NAR Section 578

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WASHINGTON AEROSPACE

INSIDE THIS ISSUE:

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FROM THE PRESIDENT.....

BY KENT NEWMAN

The rains are well in force in the Puget Sound area now and the Holiday Season is upon us. 2001 turned out to be a year of trial and tribulation throughout the country but hobby rocketry managed to continue to be a strong and growing interest. Aerotech, the major manufacturer of composite motors, suffered a fire that destroyed its manufacturing capability and injured three employees with one employee ultimately succumbing to his injuries. The horrific destruction that took place in New York and Washington, D.C. closed the skies to recreational use for a period of time. But with the intent to maintain a normal way of life in America, recreational airspace was reopened to the hobby in relatively short order.

Congratulations to all of you for maintaining our hobby while the country suffered through a hard economic downturn, job lay-offs and a terrorist attack upon our soil. 2002 will only be better!

Launch Schedules

The abundance of flying opportunities continues throughout the Northwest. Launch event sponsors are even now submitting launch schedules for 2002.

With some dates tentative at this time and the sheer number of events so plentiful, a complete year' s launch schedule will be published in next month' s newsletter as a separate item rather than on the back page. The back page of the newsletter will continue to list launches for the coming four to six months from the date of each issue.

Hybrid Motors

Even without the possible short supply of composite motors this coming year, there seems to be a growing interest in alternative rocket propulsion in the rocket community. The variations on this theme range from "roll your own" composite propellant based upon ammonium nitrate, ammonium perchlorate, and sucrose/ KNO3 to nitrous oxide hybrid motors. Note the article submitted by Andrew MacMillen in this issue with additional information to follow in the January issue. We' ll include information on solid propellant later this spring.

My 5.5" Doorknob is ready to launch outside of Brothers, OR, on a K700/J415/H128 combo.

NAR Competitions

Jim Pommert has been diligent about putting together a schedule for NAR competitions and competition-like activities for 2002. The scattering of events held this past year has been just enough to whet people' s appetites. This is an excellent way to test your rocket building and flying skills, to meet people and to involve the family, both young and old.

Events will be held both at Monroe and at Offutt Lake. Be sure to read the January issue to plan your competition activities for the coming year.

“A major change from 2000 was the reduction in mid power flights and the increase of high power and low power.”

Monroe Space Port

By Kimberly Harms

Hello Rocket Comrades!

It was a cold day at the Monroe Space Port on Sunday, December 2nd, but us dedicated flyers managed to get some rockets in the air. Flight activity was limited by the 11:00 a.m. to 2:30 p.m. launch day but the field, while wet with standing water in a few places, was usable. The winds were generally light and away from the larger water hazards.

The flight breakdown was:

1/2 A: 1	F: 8
A: 3	G: 6
B: 3	H: 9
C: 9	I: 0
D: 3	J: 1

For a total of 44 flights for the abbreviated launch this month.

For 2001 the total flights recorded was 1,345. This is off from 2000 by 88 flights. It should be noted that weather restricted the amount of launch time available to us this year. Therefore, the comparison is totally accurate.

However, there are some trends worth mentioning. The breakdown for the year was 57.9% low power, 25.3% mid power, and 16.4% high power. A major change from 2000 was the reduction in mid power flights and the increase of high power and low power.

2000:	2001:
Low: 754	Low: 779
Mid: 481	Mid: 341
High: 195	High: 221

So all the lost flights came out of mid power. These numbers show a trend of flyers moving up the power scale. Low power continues to hold its own which demonstrates both on-going adult interest and the introduction of young flyers to our hobby.

At this month's launch we also had some certification flights:

Thor Radford,	PML "Red", H128.
Ric Testagrossa,	Scratch "DD4", H128
Stephen Willey,	PML "IO", H128
Matt Beland,	BSD "Horizon", H180

Congratulations to all these flyers and welcome to high power!

As we conclude the flying year a few comments.

First, a big thanks from all of the Staff and flyers to those folks who volunteer with LCO, Pad Manager and setup and take down. Without you folks these launches would not happen.

Second, a reminder that we start fresh in January with new liability waivers to be signed and new yearly launch fees to be paid.

See you all January 6th!

Kimberly Harms

Construction Tip – “Heat Guns”

By Kent Newman

I was looking over the “ fleet” the other day and noticed that I had two rockets that probably could use rail guides but had not yet been converted. Both birds had Acme launch lugs on them. You know, the really nice lugs that have a conforming shape that match the contour of the body tube they are attached to. The ones that come with a great adhesive. The ones that I decided to even “help out” a little by epoxying under and around the attachment surface. The ones that are not coming off, even on Judgment Day!

I wanted to remove *those* launch lugs.

Well, now. The secret to performing this little feat of magic is to use a heat gun. Heat guns are much like an industrial hair dryer that puts out forced air at anywhere from 250 to 1100 degrees F (or more depending upon the gun).

Applying the heat at the low setting resulted in the epoxy softening up within two or three minutes. I was able to lift the lugs off with the end of #2 screwdriver without any difficulty and there wasn’t even any damage to the fiberglassed body tube.

The gun is great in helping remove misplaced fins from a motor mount; in pulling up old decals that need to be replaced; in helping cure epoxy by directing heat into a curing oven; and for touching up that coiffure before hitting the launch site!

Try www.grizzly.com for a good quality, reasonably-priced heat gun. And, in a pinch, a hair dryer can be used!

ROCKETMAN HOLIDAY OFFER

(*ROL Newswire*) -- Rocketman Enterprises, Inc. is offering a Holiday special on their red, white and blue patriotic 1.1 rip-stop nylon R7C & R9C parachutes! We have manufactured only 50 of each size of these high quality professionally made chutes. They will make great Christmas gifts!

Sale Price on R7C - $33.75 - a 25% SAVINGS! ($45.00 Listed Price)
Sale Price on R9C - $45.00 - a 25% SAVINGS! ($60.00 Listed Price)
Check out our other fine line of Rocketman Products at http://the-rocketman.com. Call 1-800-732-4883 to order!

Our Christmas offer of buy two videos and get one free offer is still going on until January 1st! We have an excellent selection of over 25 videos of high flying awesome rockets from across the country plus our ever popular Flaming Rockets video.

Single Mold Composite Airframes from Carde Systems

Waterloo, Ontario, Canada (*ROL Newswire*) -- Carde Systems has commissioned the long awaited, limited pre-production run of longitudinally molded 4" fiberglass rocket airframes. This airframe kit is 100% fiberglass with integrated nose cone, airframe, tail cone, motor mount, fins, fin fillets & bevels. The unique properties of molded fiberglass construction provides for a low cost, high strength, low weight airframe. This gives rise to unheard of levels of versatility illustrated by test flights over a wide impulse range inclusive of F through L, and corresponding altitudes of 200' to more than 10,000'. The light weight construction allows for mid-power flights, while the strength of fiberglass makes it ideal to be employed as the skin of an advanced composite construction airframe capable of extended transonic flight. The glass smooth exterior surface finishes with ease, and the molded construction allows quick assembly and flight.

Visit http://www.carde.ca for more information.

<u>Small Sounding Rockets</u> By Richard B. Morrow with Mitchell S. Pines

BY KENT NEWMAN

Satellites are taken for granted as being a way of life for monitoring the weather and the atmosphere. But, before there were satellites, there were *small sounding rockets*.

Daily launches of these small meteorological sounding rockets throughout the continental United States provided real-time data of atmospheric conditions from 35,000 to 100,000 feet. The data was assembled and interpolated to provide weather forecasts throughout the country.

This fine paperback book reviews the design and development of meteorological rocket programs from the viewpoint of the engineers and scientists who were involved. The time period covered is from the mid-1950's through the mid-1970's.

The contents include discussions on the inventor of composite solid rocket propellant (Charles Bartley), the beginnings of the Jet Propulsion Laboratory, the adaptation of military rockets to meteorological programs and more. The history of various rocket companies are also chronicled along with the key personnel involved. Think of Aero Dyne Corporation, Space Data Corporation, Atlantic Research Corporation. But, then, also think of the Grand Central Rocket Company, the Cooper Development Corporation, the Zimney Corporation and Universal Propulsion.

These companies are responsible for such sounding rockets as the Taifun, the LOKI-DART, the Asp and its variations, the Raven, the Cajun-Dart, the Arcon, the Metroc, the Frangible Arcas, the Oriole, the Terrapin and many more.

An unexpected offering is the inclusion of the actual blueprints of many of these rockets. Do you have the desire to build a scale rendition of the Viper-III A? The actual plans are right here on page 322.

Flight performances, propulsion characteristics, and general specifications are included for many of the rockets discussed in this book. Black and white pictures are spread throughout the book as well.

The book is a very good reference for those interested in the sounding rockets so many of us attempt to model today.

"a very good reference for those interested in the sounding rockets so many of us attempt to model today."

Composite Materials

By Kent Newman

Okay. You' ve just certified Level 1 and you' re really anxious to start on that L2 project that will incorporate some real rocket science.

Or you' ve just managed to convince your significant other that your dream project is ready to be pulled off of the backburner and turned into reality for the 2002 season.

In either case, you just know that you have to fiberglass the rocket. Or at least put some kinda expensive cloth on the darn thing, anyway. It's almost a right of passage!

This article will address composite materials to aid you in deciding what material to use. Now, keep in mind that the date presented is heavily plagiarized. I am writing from notes and clips taken from my own investigation of composite construction over a period of time. I wish I could be specific and give credit to each reference, table and chart but, frankly, I did not keep the detail necessary to do so.

"This article will address composite materials to aid you in deciding what material to use."

Next month will continue a discussion of the topic by focusing on the methods of application and finishing most commonly used by hobby rocketeers.

COMPOSITE MATERIALS

"Composites" are widely known as reinforced plastics. Any composite material is a reinforcing fiber in a polymer matrix. The fibers bear the structural loads and are called the "reinforcement". The polymer transfers the load from fiber to fiber and is called the "matrix". The polymer matrix is most often a polyester, vinyl or epoxy resin with epoxy being the resin of choice for most rocketeers.

The reinforcing fiber is generally fiberglass with occasional use of superior high strength fibers such as aramid and carbon. The greatest advantage of using composite reinforcement is using the orientation and mechanical properties of different fibers along with the matrix properties to determine the mechanical characteristics of the final product. That' s just a slick way of saying that composites lend themselves to customizing an application for any given purpose.

FIBER

Let' s talk about some of the more common composite materials and how they stack up against one another.

Fiberglass—This is the most common material used for reinforcement and is available in several different forms:

E-Glass is the least expensive and most commonly used fiber. The "E" refers to "electrical" because of its superior insulation properties. E-Glass has high fiber strength relative to both carbon and aramid and relatively low fiber modulus.

S-Glass is an aerospace type of glass which is stronger and has a higher modulus (i.e., "stiffness" or "force required to elongate the material") than E-Glass. The "S" stands for "Strength" and is a product of Owens-Corning. Other manufacturers with comparable products are identified as "Te-glass" and "R-glass". Basically the same material.

C-Glass is a corrosion-resistant glass that is typically used as a surface veil on other composite fiber surfaces. We don' t see this material much in rocketry but it does appear occasionally.

Carbon (graphite)

This fiber is typically suspended in an epoxy matrix resulting in a superior composite with exceptional strength and stiffness. Examples are aircraft and aerospace load-bearing components, golf shafts, military ordinance, bicycle frames, etc.

Aramid

Used in either a polyester or epoxy matrix, aramid offers exceptional strength and toughness but poor compressive properties. Industrial examples might be pressure vessels, armor and cordage.

The most common aramid fiber used is "Kevlar" which is a DuPont trade name. Kevlar was developed in 1965 and introduced commercially in 1971. Another aramid fiber available commercially is "Twaron" which is a trade name of the Akzo-Nobel" company.

Cost of material is a consideration. If you' re going to build a rocket, consider the relative costs of various materials that might be used. Note that the table on the next page illustrates the relative costs of various construction materials.

Fiberglass tends to be the fiber of choice in most applications with carbon used in situations where high stiffness is required and Kevlar used where high abrasion resistance is needed.

COMPOSITE MATERIALS—CONT.

Material	Cost
4140 Steel	~$2.00/lb.
6061 T651 AL	~$5.00/lb.
E-Glass Composite	~$1.00/lb
S-Glass Composite	~$8.00/lb.
Kevlar Aramid Composite	~$20.00/lb.
33 Msi Carbon Composite	~$9.00/lb
50 Msi Carbon Composite	~$35.lb.

Remember, again, that although each fiber has unique qualities desirable for composite construction , a combination of materials can be used to meet specific project goals

FABRIC

After determining what material is to be used for an application, the fabric type should be considered. The fabric pattern or style is the weave pattern of the fabric. There are three primary types to choose from:

Plain weave is the least expensive and least pliable fabric but the fabric holds together well when cut. The consistent over/under crossing s of the threads reduces the strength of the plain weaves but it is still adequate for all but the highest performance applications.

Satin weave results in one filling yarn floating over three to seven other warp threads before being stitched under another warp fiber. Threads run straighter much longer in this loosely woven type maintaining the theoretical strengths of the fiber.

Twill weaves offer a compromise between satin and plain weave types.

General comments on weave? Well, the weave pattern describes the manner in which the warp yarns and the filling yarns are interlaced.

Plain weave in any fabric is the least flexible.

Any weave will see increased flexibility if the fabric count is reduced.

Any weave will see improved flexibility if the orientation of the fabric is oriented 45 degrees to the curve.

“Fiberglass tends to be the fiber of choice in most applications ”

Specifications	Fiberglass Fabric w/Epoxy	Graphite Fabric w/Epoxy	Kevlar Fabric w/Epoxy
Fabric Specifications	9 oz., E-Glass	5.7 oz., 3K Graphite	5 oz. Kevlar
Laminate Construction	10 Plies Glass	10 Plies Carbon	10 Plies Kevlar
Laminate/Resin Content	50% Resin/50% Glass	56% Graphite/44% Resin	51% Kevlar/49% Resin
Elongation@Break %	1.98%	.91%	1.31%
Tensile Strength, PSI	45,870 PSI	75,640 PSI	45,400 PSI
Tensile Modulus, PSI	2.520,000 PSI	8,170,000 PSI	3,770,000 PSI
Flexural Strength, PSI	66,667 PSI	96,541 PSI	34,524 PSI
Flexural Modulus, PSI	3,050,000 PSI	6,480,000 PSI	2,500,000 PSI

Composite Materials—cont.

“the reasons first offered may not be the best reasons to laminate any rocket project”

Which Material Do I Choose?

This is a common question perhaps best answered by really thinking about why one wants to add a composite material to their rocket projects.

And, typically, the reasons first offered may not be the best reasons to laminate any rocket project:

“It’ s a Level 3 rocket” meaning that the project is big and heavy and might collapse in on itself during lift-off if one fails to add composite reinforcement. Not true! I can’ t think of any Level 3 project that I have seen that either flew very well without any reinforcement or could have flown well without any reinforcement.

Now, let’ s assume that your project is a 54mm minimum diameter rocket expected to hit mach 6 (yeah, right!). Beyond the concern expressed above , you’ re worried about some sort of turbulent airflow causing this minimum diameter rocket to “bend” or change angle of attack will wind up destroying itself in mid-flight.

Forget about it. There should be a much greater concern about the number of and the “quality” of breaks in the airframe. In other words, there probably is a much greater likelihood that a failure occurs at a coupler joint (the weakest point in the airframe continuum) than having the airframe itself actually fail. If you have any concern about the coupler, consider laminating the inside of it. Also, be sure to make sure that there is full contact between the upper and lower edge portions of the airframe that are joined by this coupler. The airframe pieces should be of the same diameter with nothing but smooth air flowing from the upper piece to the lower piece.

So, after saying all of that, why should one even bother to laminate an airframe at all? The biggest reason is durability. My rockets probably suffer as much from handling and transport as they do from flying. They slide from a leaning position against my car and land on the road. They bounce against one another in the car. I whack the end of my 4” as I walk out the door to load up my car.

And, then, there is the flight. A perfect boost! A perfect deployment at apogee! And the fin can swings around and clobbers the parachute bay. The rocket deploys the main and “gently” lands on the pick-up next to my canopy. Yep, durability. And, of course, there is the psychological factor.

S-glass is about 30% stronger and 15% stiffer than E glass. It has 25% of the stiffness of graphite and is as strong, but it is also 30% heavier. S glass has only half the strength and stiffness of Kevlar and twice the weight. Kevlar is 40% stronger and 25% lighter than graphite but has only half the stiffness of graphite. It would appear that no one material has all of the answers.

Ah ha! Well, how about developing a sandwich of materials that combines the attributes of each of the materials being examined?

For example, carbon is great for fins. The stiffest material that could be added to the fin axis. But carbon would no t be the best choice for an airframe. Carbon does not have the ballistic properties of either S glass or Kevlar. Why not put two such materials together? A kevlar or S-glass base and carbon fiber over the top. In whatever weights and numbers of wraps, the end product now has impact resistance as well as lightweight axial strength.

Hybrid cloths often do this for the user.

If one were to weight each of the parameters listed on the table below with equal value, it should become apparent that S glass might be the single best product to choose. Economical, middle weight, middle stiffness, high heat resistance, high toughness and high impact resistance.

Best ←——————→ Worst

Cost	E Glass	S Glass	Kevlar	Graphite
Weight (Density)	Kevlar	Graphite	S Glass	E Glass
Stiffness	Graphite	Kevlar	S Glass	E Glass
Heat	S Glass	E Glass	Kevlar	Graphite
Toughness	Kevlar	S Glass	E Glass	Graphite
Impact Resistance	Kevlar	S Glass	E Glass	Graphite

THE LAUNCH PAD—PERSHING 1A

By Andrew Bronfein

Brief:
A single motor mid-power (E+) scale rocket with recovery by 18" x 30" oblong parachute.

Construction:
Kit includes:

- One (1) main 3.75" body tube
- Two (2) 2.6" centering sections
- One (1) 1.6" upper body tube
- One (1) paper transition shroud
- One (1) balsa nose cone
- Four (4) fiber 3.75 - 2.6" C/Rs
- Two (2) 2.6 - 1.6" C/Rs
- One (1) 1.6 - 2.1" C/R
- Three (3) rear balsa fins
- Three (3) forward fins (sculpted with card stock over balsa)

As a stock kit, a well experience rocketeer should be able to make short work of this kit, however I would definitely not recommend it for the beginner. There are issues here that need a patient hand and a good eye for detail.

I will begin with the 15" x 3.75" to 1.6" transition: This is a three (3) piece thick paper transition, looks like about 65# card stock, maybe a little thinner. As with all paper transitions there will be small section where the paper joins that is not even with the rest of the transition. For a quality build this area must be filled, and feathered into the rest of the transition. I do like the way Chuck suggests that you stagger each joint so that you don't get one continuous bump down one side of the transition. This is definitely the most difficult and time consuming part of the build.

Next the forward fins are sculpted to a taper using three (3) small balsa sticks and a section of balsa to keep them rigid. These sticks absolutely must be cut to the proper angles or you will wind up with sickly looking tapers. Finally there are runners (platforms) under each fin that are made from very thin balsa, which are recommended to have some glue built up under them for stability around the circumference of the body tube. I took a slightly different approach. After marking the center lines on the fins and on the platforms I ran one thin line of CA along the centerline of the body tube then matched the centerline of the platform to it not securing the edges yet. Once the CA cured I secured each side by using a bit if thin CA and pressing the platforms down so they actually contour the circumference of the body tube. I also glassed the paper shroud with 3.2 oz glass using a cutting template made from VCP. This adds weight to the rocket. If you plan on flying this thing with some of the more robust 24mm D motors on the market be sure, if you glass the shroud, that you have enough power to get this bird off of the pad safely. Even stock, Estes D12-3's will not cut it.

Finishing:
Finishing the paper shroud, if stock, definitely would require much filling and feathering to make the transition perfect. Glassing it like I did took a lot of that work away but again made the rocket heavier. Painting was a breeze as I used the stock TLP paint scheme just to get this one ready for a launch in time. I will go back and paint it to a color scheme that I like better. No decals here but Chuck provides you with instructions and sizes to make your own US ARMY decals if you want them. As all TLP kits, decals would make this bird totally complete.

Construction Rating: 4 out of 5

Flight:
I flew the rocket 4 times during the launch on E15's and one E30. On the E-15's the rocket was very slow and majestic, almost reminded me of a good Saturn V launch. The E30 gave it a bit more juice off of the pad but it was still nice and slow. I plan to go with other 24mm E's and F's in the future but for that scale lift-off, as the Pershing was a very large and heavy rocket, the E15 just makes it look cool. In all TLP kits you will find a bulkhead that will hold the parachute forward helping your CP/CG relation. This is a MUST in the Pershing, if it is discarded you take the chance of losing your chute into the 3.5" tube and it won't come out at apogee. Motor retention is a simple motor clip which I left out just because one day I might get brave enough to put this rocket up on a 24mm G motor.

Recovery:
I don't like the 1/8" elastic that Chuck uses in his kits so I replaced the shock cord with 24" of 35 pound Kevlar®. I also opted for a 30" cross-form chute instead of the 18" x 30" oblong that comes with the kit (because I like cross-form chutes). Rocket deployed just after apogee and landed nice and soft under this configuration, no crimps, cracks or bends to repair at all.

Flight Rating: 4 ½ out of 5

Overall Rating: 4 ½ out of 5

"a well experience rocketeer should be able to make short work of this kit"

A HYBRID PRIMER

BY ANDREW MACMILLEN

===== Theory =====

Like other chemical rocket engines, hybrid motors combine fuel and an oxidizer to produce combustion gases and thrust.

Liquid rockets achieve this using liquid fuel and liquid oxidizer stored in tanks. The propellants are either pressure fed or pumped from their tanks into a combustion chamber. They generally provide good thrust, can be throttled, and tend to be the most efficient. However, due to plumbing complexity, redundancies for reliability, and propellant storage issues, their cost & weight can be high.

In solid rocket motors, the fuel and oxidizer are chemically premixed to form a solid fuel grain. When ignited, the oxidizer and fuel react and produce thrust. The geometry of the grain's central core can be varied to produce a desired thrust profile. Solid motors are very simple. However, they are not as efficient as liquid motors, can not be throttled or stopped, and may present an explosion hazard.

"Solid motors are very simple. However, they are not as efficient as liquid motors, can not be throttled or stopped, and may present an explosion hazard."

Hybrid motors combine elements from both systems. Gaseous or liquid oxidizer - generally liquid oxygen (LOX) or nitrous oxide (NOX) is stored in a tank, and a hollow fuel grain - generally plastic or rubber - lines the combustion chamber. A source of ignition is applied to the fuel grain, vaporizes some of the fuel, and the oxidizer is injected into the chamber. At about 1000 degrees, the 36% oxygen (by molecular weight) in NOX is released to combust with the fuel vapor in a thin boundary layer above the fuel grain, create gases and more heat, which in turn continues to vaporize the fuel grain. The oxidizer flow can be increased or decreased for throttling, and if the ignition system is re-usable and onboard, the motor can be stopped and re-started in flight.

A reverse hybrid motor uses a solid oxidizer and liquid fuel, however this combination does not provide the advantages of a regular hybrid motor, since either or both propellants may not be inert.

All certified high power model rocketry (HPR) hybrid motors use NOX. Since NOX is self-pressurizing at 650-750 pounds per square inch, no pumps are needed, and the combustion chamber can be up to ~550 psi. As the tank empties, it cools evaporatively, which lowers the tank pressure, thus the combustion pressure, providing a regressive thrust curve.

When the liquid NOX runs out, the gaseous NOX left in the tank provides reduced thrust for a short period known as "blow-down".

Since the chamber pressure of HPR motors must be kept below 550 psi, the grain and combustion chamber must have a large enough surface area to generate sufficient gases. This, combined with the tank, is why HPR nitrous motors are so long. The traditional raspy buzz or howl of a hybrid motor is due to combustion chamber pressure fluctuation. Nitrous enters the chamber raising the pressure; combustion & exhaust occurs which lowers the chamber pressure.

===== Pros, Cons & Costs =====

Pro:

- safer fabrication, storage, transportation and operation due to both the inert fuel and separated propellants - no LEUP for HPR
- higher specific impulse than solids
- higher density impulse than liquid systems
- less than half the complexity of a liquid fuel motor stronger fuel grain than solid motors
- start, stop, restart and throttle capabilities
- can produce environmentally safe exhaust products less expensive due to simpler safer components
- for HPR, nitrous is conveniently self-pressurizing, and contains a large mass of oxygen at a reasonable pressure and temperature

Con:

- combustion efficiencies are slightly lower than liquid or solid systems
- lower system density impulse and thus a larger volume than solid propellant systems (smaller HPR hybrid motors have a lower-thrust-to-weight ratio than composite motors, due to the extra hardware for the tank & longer combustion chambers. In the lower impulse ranges (H-K), they average 1/2 - 2/3 the total impulse per pound of motor. This is not as much of a problem for larger sizes due to volumetric gains: the Hypertek M1000 has 90% of thrust-to-weight compared to the Aerotech M1419)
- some fuel usually remains in the combustion chamber after burnout which reduces motor mass fraction

A HYBRID PRIMER—CONT.

For commercial purposes, the result is a less expensive environmentally safe rocket motor that cannot explode, can be shut off, restarted and throttled. For HPR users, the advantages are safety, no need for a LEUP, and significant cost savings for larger motors.

HPR flight cost comparison:

RATT H70 - $60 hw, 3 reloads $30, $3 nitrous = $32/flight

Aerotech H180 - $62 hw, 3 reloads $48 = $37/flight

Hypertek J250 - $150 hw & 3 reloads, $16 nitrous = $55/flight

Aerotech J350 - $50 hw, 3 reloads $130 = $60/flight

RATT K240 - $250 hw, 3 reloads $100, $21 nitrous = $124/flight

Aerotech K550 - $120 hw, 3 reloads $270 = $130/flight

Hypertek M1000 - $450 hw & 2 reloads, $70 nitrous = $260/flight

Aerotech M1419 - $380 hw, 2 reloads $800 = $589/flight

5 flights Hypertek M1000, including GSE* = $299/flight

5 flights Aerotech M1419, excluding GSE* = $541/flight

Notes:

1. Hybrid motors require electronics for recovery which will add to flight costs, especially for lower power flights where a solid motor will have an ejection charge.
2. Special ground support equipment (GSE) is expensive unless provided by a group or organization, and will add significantly to flight costs at lower power levels.
3. Even with a GSE purchase, the cost savings in the M range are significant.
4. Motors compared are of a similar impulse where possible.
5. Prices are from Pratt Hobbies, Now, Hybrids*, and Magnum Rockets on 11/30/2001.
6. $3.50/lb for racing NOX for the total flights with some leakage & venting.

*www.NowHybrids.com

A historic perspective of hobby hybrid technology will be presented next month. In the mean time, if you have any questions, please direct your correspondence to Andrew MacMillen at andrewm@hawkfeather.com .

"For HPR users, the advantages are safety, no need for a LEUP, and significant cost savings for larger motors"

New Company—"Performance Rocketry"

Curtis Turner is establishing the Performance Rocketry Company specializing in fiberglass nosecones and kits. Some of his current offerings are as follows with many more items in the making:

29mm 4:1 Ogive	$12.50
38mm 4:1 Ogive	$15.00
38mm 5:1 Conical	$15.00
54mm 5:1 Ogive	$20.00
54mm 5:1 Conical	$20.00
54mm 6:1 Conical	$20.00
3" 4:1 Conical	$25.00
3" 5:1 Conical	$25.00
4" 4:1 Conical	$30.00
4" 4.5:1 Conical	$30.00
4" 5.5:1 Conical	$30.00
4" 3:1 Ext Ogive	$25.00
4" 5:1 Ext Ogive	$30.00
4" 5:1 Ogive	$30.00
6" 4.5:1 Conical	$79.00
6" 5:1 Ogive	$79.00
9" 3:1 Ogive	$125.00
11.5" 3.5:1 Ogive	$150.00

A new line of kits will also be available :

11.5" Fiberglass V2	Available
8.5" 'Glass Nike Smoke (1/2 Scale)	3-4 weeks
7.5" Fiberglass Pershing 1A	4-6 weeks
7.0" Fiberglass AMRAAM (Full Scale)	6-8 weeks
5" Fiberglass Sidewinder (Full Scale)	6-8 weeks
4.5" Fiberglass Arcas (Full Scale) HV	2-4 weeks

The Performance Rocketry Website is in the making @ www.performancerocketry.com

Questions - info@performancerocketry.com
Sales - sales@performancerocketry.com
Phone - to be announced.

Club Meetings

The first Saturday of every month!

Where: Peace Lutheran Church
214 East Pioneer
Puyallup, WA 98372

Time: 7:00 p.m.

We' re on the Web!
www.hawkfeather.com/wa-aero/

Regional Launch Schedule

Notes:

1) Monroe launches status may be obtained by calling xxx-xxx-xxxx between 9:00 a.m. and 12:00 p. m. on the day of the launch.
2) BEMRC launches (Boeing) are model rockets only. "C" impulse maximum.
3) "EX" motors are not allowed at certified motor launches; and certified motors are not allowed at "EX" launches except when flown with an "EX" motor.

January 5th (Sat)	Puyallup, WA **(WA Aerospace Meeting)**
January 6th (Sun)	Monroe, WA (TRAPS/WA)
February 2nd (Sat)	Puyallup, WA **(Washington Aerospace Meeting)**
February 3rd (Sun)	Monroe, WA (TRAPS/WA)
February 23rd-24th (Sat-Sun)	Touchet, WA (Washington High Power)
March 2nd (Sat)	Puyallup, WA **(WA Aerospace Meeting)**
March 3rd (Sun)	Monroe, WA (TRAPS/WA)
March 16th (Sat)	Offutt Lake, WA (WA)
March 23rd-24th (Sat-Sun)	Touchet, WA (WHiP)
April 6th (Sat)	Puyallup, WA **(WA Aerospace Meeting)**
April 7th (Sun)	Monroe, WA (TRAPS/WA)
April 14th (Sun)	Spokane, WA (SPARC)
April 20th (Sat)	Offutt Lake, WA (WA)
April 20th-21st (Sat-Sun)	Sheridan, OR (OREO)
April 20th-21st (Sat-Sun)	Brothers, OR (OREO- **"EX" Launch**)
April 27th-28th (Sat-Sun)	Touchet, WA (WHiP)
May 4th (Sat)	Puyallup, WA **(WA Aerospace Meeting)**
May 5th (Sun)	Monroe, WA (TRAPS/WA)
May 18th (Sun)	Spokane, WA (SPARC)
May 18th (Sat)	Offutt Lake, WA (WA)
May 18th –19th (Sat-Sun)	Brothers, OR (OREO)
May 25th-27th (Sat-Mon)	Touchet, WA (WHiP)
June 1st (Sat)	Puyallup, WA **(WA Aerospace Meeting)**
June 2nd (Sun)	Monroe, WA (TRAPS/WA)
June 8th-9th (Sun)	Spokane, WA (SPARC)
June 15th (Sat)	Offutt Lake, WA (WA)
June 15th-16th (Sat-Sun)	Brothers, OR (OREO)
June 22nd-23rd (Sat-Sun)	Touchet, WA (WHiP)

Launch Contacts:

Washington Aerospace (WA)	Kent Newman	360-893-1148
Tripoli Puget Sound (TRAPS)	Christopher Scott	253-858-7256
Monroe Launches (TRAPS-WA)	Christopher Scott	253-858-7256
Wahington High Power (WHiP)	Scott Binder	509-525-4461
Blue Mountain Rocketeers (BMR)	Tim Quigg	509-382-4176
Boeing Emp Model Rocket Club (BEMRC)	Bruce Johnson	425-742-2252
Seattle NAR (SEANAR)	Don Qualls	206-784-1667
Spokane Area Rocket Club (SPARC)	Bret Conant	509-299-7122
Oregon Rocketry Enthusiast' s Org (OREO)	John Lyngdal	503-649-7371
Tripoli – Oregon	Gary Fillible	503-843-3137
Tripoli – Portland	Dennis Winningstad	503-297-3685