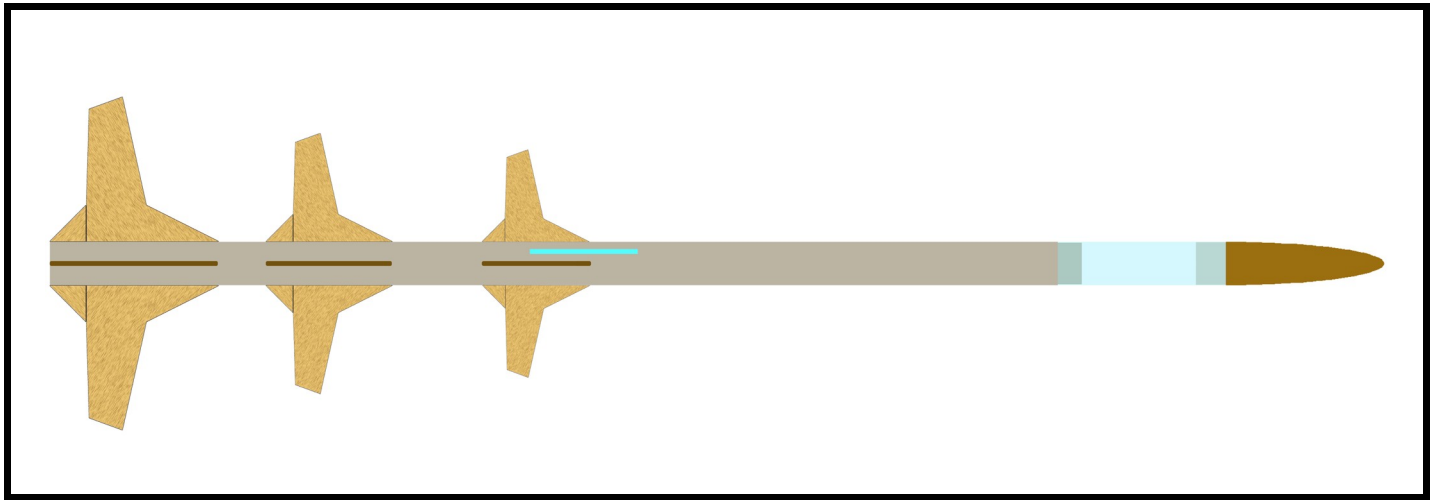




Skill Level 2



Created by C. P. McGraw



Parts List

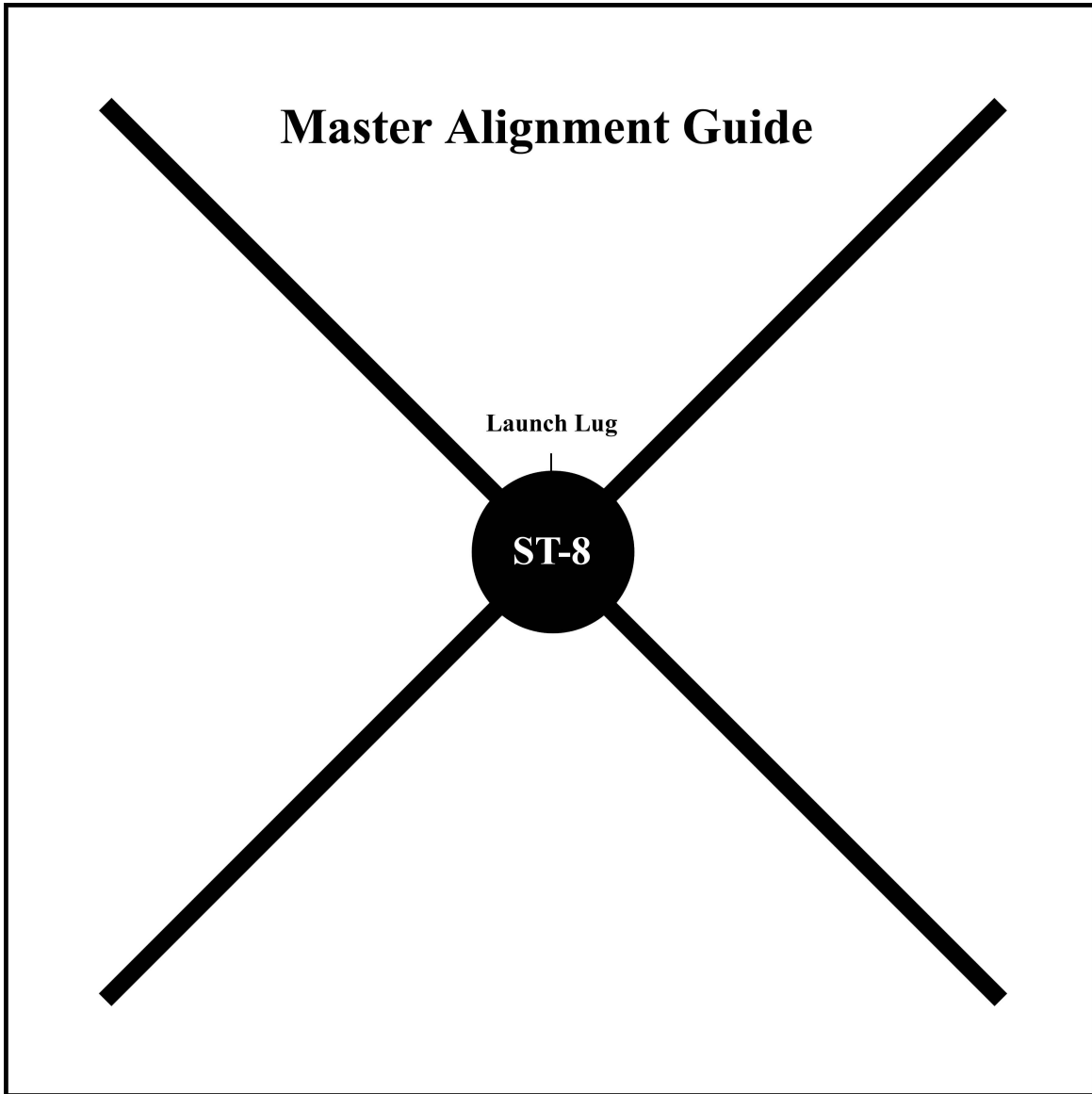
- Nose Cone.....BC-833
- Booster Body Tubes.....(2) ST-845
- Sustainer Body Tube.....ST-8120
- Payload Body Tube.....CPT-835
- Balsa Bulkhead.....BTC-8
- Couplers.....(2) HTC-8
- Engine Mounts.....(3) EM-78
- Launch Lug.....LL-18
- Fin Stock.....3/32" Balsa Sheet
- Parachutes.....(2) CPK-12
- Kevlar Thread.....SCK-24
- Elastic Shock Chord.....SC-24
- Screw Eye.....1"
- Snap Links.....(3) #10

Strip of self-adhesive label material, 3/8" wide, 4" long

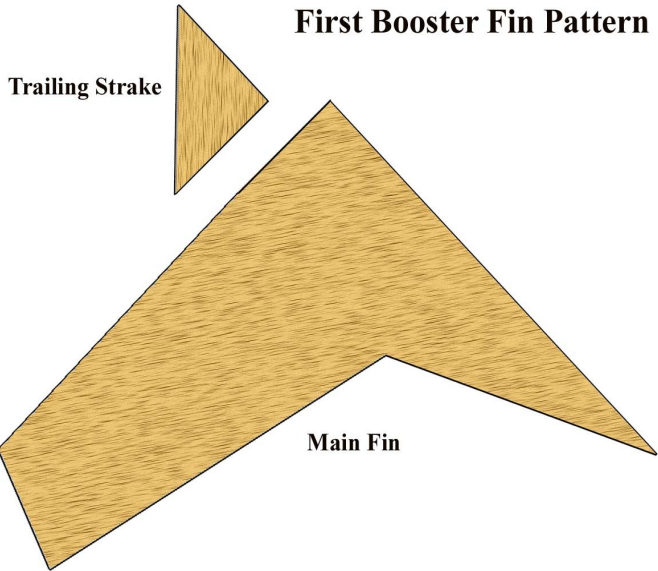
Length	27.80"
Diameter	0.908"
Weight	1.30 oz
Fin Span	6.908"

Additional Items Required

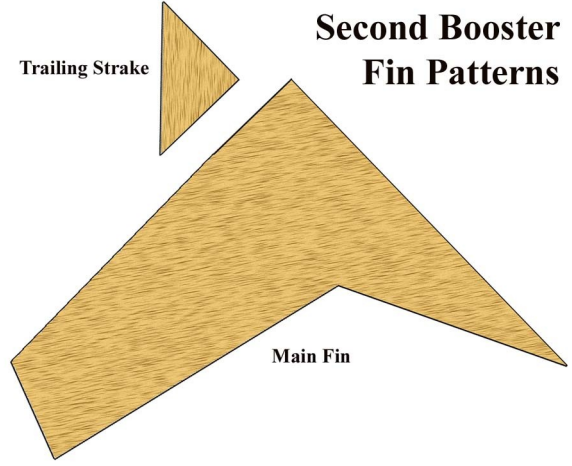
Pencil (0.05mm); steel ruler; sharp hobby knife; soft-bristle hobby brushes; tack rag; sheets of 220-, 400-, and 600-grit sanding papers; sanding twigs; small bottle of yellow carpenter's glue; sprayable primers, paints, and gloss clear Acrylic; brass angle stock, 1/2" x 12"; one or more empty CD spindles; copy of *The Model Rocketry Handbook, Seventh Edition*, by G. Harry Stine and Bill Stine...



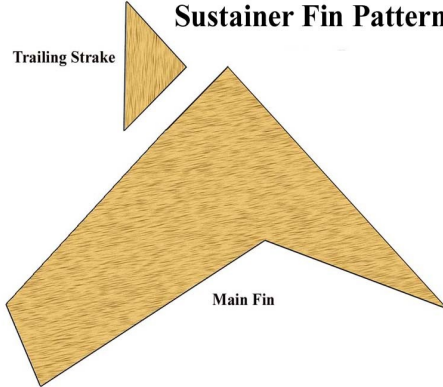
First Booster Fin Pattern



**Second Booster
Fin Patterns**



Sustainer Fin Pattern



- **Step 1** Give the booster and sustainer body tubes a complete sanding to remove the shine from the surface. This will help the primer to “bite” into the surface and reduce the chances for “delaminating” later.

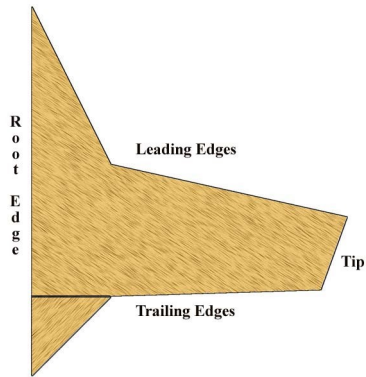


Figure 1

- **Step 2** Cut out all of the pieces for the fins, and assemble them according to the layouts on the pattern sheet. Use clamps, weights, or other devices to hold the pieces flat to the building surface while the glue dries, to ensure there are no warps or misalignments. Study the image in Figure 1. Make sure all of the **root edges** are straight, trimming or sanding the joint lines between the pieces as needed.



Flat notches to fit motor hook

Figure 2

- **Step 3** Modify **all** of the CR-78 centering rings in the three Semroc EM-78 packages with a flat notch on their inner diameters, as shown in the **left-side** image of Figure 2. This notch should only be as wide as the engine hook, and as deep as the thickness of the hook. Use either a sharp knife, or a “sanding twig” of the proper width, to make

this notch.

- **Step 4** Modify **one** of these six CR-78 rings with an additional “V” notch, as shown in the **right-side** image of Figure 2. This notch will allow passage of the Kevlar shock chord mount in a later step.
- **Step 5** Assemble **two** of the EM-78 engine mount kits according to the Semroc instruction sheet, aligning the flat notch directly over the engine hook. This flat notch will eliminate the possibility of the motor tube being mounted in the body tube **off-center, or vectored** to an angle away from the centerline.
- **Step 6** Assemble the third EM-78 kit according to the Semroc instruction sheet, but place the ring with the “V” notch toward the front of the mount. As with the other two mounts, the flat notch should align over the engine hook. Clean out any glue from the “V” notch area before it has time to dry. You need this notch open for a later step. Label this engine mount for the **sustainer**. Set all three engine mount subassemblies aside to dry.

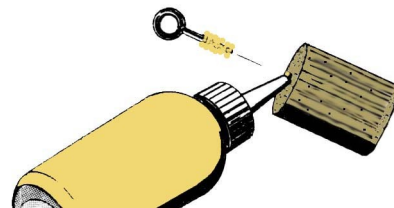


Figure 3

- **Step 7** Use the threads of the screw eye to cut a threaded hole into one end of the balsa bulkhead. Carefully reverse the screw eye out of the hole. Force yellow glue deep into the hole, and coat the screw eye threads with glue, as shown in Figure 3. Reinsert the screw eye into the hole, and set this subassembly aside to dry.

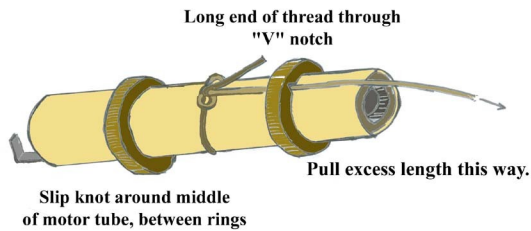


Figure 4

- **Step 8** Tie a slip knot around the middle of the **sustainer** engine mount, as shown in Figure 4, using the Kevlar shock chord mount. Push the long end of the Kevlar thread through the “V” notch, and slide the loop up to the back edge of the forward ring, pulling the excess thread as you tighten up the loop. Apply a thinned layer of yellow glue to this loop to secure it, and set aside to dry.

- **Step 9** Sand both surfaces of all twelve fins with 220-grit paper to remove any excess glue, and to remove any fuzziness in the wood. Do not gouge the wood, or sand too deeply. 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 up the root edge, as shown in Figure 5.

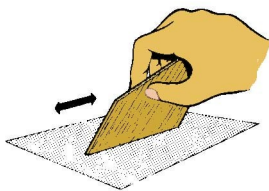


Figure 5

- **Step 10** Print several Alignment Guides on cardstock, and cut these out with a sharp knife. Remove the inner silhouette, but leave a large enough area around the pattern to provide some structural stiffness.
- **Step 11** Slide one of the alignment guides onto the first booster and mark the tube for the four fins. Repeat this for the second

booster. Mark the sustainer tube for four fins and the launch lug.

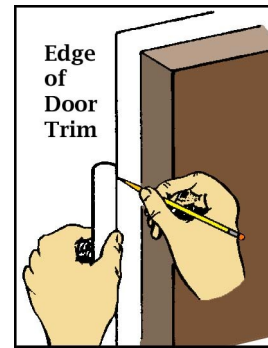


Figure 6

- **Step 12** Use the edge trim around a door, or use the brass angle stock, to draw straight lines down the length of the body tubes for each of the fins and the launch lug. Draw these lines the full length of their corresponding fins' root edges. All fins have the rearmost point of their root edges at the bottom edge of their respective tubes. The bottom edge of the launch lug is 1/2” forward of the rear edge of the sustainer tube. The length of this line is 2 1/4”.

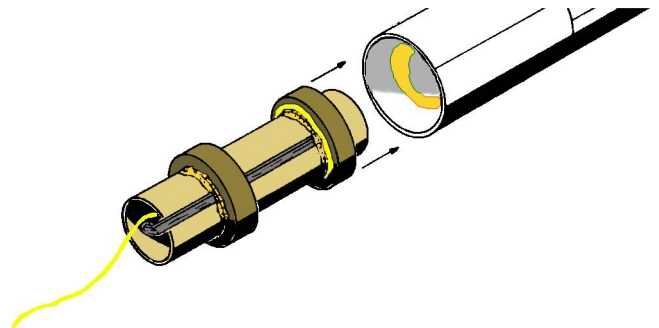


Figure 7

- **Step 13** Push the Kevlar thread down through the center of the sustainer engine mount. Apply a generous bead of glue up inside the **bottom** of the sustainer body tube, 1” up from the edge, as shown in Figure 7. Push the sustainer engine mount forward into the body tube until the bottom of the motor tube is even with the bottom of the sustainer body. Do this in one continuous motion, not stopping at any time

until the mount is fully in place, or the glue will “freeze” the mount in the wrong position. Set this unit aside in a **vertical** orientation, top-side-up, until the glue has dried.

- **Step 14** In a similar manner as Step 13, apply a generous bead of glue 1” up inside the **bottom** end of one of the booster body tubes, and insert one of the two booster engine mount subassemblies. Repeat this procedure with the second booster and the remaining booster engine mount. Set the two boosters aside vertically, top-end-up, until the glue dries.

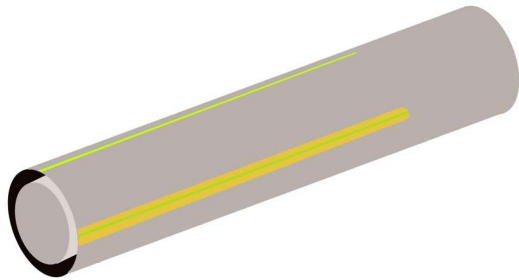


Figure 8

- **Step 15** Mix up a quantity of thinned yellow glue and brush this onto the booster body tubes, and on the sustainer body, along the lengths of the fin locator lines and on the launch lug line. Apply glue also to all of the root edges of the fins, and to the launch lug. Set these aside to dry completely.
- **Step 16** At this time, you need to read carefully and understand the chapter on **Construction** in the *Handbook*, specifically the text on the **double-glue** method for attaching fins. Apply a narrow bead of full-strength glue to the root edge of a **first booster** fin, directly on top of the dried layer of thinned glue. Apply a narrow bead of full-strength glue on top of a fin alignment line of the **first booster** body tube, again, directly on top of the dried layer of glue already present. As shown in Figure

9, carefully place the root edge onto the body tube along the alignment line and press the fin to ensure full contact. Hold the fin in place for about 12 seconds before releasing. The fin should now be **stuck** to the body tube. Use a moist, soft-bristle hobby brush to smooth out the glue that squeezes out from the joint on both sides of the fin. Slide one of the alignment guides down over the top of the tube, and another guide up from the bottom of the tube, onto the fin in at least two places. Gently adjust the angle of the fin to fit into the slots of the guide. Set this aside to dry for about 20 minutes.

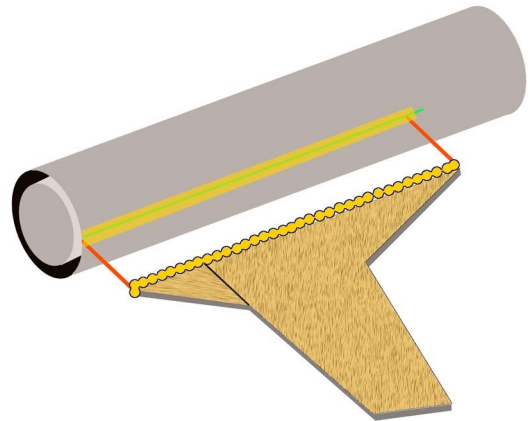


Figure 9

Repeat this sequence for **each** of the remaining fins on both booster tubes and the sustainer tube, and allow about 20 minutes between each fin for drying time.

- **Step 17** Attach the launch lug to the sustainer tube in a similar manner to step 16, and set the sustainer aside for about 20 minutes.
- **Step 18** As shown in Figure 10, draw a line around each of the two HTC-8 couplers 3/8” from one end. Apply a bead of glue completely around the top-inside of the **first booster**, but no deeper than 1/4” from the edge. Insert a coupler short-end first, into the glue bead and press inward until the line

on the coupler touches the edge of the tube. Repeat this sequence for the **second booster**, then set both boosters aside to dry.

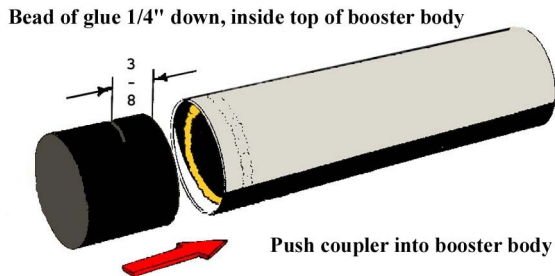


Figure 10

- **Step 19** Apply a strip of self-adhesive label material, 3/8" wide, around the **inside-bottom** end of the clear payload tube. Trim the label so that it does not overlap itself. As shown in Figure 11, draw a line completely around the balsa bulkhead 3/8" from the **opposite** end as the screw eye. Apply a bead of glue 1/8" from the tube edge on the inner surface of the label. Insert the balsa bulkhead into the glue area, short-end first, until the line around the bulkhead is even with the edge of the tube. Allow to dry. Do not attach the payload section into the model
- for priming, painting, or clearcoating. Keep the payload section separate until after the clearcoating step is completed.
- **Step 20** Read the chapter on **Multi-Stage Models** in the *Handbook* to understand what you are about to do in this step. Draw a line completely around the **top ends** of both booster tubes, 1" down from the edge. Locate two points on each of these lines, 180 degrees apart (half-way between two fins). Cut a 1/4" hole at each of these locations through the booster body tubes. These holes will act as **pressure relief vents** to ensure that staging (and ignition of the following stage) takes place correctly.

3/8" wide label strip around inside of payload tube;
Bead of glue around inside of label, 1/8" from edge

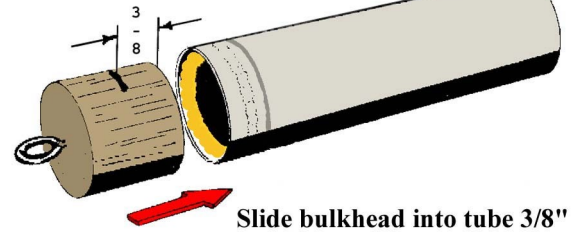


Figure 11

- **Step 21** Assemble the two CPK-12 parachute kits according to the Semroc instructions, then attach the barrel end of a snap link to each set of shroud lines.
- **Step 22** When the glue has completely dried on all parts of the model, gently sand the root edge joints of all the fins with 220- and 400-grit paper to remove any sharp edges that may have formed. Do not sand too deep. This is only meant to be a surface treatment, not a vigorous reshaping. Tack-rag the model, then apply a full-strength bead of glue to the root edge joints of all fins, smoothing these down with a moist finger or soft-bristle brush. This adds a reinforcing fillet to the fins, as well as a smooth surface for priming and painting later. Allow to dry completely.
- **Step 23** Use a scrap piece of ST-8 body tube to hold the nose cone for the next few steps. Apply a lightweight filler to all exposed balsa surfaces of the fins and the nose cone, but **not** to the balsa bulkhead, or to the shoulder area of the nose cone. Our current preference is Elmer's Fill-N-Finish, thinned to a pea-soup consistency with water and worked into the grain with a 1/4" wide hobby brush. Apply this filler to **both sides** of the fins in the same step so that any warping due to the excess moisture is balanced out. Give this material at least **one full 24-hour day** to air-dry before sanding with 220-grit paper. Tack-rag the dust, and examine the wood. If there are any gouges or noticeable imperfections, reapply the compound, let dry, and sand again. Do this

as many times as needed to eliminate the grain pattern and any construction damage that may have occurred.

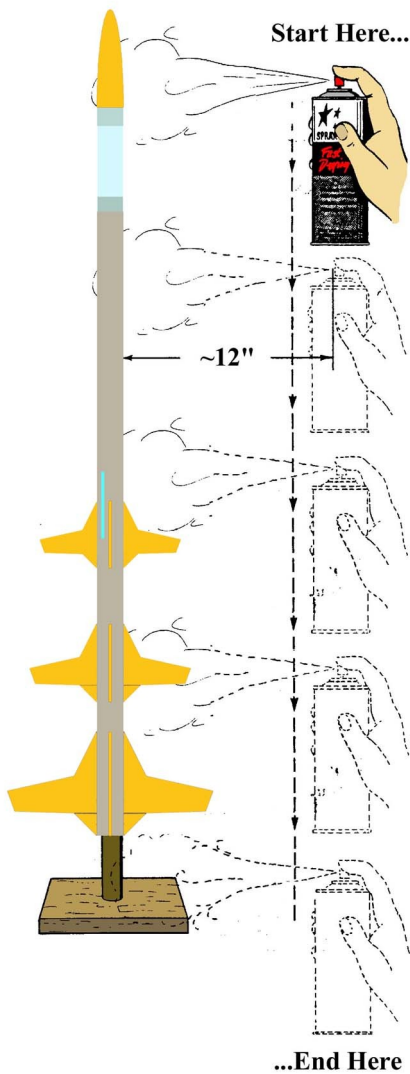


Figure 12

- **Step 24** The illustration in Figure 12 shows the correct way to spray your model, regardless of the equipment used. Always spray the model from top- to-bottom, never from side-to-side, or bottom-to-top. Use the CD-R spindle as a cheap holding spike. Maintain a distance of about 12" between the tip of the spray and the model. This step applies to primers, paints, and final gloss coats.

- **Step 25** Apply at least two complete coats of primer to the model before sanding it, allowing time for each coat to dry completely (to a point where you can no longer smell any solvent). Our current preference is **Rust-O-Leum** Clean Metal Primer, White. Sand carefully with 220-grit paper to remove the excess primer, then tack-rag to remove the dust. Re-prime and sand as many times as needed to eliminate all visible surface imperfections (such as the spiral wrap in the tube). When you reach a point where you are satisfied with the surface, give the model a final prime and sand with 400- and 600-grit paper to achieve a glass-smooth surface. If you damage the primered surface, respray another two coats of primer over the damaged area, let each coat dry overnight, and **sand with less pressure**, repeating this process until the damage is completely hidden. Tack-rag the model thoroughly before proceeding.

- **Step 26** We recommend spraying the nose cone as a separate item from the body, to make the color separation cleaner. Keep the nose cone in the piece of ST-8 tube at this time. Wrap a layer of masking tape around the exposed couplers to protect them from paint. The body should be gloss white, while the nose cone should be gloss red, orange, or any other bright color of your choice. Allow at least one full day between the base color and masking for any trim color, and another day for **each** trim color to dry. Simple trim schemes are often the best, but the remainder of the color pattern is up to you. Remember that much of the trim work can be done with waterslide decals instead of paint, and these can easily be created and printed with your home computer. You can also purchase commercially-printed decals from a number of hobbyists via the Internet. In any case, after the base and color coats have been applied, give the paint at least two days to air out (no solvent smell) before going on to the next step.

- **Step 27** When all of the solvent smell from the paint has dissipated, spray a complete coat of gloss clear Acrylic over the model. We have used several brands, including *Krylon* and *Valspar*, with equal success. Allow this coat to dry a full day, then apply any waterslide decals you may wish to use. When these are fully dry, gently wipe the adhesive residue away with a soft cloth. Spray the model again with a coat of clear Acrylic, and let this dry for at least one full day before handling, to prevent fingerprints from ruining the surface finish.

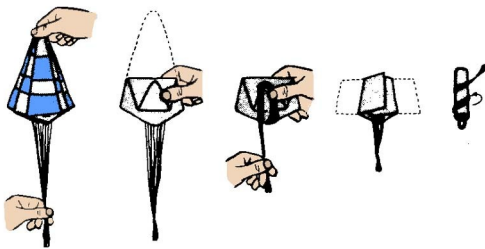


Figure 13

- **Step 28** Using Figure 13 as a guide, fold the parachute just before you are ready to launch. Never store the parachute inside the rocket. This is why you are instructed to attach a snap link to the parachute lines. When preparing to launch, attach the snap links of both parachutes to the screw eye in the base of the payload bulkhead.

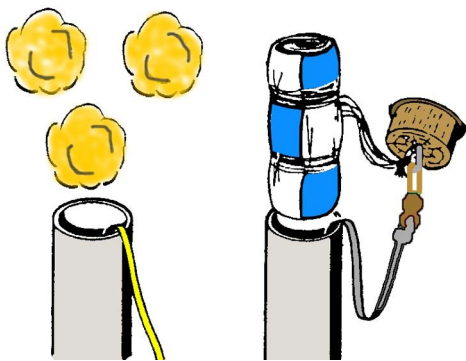


Figure 14

- **Step 29** Using Figure 14 as a guide, select either a pre-packaged flameproof recovery wadding, or flameproof cellulose

insulation (shredded newspaper treated with a flameproof chemical, such as boric acid), to form a gas seal between the top of the motor and the parachute. Usually, three to five sheets of the wadding, crumpled into loose balls, or about 2" to 3" of the shredded material, is enough to do the job. Push the material down through the body tube but do not pack the material tightly. The material only needs to provide a barrier to the hot gases and burning particles released by the motor at deployment, and must be able to come out easily. Insert the shroud lines next, followed by the folded parachutes, and then the payload section. The cone **should not be glued** into the top of the payload section, but it should be a snug fit. Adjust the fit of the cone with bits of masking tape attached to the shoulder, or gently sanding down the shoulder with 400-grit paper, depending on if the fit is loose or tight. Do the same for the fit of the payload bulkhead into the sustainer body.

- **Step 30** For the first flights of this model, we recommend flying in a single-stage configuration using the A8-3 motor, so that you can get a feel for the model's performance. For the first multi-stage flights, select the B6-0 for **one** booster and the A8-5 for the sustainer. Use the **second** (or upper) booster for this configuration. In a three-stage configuration, use the C6-0 in the first booster, followed by the B6-0 in the second booster, and finally the A8-5 or B4-6 in the sustainer. Wrap a narrow strip of masking tape around the mid-body of each motor, such that the fit of the motors into the motor tubes is slightly snug, but not excessively tight. You only want to create a gas seal here, as the mount hooks will keep the motors in place.

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

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by C. P. McGraw**

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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 ignitors. 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