Seattle ROCKET WORKS

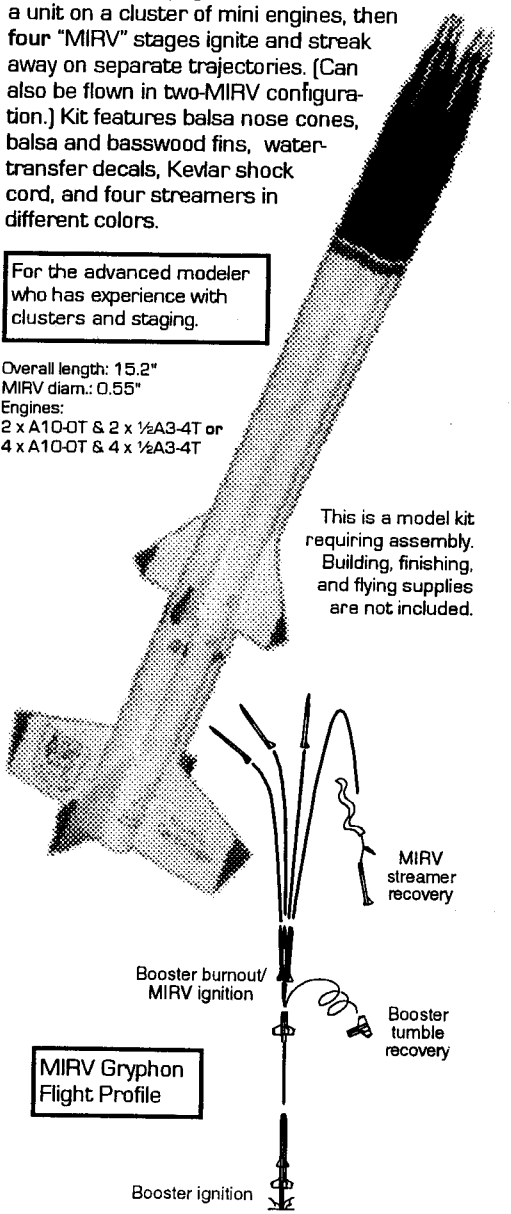
M.I.R.V. GRYPHON

Multiple Independent Rocket Vehicle technology for unparalleled flying excitement! Boosts as a unit on a cluster of mini engines, then four "MIRV" stages ignite and streak away on separate trajectories. (Can also be flown in two-MIRV configuration.) Kit features balsa nose cones, balsa and basswood fins, water-transfer decals, Kevlar shock cord, and four streamers in different colors.

For the advanced modeler who has experience with clusters and staging.

Overall length: 15.2"
MIRV diam.: 0.55"
Engines:
2 x A10-0T & 2 x ½A3-4T **or**
4 x A10-0T & 4 x ½A3-4T

This is a model kit requiring assembly. Building, finishing, and flying supplies are not included.



MIRV Gryphon Flight Profile

MIRV GRYPHON

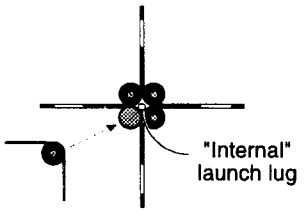
Introduction

The MIRV Gryphon[1] from Seattle Rocket Works features advanced *M*ultiple *I*ndependent *R*ocket *V*ehicle technology. It consists of a clustered booster and **four** sustainer stages (MIRVs). As can be seen in the accompanying flight profile, the MIRV Gryphon launches as a unit. At booster burnout the four MIRV stages ignite and follow separate trajectories while the booster tumbles to earth. The MIRVs are recovered under streamers. The MIRV Gryphon can also be flown in a two-MIRV configuration (recommended for first flights).

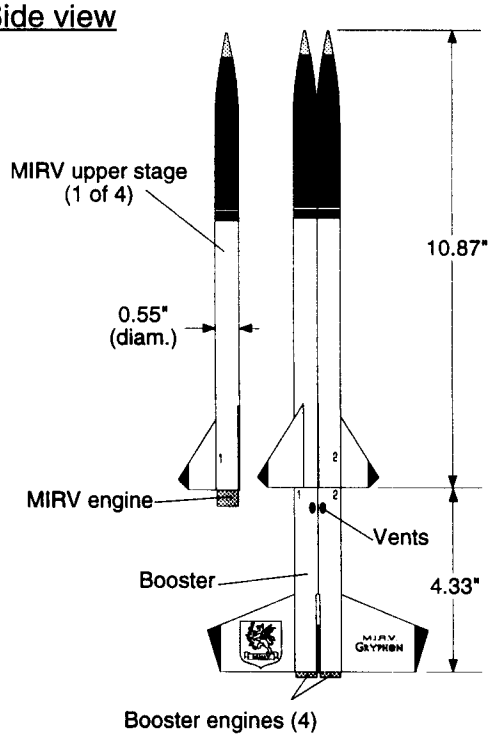
The most unusual aspect of the MIRV Gryphon's design lies in the unique two-fin configuration of the MIRV stages, which allows the MIRVs to be packed closely atop the booster. Staging is accomplished using vented booster tubes. This technique eliminates the need to tape engines together, and is described fully in the *Handbook of Model Rocketry*[2]. Each booster engine stages to its associated MIRV independently of the others.

Building and flying the MIRV Gryphon requires a significant amount of model rocketry experience. The following instructions assume that you know how to work with balsa, how to choose and use glue, and how to paint. Read through the instructions before beginning, and plan ahead. Test-fit all parts. For flying, you should have experience with clusters and multi-staged rockets. Given all that, the MIRV Gryphon should provide you with many exciting flights.

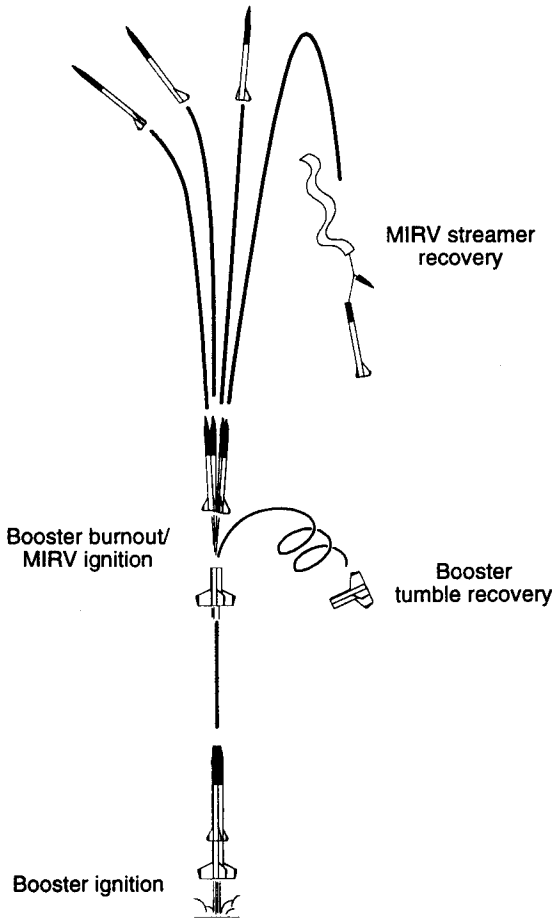
Top view



Side view



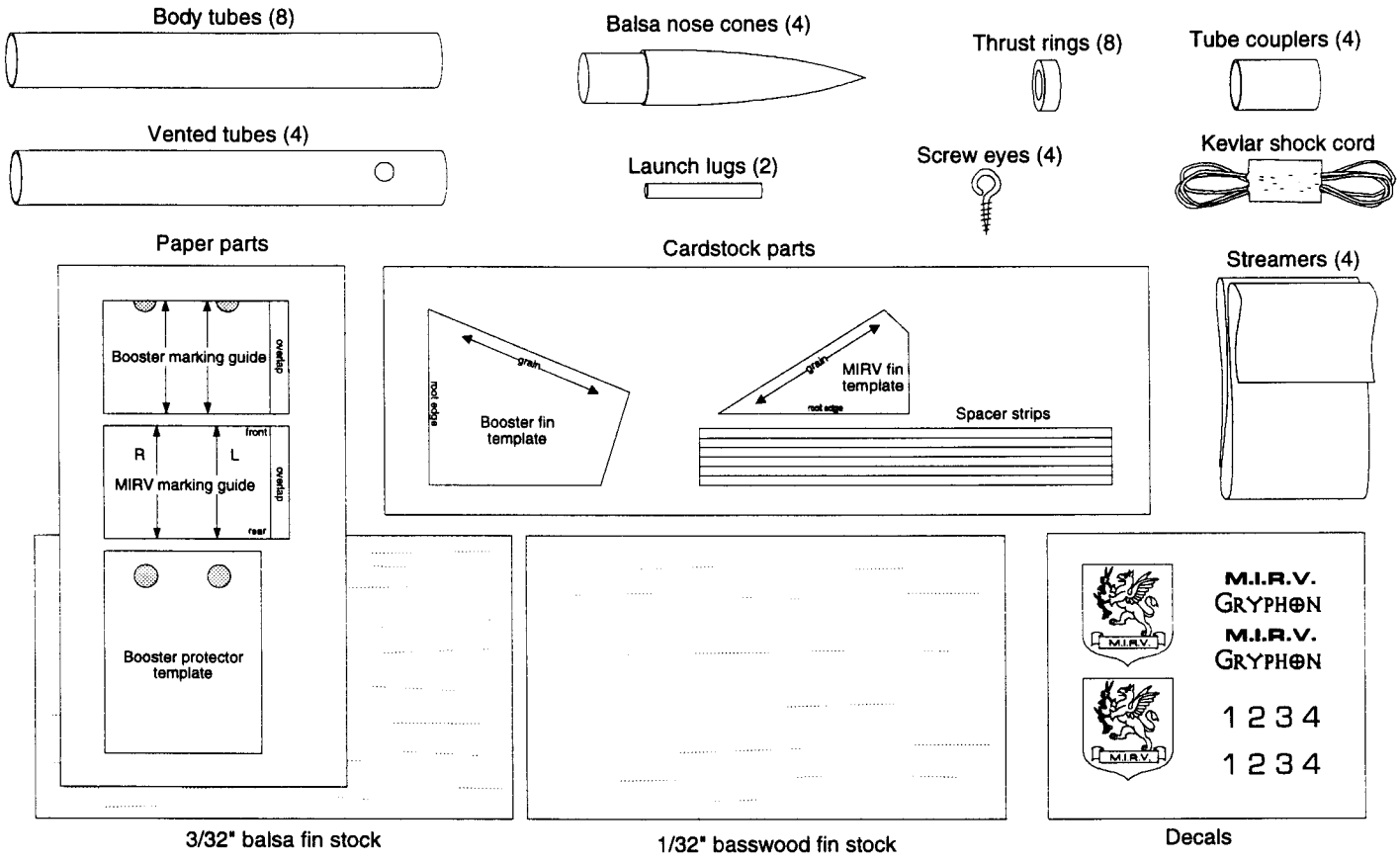
Flight profile



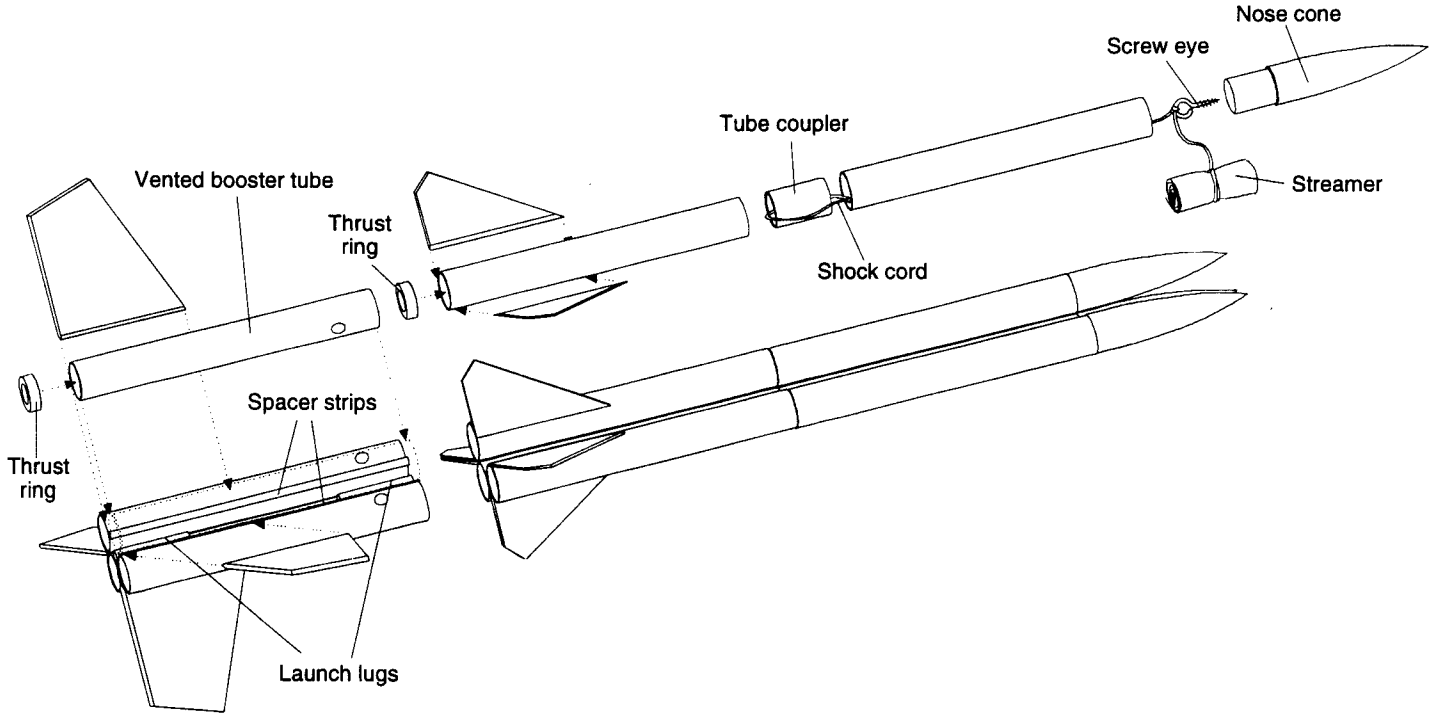
[1] *Gryphon* is a variant spelling of *griffin*, a mythological creature that was half-eagle and half-lion.

[2] G. Harry Stine (1994) *Handbook of Model Rocketry*, 6th edition, John Wiley & Sons.

Parts list



Exploded view

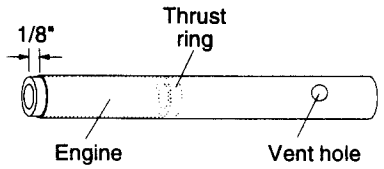


Booster construction

The booster consists of four vented body tubes in a 2x2 configuration, with fins mounted in the "valleys" between body tubes. Cardstock spacers between the booster tubes compensate for the thickness of paint on the upper stages.

1. Thrust ring

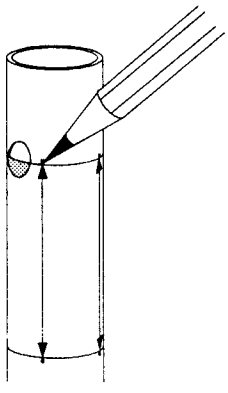
Apply a ring of glue inside a booster tube about 1 1/2" from the aft end (the vent holes are at the forward end). Use a mini-engine to push the thrust ring 1 5/8" up the tube (1/8" of the engine will protrude out the back). Remove the engine. Repeat for all four booster tubes.



x4

2. Tube lines

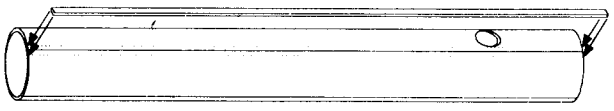
Cut out the booster tube marking guide. Wrap it around a booster tube, aligning the shaded semicircles with the vent holes. Mark the tube at the four arrowheads. Remove the marking guide. Connect pairs of marks with straight lines extending the length of the tube. Repeat for all four booster tubes.



x4

3. Spacer strips

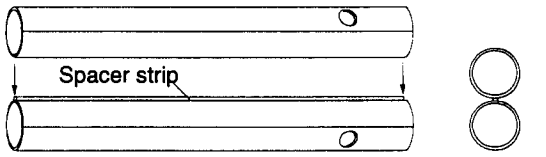
Cut out four booster spacer strips with a knife and straightedge. Extra strips are included just in case. Glue a spacer strip to a booster tube, centered along one of the lines drawn in the previous step. Make sure the strip is flat and straight. Do the same with one other spacer and booster tube.



x2

4. Pair tubes

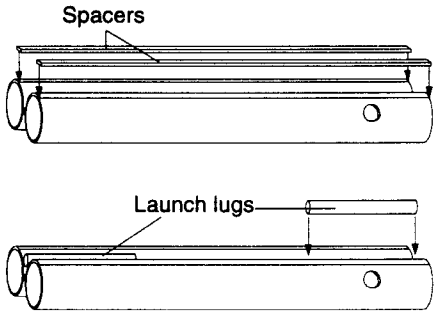
Take one booster tube with spacer strip attached and one tube without spacer. Apply glue to the spacer strip and join the tubes as shown. Pay close attention to the correct orientation of the vent holes. Repeat with the other pair of tubes.



x2

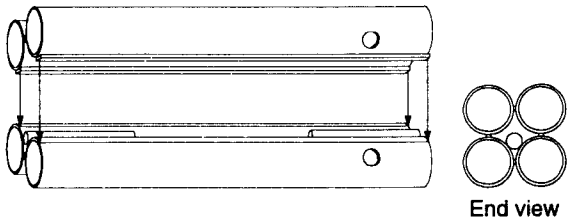
5. Launch lugs and more spacers

Take the two remaining spacer strips and glue them to one of the paired booster tubes on the lines. Glue the two launch lugs to the other booster pair, one lug at the front, one at the rear. The lugs go into the "valley" formed by the tubes, on the side with the lines.



6. Assemble all booster tubes

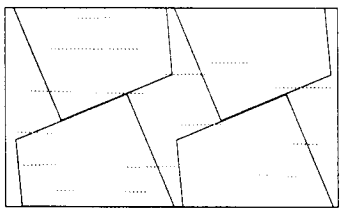
Join the two pairs of booster tubes as shown, making sure they form a good "square."



7. Fins

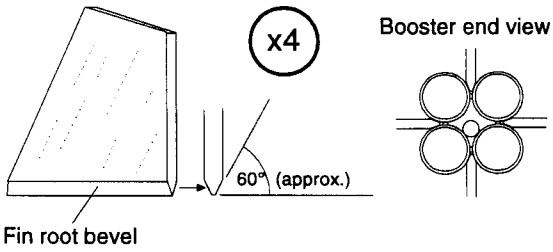
Use the booster fin template to cut out four fins from the 3/32" balsa fin stock (not to be confused with the 1/32" basswood fin stock). Remember to align the leading edge

with the grain. Stack the fins together and sand the edges flat to make sure all the fins are the same size and shape. (Sanding the fins to an airfoil is optional.)



Since the booster tumbles to the ground, the fins must be attached very securely. On each fin, bevel the root edge on both sides. A bevel angle of approximately 60° will let the fin sit in the inter-booster "valley." Glue the fins into place with their trailing edges flush with the rear of the booster.

Use a double-glue joint for maximum strength. Add fillets to taste.



MIRV construction

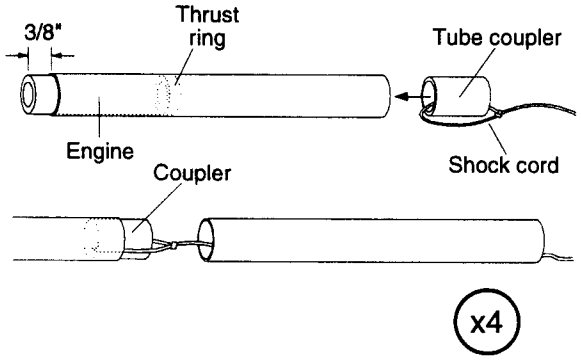
Each MIRV is identical in construction. The trickiest part is attaching the fins at the proper angle; careful and patient work will be rewarded with a set of MIRVs that fit neatly together.

1. Cut shock cord

Cut the Kevlar™ line into four equal lengths to serve as shock cords for the MIRVs.

2. Body tube assembly

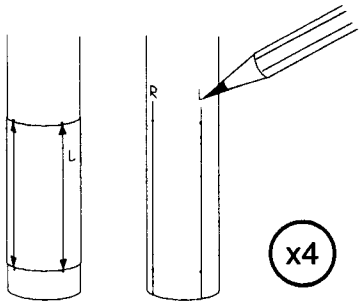
The MIRV body consists of two body tubes joined with a tube coupler. Select two body tubes and use a mini-engine to glue a thrust ring 1 3/8" into one (the engine will protrude 3/8" out the back.) Remove the engine. Tie one end of a shock cord around a tube coupler and glue the coupler halfway into the first body tube. If the fit is too tight, sand



down the outside of the coupler. Glue the second body tube to the coupler, making sure the two sections are straight. Repeat to make four MIRV bodies.

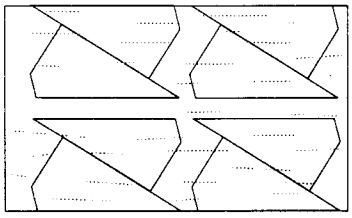
3. Tube lines

Cut out the MIRV marking guide. Wrap it around a MIRV body near the aft end, with the end of the guide marked "rear" pointed to the rear of the body. Mark the body at the four indicated points. Remove the guide and join pairs of points with straight lines running at least 2" from the end of the body. Mark one of the lines *L* and one *R* as indicated on the marking guide to remind you which fin goes where. Repeat for each MIRV body.

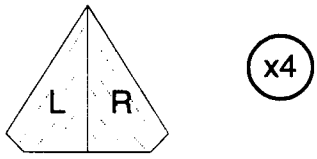


4. Prepare fins

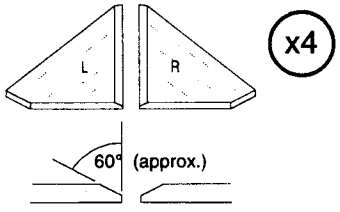
Use the MIRV fin template to cut out eight fins from the 1/32" basswood fin stock. Watch the grain direction; it's easy to confuse the leading edge with the root.



Stack and sand the fins to a uniform size. Pair up the fins and mark one of each pair *L* and the other *R*:

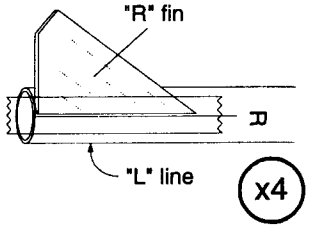


Bevel the root edges as shown, leaving an edge approximately one-third the original thickness. The exact angle and thickness are not as important as consistency in all the bevels.



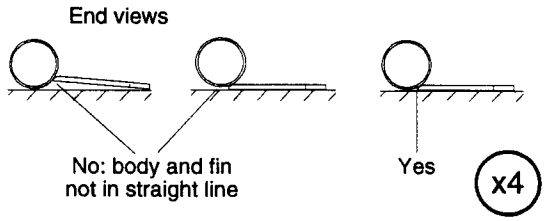
5. First fins

Apply a strip of transparent tape along the root of a fin on the unbeveled side. Tape the fin root along the appropriate body tube line (that is, if it's an *R* fin it goes on the *R* line.) The beveled side should be



against the body and the trailing edge should be even with the aft end of the body.

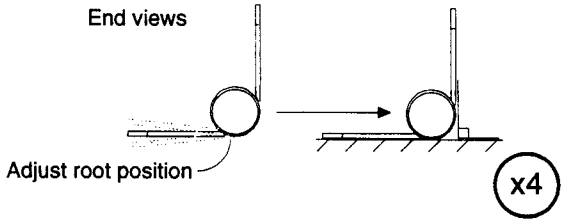
Using the tape as a hinge, expose the bevel and apply glue. Place the fin and body on a flat surface. The fin should lie flat and the body should touch the surface as shown here:



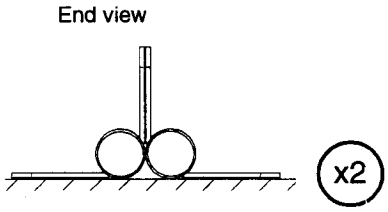
Secure the fin and body to the work surface to maintain the proper position as the glue dries. Repeat for the other MIRV bodies, one fin each. (You might want to do two *L* and two *R* fins so that in the next step you can pair opposites.) Allow the glue to dry completely.

6. Second fins

The second fin is attached similarly to the first. You may have to adjust the position of the fin several times until it forms a precise right angle with the first fin. It's all right if the fin root is not on the line, but it must be parallel to the line.

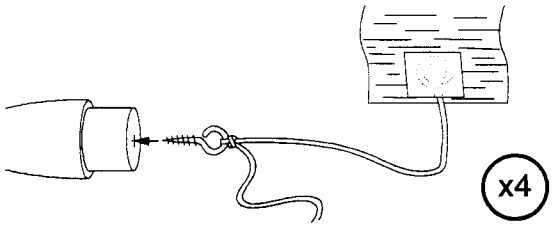


You might want to set pairs of MIRVs side-by-side to dry. Make sure everything is held in place while the glue dries. After the glue has dried, remove the transparent tape. Add fillets as desired.

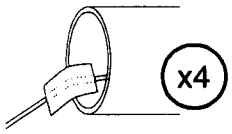


7. Recovery system

Attach a screw eye to the base of a nose cone. Tie the loose end of shock cord to the screw eye, leaving 2–3" free. Form the end into a loop and secure it to one end of the streamer with a square of sticky tape. Press the tape and streamer together firmly so that they mold around the loop.



Take a piece of masking tape or duct tape about ½" square and fold it over the shock cord, then slide it halfway into the body as shown. This should help prevent the shock cord from cutting or "zippering" the body tube at ejection. Repeat for all MIRVs.



Finishing

Finish the rocket using your favorite techniques. You may want to take into account the fact that the area around the booster vents is exposed to high temperatures, as is the tail-end of each MIRV on the side facing the center of the cluster.

The decal sheet is essentially one big decal, so you must cut out the individual markings before use. Soak each decal in water until it slides easily off the backing and onto the model. Don't use too much water or the decal may float away and become unusable. The decal film is very thin and tends to fold over on itself, so be careful when applying it. When the decals dry, spray them lightly with a clear-coat to protect them.

Flying the MIRV Gryphon

1. Engine selection and installation

The MIRV Gryphon uses readily available 13mm "mini engines"—type A10-0T for the booster, ½A3-4T for the MIRV stages. As mentioned previously, the MIRV Gryphon can be flown in either a two- or four-MIRV configuration. The two-MIRV configuration requires two A10-0T engines mounted in two **diagonally opposite** booster tubes to keep the thrust balanced about the centerline; the other two booster tubes are left empty. The four-MIRV configuration requires four A10-0T engines in the booster.

Each engine must be wrapped with a piece of masking tape; adjust the amount of tape until the engine fits tightly, but not **too** tightly, into its tube. You don't want the engine to be kicked out (by its ejection charge, for example) but you do want to be able to remove it after the flight.

2. Booster preparation

To protect the inside of the booster tubes from heat damage, paper protectors must be installed before each flight. Use the booster protector template to cut out four booster protectors from a sheet of paper. Punch or cut holes at the indicated locations in each protector. Roll each protector and slide it into a booster tube from the front. Don't forget to line up the holes in the protector with the booster vent holes, or else excess pressure may cause the MIRV to separate before second stage ignition has occurred.

3. Igniter installation

Follow the engine manufacturer's instructions for installing igniters into the booster engines (of course, the MIRV engines do not require igniters). For clustered ignition, the igniters should be wired in parallel. This will require that some igniter leads be twisted together. (Also, the use of a "clip whip" is highly recommended.) When twisting igniter leads together, be careful not to disturb the position of the igniter in the engine. The igniter must make good contact with the propellant to ensure reliable ignition. When deciding how to connect the igniters, don't forget that the launch rod has to pass up the center of the rocket.

4. MIRV preparation

Fold the streamer in half a few times, then roll it up. Wrap a few turns of shock cord around it, then pack some recovery wadding, the shock cord, and streamer into the MIRV. Some tracking powder, such as powdered tempera paint or carpenter's chalk, placed above the streamer will aid in tracking by making a colored cloud at ejection. Install the nose cone, then fit the MIRV onto the booster. In the two-MIRV case, make sure that each MIRV is installed above a booster tube containing an engine. The rear end of the MIRV engine should slide smoothly into the front of a booster tube. If the fit is too loose, put small pieces of tape around the end of the engine. It should be a snug enough fit that the MIRV doesn't wobble or fall off, but it shouldn't be so tight that it interferes with staging.

You can improve staging reliability by scratching the MIRV engine's propellant with a sharp, narrow object inserted up the nozzle. This will expose fresh propellant which is more easily ignited by the hot particles thrown up by the booster engine. Avoid scraping or damaging the nozzle, and use a **non-metallic** tool to preclude any possibility of sparks.

5. Launch system

The MIRV Gryphon requires a standard 1/8" launch rod. When sliding the rocket onto the rod, be sure that the rod passes through both launch lugs. Use a 12V launch system for reliable cluster ignition.

6. Range safety considerations

The MIRV Gryphon should be flown in conditions of low wind and good visibility. A tracking crew is a good idea, as the many separate components of the rocket can pose a significant tracking challenge.

The launch of the MIRV Gryphon, or any clustered rocket for that matter, must be a "heads up" launch, with all persons on the range paying attention and on their feet, ready to move out of harm's way if the need arises. If not all the engines in the cluster ignite, the rocket will veer off of its intended trajectory. In the MIRV Gryphon's case, an unignited booster engine also means the associated MIRV will not ignite, and the rocket will crash into the ground. Therefore, take every precaution for the safety of spectators and property.

Always conduct your launches in accordance with the National Association of Rocketry Safety Code (see next page).

Seattle Rocket Works shall not be held responsible for injury or damage caused by the storage, handling, or use of this product.

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NAR Safety Code

1. Materials

My model rocket will be made of lightweight materials such as paper, wood, rubber, and plastic suitable for the power used and the performance of my model rocket. I will not use any metal for the nose cone, body, or fins of a model rocket.

2. Motors/Engines

I will use only commercially-made, NAR-certified model rocket motors in the manner recommended by the manufacturer. I will not alter the model rocket motor, its parts, or its ingredients in any way.

3. Recovery

I will always use a recovery system in my model rocket that will return it safely to the ground so it may be flown again. I will use only flame-resistant recovery wadding if wadding is required by the design of my model rocket.

4. Weight and Power Limits

My model rocket will weigh no more than 1,500 grams (53 ounces) at lift-off and its rocket motors will produce no more than 320 newton-seconds (71.9 pound-seconds) of total impulse. My model rocket will weigh no more than the motor manufacturer's recommended maximum lift-off weight for the motors used, or I will use motors recommended by the manufacturer for my model rocket.

5. Stability

I will check the stability of my model rocket before its first flight, except when launching a model rocket of already proven stability.

6. Payloads

My model rocket will never carry live animals (except insects) or a payload that is intended to be flammable, explosive, or harmful.

7. Launch Site

I will launch my model rocket outdoors in a cleared area, free of tall trees, power lines, buildings, and dry brush and grass. My launch area will be at least as large as that recommended in the accompanying table:

LAUNCH SITE DIMENSIONS			
Installed Total Impulse (newton-seconds)	Equivalent Engine Type	Minimum Site Dimension (feet)	(meters)
0.00–1.25	¼A & ½A	50	15
1.26–2.50	A	100	30
2.51–5.00	B	200	60
5.01–10.00	C	400	120
10.01–20.00	D	500	150
20.01–40.00	E	1000	300
40.01–80.00	F	1000	300
80.01–160.00	G	1000	300
160.01–320.00	2Gs	1500	450

8. Launcher

I will launch my model rocket from a stable launch device that provides rigid guidance until the model rocket has reached a speed adequate to ensure a safe flight path. To prevent accidental eye injury, I will always place the launcher so the end of the rod is above eye level or I will cap the end of the rod when approaching it. I will cap or disassemble my launch rod when not in use and I will never store it in an upright position. My launcher will have a jet deflector device to prevent the motor exhaust from hitting the ground directly. I will always clear the area around my launch device of brown grass, dry weeds, or other easy-to-burn materials.

9. Ignition System

The system I use to launch my model rocket will be remotely controlled and electrically operated. It will contain a launching switch that will return to "off" when released. The system will contain a removable safety interlock in series with the launch switch. All persons will remain at least 15 feet from the model rocket when I am igniting model rocket motors totaling 30 newton-seconds or less of total impulse and at least 20 feet from the model rocket when I am igniting model rocket motors totaling more than 30 newton-seconds of total impulse. I will use only electrical igniters recommended by the motor manufacturer that will ignite model rocket motors within one second of actuation of the launching switch.

10. Launch Safety

I will ensure that people in the launch area are aware of the pending model rocket launch and can see the model rocket's lift-off before I begin my audible five-second countdown. I will not launch my model rocket so its flight path will carry it against a target. If my model rocket suffers a misfire, I will not allow anyone to approach it or the launcher until I have made certain that the safety interlock has been removed or that the battery has been disconnected from the ignition system. I will wait one minute after a misfire before allowing anyone to approach the launcher.

11. Flying Conditions

I will launch my model rocket only when the wind is less than 20 miles per hour. I will not launch my model rocket so it flies into clouds, near aircraft in flight, or in a manner that is hazardous to people or property.

12. Pre-Launch Test

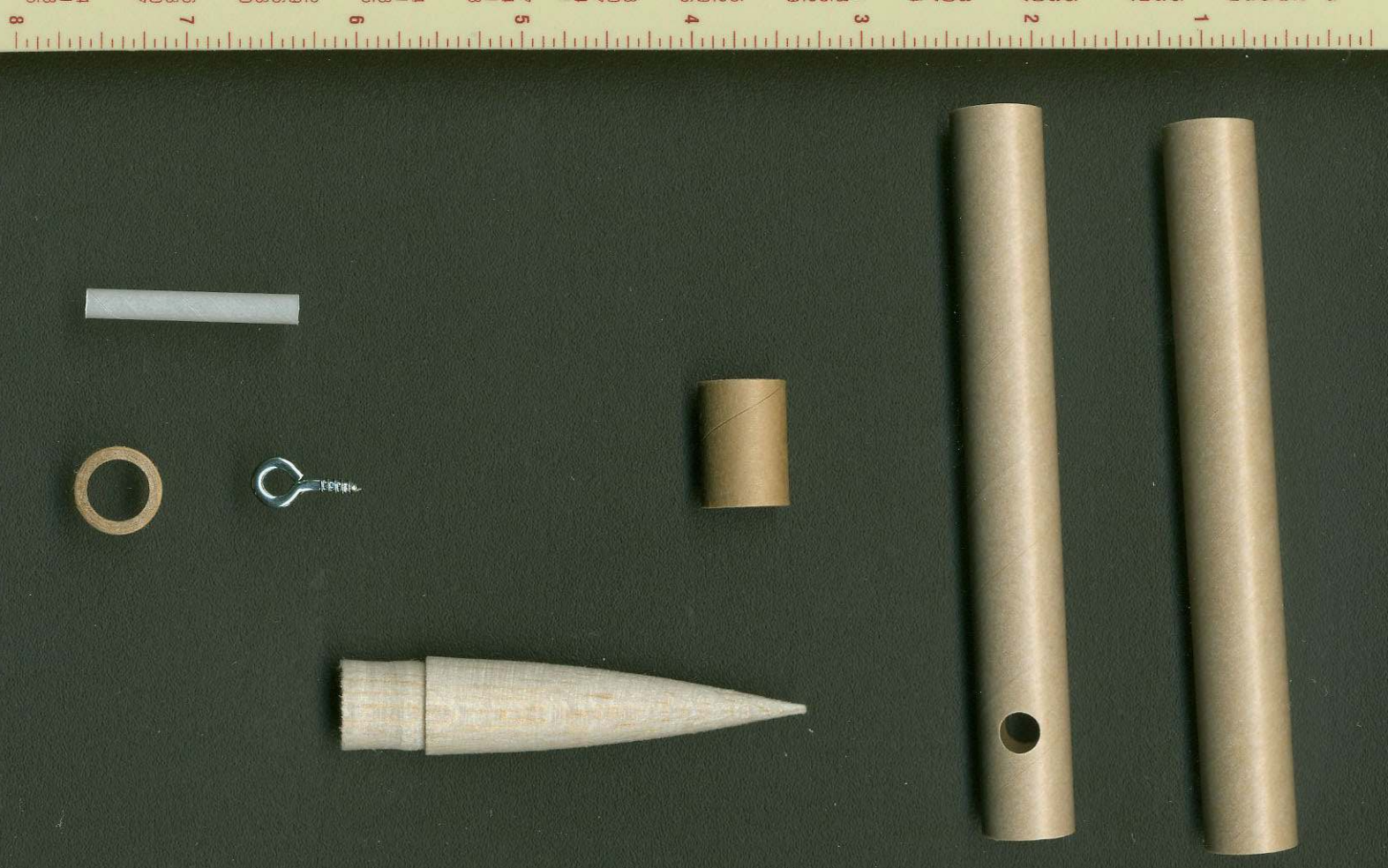
When conducting research activities with unproven model rocket designs or methods I will, when possible, determine the reliability of my model rocket by pre-launch tests. I will conduct the launching of an unproven design in complete isolation from persons not participating in the actual launching.

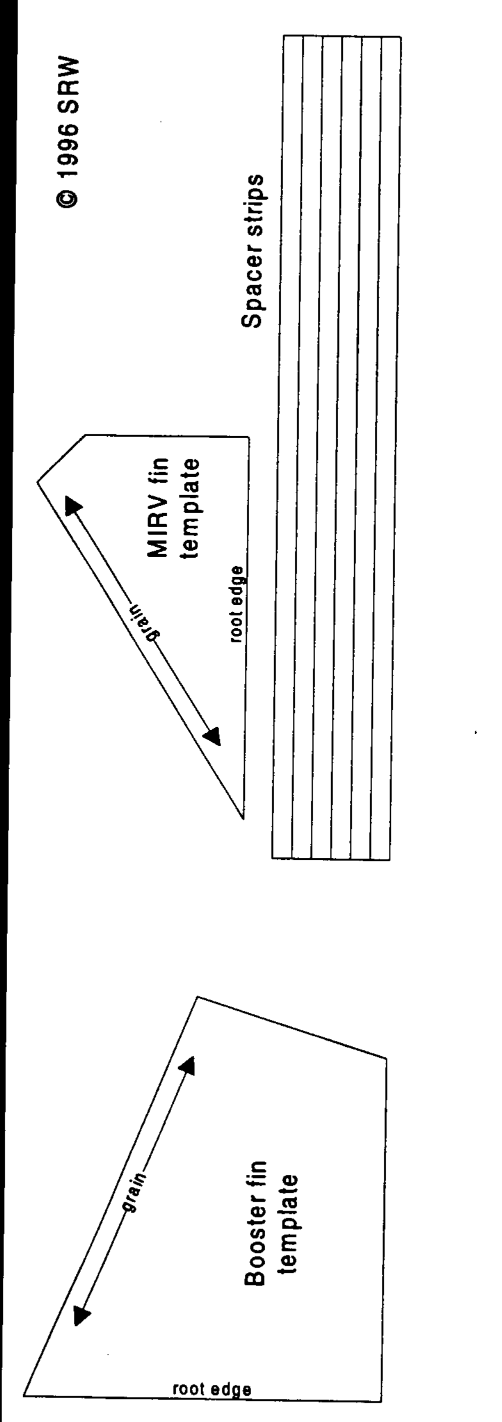
13. Launch Angle

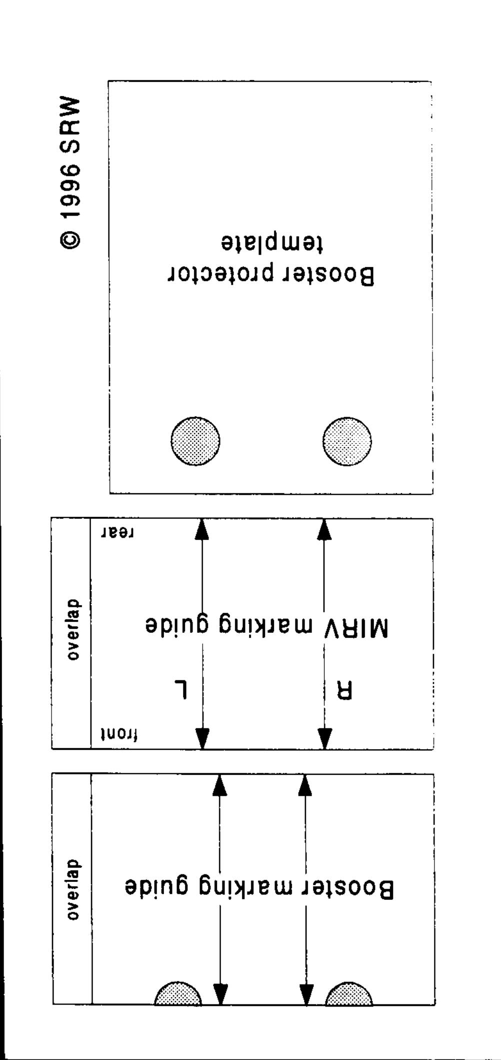
My launch device will be pointed within 30 degrees of vertical. I will never use model rocket motors to propel any device horizontally.

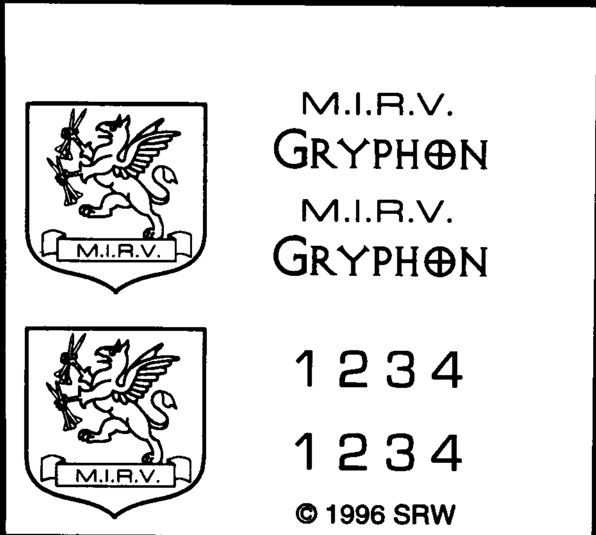
14. Recovery Hazards

If a model rocket becomes entangled in a power line or other dangerous place, I will not attempt to retrieve it.




© 1996 SRW
Spacer strips
MIRV fin template
grain
root edge
Booster fin template
grain
root edge


© 1996 SRW
Booster protector template
MIRV marking guide
rear
front
overlap
L
R
Booster marking guide
overlap


M.I.R.V.
M.I.R.V.
GRYPHON
M.I.R.V.
GRYPHON
M.I.R.V.
1234
1234
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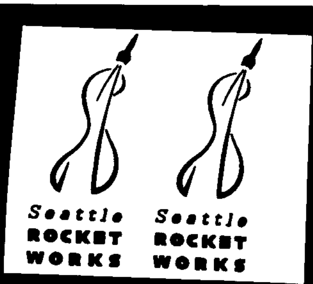
Seattle ROCKET WORKS
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