevlar thread. Pull the knot tight, and push the long, free end of the thread through the “V” notch, as shown in Figure 2. Slide the loop up against the **back** of the **forward** ring, pulling the excess thread as you do so. Secure this thread in place with a thinned layer of glue. Allow to dry.

- **Step 4** Cut out all of the fins from their respective sheet stocks, and give the faces of all fins a careful sanding with 220-grit paper. Do not gouge into the surface, just remove the fuzziness. Round over all of the **outer edges** of the fins with 400-grit paper, but **do not** round over the **root edge** of the fins. Square these edges, as shown in Figure 3.

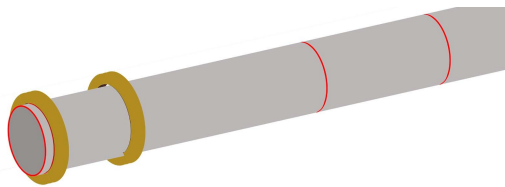


*Figure 3*

- **Step 5** Give all four body tubes a complete sanding with 220-grit paper to remove all of the shine from the surface. Do not sand through the outer layer of paper.
- **Step 6** Print out several copies of the **Alignment Guides** and trim out the inside areas with a sharp knife. Use the edge of a steel ruler as a guide for the blade. Slip the **Lower** guide onto the booster body and mark the tube for the four fins **only**. Next,

slip the same guide over one end of the sustainer body and mark for the four fins **and** the launch lug. Slip the **Upper** guide over one end of the upper body tube and up from the edge about 5". Mark this tube for four fins.

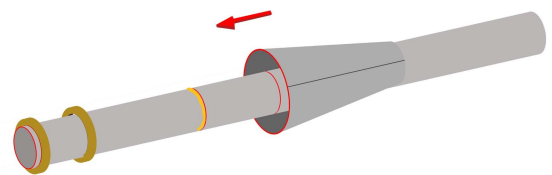
- **Step 7** Mark the upper body tube at locations 0.125", 1.625", 4", and 5.75" from the bottom of the tube. Draw lines completely around the tube at these marks.



*Figure 4*

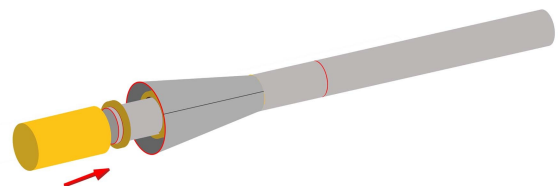
- **Step 8** Slip the two remaining TD-7 rings over the ST-5 tube, and position both rings **between** the lines at 0.125" and 1.625". As shown in Figure 4, apply a bead of glue around the tube just **ahead** of the line at 0.125", and slide the lower ring down through the glue until it is **just touching** the line. Apply a similar bead of glue just **behind** the line at 1.625", and slide the ring up through the glue until it is just touching the line. Allow to dry.
- **Step 9** Print the shroud patterns onto cardstock, and cut out the two pieces that make up the tapered shroud. Use a dowel or other solid, round tube to pre-shape the shroud to a curled form without any surface creases. Apply a layer of glue to the inside edge of one end of the shroud,

and attach the underlap tab. Allow to dry. Apply a similar layer of glue to the **other** end of the shroud, and attach this end to the tab. The two edges should butt together with no overlap to each other. The tab should take care of the joint. Allow to dry.



*Figure 5*

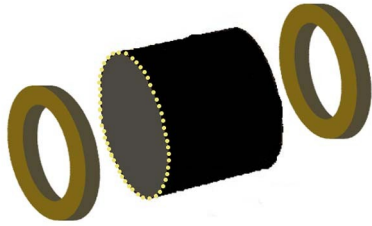
- **Step 10** Slide the shroud onto the upper body from the top, until the bottom of the shroud is just **ahead** of the line at 4". Do not force this fit. If the shroud is too tight, nibble the opening slightly larger with a hole punch and try again. Apply a bead of glue around the tube at the 4" line, and slide the shroud down until the **top of the shroud** is even with the line.



*Figure 6*

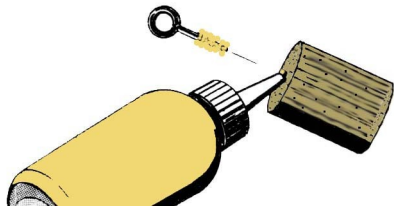
- **Step 11** Apply a generous bead of glue to the inside of one end of the ST-72 inner body tube, and as seen in Figure 6, slide it onto the two TD-7 rings until the bottom edge of the inner body is even with the bottom edge of the **ring**. Do not allow the

tube to stop during this push, or the glue will “freeze” the tube in the wrong place.



*Figure 7*

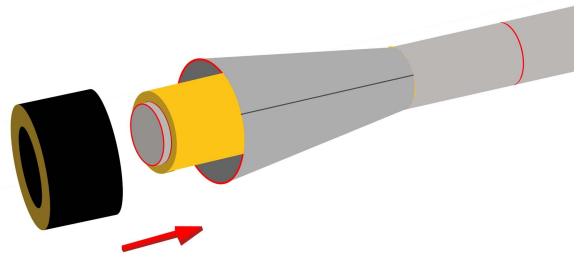
- **Step 12** Assemble the coupler as shown in Figure 7, using the remaining two **unmodified** CR-710 rings. Set this aside to dry.



*Figure 8*

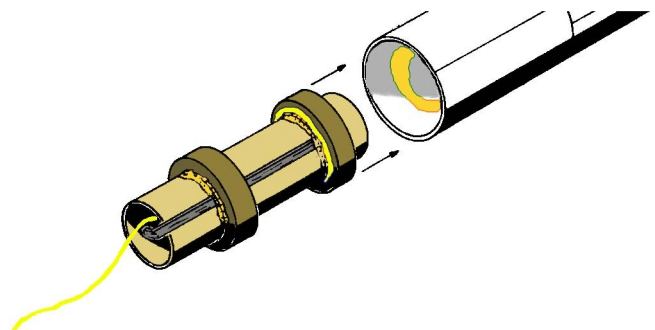
- **Step 13** Use the screw eye threads to cut a threaded hole into the base of the balsa bulkhead. As shown in Figure 8, force glue deep into the hole, and coat the threads on the screw eye. Re-thread the screw eye into the hole and allow the glue to dry.
- **Step 14** Apply a generous bead of glue to the outside of the inner body tube, and to the inside of the large end of the shroud. As shown in Figure 9, slide the coupler subassembly from

Step 12 onto the tube, until the **top edge of the top ring** is touching the shroud and is in full contact with the glue. It is more important that the coupler is in contact with the shroud than where the bottom of the coupler lines up on the inner body. Allow to dry.



*Figure 9*

- **Step 15** Apply a bead of glue inside the bottom of the upper body tube, and insert the balsa bulkhead, with the screw eye to the outside. Apply a similar bead of glue just inside the opposite end of the upper body tube, and insert the nose cone. Set this aside to dry.



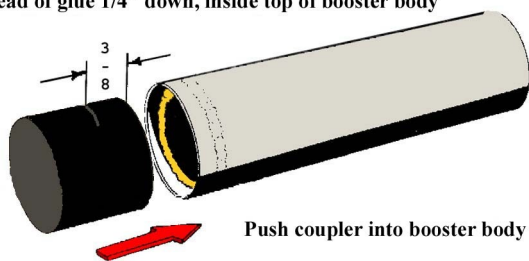
*Figure 10*

- **Step 16** Push the Kevlar thread down through the center of the **sustainer engine mount**, and pull the excess thread out. As shown in Figure

10, apply a generous bead of glue up inside the **bottom** of the sustainer body tube, then push the mount completely inside in one motion, until the **bottom edge of the motor tube** is even with the bottom edge of the body tube. Do not stop during this task, as the glue will “freeze” the mount in the wrong place. Set this aside to dry.

- **Step 17** In a similar manner to Step 16, apply glue inside the booster body tube and insert the **booster engine mount**. The bottom edge of the motor tube should be even with the bottom edge of the booster body. Allow to dry.

Bead of glue 1/4" down, inside top of booster body



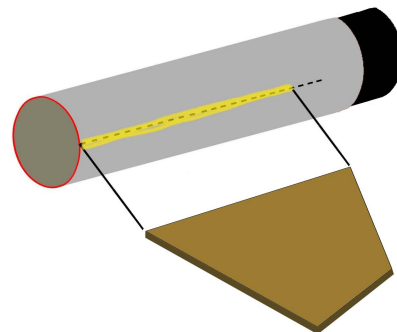
*Figure 11*

- **Step 18** Mark the remaining coupler 3/8" from one end. Apply a bead of glue inside the top of the booster body, about 1/4" wide. As shown in Figure 11, insert the coupler, short-side of the line, into the top of the booster tube, until the edge of the tube is even with the mark on the coupler. Make sure the coupler is straight in the tube, and not sitting at an angle. Allow to dry.

- **Step 19** Read and understand the

chapter on **Multi-Staged Models** in *The Model Rocketry Handbook*, as it will explain in greater detail what is being done in this step. Mark the top of the booster body 1" below the edge of the tube, and draw a line completely around the tube. Locate two points on this line, 180 degrees apart. Cut a hole through the body tube at each of these marks, 1/4" in diameter. Do not get the holes too large. These are pressure vents which will allow the sustainer motor to fully ignite before the booster separates.

- **Step 20** Extend the fin locator lines on the booster body upward for 3" from the bottom of the tube. Extend the lines for the sustainer body fins upward for 2.75", and the lug line for 3.5". The upper body fin lines extend between the top of the shroud (at the 4" line) and the line at 5.75". Apply a layer of **thinned** glue to the root edges of **all** fins, to all of the fin locator lines on the three body tubes, and to the lug line on the sustainer from the 3.5" mark **rearward for a distance of 2.25"**. Allow these to dry completely.



*Figure 12*



- **Step 21** Apply a bead of glue to the root edge of a booster fin (a second layer of glue to the layer applied in Step 20), and to the booster body along the locator line, as shown in Figure 12. Attach this fin to the tube, with the fin trailing edge even with the rear edge of the tube, holding it in place for a few seconds to let the glue “grab”. Use a moist hobby brush to smooth out the glue that squeezes out from the joint, forming the first fillet. Slide the lower alignment guides over the booster body from the front, down over the fin, to accurately position the fin relative to the body. Allow to dry, then repeat this step for each of the three remaining booster fins.

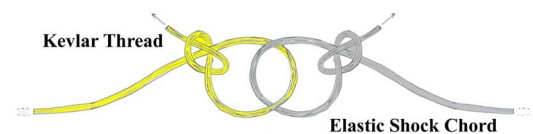
- **Step 22** In like manner, attach the sustainer body fins to the sustainer body and allow to dry.

- **Step 23** Also in like manner, attach the upper body fins to the upper body tube, using the upper alignment guide. The trailing edge of the fins touches the top edge of the shroud at the 4” line, and the leading edge of the fins should touch the line at 5.75”. Allow to dry.

- **Step 24** Attach the launch lug to the sustainer body tube on the lug alignment line, with the top of the lug touching the 3.5” mark. Allow to dry, then apply a bead of full-strength glue to the root edges of all the fins, both sides, and smooth the glue down with a moist finger or hobby brush. This will form a reinforcing fillet to give

these joints added strength.

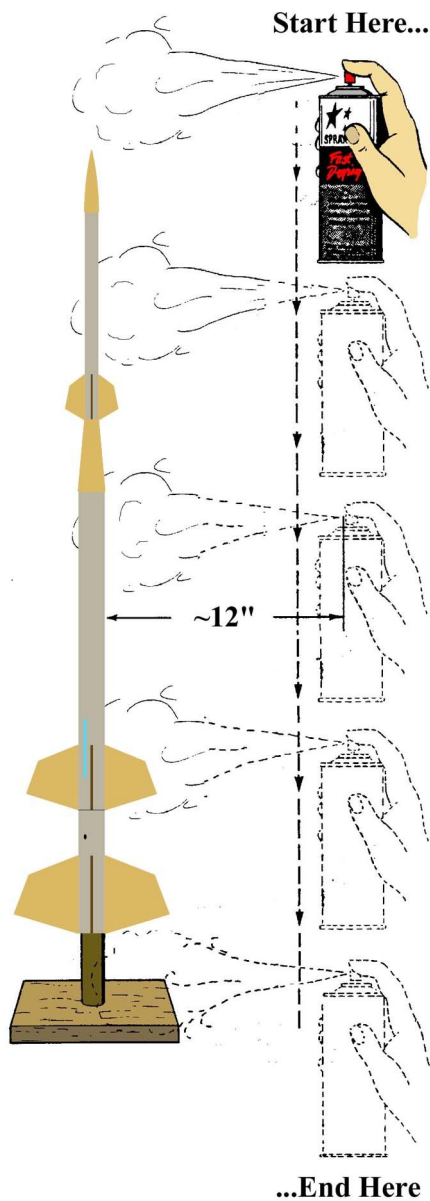
- **Step 25** Pull the free end of the Kevlar thread out the front of the tube. Tie a slip knot in the end of the thread, as shown in Figure 13, and push one end of the elastic chord through the loop. Tie a slip knot in the elastic around the Kevlar loop and pull the knots tightly against each other. Secure these knots with thinned glue, and let dry.



*Figure 13*

- **Step 26** Fill the grain of the balsa fins and the nose cone with a lightweight compound. We prefer Elmer's Fill-N-Finish, thinned with water to a pea-soup consistency, and brushed onto the surface. Allow at least a day to dry, then sand smooth with 220-grit paper. Repeat this treatment if there are any difficult areas still needing to be filled.

- **Step 27** Figure 14 shows the correct way to spray your model, regardless of the equipment used. Always spray from the top down, never from the bottom up, or from side-to-side. Keep the spray nozzle about 12” from the model, and do not stop the motion once you've started the spray.



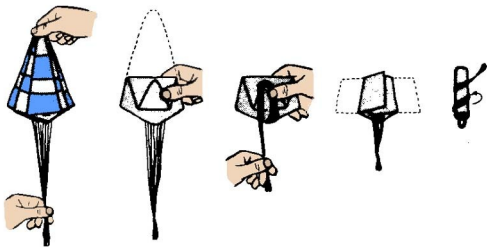
**Figure 14**

- **Step 28** Our current primer of choice is Rust-O-Leum brand White Clean Metal Primer, thinned with mineral spirits and applied with an airbrush, or spray gun. Push the Kevlar thread back up through the engine mount, into the sustainer body. Spray two complete coats of primer, and allow two full days to dry. Sand

the primer with 220-grit paper, but do not penetrate through the outer layer of the body tube. Tack-rag the model, and inspect for surface imperfections. Repeat with another spray of primer, let dry, and sand again until the surface is without blemish. When the major areas have been brought under control, prime again and switch to 400-grit paper, this time with emphasis on polishing the surface. When the model has reached a surface condition that you are satisfied with, proceed with the next step.

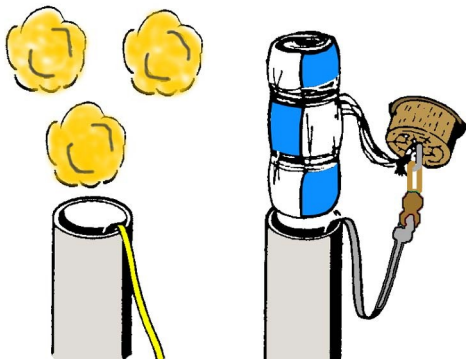
- **Step 29** The model should be painted an overall white, with a trim color of your choice. Suggestions include medium or dark blue, medium green, medium red, chrome silver or metallic copper. Allow at least a day between sprays before masking off for an additional color.
- **Step 30** Give the model a complete coat of spray Acrylic gloss clearcoat to protect and seal the color layers, and to prepare the model for decals (if desired). Allow this to dry until there is no more solvent smell in the model. Apply waterslide decals as desired, then clearcoat the model again and allow to dry.
- **Step 31** Assemble the parachutes using the Semroc instruction sheets packed with the CPK-12 kits. Attach each set of shroud lines to a snap link, at the barrel end. Attach the remaining snap link to the free end of

the elastic chord.



*Figure 15*

- **Step 32** Study the illustration in Figure 15 for the correct method of folding the parachutes. Do not wrap the lines around the parachute tightly, but just enough to hold the shape. Do not store the parachutes in the rocket when you are not flying, but keep them loose and open. In cold weather, and in colder climates, you will probably find it easier to work with the parachute if you dust it with talcum powder. This will help the parachutes open up when deployed.
- **Step 33** Attach the snap links on the two parachutes, and the shock chord, to the screw eye in the base of the upper body tube.



*Figure 16*

- **Step 34** Choose which form of recovery wadding you intend to use, either the old-style, pre-packaged flame-resistant sheets sold in hobby shops, or the shredded cellulose insulation which is becoming more popular. Both materials are chemically-treated to be flame-resistant, but the shredded material is considerably less expensive, and does a better job at forming a gas seal between the recovery devices and the deployment charge of the engine. As shown in Figure 16, use several sheets (5-6 at least), or push about 2"-3" of the bulk material, into the main sustainer tube down to just above the top of the motor tube. Do not pack this material tightly, as it must come out to function properly. Insert the elastic shock chord and Kevlar thread next, followed by the two parachutes, one at a time.
- **Step 35** Insert the upper body assembly into the sustainer body, and test for a proper fit. It should not be tight, but also not so loose that it falls out if held upside-down. Adjust the fit with a light sanding of the coupler assembly or the inside-top of the sustainer tube if tight. Use bits of masking tape applied around the inside-top of the sustainer tube if the fit is too loose.
- **Step 36** For the first flights, we recommend using the B6-0 as the booster engine, and the B6-6, B4-6, or A8-5 as the sustainer engine. Wrap a narrow strip of masking tape around each engine casing before inserting

the engines into the engine mounts. This helps seal the motor tube against excessive gas leakage at sustainer ignition, and at recovery deployment. Finally, insert the booster body coupler into the bottom of the sustainer body tube, and check for proper fit here, too. Use the same method from Step 35 to adjust the fit of the coupler. It should not have to be forced, but it should not fall out easily, either.

**Developed for BARCLONE Rocketry  
by C. P. McGraw**

**Model design copyright © 2005  
by C. P. McGraw**

**Instruction text copyright © 2005**

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# Model Rocket Safety Code

**Materials:** I will use only lightweight, non-metal parts for the nose cone, body, and fins of my rockets.

**Motors:** I will use only certified, commercially-made model rocket motors, and will not tamper with these motors or use them for any purposes except those recommended by the manufacturer.

**Ignition System:** I will launch my rockets with an electrical launch system and electrical motor igniters. My launch system will have a safety interlock in series with the launch switch, and will use a launch switch that returns to the "off" position when released.

**Misfires:** If my rocket does not launch when I press the button of my electrical launch system, I will remove the launcher's safety interlock, or disconnect it's battery, and will wait 60 seconds after the last launch attempt before allowing anyone to approach the rocket.

**Launch Safety:** I will use a countdown before launch, and will ensure that everyone is paying attention and is a safe distance of at least 15 feet away when I launch rockets with "D" motors or smaller, and 30 feet when I launch larger rockets. If I am uncertain about the safety or stability of an untested rocket, I will check the stability before flight and will fly it only after warning spectators and clearing them to a safe distance.

**Launcher:** I will launch my rockets from a launch rod, tower, or rail that is pointed to within 30 degrees of the vertical to ensure that the rocket flies nearly straight up, and I will use a blast deflector to prevent the motor's exhaust from hitting the ground. To prevent accidental eye injury, I will place launchers so that the end of the launch rod is above eye level or I will cap the end of the rod when it is not in use.

**Size:** My model rocket will not weigh more than 1,500 grams (53 oz) at liftoff, and will not contain more than 125 grams (4.4 oz) of propellant or 320 N-sec (71.9 lb-sec) of total impulse. If my model weighs more than one pound (453 grams) at liftoff, or has more than four ounces (113 grams) of propellant, I will check and comply with Federal Aviation Administration (FAA) regulations before flying.

**Flight Safety:** I will not launch my rockets at targets, into clouds, or near airplanes, and will not put any flammable or explosive payload into my rockets.

**Launch Site:** I will launch my rockets outdoors, in an open area at least as large as shown below, and in safe weather conditions with winds speeds no greater than 20 MPH. I will ensure that there is no dry grass close to the launch pad, and that the launch site does not present risk of grass fires.

LAUNCH SITE DIMENSIONS		
Total Impulse (nSec)	Motor Size	Minimum Size
0.00 – 1.25	1/4A – 1/2A	50'
1.26 – 2.50	A	100'
2.51 – 5.00	B	200'
5.01 – 10.00	C	400'
10.01 – 20.00	D	500'
20.01 – 160.00	E, F, G	1000'
160.01 – 320.00	2G	1500'

**Recovery System:** I will use a recovery system, such as a streamer or parachute, in my rockets so that they return safely and undamaged and can be flown again, and I will use only flame-resistant or fireproof recovery system wadding in my rockets.

**Recovery Safety:** I will not attempt to recover my rocket from power lines, tall trees, or other dangerous places.

Model Rocket Safety Code  
developed by the  
National Association of Rocketry  
Revised Code November, 2004