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APOGEE PEAK OF FLIGHT NEWSLETTER

Two Quality Baffle Designs

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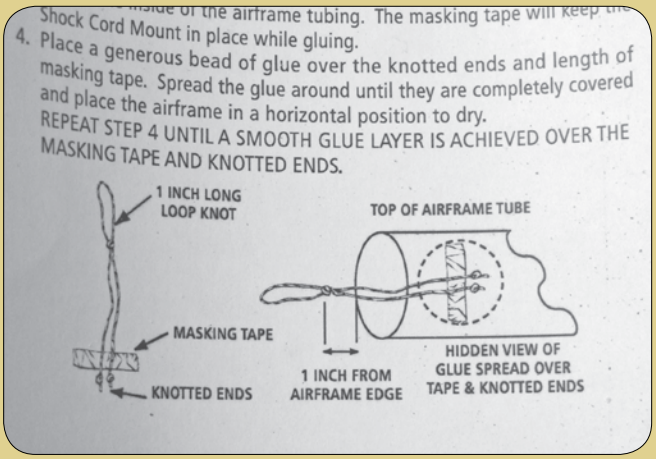
Apogee Components
3355 Fillmore Ridge Hts
Colorado Springs, Colorado 80907-9024 USA
www.ApogeeRockets.com e-mail: orders@ApogeeRockets.com
Phone: 719-535-9335 fax: 719-534-9050

Two Quality Baffle Designs

By Thomas Kindig

The UPS guy just delivered that rocket kit you've been waiting for all week. You open the kit and it is almost everything you had hoped for. Almost, because as you read through the instruction sheet you see something sickeningly familiar. You see instructions directing you to use paper and a big old wad of glue to secure .03 cents worth of nylon into the throat of the airframe of this $68 kit.. This will be your recovery system anchor. Just like the first Estes™ Skill Level 1 kit you ever build. I don't think so!

This is the very experience that got me started on finding a better solution. A solution for where to anchor your recovery works, and for eliminating the need for



recovery wadding. I have built AeroTech kits with the built-in gas discharge baffle. Very nice, but kinda heavy. By the way, be sure and blow that baffle out with compressed air now & then. It will get clogged eventually. I once built an Io from Public Missiles Ltd. It worked fine for me, but I understand that you have to be cautious in hot weather. The piston may catch and deployment may fail. This too is a pretty heavy solution.

Here I offer two very lightweight, simple, and sturdy solutions for deployment discharge baffles. The first one is for rockets with ample space between the motor mount tube and the airframe. The second is for low or zero clearance rockets, where the body tube is the motor mount, or close to it.

A Cold Gas Piston

My favorite design is my most recent innovation. I call it a Cold Gas Piston, despite the fact that there are no moving parts. The volume of cool gas stored within the baffle acts just like a piston in response to deployment discharge.

If you have clearance to fit a 10mm or larger tube between the outside wall of the motor tube and the inside wall of the airframe, this system will work for you. Your kit will typically come with two centering rings. Begin by cutting out a bulkhead, preferably of the same material, sized to the outside diameter of your centering rings (the inside diameter of your body tube). You will want to take advantage of the unused space normally reserved for nothing, above the top edge of your fins. Instead of placing your top centering ring near the top of the motor mount, you will want to place it just above the fin anchors that come in through the body tube. This will provide your piston with as much volume as possible. I didn't bother with any math here. You see, the length of the motor tube is a pretty good indicator of the largest motor you may use. Simply take advantage of the available space and you will have ample cold gas on hand for the task. I keep an assortment of small tubes handy for projects like this.

Next, draw a circle matching the outside diameter of your motor tube, centered on the bulkhead. You will want your vent tubes to fit to the outside surface of the motor tube. Epoxy will couple them to the motor tube and join

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Newsletter Staff
Writer: Dave Virga
Layout / Cover Artist: Dave Curtis
Proofreader: Michelle Mason

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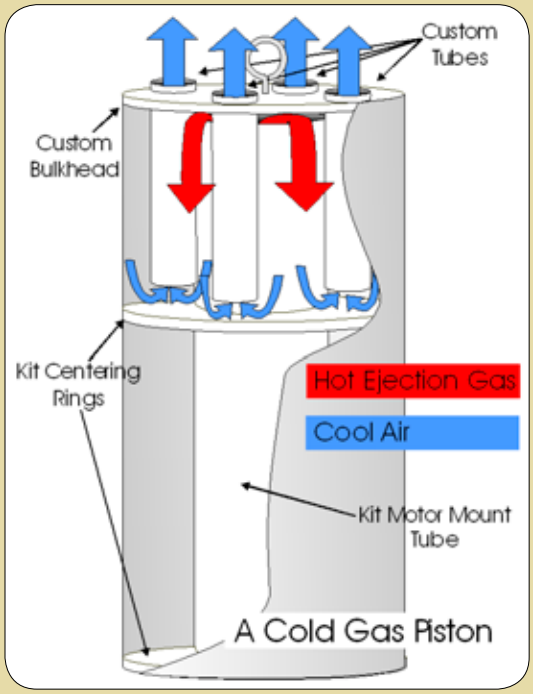
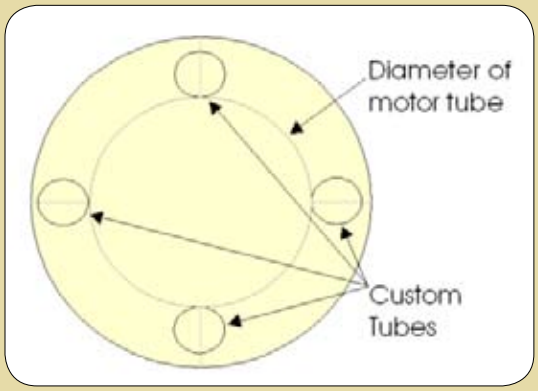


them to the bulkhead. So, using your new circle as a guide, draw four circles for your vent tubes. (If you are using very small tubs, you may wish to do six or eight elements instead of just four.)

This is the part where you explain sweetly to your family how nice it would be to get a drill press for Father's Day. You will drill a hole for your eye-hook in the center of this bulkhead. Then cut the holes for the vent tubes. The assembly I show here only added 3/8 oz to my rocket, using 3mm birch plywood and 11.2mm tubes, 120mm long.



When you have sanded and dry fitted your bulkhead to the body tube, you are ready to grab a few rubber bands and your favorite epoxy, to assemble your cold gas piston. I believe that a liberal coat of epoxy adds strength and fire resistance to any material. I put on a pair of latex gloves for this operation and then coat the tubes, bulkhead, and the portion of the motor tube above the second centering ring, with 30 minute epoxy. Then it is a simple matter of assembling your tubes and bulkhead, mounting them on the motor tube, and holding them in place while the epoxy cures. Note the 1/2 inch gap between the top of the motor tube and the bulkhead plate. You must leave amble space for the ejection gas to pass down the sides of the motor tube. Also, bear in mind the length of the longest motor you wish to use. If you need a bigger gap, then use longer tubes and leave enough room for that motor.

I first tested this design in a LOC Precision LOC IV and I was very pleased with the results. At recovery time, there was still a wisp of smoke drifting up out of the baffle. I examined the 24 inch chute carefully and found no damage. As a matter of fact, it didn't even smell of spent powder! By the time the hot gas makes its way through this baffle, the chute is long gone.

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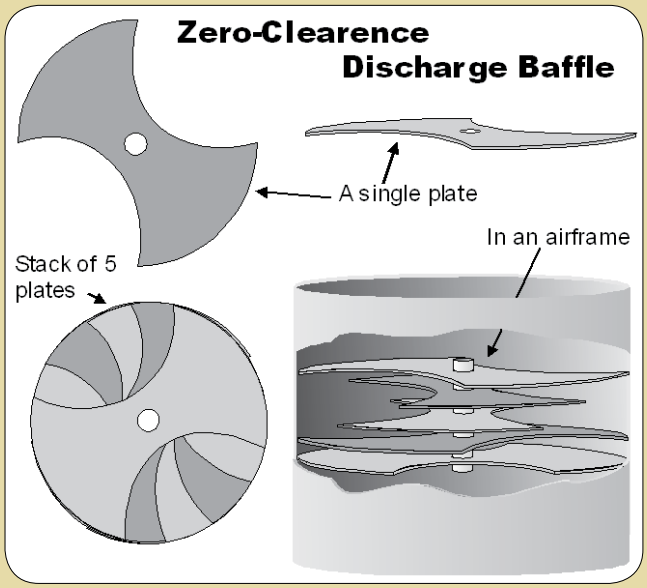
Zero Clearance Baffle

So what do you do when there is no space for the Cold Gas Piston? This design was my first idea. It turns out that it works well for smaller rockets, or for larger ones where the motor mount is nearly the size of the body tube. This, of course, is where I really started hankering for that drill press.

This baffle also delivers a volume of cool air to deploy your recovery package, and stops the particulate matter from the deployment charge from peppering your works. I have built these with five and six stages. I use solid cardboard, liberally doped with epoxy on all surfaces. The center hub could be a dowel, but I have always used a launch lug. This is so that I can run a Kevlar cord down through the baffle and tie it off at the bottom with a small washer. I then epoxy the washer to the first baffle element.

I think it is reasonable to use cardboard the same thickness as your centering rings (if any).



You begin by cutting out five or six plates sized to the inside diameter of your body tube. Once these are sanded down and dry fitted, you will clamp them together and drill your center hole down through the entire set. Use one the the plates to do the layout lines for the arcs you will cut out of your plates. Clamp them together again and use a coping saw to cut out the arcs.

Sand and fit your center tube or dowel, don the latex gloves and dope everything with 30 minute epoxy, then load your disks on to the center element. Rotate each disk 15 degrees or so in a spiral, so that you cannot see through the disks looking down on them. Again, I didn't do any math on this. I just used the available space and decided on how far apart to space the baffle plates and how long the center tube needed to be. On the left, is a baffle I applied to a 54mm body.

Installing the Zero-Clearance baffle into the body tube requires that you use a liberal application of epoxy on both the edges of the baffles, and the area inside the body tube where the baffle is to be placed. I use a wooden dowel to apply epoxy up inside the 54mm body tube. In another case I used a tube-coupler to construct a baffle, then slid it up into a 2.6" body tube. Both rockets have been working fine.

When I first spoke to fellow rocketeers about these designs, they shrugged and showed me the bag of recovery wadding. "Just stuff the end of the motor tube," they said. Well, I'm one of those green kinda guys who makes an effort to to collect his trash after the event. I am also attached to the idea of building a rocket to fly again and again. Both of these designs provide a solid anchor for your recovery system, and eliminate the need for recovery wadding. Well worth the effort if you ask me.

About The Author

Thomas Kindig is a Network Administrator and Server Jockey for White Sands Federal Credit Union in Las Cruces, NM. His love of rocketry bloomed late. On Father's day, 1996, the gift of a Aerotech Starter kit started Father, Wife, and Son on an on-going adventure with amature rocketry. All three build and launch rockets with FLARE, the Fellowship of Las Cruces Area Rocketry Enthusiasts. Thomas is NAR certified Level 1, Secretary of FLARE, and Webmaster of http://www.shootthesky.org

DEFINING MOMENTS

Specific Impulse

Specific Impulse (Isp) in general, is a measure of a motor system's efficiency. It is an indicator of the amount of thrust that a motor can produce from a unit of a given fuel. The measure is applicable to any type of motor – reciprocating piston engine, gas turbine and rocket motors, for example. In scientific terms, specific means 'divided by weight or mass.' So, as applied to rocket motors, Isp is defined as the amount of thrust produced by a complete motor system per unit of mass per second.

The full specific impulse equation is well discussed on the Glenn Research Center website (http://www.grc.nasa.gov/WWW/K-12/airplane/specimp.htmlI). A useful simplification of the full equation is:

$$Isp = \frac{I_{tot}}{(m_{tot})(g_0)}$$

where I_{tot} is the motor's total impulse, m_{tot} is the propellant total mass, and g_0 is the gravitational constant 9.8m/s2.

As part of the National Association of Rocketry's (http://www.nar.org) and Tripoli Rocketry Association's (http://www.tripoli.org) motor certification programs, they measure and publish each motor's propellant mass and total impulse. So, you can use the values published on the certified motor lists to calculate the motor's specific impulse.

It's also worth noting that specific impulse is relative for each motor design; don't try to directly compare a rocket motor's Isp to a turbine engine, for example. (Rocket motors are actually at the low end of the Isp scale.) You can compare the relative efficiency of various rocket motors, however. So grab your calculator and get specific!

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BY DAVE VIRGA

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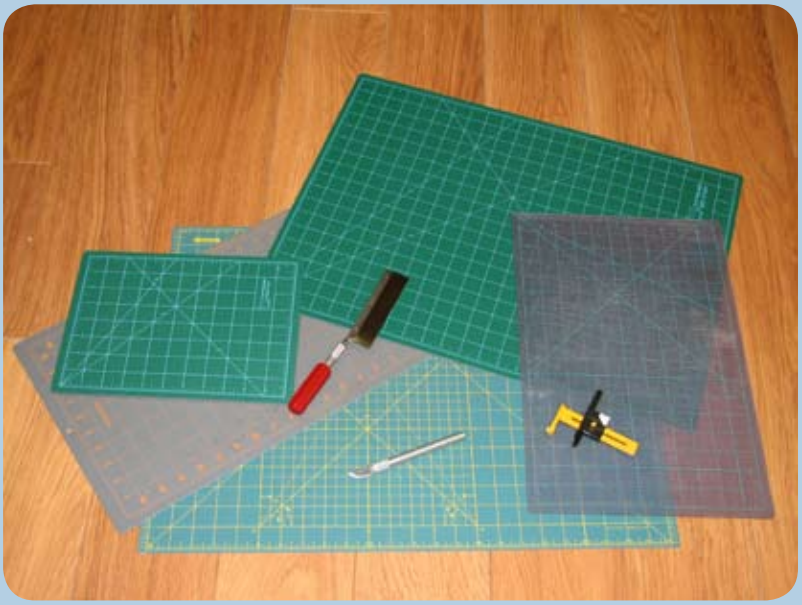
We rocketeers use a wide variety of tools and adhesives that can wreak havoc on a table or counter top. The best solution to this problem is a self-healing cutting mat. You can find them at just about every hobby and craft store, and they come in sizes from tiny to huge. They are made out of one of the dense yet pliable waxy plastics that are nearly impervious to many adhesives, and they stand up to the repeated abuses of our razor-sharp blades. They are also imprinted with a measuring grid and a few common angle lines on one side. Best yet, they are inexpensive and last a long time. So grab one for the work room, one for the garage workbench, one for the kitchen, one for the dining room table….



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www.ApogeeRockets.com/job_opportunities.asp

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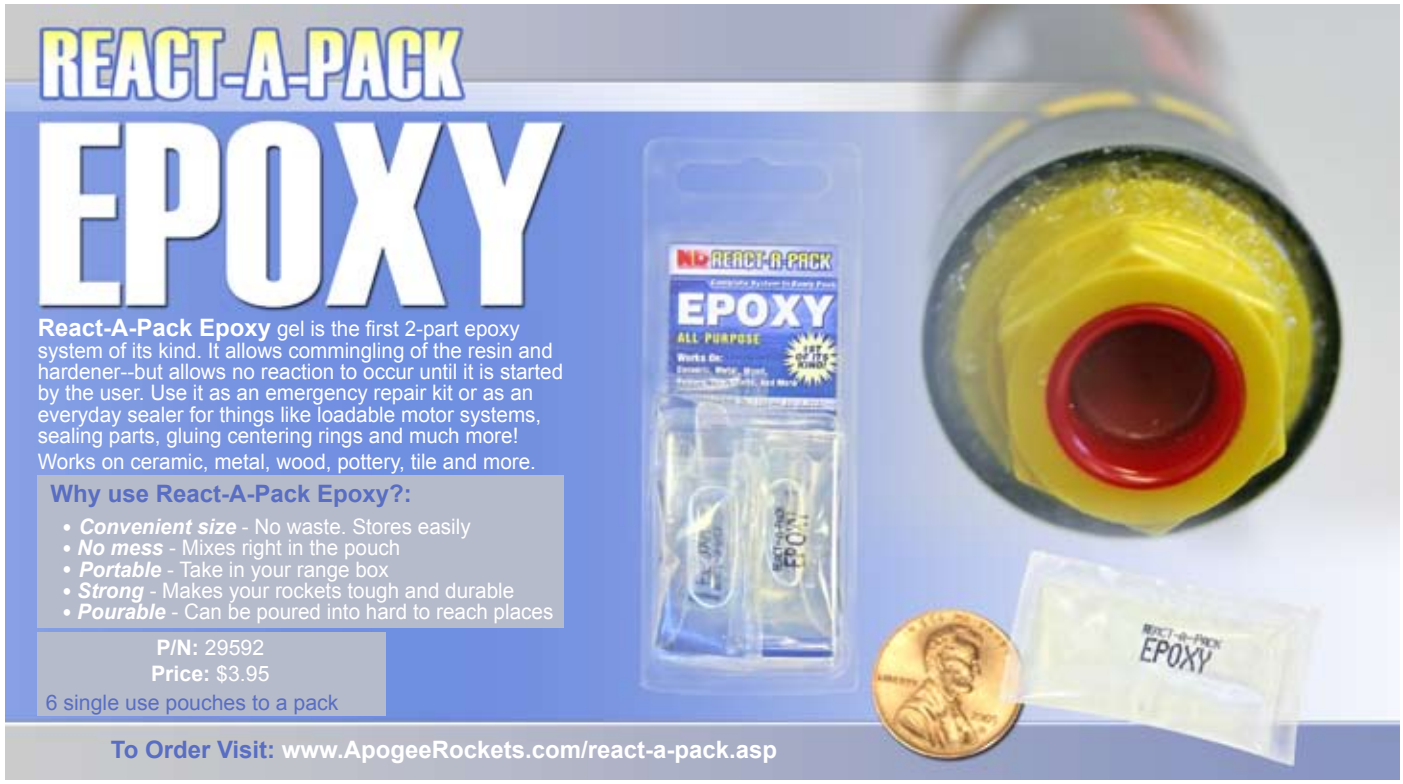
Web Site Worth Visiting

Heavens Above

Have you ever been stargazing and happened to spot a moving star? Well, it's actually not a star, but a satellite in orbit. Most of the lower-altitude and more visible satellites are in polar orbits, so spotting them is a bit easier since you only need to scan for northbound or southbound moving objects. The International Space Station is also very clearly visible when it's overhead, traveling from west to east. The most dramatic of orbital phenomena though are Iridium Flares. The Iridium satellites support a world-wide satellite telephone system; they have highly reflective antenna panels, and the paths of the earth-bound reflections of the sun from these panels can be calculated. So how do you find out when and where to look for these stellar spectacles?

It's very simple! Go to Heavens-Above (http://www.Heavens-Above.com), and enter your nearest large city or your latitude/longitude; the website will calculate exactly when and where to direct your attention. Chris Peat, from Munich, Germany, runs this site; he tracks a huge number of satellites, including radio amateur satellites, as well as comets, planets and more. Happy stargazing!



Question & Answer

Q: There are different maximum liftoff weights for the same motor, depending on its delay. For example, the Apogee Medalist F10-4, -6 and -8 have maximum liftoff weights of 238, 205 and 170 grams respectively. Why is this?

A. You would think that a motor's maximum liftoff weight would be based solely on its propellant load and thrust curve. But this is not true. You also need to take into consideration the rocket's total mass at liftoff as well as its drag coefficient (Cd). Higher values of either or both of these factors will cause two things to happen. First, the rocket will not reach as high of a velocity during the boost phase. Second, the rocket will decelerate more quickly due to gravity (for higher mass) and/or due to aerodynamic friction (for higher Cd). The issue is the speed of the rocket at ejection, and the ability to safely deploy the recovery device without damage, thus assuring the rocket's safe return to earth.

The differing maximum liftoff weights are the result of analyses that take these factors into account and provide a recommendation for the maximum liftoff weight that will result in a safe deployment speed for a rocket given the motor's delay time.

Try it for yourself with RockSim! If you don't already own a copy, download the trial at http://www.apogeerockets.com/rocksim_demo.asp. Experiment with different rocket designs, noting liftoff mass and Cd values, and their effects on coast time to apogee. In the example of the F10 motor, you'll clearly see how an F10-8 motor would be disastrous in a 238 gram rocket!