THE LEADING EDGE

Newsletter of the Northern Illinois Rocketry Association, **Volume 26, Number 2**
NAR Section #117 **March/April 2003**

Club News and Notes

First Launch of the Season – NIRA's first launch of 2003 will be on April 20th at the East Branch Forest Preserve. A map is on page 2.

Watch The Grass Grow - Todd Bavery has volunteered to run WTGG this year. Tentative plans are to have it at the Beaver Run sod farm sometime in September (like last year). If you'd like to help, please let Todd know.

Midwest Fun Fly - There was some discussion about MRFF at the April meeting, with the general agreement that it's too late to plan one for this year (with only 2 months left). Currently under consideration is a 2 day club launch in June instead.

Field Search - One of the issues with MRFF (and all club launches) is the lack of a large launch site. If you know of a site that would be suitable for MRFF (50+ cars, vendors on site) or just for regular club launches, please let one of the officer know about it.

February Model of the Month contest –
Ryan Perryman – Estes Goliath (Youth Winner)

Jeff Liebich – kitbashed "Sparrow 1" (Adult Winner)
Ken Goodwin - Estes SR-71
Jonathan Charbonneau - Aerotech Arreaux
Rick Gaff - Little Berth X2 (Estes plan)
Chuck Swindler - Scratch built (Aerotech parts)
Mark Knapp - DG&A Defender (54 mm)
Marty Schrader – Rocket Research Jayhawk

March Model of the Month contest –
Kevin Keehn – Scratch built (Adult Winner)
Jonathan Charbonneau - VB Extreme 38
John Boren - cloned Estes Trident & Bomarc
Greg Cisko - PML Endeavor
Mark Knapp - Skunkworks Pershing II
Marty Schrader – Estes Explorer (modified)
Matt Miller – Aerotech Mustang

Leading Edge Update– The deadline for the next issue of the Leading Edge is May 2nd, 2003 - the same day as the club meeting.

In a change from last issue, the next editor of the Leading Edge will be Adam Elliot. He will take over as of the July/August issue.

Senator Enzi Introduces S. 724

Hobby rocketeers who want to send their crafts to the skies will not have to first navigate through clouds of red tape and federal government permits if U.S. Senator Mike Enzi, R-Wyo., succeeds in passing a bill he introduced.

Enzi's bill, S. 724, would exempt users of certain model rocket propellants from explosive permit requirements, much like antique firearm users are exempted from permit requirements for black powder use.

"Model rocket enthusiasts across the country and even across the ocean are very worried about how enforcement of regulations and the passage of new restrictions in the Homeland Security Act could negatively affect them. It was not Congress' intent to harm model rocketry with passage of the Homeland Security Act. My bill would simply assure that people can go on enjoying their hobby without having to jump through a lot of needless regulatory hoops,"

Hobbyists are most concerned with added requirements regarding the use of Ammonium Perchlorate Composite Propellant (APCP), which is classified by the Bureau of Alcohol, Tobacco and Firearms (BATF) as an explosive. Before 1997 the BATF exempted APCP used for consumer rocket motors from the permits required for other substances on the explosives list. Since that time only rocket motors with less than 62.5 grams of APCP have been exempt. Handlers of rocket motors that contained more than 62.5 grams of APCP were required to get permits to purchase and transport the motors between states. Now, with the passage of the Homeland Security Act the permits are scheduled to be applied to those who purchase and transport the motors within a state.

"Some shipping companies are refusing to transport rocket motors because of added requirements. This hurts the shipping company itself, small business owners who operate hobby shops and the kids and adults who build and launch model rockets," said Enzi. "People who build and launch model rockets for fun aren't the bad guys. They shouldn't have to go through a rigorous set of obstacles in order to enjoy their hobby. We should be encouraging youth to take up this mind-expanding activity, not squelching initiative."

Enzi said the current 62.5 gram APCP exemption is still too restrictive.

Enzi took great care to write the bill so the exemption would only apply to legitimate hobby use of rocket propellant. The exemption would only apply to non-detonable rocket propellant. There are some high-energy APCP composites that have additional chemicals in their composition that make them detonate, instead of burn at a moderate rate. The high-energy APCP is not used in amateur rocketry and would not be exempted under Enzi's bill.

Source: ROL Newswire Service

WOOSH (Section 558) Presents a training seminar with the BATFE

April 19, 2003 - 9 am. to 12 pm.
Richard Bong Recreation Area Auditorium

Mary Jo Holpit, Special Operations Inspector of the Milwaukee office of the BATFE will present a slide show and answer questions regarding filing for LEUP applications

All pertinent questions regarding the new limited user permit; storage requirements, and record keeping are welcomed.

Bring your paperwork and have any questions you have about filing answered on the spot by the people who know the regulations best!

This seminar is not a forum for the debate of rulemaking and policies of the BATFE. Persons who do not stay on topic or disrupt the meeting with questions regarding such will be given one warning and upon a second offense will be asked to leave.

If you intend to fly motors larger than the 62.5 - gram limit after May 24, 2003 and have not yet investigated the LEUP application process this meeting is for you.

For further information see the Woosh website at: www.wooshrocketry.org

THE LEADING EDGE

Volume 26, Number 2
March/April 2003

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Email list: http://groups.yahoo.com/group/NIRA

InfoLine: (630) 830-1587

CLUB MEETING DATES

All meetings start at 7:30 pm. Bring a model for 'Model of the Month.' We always need volunteers for pre-meeting lectures, contact Rick Gaff if you want to schedule a date. The location is usually the Glen Ellyn Civic Center, 535 Duane Street (check the board in the lobby for the room number).

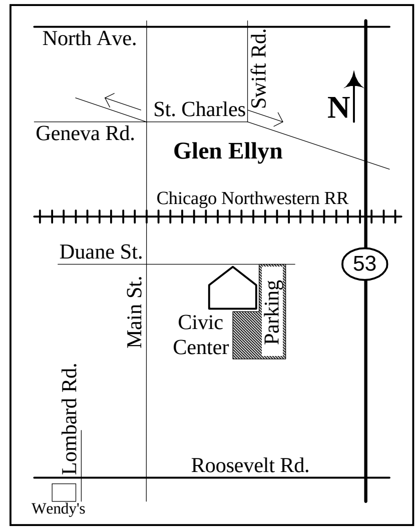
April 4

May 2

June 6

July 11

August 1



CLUB LAUNCH DATES

Launches are BYOL (bring your own launcher). Call the NIRA infoline for pre-launch information: 630-830-1587.

As the map shows, our new launch field is the East Branch Forest Preserve but the arrangement may not be permanent! **Please** call/check the infoline/website before coming!

April 20, 2003 - East Branch Forest Preserve

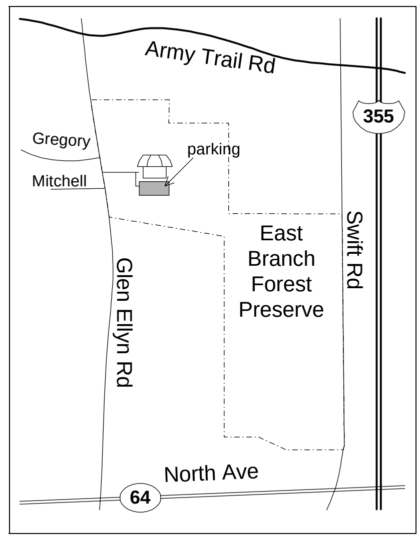
May 18, 2003 - East Branch Forest Preserve

June 14-15, 2003 - Midwest Regional Fun Fly (site TBD)

July 20, 2003 East Branch Forest Preserve

August 17, 2003 East Branch Forest Preserve

August 21, 2003 East Branch Forest Preserve



Model of the Month Winners! (Jeff Pleimling photos)

February – Jeff Liebich was the Adult winner with his "Sparrow 1" (a kitbash of the Flash and Pipsqueak). Ryan Perryman won the Youth category with his Goliath - his first rocket ever!

March – Kevin Keehe was the Adult winner with a scratch built rocket done for the 8th grade science class he teaches. Kevin's students scratch build rockets and read 'Rocket Boys'..

Quest Big Rage Conversion
by Bob Wiersbe

While I was innocently digging through my boxes of rocket stuff looking for something that my sons could use to build terrain for their Warhammer game, I came across an unopened Quest Big Rage kit. Naturally the bug to build the kit hit me, so I put it on the bench for later. When later came and I opened the kit, I was dissatisfied with the 18mm motor mount. I decided to give it "more power" and put in a 24mm motor mount.

The challenge was to find parts to fit a 24mm tube into the Quest plastic fin unit and the Quest body tube. Quest doesn't make kits for 24mm motors yet; they are producing D motors but haven't released them at this time. I started digging through the box of centering rings and found one of the motor mount kits that Estes used to make for their E15 motors (now discontinued). This kit has a thicker, longer BT50 motor mount tube, 3.5" engine hooks (.25" too short for the new E9's), BT55-50 thick cardboard centering rings, and an assortment of couplers.

Perfect, except for the fact that the centering rings were too narrow for the Quest tubing. But not by much. Back to the boxes of stuff to find some scrap BT55. Sure enough, the BT55 fit perfectly inside the Quest body tube, and the plastic fin unit too! Problem solved.

Unfortunately as I built the kit I didn't take measurements or photos of what I did, so the rest of this article will just be a general description of the conversion. Use your own parts, scavenge, and modify as you see fit. The diagram below is not exact, but will give you the general idea.

The engine hook had to be modified for the 3.75" long E9 motors. What I did was to bend the stop tab back 270 degrees to form a U. The motor mount kit comes with engine hook retainers that slide over the engine hook and the motor mount tube, and the U slides into the retainer. An engine block installed in the motor mount tube (why do we call them "motor mounts" and every thing else "engine"???) prevents the motor from exiting the rocket during flight, and the U prevents the motor from kicking out at ejection. A centering ring butted up against the retainer insures the hook won't move.

To cut the BT55 to the right length I inserted it into the plastic fin unit until it was tight, and then used an Xacto knife to cut the tube at the base of the fin unit. I made two lengths of BT55, one for the plastic fin unit, the other for the Quest body tube. I used plastic cement to glue the BT55 in the fin unit, and left the other piece for later.

I assembled the motor mount by inserting an E9 in the motor tube, putting the engine hook in place, and then gluing on the retaining ring. Once the glue had set I glued the engine block in place, then removed the engine and glued a centering ring at the base of the retaining ring. I had to remove a layer of paper inside each of the BT55-50 centering rings so that they would fit over the thicker BT50 motor mount tube. A second centering ring was glued over the engine hook, about 1" from the bottom of the motor mount tube. This ring is the one that is glued into the tube in the fin unit. The forward centering ring is left off until after the motor mount has been glued into the fin unit.

To glue the motor mount into the fin unit you need to put the glue between the two centering rings. I did this by inserting the motor mount until the first ring was inside, then putting the glue in the BT55 tube and inserting the motor mount. Before the glue could set I slid the forward centering ring on the mount (do NOT glue in place at this time!), slid the other piece of BT55 over that, and then the Quest body tube over that. This was to make sure the motor mount was glued in straight. I left 1/8" of the motor mount tube sticking out of the fin unit, mostly because the bent engine hook was too big to fit out the narrow end of the fin unit. You may or may not have the same problem, depending on what parts you use.

After the glue dried I disassembled the body tube/BT55/centering ring combo, then reassembled it again after putting the Kevlar shock cord under the centering ring, except this time with glue (yellow glue inside the body tube, plastic cement on the fin unit). The rest of the rocket was built according to the instructions. I'm probably going to connect the payload section to the main rocket with some elastic or Kevlar and just use one parachute to recover it.

I haven't done any Rocsim simulations to see if the rocket will be stable with E motors, but a quick and dirty balancing test looked like it might need some nose weight. It should be fine on C11 and D12 motors, but you should test your model before any flight.

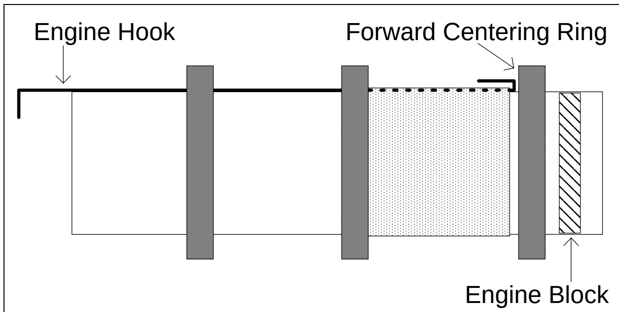


Figure 1: Bob's modified motor mount

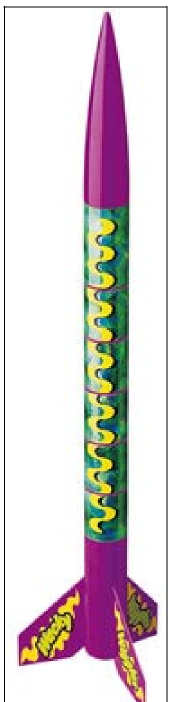
Review: Estes Wacky Wiggler
by Rick Kramer

What else can I say, but "Break-Apart recovery on a grand scale."

People have been complaining that Estes hasn't been very innovative lately, that the product line keeps shrinking, that they keep re-releasing old kits and recycling old parts. Well this kit proves the nay-sayers completely wrong. The Wacky Wiggler is a new kit in the E2X line that anyone with a tube of plastic cement can assemble in a short time.

No painting is necessary, as the body tube sections are pre-finished in prismatic green, and all of the plastic parts are pink. Yes, that does look like a set of Skywinder fins, but they are molded in pink plastic! I found the parts to be very well engineered for a perfect fit with a minimum of excess plastic flash to trim off.

The holes and slots in the paper tubes mated perfectly with the plastic parts. The only cautions needed are not to slop too much of the tube type plastic cement around. You don't want to leave any permanent cement fingerprints showing on your rocket. Use as small of an amount as you can to get the job done, and try not to breathe in the toxic vapors.



Also, when attaching the body tube segments to the six foot long nylon cord, be careful that you don't install one of them upside down.

The real fun is flying the Wacky Wiggler. It takes off like a normal rocket and can reach 1,000 feet on a C-6-5 motor. The recovery is spectacular! Instead of a parachute or streamer, when the ejection charge fires, The Wacky Wiggler separates into seven pieces connected by a six foot cord and literally wiggles back to the ground. It kind of reminds me of the 1980's arcade game, Centipede.

I want to get two more of these kits and construct a tube finned Wiggler.

Estes 'Wacky Wiggler' Specifications:
Length: 17.8"
Diameter: 1.1"
Weight: 2.0oz.
Fins: 3 - Plastic molded fin unit
Recovery Type: Break-Apart
Recommended Motors: 1/2A6-2, A8-3, A8-5, B4-4, B6-4, C6-3, C6-5
Skill Level: E2X
List Price: $11.99

For Sale

For Sale: 12v (2x6V) 7?AH Panasonic Gel Cell. Used in a computer UPS since 1998, in excellent condition. $10 donation to the NAR legal fund.

I will not ship them, but contact me and I'll deliver at any NIRA event.

See Bob Kaplow.

The Rotacrock 20 13mm Helicopter Duration model

by Bob Kaplow (NAR 18L)

This rocket is an obvious modification of George Gassaway's popular Rotaroc helicopter design. I flew some of his early designs, but found several things I didn't like.

The major one being the kludge and draggy nose assembly. I eliminated the elongated proboscis by replacing the rubber bands with torque rods. Second was cutting and regluing the blades. Instead I soak them in water, and warp them using a PVC tube as a mold.

I've been using this design, and its 18mm big brother in competition since 1986, and have collected 7 places at NARAM, plus a handful of local places, and set 2 US records.

A note regarding how I build competition models. Rule #1 BUILD LIGHT! Rule #2 BUILD LIGHT! Rule #3 BUILD LIGHT! Rule #4 Add strength where necessary using composite reinforcing materials. If you aren't into high tech, you can build this model without the Kevlar reinforcing, but you may need to increase the balsa thickness to avoid shredding with some motors. I did build a Rotacrock 20 with no reinforcing, and flat unairfoiled rotors to beta test the Apogee rotor hub, but never flew it with A motors.

Building:
Cut the three rotor blades from a sheet of A grain balsa. Airfoil them as you would a glider wing. Then soak them in hot water until they soften. Wrap the PVC pipe with several layers of newspaper. Lay the 3 blades along the pipe, with the leading edge of the airfoil on the LEFT side. Then rotate the bottom end of the blades about 50% of the blade span towards the leading edge. Tape in place, wrap with several more layers of newspaper, then wrap the whole thing with some 1" elastic shock cord, or an ACE bandage. Allow to sit until dry.

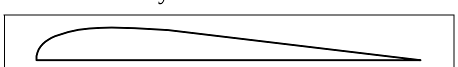


Figure 1: Airfoil

I designed this rocket before the Apogee molded rotor hub was available. You can certainly use one of those if you have one. I actually prototyped one of these for Apogee when the hub was in beta test.

Photo 2: Close-up look at the nose assembly.

Otherwise you need to sand/file/machine three flats in the nose cone for the hinge half. I do this with a milling machine setup, but low tech solutions should do just fine.

Disassemble the Klett hinges. Tack one half of each hinge to the flats on the nose cone so that the hinge line is even with the nose cone/shoulder seam, and the hinge pins are oriented in the same direction, using a drop of CA. Now drive a toothpick tip into each of the hinge holes to "pin" it in place, and cut off flush. Wrap the assembly with some Kevlar thread, tacked in place with CA to prevent slipping. Then coat the nose, hinges, and thread with some epoxy, making sure none gets in the hinge pin holes.

While these are drying, build the booster. Cut out and airfoil the three fins. Draw 3 fine lines on one end of the body tube. Extend those lines about 2/3 the length of the tube. Draw 3 shorter lines near the center of the tube, half way between the fin lines. Using a brad point drill bit or a rotary tool, drill 3 holes along the short lines, spaced at least one body diameter apart. Debur those holes with a rifler file or a dowel with some sandpaper glued to the end from inside.

Photo 3: Close-up look at the fin area.

Glue the 3 fins to the tube along the lines at the end of the tube, about half a centimeter from the end of the tube. Allow to dry, then fillet.

Using needle nose pliers and an expended motor casing, bend the fat wire into a motor retainer hook. With a needle, punch a hole between 2 of the fins 4.0 cm from the end of the tube. Stick one end of the motor hook through the hole. Align the hook and tack it in place with a small piece of masking tape. Wrap a piece of adhesive Mylar (or strapping tape) around the full tube diameter, covering the motor hook from the hole to the fin leading edge. About one body diameter ahead of the motor hook make a pin hole

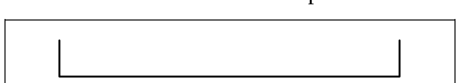


Figure 2: Engine Hook

Photo 1: Finished Rotacrock 20.

through both sides of the tube for the sewing elastic. I recommend reinforcing the area of the tube that was drilled for vent holes by gluing down 3 strips of Kevlar yarn extending several cm beyond the holes in each direction. Coating the holes and the area around them with some thin CA or epoxy couldn't hurt either.

Now tack the remaining 3 hinge halves to the bottom surface of each rotor. Make sure you've got the right end of the rotor, and that all three hinges are aligned to nest with the hinge halves on the nose cone. Carefully drill the hinge holes, and pin the rotors with toothpicks, then cut and sand flush on both sides. Then glue the balsa rotor stop to the top surface of the rotor, over the center of the hinge.

Using a laminating epoxy or Amberoid, reinforce both sides of the rotors with the Kevlar yarn from the end of the hinge to the tip, and from the end of the rotor stop to the tip. Using a finger and glove, or a plastic scraper squeeze down to make the yarn/glue as smooth and flat as possible, and to remove any excess glue. Coat both sides of the hinge rotor assembly with some epoxy to secure the hinge and fillet the rotor stop.

Photo 4: Underside of the rotors.

Using needle nose pliers, bend the three torque rods for HALF the "Z" pattern as shown. Align the rotor hinge with the nose hinge, thread the rod through the hinge holes from leading edge to trailing edge, with the bent part UNDER the rotor. Adjust the bend so the corner is even with the LE of the rotor, and the end tab is over the hinge tab. Use a masking tape tab to hold the rod end to the hinge. Once all three are installed, use

*(**Rotacrock 20** continued on page 8)*

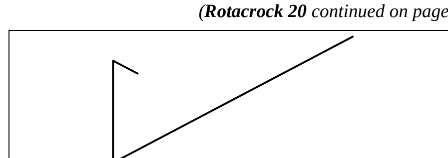


Figure 3: Bent Torque Rod

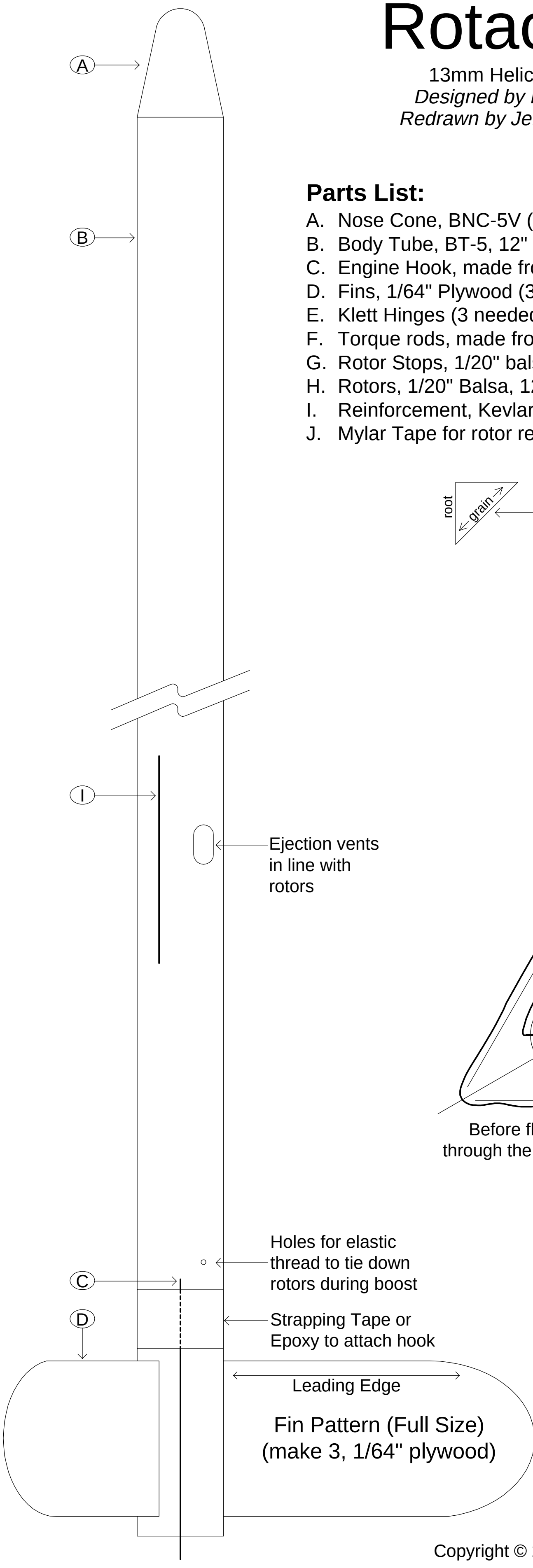
Rotacrock 20

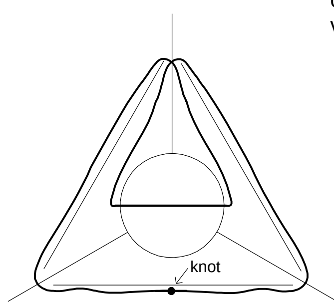
13mm Helicopter Duration model

Designed by Bob Kaplow (NAR 18L)
Redrawn by Jeff Pleimling (NAR 63951)

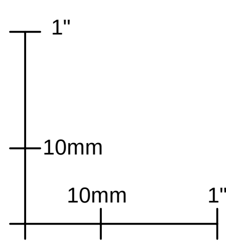
Parts List:

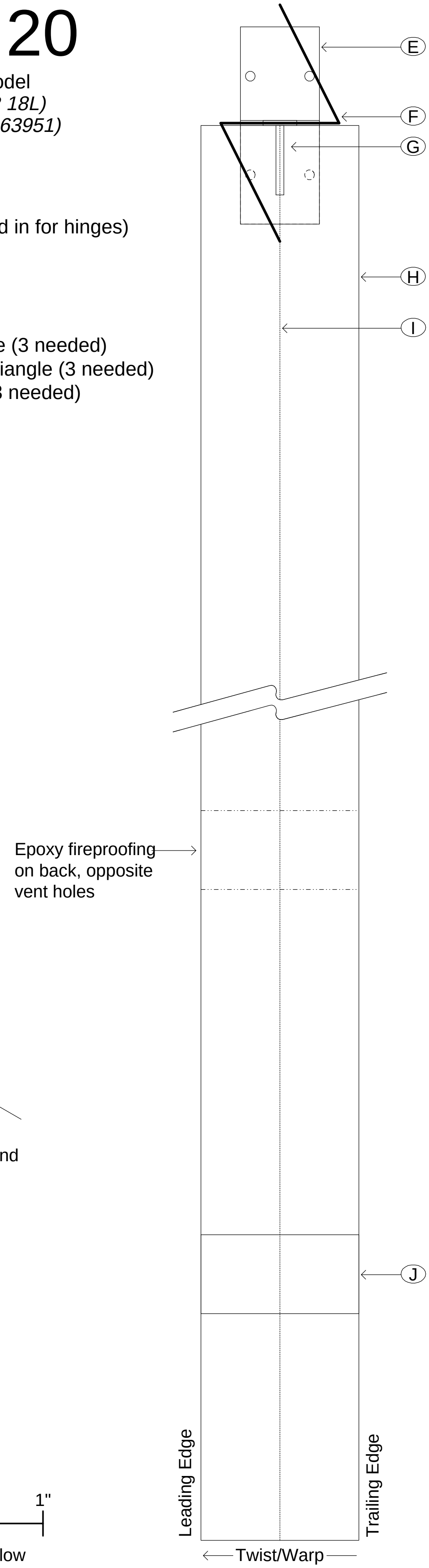
A. Nose Cone, BNC-5V (w/3 flats machined in for hinges)
B. Body Tube, BT-5, 12"
C. Engine Hook, made from music wire
D. Fins, 1/64" Plywood (3 needed)
E. Klett Hinges (3 needed)
F. Torque rods, made from .015 music wire (3 needed)
G. Rotor Stops, 1/20" balsa, 1 cm x 1 cm triangle (3 needed)
H. Rotors, 1/20" Balsa, 12" x 1", airfoiled (3 needed)
I. Reinforcement, Kevlar or Carbon yarn
J. Mylar Tape for rotor reinforcement





Before flying, thread elastic through the body and then around the rotors.





Space Launch Report: Boeing's Delta 4

by Tim Johnson

On November 20, 2002, a brand new rocket roared to life at Cape Canaveral's Space Launch Complex (SLC) 37B. For a moment, the 195-foot tall orange and white machine sat on its launch pad, its base immersed in a slowly expanding reddish-yellow ball of flame, while its single main engine built up thrust. Then two solid boosters strapped to the base of the first stage ignited and the 723,000 pound rocket began to rise straight up into the Florida night sky. As it rose, the trombone howl of a Rocketdyne RS-68 rocket engine echoed across the Cape for the first time.

Nov 20th 2002, First flight for Delta IV. (Boeing photo)

The rocket, Boeing's first Delta 4, successfully orbited Eutelsat W5, a commercial communication satellite, during this, its inaugural, flight. Boeing dubbed the mission "Delta 293", but this Delta had little in common with the 292 Deltas that had flown before it. Those launchers used Thor-type first stages derived from a 1950s-era IRBM design. Delta 4 was a clean-sheet design conceived to compete for U.S. Air Force Evolved Expendable Launch Vehicle (EELV) contracts.

The EELV program began in 1995. Its goal was to replace Titan 4 and other ballistic missile-based space launchers with a brand new vehicle that would cost less and be more reliable. The Air Force narrowed the competition from four companies to two in December 1996. In late 1997, the Air Force announced that, rather than reducing the field to one design as planned, it would divide the launch work between Boeing's Delta 4 and Lockheed Martin's new Atlas 5. This was meant both to encourage competition and to provide redundancy.

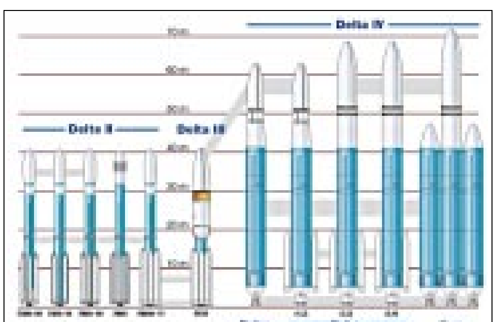
On October 16, 1998, the Air Force awarded 19 EELV launches to Boeing for $1.38 billion and 9 launches to Lockheed Martin's Atlas 5 for $650 million. Later, the Air Force shifted payloads and added a Heavy-class test flight so that Boeing held 22 of 29 planned launches. Boeing won the only two EELV Heavy class payloads in the package, forcing Lockheed to shelve both its Atlas 5 Heavy design and its plans to build a West Coast Atlas 5 launch pad. Both companies also received an additional $500 million for EELV research and development.

Boeing based its EELV design on a 200-inch diameter, 150 foot long Common Booster Core (CBC) first stage powered by a single 656,000 pound thrust RS-68. The engine, the first big new U.S. liquid propellant rocket engine in more than 25 years, burns liquid hydrogen (LH2) and liquid oxygen (LOX), making it the most powerful liquid hydrogen fueled engine yet flown.

RS-68 operates at comparatively moderate chamber pressure using a gas generator cycle. The gas generator drives a turbopump. Turbine exhaust gases are ejected through a vectoring nozzle that provides first stage roll control. The thrust chamber gimbals for pitch and yaw control. RS-68 uses an ablator to dissipate heat, eliminating thousands of coolant tubes used in previous designs. The engine can be throttled. RS-68 engine testing began at Edwards Air Force Base, California in August 1998.

The CBC is composed of four main structural subassemblies. These include an engine section, an aft LH2 tank, an intertank mid-body section, and a forward LOX tank. The tanks are made of eight-foot wide aluminum skin panels that have triangular isogrid patterns machined into their interior side to reduced weight. Five panels welded together make a cylindrical tank barrel. Interior stingers provide reinforcement. An exterior spray on foam insulates the tanks, providing a distinctive orange coloration. A LOX feed pipe runs from the upper tank to the engine on the outside the LH2 tank. An exterior wiring tunnel runs the length of the stage. CBC weighs 54,000 pounds empty and 480,750 pounds when loaded with propellants.

Two types of Delta 4 LOX/LH2 second stages are available. One is a stretched Delta 3 second stage with a 4-meter diameter forward LH2 tank built by Mitsubishi Heavy Industries of Japan (based on NASDA's H-2 tanks). A second model has a 200-inch diameter LH2 tank. Both designs use a 3-meter diameter LOX suspended beneath the LH2 tank by an intertank truss structure. Both designs have an Allied Signal Redundant Inertial Flight Control Assembly (RIFCA) that is used to control the entire vehicle.



Size comparison of Delta II, III and IV from Boeing's Delta Product Card. (Boeing drawing)

Two to four Alliant GEM-60 solid rocket motors can be strapped to the side of a Delta 4 CBC to augment the liftoff thrust. Each motor is 60 inches in diameter, 50 feet long, weighs 42,500 pounds at liftoff, and produces 195,000 pounds of thrust.

There are five Delta 4 versions. They include the Medium, Medium+(4,2), Medium+(5,2), Medium+(5,4), and the Heavy. These will respectively be able to put 9,285 lbs, 12,890 lbs, 10,230 lbs, 14,475 lbs, and 28,950 lbs into geosynchronous transfer orbit (GTO).

Delta 4 Medium, the most basic version and the one used during the second successful Delta 4 launch in March, 2003, uses one CBC, a 4-meter diameter second stage, a Delta 3 composite payload fairing, and a tapered interstage.

Two GEM-60s added to the base of the CBC turns the rocket into a Delta 4 Medium+(4,2), the version used during the inaugural flight.

Delta 4 Medium+(5,2) and Medium+(5,4) use two to four GEM-60s, respectively and are equipped with a 200 inch diameter second stage, interstage, and aluminum payload fairing.

Delta 4 Heavy, the most powerful version, uses three CBCs, with two CBC configured as strap-on liquid rocket boosters. The first Heavy demonstration flight is expected to occur in late 2003 or early 2004.

First Air Force EELV flight, Mar 10th 2003. (Boeing photo)

Flight profiles

On Medium missions, the CBC burns for more than four minutes, separating when the vehicle is more than 60 miles above the earth. On Medium+ missions, two to four GEM solid rocket motors augment the CBC thrust during the first 88 seconds.

On Delta 4 Heavy flights, all three CBCs will ignite on the pad. The core CBC will throttle down to 60% after about one minute. The twin strap-on booster CBC units will burn at full thrust until the 3.85 minute mark. At that point, the strap-on units will throttle down to 60% and the core will throttle up to 100%. The strap-on units will burn out and separate after 4.3 minutes. The core CBC will shut down about a minute later.

On most flights the second stage performs two burns. The first burn lasts from 7.6 to 13.6 minutes depending on vehicle type and mission. Typically, low earth orbit (LEO) missions will use longer burns. The vehicle uses a gravity turn followed by a series of pitch commands to reach a temporary parking orbit. The payload fairing usually separates just after second stage ignition.

On Canaveral GTO missions, the second stage restarts on either the descending node over the South Atlantic or the ascending node over the Indian Ocean. The second burn lasts about four

(*Space Launch Report* continued on page 7)

(*Space Launch Report* continued from page 6)
minutes, injecting the payload into the final transfer orbit. On Vandenberg LEO missions, the second stage will restart at first apogee to circularize the orbit.

Delta 4 Operations
Delta 4 is integrated horizontally in a new Horizontal Integration Facility (HIF). The integrated vehicle is then moved intact and erected at the launch pad no less than eight to twelve days before launch. The encapsulated payload is mated to the vehicle on the pad only five days before launch.


The first 'west coast' Delta IV arrives at Vandenberg AFB on January 14th, 2003. (Boeing photo)

At Cape Canaveral, the long-dormant former Saturn 1/1B SLC 37B pad has been refurbished for Delta 4. The site includes a new 300+ foot tall rail-mobile mobile service tower and a fixed umbilical tower. The old Saturn blockhouse, once frequented by Werner von Braun and Kurt Debus, is now used as a support building.

At Vandenberg, Delta 4 will be launched from infamous "Slick Six" (SLC 6), a pad developed but never used for space shuttle launches. SLC 6 facilities include a mobile service tower and a mobile assembly shelter, massive structures that enclose the launcher from two directions like a clamshell. A new two-bay HIF has also be constructed northwest of SLC 6.

CBCs are constructed at a new plant in Decatur, Alabama where automated welding tooling allows construction of dozens of CBCs per year. When finished, the CBCs are floated on a self-propelled vessel down the Tennessee River and Tombigbee Waterway (canal) to the Gulf of Mexico. From there CBCs travel either to Cape Canaveral via the Intercostal Waterway or Vandenberg Air Force Base, California via the Panama Canal. Delta 4 second stage construction, as well as Delta 2 and 3 production, will soon be moved to Decatur as well.

Welcome to the Club!

Mark Knapp is the only new member in the past few months. Welcome to the club!

(If I somehow missed your name, please let me know!)

Confused Stages – Stage 30
by Jonathan Charbonneau

"GSE, what the heck is it?" You've probably seen 'GSE' in the text of some articles in *Sports Rocketry*[1]. If you don't know what it means, here's a hint: you've seen it at every rocket launch. In fact, you use it yourself every time you fly rockets. Still stumped, well read on. This stage is all about 'GSE.'

'GSE,' is a monogram for "Ground Support Equipment." This is simply a more technical name for a launch pad.

There are three principle types of GSE: rod, rail and tower.

Rod: This is the most common type of GSE in model rocketry. It is simple and inexpensive. Rods can be found in hardware stores. Stainless steel is best; they're stronger and can be cleaned with steel wool. The main drawback is larger diameter rods are harder to find in the required lengths, e.g. 3 feet is too short for rockets requiring rods 1/4" or more in diameter. Another is rods sway when it's breezy.

Rail: Rails are less common but are used by some model rocketeers and are seen more often at high power launches. Rail launchers are more expensive and take longer to set up. They also require that the rocket be fitted with special launch lugs to fir the rail. The advantage of the rail is in its stiffness. It doesn't sway in the wind like a rod, hence the rocket gets better guidance from a rail then from a rod.

Tower: Tower launchers are the most complex and most expensive launchers. They also have to be readjusted each time a rocket of a different diameter from the last one is to be flown. This takes more time then changing the rod on a rod launcher as well as arising more often. Another con is a tower designed for 3 finned rockets cannot be used to launch a 4 finned rocket, nor can a tower designed for 4 finned rockets be used for a 3 finned rocket. As if that isn't enough, rockets that aren't radially symmetrical (e.g. Tomahawk and Bomarc) require towers that are dedicated for those particular rockets, since the rails on the tower must clear all of the rockets protuberances and touch only the rocket's body. This may sound like a lot of cons, but towers do have their pros. For starters, they are the most rigid. They support the rocket on at least 3 sides instead of just one. This is much safer for the rocket, especially when it's breezy. Many level 3 high power rockets are launched from towers. Many competitive rocketeers use towers because they eliminate the need for launch lugs. Launch lugs have been found to account for as much as 30% of the rocket's total drag[3]. The Centrix[2], for example, will have less drag without the launch lug. Some argue that the friction of three rails on a rocket is worse then the friction of a lug on a rod. They claim that this factor cuts down on the rocket's performance even more then the additional drag of the launch lug, and some have even produced data to support their point.[4]

Some competitive rocketeers use piston launchers. These are tricky to use and it is beyond the scope of this article to discuss them. They're mainly used in competition and aren't used for high power rockets. For more information on piston launchers, check out either the *Handbook of Model Rocketry* by G. Harry Stine[5] or *Model Rocket Design and Construction* by Tim Van Milligan[6].

Notes:
1. Sports Rocketry is the NAR's bimonthly magazine.
2. Page 27, *Model Rocket Design and Construction*, 2nd edition.
3. Centrix is a rocket kit manufactured and sold by Apogee Components.
4. Page 110, *Handbook of Model Rocketry*, 6th edition.
5. Author of the *Handbook of Model Rocketry* and the founder of the National Association of Rocketry (NAR).
6. Author of *Model Rocket Design and Construction* and owner of Apogee Components.

Bibliography:

Stein, G. Harry Handbook of Model Rocketry, 6th edition 605 Third Ave, New York, NY, John Wiley & Sons, Inc, 1194.

Van Milligan, Timothy S. Model Rocket Design and Construction, 2nd edition 630 Elkton Dr., Colorado Springs, CO 80907, Apogee Components, 2000.

NAR Standards &Testing News

R88 New Motor Certifications 12 Mar 2003
The following motors have been certified by NAR Standards & Testing for general use as high power rocket motors effective January 20, 2003. They will not be certified for NAR contest use as they are not model rocket motors.

The following are reloadable motors, certified only with the indicated size casings and manufacturer supplied nozzles, end closures, delays (or smoke devices), and propellant slugs.

Animal Motor Works:
- 54mm x 326mm (54-1050 casing):
  - J370GG-P (1040 Newton-seconds total impulse, 598.3 grams propellant mass)
- 54mm x 403mm: (54-1400 casing):
  - K475WW-P (1400 Newton-seconds total impulse, 728.6 grams propellant mass)
  - K530GG-P (1410 Newton-seconds total impulse, 796.7 grams propellant mass)
- 54mm x 728mm (54-2550 casing):
  - K1075GG-P-SM (2400 N-seconds total impulse, 1399.9 grams propellant mass)

Propellant Key:
- GG = Green Gorilla
- WW = White Wolf
- SM = Produces 10 to 15 seconds of smoke after burnout

Jim Cook, Secretary for
NAR Standards & Testing

Jack Kane, Chairman

(*Rotacrock 20 continued from page 4*)
the needle nose pliers to complete the “Z” bend. Note that the “Z” is not flat, but at a right angle to the first bend (see photo 2). See flying instructions for the final step of the torque rod preparation (do NOT do now!).

Finally slip the nose cone/rotor assembly onto the top of the body tube. Align the rotors so they fit between the fins. This means that the top of the rotors will NOT match up with the fin gaps. mark the nose and tube for alignment, then glue the nose cone in place.

Put a strip of adhesive Mylar over the top surface of each rotor centered on the 2 pin holes for the burn string, to prevent the string from cutting into the rotor blades. Coat the back side of each blade where the ejection port holes are with a thin layer of epoxy or more adhesive Mylar to prevent rotor charring.

I finish my Rotacrock wood surfaced with a single coat of thinned dope to reduce warping. I’ll typically use 2 colors to aid in spotting the model both in the air and on the ground. A bit of reflective Mylar on one fin surface makes a nice flashing beacon during recovery.

Flying:
I store my Rotacrock with the springs released from the adjacent hinge. To fly I use my fingers, or a needle nose pliers or hemostat to hook the end of the torque rod under the hinge of the next rotor. This holds the rotors open. Bend if necessary to increase the opening torque. It is not necessary for the torque rods to hold the rotors fully deployed, as long as it holds them roughly horizontal. [Reverse the process when done flying. You won’t forget because it’s hard to store the model with the rotors forced open!]

Next thread a 15cm piece of sewing elastic through the needle hole. Now carefully close the three rotors down towards the body of the model. It’s easier to have a helper do this for you. Cross the elastic as shown on the plans and wrap it around the 3 rotor blades, and pull as snug as possible. Then tie a double knot and trim off any extra elastic. Be sure the elastic is over the Mylar strip.

After safety check insert the motor using the wire clip to hold it in place, and if desired a wrap of tape. Install the ignitor. The model needs no launch lug, since the torque rod at the top and the fin/blade cavities form built in launch lugs.

The Rotacrock 20 flies well on 1/2A3-2T and A3-4T motors. I used to use A3-2T and even 1/4A3-2T when they were available. I’ve yet to try a 1/4A3-3T.

[The Rotacrock 23 & 24 are 18mm versions of this same rocket. See the alternate parts list at left. The only difference between the two is that the Rotacrock 23 uses 1/16” balsa for the rotors, and the Rotacrock 24 uses 3/32” balsa rotors. 3/32 is necessary for C6-3s but 1/16 holds up fine for B4-2.]

Rotacrock 20	Parts:	**Rotacrock 23 & 24**
1 30cm BT-5	Body Tube	45cm BT-20
1 BNC-5V	Nose cone with 3 flats milled	1 BNC-20A
3 2.5x5cm 1/64"	plywood fins	1/32"x3x6cm
3 2.5x30cm 1/20"	A-grain balsa rotors	3/32"x4x45cm
3 1cm 1/20"	A-grain balsa triangles	3/32"x1.5cm
3 small	Klett hinge or equivalent	3 small
.015"x6cm	Music wire torque rods	.020"x8cm
1 .020"x6cm	Music wire motor retainer	.032"x8cm
2.5 meters	Kevlar (or graphite) yarn	4 meters
	Kevlar thread	
6	Round Toothpicks	6
	Adhesive mylar tape	
	Sewing elastic	
1.5"	PVC pipe	2" PVC
	Laminating epoxy or amberoid	
	Titebond or other glue	

Table 1: Full parts/supply list for several Rotacrock models

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If it says Membership Expired or Membership Expiring this will be your last newsletter!