Introduction to rec.models.rockets and this FAQ

Posted: November 24, 2002

Last modified: November 24, 2002

Rec.models.rockets (r.m.r) is a Usenet newsgroup created for discussions and topics related to model and high-power rocketry. The purpose of this newsgroup is for the exchange of information between anyone wanting to build, fly, or use model rockets or high power rockets. These are viable alternatives to amateur rocketry. The term "model rocket" is defined based on non-metalic structural components, weight, propellant and total impulse restrictions, electrical ignition, recovery devices, and factory-made, solid propellant engines. The term "High power rocket" refers to any rocket using model rocket technology (as described above) except without the weight, propellant, and total impulse restrictions of model rocketry. Amateur rocketry, pyrotechnics, rocket motor-making, and "EX" rocketry are related topics that fall outside of the scope of this newsgroup.

This FAQ (list of Frequently Asked Questions) is an attempt to compile a number of questions and suggestions that have been repeatedly posted to r.m.r into a single, quickly readable document. This document was NOT meant to be a 'how to' on any form of non-professional rocketry It's hoped that it might be of use in answering some of the more commonly asked questions, summarizing some good tips and suggestions, and directing the reader to other documents, books, sources, etc., where more information may be found. The FAQ has evolved into something monstrous (and very informative). For this reason, only this introduction and the first three sections of the FAQ will be posted biweekly. The entire FAQ will make its appearance on r.m.r. monthly.

This FAQ is organized as a list of primary topics (see the Table of Contents below) with a number of questions and answers under each. The majority of this document deals with, but is not limited to, consumer rocketry in the United States and Canada.

This entire FAQ is available on the web.
HTML version of the entire FAQ:
http://www.ninfinger.org/~sven/rockets/rmrfaq.toc.html

Most recently posted version of the FAQ:
http://www.faqs.org/

Copyright Notice

Posting Frequency

The entire FAQ is posted to rec.models.rockets every month. A shorter version comprised of this Introduction and Sections #1, #2, and #3 are posted every two weeks or so.

Acknowledgements

This document was originally compiled (with help from many others) by Buzz McDermott and Jack Hagerty. This document is now maintained and edited by Wolfram v.Kiparski with help from others. This FAQ would not be possible without the constant flow of tips, suggestions, and sound advice from the readership of rec.models.rockets. Comments, corrections and suggestions for additions are welcomed and encouraged. Please send your suggestions to:

Wolfram v.Kiparski rmrfaq@n2netmail.com

or send them to the editor of the portion of the FAQ for which you have a comment. The FAQ editors are:

Part 01:	Wolfram v.Kiparski (rmrfaq@n2netmail.com)
Part 02:	Wolfram v.Kiparski
Part 03:	Wolfram v.Kiparski
Part 04:	Wolfram v.Kiparski
Part 05:	Wolfram v.Kiparski
Part 06:	Wolfram v.Kiparski
Part 07:	Wolfram v.Kiparski
Part 08:	Bob Kaplow (kaplow_r@encompasserve.org)
Part 09:	Andy Eng (aeng@houston.rr.com)
Part 10:	Wolfram v.Kiparski
Part 11:	Wolfram v.Kiparski

Part 12:	Wolfram v.Kiparski	
Part 13:	Canada:	editor needed
	Australia:	editor needed
	United Kingdom:	Darren J Longhorn (darrenlonghorn@yahoo.com)
	New Zealand:	editor needed
	Germany:	Oliver Missbach (omissbach@web.de)
	Italy:	Luca Benassi
Part 14:	Wolfram von Kiparski	

***** PLEASE READ THE FOLLOWING *****

Many of the tips and suggestions included in this FAQ include references to particular companies and/or products. Opinions expressed are those of the submitters. Several submitters have asked that readers do not request the company names and addresses from them. PLEASE refer to Part 2 of the FAQ or a recent issue of one of the rocketry magazines. Check this FAQ first.

Table of Contents

Part 1: General Information

1. What, exactly, is a 'model rocket' versus a 'high power' rocket? Where do liquid fueled and homemade rocket motors fit in? What about amateur rockets?
2. NFPA, FAA, DOT, ... Who are all these organizations and how do they affect the rocketry hobby?
3. What is the current legal status of model and high power rocketry in the U.S.?
4. I would like to get into Large Model Rockets. What are my options? Who has NAR certified E, F and G motors today?
5. Is the proper term rocket 'engine' or rocket 'motor'?
6. What do the letters and numbers on a model rocket motor mean?
7. What is a CATO? Is it CATO pronounced KAY-TO or CAT-O?
8. When a consumer rocket motor fails (i.e., CATOs) does it explode or detonate?
9. Why don't I just make my own model rocket motors? Shouldn't I be able to custom-make better, more powerful motors at a cheaper price?

Part 2: Names and Addresses

1. National rocketry organizations
2. Rocketry manufacturers and suppliers
    1. Model and High Power Rocket Manufacturers kits/motors/supplies/etc.
    2. Electronics/Recovery Systems/Other Rocketry Components and Supplies
    3. Miscellaneous suppliers of raw materials, supplies, and equipment
    4. Mail Order Vendors
    5. Sources for Out-of-Production Model Rocket Kits
    6. Books/Videos/Computer Software/Technical References
    7. International (outside U.S.A.) rocketry sources
3. Rocketry books
4. Rocketry magazines

Part 3: Rocketry on the Internet

1. How do I get to the r.m.r archive site?
2. What is available from the r.m.r archive?
3. How do I upload files to the r.m.r. archive?
4. I have read-only access to r.m.r. Is there any way I can still post articles to the newsgroup?
5. What are some neat rocketry web pages to check out?

Part 4: Born-Again Rocketeers

1. What the heck is a BAR, 'Born Again Rocketeer'?
2. I have been out of model rockets for many (i.e. +) years now. What's been happening in the hobby over the past couple of decades? What's new? What's gone?
    1. Who's Left, Who's Not & Who's New
    2. Changes in Motor Technology
    3. Competition
    4. High Power Rocketry
    5. Electronics Advancements
    6. Regulations, Regulations, Regulations
3. Are my old rocket kits worth anything today?

4. Where can I find plans of old kits?

Part 5: Model Rocketry

1. Can I legally fly model rockets in my state? What are the restrictions?
2. When do I need to notify the FAA before flying a large model rocket?
3. I have a son/daughter that is (less than 9) years old. Is this too young for model rocketry? If not, are there any tips for helping to keep their interest in the hobby?
4. Is there any way I can buy model rocket kits, parts and engines at less than full retail?
5. I've had a large number of motors CATO recently. The engines are only about 2 years old. I've had them stored in my (attic/garage/basement).
6. Is it safe to use my old rocket engines from <nn> years ago?
7. What's a good way to find other rocket enthusiasts in my area? How can I found out about local rocket clubs?
8. Are the Aerotech composite motors the same size as Estes/MRC/Quest motors?
9. Can I use Aerotech or other composite motors in my Estes rockets?
10. Will my Estes launch system work with Aerotech composite motors?
11. Can I use Aerotech composite motors as boosters in my multi-stage rockets?
12. How can I tell the age of my Estes motors?
13. Are reloadable model rocket motors shippable the same as disposable model rocket motors?
14. My flying field is so small I keep losing my rockets. What can I do?
15. Are Jetex engines still available? Where can I get them?
16. BT-20, BT-50, BT-55. What the heck do the numbers mean on Estes body tubes? Is their any special meaning in these numbers?
17. I've seen mention of all kinds of rocket motor types and sizes. Could you give a brief history and summary of the main marketing names for model rocket motors?
18. Why don't I just make my own model rocket motors? Shouldn't I be able to custom-make better, more powerful motors at a cheaper price?

Part 6: Model Rocket Construction and Finishing Tips

1. Cutting, Sealing, Attaching Fins
2. Body Tubes (Cutting, Joining, Filling)
3. I'm fed up with tangled plastic parachutes with broken shroud lines. How can I improve on the standard chutes, or make my own?
4. Alternatives to Recovery Wadding

5. Are there any good tips when making my own nose cones?
6. Getting Paint to Stick to LOC and Aerotech Nose Cones
7. Is it possible to get a high gloss, durable finish on a model rocket?
8. Are there any good paints for silver details on scale models?
9. How can I prevent a rocket painted white from yellowing?
10. Which is better, white or yellow glue? Epoxy? Cyano?
11. Improving on the Estes Shock Cord Mount
12. I've built several BT-80 based models. How can I strengthen future models to take larger motors, such as Aerotech 24mm or 29mm reloads?
13. How can I prevent balsa fins from breaking off on landing (especially for models with swept fins)?
14. I just lost my favorite rocket and the kit is discontinued. How can I make another one just like it?
15. How can I reduce damage to the booster stage of two stage models caused by the engine exhaust of the second stage?
16. Is there a way to increase the stability of nearly finless models?
17. How can I build a rocket with less wind resistance?

Part 7: Scale Modeling

1. I would like to make a scale model of the <??> rocket. Where do I start looking for technical data, dimensions, flight substantiation data, etc.?
2. What are some specific sources for general scale data?
3. I've never built any scale models. Are there any recommended kits for first timers?
4. What other scale/sport scale kits are available? I'd like to build another kit or two before tackling a scratch scale project.
5. O.K., I've done all my research, collected all the data I can. I've even built a couple of scale kits a a warm up. Now I'm ready to build a model I can be proud of. How do I...?
6. What tools do I need?
7. Where can I get more information on modeling techniques?
8. Got any tips for generating scale plans from original dimensions?

Part 8: Boost Gliders and Rocket Gliders

1. R/C Rocket Gliders
    1. Have there been any construction reviews of R/C rocket gliders?
    2. I'm building the 'XXX' R/C Rocket Glider and it uses foam core wings. Are there any

things I should know about working with foam?
3. Any tips for sheeting the wings on my Aerotech Phoenix?
4. How about help with my Estes Astroblaster wings?
5. How do you repair damaged foam wings?
6. Some more uses of foam in rocketry...
7. I need to cut the piano wire control rods. Bolt cutters don't work well, as the metal is too hard. Any ideas?

2. Free Flight Boost and Rocket Gliders
    1. What is the difference between a Boost/Glider and a Rocket/Glider?
    2. What are some types of gliders?
    3. What are all these funny names I see referenced?
    4. I'm just starting. What kits or plans are available?
    5. Why do most gliders have the rudder under the fuselage?
    6. These things are very different from what I've built before. Are there any tips for building them?
    7. [How] Should I paint my glider?
    8. Can I convert a hand launched glider (HLG) to rocket power?
        1. How do I attach a pop pod to a glider?
    9. I'd like to design my own glider. How do I know if it will work? How do I compute the CP for a glider?
    10. What motor should I use to fly my glider?
    11. This thing looks weird sitting on the pad. How do I launch a glider?
    12. My glider looped and crashed into the ground. What is wrong?
        1. How do I get the Estes Tomcat to glide?
    13. My glider shredded. What is wrong?
        1. How to tissue a glider
    14. The pod stuck on my boost/glider and the thing crashed. What is wrong?
    15. My glider glides like the space shuttle (or worse). What is wrong?
        1. How do I trim a Flexie?
    16. My glider never came down and flew away. What is wrong?
        1. So how do I find a thermal?
    17. Glossary
    18. References: (kits, books, publications, catalogs)

Part 9: Competition and Records

1. Are there any manufacturers making kits specifically designed for competition?
2. What are the major categories of competition model rocketry?
3. Strategy & Tactics - What are some good events to try when first getting into competition? Any

'sage' advice?

1. Getting Jump Started
2. What is a 'piston' launcher? Does it really help?
3. Wire Loops
4. Pop Lugs - A CMR pop lug described
5. Flying naked
6. Regarding streamers
7. Super Roc Duration
8. Flex wings
9. Tracking powder
10. Packing large chutes
11. Tandems
12. Helicopter design
13. Optimal thrust

4. Aside from hanging around 'old timers', how can I learn more about competition strategies and techniques without re-inventing the wheel many times over?
5. Tripoli Altitude Records
6. NAR Competition Records
7. Some Unofficial High Power Altitude Attempts
8. Biggest Non-metallic Rocket Flights
9. Other Non-professional Flights of Note
10. Some other highest verified altitudes
11. The Best of the BMWQF
12. Do's and Don'ts

Part 10: High Power Rocketry

1. I'm a successful model rocketeer. What do I need to get into HPR?
2. What are the major differences between model and high power rockets, besides size and engines? Are they built differently?
3. How do I get high power certified?
4. What is a 'reloadable' motor. Are they worth the price? Are they legal?
5. What are these different 'types' of composite motors I hear about (White Lightning, Black Jack, Smokey Sam, etc.)?
6. What's an FAA waiver? Which rocket flights require one? This section includes the relevant parts of FAR 101.
7. OK. I want to fly some high power rockets. How do I get an FAA waiver?
8. Is high power rocketry legal in every state, if the proper forms are obtained?
9. Where do I find out the proper way to use HPR rockets and motors? I'm familiar with the NAR

Model Rocketry Sporting Code. Is there an HPR equivalent?
10. What are some good kits to build when first getting into high power rocketry (assuming I have all of the basic model rocketry skills)?
11. When is a Federal Low Explosives Permit required?
12. How do I get an LEUP? Are there any requirements?
13. How is thermalite affected by the ATF regulatory enforcement?
14. How can I get the Orange Book (explaining the ATF explosive laws and regulations) and the proper LEUP forms?
15. Just what is a 'hybrid' rocket motor? Who makes them?

Part 11: High Power Construction and Finishing Tips

1. Do you have any tips for cutting and sealing fins used on HPR rockets?
2. How do you keep a high power motor in its mount, but still allow for the numerous lengths in which HPR motors are sold?
3. Custom Decals for High Power Rockets
4. I've had several rocket body tubes ruined by the shock cord tearing into the body tube at ejection and making long slits. How can I prevent this?
5. Estes 'toilet paper' recovery wadding strikes me as a bit wrong for HPR rockets. What are some alternatives?
6. What are the differences between the various HPR body tube materials used by the 'major' HPR manufacturers?
7. How can I strengthen my thick paper (i.e., LOC type) body tubes?
8. Is there any way to retrofit my existing rockets to have some type of positive retention system?
9. All these high power motors are different sizes. How do I hold them in? What do I use for a motor block and where should I put it?

Part 12: Ignition and Launch System Tips

1. Copperhead, squib, electric match, thermalite, flash bulb. What are all these types of igniters, how much current do they require, and when are they used?
2. How do those 'Copperhead' igniters work? They only have one wire?
3. I've heard that Copperhead igniters are 'unreliable' for igniting HPR motors. Is that true?
4. Do you have any specific suggestions or tips for an ignition power sources? Can I use my old Estes ignition system with composite models?
5. WARNING: Be very careful using any ignition system with 'flashbulb' or electric match type

igniters.
6. The ignition of rockets by other than electrical means is banned by both the NAR and Tripoli safety codes and should not be used.
7. What is thermalite fuse and how is it involved in igniting rocket motors?
8. How do you ignite second stage composite motors? Can I use a black powder booster for the first stage to ignite the second (as I do with multi-state A-D rockets)?
9. What is 'flash in the pan' ignition and for what is it useful in rocketry?
10. I would like to perfect a method for reliable ignition of clustered multi-stage rockets. Any suggestions or tips?
11. How do I cluster rocket motors? When igniting a cluster of rocket motors, should the igniters be wired in parallel or in series? Why?
12. I am new to rocketry. I was wondering whether anyone has tried using waterproof wicks instead of igniters to ignite a rocket engine.
13. The alligator clips on my launch system have worn out. What should I use to What should I use to replace them?
14. Other Ignition Tips:

Part 13: International Rocketry

1. Rocketry in Australia
    1. What rules apply to model rocketry in Australia?
    2. What are good sources of model rocketry kits/wg's/parts, etc?
    3. Are there any regular rocket contests, launches, clubs, etc?
    4. Info on amateur groups/activities (such as AusRoc) in the Australia.
2. Rocketry in Canada
    1. Are there any national organizations to which I can join in Canada? What services do they offer?
    2. What kinds of rockets (model and/or high power) are legal to fly in Canada?
    3. Are there any High Power launches at all in Canada?
    4. What kinds of rocket motors are available for purchase in Canada?
    5. Are there any Canadian mail order houses where I can purchase model rocket kits, motors and supplies?
3. Rocketry in the United Kingdom
    1. Is model rocketry legal in the UK?
    2. What size model rockets can be flown?
    3. What model rockets are available?
    4. What types of engines are available?
    5. Where can I buy model rockets?
    6. Are there any events/competitions?

7. Are there any clubs?
8. What are addresses of some of the shops that carry model rocketry?
9. What are some of the rocket clubs in the U.K., and do they have any problems getting permission to fly their rockets?
4. Rocketry in South Africa
5. Rocketry in New Zealand
6. Rocketry in Germany
    1. German Explosives Law
    2. German Aviation Regulations
    3. What Rockets and Motors can I buy and use in Germany?
    4. Clustering and Staging
    5. Can I make my own rocket motors?
    6. Can I use rocket motors made for display fireworks?
    7. Importing Rockets, Parts and Motors
    8. Where can I launch my Rockets?
    9. Where can I launch rockets with bigger motors?
    10. What Insurance do I need?
    11. Addresses of Rocketry-related Clubs

Part 14: Amateur Rocketry

1. DISCLAIMER
2. How do I make my own rocket motors?
3. My primary interest is in amateur rocketry. Where can I find information about amateur rocketry?
4. Amateur rocketry on the Internet
5. Manufacturers, suppliers, publishers, and consultants

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 2: Names and Addresses

Posted: May 31, 2002

Last modified: May 31, 2002

This portion of the r.m.r FAQ is maintained by Wolfram v.Kiparski.
If you notice any errors, inconsistencies, or ommissions, kindly email
Wolf, at rmrfaq@n2netmail.com so that it can be corrected.

1.2 Are their any national-level rocketry organizations which I might join? What services do they offer?

National Association of Rocketry
P.O. Box 177
Altoona, WI 54270
(800) 262-4872

nar-hq@nar.org
http://www.nar.org/

Complete information is available at the NAR's web site.

Model and high power rocketry for aerospace modelers in the U.S. and around the world.
- sanctions contests and records
- NARAM and NSL yearly national competition and sport launches
- Liability insurance for rocket flying activities
- "Sport Rocketry" magazine
- Motor safety certification (model and high power rocket motors)
- High Power (Level 1-3) flyer certification
- NARTREK continuing education program

Tripoli Rocketry Association, Inc.
P.O. Box 970010
Orem, UT 84097-0010
http://www.tripoli.org

High power rocketry enthusiasts
- Sanctions & insures high power rocket launches
- High power certification
- Yearly national sport launch (LDRS)

2.2 What are the addresses of some the rocketry manufacturers and suppliers? Do they offer catalogs?

Here is a list of rocketry manufacturers and suppliers. The list is divided into a number of categories. Each address appears only once, but may in fact qualify to fit into more than one category. The rocketry industry is rather dynamic, so if this list is six months old, it may be out of date. The editor(s) of this FAQ can not verify if the companies are, or are not in business. Reasonable attempts have been made at completeness, though it is reasonable that this list may not be complete. If you notice any errors or omissions, kindly email Wolf at rmrfaq@n2netmail.com, and the corrections will be applied ASAP.

Caveat Emptor

2.2.1 Model and High Power Rocket Manufacturers - kits/motors/supplies/etc.

AAA Model Aviation Fuels	OUT OF BUSINESS
Aardvark Rockets http://www.aardvarkrockets.com	mid-to-high power kits parts and supplies, custom work
Aerospace Specialty Products P.O. Box 1408 Gibsonton, FL 33534 http://www.asp-rocketry.com	Scale and competition kits, parts, G-10 fiberglass, adhesives, abrasives, mylar parachutes, sheeting, and tape Catalog - $2.00
Aerotech, Inc. 3100 E. Charleston Blvd. Ste. 123 Las Vegas, NV 89104 (702) 641-2301 (702) 641-1883 FAX customerservice@aerotech-rocketry.com http://www.aerotech-rocketry.com	Composite motors, reloadables (B - M) Large model rocket kits; high power rockets, parts, supplies Hybrid motors
Apogee Components 1431 Territory Trail Colorado Springs, CO 80919-3323 tvm@apogeerockets.com (Timothy Van Milligan) (719) 535-9335 http://www.ApogeeRockets.com	rocket motors 1/4A - F Micro Motors (10.5mm) Composite B and C motors Long burn D, E, and F motors Kits, supplies, and software Educational materials and books Catalog - see website
Binder Design P.O. Box 13376 Salem, OR 97309 (503) 581-3180 phone/fax binderdesign@aol.com http://www.binderdesign.com/	mid-high power rocket kits parts and components experimental online ordering
Blackhawk R&D 1 Grand Central Park Suite 2152 Keyser WV 26726	mid-high power rocket kits parts and supplies fiberglass parts specialist

(304) 788-7660
sales@blackhawkrd.com
http://www.blackhawkrd.com/
online ordering

Centuri Engineering
Phoenix, AZ
OUT OF BUSINESS 9/81

Cesaroni Technology, Inc.
P.O. Box 246
2561 Stouffville Road
Gormley, Ontario
CANADA L0H 1G0
http://www.cesaroni.net/
http://www.pro38.com/mainpage.html
Reloadable rocket motors
38mm G - J impulse range
also mfgs Hypertek Hybrid motors

Cluster R
See 'Rocket R&D/THOY/Cluster R'

Competiton Model Rockets
Alexandria, VA
OUT OF BUSINESS 12/87
(see Pratt Hobbies)

Cosmodrome Rocketry
1724 W. Great Oak Dr.
Tucson, AZ 85746
(520)295-1529
j9andmike@earthlink.net
http://www.cosmodromerocketry.com/
E - H power scale rocket kits
online ordering

Custom Rocket Co.
somewhere in Arizona
Model rocket kits and parts

Doctor Rocket
DrRocket@DrRocket.com
http://www.drrocket.com/
Licensed manufacturer of Aerotech compatible reloadable motors.

Dynacom
P.O. Box 85
Boston, PA 15135-0085
(412) 751-9515
dynacom@icubed.com
http://www.Dynacom-Inc.com/
High power rockets (fiberglass and composite components).
Catalog - $3.00

Eclipse Components
OUT OF BUSINESS

Edmonds Aerospace
13326 Preuit Place
Herndon, VA 22070
(703) 471-9313
RobEdmonds@aol.com
http://Members.aol.com/RobEdmonds/Edmonds.html
Model rockets and competition kits, B/G, R/G, RC/G
Inexpensive, and reputedly of high quality.

Energon Systems, Inc.
OUT OF BUSINESS

Estes Industries, Inc.
P.O. Box 227
Model rocket kits & motors
Largest rocketry manufacturer

1295 H Street
Penrose, CO 81240
(719) 372-6565
(719) 372-3419 FAX
(800) 525-7561
(800) 820-0202 replacement parts
http://www.estesrockets.com/

1/2A through E engines

Fat Cat Rockets, Inc.
1465 Orlando Circle
Orlando, FL 32818
(407) 298-1363
info@fatcatrockets.com
http://www.fatcatrockets.com/

unique custom rocket kits
model rocket through high power

Flight Systems, Inc.

OUT OF BUSINESS

Hawk Mountain Enterprises
RD 1 Box 231
New Ringgold, PA 17960
(570) 943-7644
(570) 943-2735 fax
adg@losch.net
http://hawkmountain.blastzone.com/

All fiberglass mid-high power kits
G-12 fiberglass tubing, FR4 phenolic sheet, kevlar, fiberglass nose cones, and more...
Online ordering
Catalog and tube sample: $2.50

Holverson Designs, Inc.
25075 Co Hwy L20
Soldier, Iowa 51572
dholverson@cox.net
http://pionet.net/~holvrson/index1.html

Model rocket kits, rocket/gliders
launch pads, tubes and parts
Centuri-equivalent tubing

Hypertek
mfg. by Cesaroni Technology
P.O. Box 246
2561 Stouffville Road
Gormley, Ontario
CANADA L0H 1G0
info@hypertekhybrids.com
http://www.hypertekhybrids.com/mainpage.html

Hybrid high power rocket
motors and launch systems.
(I, J, L, and M total impulse)

Kosdon East
c/o Paul Robinson
5 Old Bridge St. South
Pelham, NH 03076
rrocket@tiac.net
http://www.kosdon.com/

reloadable rocket motors
E-M impulse range

(The) Launch Pad
477 North Carolina Road
Manquin, VA 23106
vamidpowr@aol.com
http://www.the-launch-pad.com/

midpower and clustered model rocket kits and plans.
specializes in scale military missiles
Catalog - $2.75
(see part 07 of this FAQ)

Lawn Dart Rocketry
879 Westfield Row

model rocket kits
reproduction classic kits

Acworth, GA 30102-6900
info@lawndartrocketry.com
http://www.lawndartrocketry.com/

helicopter duration kits
CogAero dealer

LOC/Precision
P.O. Box 470396
Broadview Heights, OH 44147
(440) 546-0413
(440) 546-7942 fax
http://www.locprecision.com/

Large model rocket kits; high power rocket kits; parts and supplies;
Catalog - $4.00

Maximum Thrust Rocketry
a division of RDS
formerly HOTT Rockets
http://www.maximumthrust.com/

Big kits for Big HPR

see also Rocket Dyanamic Systems entry

Model Rectifier Corporation

OUT OF THE ROCKET BUSINESS

Nordic Rocketry
P.O. Box 1164
Wisconsin Rapids, WI 54495-1164
(715) 424-0240
nordic@wctc.net

Model Rocket kits
mid-power, high power
Catalog - $1.00
- free with email request

North Coast Rocketry

OUT OF THE BUSINESS

Nova Hobbies
PO Box 70547
Fairbanks, AK 99707-0547
d005794c@dc.seflin.org (James Wentworth)

scale model rocket kits
space history oriented
ASP kit (see part 7 of FAQ)

Original Rockets, Inc.
P.O. Box 611722
Port Huron, MI 48061-1722
(810)982-3690 voice
(810)985-4643 fax
RGilbert1@aol.com
http://users.aol.com/rgilbert1/ori/ori.html

scale models of old kits for HPR

Propulsion Polymers
RR#3
Smiths Falls, ON
Canada K7A 4S4
http://propulsionpolymers.com/

hybrid rocket motor systems
38mm I140 motor

Public Enemy Rockets
RWW Distributing
PO Box 6001
Moreno Valley, CA 92554-6001
909/243-7398
rwwdist@riverside.quik.com (Roy Weid)
http://www.publicenemyrockets.com

mid-to-high power rocket kits
clustered, scale, etc.
Catalog - $2.00

Public Missiles, Ltd.
349 Cass Ave., Suite C

Large model rockets and high power rocket kits, parts, and supplies

Mt. Clemens, MI 48043
(810) 468-1748
(810) 465-2911 FAX
http://www.publicmissiles.com/

phenolic tubing, G-10 fins
Catalog: $3.00

Qualified Competition Rockets
c/o Kenneth Brown
7021 Forest View Drive
Springfield, VA 22150
http://www.cybertravelog.com/qcr/

Offers a wide variety kits for competition rocketry, incl. piston launchers, tubing, NARTREK packages, publications inexpensive
Catalog: SASE

Quest/Toybiz Inc.
P.O. Box 42390
519 West Lone Cactus Drive
Phoenix, Arizona 85989-2390
(800) 858-7302 (toll free)
(602) 582-3438 (voice)
(602) 582-3828 (fax)

Model rocket kits & engines (A-C), launch systems, and supplies
Catalog: FREE

R.A.T.T. Works
1504-A Industrial Park Street
Covina, CA 91722
(626) 967-2242
(626) 967-9044 (fax)
montmach@aol.com
http://www.rattworks.night.net/

Hybrid rocket motor systems
29mm and 64mm (H/I and K)
launch rails and rods

Rocket Dynamic Systems
PO Box 801208
Santa Clarita CA.
91380-1208
(888) 692-9548
http://www.rocketdynesys.com/

Big kits for HPR
mid-HIGH power

Rocketflite
836 Houston Dr.
New Haven, IN 46774
rocketflt@aol.com (Greg Dyben)
http://www.rocketflite.com/

BACK IN BUSINESS!
Magnalite Igniters in kit form
ignition systems

Rocketman Enterprises, Inc.
8337 Penn Avenue South
Bloomington, MN 55431
(800) 732-4883
(612) 884-3424 FAX
http://www.the-rocketman.com/

High power rocket kits, recovery systems, videos and launch support systems
Catalog - $3.00

Rocket R & D
209 N. Main Street
Homer, IL 61849
(217) 896-3041
(217) 896-3042 (FAX)
http://www.rocketrd.com/

HPR kits and supplies, also THOY/Cluster R dealer
tubes, centering rings, parts, nose cones, chutes.

Rogue Aerospace Corporation
P.O. Box 596
Lexington Park, MD 20653
(410) 326-3761
(508) 462-0729 fax
aero@RogueAerospace.com
http://www.rogueaerospace.com/
http://www.roguelight.com/

Model rocket kits, parts, and supplies
Catalog - FREE

Scotglas Manufacturing
7215 Gillett Road
Canutillo, TX 79835
(915) 877-4405
chris@scotglas.com
http://www.scotglas.com/

fiberglass components
nose cones

Shecter Rockets
20505 E Clear Spring CT
Walnut, CA 91789-3887
http://www.geocities.com/fredeshecter/index.html

Model rocket kits and parts:
BT-5 to BT-55, inexpensive,
Catalog - $1.00

Shrox Industria
shrox@shrox.com
http://www.shrox.com/

fantasy-scale model rocket kits

Smokin Rockets
183 Walnut St.
Northvale, NJ 07647
smokinrkts@aol.com
http://members.aol.com/SMOKINRKTS/home.html

big high power kits

Stellar Dimensions

OUT OF BUSINESS

Tiffany Hobbies of Ypsilanti (THOY)

See 'Rocket R&D/THOY/Cluster R'

Trailing Edge Technologies
(214) 670 5244
jrturner@aol.com (Jim Turner)

Igniter manufacturer for all types of motors
micro through Level III HPR

True Modelers Rocket Kits
P.O. Box 186
Harbeson, DE 19951
(302) 684-5419
http://www.truemodeler.com/

kits for the true modeler/craftsman
scale and scale-like model rockets
order online

Vaughn Brothers Rocketry
4575 Ross Drive
Paso Robles, CA 93446-7320
(805) 239-3818
(805) 239-0292 (fax)
JerryVBR@tcsn.net
http://www.vaughnbrothers.com/

Model and high power rocket kits
kits and supplies; group launch systems
Catalog - $2.00

VectorAero

R/C Rocket Gliders

KMcKiou@aol.com
(Kevin McKiou)

Vulcan Systems, Inc. — OUT OF BUSINESS

Yank Enterprises
1004 Ollie Lane
Plymouth, WI 53073
(920) 254-0657
(810) 454-0152
http://www.yankenterprises.com/
— High power rocket kits parts and supplies

2.2.2 Electronics/Recovery Systems/Other Rocketry Components and Supplies

ACME Engineering
http://www.acmeaero.com/
— composite fin canisters for HPR conformal launch lugs

Adept Rocketry
2545 Overlook Drive
Broomfield, CO 80020
http://www.diac.com/~adept/
— Electronic stagers, timers, altimeters, flight computers. Catalog - $2.00

Aero Pack International/Missile Systems
8190E Mira Mesa Blvd. 308
Miramar, CA 92126
(619) 566-2900 FAX
http://www.aeropack.net/
— Phenolic airframe tubing, threaded aluminum motor retainers

The b2 Rocketry Company
b2rocketry@mindspring.com
http://b2rocketry.home.mindspring.com/
— Parachutes for high power rocketry

Balsa Machining Services
11995 Hillcrest Dr.
Lemont, IL 60439-4145
(630) 257-5420
(630) 257-0341 (fax)
sales@balsamachining.com
http://www.balsamachining.com/
— Balsa and hardwood nose cones, centering rings, transitions, and fins semi-custom work Replica Estes/Centuri nose cones Tower Launcher Catalog - download from web site

Black Sky Research Associates
3179 Roosevelt St.
Carlsbad, CA 92008
(619) 730-3702 (voice)
(619) 730-3704 (fax)
blacksky@earthlink.net
http://www.blacksky.com/
— altimeters, timers, launch rails electic matches, ignition systems 38mm reloadable motors and reloads hydrid motor dealer high power kits

Cotriss Technology — OUT OF BUSINESS

Emmanuel Avionics, Inc. — OUT OF BUSINESS

Giant Leap Rocketry
6061 Hibiscus Drive
Baton Rouge, LA 70808
(504) 769-6040 evenings and weekends
(504) 769-0710 FAX
http://www.giantleaprocketry.com/

most inexpensive phenolic tubing
on the rocketry market
G10 fiberglass sheet
fiberglass nose cones
custom work

Impulse Aerospace
22833 Bothell Way SE, Suite 1148
Bothell, WA 98021
(800) 568-2785
http://www.homestead.com/impulseaerospace/

Ignition and recovery systems,
launch pads, high power supplies,
tubular nylon,

Jim Walston Retrieval Systems
725 Cooper Lake Road, S.E.
Smyrna, GA 30082
(404) 434-4905
(800) 657-4672

Electronic rocket locators
(transmitter/receiver)
Catalog - FREE

Mach 1 Industries Inc.
20 W. Lake St.
Chisholm, MN 55719
(888) 225-4007
http://www.cpinternet.com/~mach1/

Balsa-Ply specialty balsa plywood
airframe tubing, nose cones, modeling
supplies, and rocket kits
Catalog - FREE

Missile Works Corp.
453 East Wonderview Ave.
Estes Park, CO 80517
(303) 823-9222 tel/fax
http://www.missileworks.com/

R/C ejection systems, barometric altimeters
mid-high power scale kits
flexible phenolic/kraft hybrid tubing
online ordering

North Country Radio
PO Box 53 Wykagyl Station
New Rochelle, New York 10804-0053
(914) 235-6611
(914) 576-6051 fax
http://www.northcountryradio.com/

CCD cameras, transmitter/receiver
kits, and other electronics
suitable for rocketry use.

Perfectflite
15 Pray Street
Amherst, MA 01002
(413) 549-3444
http://www.perfectflite.com

microAlt Alitmeter - fits in BT-50

Pratt Hobbies
2513 Iron Forge Road
Herndon, VA 20171
(703) 689-3541 (voice/fax)
dpratt@compuserve.com
http://www.pratthobbies.com

Nomex recovery systems & cool rocket stuff
altimeters, kits, kevlar
NiCad systems. CMR-style nose cones
and egg capsules.
Catalog: FREE

Retro Rocket Works

OUT OF BUSINESS

Robby's Rockets
P.O. Box 171
Elkhart, IN 46515
(219) 679-4143

Ignition and ejection supplies
Catalog: $1.00 in postage on large SASE, or $2 for catalogs

Sentell Enterprises
104 Linden Drive
Hendersonville, TN 37075-2032
(800) 4-CHUTES (orders only)
(615) 822-6565

Parachutes, streamers, and other recovery devices.
Catalog - $1.00 (includes fabric samples)

Sonic Systems Ltd
4509 East Hobart
Mesa, Arizona 85205

Custom nosecone for LOC 7.67" nice cones
Clear polycarbonate tubing

Spherachutes
433 38th Ave.
Greeley, CO 80634
(877) 4CHUTES
info@spherachutes.com
http://www.spherachutes.com/main.html

Parachutes/recovery devices.
Catalog: $1 (includes fabric sample)

Tango Papa Decals
1901 Mitman Rd.
Easton, PA 18040
(610) 252-8543
BakerTom@aol.com
http://www.tangopapadecals.com/

Reproduction decals from out of production Estes and Centuri kits
Mars Lander kits, upscale decals, decal paper, printer cartridges

Thrust Aerospace

OUT OF BUSINESS

Top Flight Recovery
S12621 Donald Road
Spring Green, WI 53588
(608) 588-7204
tfr@execpc.com
http://www.topflightrecoveryllc.homestead.com/

Recovery devices (parachutes, X-form chutes, and streamers).
Catalog: $2.00

Totally Tubular
10555 McCabe Rd.
Brighton, MI 48116-8526
(810) 231-6474 FAX
jfackert@cac.net (Jim Fackert)
http://www.totubular.com/

rocket tube supplier - wide variety
6mm through 4.5" size couplers and rings
hard to find items
nomex paper, kevlar cord

Transolve Corporation
6501 Sebert #3
Cleveland, Ohio 44105
(216) 341-5970
johnf@apk.net
http://www.transolve.com/Transolve/index.html

Timers, altimeters, location beepers, etc.
Catalog: FREE

Tru Point Products, Inc.
140 Baker St.
Coloma, MI 49038

Heavy duty launch pads

(616) 486-4611
http://www.trupoint.com

2.2.3 Miscellaneous suppliers

For those of you who like to buy their tubing, balsa, and other materials in bulk, this section may have the supplier that you are looking for. Also included are suppliers of the kind of goods that many of us find useful for model and high power rocketry. While there are very many sources of materials from which one can build rockets, and there is no way that a list can completely cover this broad category. Here is a list of companies that have been mentioned on r.m.r., or have been recommended to the author. No company listed in this section is a rocketry specialty company. Many of the companies in the preceding sections also sell "raw materials," so rocketry-related questions are best directed to them.

Ace Resin
7481 E. 30th St.
Tucson, AZ 85710
(520) 886-8051
http://crystaltower.com/aceresin/

Resin casting and molding supply
polyurethane rubber and
RTV rubber, supplies

Aerospace Composite Products
14210 Doolittle Drive
San Leandro, CA 94577
orders: (800) 811-2009
technical: (510) 352-2022
FAX: (510) 352-2021
info@acp-composites.com
http://www.acp-composites.com/

Composite building materials
fiberglass, kevlar, carbon
Full line of supplies and equipment
Custom fabrication and specialty products

Alexander Aeroplane Company
P.O. Box 909
Griffin GA 30224
(800) 831-2949
http://www.airsport.com/alexaero.htm

Composite building materials

Catalog - FREE

Alumilite Corporation
315 North Street
Kalamazoo, MI 49007
(800) 447-9344
(616) 488-4001 FAX
http://www.alumilite.com/

resin casting and molding supply
resins and supplies
will send literature, specs, and cured samples on request

American Science & Surplus
3605 Howard St.
Skokie, IL 60076
(847) 982-0870
(800) 934-0722 FAX
http://www.sciplus.com/

All kinds of surplus, used, and new equipment, gadgets, gizmos, and useful odds and ends.
Their address here is for mail order, but they also have retail stores in Chicago, Geneva (IL), and Milwaukee.

Balsa USA
P.O.Box 164
Marinette, WI 54143
(906) 863-6421
(800) BALSA-US orders only
http://www.balsausa.com/

Balsa, basswood, plywood, and adhesives, fresh US-mfg CA Wholesale prices
Catalog - $2.00

Bare Metal Foil and Hobby Co.
P.O. Box 82
Farmington, MI 48332
(248) 477-0813
http://www.bare-metal.com/

Por-A-Kast, Por-A-Mold dealer urethane resin molding and casting, adhesive metal foil, decal paper

The Castolite Company
4915 Dean St.
Woodstock, IL 60098
(815) 338-4670
(815) 338-4671 FAX

casting resins
polyester resins and rubber

Composite Structures Technology
P.O. Box 622
Tehachapi, CA 93581
(800) 338-1278
http://www.cstsales.com/

Composite materials
fiberglass,kevlar,carbon,epoxy,
foam core, vacuum bagging, etc.
Catalog - FREE
occasionally sells materials at bargain prices.

Fibre Glast Developments Corp.
1944 Neva Drive
Dayton, OH 45414
(800) 821-3283
fibreglast@aol.com
http://www.fibreglast.com

Large supplier of composite materials, polyester and epoxy resins, vacuum bagging equipment, and all related supplies
Catalog - FREE

McMaster-Carr Supply Company
P.O. Box 440
New Brunswick, NJ 08903-0440
http://www.mcmaster.com/

Looked everywhere?
Can't find that "rocket part" anywhere? Give McMaster a call.

Micro-Mark
340 Snyder Ave.
Berkeley Heights, NJ 07922-1595
(800) 225-1066
http://www.micromark.com

Small tool company.
The company isn't small!
Perfect tools for working on rockets.

Middlesex Paper Tube Company, Inc.
P.O. Box 588
345 Chelmsford Street
Lowell, MA 01851
(800) 466-9317
(978) 458-9317 FAX

Large manufacturer of paper tubes
I.D.'s from 0.250" to 18.000"

Para-Gear Equipment Co., Inc.
3839 West Oakton Street
Skokie, IL 60076-3438

Full-service parachuting supply company.
Parachute fabric, tapes, threads,

708/679-5905
708/679-8644 - FAX
800/323-0437 (orders - outside IL only)
http://www.para-gear.com/

cords, webbing, and hardware.
Nylon, nylon, nylon!!!
Catalog - $5.00 (refundable)

Paramount Tube Division
P.O. Box 80400
Fort Wayne, IN 46898
(219) 484-4111
(219) 483-0393 FAX
http://www.paramounttube.com/

Large manufacturer of
paper tubes.
I.D.'s 0.093" - 12.000"

Peck Polymers
P.O. Box 710399
Santee, CA 92072-0399
(619) 448-1818
http://www.peck-polymers.com/

Japanese tissue for tissuing
those contest gliders.
Dethermalizer fuse, wood,
free-flight glider kits
Jetex dealer

SIG Manufacturing Co., Inc.
401-7 S. Front St.
Montezuma, IA 50171-0520
(800) 247-5008 (Orders)
http://www.sigmfg.com/

Balsa, basswood, plywood.
Wood building supplies for
hobbyist, and more...
Catalog - $3.00, or order online

2.2.4 Mail Order Sources

This is a very incomplete list. Check out the pages of 'High Power Rocketry' or 'Sport Rocketry' for many more possibilities. Check your phone book too!

Advanced Rocketry Group Ltd. (ARG)
130 Matheson Blvd., East - Unit 10
Mississauga, Ontario L4Z 1Y6
(905) 501-0456
(905) 501-1846 fax
arg@look.ca
http://www.uk-air.com/arg/

Model and high power rocket kits,
parts, motors, and supplies.
Also mfgs their own line of kits,
Imported Competition supplies,
airframe tubes, scale data, scale kits

Ballistic Bob
1575 Catalina Blvd.
San Diego, CA 92107
(619) 224-6435
bbobrocket@aol.com
http://www.ballisticbob.com

Model and high power rocket kits,
parts, motors, and supplies
20% discount on everything

Belleville Wholesale Hobby
1944 Llewellyn Road
Belleville, IL 62223-7904
(618) 398-3972
(618) 398-3477 (fax)
http://www.bellevillehobby.com/

Estes motors,
rocket kits, supplies, etc.,
at 30-40% discount from
retail.
Catalog - $3.00

Bobby Hall's Hobby House

Model and high power rocket kits,

4822 Bryan Street
Dallas, TX 75204
(214) 821-2550

parts, motors, and supplies

Bruckner Hobbies
3587 E. Tremont Ave.
Bronx, NY 10465
(718) 863-3434 (Info)
(800) 288-8185 (Orders only)
http://www.brucknerhobbies.com/

Estes, Quest, Aerotech, Launch Pad, Top Flite Recovery, 1/2A - G motors.
Catalog - Free

Commonwealth Displays, Inc.
12649 Dix-Toledo Road
Southgate, MI 48195
(734) 282-1055
order@commonwealth.net
http://www.commonwealth.net

Model and high power rocket kits, parts, motors, and supplies.
Catalog - $2.00

Countdown Hobbies
7 P.T. Barnum Square
Bethel, CT 06801-1838
(203) 790-9010 (voice/fax)
KevinCountdownHb@cs.com
(Kevin Nolan)
http://countdownhobbies.com/

Model and high power rocket kits, parts. motors, and supplies; discontinued kits; space, science, and collectors items
catalog - $3.00 ($3 Canada, $4 overseas)

C&T Hobbies Inc.
10181 Townline Rd.
Cheboygan, MI 49721
(616) 627-3603
http://www.cthobbies.com

Model and high power rocket kits, parts, motors, and supplies

Discount Hobby Center
P.O. Box 370
Utica, NY 13503
(315) 733-3741
(315) 733-1723 FAX
http://www.discounthobbycenter.com/

Model and high power rocket kits parts, motors, and supplies

Discount Rocketry
25944 Kaywood Court
Escondido, CA 92026-8408
(760) 432-9626
kfunk@ix.netcom.com (Kevin Funk)
http://www.discountrocketry.com/

Aerotech, Apogee, Binder, Edmonds, Cosmo., Custom, LaunchPad, LOC, Quest, Estes, more
Miss Rocket Booster posters

Magnum Rockets, Hobbies and More, Inc.
P.O. Box 124
Mechanicsburg, Ohio 43044
(513) 834-3306 (voice and fax)
http://www.magnumrockets.com/

Model and high power rocket kits, motors and supplies. "Class B" motor sales. Hybrid motors.
Catalog - $4.00

Orbital Dynamics, Inc.
P.O. Box 45375
Rio Rancho, NM 87174-5375

Model and high power rocket kits, motors and supplies.

(505) 994-4000 Voice
(505) 994-1000 Fax
rockettech@OrbitalDynamics.com
http://www.OrbitalDynamics.com/

Red Arrow Hobbies
5095 Red Arrow Hwy.
Stevensville, MI 49127
(616) 429-8233
75564.1512@compuserve.com
http://www.redarrowhobbies.com/

Model and high power rocket kits, motors and supplies.

Catalog - FREE

Ring Rocketry
206 East Mary Street
Holland, IN 47541
(812) 536-5000
ring@psci.net (Chad Ring)
http://www.wooshrocketry.org/misc/catalog0202.htm

Model rocket kits, motors, supplies specialty and hard-to-find items

Rocket Science
Larry Smith
2714 Augusta Hwy.
Lexington, SC 29072
(800) 221-7205

HPR and model rocketry dealer kits, motors and supplies. "Class B" motor sales Hypertek dealer

Space Modeling Solutions
486 East Devon Drive
Gilbert, AZ 8529
(480) 497-1960
(703) 832-3237 Fax
ridell@prodigy.net
http://www.smsrocketry.com/

Model and high power rocket kits, motors, parts, and supplies.

Uptown Sales Inc., The Hobby Place
33 North Main St.
Chambersburg, PA 17201
(800) 548-9941 orders only
http://www.hobbyplace.com/

Discount Estes dealer

catalog - $1.00 refundable

Zeppelin Hobbies
92 Route 23 North
Riverdale, NJ 07457-1200
(973) 831-7717
(973) 831-5989
zephobby@aol.com
http://www.zephobby.com/

Model and high power rocket kits, motors and supplies.

Catalog - FREE

2.2.5 Sources for Out-of-Production Model Rocket Kits

Wondering if you can ever find and build that old kit you that you once had? Give these folks a call (find their addresses, phone numbers, etc. in the preceding section).

Countdown Hobbies	Estes, Centuri, MPC, Cox, and more... kits, parts, ephemera

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2.2.6 Books/Videos/Computer Software/Technical References

NAR Technical Services (NARTS) P.O. Box 1482 Saugus, MA 01906 narts@nar.org http://www.nar.org/NARTS	Plans, technical reports, scale data and more. Catalog: Free to NAR members and also on r.m.r archive and www.
Odyssey Productions P.O. Box 450264 Garland, TX 75045-0264 (972) 495-8576 RLT2K@aol.com http://members.aol.com/rlt2k/index2	Videos high power and model rocket launches
Point-39 Productions c/o Earl Cagle, Jr. 1607 Apple Valley Drive Augusta, Georgia 30906 (706) 790-5544 earl39@csra.net (Earl Cagle)	Videos of high power rocket rocket launches (like LDRS)
Raging Rockets (800) 899-2788	'How to' videos for high power rocketry.
Rogers Aeroscience P.O. Box 10065 Lancaster, CA 93584-0065 (818) 349-4825 70574.2257@compuserve.com	Altitude prediction software and reference materials. Rocketry books - new and used
Saturn Press P. O. Box 3709 Ann Arbor, MI 48106-3709 (313) 677-2321 PeteAlway@aol.com (Peter Alway) http://members.aol.com/satrnpress/saturn.htm	Books on scale rocketry, rocketry scale reference materials, a great rockets of the world poster. (see section on books) Catalog: FREE

2.2.7 International (outside U.S.A.) rocketry sources.

The following is a listing of rocketry dealers, suppliers, manufacturers, hobby shops, etc. This listing is very incomplete. Please send comments and revisions to wolf@netheaven.com so that this listing can be updated. In the future, it is hoped that Part 13 of the rec.rockets.models FAQ will handle this section. Please refer to Part 13 of the FAQ for more information.

Advanced Rocket Components
P.O. Box 12957
London W12 0WE
England, UK
44 (0) 181 932 7772
106637.277@compuserve.com

High-power rocketry supplier
motors, kits, books, supplies

Aerospace Education
Box 13-368 Onehunga
Auckland NEW ZEALAND
09-624 3091
09-624 2165 (FAX)
gamlnz@iprolink.co.nz
http://www.creative.co.nz/index/lyle/hpr.htm

Model rocketry and high power
kits, engines, and supplies

Atlas Ingenjorsfirma AB
Nordana 147
S-232 91 Arlov
Sweden
46 40-44 55 80

Manufacturer
Scale rocket kits
Model rocket motors (1/2A - D)

Rocketeers
Box 7032
Roodeport
SOUTH AFRICA 1715
011 27 11 475 0880

Model rocketry and high power
kits, engines, and supplies

List of known European Manufacturers and Dealers:

http://www.EuropeRocketry.com/

2.3 What are some good books to read to learn more about model and high power rocketry?

Handbook of Model Rocketry, Sixth Edition
G. Harry Stine
Synopsis:
THE handbook on model rocketry. Covers just about everything you need to get started. Good tips for experienced modelers as well. Sixth edition was published March 1994. Available from several sources, including NARTS.

Basics of Model Rocketry, 2nd edition
Douglas R. Pratt
Kalmbach Books, 1993
Synopsis:
A general introduction to model rocketry.
The 2nd edition is highly revised and has become available as of Jan. 1993. The first edition is very Estes/Centuri/FSI oriented. The second edition includes sections on composite motors, Aerotech, NCR and other more recent manufacturers.

Model Rocket Design and Construction

Timothy S. Van Milligan (102374.2533@compuserve.com)
Kalmbach Books, 1995
Synopsis:
120 pages, 16 chapters, 240 illustrations, 40 photographs;
This book is geared towards modelers wanting to know more about the art and science of building better rockets. Includes chapters on design, improving performance, constructions and other topics. The coverage of glider and helicopter recovery, the glossary, and construction and repoir techniques is very good.

69 Simple Science Fair Projects with Model Rockets: Aeronautics
Timothy S. Van Milligan (102374.2533@compuserve.com)
Published by Apogee Components
ISBN 0-9653620-0-0
Synopsis:
104 pages pages consisting of 5 chapters and 3 appendicies; including 83 illustrations. Soft cover with 4-color artwork.
This book contains topic ideas for rocketry related science fair projects from very simple experiments that can be done in an afternoon, to some complex ones that require more sophisticated measuring equipment. Each project begins with some background information that explains why the topic is important and should be researched. Most projects also give a starting point that tell what type of equipment may be needed, and also where the experimenter should go for additional background research. This is not a cookbook approach, as the actual experiment must be designed by the researcher.

The Model Rocketry Handbook
Stuart Lodge
Argus Books 1990
ISBN 1-85486-047-X
Synopsis:
British handbook on model rocketry. Geared towards beginners, but some good tips for more experienced rocketeers.

Stu's Space: The Gospel According to Stuart Lodge
Stuart Lodge
25 Huntington Drive
Castle Donington
Derby DE74 2SR
U.K.
Synopsis:
A more advanced book than his "The Model Rocketry Handbook". Includes 10 chapters on Construction Techniques, Ignition and Launch Systems, Recovery Systems, Stability, and more. Self published by Stuart using high quality photocopies. Available directly from Stu.

Rockets of the World, 2nd edition
Peter Alway (petealway@aol.com)
Saturn Press, 1995
Synopsis:
This book contains information on more than 200 versions of 137 rockets from 14 countries and Europe. An absolute must buy for scale modeling enthusiasts and rocketry enthusiasts in general. Available via mail order from Saturn Press, NARTS, Quest, Countdown Hobbies, Magnum, Mountainside Hobbies and other sources.

Retro Rockets: Experimental Rockets 1926-1941
   Peter Alway (petealway@aol.com)
   Saturn Press, 1996
   Synopsis:
      More than 30 rockets flown by Robert Goddard and his
      contemporaries, depicted with dimensioned drawings,
      color-keyed drawings, and photographs. Historical
      backgraound for each. 96-page hardcover.

Second Stage: Advanced Model Rocketry
    Michael A. Banks
    Kalmbach Books, 1985
    Synopsis:
      A good introduction to E/F/G level rocketry. Some good construction
    hints.
    75300.2721@compuserve.com
    http://ourworld.compuserve.com/homepages/Mikebanks

Rocket Propulsion Elements, An Introduction to the Engineering of Rockets.
    George P. Sutton.
    Sixth Edition, A Wiley-Interscience Publication,
    John Wiley & Sons, Inc., 1992

Teaching Science Through Model Rocketry
    Tony Wayne
    3 Pigs Publishing, 1994
    Synopsis:
      The book is for the individual who teaches rocketry to others or is
    looking for another aspect of science to teach. It covers lesson plans,
    class setup, physics demonstrations, rocketry labs, rocket science
    background, teaching aides and more. Over 250 pages.
  Contact:
    Tony Wayne
    58 Court Place
    Charlottesville, VA 22901-2457

2.4 Are there any rocketry magazines available?

"Sport Rocketry"
    Journal of the National Association of Rocketry
    Published 6 times/year
    Subscription: Sport Rocketry
                    c/o National Association of Rocketry Headquarters
                    P.O. Box 177
                    Altoona, WI 54270
                    (800) 262-4872
                    http://www.nar.org/SPR/

"Extreme Rocketry"
    "An alternative rocketry magazine"
    Oriented towards large high power projects
    Subscription: Extreme Rocketry
                    109 E. Charleston Suite 101

Las Vegas, NV 89104
info@extremerocketry.com
http://www.extremerocketry.com/

"High Power Rocketry Magazine"
An independent consumer rocketry magazine. Formerly the journal of the Tripoli Rocket Society.
Published irregularly 9 times/yr. or so
subscription $37.50/year
Subscription: High Power Rocketry
PO Box 96
Orem, Utah 84059
71161.2351@compuserve.com

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 1: General Information

Posted: November 17, 1998

Last modified: November 17, 1998

This portion of the r.m.r FAQ is maintained by Buzz McDermott, at bmcdermo@ix.netcom.com. Comments, criticisms, suggestions and corrections for this section should be sent to that email address.

1.1 What, exactly, is a 'model rocket' versus a 'high power' rocket? Where do liquid fueled and homemade rocket motors fit in? What about amateur rockets?

'Model', 'high power', 'advanced', and 'amateur' are all terms which have many definitions, depending to whom you are speaking. In r.m.r., and in the FAQ documents, the definitions (if any) accepted by the NFPA, National Association of Rocketry, and Tripoli High Power Rocketry Association are used. If these definitions conflict the NAR definition is used.

'Model rockets' are rockets that conform to the guidelines and restrictions defined in the NFPA 1122 document. These rockets weigh less than 1500 grams, contain less than 125 grams of total fuel, have no motor with more than 62.5 grams of fuel or more than 160 NS of total impulse, use only pre-manufactured, solid propellant motors, and do not use metal body tubes, nose cones or fins. One inconsistancy with this is the CPSC definition of a model rocket motor, which by their definition must contain no more than 80NS total impulse. NFPA document 1127-94 contains the most complete definition of a model rocket and the model rocket safety code. This is the same safety code as adopted by the NAR.

'Large Model Rockets' is a term used in the FAA FAR 101 regulations. It refers to NAR/NFPA model rockets that are between 454 and 1500 grams (1 to 3.3 pounds) total liftoff weight and contain more than 113 grams but less than 125 grams of total fuel.

'High power rockets' are rockets that exceed the total weight, total propellant or single motor total impulse restrictions of model rockets, but otherwise conform to the same guidelines for construction materials and pre-manufactured, commericially made rocket motors. High power rockets also allow the use of metal structural components where such a material is necessary to insure structural integrity of the rocket. High power rockets have no total weight limits, but do have a single motor limit of no more than O power (40,960NS maximum total impulse) and have a total power limitation of 81,920NS total impulse. NFPA document 1127-1985 contains the most complete definition of a high power rocket and also the high power rocketry safety code. This safety code has been adopted by both the NAR and TRA. Metal bodied rockets are allowed by NFPA 1127 where metal is required to insure structural integrity of the rocket over all of its anticipated flight.

'Amateur' rockets covers all other non-professional rockets that do not meet the criteria for model or high power rockets. This includes metal bodied rockets, liquid or hybrid fueled rockets, and rockets with any type of homemade rocket motor.

'Experimental' rockets is an ambiguous term. In the early 1980's it was used (reportedly coined by the magazine 'California Rocketry') to describe rockets that exceeded the model rocket limit at that time (1 pound total liftoff weight and no motor above F power). More recently, it has been used by the Tripoli Rocketry Association to describe the class of rockets that use pre-manufactured solid or hybrid rocket motors but that do not qualify as high power rockets. This includes metal bodied rockets and those with more than 80,000NS of total power.

'HPR-lite' is not any type of 'official' rocket designation but has been used to refer to rockets that exceed the old NFPA model rocket limit of 1 pound but still qualify as NFPA model rocket under current guidelines. These rockets typically use E through G power and are built with much the same techniques as high power rockets. This term originated in the internet rec.models.rockets newsgroup. It should be noted that this term refers to legal model rockets, not any type of high power rocket, and might therefore be misleading to many. The term 'Large Model Rocket' should be used instead.

Another term that has no formal definition but is more and more being used in the literature is 'hobby rocketry'. This term includes both model and high power rockets, but excludes amateur rockets. The term 'consumer rocketry' has also been used, and means the same thing.

The term 'non-professional rocketry' encompasses all forms of model, high power and amateur rocketry.

Finally, the editor of this document wishes to get on his soapbox for just one moment and add the term 'stupid rocketry' to cover all those who attempt to casually produce their own rocket fuel and/or motors without the benefit of very serious study, and implementation, of the

processes involved and safety measures required. Especially note that this comment is NOT aimed at serious amateur rocketry organizations, college level research, etc. End of soapbox.

1.2 NFPA, FAA, DOT, ... Who are all these organizations and how do they affect the rocketry hobby?

DOT (Dept. of Transportation) regulates shipping of rocket motors and reloads.

CPSC (Consumer Products Safety Commission) regulates what may and not be sold as a 'consumer' items at the retail level.

FAA (Federal Aviation Administration) is responsible for airspace control and regulates flights of rockets that exceed 1 pound and enter FAA regulated airspace.

NFPA (National Fire Protection Association) makes recommendations for use of non-professional rocket motors. Although the NFPA only makes recommendations, most state and local laws concerning the use of model rockets are based, at least in part, on NFPA recommendations; especially NFPA 1122. The NFPA also has a draft definition and safety code for High Power rockets, NFPA 1127.

BATF (Bureau of Alcohol, Tobacco and Firearms) has responsibility for regulations concerning storage and use of explosives. This agency has taken a recent interest in looking into how high power rocket motors are stored and used.

ATC (Air Traffic Control) You must notify the nearest FAA ATC center prior to flying Large Model Rockets or High Power Rockets.

1.3 What is the current legal status of model and high power rocketry in the U.S.?

A. FAA Regulations:

* Rockets containing less than 113 grams of total fuel and weigh less and one (1) pound do not require any type of FAA notification and are not restricted by the FAA except where they pose a threat to aircraft.
* FAA "large model rockets" (see the definition in #1, above) require that the nearest Air Traffic Control center (ATC) be notified of the launch between 24 and 48 hours prior to the launch. This is notification and not permission. In the U.S., try calling 1-800-WX-BRIEF to get the number of the ATC center nearest you.
* FAA High power rockets (weighing more than 3.3 pounds, containing HPR motors, or containing a total of more than 125 grams of fuel) require a formal waiver be approved by the FAA and activated prior to the launch. Refer to the full r.m.r FAQ (dated 1 Oct 94 or later) for more complete details.
* NOTE THAT THE FAA DOES NOT PLACE ANY RESTRICTIONS ON FUEL-PER-MOTOR OTHER THAN THE TOTAL LIMIT OF FUEL. HOWEVER, MOTORS WITH MORE THAN 62.5 GRAMS OF FUEL ARE HIGH POWER ROCKET MOTORS AND REQUIRE HIGH POWER CERTIFI- CATION TO FLY. This does allow HPR

certified flyers to conduct low-end HPR launches (with up to about 240NS composite motors) without having to obtain a waiver.
* Remember that HPR waivers, ATC notification and high power certification are all separate issues and must all be properly followed.

B. CPSC Regulations/Restrictions:
* G class model rocket motors (80.01-160.00NS total impulse) have been classified as high power by the CPSC. They are considered model rocket motors by the NFPA. These motors are now restricted for sale to buyers 18 years of age or older. This includes the sale of G reloadable motors.

C. DOT Shipping Restrictions:
* Most single use rockets motors with less than 62.5 grams of propellant are now classified as UN 1.4s and can be shipped via UPS (with a HAZMAT fee) or regular parcel post.
* Most reloadable rocket motor fuel grains weighing less than 62.5 grams each are now classified as 'flammable solids' and may be shipped via UPS (with HAZMAT fee) or regular parcel post.
* The UPS HAZMAT fee is now $10
* Any single use rocket motor containing more than 62.5 grams of fuel, and any reloable motor fuel grain weighing more than 62.5 grams are classified as UN 1.3c, or Class B, explosives. These motors and reload grains may be shipped ONLY via Federal Express to certain designated shipping points.
* Aerotech has announced it has received an exemption for single use motors up to K class and reload grains for at least L, and possibly M class motors, which allow these motors and reload grains to be shipped UPS ground in the same manner as motors containing less than 62.5 grams of propellant. Aerotech says these are now shippable as class 4.1 flammable solids.

D. BATF Restrictions:
* Any rocket motor or reloadable fuel grain containing more than 62.5 grams of propellant is now classified by the ATF as a Class B Low Explosive. This includes Aerotech reloads from J power and up.
* You must have a federal Low Explosives Uers Permit (LEUP) to legally purchase Class B rocket motors and reloads, except under certain restricted circumstances.
* You must have a federal LEUP to legally store rocket motors or reload grains which contain more than 62.5 grams of propellant.
* You must comply with federal low explosives regulations when transporting and storing Class B rocket motors.
* You must be 21 years of age to obtain an LEUP.

E. Other High Power Restrictions:
* You must be 'high power certified' to fly high power rockets.
* The NAR and Tripoli both have programs for obtaining high power certification. You need to join one or both of these organizations if you want to fly high power rockets.
* You must be at least 18 years of age to become high power certified.

1.4 I would like to get into Large Model Rockets. What are my options? Who has NAR certified E, F and G motors today?

The following manufacturers currently have NAR certified E, F and G motors, as indicated.

Motor Class	Manufacturer	Propellant Type
E	Flight Systems, Inc.	Black Powder
E	Aerotech	Composite (ammonium perchlorate)
F	Flight Systems, Inc.	Black Powder
F	Aerotech	Composite (ammonium perchlorate)
G	Aerotech	Composite (ammonium perchlorate)

There are 18, 21, 24, 27 and 29 mm diameter motors available. One manufacturer (Aerotech) has reloadable motor casings for 18, 24, and 29 mm motors.

Several manufactuers sell rockets designed for E through G powered flight. Refer to the previous list of addresses and get a few catalogs. R.m.r readers have recommended kits from NCR, THOY, LOC, Aerotech, Vaughn Brothers, Microbrick/MRED, and others. Look for the following minimum features in E through G powered kits:

- plywood or fiber centering rings rather than paper or cardstock
- plywood, thick plastic, or G10 fins rather than balsa
- thicker motor tubes
- cloth rather than plastic parachutes
- thicker-walled body tubes

Remember to build these models stronger than smaller model rockets. Use CA and epoxy rather than white or yellow glue. These rockets will have to survive much higher stresses than smaller model rockets.

1.5 Is the proper term rocket 'engine' or rocket 'motor'?

I don't know. I don't really care. And neither should you! In this document 'motor' and 'engine' are taken to mean the same thing and both refer to "the thing in the rocket which makes it go 'whoosh!!' (or 'roar', if flying high power :-)". If you want a sure way to start a fight with a fellow rocketeer, just argue that whatever term he/she uses is the wrong one.

1.6 What do the letters and numbers on a model rocket motor mean?

The NAR has developed a motors classification scheme which has been mandated by NFPA 1122 and most state regulations. This system specifies the motors total impulse class, average thrust, and ejection charge delay. This is printed on any motors certified by the NAR. the pieces are as follows, given the example:

E15-10W

The first letter indicates the power range, as specified in the table below. The number to the left of the dash is the average thrust of the motor, in newtons. The number to the right of the dash is the approximate ejection delay in seconds starting at the time of motor burnout. The final letter is an optional manufacturer designation for motor or fuel type. Note that letter designating total impulse of the motor specifies an impulse *range*, not an exact total impulse. For example, there are G motors that have anywhere from 90 to 160 NS of total impulse....an Aerotech G42 is rated at 90NS and a G40 is rated at 120NS. Motors with more than either 62.5 grams of total propellant or have more than 160NS of total impulse are considered High Power motors. You must be certified to purchase and fly these motors. Soon, it may also become necessary to have a license to store high power motors.

Andrew Mossberg (aem@hypertek.com) recently posted this chart to rmr, which includes approximate propellant weights for maximum impulse motors for each class:

POWER	Low Limit (NtSec)	High Limit (NtSec)	Low Limit (lbsSec)	High Limit (lbsSec)	200 ISP Propellant Weight (grams)	(lbs)
A	1.26	2.5	0.28	0.56	1.3	0.0028
B	2.51	5.0	0.56	1.12	2.5	0.0056
C	5.01	10.0	1.13	2.25	5	0.0112
D	10.01	20.0	2.25	4.5	10	0.02
E	20.01	40.0	4.5	9	20	0.04
F	40.01	80.0	9	18	41	0.09
G	80.01	160.0	18	36	82	0.18
H	160.01	320.0	36	72	163	0.36
I	320.01	640.0	72	144	326	0.72
J	640.01	1,280.0	144	288	652	1.44
K	1280.01	2,560.0	288	575	1,305	2.88
L	2560.01	5,120.0	575	1,151	2,609	5.75
M	5120.01	10,240.0	1,151	2,301	5,219	11.5
N	10240.01	20,480.0	2,301	4,602	10,438	23.0
O	20480.01	40,960.0	4,602	9,204	20,875	46.0
P	40960.01	81,920.0	9,204	18,409	41,751	92.0

Currently, consumer rocketry stops at rockets with a total of no more than 81,920NS of total impulse. Anything larger than that is by definition an amateur rocket.

1.7 What is a CATO? Is it CATO pronounced KAY-TO or CAT-O?

The following definition has been posted to r.m.r. by Jack Hagerty, (jack@rml.com) editor of the excellent r.m.r Glossary. For even more complete information on the term CATO, refer to the glossary.

A motor failure, generally explosive, where all the propellant is burned in a much shorter time than planned. This can be a nozzle blow-out (loud, but basically harmless), an end-cap blow-out (where all of the pyrotechnic force blows FORWARD which usually does a pretty good job of removing any internal structure including the recovery system) or a casing rupture which has unpredictable, but usually devastating, effects. Another form of CATO is an ejection failure caused by either the delay train failing to burn or the ejection charge not firing, but the result is the same: the model prangs.

Opinions on the meaning of the acronym range widely. Some say it's not an acronym at all, but simply a contraction of 'catastrophic' and should be pronounced 'Cat-o' (which sounds better than 'cata' over PA systems :-). Others maintain that it is an acronym but disagree on the meaning, offering a broad spectrum of 'CAtastrophic Take Off,' 'Catastrophically Aborted Take Off,' 'Catastrophe At Take Off' and the self referential 'CATO At Take Off.' The acronym crowd pronounces it 'Kay-Tow', like the Green Hornet's side kick. It has been pointed out, though, that all of the above are 'post-hoc' definitions since LCO's were using the term over range PA systems long before any formal acronym was established.

1.8 When a consumer rocket motor fails (i.e., CATOs) does it explode or detonate?

To be precise, consumer rocket motors do NOT 'detonate'. Black powder rocket motors 'deflagrate'. Detonation involves the creation of super-sonic shock waves. Use the term 'explode' when discussing CATOs involving split motor casings, holes blown out the sides of models, etc.

1.9 Why don't I just make my own model rocket motors? Shouldn't I be able to custom-make better, more powerful motors at a cheaper price?

This subject has been hotly debated on r.m.r. It is one of those 'emotional' subjects that find people either firmly for or against.

The bottom line is that rec.models.rockets is primarily a newsgroup for discussing *consumer* rocketry (which covers model rocketry and high power rocketry). Some amateur issues are discussed, but these are not the primary focus of the group. Manufacturing your own rocket motors can be a very dangerous thing to do, unless done properly, and with extreme care. The odds are you will not make motors that are of any higher quality, total impulse, reliability, or cost less than pre-manufactured consumer rocket motors.

It is the opinion of the editor(s) of this FAQ that you should NOT try to manufacture your own motors. If, however, you insist on partaking in amateur rocketry, then the editor(s) of this FAQ urge you to get in

contact with an established amateur rocketry group for guidance and assistance.

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 3: Rocketry on the Internet

Posted: May 31, 2002

Last modified: May 29, 2002

3.1 How do I get to the r.m.r archive site?

The old Sunsite rec.models.rockets archive has not been active since sometime in 1999. The archives are now part of the ibilio.org domain:

http://www.ibiblio.org/pub/archives/rec.models.rockets

3.2 What is available from the r.m.r archive?

The r.mr. archive used to be the 'official' archive site for rocketry-related materials submitted by r.m.r contributors. The archive has been static for the past few years. The archive still has a number of useful files. The following are some of the subdirectories of the archive, and a brief description of what is in them.

ARTICLES - documents. Informative how-to articles, and other text.

BATF - BATF information

CATALOGS - manufacturer catalogs (a few might actually be current)

CYBERROC - various software for rocketry, including VCP

DIGITRAK - a directory for DigiTrak rocket flight modeling software

ELECTRONICS - rocketry electronics

FAA - FAA information

GRAPHICS - pictures of rockets, launches, and people, scale data, logos, etc.

LISTS - certified motor lists, club listings

PLANS - rocket plans, including old kit plans and decal scans

PROGRAMS - rocketry software, including tracking software and propep

PROGRAMS.MAC - rocketry software for the Mac

PROGRAMS1 - more rocketry software

PROGRAMS2 - even more rocketry software

PROGRAMS3 - yet even more rocketry software

PROGRAMS4 - lots more rocketry software - Go Nuts!

R.M.R_POSTINGS - an archive of every r.m.r. posting since late Nov. 1991

RASP - a directory for RASP rocket flight modeling software (PC and Mac)

RMRFAQ - the r.m.r. FAQ

ROCKetCAD - demo CAD software for rockets

SOUNDS - .WAV and Macintosh System 7 sound files of launches

Winroc - a directory for WinRoc rocket flight modeling software

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3.3 How do I upload files to the r.m.r. archive?

At this time, you can't. This will change soon.

3.4 I have read-only access to r.m.r. Is there any way I can still post articles to the newsgroup?

Try http://www.google.com/

3.5 What are some neat rocketry web pages to check out?

*** IMPORTANT ROCKETRY WEB SITES ***

HTML version of the entire FAQ:

http://www.ninfinger.org/~sven/rockets/rmrfaq.toc.html

ROCKETRY ONLINE
http://www.rocketryonline.com/

Rocketry Online is a comprehensive web site for everything to do with rocketry and the Internet.

NAR - The National Association of Rocketry home page
http://www.nar.org/

Home page for the worlds largest and oldest consumer rocketry organization.

TRA - Tripoli Rocketry Association
http://www.tripoli.org/

Official home page of the Tripoli Rocketry Association

CAR - Canadian Association of Rocketry
http://www.canadianrocketry.org/

Home page of the Canadian Association of Rocketry. Check out what's happening north of the U.S.

UKRA - United Kingdom Rocketry Association
http://www.ukra.org.uk/

Home page for the United Kingdom's largest consumer rocketry organization.

European Model Rocketry
http://www.europerocketry.com/

Comprehensive Web site for rocketry in Europe.

New Zealand Rocketry Association
http://www.rockets.co.nz/nzra/nzra.htm

Home page for the New Zealand Rocketry Association.

SAMROC - South Africa Model Rocket Club
http://www.samroc.org.za/

*** ROCKETRY CLUB HOME PAGES BY STATE ***

ALABAMA
HARA: Huntsville Area Rocketry Association, NAR Section 403
http://home.hiwaay.net/~bday/hara/

ARIZONA
Arizona High Power Rocketry Association
http://www.goodnet.com/~roktdan/ahpra/

SARA: Southern Arizona Rocket Association, NAR Section 545
http://www.sararocketry.org/

SSS: Superstition Spacemodeling Society - Tripoli Phoenix
http://www.sssrocketry.org/

CALIFORNIA

AEROPAC: Association of Experimental Rocketry of the Pacific
http://www.aeropac.org/

BAYNAR: NAR Section 359
http://www.bynar.org/

DART: Diego Area Rocket Team
http://www.tns.net/dart

LUNAR: Livermore Unit of the NAR, NAR Section 534
http://www.lunar.org/

ROC: Rocketry Organization of California - Tripoli Anaheim
http://www.rocstock.org/

SCRA: Southern California Rocket Assoc., NAR Section 430
http://home.earthlink.net/~mebowitz/

COLORADO

COSROCS: Colorado Rocket Society, NAR Section 515
http://www.cosrocs.org/

Colorado Rocketry Association of Space Hobbyists - CRASH
http://www.crashonline.org/

CONNECTICUT

CATO: CATO Rocketry Club, NAR Section 581
http://www.catorockets.org/

CTRA/NARCONN
http://www.ctra-narconn.org/

FLORIDA

Florida Spacemodeling Association
http://fsatwp2001.tripod.com/

Spaceport Rocketry Association, NAR Section 342
http://home.cfl.rr.com/sra/

THOR - Tampa/Hillsborough Organization of Rocketry
http://members.surfbest.net/bwynn@surfbest.net/thor.htm

GEORGIA

Southern Area Rocketry
http://www.soar571.com/

ILLINOIS

CIA: Central Illinois Aerospace, NAR Section 527
http://www.prairienet.org/cia/

NIRA: Northern Illinois Rocketry Assocation, NAR Section 117
http://www.NIRA-rocketry.org/

INDIANA

Rocketeers of Central Indiana
http://www.indyrockets.org/roci.html

SCAM: Summit City Aerospace Modelers, NAR Section 282
http://www.mixi.net/~bobhart/

Launch Crue - Holland, IN
http://www.geocities.com/launchcrue519/

KANSAS

K.L.O.U.D.Busters Inc., TRA Prefect
http://www.kloudbusters.org/

KENTUCKY

Kentuckiana Rocketry Association
http://www.ntr.net/~cdutley/krahome.htm

MARYLAND - WASHINGTON DC

NAR Headquarters AeroModelers Society, NAR Section 139
http://www.narhams.org/

Tripoli Maryland
http://www.mdtripoli.org/

MASSACHUSETTS

CMASS: Central Massachusetts Spacemodeling Society, NAR Section 464
http://www.cmass.org/

MICHIGAN

Huron Valley Rocket Society
http://www.huvars.org/

MISSOURI

St. Louis Rocketry Association
http://www.stlouisrocketry.org/

NEW JERSEY

Garden State Spacemodeling Society
http://www.robnee.com/gsss

Tripoli North Jersey
http://www.metrarocketclub.org/

Southern Jersey Area Rocket Society
http://www.sojars.org/

NEW YORK

ASTRE: Albany-Schenectady-Troy Rocket Enthusiasts of New York, Section 471 of the NAR
http://www.astre471.org/

MARS: Monroe Astronautical Rocketry Society
Section 136 of the NAR
http://www.marsclub.org/

LIARS: Long Island Advanced Rocketry Society, TRA Prefecture 29, and the North Shore Section 142 of the NAR
http://www.liars.org/

Buffalo Rocket Society - Tripoli Western NY
http://www.buffalorocketsociety.org/

OHIO

Northern Ohio's Tri City Sky Busters, NAR Section 535
http://www.skybusters.org/

Northeastern Ohio's Mantua Township Missile Agency, NAR Section 606
http://web.raex.com/~markndeb/rockets/mtma/

Queen City Area Rocket Klub - QUARK
http://crash.to/quark

Toledo Area Rocketry Society
http://pages.prodigy.net/jjschmidt/

OKLAHOMA

Oklahoma Tripoli
http://members.cox.net/tripoli-oklahoma

PENNSYLVANIA

Pittsburgh Space Command, NAR Section 473
http://www.psc473.org/

Southern Pennsylvania Area Association of Rocketry
http://www.spaar.org/

Blastoff Rocket Club - Erie
http://frontpage.velocity.net/duane/index.html

SOUTH CAROLINA

Tripoli South Carolina
http://www.tripolisc.com/

TEXAS

DARS: Dallas Area Rocket Society, NAR Section 308
http://www.dars.org/

AARG: Austin Area Rocketry Group
http://www.aarg.org/

NHRC: NASA/Houston Rocket Club, NAR Section 365, TRA 002
http://www.nhrc.homestead.com/

UTAH
UROC: Utah Rocketry Club
http://www.uroc.org/

VIGINIA
NOVAAR: Northern Virginia Area Association of Rocketry
http://www.geocities.com/CapeCanaveral/8561

WEST VIRGINIA
West Virginia Society of Amateur Rocketry
http://www.wvsoar.org/

WISCONSIN
Wisconsin Organization of Spacemodeling Hobbyists - WOOSH
http://www.wooshrocketry.org/

*** WEB SITES OF GENERAL INTEREST TO ROCKETRY ***

Apollo-Saturn Reference Page
John Duncan's guide to the Saturn V and Saturn 1b, with loads of scale data for the modeler.
http://www.apollosaturn.com/

BATF
http://www.atf.treas.gov/

BATF "Orange Book"
A scanned copy of the BATF non-copyrighted book titled, "ATF - Explosives Law and Regulation,"
http://www.info-central.org/regulatory/orangebook/
http://members.aol.com/RocketWeb/regulate/atf/orange.htm

Certified Motor Listings
NAR Standards and Testing Committee
http://www.nar.org/SandT/NARenglist.shtml
Tripoli Motor Testing
http://www.tripoli.org/motors.htm

Cineroc Sites
Places were you can find stuff about the old Estes Cineroc movie camera
http://www.techblvd.com/Rvideo/rvideo.htm
http://groups.yahoo.com/group/OldRockets/

Competition Rocketry
http://www.nar.org/competition/
http://groups.yahoo.com/group/contestRoc/
http://www.acmenet.net/jvincent/nercb.html

Early Space Flight

John Sisson of UC Irvine has created terrific web page about early visions of spaceflight, including material from Ley, Disney, and our own G. Harry Stine.
http://sun3.lib.uci.edu/~jsisson/john.htm

Electronics and Rocketry
Ed's web site devoted to electronics used in consumer rocketry. Currently has VCP files and information about Taniwha Flight Computers
http://www.geocities.com/CapeCanaveral/7318

FAA Form 7711-2 Application for Certificate of Waiver
downloadable/printable copy of Form 7711-2
http://www.faa.gov/avr/afs/Waiver.htm

Model/High Power Rocketry Motor Dimensions
http://www.dnaco.net/~dantassi/motors.html

Model Rocket Drag Analysis
John DeMar's R&D report containing useful CD data
http://web.syr.edu/~smdemar/rocketdrag.html

National Fire Protection Association
http://www.nfpa.org/

Northeast Regional Contest Board page
http://www.acmenet.net/jvincent/nercb.html

Old Rockets, Old Rocketeers, Nostalgia
http://groups.yahoo.com/group/OldRockets/
http://www.dars.org/jimz/rp00.htm

rec.models.rockets Design Contest Homepage
Enter your rocket design in the ongoing r.m.r. Design Contest! Winners receive prizes from generous r.m.r. readers.
http://www.aeroconsystems.com/descon/rmr_descon_index.htm

VCP Software Archive
Official site for Gary Crowell's CP/CG Calculator. Stabilize your designs!
http://www.v-serv.com/vcp/

Water Rockets
Gary Ensmenger's Water Rocket Playground:
http://www.h2orocket.com/

Yahoo -
http://www.yahoo.com/Recreation/Hobbies_and_Crafts/Rockets

The above is a great starting point and has a large number of pointers to other rocketry sites.

This is the rocketry page of Sven Knudson.
He has the most up-to-date HTML version of the rec.models.rockets FAQ.
He also has great rocketry pages and the rec.models.scale FAQ.

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 4: Born Again Rocketeers

Posted: April 14, 1997

Last modified: April 14, 1997

4.1 What the heck is a 'Born Again Rocketeer'?

A Born Again Rocketeer (BAR) is a person who started out in model rocketry in their 'younger' days, dropped out of the hobby for some number of years, and then came to their senses and got back into it. BARs are noted for re-entering the hobby with extreme enthusiasm and much deeper pockets than they had during their first encounter with the hobby. The editor of this FAQ is a BAR (and proud of it :-).

Paul Wolaver <pwolaver@sybase.com> wrote this BAR observation:

> Be prepared for the BAR phenomenon. Open your wallet. Write off your weekends. Set aside a room in your house to build rockets. Buy epoxy.

An informal survey of 49 Born-Again Rocketeers on r.m.r. yielded the following information:

- average number of years away from the hobby - 18.6

- Why did you get back into rocketry?

  The answers varied greatly, but these three were at the top:

  1. Involvement with children (33%)
  2. 'discovered' rec.models.rockets (12%)
  3. wanted to get into HPR after seeing how much the hobby has changed. (8%)

- current 'mode' of flying rockets
  1. model rocketry (49%)
  2. high power (20%)

3. high power 'lite' (10%)

- what did you fly first?

  Seems like everyone did something different. Estes kits were the overwhelming majority, with the Big Bertha, Alpha, Alpha III, and Phoenix all being mentioned more than once or twice.

- what were your old favorites, way back when?

  Again, everyone liked something different, and everyone had more than one single favorite kit. Estes kits figured prominently in the memories of the surveyed. The Big Bertha, Mars Lander, and Orbital Transport kits were most popular. A few folks were Centuri fans, with the Orion kit getting the most votes (2). A few eschewed the kit scene completely, and someone recalled fond memories of building ZnS rockets.

4.2 I have been out of model rockets for many (i.e. <nn>+) years now. What been happening in the hobby over the past couple of decades? What's new? What's gone?

4.2.1 Who's Left, Who's Not & Who's New

To sum it up...

Gone:	Centuri/Energet
	Rocket Development Corporation
	Space Age Industries
	MPC rocket kits
	Coaster
	'S' Series (short) 18mm motors
	Competition Model Rockets
	AVI motors
	Camroc/Cineroc
Still here:	National Association of Rocketry (NAR)
	Estes
	Flight Systems
New:	High Power Rocketry, with *BIG* rockets
	Tripoli Rocketry Association
	MANY new companies
	Composite rocket motors are commonplace
	Reloadable solid rocket motors
	Hybrid rocket motors
	Phenolic and fiberglass rocket components
	Electronic altimeters, flight computers,....
	Much improved rocketry simulation software
	And a whole lot more.....

Basically, it's all pretty much the same, or totally different, depending on your interests. Estes is still Estes. Most of their kits are still the same materials, etc. The trend for the last 10 years has been for Estes to sell simpler and simpler kits. There are lots of plastic nose cones and fin units (already around when you were active before). There are now kits with pre-slotted body tubes and plastic fins (as in the Estes E2X series). Lots of good stuff for beginners and kids. Estes now makes engines in the 1/2A - D range, all black powder. Estes has some Large Model Rocket offerings ready, as well. Read below for details.

Flight Systems (FSI), another motor and kit manufacturer that got its start in the late 60's, was reported in 1995 to have ceased its model rocketry operations. They have restarted production in 1996, and plan on being up to full production by 1997.

Centuri, sadly, 'went away' in 1980. Daemon Industries bought both Estes and Centuri in the 1970's. They operated both companies as independent units for several years. Finally, Centuri was dissolved and its products absorbed into Estes. Every now and then an old Centuri kit surfaces under the Estes banner. An interesting piece of trivia is that the tax and incorporation laws were more favorable in Arizona (home of Centuri) than Colorado (home of Estes). So, Damon, on paper, had Centuri acquire Estes, even though it was Centuri's operations that were eventually shut down. Damon sold off Estes to a group of investors in the early 90's.

Now for 'who is new'. First, in model rocketry there is a new kid on the block: Quest. This is Bill Stine, some ex-Centuri people and others. They are a direct competitor to Estes. They have a line of kits and engines (A-C). Good quality. Less expensive than Estes.

There are many other smaller companies making and selling model rocket kits. See Part 02 of the FAQ for addresses. Custom Rockets is another company with rocket kits similar to those offered by Estes and Quest. Custom offers quality paper tube/balsa finned kits in the A-D power range.

Aerotech, LOC/Precision, Rocket R&D, Public Missiles, and North Coast Rocketry are some new names in the business. These companies cater to both larger model rocket and high power rocket markets. Estes bought manufacturing rights to all NCR products in 1995. Estes has announced a line of F/G rockets (based on NCR designs) to be released in the first quarter of 1996. Estes may also release a small line of F and G composite motors in 1996. A newer outfit, Rocket R&D, bought out THOY and another smaller HPR manufacturer, Cluster R.

Aerotech manufactures both single-use and reloadable composite rocket motors ranging from C to M total impulse classes. They also offer a few kits designed for E to G engines.

A couple of outfits make kits using newer technology materials, including phenolics, fiberglass, and composites. These include Public Missiles (PML),

Rocketman and Dynacom. Be prepared to pay more dollars for the more advanced materials. A $60-75, 4" diameter, heavy paper tube based kit, such as manufactured by LOC, might cost $100-125 in a phenolic based kit, such as produced by PML. A Dynacom fiberglass kit of the same size might cost closer to $350.

If you were into rocketry in the early 1980's then you probably remember AAA Model Aviation Fuels. They're still here, with a line of HPR and Large Model Rocket kits.

If you were into competing you might have been familiar with Competition Model Rockets (CMR). They are now defunct but there are constant rumors of a rebirth 'sometime in the near future'. Other companies have stepped in to fill the space left by the exit of CMR. See the section 'Competition' for some names and addresses. Two notable new companies are Apogee Components and Qualified Competition Rockets. Apogee was started by long-time rocketeer Ed LaCroix. QCR was started by another long-time rocketeer, Kenneth Brown. Ed has now joined the Aerotech team and dropped most of his product line. A new company, Eclipse Components, is picking up most of the Apogee Components line, except for motors. Apogee will still be selling those. Pratt Hobbies has indicated that it will pick up some of the old CMR product line, and has already made the CMR egg capsules available again.

A lot of the 'neat' Estes kits of the 60's and 70's are no longer available. However, Estes is bringing them back (one by one) in so-called, 'limited run collector series'. The original 'Mars Snooper' and 'Maxi Honest John' kits have been re-issued, so far, along with the Star Trek and Star Wars kits. More releases are supposed to be forthcoming. WARNING: Be prepared to pay a much higher price for these re-released kits. Remember that inflation has led to some items having much higher prices now than in the mid 60's and 70's. No doubt Estes will take advantage of the demand for the re-released kits, as well, and charge an additional premium.

4.2.2 Changes in Motor Technology

The big changes have come in motors. Expendable composite fuel motors are now available in B-G range for model rockets. These motors use ammonium perchlorate for oxidizer and rubber as the fuel, similar to the rocket boosters on the space shuttle, allowing them to pack two to three times the power in the same space as a black powder motor. The B motors from Apogee are the same size as Estes mini-motors (13x45mm). The C motors (also from Apogee) are 18x50mm, while the D motors are the same size as Estes A-C motors (18x70mm). The D is a full D (rated at 20 Newton-seconds versus the Estes 24x70mm D of about 17 N-s). E motors range in size from 18x70mm to 29x124mm. All of the motors give Estes kits an incredible ride, if the models hold together. These kits require stronger construction methods and materials than typical model rockets. Put an Aerotech D21 or E25 in your old Big Bertha at your own risk!! You're likely to end up with a model with no fins (i.e., a complete 'shred').

Another new trend is 'reloadable' motor technology. With reloadables

you have a metal motor casing that you manually reload with solid fuel pellets, delay and ejection charge for each flight. The casing is reusable. Reloadable motors are available in everything from 18x70 mm (with B - E power), 24mm, (with D - F power), 29mm, 38mm, and much larger. Again, you can get all the way up to 40,000+ Newton-seconds of total impulse.

The latest technology to hit the High Power rocket scene is the hybrid rocket motor. Hybrid motors use components from both liquid and solid ful rocket motors. Two companies have currently certified hybrid motors with Tripoli, Aerotech and Hypertek. The advantage of hybrid motors is that they use totally inert fuel grains, such as a cast polymer plastic or compressed paper pulp, which do not have any DOT or ATF restrictions. With both motors, nitrous oxide is used for the oxidizer.

4.2.3 Competition

One notable difference between the time I left the hobby (late 1970s) and today is that competition rocketry is not as popular as it once was. It used to be that one would see 30 or more people at an NAR regional, but today it sometimes seems like you are lucky if you get enough people to show up. Because I got back in to the hobby to fly competition, I am concerned about the apparent loss of interest in competition rocketry.
Still, competition is NOT dead, no way. Yearly NARAMs are still held, and are well-attended. About half of the NAR sections still host meets, or have members that fly competition. The rest fly sport and/or high power rocketry only.

4.2.4 High Power Rocketry

Now there is also HIGH power rocketry (HPR). These are rockets with motors up to type O (with greater than 40,000 Newton seconds of impulse). There has been a lot of discussion about high power recently. You have to be a member of either the NAR or Tripoli to fly rockets with H motors or above. To fly with H or above both organizations require that you be 'certified' by safely demonstrating a successful flight with a high power model in the presence of one or more 'qualified' members of the organization. There is now a HPR safety code as well as the original model rocketry safety code. There are expendable and reloadable (discussed below) HPR motors available. They are increasingly expensive as the power goes up ($13 for a G up to hundreds of dollars for a really big (O) motor). High power rockets start where model rockets leave off (i.e., > 1500 grams). High power models weighing more than 50 pounds are not uncommon. The record weight for a high power flight is over 1000 pounds.

Oh, yes, HPR requires a duly authorized, signed-in-blood (in triplicate, etc.) FAA waiver for each day you wish to fly. It is ILLEGAL to fly high power rockets without a proper waiver. See Part 10 of this FAQ for more information on FAA waivers.

Depending on the type of motors you buy, use, and store, as well as where and how you buy them, you might need some additional, FEDERAL, permits

for high power rocketry. More on this below, and a lot more in Part 1 of this FAQ.

4.2.5 Electronics Advancements

Advances in electronics technology have created many opportunities for new ideas in consumer rocketry. Electronic ignition of upper stages of multi-staged rockets is now common. Several altimeters more recording maximum altitude are available. Electronic deployment of recovery devices, as well as deployment based on altitude, is now practical. The FAQ section on High Power Rocketry has more to say about this. See Part 2 of this FAQ for addresses of some companies selling rocketry electronics.

4.2.6 Regulations, Regulations, Regulations

There is some good news and some bad news concerning rules and regulations relating to consumer rocketry. On the positive side, you can now buy up to G power motors in most states. Also, some states, such as New Jersey, have recently relaxed restrictions on model rockets. There is a menacing down side as well, though. California still has some of the most restrictive regulations in the country. The ATF and DOT have both become quite interested in high power rocketry and have begun enforcing shipping and explosives regulations. Read the current regulatory summary in Part 1 of this FAQ.

4.3 Are my old rocket kits worth anything today?

With all of the BARs coming back into rocketry, many wanting to rebuild some of their favorite kits from their youths, models rockets have become 'collectable'. In fact, the demand for some classic kits has gotten quite high. The explosive growth of the internet has helped fuel several recent 'class kit' auctions. Model rocket kits from the late 60's and early 70's can still be found, but be prepared to pay quite a premium. It isn't unusual to see what was a $5 kit from the early 70's going for $50 or more in an auction. Remember the 1/70 scale Estes Estes Saturn 1B? It cost $11 in 1970, $15 in 1977. If you bought one today at a model rocket auction, it is doubtful that $200 would get it. How about the Maxi Brute Pershing 1A, which sold for $17 in 1977? That kit, in good condition, might bring over $150 today.

Old kits that are still in their unopened, original packaging, might be worth something. Once you open the package, the value drops. Missing or partially constructed pieces lower the value even further.
So, all you BARs with old kits up in the attic might want to think twice before ripping open the boxes and finally building that Orbital Transport you got on your 12th birthday.

Opinions about the collectibility of old kits varies on r.m.r. Some frown on collecting kits, and feel the rocket should be built and flown for maximum enjoyment. Some would consider building the old kit a great loss.

Others take a middle road, and "clone" the kit - produce a duplicate, and keep the original. Still others create scaled-up versions of old kits for HPR flying fun. Regardless of what you do with it, old kits can be a lot of fun, and there is even a magazine devoted to collecting old kits (see Part 2 of this FAQ under books and magazines).

Those interested in cloning an old kit should check out the PLANS subdirectory of the r.m.r. sunsite archive.

http://sunsite.unc.edu/pub/archives/rec.models.rockets/PLANS

Plans for old kits not in the archive are out there, usually for just the asking. Post a request. Chances are someone has plans for that favorite oldie.

Where can I find plans of old kits?

Plans of old kits are available. The r.m.r. sunsite archive has a few old kit plans, and hopefully, there will be more in the future.

Old kit plans available on the sunsite archive are:

- Estes Avenger (2 stage model)
- Estes Cherokee-D (first D motor kit for many)
- Estes Cobra (3 engine cluster)
- Estes Drifter (competition parachute duration model)
- Estes Farside (big 3 stage model)
- Estes Gyroc (gyro-recovery model)
- Estes Mark (classic model, essentially the same as a Mark II)
- Estes Nighthawk (canard boost glider)
- Estes Pegasus (scale-up plans)
- Estes Ranger (3 engine cluster version of a Big Bertha)
- Estes Scout (classic, one of Estes first models)
- Estes Sprite (ring tail, mini-model)
- Estes Starlight (unique design)
- Estes Trident (old timer favorite)
- Estes X-Ray (classic payloader)

Centuri Payloader II (classic beginners kit)

To get to the r.m.r. plans archive, try:

http://sunsite.unc.edu/pub/archives/rec.models.rockets/PLANS

http://www.cmass.org:8000/sunsite.unc.edu/PLANS

Other sources:

Doug Holverson scanned the paper shrouds of:

Centuri Vulcan

Centuri X-24 Bug

You can find them on his web site:
http://www.probe.net/~dholvrsn/fanghome.html

Estes Mars Lander plans online:

Richard Pitzeruse <rmpitzer@mailbox.syr.edu> tells us:
OK folks, I FINALLY got the Mars Lander plans on my webpage.
They are scanned in at 300 dpi, 1 bit/pixel. They are saved as
tiff files (uncompressed) and then zipped into 2 different files.
Feed back is welcome and encouraged!
To get directly there, point your browser at...
http://128.230.82.205/RocketPics/plans/lander.html

List of every Estes kit ever made:

Tom McAtee <m219487@SL1001.mdc.com> wrote:
OK! I uploaded it to Sunsite...
The file is called ekdir.txt (for Estes Kit Directory)...

http://suniste.unc.edu/pub/archives/rec.models.rockets/LISTS/ekdir.txt

Jim Zalewski's site:

Jim <jimz@rust.net> tells us:
I just added some plans to my webpage.
Check them out and let me know what you think.
http://www.rust.net/~jimz/rp1.htm

Estes Andromeda plans online:

Lemeul E. Bryant <bryantl@swbell.net> scanned the Andromeda decal sheet:
A scan of the Decal sheet for the Estes Andromeda is available at

http://www.geocities.com/CapeCanaveral/4491/index2.html

It's not best scan in the world but it is better than nothing.
The decal sheet measures about 3 1/2 by 13 1/2 inches.
The colors are red and white with a yellow background.

Estes Bomarc (Citation Series) plans online:

Ed Bertschy <bertschy@azstarnet.com> put plans for the Bomarc online:

Complete full size templates of the Citation BOMARC wings, fins,
pods, ramjets, and re-engineered spine will be posted on my site
in .dxf and .bmp format for downloading. These measurements and plans
were drawn up from xeroxes of all the original parts. A color scan of
the decal sheet will be posted as well. You will find them at:

http://www.directfx.com/~ed

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 5: Model Rocketry

Posted: November 17, 1998

Last modified: November 17, 1998

5.1 Can I legally fly model rockets in my state? What are the restrictions?

Several states still require some type of permit to fly model rockets. The requirements vary greatly between the states. Also, local municipalities are free to impose additional restrictions beyond those defined in NFPA 1122 and any state laws. Check with your local fire marshal for restrictions in your area. For example, the states of Rhode Island, and California have stricter regulations than NFPA 1122.

5.2 When do I need to notify the FAA before flying a large model rocket?

Large Model Rocket (LMR) is an FAA designation for a model rocket that is between 454 grams (16 ounces) and 1500 grams of mass, including propellant, -OR- contains more than 113 grams (4 ounces) but less than 125 grams of propellant (all motors).

Please note that this definition is different from the definitions of a model rocket found in NFPA 1122 and 1127-94. Some rockets may be defined as LMR by the FAA, but are actually HPR according to the NFPA.

If you are planning to fly a Large Model Rocket as defined by the FAA, you must notify the "FAA ATC facility nearest to the place of intended operation" 24-48 hours before launch.

FAA notification requirements appear in FAR 101, and all of the pertinent regulations appear in Part 10 of this FAQ.

A sample FAA notification form is available at the sunsite archive at:
http://sunsite.unc.edu/pub/archives/rec.models.rockets/FAA/FAR101.22.notice

From Bob Kaplow (robert_kaplow@hccompare.com)

"you need to find the right FAA office to notify. If you don't know where they are, call 1-800-WX-BRIEF, and ask a briefer for the proper place to call. Get an FAA map of your area. From that you can get latitude/longitude, and radial/distance from your launch site to a nearby VOR. Call 24-48 hours before the launch and give them the information.

I usually write a letter and mail/fax it to the folks first. That way they have everything in writing. As a courtesy, I also call the closest flight service station (FSS - ask the folks at 1-800-WX-BRIEF where they are) and ask them to issue a locak NOTAM. Get the "L" number as proof that you called."

5.3 I have a son/daughter that is (less than 9) years old. Is this too young for model rocketry? If not, are there any tips for helping to keep their interest in the hobby?

Model rocket manufacturers all recommend adult supervision for young children (usually, those under 12). Many parents have had great success introducing these children to model rocketry. Here are a few of the tips and suggestions posted to r.m.r:

From cdt@rocket.sw.stratus.com (C. D. Tavares):

Children under 10 or 11 do best in the hobby when a parent participates actively with them. Introduce them to simple, skill-level-1 kits with plastic fin units. Build yourself a rocket at the same time, then go out and fly them together.

From jack@rml.com (Jack Hagerty):

My own experience with my son (now 5 1/2, we've been flying since he turned 4) is not to expect too much sustained interest at a time. Even though my son has a longer-than-normal attention span for his age (he'll watch a whole two hour movie!) and loves the whole idea of building and flying rockets, after 4 or 5 flights (approx. 1/2 hour) he'd rather go play on the monkey bars at the adjacent school. This is magnified if there are any kids his own age around (such as his cousins that sometimes come with us).

From dwade@jarthur.Claremont.EDU:

Watching they should enjoy. Pressing the button they should enjoy. Prepping with serious supervision. Building simple kits with some supervision and a pre-launch check. There's a huge difference in responsibility between kids. One thing to stress is that a lot of very careful kids will get bored or get pressured by bored friends to do stupid things when you're not around. I might not let kids have any access to motors when unsupervised -- and there's no real reason why that should cause them any trouble. It is possible to make safety fun, you know. I think that's something that a lot of people miss -- if you present things that way, it seems to work out. I don't have kids, but I've got rocket launching friends who do.

From J.COOK@ens.prime.com (Jim Cook):

I've successfully built an Athena and an America with a 7 year old. The body tube is pre-painted, the decals are self-adhesive, and they like the gold or silver chrome nose cone. You can build it in an hour or two - just let them run around and call them over to help periodically - "glue here", "cut here", "hold this". They feel it's still their rocket and that they helped. Estes new E2X series may also be similarly suitable, but I haven't tried, yet [ed. note: the E2X series go together with plastic model cement, such as Testors, not white glue].

Estes' new E2X series is similar in construction to the Athena and America - they can be built in an hour or two with kids.

Demo a range of motors. Go from 1/2A to A to B with a model to show kids the difference.

Kids will invariably talk about launching them out of sight or sticking a fireworks in them. Answer with, "yeah, but I wouldn't want to wreck my model that I spent so much time building." Making the kid answer forces him [or her] to think and teaches him [her] to value his [her] possessions.

From bmcdermo@ix.netcom.com (Buzz McDermott):

When my 10 year old son and I started building rockets together about 2 1/2 years ago, we started with some of the level 1 Estes kits with plastic fin units and nose cones, such as the Athena and Alpha III. He has also built a couple of the Estes E2X series, which requires use of plastic cement. He also likes the Quest Falcon (plastic fins) and Estes Big Bertha (balsa fins) because they are both big enough to use C motors and not loose the models.

My 7 year old daughter and I started building rockets about a year ago. She prefers the Quest models with the colored parts. She also finds the Quest parachutes, with their large adhesive connections for shroud lines, easier to build. The Quest Falcon is a large, easy to build model. Now she likes building some of the Level 1 kits with balsa fins. She has built the Estes Alpha and Quest Sprint.

From jstewart@software.mitel.com (John Stewart):

My daughter loves rocketry. She started when she was 3. Get colorful rockets, build them yourself (e.g. the plastic Alpha III), and don't fly them too high. (50-100' is more than fine) Let the child count to 5 (or try to!!) and push the button. Let them recover the rockets. Have say, 5 to 10 rockets loaded, ready to go when heading out. Launch them, and untangle/fix them either at the field, or at home later, depending on the child's mood. My 4-3/4 year old daughter is looking forward to launching, possibly this weekend. We spent a year in New Zealand, but she still knew all about the rockets, the parachutes, the streamers...

From rbs@cyclops.micr.Virginia.EDU (Robert Sisk):

People interested in easy to build model rocket kits for the younger

crowd should check out QUEST models. Some of the parts are color coded (centering rings, engine blocks, engine mount tube) and the fins of some models are plastic. Some of the fins are supplied as a single unit that you glue into place. Fast, easy, and with little or no sanding!

From wayne@pen.k12.va.us (Tony Wayne):

I reconstructed my launcher so that me 2.5 year can launch the rocket. The launcher is homemade and uses a shorted out 1/8 mini plug for the safety key. For my son, I attached an 8 foot loop of wire with each end attached to the poles of the mini plug. In the middle of the wire loop is a film canister with a push button. To launch the rocket I have to push the button on the launcher and my son has to push his button too! (When connecting the igniter to the launcher, I carry his launch button with me.)

He's practicing counting by leading the countdown. (Q: Is "bi-leven" greater than or less than 4?) He checks the airspace as well. ("Look boss! De'plane.") Also when we go to the field, my rockets are ready launch. For about 20 minutes things happen fast. When we are done there are rockets littering the field. We then fetch them. (He "flies" a few of them back to the pad.) His mom has to come too as diversion after fetching so I can prep and go again.

5.4 Is there any way I can buy model rocket kits, parts and engines at less than full retail?

Three mail order houses have been recommended several times by posters to r.m.r. They are Belleville Wholesale Hobby, Magnum Rockets Hobbies and More, and Mountainside Hobbies. Belleville sells MRC at 40% off list, Custom Rockets at 35% off list, and Estes at 30% off list. There is a minimum order requirement. Magnum and Mountainside sell most all of the major model and high power rocket lines. Both Estes and Aerotech model rocket motors and reloads are sold. They both advertise Estes at 28-33% off of list. Magnum will also discount educational sales (such as to schools, Scouts, YMCA, etc.) at up to 40% off of list.

Another potential source for a large discount, if you are buying several hundred dollars worth of parts at one time, is America's Hobby Center. They offer discounts of up to 40% off of Estes' list price on orders of over $400.

There are several other mail order sources that sell at discount. Some of the smaller manufacturers/suppliers of model rocketry kits and supplies are a substantial bargain. For the addresses of the sources listed above, and addition sources, refer to the 'Names and Addresses' section of this FAQ (PART 2). Shop around. There are bargains to be found.

If you do a fair amount of flying, Estes sells a 24-pack of engines called the Flight Pack. It comes with 6 A8-3, 6 B6-4, 6 C6-5, 6 C6-7, recovery

wadding and igniters. It generally retails between $32-36, which is less than the list price of the materials included. This can also be purchased at an additional discount from some mail order houses. Estes also sells 'bulk packs' of 24 A8-2 or B6-4 or C6-5 motors.

Quest motors have been recommended by several r.m.r posters. At the present time, they retail at less than the Estes equivalents. They can also be purchased direct from Quest 'bagged' in quantities of 10 or more. 'A' motors can get to less than $1 ea. when bought 50 or more at a time. 'C' motors get down to around $1.25.

You might also investigate your local NAR section, if one is located convenient to you. Clubs such as NAR sections often arrange discounts with local hobby merchants. Several of the clubs also have at least one member selling parts and supplies at discount, mostly to the club members.

5.5 I've had a large number of motors CATO recently. The engines are only about 2 years old. I've had them stored in my (attic/garage/basement).

From J.COOK@ens.prime.com (Jim Cook):

Black powder motors tend to suffer catos when they are temperature cycled. If you expose them to heat, be it storing them in the attic, on your car's dashboard, or in your metal range box in the hot sun on the launch field, you may have problems. The engine expands with the heat, but when it cools, the propellant separates from the casing inside This causes the propellant to burn faster due to burning on the side generating more pressure than was designed for, and ...boom...

Storing black powder motors in a damp basement can cause the compressed clay nozzles to soften and also blow out. If you must store your motors in a damp/humid area, put them in a zip lock plastic bag.

[Note: There is an excellent article by Matt Steele in the May/June 1992 issue of Sport Rocketry. This article goes into the theoretical reasons why black powder model rocket motors fail]

5.6 Is it safe to use my old rocket engines from <nn> years ago?

From J.COOK@ens.prime.com (Jim Cook):

I've had properly stored engines from 1972 and 1975 work just fine. If you suspect a motor, fire it by burying it in the ground with just the nozzle showing, pointing up and use your launch system to ignite it as usual. [Note: be sure and stand at least 15-20 feet away from the motor when you fire it: Buzz]

5.7 What's a good way to find other rocket enthusiasts in my area? How can I found out about local rocket clubs?

The NAR sends a complete list of its local sections (NAR sanctioned clubs) with each new member's information packet. If there isn't

a sanction near you they have a service to send you a list of other NAR members in your area, so that you can form your own section.

5.8 Are the Aerotech composite motors the same size as Estes/MRC/Quest motors?

Aerotech makes the following 'standard' retail motors in -4 and -7 second delays. The first two motors are the same size as Estes A-C motors. The next two are the same size as Estes D motors. There are some other 24mm motors that are available from Aerotech that are longer than Estes D motors. Some of these 'non-standard' Aerotech 24mm motors are listed after the four 'standard' ones. The F and G motors may be obtained from some dealers and mail order sources, but are not packaged for retail sale.

Motor	Size	Power	Same Size As
D21	18x70mm	20NS	Estes/Quest/MRC A-C
E25	18x70mm	22NS	Estes/Quest/MRC A-C
E15	24x70mm	40NS	Estes D motor
E30	24x70mm	40NS	Estes D motor
F32	24x124mm	80NS	Non-standard size
F44	24x101mm	70NS	Non-standard size
G42	24x144mm	90NS	Non-standard size
G55	24x177mm	125NS	Non-standard size

Aerotech makes and sells reloadable motor casings and reloads in 18, 24 and 29 mm sizes. The 18mm is the size of an Estes C motor. The 24mm is the size of an Estes D or Aerotech E motor. The 29mm is the size of an Aerotech G motor. Aerotech High Power, formerly ISP Consumer Rocketry division, makes a 60NS F and 100NS G casing, both 29mm in diameter.

5.9 Can I use Aerotech or other composite motors in my Estes rockets?

Yes and no. They are the same size. Composite motors have 2 to 3 times the power of comparably size BP motors. Balsa-finned 18mm powered models tend to loose body parts in quantity when launched with a D21 or E25. The ejection charges seem to be hotter, as well (IMHO). The same holds true for Aerotech 24mm motors. Care should be taken before launching a 24mm-based model on an E15, let alone an E30. I have an old MegaSize that I fly on E15-10's. Works great. The Estes Saturn V flies well on E15's, too. E30's tend to shred all but the strongest D models, though. E30's also tend to relocate motor mounts to someplace OUTSIDE of the rockets, as well. If I plan to use E's in an Estes model I make it a point to reinforce the motor mount, especially for EM-2060, EM-2070 and EM-5080 mounts. You also want to use an engine block (a 2050 adapter ring works great) in addition to the metal clip. IMO, I would also reinforce fin/body tube joints. Five minute epoxy fillets work great. Generous cyano fillets also seem to work well. White glued fins don't seem to survive E15/E30 launches with any consistent success

(i.e., the failure rate tends to be > 50% :-). Many modelers also recommend that stronger 24mm motor tubing, such as that from LOC or Aerotech, be used for models flying with composite motors. The stronger tubing holds up better to the ejection charges of the composites.

There are now several D and E reloads available for the 18 and 24 mm casings that might not over power 'standard' model rockets. The RMS motors have a variety of reloads available, some with fairly low average impulse.

5.10 Will my Estes launch system work with Aerotech composite motors?

The classic Estes, Quest and MRC 6 volt launch systems will not reliably ignite the Copperhead (TM) igniters that come with Aerotech motors, and Estes Solar Igniters (TM) will not ignite a composite. These motors need 12 volt systems for reliable ignition.

5.11 Can I use Aerotech composite motors as boosters in my multi-stage rockets?

Basically, NO. Black powder booster motors will not ignite composite motors. Therefore, you cannot use a composite upper stage in a traditional multi-stage, black powder rocket. Also, there are no composite booster motors currently in production. They all have delays (4 seconds being the shortest current delay from Aerotech, for example) or are plugged. Typically, you cannot (and should not) use these as boosters in standard black-powder multi-staged rockets.

If you want to use composite motors in multi-stage models then you have to use other methods of igniting the upper stage (whether black powder or composite) than are used with black-powder-only rockets. One method is to electronically ignite the upper stage motor using a mercury switch to complete an electrical connection to a capacitor at first stage burn-out. This, in turn, sets off a flash bulb/thermalite fuse combo which ignites the upper stage motor. Another method is to ignite lengths of thermalite fuse at the time the booster is ignited. The length of fuse determines the delay before the upper stage is ignited. Refer to the 'Other Sources of Information' section in Part 1 of the FAQ. The NCR High Power technical reports on staging composite motors is applicable to multi-staged, composite motor powered model rockets as well.

Bob Weisbe uploaded plans for a mercury switch-based staging system that he used in a converted Estes Terrier-Sandhawk kit. The URL for these plans is:

http://sunsite.unc.edu/pub/archives/rec.models.rockets/PLANS/terrier_sandhawk.ps

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5.12 How can I tell the age of my Estes motors?

Estes uses a date code on their rocket motors. It's of the form XXYZZ (example, 25T9) where the first number is the day of the month of manufacture, the letter is a code indicating year of manufacture, and the last number is the month (1 = January, 12 = December). Date codes run progressively through the alphabet, as follows:

T	1989
U	1990
V	1991
W	1992
X	1993
Y	1994
Z	1995
A	1996 - Estes cycled back to the beginning of the alphabet

In the early 70's, Estes motors had the actual date stamped on them.

5.13 Are reloadable model rocket motors shipable the same as disposable model rocket motors?

The Aerotech RMS line of model rocket reload kits (of B through G power levels) has been certified by the DOT for shipment as Class C Flammable Solids. This means that the reload kits may be shipped the same as other model rocket motors, such as those made by Estes and Quest.

There are no shipping restrictions of any kind on the motor casings and closures.

5.14 My flying field is so small I keep losing my rockets. What can I do?

DON'T GET DISCOURAGED. Everyone loses rockets. It's part of the hobby. There are ways to minimize this when you're forced to fly in smaller fields, though. The following is a consolidation of tips posted to r.m.r by numerous individuals:

Recovery Modifications:

1. For smaller rockets, use a streamer instead of a parachute. This can be done with rockets of up to BT-50 body tube size and up to 18" long. Be sure and check rocket weight, though. If the model uses heavy plastic fins you might still want to use a parachute.
2. Reef the chute lines to reduce the effective surface area. Tie or tape the shroud lines together 1/3 of the way from their end. This reduces the shroud lines to 2/3 of their original length and prevents the chute from fully opening. The rocket will come down faster and drift less.
3. Cut out the Estes or Quest logo from the center of the chute. This lets more air spill through the chute and reduces its drag. Be careful to cut out the whole logo. Cutting only a small whole (say, less than 2" in diameter) can improve the chute's stability and actually make it lift better and drift further.
4. Use a smaller chute. Try cutting down an 18" chute to a 15" chute, or a 12" chute to a 10" chute.
5. Use longer ejection delays. If a B6-4 ejects the parachute right at

apogee, use a B6-6 to let the rocket come down a little before popping the chute. Less time chute is open equals less drift. Take care in making the chutes and recovery attachments extra strong, though, as the descending model will put more strain on the recovery system than if it were to deploy at apogee.

Other Suggestions:

1. Find a different field. If you fly alone, try and find a local rocket club. The odds are the club will have found a better field in which to fly.
2. Fly larger rockets. A Big Bertha on a B6-2 will drift a lot less than a Sky Hook or other small model on a B6-4 or B6-6. Larger models have more impressive liftoffs, as well. Larger diameter rockets don't fly as high and come down faster than the really small ones. The big ones are also easier to spot in high grass, weeds, trees, etc.
3. Use smaller motors. If the recommended motors for a rocket are, for example, A8-3, B6-4 and C6-5 or C6-7, try it on A8-3's first. If the model lands well within the recovery area you can then decide if the larger motors will allow the model to be retrieved.
4. Launch rockets at a slight angle into the wind. The rockets will weathercock and deploy recovery systems upwind. If all goes well, they will land closer to the launch site.

5.15 Are Jetex engines still available? Where can I get them?

Although, technically, jetex type products are NOT model rocket motors and do not fall under NAR/NFPA guidelines and safety codes, a number of questions do pop up about these on r.m.r. The following sources have been quoted on r.m.r as selling Jetex products:

Peck Polymers
P.O. Box 2498
La Mesa, CA 92041

Doylejet
P.O. Box 60311
Houston, Texas 77205
(713) 443-3409

5.16 BT-20, BT-50, BT-55. What the heck do the numbers mean on Estes body tubes? Is their any special meaning in these numbers?

From: PeteAlway@aol.com (Peter Alway)

Estes tube numbering seems to have progressed like the numbering of steps in a BASIC program. The very first Estes Catalog had numbers unlike the BT-20..BT-50... etc. system they use now. Sometime in the early 60's they gave numbers 10, 20, 30, 40, 50 to their tubes in order of size. 10, 20, and 30 were almost identical in diameter (though 10 could be coaxed to fit into 30) All were meant to hold 18 mm rocket engines. BT-10 was an ultra-light spiral-wound mylar, BT-20 was essentially as it is today, and BT-30 was a parallel wound heavy-duty tube. BT-40

was also a parallel wound heavy tube that fit over BT-20. (rather like Quest T-20, but thicker and parallel wound.) BT-50 was as it is today, as was BT-60. BT-5 came along later, I believe created for the top of the Aerobee 300, and numbered halfway between 0 and 10. BT-55 came along after BT-60 and was numbered to fit in. PST-65 egg tubing came after the much larger BT-70 (originally used just for the Sprite tail ring) BT-100 and BT-101 first appeared in the 1/70 scale Saturn IB. BT-80 was created for the Saturn V. It is interesting to note that two standard HPR diameters, 2.6" and 4" began as scale model components. Estes also created BT-3 for the Saturn IB, and BT-51 for the tanks. BT-52 was produced for the BT-60 Semi-Scale Saturn V, and this tube still appears as a hook-retaining sleeve on some Estes D engine mounts. The sleeves are still correct for a 1/242 Saturn V. Many BT-5 clone kits still use the length for an Aerobee 300.

5.17 I've seen mention of all kinds of rocket motor types and sizes. Could you give a brief history and summary of the main marketing names for model rocket motors?

From: msjohnso@WichitaKS.NCR.COM (Mark Johnson)

The original hand-loaded motors made by Orville Carlisle and sent to Harry Stine in about 1956 were 0.5 in dia. (13mm) x 2.25 long (55 mm). These were used in early testing up until the time Model Missiles Inc (Stine's company) began to produce commercial product in sufficient quantities that Carlisle could no longer make motors fast enough. These had total impulse roughly from today's 1/2A to about the middle of the B range.

Stine contracted with Brown Fireworks Co. of Missouri in 1958 to make mass-produced motors. Brown could have made them in the same size as the Carlisle motors, but it would have meant costly new tooling. Mr. Brown offered to produce a low-cost motor for MMI using his "Buzz Bomb" case size - 0.7 x 2.75 in (18 x 70 mm) - the Buzz Bomb had a small aluminum blade on one side of the case and a nozzle drilled into the side of the case opposite, where a fuse was inserted. Strictly a fireworks piece.

In about 1959 or 1960, Vern Estes entered the picture, having offered to produce motors for less than whatever price MMI was paying Brown. G. Harry took him up on the offer, and Vern began making motors in the now-standard 18 x 70 mm size. He quickly automated production with the first of several "Mabel" machines and was able to make far more motors than MMI needed. That's when Estes entered the model rocket business himself.

The short motors were 1/4A and 1/2A motors which came about in around 1963 or 64 when somebody at Estes realized that the upper 1" of the casing had nothing in it, and was just dead weight. So Estes started producing the "S" series, with a case size of 18 x 45 mm (0.7 x 1.75 in). These continued in production until 1970 or so.

In about 1970 or 1971, Stine (whose MMI had gone out of business somewhere around 1962) reentered the hobby as a paid consultant to Model Products Co. (MPC), which later spun off its rocketry business as AVI (Aerospace Vehicles Inc). Stine persuaded Mike Bergenske that there was a market for

the "classic" 13 x 55 rocket motors as a high-performance motor, in sizes from 1/4A to B. These were the Mini-Jet motors, which quickly resulted in rewriting the NAR altitude record books. Estes followed suit with its mini- motor line, originally trademarked "Mini-Brutes" with the 13mm diameter but choosing to go with a length compatible with the old "S" series at 45 mm (so they could use the old "S" series engine hooks, I presume). Centuri's "M" motor series, in sizes from 1/4A to B, were released at about the same time. These were 13 x 50 mm (0.5 x 2 in)

The other "standard" motor type which emerged about this time was the Estes "D" motor, which was sized to fit easily in the BT-50 or 25mm tube, while keeping the 70 mm length constant (save the engine hook tooling again, I guess). These first hit the marketplace about 1969; I still have the original announcement flyer somewhere in all my old files. The 24 mm diameter has become the "small high power" standard for D, E, F, and even a few G motors, mainly from AeroTech. Estes chose to keep the existing standard diameter and extend the length on their new E15, introduced during 1993.

The 29 mm standard motor emerged from the Enerjets. The original Enerjet-8, a fiberglass-cased motor developed and produced by Rocket Development Corp. of Indiana (RDC, later acquired by Centuri as Enerjet, Inc) was an external-delay, 29 mm diameter motor with about 35 N-sec of total impulse (8 lb-sec). The Enerjet-8's external delay was too cumbersome for unsophisticated users, and was replaced by a conventional internal delay when the Enerjet E24, F52, and F67 were introduced in 1973 by Enerjet and Centuri, its parent. The F67 was the first full 80 N-sec F motor produced in the US.

FSI is a bit of a cipher in all this. They chose to go with a 21 x 70 mm motor for A, B, C, and small D motors, beginning in about 1966 or so. Their full D and small E motors are in 21 x 95 mm cases. (D18, D20, and E5). The larger FSI motors are in 27mm cases of various lengths. The E60 is about 95 or 100 mm long, and the F7 and F100 are 125 mm. FSI started producing 18 x 70 mm A, B, and C motors in about 1985 or so.

5.18 Why don't I just make my own model rocket motors? Shouldn't I be able to custom-make better, more powerful motors, at a cheaper price?

This subject has been hotly debated on r.m.r. It is one of those 'emotional' subjects that find people either firmly for or against. The following post from Lawrence Smith probably says it all best.

From: thesmiths@mv.mv.com (Lawrence Smith)

In our pre-made, factory-produced society there is a bit of nostalgia for doing things the "old-fashioned" way - "home made" carries with it the feeling of being somehow "better". It could be tastier, more durable, easier to maintain, or cheaper, it is some quality that we don't find in mass-produced items. It is therefore natural for fans of rocketry to look at the prices of the ingredients of an engine and think to themselves that such engines really can't be all that difficult to make - and that "home made" might be not only cheaper, but

just as good as factory engines in other ways.

There is a grain of truth here - **just** a grain - but that is enough to make the idea pretty dangerous. Most readers of this will not be old enough to remember the "Basement Bomber" headlines from the late fifties and early sixties. Making solid-fuel rocket engines **is** a pretty dangerous proceeding, unless you do it **right**. And even if you do it **right**, you must be **consistant** in following the safety precautions. It really won't matter whether it is the first or the fiftieth engine that blows your hand off in the long run. It is the need to watch the safety precautions that is your first "hidden cost", something that most people dreaming of home-made engines seldom add to the calculation.

You need **room**, you can't do it in your basement, nor, indeed, in your house at all. Nor in your apartment, nor in your school chem lab, nor anywhere else there is something you don't want blown up. You must **assume** the engine **will** blow up, and ask yourself where it would be okay. Maybe an outbuilding on your property, maybe out in some field. You need **space** to build engines. You either need to own that space or have the permission of people who do, too.

In most places in the country, you need some sort of **license**. Rocket engines are first cousins to pipe bombs, and there are few municipalities that would care to have you building those. On the other hand, there are many municipalities that don't care if you reload spent shotgun shells, even without a license. You need to know and understand the local regulations. You are not building a class "C" toy propellant device. Even if you **think** you are. That is a legal name, not a descriptive one.

You **can't** reuse Estes or other maker engine casings. Spent casings have undergone considerable stress, they can no longer be guaranteed to hold if reloaded and fired again. Yes, they have a fairly consider-able safety margin. It isn't enough to reload them.

You **can't** use the same stuff Estes uses, nor can you easily obtain composite fuel. Estes uses black powder - gunpowder - but they are using a special formulation, not just mixing the usual ingredients. In fact, it's pretty dumb to use any powder at all. Powder must be rammed to make it solid enough for "solid fuel" - that means you have to pour the powder into the casing and then take a stiff rod and ram it up and down, like one of those old-time muskets. Ramming will compress the powder - which is the objective - and will also heat it, which will also make it more shock-sensitive, not to mention the heat from the friction of the rod itself moving up and down in the casing. It can also raise dust, which is also more easily ignited than a solid slug. A fellow by the name of Jim Flis posted a commentary on creating such engines, I recall. If anyone saved that post, I'd like to see to see it inserted here.

Even if you manage to pull off all the above, the engine may not perform like you expect. Your ingredients may not be up to snuff, or maybe you didn't ram enough, or maybe something else got mixed in by mistake, or

maybe you forgot to add the final layer to the casing - whatever. There is a real good chance any home-made engine is going to do serious damage to your rocket, even if it didn't do any to you. One of the things you pay for from Estes and Quest is **qualitycontrol**. And even with professionals with years of experience with A, B, and C engines, Estes has problems with D and E engines. Can you really do better?

Estes, Quest, and the others have **time**, they have **equipment**, they have **space**, they have **quality control** and lastly, they have **liability insurance** for when something happens with one of their engines. **That** is what you are paying for, not just a couple teaspoons of black powder and a bit of clay and cardboard. As you can see, there is more than meets the eye in an Estes or Quest engine. The fact of the matter is this: a premade, off-the-shelf engine **is** cheaper, more reliable, and far, far less effort to obtain. There is really no reason to try to duplicate a standard engine.

That said, there will remain a small core of people who still want to roll their own. Maybe they need a non-standard size, or they just are more interested in the engine than in the rocket. Before you proceed, you will need a copy of "Rocket Manual for Amateurs" by Bertrand R. Brinley, Capt. It's out of print, so you'll have to do some looking. If you aren't patient enough to track down a copy then you aren't patient enough to build engines. Take the hint.

Brinley gives a good overview of propellant technology up to the mid-sixties or so, which is good enough for you, since the advances have mostly been in the realm of "real" rockets with incredibly exotic chemistry. He concludes that amateurs should stick to zinc and sulfur. Zinc and sulfur can send rockets high enough to need an FAA waiver, so this is really not limiting. Also, though zinc and sulfur can be rammed, they can also be mixed with acetone or alcohol to form a putty that can be inserted into a casing and cast into shape. This he terms "micrograin". I won't go into detail on proportions or other information, you'll have to find the book. **I'm** not telling you how to build an engine, **I** won't do it, and I don't think **you** should, but if you are anyway I want you to be aware of what you need to do to succeed, for if you fail the consequences will be horrible.

While Brinley is helpful for fuel, he is more valuable for the kinds of safety precautions you need to take. You are going to need sandbags. Take the hint.

One thing Brinley assumes, though, is using metal cases, including CO2 cases for small engines. This will **definitely** make your rocket require an FAA waiver, and the metal content will make it easy to spot your rocket on radar, so you better not try to mickey-mouse it. Of course, the FAA will **not** be forthcoming with a waiver for an experimental free-flight rocket, unless you are launching from someplace in the southwest desert area, and maybe not even then. In a way, this is an advantage. A metal-encased engine will fragment when it explodes, and is far more dangerous that one in fiberglass or carbon fiber. Also, metal is far more likely to cause a spark somehow than are non-metallic components, and so are safer to handle. This limits the size and

materials you can use.

You will need to improvise on Brinley and develop a fiberglass or carbon-fiber casing and clay or other material nozzle. I have an ulterior motive for mentioning this, and I admit it freely. Making a casing like that is not trivial to begin with, and you will find it's pretty expensive, both monetarily and in terms of time. If that still does not deter, at least you will be encouraged to make your engines **small** - which will make the process safer, for there will be less to explode. I have no idea how thick the casing needs to be, nor would I say if I did. Again, you need to do your home-work.

If you take the advice in this post to heart, you will not make a rocket engine. If you take only some of it, you will build a much smaller engine, in a casing less likely to become deadly shrapnel (not **un**likely, just **less** likely), and with techniques less likely to cause an explosion. You will be doing it with the advice of a professional (Capt. Brinley, not me) and hopefully will succeed, and then either give it up or go legit and start a career with Morton Thiokol. Who are, of course, the makers of the shuttle SRB's used on the last flight of the Challenger, just in case you thought being a professional meant that you had everything figured out.

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 6: Model Rocket Construction and Finishing

Posted: November 17, 1998

Last modified: November 17, 1998

This section includes tips and suggestions on various topics having to do with construction and finishing techniques. These have been posted to r.m.r or mailed to the moderator by way of r.m.r request. Refer to the High Power Construction section for additional tips, oriented towards high power and advanced rocketry requirements. Even more construction tips can be found in the Scale Modeling section.

[Note: This part of the FAQ is maintained by Robert C. Santore (rsantore@MailBox.Syr.Edu)
Any additions or corrections should be sent to that address]

6.1 Cutting, Sealing, Attaching Fins

From: JCook@Epoch.COM (Jim Cook)

Skip using glue W/ balsa dust, dope, or any other junk for filling the grain in balsa fins or nose cones. Use Elmer's "Fill 'n Finish" diluted with water to a thick paint (like white glue is) and paint it on. Non-toxic and a coat or two will do. Use Elmer's "Carpenter's Wood Filler" thinned similarly to fill the spiral in body tube. Both come in a white plastic tub with an orange lid. Note - the latter is harder to sand, so don't make the mistake of using it on balsa as it will require a lot of sanding.

From: cdt@pdp.sw.stratus.com (C. D. Tavares)

Fill your fins BEFORE attaching them. (Don't fill the root edge).

From: utidjian@remarque.berkeley.edu (David M.V. Utidjian)

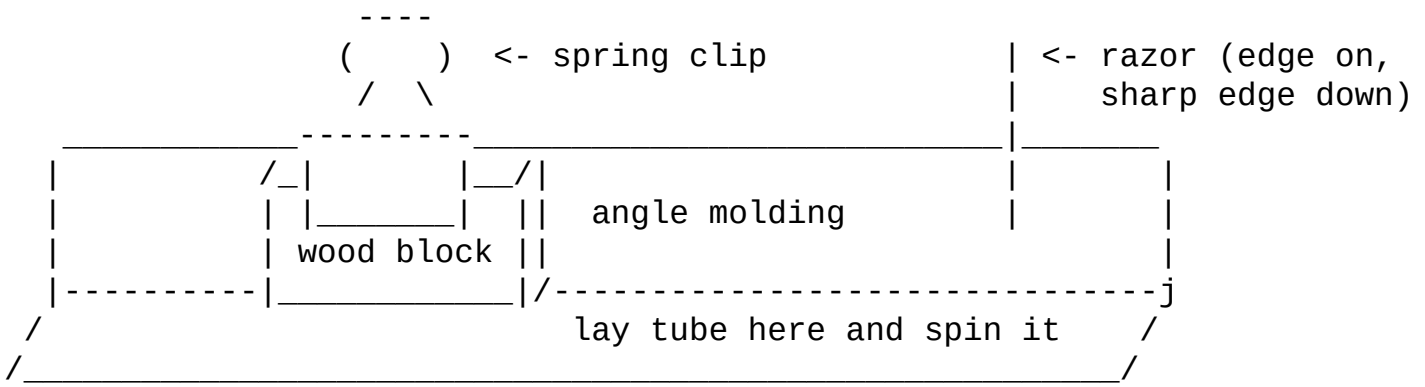
[To hold fins in place and aligned while drying I bought an Estes fin alignment kit]. At 15-16 bucks it seems a bit expensive but is well worth the aggravation and time it saves. You

can even make your own if you are handy. I just set up my body tube in the jig and then check the alignment of all of the fins to the body tube. Then I use a thin bead of 5-min. epoxy. and in ten minutes I am done. When I do the fillets I can do them all at once but don't have to worry about the softening the glued on fins so they droop. You still have to lay the model on its side though but only for 5 minutes.

From: kaplowro@hccompare.com (Bob Kaplow)
The Estes Fin Alignment Kit has now been discontinued for '96. You can use the newer Rocket Builder's Marking Guide ($5-8) to do one fin at a time. [Editor's note: This is a HIGHLY RECOMMENDED item to purchase. It provides everything needed to mark BT-5 through BT-60 body tubes for 2, 3, 4, 6, or 8 fins.]

6.2 Body Tubes (Cutting, Joining, Filling)

From: cdt@pdp.sw.stratus.com (C. D. Tavares)
[On cutting Estes-style body tubes]
The simplest and best I ever used was Howard Kuhn's jig from the old CMR. It's a simple piece of wood L-angle molding, with a notch for a razor blade cut into one side (from the wing toward the elbow) at one end. The only other parts are a wood block and a large black spring clip (the kind you hold really thick reports together with). If you want, say, a 6" piece of tubing, you set the block 6" away from the razor notch and clamp it there with the spring clip. Now lay the tube down the L-angle, butting it up against the wood block. Insert the razor blade, press lightly, and turn the tube. (Put a dead engine into it if the tube is the right size to fit one.) Three to six turns, and you have an edge that looks factory-cut.



From: soc1070@vx.acs.umn.edu (Tim Harincar)
[On cutting Estes-style body tubes]
When I cut tubes, I always wrap the tube with about two layers of drafting tape with the edge of the tape along the cut line. This accomplishes two things: First the thick tape edge providing a excellent knife guide. Second, you can assure a straight cut. If the tape wrinkles when you wrap the tube, you know it is not on straight; simply remove the tape and try again until you know its down flat.

Drafting tape is better than regular masking tape because it

has almost the same thickness but is made to be removed.

This method is in addition to reinforcing the inside with a stage coupler or spent motor. Also, always use a new x-acto blade for the best cut.

From: Jim Bandy (NAR member not on net)
Use a piece of aluminum 'angle iron' for joining body tubes. Place one tube in the angle, insert and glue the joiner, then insert and glue the other tube. It gives very straight joins. The angle can also be used for marking fin lines on body tubes, etc.

6.3 I'm fed up with tangled plastic parachutes with broken shroud lines. How can I improve on the standard chutes, or make my own?

From: soc1070@vx.acs.umn.edu (Tim Harincar)
Making your own parachutes is pretty easy. Start with the desired material (usually mylar or a light plastic). Make a cutting pattern out of cardboard by first drawing a circle that will be the maximum size of the chute (i.e. 16"). Take a compass [or] something that will give you an accurate radius of the circle. Pick a point anywhere on the circle and using the radius as a length draw an arc that crosses the circle. At the point where the arc crosses, reposition the compass on that point and draw another arc. Keep doing that all the way around the circle - you will end up with six points including the starting point on the circle. Connect these points with a straight edge and Presto! a hexagon. Cut out the hex from the cardboard (I use artists matboard...) and this is your cutting template. Lay the template on the material and using an EXTREMELY SHARP XACTO KNIFE cut along the outside of the template. Make shrouds from a heavy gauge thread - cut three equal lengths twice as long as the diameter of the chute and connect the ends to corner points adjacent to each other.

From: Roger.Wilfong@umich.edu
I usually build 12-24 line round chutes out of Estes material (just cut around the outside of the red and white circle and attach at the red /white boundaries) because they look more like real parachutes. I use embroidery floss for shroud lines and separate the 6 strands (for 12 lines - use two lengths for a 24 line). This makes a strong chute. With out crossing the lines over the top of the canopy, I've only had one failure of a 12 line chute (an EL that tipped off dramatically - i.e. cruise missile) and never had a 24 line fail. In the 10 years I've been back in the hobby and using this technique, my shroud lines have always come out the same length (within a couple of percent tolerance).

From: hal@HQ.Ileaf.COM (Hal Wadleigh)
1. Use fisherman's snap swivels for your attachments. It lets you store 'chutes separate from rockets and helps prevent fouling due to spin at deployment.[Note...modelers have always reported mixed results with snap swivels; they have been known to fail...Buzz]
2. Use nylon coat thread for shroud lines on homemade 'chutes (and

plastic bread wrappers are the best cheap 'chute material).

3. Pay special attention to the security of the attachment points. Those standard stickers often look secure, but are actually not attached. A small knot in the part of the shroud line under the sticker serves as a good anchor point (with the rest of that part looped around the knot, as per standard practice).
4. Very small 'chutes should be crossform type. Cut about a 5" square, then take out about 1.25" squares from each corner. Attach 4 lobes of shroud across the flat ends and secure as above. Be careful to use small stickers for the corner attachments. These make good substitutes for streamers in .5" body tubes and can also be used as drogues to help in the deployment of large 'chutes [A note from cdt@sw.stratus.com (C. D. Tavares): Either round off the inside corner of that 1.25" square or reinforce the angle with something. Otherwise, it's a really handy place for the parachute to rip during a fast deployment.]

From: smith@mrcnext.cso.uiuc.edu (Greg Smith)

Nylon coat thread is very good for small, lightweight competition parachutes, but it's not real strong and does have a tendency to melt if it encounters a bit too much ejection charge heat. For sport and payload models with 12" - 24" plastic 'chutes, I use 15 lb. *braided* nylon fishing line. It's thicker than the coat thread, similar in diameter to the Estes cotton stuff, but tremendously stronger. In the last fifteen years, of the plastic parachutes I have built using this line (and always crossed over the top of the 'chute for reinforcement), I have had *zero* shroud line or attachment failures. The braided line has a hard, smooth surface that doesn't encourage tangling, and it doesn't unravel where cut.

From: whitman@nssdca.gsfc.nasa.gov (Rusty Whitman)

I've tried about everything to keep shroud lines from pulling off of plastic or mylar parachutes. Those little tape disks are just about worthless. Tying knots and cyano'ing the ends helps but you still have problems. I don't know why I never thought of this before but I ran across a roll of duct tape in my closet and knew immediately that was the answer. I cut out some little squares of duct tape and attached some lines to a parachute and they won't pull free without ripping the plastic. I don't know who invented duct tape but they deserve some kind of statue, its got more uses than a paper clip.

From: kaplowro@hccompare.com (Bob Kaplow)

1. Make shroudlines from Kevalr thread. This won't burn through. Tie a knot 1/2" from the end and fray the end. Attach that end to parachute.
2. Use the much stronger kite snap swivels instead of fishing swivels - make sure they lock, and don't just clip like a safety pin.

6.4 Alternatives to Recovery Wadding

From jack@rml.com (Jack Hagerty):

Just go down to your local building supply store and get a bale of

cellulose wall insulation. This is just shredded newspaper treated in the same fire suppressant [as Estes recovery wadding]. A $5 bag will give you enough wadding to last years!

From MASSEY@TRAVIS.llnl.gov (Warren Massey):
I have found crepe paper to be a must more cost effective alternative. It comes in either sheets or rolls (I prefer the sheets) in a variety of colors and is every bit as flame retardant at a fraction of the price. I can even get several flights off a single ball of wadding. It is somewhat stiffer than the tissue but I've never found that to be a drawback.

Unattributed:
A piston ejection system works well on rockets of BT-60 size or greater. Pistons eliminate the need for recovery wadding of any type. Plans for a D powered rocket using piston ejection may be found on sunsite.unc.edu in the file 'pub/archives/rec.models.rockets/PLANS/dust-devil.ps'. The rocket was designed and drawn by pfeiffer@nmsu.edu (Joe Pfeiffer).

From: kaplowro@hccompare.com (Bob Kaplow)
Use a baffle system (I posted this to RMR a while back) to eliminate the need for wadding. This also provides the benefit of a third centering ring (see Pete Olivila article) as part of the baffle ssytem. Stainless steel mesh can be used to trap hot particles, but be careful that ejection caps don't plug it up.

6.5 Are there any good tips when making my own nose cones?

From Chris Jennison
To keep nose cones from wobbling and coming out asymmetrical when using an electric hand drill as a lathe...
Use a blank (dowel, broom stick or balsa block) 1/8 inch larger (diameter) than the nose cone that you need. Drill a 1/4 in. diameter hole as close to dead center as you can and push in a 1/4 in dowel. Dowel length should allow the nose cone end to seat against the face of the drill chuck. Find dead center by running the drill clamped in a vise at moderate speed & slowly move a soft pencil toward the end at what appears to be the center of rotation. After a couple of tries you will find the center because your misses will draw concentric circles like a bullseye. Now remove the dowel from the drill, clamp the shoulder end in the vise and rough shape the nose cone with a file or rasp using the marked center as a guide. Final contouring and finishing is done in the drill with progressively finer sand paper.

6.6 Getting Paint to Stick to LOC and Aerotech Nose Cones

From: kwolfe@interramp.com (Ken Wolfe)
VERY VERY important.....WASH THE PLASTIC FIRST!
I had this problem until I started to wash the plastic before even assembling anything. This solved most of the problems I was having.

From: Roger.Wilfong@umich.edu (Roger Wilfong)

I have had success painting nose cones from both companies using Krylon and Walmart paints. The technique I use is to wash the nose cone with a Brillo pad followed by a thorough rinse. Fill the mold parting mark with auto body putty and sand it smooth. I next use a coat of primer (I've used Krylon's grey sandable, Walmart's grey and Black Baron - the Black Baron was the best, but also the most expensive and took the longest to cure). This is followed by a light sanding and another coat of primer, followed by sanding. After the primer cures (a week, if I'm in the mood to paint, a year if I'm not), paint it with some paint that's compatible with the primer.

This technique works fine on the LOC nose cones, the only problem I've had with the Aerotech nose cones is that the very tip tends to get chipped off.

I have a LOC PNC-3.00 that has lawn darted into hard ground twice. The original paint is scratched, but it shows no signs of flaking off.

From: smith@mrcnext.cso.uiuc.edu (Greg Smith)

I rough up the surface of plastic nose cones with 60 grit paper, then use my basic epoxy painting regimen as I've described earlier. After the first coat of primer, the surface is *really* fuzzy; the paint reinforces and thickens all the little plastic strands that are raised by the sandpaper, and the surface feels like rough concrete. But a little sanding knocks off most of it, and after the third primer coat or so, the surface is as smooth as anything else on the model.

The only time I've ever damaged the finish on one of these nose cones happened when a model fell off the workbench and onto the concrete floor in my basement, which chipped the tip of the cone a bit. Normal flying (including one or two landings on concrete) hasn't affected them at all.

From: jsvrc@rc.rit.edu (J A Stephen Viggiano)

As I have said repeatedely, the most effective way to paint on these plastics is to introduce carboxyl groups at their surfaces. This will give the paints something onto which they can grab.

A carboxyl group, also known as a fatty acid group, consists of a carbon atom, to which an atom of oxygen is doubly bonded, and also a hydroxyl group is bonded. In order to convert the end of a polymer chain into a carboxyl group, you need to provide oxygen and some energy. The oxygen may, of course, come from the atmosphere.

In the packaging industry, when polypropylene and polyethylene must be printed, they are given either a "corona discharge treatment," in which the surface is passed beneath a high-potential device called a coratron, or a "flame treatment," in which a gas flame is allowed to impinge on the surface for an instant. For historic reasons, the second treatment may be referred to as a "corona treatment," even though no corona discharge is involved.

I've used the gas flame from my kitchen range with excellent results. Don't overdo it, for obvious reasons. Only an instantaneous contact

with the flame is needed.

Since using this treatment, I have had virtually no problems with paint flaking from my polypropylene nose cones.

From: preddym@ucs.orst.edu (M Preddy)
I've had good luck with Rustoleum primer on LOC nosecones. Krylon sticks to it fine.

From: kaplowro@hccompare.com (Bob Kaplow)
Consider covering nose cones with econo-kote.

6.7 Is it possible to get a high gloss, durable finish on a model rocket?

From: p_hamilton@usa.pipeline.com (Paul Hamilton)
I put on a clear coat of dope or Krylon, sand with #600 wet-or-dry sandpaper, and then buff with "Rotten Stone" or similar rubbing compound. This is a fine abrasive that on mixes with water. I have used toothpaste or silver polish as a substitute for rubbing compound when there has been no hardware store around.

6.8 Are there any good paints for silver details on scale models?

From: Orville ????
The Krylon silver paint looks very much like real silver, that's because it's made of a clear coat plus real metal flakes.
The only problem is when you touch it the finish becomes dull.

The solution to this problem is:
Finish your surface as usually.
Spray a final coat of Krylon on and let dry 2 days, but don't even think about touching it. After 2 days spray Krylon clear coat over the silver with very light coats ,letting each coat dry 5 minutes between sprayings. This will give you a very nice finish.

From: Peter "wondered if they had silver spray paint for the Tin Woodman's axe in the Wizard of Oz" Alway (petealway@aol.com)
I'm starting to get serious about silver paints, now that I am working on 1930's rockets. I think it's worth getting a sense of several metallic colors, all for different purposes. As near as I can tell, most are either simply glossy (Testors Chrome, Dutch Boy silver) or matte (Testors silver, and apparently Krylon.

As an experiment, I tried buffing some Testors siver on a nose cone (it was still chucked up on the drill press where I turned it) last weekend. I found I needed to use some #600 sandpaper to get a truly smooth surface, then I just buffed it with ordinary paper. The result was pretty convincing, but a darker shade than the original paint. (unfortunately, on Goddard's rockets, the nose was usually a lighter shade of Aluminum) I was impressed that the result looked

like real metal to me.

Testors has some buffable paints in their Metalizer line. I tried their "Titanium" on a Glencoe 3-stage rocket ship (a von Braun design), but when polished, I thought it looked more like hematite than actual metal. I'm starting to believe that with silver paint, it's more important that you represent the differences between silver shades than get the siver just right. So for instance, on a Goddard rocket, I would use the glossy Dutch Boy silver for the nose cone, buffed silver paint for the nickel-steel propellant tanks, and Testors silver for the duralumin body. This should at least suggest the differences between the materials that you can see in the photos.

From: Bob Craddock (craddock1@aol.com)

After building and re-building about a half-dozen Saturn V's, I have a couple of recommendations to make:
For the Service Module color, I suggest getting a bottle of Micro Metal Foil Adhesive and some Reynold's Wrap. Spread the adhesive on the **shiny** side of the foil. The silver on the SM was somewhat dull, and just about ANY silver paint sucks badly! The foil will give you the look you need, and the adhesive is extremely easy to work with. The white raditor details can be added by using shroud line or Evergreen styrene strips. White glue works well with the shroud line, but I would recommend fast epoxy for the strips. Mask off the radiator areas so you can paint them white when you paint the entire rocket.

6.9 How can I prevent a rocket painted white from yellowing?

From: curcio@telerama.lm.com (LarryC)

Future floor polish (it isn't wax) doesn't yellow. I find it useful for rockets but...

1) It must be used over some kind of paint or over acrylic gesso. If it seeps into cardboard or wood, the material will become brittle;

2) It will cause dope and (even permanent) Magic Marker color to run. This effect can be used to advantage, but it can also ruin a model if it's unexpected. Future does not cause enamel paint to run, and may certainly be used to cover decals. Don't know if the decal will yellow beneath the coating.

3) A glossy finish is not always desirable, and Future yields only a glossy finish. Art stores sell equivalent mixtures that come in gloss or matte finishes. The are called "Acrylic Gloss Medium," and "Acrylic Matte Medium," respectively. They are thicker than Future, but they can be thinned with water.

4) Acrylic colors, available in art stores, can be used on rockets, as long as acrylic gesso is laid down first. The colors should be thinned with water or Future. Acrylic paints are normally labeled to tell you how opaque they are and how toxic they are. Both qualities vary from

color to color. Even though the tubes seem expensive, the opaque colors have excellent covering power and they turn out to be very good buys.

5) From my own experience, commercial acrylic model paints are to be avoided. They are over-thinned, and they yield undesirable, cracked finishes.

From: kaplow_r@eisner.decus.org (Bob Kaplow)
Try adding a small amount of BLUE to the white paint (a few drops per bottle). The faint blue tint hides the yellowing, much like bluing in the white laundry.

6.10 Which is better, white or yellow glue? Epoxy? Cyano?

From: bmcdermo@ix.netcom.com (Buzz McDermott)
Yellow wood glue, such as Elmers Carpenter's Glue or Titebond, is far superior to regular Elmer's white glue for building wood and paper model rockets. Built carefully, with proper fin fillets, yellow alphetic resin will hold together on rockets with up to G power. Yellow glue also dries faster.

Three and five minute epoxy is often used for quick repairs. This quick drying time does not allow the epoxy to soak into the wood and/or paper very well, though. If epoxy is to be used, then use one with at least a 15 minute, and preferably a 30 minute, listed 'drying' time. Thirty minute epoxy will give a much stronger bond than yellow glue. However, 5 minute epoxy often yields a weaker bond than yellow glue.

Cyano is often used for quick building. It bonds strong, dries extremely fast (especially when using an accelerator), and is relatively easy to use. Regular cyano can also be used to bond plastic to wood or paper.

No matter which glue is used, the most important factor is to have a properly prepared surface. Glassine coated Estes-stype body tubes should be lightly sanded where the glue is to be applied. All bonding surfaces should be clean and unpainted. You want whatever bonding agent is used to be able to soak into the paper and/or wood.

From: kingrat@sisko.dnaco.net (kingrat)
I've been using CA to bond fins to the tube and then a fillet of epoxy. If you go this route I recommend thin CA and a fin alignment guide. Make sure the fins are aligned properly before you CA and check again before applying the epoxy. Unlike white glue, if you mess up it's REALLY hard to fix. It's also REALLY hard to pop the fin off too. :)

This works just fine with balsa or plywood fins from what I've seen. CA is good for tacking the lugs in place too, however I would never use CA on a vital part of the rocket (ie. motor mount) CA just isn't strong enough because it turns brittle. Epoxy will flex somewhat without breaking and you can add microballoons to allow it to flex even more. In short, use CA to tack and epoxy to bond.

From: rsantore@syr.edu (Bob Santore)

There is an easy test to tell if the glue you are using is strong enough. A glue joint only needs to be as strong or stronger than the material it is gluing together. To test for glue strength you need to test the strength of the glue joint relative to the strength of the material you are bonding. This test is very easy and can be used for any type of glue. Glue some scrap pieces of whatever you are gluing together in a configuration similar to how you intend to use it (i.e., don't test a surface mounted fin if you intend to use a TTW fin). When cured, pull the two parts apart. Did the glue bond fail? If it did, don't use that brand of glue. If the pieces you glued didn't fail, then this glue is fine. If your rocket falls apart anyway, then you need stronger rocket parts! The only exception I can see to this very simple test would be near the motor mount where heat can weaken the glue. You could always heat the pieces before destructive testing to see if heat changes the properties of the glue joint.

6.11 Improving on the Estes Shock Cord Mount

There are a number of ways to improve on the old paper-and-rubber-band shock cord mount used by Estes for the past 35 or so years. The following suggestions have been repeatedly made in r.m.r.

1. Replace the rubber band or short elastic in the kit with sewing elastic at least twice the length of the model. This will help to avoid tube zippering or ripped out shock cord mounts when you have a 'hard' ejection.

2. Epoxy the shock cord mount to the inside of the body tube rather than using white or yellow glue. Thirty minute epoxy works best for this. Be sure and lightly sand the inside of the tube where the shock cord mount is to be placed. Also be sure and 'cover' the entire mount with a very thin layer of epoxy. This method works best for models with BT-60 or larger body tubes.

3. Use a 'Quest-style' kevlar-and-elastic shock cord mount. This type of mount uses a length of 50 to 150 pound test Kevlar (such as Stren Kevlar fishing line or Kevlar kite string). The Kevlar is tied and glued to the motor mount (motor block, centering ring, or around the motor tube). It is sized to end just shy of the front end of the body tube when a length of elastic shock cord is tied onto the free end of the Kevlar. This method eliminates any shock cord mount on the inside surface of the body tube. Estes-style shock cord mounts have been known to interfere with parachute deployment. You can used this method on any sized rocket. Size the Kevlar appropriately.

4. You can also use a 'LOC-style' shock mount for body tubes in the 1.5" and up range. With this you take a short length of Kevlar line, fold it in half, and make a 1-2" loop in the closed end of the folded line. You then epoxy the loop to the inside of the body tube in such a manner as to have the end of the loop extend a little past the open

end of the body tube. A shock cord is tied to the loop. The advantage of this technique is that is allows damaged shock cords to be easily replaced. It tends to work better on body tubes greater than 1.5" in diameter.

6.12 I've built several BT-80 based models. How can I strengthen future models to take larger motors, such as Aerotech 24mm or 29mm reloads?

Estes recommends using just D motors in their BT-80 based kits, such as the Broadsword (Super Big Bertha) and Shadow (Optima). There are a number of steps that posters to r.m.r have done to strengthen these rockets to fly with larger motors. Remember in doing this that you are modifying and using the rocket kit in a manner NOT recommended by the manufacturer.

From: Buzz McDermott (bmcdermo@ix.netcom.com)

Here's a summary of what I've done to strengthen my Shadow and Broadsword kits to fly on 24mm reloads and up to 24mm G42 motors. You will need a LOC-style 2.56 inch tube coupler, 3/4 oz fiberglass, 15-30 minute epoxy, and 20 minute 'coating' or 'finishing' epoxy:

1. If the kit comes with the 'plain' BT-50 type motor tube, replace that with LOC-type, thick-walled 24mm motor tube. You will only need about 6".
2. Reinforce each body tube section with 3/4 oz fiberglass. Apply it using one of the methods discussed in the section on High Power Construction Techniques. Be sure to completely sand off the glassine coating of the body tubes prior to applying the fiberglass.
3. Also fiberglass-reinforce the thick paper centering rings supplied with the kit. Glass both sides of the rings. If you want to build a payload section in the Shadow, then leave the center cut-out in one of the rings and glass over it.
4. If you plan to use only 24x70 disposable motors (including Aerotech E's) and/or 24mm reloads, then yellow glue or epoxy a motor block 2.5" into one end of the 6" motor tube. If you install the motor hook, file down the part that sticks into the tube. This will let you fit in 24mm reloads. Be sure and lightly sand the motor tube prior to installing motor hook. [NOTE: If you plan to use non-standard 24mm Aerotech motors than skip this step.]
5. Epoxy one fiberglass-and-epoxy-reinforced centering ring 1/2" from the rear end of the motor tube. Be sure there is a notch in the ring to allow some movement of the motor hook. Epoxy a second centering ring in the middle of the motor tube. Epoxy a third ring 1/8" from the front of the motor tube. Install the motor tube into the main body tube with the motor tube flush with the bottom of the main body tube.
6. Fiberglass-reinforce all of the fins. Apply the glass to both sides of the fins. Be sure that the fins are completely sanded (and any airfoiling/rounding completed) before applying the cloth. An optional step is to apply some 1/2" wide strips of glass along all of the fin edges EXCEPT the root edge.
7. Rough up the epoxy on the main body tube along the lines where the fins will attach. Use 220 or coarser sandpaper. You really want the smooth epoxy coating roughed up. You can also drill a few 'rivet'

holes along the fin attachment lines.
8. Apply epoxy where the fins will attach and attach the fins. Do not fillet at this time.
9. When the fins are dry, apply 1/2" strips of fiberglass cloth along each fin root edge, with 1/4" on the body tube and the other half of the width along the fin side. Coat this will coating epoxy. When dry, YOUR FINS WILL NOT COME OFF.
10. Couple the bottom two body tube sections together. An option step is to make a payload section out of the third body tube section that comes with the Shadow. Use the LOC coupler to make a payload section. You can sand down the solid centering ring to slide inside the LOC coupler to form a bulk-head. Epoxy a 2"x 2" piece of scrap 1/16" plywood or 1/8" balsa to the inside surface of the bulkhead to add strength. Install either a large screw-eye or small eye-bolt to the center of the bulkhead, to be used to shock cord and parachute attachment.

The end result of the above is a model which is really too heavy to fly on a D12. My modified Shadow came out to about 14 oz (I built it VERY heavy and added the payload section). My modified Broadsword came out to about 12 oz. Both have been flown on motors as small as composite D's (D21-4, D13-4R). The Shadow has flown on E15-4 (perfect), E30-4 (a -5 is really needed), F24-7R, F39-7R, and G42-8. The Broadsword has just been test-flown on the D21-4 and E15-4. It WILL be flown on G42's, though.

If you want to use 29mm motors in BT-80 based models, I would recommend either switching to plywood centering rings or sticking to low-thrust motors, such as the F14. In the end, if you want to fly 29mm, you would really be better off getting a kit designed as a Large Model Rocket from the start.

6.13 How can I prevent balsa fins from breaking off on landing (especially for models with swept fins)?

From: craddock1@aol.com (Bob Craddock)

Take your fin pattern, reduce it by ~90% on a xerox machine, and make as many copies as you need to glue one pattern on both sides of each fin. Put about two coats of sanding sealer on the new paper surface, sand, and then paint the fins all over again. A friend of mine was having the exact same trouble on his Super Big Bertha, and the paper reinforcement was his solution. It worked great, but next time I say use bass wood on everything.

From: silent1@ix.netcom.com (The Silent Observer)

There's a variation on this technique, that needs to be applied during building, that can make balsa fins stronger than bass (and still lighter). What you need to do is simply to cover the fins before painting. I used silk tissue (like model airplane tissue made from silk fibers) on my Big Bertha, and in a dozen flights (before it lodged high in a tree) never had so much as a crack, even when flown on a D21 (and including one "plastic wad" recovery when the rocket hit the ground

fairly hard). You could use ordinary Japanese tissue, or Silkspan (R), or you could even use something like nylon cloth or very light fiberglass (attached with epoxy or CA in this case). With tissue, you need to cover the entire surface -- I simply wrapped it over the rounded leading edge, and trimmed it off at the tapered trailing edge, leaving the square "bottom" edge and the root uncovered. You can attach Silkspan with almost any glue, but silk tissue (as I found) "fuzzes" if you get it damp and handle it, so something like Testor's model airplane glue or thick, clear nitrate dope might be a better choice; it won't soften the binder that holds the fibers in the tissue together. Any of these, done after sanding (and filling, in the tissue cases) will add significantly to the strength of the fin, while adding very little weight. Making fins out of basswood or ply is probably okay with a Bertha derivative -- they tend to be overstable in any case -- but may lead to an unstable model if you have a design with less margin.

From: dbucher@mcn.org (David Bucher)

There are two things you can do, both of which lower the rocket in a "fin up" attitude. The first works by making a "yoke" or harness for lowering the rocket body horzontally (if you choose). Install an anchor (screw eye, inch worm shaped brass wire clip, etc.) through the body tube wall between the fins at the rear end of the body. Attach a squid line or kevlar thread to the anchor and run it up the outside of the body (tightly) and attach to the nose cone or 'chute. Configure it to lower rocket as above.

The other (and better!) way for the rocket you describe is to use rear ejection. This will not help you with the present rocket, but any other rocket with sufficient body width will work just fine. When making the motor mount assembly. substitute a longer motor tube (29mm LOC tube for instance) and make up some ply or G10 centering rings including two with a fair spread between where you can wrap the 'chute around the motor tube. Install a solid bulkhead with cable lanyard to serve as a thrust ring and pressure block. Make sure the motor mount unit slides well in the body and attach elastic to the cable lanyard and now you've got a rocket that ejects to the rear. Just cut a small notch in the farthest foward centering rings to allow the shock cord to pass. This method works great and if you're confused by what I just wrote (a not unheard of possibility!) just think of the internal "power pod" in some BGs. It works the same way except you must make provision to connect ALL parts together.

6.14 I just lost my favorite rocket and the kit is discontinued. How can I make another one just like it?

From: <silent1@ix.netcom.com> and <bmcdermo@ix.netcom.com>

I don't know if everyone else already does this, but I've started saving the kit card, instructions, and a copy of the fin shape or shapes for every kit I build -- rockets have a way of getting lost or broken, and model rocket companies have a way of discontinuing my favorite kits. Getting a color copy of the decal sheet (or better yet, a color scan) is also a good idea.

6.15 How can I reduce damage to the booster stage of two stage models caused by the engine exhaust of the second stage?

From: phunter@numill.com (Perry Hunter)

Try scotch tape instead of masking tape. It should release fractionally faster and >might< reduce scorching of the lower stage.

In some cases, it's possible to line the inside of the top of the lower stage with 20lb xerox paper, and it will take the damage rather than the exposed section of the stage. It's not possible to cover everything (slip fit couplers , etc. prevent lining all of it) but it can help.

6.16 Is there a way to increase the stability of a model with near neutral stability?

From: Peter "My views are not to be confused with those of a rabbit librarian" Alway (petealway@aol.com)

Sounding rockets that are aerodynamically stable are often spun at a slower rate that insures that any off-axis thrust will cause the rocket to corkscrew, rather than follow an arc. The corkscrew may be subtle--but it beats an equally subtle arc. A sounding rocket that naturally describes an arc with a 20-mile radius due to its asymmetries cannot reach higher than 20 miles. But if the rocket is spun through 360 degrees every few hundred feet, the 20-mile-radius arc turns into a very suble corkscrew.

Imagine the modeler puts a very slight misallignment between the forward and rear fins of a sidewinder. Suppose it's just one degree. also suppose the fins are 1 foot apart. the rocket will naturally arc in a circle with a 360-foot circumference and a 57-foot radius. That's instant doom! make the error half as bad and you are in trouble. But if the rocket spins every 10 feet, the path will be a generally upward corkscrew, less than ideal performance, but a safe flight.

So with model rockets, a spin on ascent is a good way to make a marginal or asymmetrical model safe. Estes used to sell a space shuttle orbiter kit that had a spin tab for this reason, and the old Astron Space Plane had spin tabs as well.

6.17 How can I build a rocket with less wind resistance?

From: John DeMar (smdemar@mailbox.syr.edu)

The best thing you can do is to NOT use launch lugs. Use a launch tower instead. A polished, smooth finish makes a big difference too. If the design allows, use a boattail and make sure all transitions are smooth (from nosecones/payload sections,

etc.). Fin shape is a minor effect if they are relatively thin, otherwise make sure the edges are at least rounded.

Here are some numbers for comparison:

Standard finish, no transitions, with lug:	Cd = 0.88
Standard finish, no lug:	0.68
Polished finish, no lug:	0.61
Standard finish, no lug, 2:1 boattail:	0.52

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 7: Scale Modeling

Posted: April 14, 1997

Last modified: April 14, 1997

NOTE: This section was originally edited for the FAQ by Bob Biedron, the 1992 FAI World Champion scale spacemodeler. It has since been edited by others, including Buzz McDermott and Peter Alway. Opinions expressed in this section should not be taken as those of Bob, and should be considered a composite work of submitters to this section in general, and not endorsements by any one of the editors/ submitters. A special thanks goes to Peter Alway for extensive editing and additions to the Nov, 1995, updates to this section.

7.1 I would like to make a scale model of the <??> rocket. Where do I start looking for technical data, dimensions, flight substantiation data, etc.?

A great place to start looking would be Peter Alway's book of scale data, "Rockets of the World." This book was first published in 1993. A second edition was published (hard cover only) in 1995. This book is a reference collection of scale data assembled specifically for modelers. Peter also has another book, "The Art of Scale Model Rocketry." This book is describes scale modeling techniques, and includes limited scale data. It also includes model plans and an index of scale data sources.
See Part 2 of the FAQ for address information.

Those wanting to construct detailed models may need additional data. This usually presents something of a problem. Back issues of "Sport Rocketry" and "American Spacemodeling" are a source of scale information and detailed data. The old "Model Rocketry" and "Model Rocketeer" also had a number of articles over the years. The last three magazines are no longer in print. With the exception of articles in AmSpam and SRM after 1990, all photos in the above mentioned magazines are black and white.

If none of the above sources contain data on the prototype that you want to build, or if you require more data than is found in these sources, then two routes are open. First, ask around - someone may already have data on the prototype that you seek. Many (most?) people collect data without actually ever building a model. Others never get around to publishing their data. NASA and the National Air and Space Museum can be good sources of data (see addresses below). If you still have no luck in finding the data you need, try writing the manufacturer directly. The response you get from the manufacturer depends on a couple of factors. First, your letter must end up on someone's desk who is sympathetic to your cause and is willing to do some digging in the archives. Second, the data you request must still exist! - often, blueprints, photos etc. are thrown away after the manufacturer ceases to produce the prototype. When writing a manufacturer, be as specific as possible about the type of data you require, and explain why you want the material. Peter Alway has further tips for tracking down data in his book.

There is a surprising amount of scale data out there, from simple overall configuration drawings to those showing screw/bolt dimensions. The following list is derived from one Kevin McKiou submitted to this newsgroup in February of 1992. Peter Alway added to it in November of 1995. It contains the majority of the scale data that has been published in the model rocket literature to date, as well as listings of the "private stashes" of a few individuals.

7.2 What are some specific sources for general scale data?

Available from NARTS (price below + 10% standard postage ($1.50 min)):

NARTS
P.O. Box 1482
Saugus, MA 01906
email: narts@nar.org
www: http://www.nar.org/NARTS

Aerobee 350-Full substantiation data with plans, three color slides, and one b & W slide.
SP-1 $3.50

Aerobee Photos-Four 8 x 10 color photographs of the same Aerobee 350 flight as SP-1. These photos are slightly different views than those in the SP-1 packets
SP-1A $10.50

ISQY Tomahawk-This packet contains plans, an 8 x 10 B & W photo, and a history of this single stage sounding rocket which was developed for the International Year of the Quiet Sun.
SP-2 $4.00

Super Loki Dart-This packet contains complete data including two 8 1/2 x 11 drawings, a label detail sheet, background information-tion, color documentation, and four 8 x 10 B & W photos.
SP-3 $4.00

Sandhawk-This packet consists of a set of plans, history on the vehicle, and an 8 x 10 color photograph of the vehicle on its launcher.
SP-4 $5.00

Scale Data Reduction Sheets-Handy sheets for competition scale packets. Includes spaces for scale factor, prototype dimensions, and model dimensions. Set of 10.
SDRS $1.00

"Sport Rocketry Magazine" is the official publication of the National Association of Rocketry (NAR). The address of the NAR is given elsewhere in the FAQ. Prior to October 1993, the journal was titled "American Spacemodeling". Scale data has been published on the following:

Razumov-Shtern (w/SpSc model plans)	Scale	Nov/Dec 1996
Talos Missile	Scale	Summer 1996
Judi-Robin Balloon Dart	Scale	May/Jun 1996
Vostok (w/SpSc model plans)	Scale	Mar/Apr 1996
Hopi-Dart	Scale	Holiday 1995
Saturn IB	Scale	Jan/Feb 1995
Raven	Scale	Oct 1994
Saturn V (Overall view)	Scale	Aug 1994
N1 (colors)	Sport Scale	Aug 1994
N1 (dimensions)	Sport Scale	Jun 1994
Vanguard (B&W photo)	Semi-scale	Jan/Feb 1993
D-Region Tomahawk (color photos)	Scale	Jan/Feb 1992
Corporal	Sport Scale	Sep/Oct 1991
SCUD-B	Sport Scale	Jul/Aug 1991
Little Joe II-Part 2 (color photos)	Scale	Jul/Aug 1991
Little Joe II-Part 1 (color photos)	Scale	May/Jun 1991
Saturn V-Part IV-Apollo Spacecraft	Scale	Mar/Apr 1991
Saturn V Part III	Scale	Dec 1989
Saturn V Part II	Scale	Nov 1989
Saturn V Part I	Scale	Jul 1989
The Delta Family Album-Pictorial Guide		Sep/Oct 1990
Scout		Sept 1988
Juno 1	Scale	Jan 1988
Nike-Hercules	Scale	Aug 1984

"Rockets of the World: Second Edition"
by Peter Alway. 384 pages, hard cover.

THE DEFINITIVE SCALE MODELERS' GUIDE. Currently in print. See Part 2 of this FAQ for address.

Included in ROTW:

1. Dimensioned drawings, color-keyed drawings, B&W photographs, and brief histories of selected rockets:

Germany:

- Maul Photo Rocket
- Winkler's HW-2
- A-3
- V-2 (A-4)
- OTRAG 1

The USSR, Russia and Ukraine:

- GIRD 09
- GIRD X
- V-2-A
- V-5-V Vertikal 1
- V-11-A
- M-100B
- MR-12
- MMR-06
- MR-20
- Sputnik
- Vostok/Luna
- Soyuz
- Small Cosmos B-1
- Large Cosmos C-1
- V-3-A Vertikal
- Proton
- Tsyklon
- N-1 moon rocket
- Zenit
- Energiya-Buran

United States:

- Goddard's March 16, 1926 Rocket
- Goddard's L-16
- American Rocket Society ARS-2
- Wac Corporal
- Bumper
- Aerobee
- Aerobee-Hi/150
- Aerobee 300
- Aerobee 150A
- Aerobee 350
- Viking
- Deacon
- Deacon Rockoon
- Terrapin
- Asp
- Loki Rockoon
- Loki HASP
- Super Loki Dart
- Arcas
- Sparrow-HV Arcas
- IRIS
- IQSY Tomahawk
- D-Region Tomahawk
- Sandia Tomahawk
- Sandhawk
- Terrier-Sandhawk
- Nike-Deacon
- Nike-Cajun
- Nike-Asp
- Nike-Apache
- Nike-Tomahawk
- Nike-Smoke
- Argo D-4 Javelin
- Trailblazer I
- Taurus-Tomahawk
- Hermes RV-A-10
- X-17
- Ram B
- Shotput
- Little Joe I
- Trailblazer II
- Astrobee 500
- Astrobee 1500
- Astrobee D
- Aries
- Vanguard
- Juno 1/Jupiter C
- Mercury-Redstone
- Sparta-Wresat
- Jupiter
- Juno II
- Thor-Able
- Thor-Agena A
- Delta B
- Delta E
- Delta M
- Delta II
- MX-774
- Atlas-Score
- Mercury-Atlas
- Atlas-Agena D
- Atlas-Centaur
- Scout
- Little Joe II
- Apollo Pad Abort Test
- Gemini-Titan II
- Titan IIIC
- Titan IIIB
- Titan IIIE
- Titan IV
- Saturn I
- Saturn IB
- Saturn V
- Space Shuttle
- Pegasus
- DC-X

France:

- Veronique
- Vesta
- Dragon III
- Diamant A
- Diamant B
- Diamant B-P4

Japan:

- Kappa 6
- Kappa 7
- Kappa 9
- Lambda 4S
- Mu 4S
- Mu 3S-II

China:

- Long March 3

United Kingdom:
- Skylark - Black Knight - Black Arrow

India:
- Rohini RH-75 - SLV-3

Argentina:
- Orion II

Australia:
- HAD - Aero-High

Brazil:
- Sonda 1 - Sonda 2

Canada:
- Black Brant II - Black Brant III - Black Brant IV
- Black Brant V - Black Brant X

Poland:
- Meteor 1 - Meteor 2K - Meteor 3
- RP-3 - Rasko 2

Spain:
- INTA-255

Europe:
- Europa - Ariane 1 - Ariane 4
- Maxus

2. Mail order Resources: Addresses for companies and institutions selling scale drawings or photographs. Each drawing also provides sources for more data in case you desire more detail.

Advanced Rocketry Group Ltd.
130 Matheson Blvd, East - Unit 10
Mississauga, Ontarion
L4Z 1Y6 Canada

Source of Ukranian and Russian launch vehicle scale data
Black Brandt series scale data

The Launch Pad
8470-H Misty Blue Court
Springfield, VA 22153
(703) 455-8418

Source of military missile scale data

"T minus 5" is the bi-monthly newsletter of the Huron Valley Rocket Society (HUVARS) NAR Section #463. HUVARS is the NAR section with which Peter Alway is associated. In the past it has been rich with scale data and plans. Peter Alway has been a big contributor to this and hopefully this tradition will continue now that Peter has published his book.

Non-member subscriptions to "T minus 5" are $8.00 (U.S. and Canada) and $11.00 elsewhere. Send correspondence to:

Jim Fackert
Huron Valley Rocket Society
10555 McCabe Rd.
Brighton, MI 48116

"Model Rocketeer" was the official publication of the NAR from 1971 through June, 1984.
Scale Data Published:

Nike-Tomahawk	Scale	Feb	1974
V-2	Scale	Jun	1976
Trailblazer 2	Scale	Nov	1980

"Model Rocketry" was published by George Flynn in the late 60's and early 70's.
Scale Data Published:

Viking	Scale	Jan	1969
Asp	Scale	May	1969
Rohini RH-75	Scale	Aug	1969
Little Joe II	Scale	Sept	1969
Nike-Smoke	Scale	Oct	1969
Nike-Apache	Scale	Nov	1969
Pershing	Scale	Jan	1970
HAD	Scale	Apr	1970
Vostok	Scale	Jul/Aug	1970
Falcon (AIM-4E)	Scale	Sept	1970
Skua	Scale	Oct	1970
Astrobee-D	Scale	Nov	1970
Aero-High	Scale	Oct	1971
D-Region Tomahawk	Scale	Jun	1971
Black Brant II	Scale	Dec	1971

Aerospace Industry/U.S. Government Contacts:

A very good source of photographs of NASA launch vehicles is the NASA Photography Index which you can get for free by sending a request to:

NASA
Audio Visual Section, LFD-10
Public Affairs Division
400 Maryland Ave, S.W.
Washington D.C. 20546
(202) 453-8375

Photos can be ordered from the Index for a very reasonable cost.

National Aeronautics and Space Administration
History Office
NASA HQ LH-14
Washington, DC 20546

This source was recommended by a museum technician at the Smithsonian Institution at the National Air and Space Museum (see following).

National Air and Space Museum
Archives (Bldg 12)
3904 Old Silver Hill Rd
Suitland, MD 20746-3190

Received prompt service (2 weeks) from Paul Silbermann, Museum Technician. This is a part of the Smithsonian Institution.

Aerojet-General Corp.
1051 La Jolla Rancho Rd.
La Jolla, CA 92037

Builders of the Aerobee and Astrobee series of sounding rockets

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Display Locations

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* Aberdeen Proving Grounds Armaments Museum
  Nike-Ajax on launcher, Nike-Hercules on launcher, Pershing II, US Army missiles?, V-2 on carrier, Wasserfall, WWII German SAM?

* Air Force Armament Museum at Eglin Air Force Base, SE of Pensacola, FL
  Bomarc, Bullpup, Sidewinder

* Alabama Welcome Center, I-65 south, near TN-AL line
  Saturn IB

* American legion Hall, Lakewood, NY
  Nike-Hercules

* Ames Research Center, Mountain View,
  Gemini 11?, Skylab 3?

* Neil Armstrong Museum, Wapakoneta, Ohio
  Gemini 8

* Alabama Space & Rocket Center, Huntsville, AL
  Apollo 16, Atlas, Corporal, Entac, Hawk, Hermes A-1, Honest John, Juno I, Juno II, Jupiter, Lacrosse, Little John, Mercury Sigma 7?, Mercury-Redstone, Nike-Ajax, Nike-Hercules, Nike-Zeus, Pershing, Redstone (tactical), Saturn I, Block 2, Saturn V, Sergeant, Space Shuttle Mockup, Sprint, Titan I, V-2, X-15 mockup

* Astronaut Hall of Fame, Titusville, FL
  Mercury Sigma 7

* Bowfin Submarine Museum, Honolulu?, HI

Harpoon, Polaris A-1, Polaris A-3, Subroc, Tomahawk Cruise Missile

* Centennial Park, Laurence, KS
  Polaris A-1

* Octave Chanute Aerospace Museum, Rantoul, IL
  Bomarc, Minuteman

* Museum of Science and Industry, Chicago, IL
  Apollo 8, Arcas, Lunar Module, Polaris

* Combat Air Museum, Topeka, KS
  Honest John, Nike-Ajax

* Cosmos Pavilion (now car showroom, some exhibits may remain), Formerly of Exhibition of Economic Achievement, Moscow, Russia
  M-100B?, MR-12?, MR-20?, Vostok?

* Behind a Denny's, off I-75 near Warner Robbins, GA
  Titan II

* Detroit Science Center, Detroit, MI
  Nike-"smoke"

* Fireworks Factory, US 72, South Pittsburg, TN
  Honest John

* Florence Air & Missile Museum, Florence, SC
  Bomarc, Entac, Honest John, Sparrow, Titan I

* Fort Lewis Museum, Fortlewis, near Tacoma, WA
  Honest John, Nike-Ajax, Nike-Hercules

* Fort Meade base museum, Fort Meade, MD
  Nike-Ajax, Nike-Hercules

* Goddard Spaceflight Center, Greenbelt, MD
  Delta-B, Gemini 12, IRIS, Javelin, Nike-Black Brant, Nike-Tomahawk

* Golden Gate National Recreation Reserve
  Nike-?

* Grissom Memorial Museum, Spring Mill State Park, IN
  Gemini Spacecraft

* Grissom Memorial Museum, Mitchell, Indiana
  Gemini 3

* Aerospace Park, Hampton, VA

Corporal, Jupiter, Little Joe I, Nike-Ajax, Polaris A-2

* Hill Air Force Base Museum
  Bomarc, Minuteman, MX-stage

* Hong Kong Space Museum, Hong Kong
  Mercury Aurora 7?

* Airport road & S. Memorial Parkway, Huntsville, AL
  Hermes

* VFW post on N. Memorial Parkway, Huntsville, AL
  Corporal

* Illinois Soldiers & Sailors Home, Quincy, IL
  Bomarc, Titan I

* International Space Hall of Fame, Alamogordo, NM
  Aerobee 150 (2 displayed), Aerobee 170 tail unit, Arcas, Loki-Dart, Falcon, Hawk, Lance, LM ascent engine, Javelin 4th stage motor, Little Joe II (not accurate), F1 engine, J2 engine, V-2 engine, Nike-Ajax w/launcher, Nike-Cajun, Syncom apogee kick motor, Sonic Wind No. 1 rocket sled (Stapp's sled), XLR-11 engine

* ISAS, Sagamihara Japan
  M2-SIII

* Japan Science Society, Tokyo
  Gemini 11?, Mercury Aurora 7?, Skylab 3?

* Jodrell Bank Radio Observatory Visitor Center, Cheshire, England
  Skylark

* Jet Propulsion Laboratory, Pasadena, CA
  Corporal, Sergeant

* Johnson Space Center, Houston, TX
  Apollo 17, F-1 engine (Saturn V), Gemini 5, H-1 engine (Saturn I or IB), J-2 engine (S-IVB, S-II), Little Joe II, Mercury Faith 7, Mercury-Redstone, Saturn V

* Kansas Cosmosphere, Hutchinson, KS
  Agena, F-1 Engine, Lunar Module Mock-up, Mercury-redstone, Nike-Hercules, Titan I, Titan II engine, V-2

* Keesler Air Force Base, Biloxi, MS
  Bomarc

* Kennedy Space Center
  ASTP, Atlas-Agena, F-1 engine, Gemini 9, Gemini-Titan II, J-2 Engine, Lunar Module, Mercury-Atlas, Mercury-Redstone, Saturn IB, Saturn V, Space Shuttle Orbiter mockup, Navaho SM-64 (X-10)

* 108th Light Anti-Aircraft Missile Batallion, North end of Fresno Air Terminal, Fresno, CA
  Hawk

* Leicester University Physics Department lobby, Leicester, England
  Skylark

* London Science Museum, London, England
  Apollo 10, Black Arrow, Scout, Skylark

* Museum of Transport, Auckland, New Zealand
  Gemini 12?

* Marshall Spaceflight Center, Huntsville, AL
  Apollo LES-CM Boilerplate, Hermes A-1, Juno I, Jupiter, Redstone, Saturn I, V-2

* McConnell Air Force Base, Wichita, KS
  Titan II Re-entry Vehicle

* McDonnell Douglas, St. Louis, Missouri
  Gemini 6?

* McChord Air Force Base Museum, Near Tacoma, WA
  Sidewinder

* Miami Central High School, NW 95th St, Miami, FL
  Honest John

* Michigan Space Center, Jackson, MI
  Apollo 9, F-1 engine (Saturn V), H-1 engine (Saturn I or IB), Mercury-Redstone, Talos, Tartar, Terrier

* Museum of Life and Science, Durham, NC
  Mercury-Redstone

* Musee de l'Air, Paris, France
  Apollo 13, Diamant A?

* Wallops Flight Facility Visitors Center, Wallops Island, VA
  Aerobee 150, Astrobee F, High-speed reentry rocket, Little Joe I, Nike-Cajun, Scout D

* National Air & Space Museum, Washington, DC
  Aerobee 150, Agena stage (Gemini docking target), Apollo 11, Apollo-Soyuz Mockup, Arcas, F-1 engine (Saturn V 1st stage), Gemini 4, Gemini 4 spacecraft, Gemini 7, Gemini 7 spacecraft, Goddard A-rocket, Goddard First Liquid, Goddard Hoop Skirt, Goddard Pump Rocket, Goddard second liquid, H-1 engine (Saturn I or IB inboard), Hale 24-lb rocket, Jupiter C (Juno 1), Lunar

Module, Mercury Freedom 7, Mercury Friendship 7, Mercury spacecraft Freedom 7, Mercury spacecraft Friendship 7, Minuteman 3, Nike-Cajun, Pershing 2, Polaris (silver hill), Rheintochter, Scout G, Skylab, Skylab 4, SS-20, V-2, Vanguard (late model), Viking (model II), Wac Corporal, X-15

* National Atomic museum, Albuquerque, NM
  Honest John, Little John

* Naval Serviceman's Park, Buffalo, NY
  Talos (aboard USS Little Rock)

* National Museum of Science and Technology, Ottawa, Ontario, Canada
  Apollo 7

* Oakland Museum, Oakland, CA
  Air-air missiles?

* Patric Air Force Base, FL
  Atlas, Thor, Titan I

* Pima Air Museum and Titan Missile Museum, Tucson, AZ
  Bullpup AGM-12B, Genie AIR-2A, Maverick AGM-65, Phoenix AIM-54, Titan I, Titan II, TOW BGM-65

* Point Mugu Missile Park, Point Mugu, CA
  Bat, Bullpup A, Bullpup A, Bullpup B, Bullpup B, Corvus, Hawk, KDA, Lark, Oriole, Oriole, Petrel, Phoenix, Polaris A-1, Shrike, Sidewinder, Sidewinder 1A, Sidewinder 1C, Sidewinder-Arcas, Sparoair, Sparrow I, Sparrow I, Sparrow II, Sparrow III, Sparrow III, Walleye

* Redstone Arsenal, Huntsville, AL
  Redstone

* public park, Riverview, MI
  Nike-Hercules

* Rockwell International, Downey, California
  Apollo 14

* Roswell Museum, Roswell, NM
  Goddard Rocket components

* Science Museum of Virginia, 2500 West Broad Street, Richmond, VA 23220 804-367-1013
  Farside

* Selfridge Air National Guard Base, Mt. Clemens, MI
  Tiny Tim

* St. Louis Science Center, St. Louis, MO
  Black Brant XIII, Gemini 6?, Thor

* Stennis Space Center, near New Orleans, LA
  F-1 engine (Saturn V), H-1 engine (Saturn I, IB), J-2 engine (Saturn V, IB), Jupiter C, Space Shuttle ET, Space Shuttle SRB

* Strategic Aerospace Museum, Bellevue, NE
  Atlas, Blue Scout SLV-1, Bomarc, Thor, Titan I

* Swiss Museum of Transport & Communication, Luzern
  Gemini 10

* Morthon-Thiokol Corp, Brigham City, UT
  Space Shuttle SRB, Trident Missile

* Tsiolkovski Museum, Kaluga, Russia
  M-100B, MR-12, Vostok

* US Naval Aviation Museum, Pensacola, Florida
  Skylab 2

* U S Air Force History & Traditions Museum, San Antonio, TX
  Bomarc, Thor

* U S Air Force Museum, Dayton, OH
  Aerobee, Agena A/Discoverer, Apollo 15, Bomarc, Falcon, Gemini spacecraft, Jupiter, Mercury spacecraft, Minuteman I, Minuteman III, Sparrow, Standard, Thor, Titan I, X-15, X-17, X-24

* U S Air Force Space Museum, Cocoa Beach, FL
  Aerobee, Agena A, Agena B, Arcas launcher, Asset, Athena, Atlas E, big shot shroud, Blue Scout, Bomarc A, corporal, Hawk, Honest John, Jupiter, Lacrosse, Lark?, Little John, Minuteman I, Navaho, Navaho engine, Nike-Ajax, Nike-Hercules, Pershing, Polaris A-1, Polaris A-3, Redstone, Sparrow 1, Subroc, Tartar, Thor, Thor-Able, Titan I

* public park, Warren, NH
  Redstone Missile

* Virginia Air and Space Center, Hampton, VA
  Apollo 12 capsule

* West Eight Mile Armory, Detroit, MI
  Nike-Ajax, Nike-Hercules

* White Sands Missile Park, White Sands, NM
  Aerobee 170, Aerobee Hi, Athena, Corporal, Crossbow, Dart, Falcon, Genie, Hawk, Honest John, Lacrosse, Lark, Little John, Loki, Nike-Ajax, Nike-Hercules, Nike-Zeus, Pershing, Pogo Hi,

Redstone (developmental), Sergeant, Shavetail, Shillelagh, Sidewinder, SS-10, Talos, Tartar, Terrier, V-2, Wac Corporal

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7.3 I've never built any scale models. Are there any recommended kits for first timers?

The following recommendations have been made by posters to r.m.r:

For A-D powered rockets:
Estes IRIS (A-C power, sport/semi scale) - currently out of production
Estes Black Brant II (D power, sport/semi scale)
Quest Nike-Smoke (A-C power, sport scale)

Larger models:
North Coast Rocketry Patriot (E-G power, sport scale)
Aerotech ISQY Tomahawk (E-G power, scale)
Estes Terrier-Sandhawk (D-E power, scale, sport scale)

7.4 What other scale/sport scale kits are available? I'd like to build another kit or two before tackling a scratch scale project.

Many of the really great scale kits (Estes LTV Scout, Centuri Little Joe II, Estes Saturn 5) have been long since or recently discontinued. Fortunately, there are atill a FEW scale kits from which a modeler may choose.

The following is a partial list of available scale and sport scale rocket kits available as of December, 1996. A more complete list may be found on the r.m.r. archive on sunsite.unc.edu. The archived list includes non-flying, out-of-production and high power kits as well.

Rocket	Kit#	Man	SL	Comments	Apprx. Cost
Aerobee 350	MSHRK105	MSH	3	sportscale;56x2.6in	40.00
Aerobee Hi NRL-41		AAA	3	1/9;31.3x1.64in	22.00
Aerobee Hi NRL-41		AAA	4	1/6;49.25x2.6in	43.00
ALARM	K001	TLP	4	44.5x2.6in	28.00
AMRAAM AIM-120A	K048	TLP	4	1/2.69; 54.125x2.6in	30.00
ANUBIS	K038	TLP	3	24.75X1.6"	13.00
ASM-1 (Type 80)	K002	TLP	4	29.5x2.6in	24.00
A.S.P.	RK-004	VBR	2	sport scale;83.8x3.4cm	25.00
A.S.P.	MSHRK100	MSH	2	sport scale;34x1.64in	24.00
A.S.P.	MSHRK101	MSH	2	sport scale;50x2.6in	35.00
ASRAAM	K003	TLP	4+	34.75x2.6"	24.00
Black Brant II	EST 1958	ES	2	1/13; 63.2x3.37cm	13.00
Black Brant II	1014	FSI	5	1/8; 41.5x2.1in	36.30
Black Brant II		COS	3	1:6 scale 51x2.46in	50.00
BOLO		TLP	3	27.25X1.6"	14.00
Bullpup AGM-12B	K005	TLP	4	1/4.62; 29.0x2.6in	23.00
Bullpup 12D	EST 1972	ES	2	39.7x3.37cm	9.00

Corporal	K-41	NCR	2	41.5x1.88in	35.00
DC-Y Space Clipper	3004	Q	3	Semi-scale;Height = 34.3cm	
D-Region Tomahawk		AAA	3	57.5x2.6in	45.00
Dragonfly		TLP	3	26.5x1.6"	22.00
Exocet AM.39	K041	TLP	4	1/5.30; 34.875x2.6"	25.00
Exocet MM.40	K008	TLP	4	1/5.30; 42.0x2.6"	29.00
Falcon AIM-4C		TLP	4	31.5x2.6"	27.00
Flail		TLP	3	29x2.6"	25.00
Gabriel III/AS	K010	TLP	4	30.25x2.6"	27.00
Gemini-Titan		BOY	3	1/100; 12x1.2 in.	
Gemini-Titan		BOY	2	1/160; 8.5x0.736 in.	
Grail SA-7		TLP	3	31.25x1.6"	15.00
Harpoon AGM-84A		TLP	4	29.25x2.6"	27.00
Hawk MIM-23A	K035	TLP	4	1/5/45; 37.0x2.6in	25.00
Hawk		CLR	3	2.6in diam.	32.50
Hellfire AGM-114A		TLP	3	23.625x2.6"	25.00
Honest John		BOY			
IRIS	MSHRK104	MSH	3	sportscale;50.75x2.6in	39.00
ISQY Tomahawk	2005	Q	2	sport scale;47.6x2.0cm	
ISQY Tomahawk	89014	AT	3	104x4.7cm	43.00
ISQY Tomahawk		AAA	4	len=146cm	45.00
Javelin	1025	FSI	5	1/10; 55.3x2.25in	42.00
Jayhawk	EST 2085	ES	4+	1/5; 76.2x6.35cm	36.00
Jayhawk		CLR	4	1/5; 2.6in diam.	29.00
KORMORAN AS.34	K015	TLP	4	1/5.20; 33.3x2.6in	24.00
Lance MGM-52	K042	TLP	4	1/8.48; 28.75x2.6in	21.00
Martel As.37	K053	TLP	4	1/6; 27.0x2.6in	27.00
Maverick AGM-65B		TLP	3	21.5x2.6"	25.00
Mercury-Atlas		ES	4	1/35; len=33in	
Mercury-Atlas		BOY			
Mercury-Redstone		BOY	5	1/17.5; 58x4 in.	
Mercury-Redstone		BOY	3	1/100; 9.75x0.736 in.	
Nike Ajax MIM-3A	K060	TLP	4	55" long	50.00
Nike-Apache		COS	4+	1/6;52.5x2.63in	55.00
Nike-Smoke		COS	4+	1/6; 36.5x2.63	45.00
Nike Smoke	1030	FSI	4	1/8; 72.6x5.1cm	29.00
Nike Smoke	2007	Q	2	49.5x3.5cm	
Nike-Smoke		SRW	2	1/30; 7.64x0,55in	6.50
Nike-Smoke		BOY	1	1/22; 10.5x0.736 in.	
Nike-Tomahawk	1023	FSI	5	1/8; 46.0x2.0in	34.00
Patriot	EST 0896	ES	1	mini-motors; 25.4x1.878cm	4.40
Patriot	EST 2066	ES	4	1/5;99x7.62cm; 4 motor clstr	60.00
Patriot	K-85	NCR	4	1/4;140.7x10.2cm	60.00
Patriot		THOY	4	1/4;132x10.2cm	60.00
Patriot		PML	4	1/4;132x10.2cm	60.00
Pershing 1A		BOY	2	1/30; 8.5x0.736 in.	
Perseus		TLP	3	26.25x1.6"	17.00
Phoenix	EST 1380	ES	3	1/9 (semi); 76.2x6.6cm	21.50
Phoenix AIM-54C		TLP	3	25.75x2.6"	29.00
RP-3		ASP	2		
Sandhawk		CLR	3	1/5; 2.6in diam.	38.50
Sandia Sandhawk	1031	FSI	5	1/6; 49.0x2.0in	33.00

Saturn 1B		BOY	2	1/396; 6.8x0.736 in.	
Saturn V		BOY	1	1/396; 10.7x0.976 in.	
Scimitar		TLP	4	39.25x2.6"	32.00
Sea Wolf	K052	TLP	4	1/2.72; 29.0x2.6in	30.00
Sergeant		CLR	3	3.1in diam.	38.50
Sidewinder AIM-9L	K030	TLP	4	36.0x1.6in	24.00
Space Shuttle	EST 1284	ES	4	1/162; len=34.5cm	25.00
Sparrow AIM-7F		TLP	3	46.75x2.6"	29.00
SR-71 Blackbird	EST 1942	ES	3	semi-scale; len=48.3cm	16.00
Standard AGM-78	K032	TLP	4	1/5.2; 34.6x2.6in	27.00
Standard ARM	LS-101	MRC	2	1/14 (sport);25x1.17in	
Standard ARM		CLR	3	2.6in diam.	32.50
TAN-SAM (Type 81)	K045	TLP	4+	1/2.42; 44.0x2.6in	30.00
Terrier/Sandhawk	EST 2083	ES	4+	1:9.8; 116.8x4.66cm	31.00
Trailblazer	LS-104	MRC	4	1/17;34.3x1.75in	
Type 30 Art.	K049	TLP	4	1/4/54; 40.75x2.6in	25.00
V-2	MSHRK103	MSH	2	1/25sportscale;22.5x2.6in	25.00
V-2		MSH	3	1/16.25sportscale;31.5x4"	60.00
Vostok		COS	5	1:33 scale 45x3.1in	130.00
Wasp	1024	FSI	5	1/8;34.75x2.0in	39.60

There are also a number of Ready-to-fly (RTF) and Almost-ready-to-fly (ARTF) flying rockets, if you want 'minimal' build time:

Honest John	5050	COX	1	1/24;len=13in	17.00
Saturn 1B	5025	COX	1	len=21.5in	34.00
Saturn V	5075	COX	1	len=34in	54.00
X-15	5000	COX	1	1/24	21.00

Some recently discontinued scale kits which you can still occasionally find on hobby store shelves include (all of the below were in the 1991 catalogs or later):

Honest John	EST 1269	ES	3	1/9;94x6.6cm	40.00
IRIS	EST 2007	ES	2	1/13; 17.125x.976in	7.00
Little Joe II	EST 0892	ES	3	1/100;26.7x3.91cm	12.00
Mercury Redstone	EST 1921	ES	4	1/35; 28.75x2.0in	20.00
Patriot	EST 2056	ES	2	1/10 (semi);54x4.16cm	10.00
Saturn 1B	EST 2048	ES	4	1/100;67.2x6.65cm	42.00
Saturn V 25th Anv.	EST 2001	ES	4+	1/100; 109.9x10.0cm	53.00
Sidewinder	TR108	MRC	2	1/4 (sport);30.28x1.325	
Titan IIIE(1)	EST 2019	ES	4	1/73; 71.1x5.64cm	26.00/19.00

You say you like scale models, but want something BIGGER?? Try one of these:

AMRAAM		PML	4	56x3in	80.00
AMRAAM		PML	4+	73x4.0in	100.00
Astrobee D	89015	AT	4	1/2.5; 173x6.7cm	70.00
Hawk		CLR	4+	4.0" diam.; 54mm	78.00
HV Arcas	89012	AT	3+	1/1.666; 142x6.7cm	50.00
Jayhawk		CLR	4+	4.0" diam; 38mm	58.00

Patriot	PML	4+	1/2; 97x7.5"	260.00
Sandhawk	CLR	4+	4.0" diam.; 54mm	93.00
Standard ARM	CLR	4+	4.0" diam.; 54mm	78.00
Standard ARM	CLR	4+	7.67" diam.; 5x54mm	245.00
Sandhawk	CLR	4+	5.54" diam.; 54 + 2x29mm	185.00
Navy Strike	CLR	4+	4.0" diam.; 54mm	93.00

Nomenclature Key:
SL = Skill Level (1 = Beginner, 5 = Advanced)
Prices are approximate retail prices in U.S. dollars
Man = Manufacturer (Refer to Part 02 for addresses)

AAA	AAA Model Aviation
ASP	Aerospace Specialty Products
AT	Aerotech
BOY	Boyce Aerospace Hobbies
CLR	Cluster R
COS	Cosmodrome Rocketry
ES	Estes Industries
FSI	Flight Systems Inc.
MSH	Mountainside Hobbies
PML	Public Missiles, Ltd.
Q	Quest
SRW	Seattle Rocket Works
THOY	Tiffany Hobbies of Ypsilanti
TLP	The Launch Pad
VBR	Vaughn Brothers Rocketry

NOTES:
1. Dual prices reflect last full retail price and special 'closeout' price offered by manufacturer. Kits with both prices may still be found on hobby shelves.

7.5 O.K., I've done all my research, collected all the data I can. I've even built a couple of scale kits a a warm up. Now I'm ready to build a model I can be proud of. How do I...?

Get rid of body tube seams:
Use silkspan, applied with clear dope, or .5oz. - .75 oz. fiberglass cloth applied with epoxy. Silkspan will require a number of subsequent coats of dope or primer to seal the surface and fill in the fibers of the material, while the fiberglass should only require a few coats of primer to fill in the weave. Really deep seams in the tube should filled with your favorite putty beforehand. Tubes covered with silkspan/fiberglass will be less likely to have the seams pop later on.

Sand sharp break lines in fins with diamond cross sections, like those used on Nike motors:
You can't...use a built-up fin instead. Use 1/64 ply or thin plastic. Cut out mirror images of the fin pattern, then score the breakline

with the back of an Xacto knife, being careful not to cut all the way through. Gently bend at the break line. Use a spar under the breakline to provide support and give the proper root to tip thickness distribution. Glue the three pieces (two fin halves and spar) together, and fill the open ends with wood and/or putty.

Form sharp edges on nose cone, transitions, etc. (when turning your own):
The most common material to turn these items, wood (balsa, bass) just won't take a very sharp edge. Try forming the piece slightly undersize, then apply several coats of epoxy (try to get the coats as even as possible). Then use a sanding block to sand the surface smooth, but don't sand all the way down to the wood. These steps should be done without removing the part from the lathe. The epoxy will hold a better edge than wood, and the resulting surface will have a plastic-like feel. Make sure the epoxy you use will cure to a hard surface in thin films...5 minute epoxy often remains somewhat rubbery.

Simulate weld lines:
Thread can be used, but something with a flatter cross-section usually looks more realistic. Try cutting very narrow strips of thin plastic using two X-acto or razor blades glued together (may need a plastic spacer between the blades to get the desired width). The width and thickness of the strip will of course depend on the size of the weld to be simulated, but a 2:1 or 3:1 width:thickness ratio is about right. Paint the model body tube with primer let dry and apply the plastic strip with a _small_ amount of liquid cement. Use a strip of frisk film or masking tape to provide an edge to insure the plastic strip gets applied straight. Then apply several coats of primer to fair in the edges, sanding between coats. If AmSpam ever gets around to publishing it, a future "Art of Scale" will cover this in more detail.

Simulate screws, bolts, and rivets:
For large-scale models, you may be able to find small screws in sizes 0-80 or 00-90 that will do the job that will do the job (Small Parts, Inc, P.O. Box 4650, Miami Lakes, FL 33014-0650 is one source). On smaller models you can simulate screws by embossing slots into Sig "scale rivets" with an X-acto blade. Sig scale rivets are available in both round and flat-head varieties (Sig Manufacturing Co., Inc., 401-7 South Front St., Montezuma, IA 50171). To simulate really tiny screws, emboss the shafts of the scale rivets. Socket head screws can also be simulated using scale rivets by drilling or punching a hole in the center of the head. Rivets can be simulated in a variety of ways. On large scale models, Sig scale rivets may be appropriate. For small models, the best (and most difficult) way is to emboss thin sheet material (aluminum or plastic) using a punch and die. This method gives very sharp definition to the rivet heads. An easier way that produces less definition of the rivet head is to simply punch from one side of the sheet only - no matching die is used. This allows the use of a small spur gear (e.g. a watch gear or pounce wheel) as the punch, thereby allowing a whole row of rivets to be punched very easily.

A sewing machine can also be used to punch a whole row in short order - just grind down a needle to produce the correct size rivet head. Model airplane types often use tiny drops of glue to simulate the rivet (RC56 glue supposedly works well).

Make multiple copies of parts:
Often, an number of identical parts appear on a prototype, and it is usually tedious to make just one of them. RTV rubber is a two-part rubber compound that cures at room temperature. Space does not allow a detailed discussion of the method here, but basically a high-quality master pattern is made, over which the RTV is poured. When cured, the rubber mold is removed. Epoxy or urethane resin can then be poured into the cavity to make as many copies as desired at a small fraction of the work needed to make the master. Fiberglass parts can also be laid up in RTV molds (another yet-to-be published AmSpam/SRM article). Check out back issues of "Fine Scale Modeler" magazine for a number or articles on casting parts in RTV molds. This is an **extremely** valuable technique for the serious modeler.

7.6 What tools do I need?

Well, that's kind of up to you....and your checkbook. With lots of ingenuity and perseverance, many things can be done with simple tools. For example, nose cones and transitions can be turned with just an electric drill (small sized ones at any rate), but it's sure a lot easier with a lathe (see Alway's book for details on turning with a drill). An airbrush is almost a must to have, since even the cheapest spray gun will (with practice) give a much better finish than a spray can. Cans of propellant to operate an airbrush are available, but are expensive in the long run; a portable air tank (found in many hardware stores) could provide a refillable, cheap (free from service stations) source of air for under $30. However, having a compressor is by far the most convenient (if you live in a humid clime, you will also need a moisture trap). Any precision scale work will require some measuring tools, typically a steel ruler with 1/100 inch graduations and a caliper are sufficient. Enco Mfg., a large machine tool supplier, offers a line of low cost rulers and calipers. Their number is 1-800-873-3626. Those who are really serious about scale modeling and have the $$$ to spend may want to consider a small milling machine in addition to a lathe (small lathes like the Sherline or Unimat offer an optional milling column). With a lathe and mill, almost anything can be fabricated, subject only to the skill of the operator and the size of the machine.

7.7 Where can I get more information on modeling techniques?

Since scale modeling is such a small segment of model rocketry, there's not much "how-to" info in the model rocket literature. Peter Alway gives some basic, low-tech tips in his book. For more advanced techniques, look in magazines for the plastic model enthusiast: "Scale Modeler" and

"Fine Scale Modeler" are two examples. Useful techniques also appear occasionally in the model airplane model and ship magazines.

7.8 Got any tips for generating scale plans from original dimensions?

Peter Alway (PeteAlway@aol.com) suggests an old fashioned shortcut for generating scale plans:

> I find a slide rule is better than an electronic calculator for scheming up scale models. You just set the proportion of prototype diameter to a standard body tube diameter and slide the sliding doohickey back and forth to find dimensions of all the other parts.

Jack Hagerty (jack@rml.com) counters with a more modern version:

> Not to sound too snobby, but I have an even better way to make perfect scale drawings of every piece AUTOMATICALLY. Use a CAD system. Even the cheap ones (cheap meaning ~$100) usually have a scaling function. On mine it's one of the commands under the "Copy" function.
>
> CAD systems don't care if the screen is a mile across or .01" across; it's all just numbers. When I did my Titan IIIB, the sceen was set to be about 2,000" across (the Titan/Agena is about 1,700" from tip to the bottom of the engine bells). You just draw in all of the pieces from your prototype reference data full size. Then, when you're done, you invoke the scale command to do essentially what Peter alluded to above using the diameter of the prototype and diameter of the body tube you're going to use to set your ratio.
>
> Continuing my example, the Titan is 120" in diameter and I used Estes BT-80 (2.62" dia) to build it. Once I had drawn the prototype I invoked "Copy -> Scale -> 2.62/120 -> All" and presto! Every piece, every conduit, every strut was now the correct scale size. I just plotted it full scale on my plotter and I had the perfect layout pattern.

Mark Bundick (mbundick@inil.com) adds:

> Try using a spreadsheet. They are particularly useful in cases where there are station numbers instead of actual dimensions in the drawing.
>
> In column 1, enter the part name or dimension. In columns 2 and 3 enter the station numbers from drawing. In column 4, enter a formula to take the difference between the figures in column 2 and 3. In column 5, enter a formula to apply your scale factor to the figure in column 4.
>
> If you want to model in a different scale, just change your scale factor and new dimensions are generated for every part you need on our upscaled or downscaled bird. I find it particularly helpful to just add different body diameters in different columns and then print out a whole page of dimensions for various sized birds.

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 8: Boost Glider and Rocket Gliders

Posted: November 24, 2002

Last modified: November 24, 2002

8.1 R/C Rocket Gliders

The D-G powered R/C rocket gliders now available are presenting some new problems to ModRoc'ers, who are more used to making balsa wings, fins, etc., then built-up wings. Here is a set of tips submitted by Iskandar Taib, a long time model plane enthusiast, and others. There is an excellent FAQ in the rec.models.rc news group. It includes very good information on how to get started into R/C flying, tips on where to buy equipment, etc.

8.1.1. Have there been any construction reviews of R/C rocket gliders?

Aerotech Phoenix: August, 1992, "Model Builder Magazine"
Estes Astroblaster: September, 1992, "Model Builder Magazine"

Both articles are written from the perspective of experienced R/C aircraft modelers. They both contain good construction and flying tips.

8.1.2. I'm building the 'XXX' R/C Rocket Glider and it uses foam core wings. Are there any things I should know about working with foam?

The first thing to know is that certain paints and glues dissolve foam. Both the stuff made out of white beads (referred to as "bead-board") and the blue (Dow Styrofoam (tm)) or pink (DuPont Foamular) extruded foam will behave in the same way. Once sheeted a foam wing can sometimes be finished in a paint that ordinarily dissolves foam if one is careful about not putting too much on at a time. Here is a list of what will dissolve styrofoam and what won't:

Will dissolve foam:

- Nitrate and butyrate dope
- Ambroid

"Model Airplane Cement" (you know what I mean)
Polyester resin (sold as "fiberglass resin" at K-Mart)
Thick and thin cyanoacrylates (excepting UFO)
Paints from spray cans
Dope and paint thinners
Gasoline
Dope thinner, acetone
Solvent-based contact cements

Won't dissolve foam:

Polyurethane paints and varnishes (inc. Rustoleum)
White or aliphatic glues (Elmer's, Titebond)
Epoxies
Ethanol or methanol (sometimes used to thin epoxies)
UFO superglues
Water-based contact cements (eg. Southern Sorghum)

Follow the instructions provided and you won't go wrong. Most structural building is done with white glue and epoxy is used for sheeting the wing and/or putting down fiberglass, graphite or kevlar cloth.

8.1.3. Any tips for sheeting the wings on my Aerotech Phoenix?

The Phoenix kit requires that you sheet the wing with balsa using epoxy as the glue. Aerotech also recommends that you vacuum-bag the wing for the lightest wings possible. Vacuum bagging is a fairly new technique that I will describe later.

The process involves preparing the wing skins, mixing the epoxy (needless to say, the 24 hour laminating variety, spreading it on the skins with a squeegee, scraping most of it off, applying the skins to the core, then assembling everything together in the core beds (the pieces left over after the core is cut), and putting lots of weight on top of the whole thing. Oh yeah.. the wing has to be kept straight so you'd have to do this on a very flat surface. The more pressure you can put on this, the better glue joint you'll have, and the less glue you'll have to use, which makes for a lighter wing.

VACUUM BAGGING

This is where the vacuum bagging comes in. The core bed/sheeting/core assembly is put into a large bag which is sealed on all sides. Then the air is pumped out of the bag. This is supposedly the equivalent of piling hundreds of pounds of weights on the core. In fact they tell you to limit the vacuum to so many inches Hg otherwise the cores will crush.

Vacuum bagging is also useful if you are going to lay up fiberglass on top of the balsa wing skins. Fiberglass cloth is now available in very light weights and people often use it in lieu of a covering film or fabric.

The way it used to be done was that the cloth was laid down and a thinned (with alcohol) epoxy brushed into it. Then excess epoxy was removed using rolls of toilet paper (discarding layers as they became saturated).

With vacuum bagging one lays down a sheet of drafting mylar on top of the wet glass cloth, then puts the assembly in core beds. The assembly is then vacuum-bagged. After curing the mylar sheets are removed and you end up with a glass-like finish that is extremely light since all excess epoxy has been squeezed out. This also obviates the need for lots of the filling and sanding usually necessary before painting.

8.1.4. How about help with my Estes Astroblaster wings?

The Astro Blaster kit uses contact cement for sheeting the wings. The cement is of the water based variety. It is applied to both skin and core and is allowed to dry. After this has occurred, the skins and core can then be brought together. This is a little trickier, since you don't get a second chance. Once the core touches the skin you can't separate them without breaking something. The skins are just 1/32" thick so one has to be gentle with them.

8.1.5. How do you repair damaged foam wings?

Repairing foam is fairly easy. One simply hacks out the damaged piece, glues in a block of foam and carves and sands to shape. Carving is best done with a brand new utility knife (the kind that has break-off points) and sanding can be done with a sanding block. Sheeting is replaced in the same manner - cut out the damaged piece and glue on a replacement. A little glass cloth or carbon fiber matte over the break helps too.

8.1.6. Some more uses of foam in rocketry...

Foam is interesting stuff to play with. You can cut wing cores using a hot wire and 1/16" ply or formica templates. Parts for rockets can be made by simple carving and sanding.

Even more interesting is making lightweight wings and other parts using foam, silkspan and thinned white glue. Someone called Ron St. Jean built lots of competition free flight models in this manner. The silkspan is applied wet over the foam, and thinned white glue is brushed on. When the silkspan dries it shrinks, and the result is an incredibly strong and stiff structures. One could conceivably use this method for nose cones or complex scale models. In England, foam and brown wrapping paper is used for complex ducted fan models (someone actually flies a seven foot long scale Concorde constructed like this).

If one uses heavier paper (eg. grocery sacks) perhaps one can dissolve the foam once the white glue is set (use acetone or dope thinner for this). For rockets imagine something shaped like a V2 made like this. Once the foam was dissolved you'd end up with a light weight craft paper tube of the proper shape, boat tail and all.

8.1.7. I need to cut the piano wire control rods. Bolt cutters don't work well, as the metal is too hard. Any ideas?

From: ntaib@silver.ucs.indiana.edu (Iskandar Taib)

What you want to do is get your hands on a reinforced cutting wheel like the House of Balsa Tuf-Grind. The Dremel ones tend to shatter and throw pieces at high speed. If you use them harden them with thin superglue.

8.2 Free Flight Boost and Rocket Gliders

8.2.1 What is the difference between a Boost/Glider and a Rocket/Glider?

In a Boost/Glider (referred to as a BG in the rest of the FAQ), only a portion of the rocket as launched is required to come down gliding. In a Rocket/Glider (RG), the entire model remains in one piece, and the whole model glides down. BGs can be higher performance because they do not have to carry the dead weight of the motor while gliding down. But sometimes that extra mass is helpful in trimming the model, and RGs have the advantage of not having to chase multiple pieces. Typically, this distinction is only important in NAR competition, where these two classes are distinguished. An RG is a legal entry in BG events, but a BG is not a legal entry in RG events.

The other thing to distinguish is a philosophical distinction between a BOOST/glider and a boost/GLIDER. The question is which half of the flight the emphasis is on. A BOOST/glider is a rocket that happens to have glide recovery. In reality, it probably doesn't glide that well. The Space Shuttle and Tomcat kits are good examples of this type of glider. A boost/GLIDER on the other hand is a high performance glider that is carried aloft by a rocket motor. These are the type of models typically seen in competition, and the topic of most of this FAQ.

Also note that regardless of the emphasis, all of these gliders are launched within 30 degrees of vertical, like all other model rockets. Horizontal launch and shallow climbing supported by wing lift doesn't work for these models, and is prohibited by the safety code.

8.2.2 What are some types of gliders?

Early BGs were rear engine designs. The first was built by John Schutz and Vern Estes in 1961. They usually looked like delta-winged jets or X rockets. The old Estes Space Plane is an example of this style.

In 1963 Larry Renger invented the front engine BG with the forerunner of the Sky Slash. It was basically a hand launched glider with a motor pod hung on

the front. The old Estes Falcon followed this style. A few years later, Larry invented the detachable "pop" pod. Almost all gliders today are front engine design, and pop pods are the most common of the BGs flown today. The old Centuri Swift and Estes Dragonfly (refer to the Rocky Mountain Canary for the original version that performs much better) were Pop Pod designs, as is the MPC/Quest Flat Cat.

Parasite gliders are smaller gliders attached to the outside of larger conventional model rockets. They can be as simple as a small foam glider hooked to an extra launch lug on the side of a standard model rocket. Many of the popular mass market kits fall into this category, including the Estes Manta, ARV Condor, Space Shuttle and the old Orbital Transport, the Centuri Pterodactyl and the Quest Aurora.

Flex-wing (FW) gliders were inspired by the Rogallo wing that was originally intended as the recovery device for the Gemini program. They are basically 3 sticks with a lightweight plastic covering. They fold for boost inside a long skinny rocket, and eject like a parachute. NAR competition rules prohibit "flexies" as they are called in BG and RG events, and create a separate category for them.

Gliders are further broken down into categories describing how they look or work. Some of them are fixed pod, pop pod, swing wing, slide wing, box wing, t-rail, slide pod, no moving parts, canard, auto-elevator, variable camber, flop wing, scissor wing, flying wing, swept wing, flapped wing, delta wing, Rogallo wing, etc.

8.2.3 What are all these funny names I see referenced?

Until the 1979 Pink Book revision, different power classes were designated by names. For gliders, the names were of flying creatures. Here is a decoder table:

1/8A	[none]
1/4A	Gnat
1/2A	Hornet
A	Sparrow
B	Swift
C	Hawk
D	[no official name. The "Pink Book" used to lump D and E into one category. Sometimes called Deagle or Falcon]
E	Eagle
F	Condor
G	[no official name. This class did not exist back when names were used, but was occasionally referenced as Dragon]

8.2.4 I'm just starting. What kits or plans are available?

Several model rocket manufacturers make glider kits. Very few make really good gliders. Among the non-spectacular performers are the Estes Space Shuttle and Tomcat, and assorted parasite and foam gliders.

The Quest Flat Cat is an improvement on an old design that can fly

reasonably well. Edmonds offers several excellent glider kits, also sold by Apogee and BMS. QCR has several glider kits, including a good booklet on flex-wing gliders. The Estes Trans-Wing and MRC Thermal Hawk are reasonable fliers.

NCR glider kits are gone, but plans may resurface in the future. Eclipse has a few glider kits as well. Holverson had some unique gliders, but they've been replaced with RTF foam that just isn't what the old kits were. Apogee had glider kits, but I don't know what their status is today.

My favorite BG plan for the beginner is the Flanigan Flyer, designed by Chris Flanigan of the MIT Rocket Society. Plans for it can be found in the MIT Competition Notebook available from NARTS. It is suitable for A-C 18 mm motors.

Try Mark Bundick's Parksley Eagle for 13 mm 1/2A & A motors, available from NARTS in the "NIRA Glider Plans from 'The Leading Edge'" reprint. There are several other glider related NIRA Reprints also available from NARTS. Guppy's Fish & Chips (1/2A) and High Performance Sparrow (A) BG (both in the MIT CN) were some of my favorites, but are very touchy to trim (more about that later), thus not recommended for beginners.

For C/D BG I've been flying a Gold Rush HLG using either a C6-3 or a C6-3/A3-4T cluster. While I haven't tried it, the Apogee D3 should work fine with this model. Many of the outdoor HLG designs are suitable for this class glider. Also check out Trip Barber's D-Light in the Nov/Dec 1997 Sport Rocketry.

For higher power events, the old Centuri Pterodactyl parasite glider is one of the few models that can hold up to composite motors.

For a first RG, I recommend the Seattle Special, by George Riebesehl. Plans for this model are also in the "NIRA Glider Plans from 'The Leading Edge'" reprint. It flies on A-C 18 mm motors. For 13 mm motors, try Tom Beach's Status-4 in the Winter 1995 issue of Sport Rocketry. A good D RG is George Gassaway's Stiletto-D from the May 1985 issue of American Spacemodelling [http://members.aol.com/RBGliders/Stiletto_D.htm].

For a FW, I recommend the QCR kit and manual. This proved good enough for NAR V.P. Trip Barber, a fellow FW hater, to take a first place with at NARAM-37, building the glider right on the field. Also refer to George Gassaways articles in American Spacemodelling, December 1980 and September 1986.

Many more plans are available from NAR, NARTS, NARTREK, NFFS, and AMA publications. See the references at the end of the FAQ.

Many competition plans are now on the NAR competition web site at http://www.nar.org/competition/plans/competitionPlans.html. Dozens of classic glider kits and plans are available on the JimZ web site at http://www.dars.org/JimZ

8.2.5 Why do most gliders have the rudder under the fuselage?

This is probably more for historical rather than technical reasons. Since

the motor is on top, a conventionally placed rudder would be in the exhaust. In reality, some glider tails are far enough from the exhaust that it often doesn't matter. The real question should be "Why do airplanes have the rudder on top?" :-) Aerodynamically, most would be better off with bottom rudders, but that would get in the way of minor things like wheels and the ground.

8.2.6 These things are very different from what I've built before. Are there any tips for building them?

Lots of them. The most important things to consider are to build light, strong, and warp-free. Weight is the enemy of a glider. A weak glider will break easily. A warped glider is very difficult to make glide properly. All three of these problems are hard to fix later.

Weight and strength are tradeoffs. Reducing one usually reduces the other. Weight must be controlled when building. This starts by selecting the right wood. Many kits from big manufacturers have really awful wood. If it's bad, replace it with better wood from a hobby shop or mail order supplier. More on this later. Proper shaping not only improves the airfoil, but removes excess weight. I prefer to build light, and then reinforce the glider with composite materials, thus minimizing weight and maximizing strength.

In order to keep surfaces straight and free of undesirable warps, I recommend the use of a building board. A scrap of kitchen counter, larger than the finished model is perfect for this purpose. A scrap hollow core door can also make a large workbench and building board. 2x4 ceiling tiles work well, and you can pin plans to them easily, but they can be damaged easily. The building board should have at least one straight perpendicular edge. All planing, sanding, cutting, and gluing is done on this work surface.

The flying surfaces of most gliders need to be airfoiled to work best. Unlike other rocket parts, a glider wing needs a non-symmetric airfoil. The standard fin airfoil shape, split in half, is a good place to begin. To rapidly shape a wing airfoil, use a device called a razor plane. Much like its big brother used for carpentry, this tool shaves off wood quickly. The difference is that it uses a razor blade or equivalent to do so. Many different types are available. My personal favorite is the David Combi. An inexpensive nylon one is available from Master Airscrew. The cheap cast metal planes that use double edge razor blades are usually of poor quality. These and many other handy tools can be found in model airplane catalogs. The SIG catalog in particular is an excellent source of many materials needed to build and fly gliders, including these two razor planes.

Once roughly shaped, a sanding block is needed to get everything smooth. A 6" piece of 1x2 is perfect to wrap 1/6 of a sheet of sandpaper around (or 1/3 of a sheet around a 12" block). Use thumb tacks to hold the sheet in place. The extruded aluminum sanding blocks are particularly nice for airfoiling glider wings. Sanding across the grain removes wood fast, sanding with the grain gives a nice final finish. Start with 100 grit, and work down to 400. The stab and rudder are similarly airfoiled, usually symmetrically. Note that Delta wing and canard (stab in front, wing in rear, like some of the Rutan aircraft designs) gliders often need different airfoils. Consult the instructions or plans for your model.

In order to be stable in glide, your glider will need dihedral. This is the upward tilting or curving of the wings. Some designs use multiple joints, trihedral or polyhedral. To do this, cut the wing in half (or thirds, quarters, etc. as per the plan). A razor saw is the best tool to do this, but a modeling knife and a straight edge will do. Tilt each tip up the required amount on your building board. Use a handy scrap or a piece of 1x2 to prop the wing pieces up. Now bevel the root edges using a sanding block and the edge of the building board so that they are once again perpendicular to your work surface.

The two edges can now be glued together. Standard wood glues can be used for this, either carpenters, CA, epoxy, or Amberoid or Duco. I particularly like Amberoid or Duco cement for gliders because it can be dissolved to remove parts that end up misaligned. For extra strength poke several pinholes in the edges to be joined before gluing.

The wing, stab, and rudder are now glued to the fuselage of the glider. Take care to align the parts accurately. Typically a design will call for a tilt in the wing or stab, in order to make the glider gently turn in flight. This prevents very long chases to retrieve your glider. Also designs will frequently include a few degrees of negative incidence or decalage in the stab. By putting the stab at a slight pitch angle to the wing, it aids in the transition of the glider from boost to glide, and prevents the "death dive" where the glider flys straight down. This angle can be set by tapering the fuselage at the attachment point, or by gluing a small block at the appropriate end of the fuselage to support the stab.

8.2.7 [How] Should I paint my glider?

Most competition models are not painted in a normal sense. Many gliders are left totally unpainted. Some modelers will color the model with magic marker or a thin layer of model airplane dope for visibility. Others will apply a coat or two of clear dope to prevent warping. I personally prefer Japanese Tissue and dope (discussed later), as it adds both strength and color to the model, at a very minimal weight penalty.

Conventional finishing techniques of filler, primer, paint, and decals should be left to models where glide performance is not a concern.

8.2.8 Can I convert a hand launched glider (HLG) to rocket power?

Yes. The cheap balsa "snap together" toy gliders (i.e. North Pacific) are *NOT* strong enough for flight conversion; their wings are too thin and will shread. Plans for Jetex models are usually too flimsy for model rocket power [I've estimated that a Jetex motor is about an A 0.2-P in the NAR system].

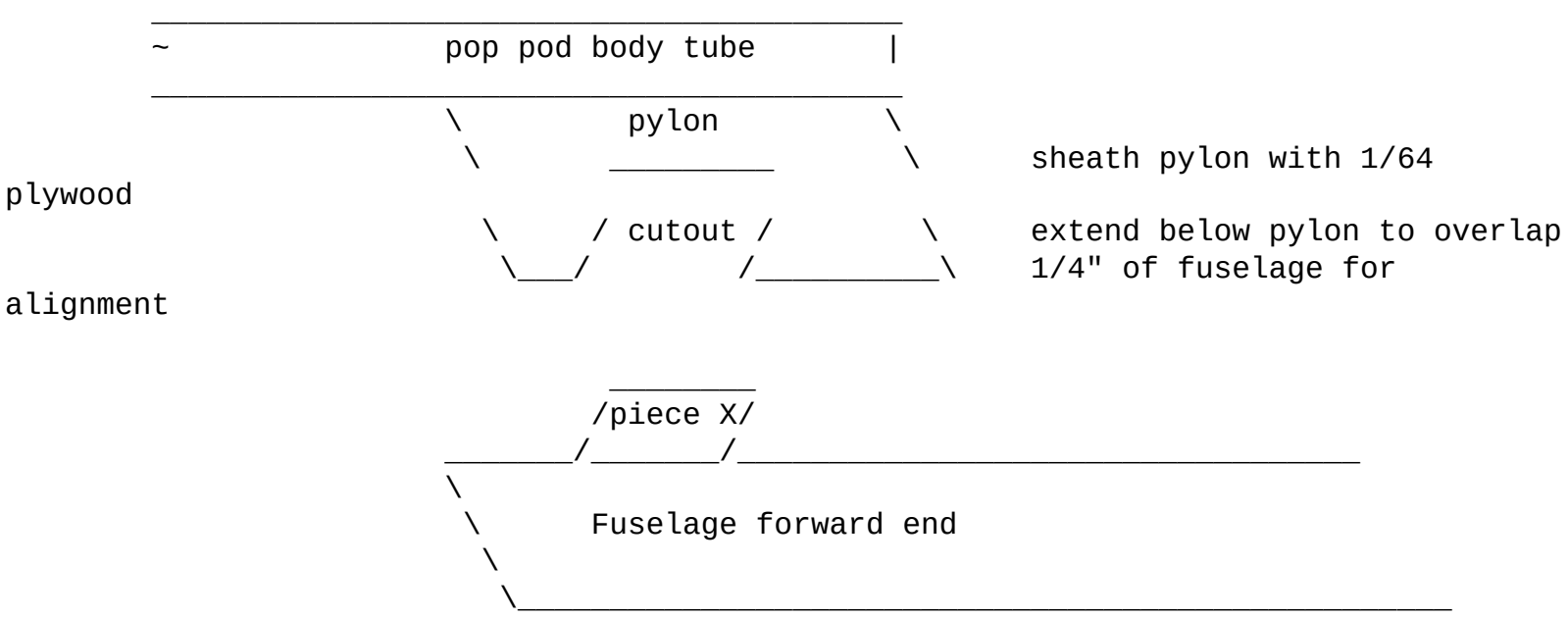
However many HLG kits and plans are convertible. Also look at the Catapult gliders, essentially HLGs flown with a fixed size rubber band instead of arm strength. A wealth of HLG plans are available from the Academy of Model Aeronautics (AMA), National Free Flight Society (NFFS), Zaic yearbooks, and some of the other RC modeling magazines. I highly recommend the NFFS newsletter, journals, plans, and publications as sources of free flight glider information.

Usually, all you need to do is to add a pop pod (or a fixed pod if you want to keep things simple) to the HLG, and perhaps invert the rudder. The references at the end of this part of the FAQ list several good HLG plans.

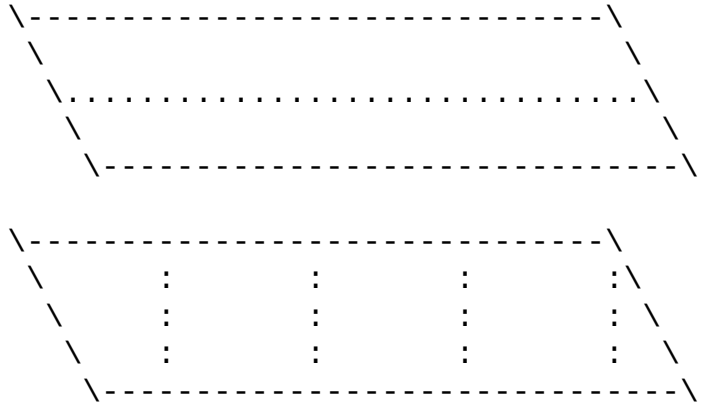
8.2.8.1 How do I attach a pop pod to a glider?

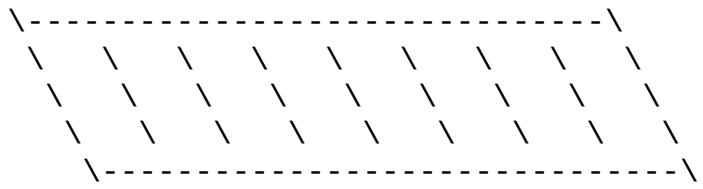
Some sort of positive hook is needed, yet it must be designed to separate easily at ejection. Once common method is the "Piece X" or xerclod hook, where a rhombus hook is cut from the fuselage and attached to the pop pod. Use a razor saw for most of this cutting. The fuselage is then sheathed with thin balsa or plywood around the notch. This creates a weak spot in the fuselage where it can break, especially during trimming.

I prefer to cut the Piece X from the pop pod and glue it to the fuselage:



A common mistake is to have the pylon grain, be it pop pod, fixed pod, or other design run parallel to the fuselage. It results from cutting the pylon from the same stick as the fuselage. DON'T! This is bad for the same reason you don't have the fin grain run this way, it can easily break off. For maximum strength, both the pylon and the piece X should have their grain running parallel to their leading edge. That requires discarding the piece X cut from the pylon, and cutting out a new one, regardless of whether you cut the X from the pylon or the fuselage. An acceptable compromise is to have the grain run perpendicular to the fuselage, so the piece X is usable.





Other attachment methods use a dowel or pin, external hooks of thin plywood glued to the outside of the pod/fuselage, nested square brass tubing (see

8.2.9 I'd like to design my own glider. How do I know if it will work? How do I compute the CP for a glider?

First, build a few kits or plans and get some experience with gliders. Designing a successful glider is a lot more complicated than designing a successful rocket. Once you've mastered building, trimming, and flying some existing designs you are ready to try your own.

Glider stability is similar to a rocket stability, but a bit more complicated. The equivalent to a rocket Center of Pressure (CP) is called the Neutral Point (NP) of a glider. There is an article on how to calculate this in the 1980 MIT Journal available from NARTS. I've used a program I wrote (FORTRAN-IV for RT-11 and VMS) in the early 80s to calculate the NP. Versions of this program for DOS and LINUX are finally available on the net at

ftp://eagle.he.net/pub/cssinc/Private/NP.zip.

Just as a rocket CG needs to be ahead of the CP, a glider CG must be ahead of its NP for it to be stable. 10-20% of the wing chord (the distance from the leading edge to trailing edge of the wing) is a good margin for free flight models. RC models can get by with much smaller margins.

Here is a sample output of my neutral point program. The program itself is based on a paper presented by Guppy at MITCON-11, and a later summary in the MIT Journal.

The Flat Cat data is from the Quest model, emailed to me by Andy Eng. I make no claim to its accuracy. I.E. if it's wrong, it's Andy's fault. Andy specified all the surfaces as being 1/8" thick! I "corrected" this, making the stab and rudder 1/16", which sounds more reasonable to me. Besides, the thickness is just used to calculate the frontal area; it doesn't affect the NP calculation. I was surprised to see the NP at 85% of wing chord. I'd really like someone to try trimming this model with the CG at 70% back and let me know how it glides.

```
        Description: Flat Cat
|               |
        Wing:   Span=  15.500     Root=  2.7500     Tip =  1.3000     PSpn=
14.671
                Swep=  1.4500     Thck= 0.12500     Dihd=  2.5000     Angl=
18.819     Frnt= 1.9375    >
                MAC =  2.0250     Area=  29.710     AR  =  7.2451     Xac =
0.42413     L   =0.81490E-01>
        Stab:   Span=  6.5000     Root=  2.0000     Tip =  1.0000     PSpn=
6.5000     %Wng= 0.32818
```

```
                Swep=  1.0000     Thck= 0.62000E-01 Dihd=  0.0000     Angl=
0.0000     Frnt=0.40300    >
                MAC =  1.5000     Area=  9.7500     AR  =  4.3333     Xac =
0.41667     L   =0.65391E-01>
        Fin:    Span=  1.5000     Root=  2.0000     Tip =  1.0000     PSpn=
1.5000     %Wng= 0.75733E-01
                Swep=  1.0000     Thck= 0.62000E-01 Dihd=  0.0000     Angl=
0.0000     Frnt=0.93000E-01>
                MAC =  1.5000     Area=  2.2500     AR  =  1.0000     Xac =
0.41667     L   =0.30000E-01>
        Front:  Dia = 0.75000     Hgth= 0.50000     Thck= 0.25000
                BstA=  3.0003     GldA=  2.4960     Bdia=  1.9545     Gdia=
1.7827     Semi= 1.1474    >
        Tail:   Momt=  6.0000     QCM =  8.4170     TVC =  1.3641     FVC = 0.43448E-
01 Wash=0.70190    >
        The Neutral Point is located at  85.38% (   2.348     units ) from wing L.
E.    NPg = 1.1540
        Stability factor 0.20 Put CG at  70.65% (   1.943     units ) from wing L.
E.    NPb =0.99614
```

There are several good articles on Boost Glider Stability in old Model Rocketry Magazine and Model Rocketeers. Reprints of many of these are available from NARTS and/or NARTREK.

When scratch building, selecting good balsa wood is important. SIG has a great reference on balsa grain and density in their catalog. Look for pieces of wood with straight grain, and no knots or swirls. For wings and stabs choose as uniform a piece as possible so you don't have density variations in the surface. Also avoid splits and cracks. See also question #13.

There's an article in the MARS Pathfinder newsletter with a V-tail BG design and calculations at: http://www.marsclub.org/path/MP15-3.pdf

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8.2.10 What motor should I use to fly my glider?

Typically, you want a low average thrust and a short delay for a glider. For example, a B class model would probably do better with a B4-2 than a B4-4 or a B6-2. The Apogee 10 mm BP motors are ideal for small gliders. Be careful of motors with large ignition spikes, like the A10-3T or C5-3, unless you want to re-kit your model. Core burning motors, including most composite motors are not usually suitable for gliders. The Apogee end burning composites: C4, D3, E6, and F10, are ideal glider motors.

The new Quest Micro Maxx motors have sparked the development of some very small lightweight gliders. See:

http://members.aol.com/GCGassaway/GENERAL/Czechmicroglider.GIF
http://www.wizvax.net/jvincent/qmm.html
http://hometown.aol.com/peterlynnc/rockets.html

JimZ even suggests using Micro Maxx motors on some WhiteWings models.

8.2.11 This thing looks weird sitting on the pad. How do I launch a glider?

Since the motor is usually near the front of the glider, there isn't much left of a 3' launch rod once you put a glider on the pad. Frequently the glider will fall off the pop pod while sitting on the pad. The other big problem is that once the motor ignites, the clips fall, and can catch in the wings or stab of the glider.

The solution to all of these problems is to launch gliders from a "Power Tower". This is nothing more than a 3' dowel with a launch rod on the top. Sharpen one end of the dowel, and pound it into the ground. You can drill a hole for the rod, or just tape it in place. I like to bevel the end of the dowel at a 45 degree angle. A scrap ceramic tile with a hole drilled near an edge makes a good blast deflector. Make sure that the exhaust is directed AWAY from the glider, and not back into the wing! The pop pod now sits on the deflector, and the glider hangs below the rod, against the dowel.

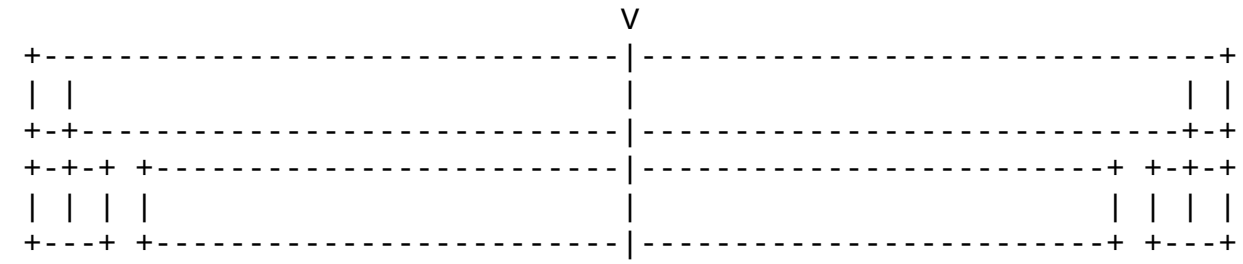
To prevent the clips from catching the tail, you can either tape the clip lead to the dowel, or better yet, use a second launch rod about a foot away as a gantry, so the clips fall away from the glider. A couple more rods are handy if it is a bit windy to prevent the glider from blowing off the pop pod, or twisting on the pad. Space them out near the wing tips.

I've gone one step farther, and made a 1/2 size version of a Chad Pad. The base of the Chad Pad has extra holes in each "leg" for extra launch rods to keep the wind from blowing the glider around, and uses another rod as the gantry for the ignition wires:

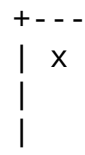
KGB Mini "Chad Pad" and tower parts list:

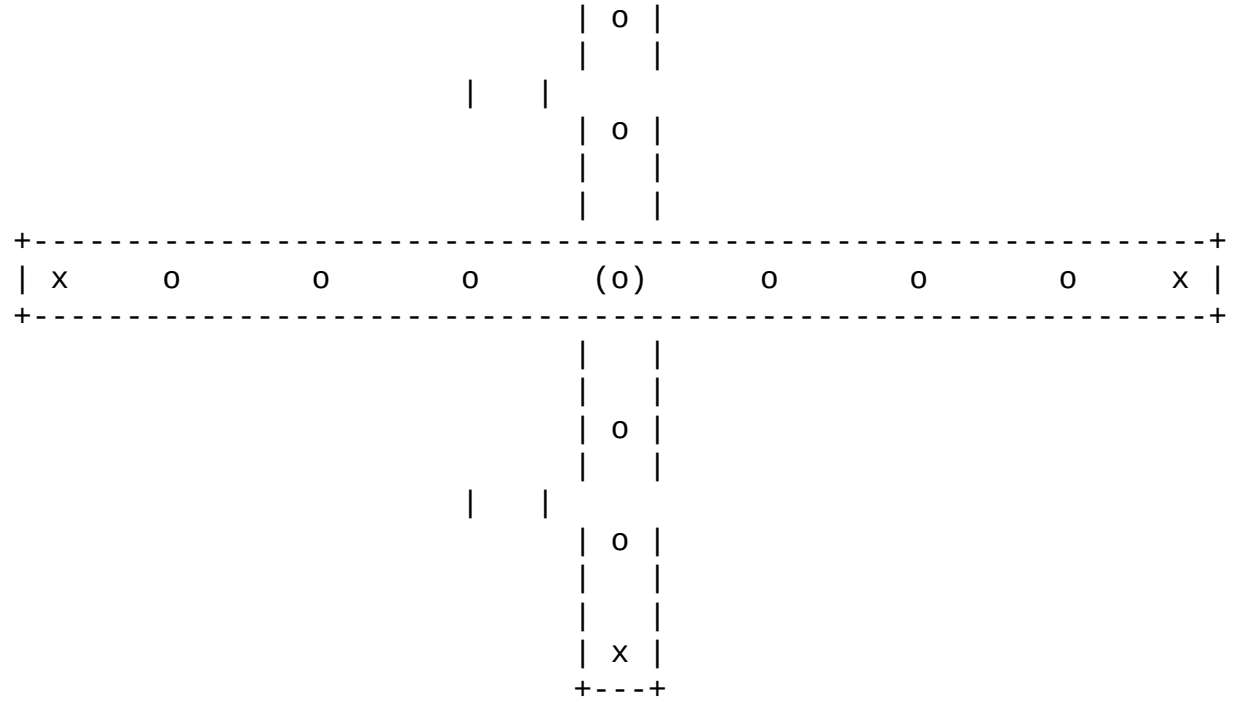
1	4' 1x2 (I used poplar instead of pine)
1	1/4"x2 carriage bolt
1	1/4" wing nut ("V" in drawing)
2	1/4" washers
1	1/4" lock washer
4	1.25" screws or nails
4	16p nails (double headed nails are most convenient)
1	ceramic tile, or stainless scrap
1	3/4" or 1" x 36" straight dowel
1	1/4" T-nut

Chad pad crummy ASCII art: (folded for storage)



and opened





The original chad pad was built from 8' of 2x4, I built a smaller one of 4' of 1x2 for gliders. Take your 1x2 and cut it almost in half, with one piece about 1/2" shorter than the other. From the short piece cut a square off each end. Nail or screw the two squares to the ends of the now significantly longer piece. Drill a 1/4" hole through the center of the two long pieces, and

put a carriage bolt up through the bottom, with a washer in the middle, and another washer, lock nut, and wing nut on top. With the wing nut loose, the whole thing now closes up as above, or opens into an "X". Drill holes in each of the 4 ends for the 16p nails to add stability.

For the glider version, Bunny and I added a 3' dowel with a threaded insert epoxied into the bottom. Cut the top at a 45 degree angle so the blast deflector sends the exhaust away from the model (I use a scrap ceramic tile or piece of stainless steel here) and add hole(s) for the desired rod size(s). Remove the wing nut, and screw the dowel into the carriage bolt, lifting the model up 3' off the ground. Perfect for gliders. Add some holes along both base 1x2 for extra launch rods to keep the glider wings from being blown around in the wind, and to use as a gantry for the wires.

Finish the whole thing as you choose to protect the wood. Bright colors or Aerotech style hazard colors might be a good choice to prevent people from tripping on it. Rust-o-leum BBQ black is a good choice to withstand repeated rocket exhaust.

8.2.12 My glider looped and crashed into the ground. What is wrong?

First check for a warp or misalignment in the wing or stab. These are the most common cause of boost problems, and the reason that accurate building is so critical. If anything is found, fix it.

Most gliders will have some pitch down at ignition and early boost, and gradually change to a pitch up condition near burnout. This results in an "S" shaped flight profile. If the deviation is minor, don't worry about it. A slight roll during boost will keep your glider headed in the right

direction.

Models that have boost problems can often be helped with a longer and/or heavier pod. Extending the fuselage to put the motor farther in front of the wing also helps. A longer rod may help boost also, as will avoiding high winds when launching.

If the model pitches down severely under thrust, the pylon may be too tall or the thrust may be misaligned. If the model pitches up under thrust, the pylon may be too low, or the thrust misaligned. If the model starts straight, then starts pitching up, the wing lift is causing the problem.

8.2.12.1 How do I get the Estes Tomcat to glide?

I remember my first time judging a 4H rocket fair. I judged the advanced group, and the Tomcat was one of the most popular models. I could easily tell which models had already flown by looking for the mud and scratches on the nose cone. every one seems to have trouble with this rocket.

Note that there were two versions of the instructions - a bunch went out with a version of the instructions that would have you put far too much deflection in the elevators, i.e. double what's needed. A single shim from the stabilizer stock is what's required.

Here are some tips John Kallend posted to RMR back on
Tue, 2 Aug 94 18:31:38 GMT

"I have now had six "successful" consecutive flights with my latest Tomcat (successful means no repairs required). I find:

1) The C5-3 is far better than the C6-3

2) Don't angle the launch rod into the wind, launch straight up. Have the top of the model toward the wind - it will pitch "up" into the wind anyway. If all goes well it will arc over inverted, into the wind and then roll upright before the wings deploy

3) The model "flops" around on the launch pad unless you do something to stop it. I put another 1/8" music wire rod into the ground, parallel to the launch rod, to support the wing and hold the model steady before launch.

4) The model seems to suffer from spiral instability on the glide. This does not really show up on the test glides (because they aren't long enough) but both of my surviving Tomcats would drop into a steep spiral on the glide. Fixing this would require a major re-design. Be very careful that your stabilizers and vertical fins are well aligned. I also reinforced the front of the body tube to avoid tearing when the nose cone hits the ground first

5) Both of my current models came out heavier than Estes suggested weight. I don't know how I could have made them any lighter.

6) I think this model could really do with a low thrust D motor (say D6 or D8). Anybody know of such a motor in an 18 mm size?

jk

[Other reports indicate prangs on the Apogee D3 and shreads on the Aerotech D21. No reports yet on the Apogee D10 which might be just what John was looking for]

And from a former R&Der Michael Dennett: "The Tomcat prototype usually flew just fine in the hands of the designer. But it was marginally stable, and I also saw many of them spiral in during testing. It suffers from no dihedral, oversized vertical stabilizers (which generally results in tightening spirals once initiated) and if finished nicely, high wing loading. Mechanically it is an intelligent design."

...

And from the kit designer himself!

"Great care must be taken to balance for flight, balance side-to-side, and to make sure the wings are not twisted, and that the hinge works well. Prayer helps too."

8.2.13 My glider shredded. What is wrong?

It was either not strong enough, or the motor was too powerful. If the motor was too powerful, then the fix is obvious: use a less powerful motor next time. Beware of cored motors, they love to shred gliders. This includes the ignition spike of the A10-3, B8, C5-3, and almost all composites. A few composites, like the AeroTech/Apogee C4, D3, E6 and F10 are designed for gliders.

Also beware of violent ejection charges on fixed pod models. They can rip the pod off the fuselage. Some reinforcing across the fuselage, pylon, and pod will fix this problem. Also refer back to the discussion of grain direction on pod pylons.

Sometimes the solution is as simple as ballasting the pod. Gliders are often under optimum weight, so adding weight to the pod slows the boost, increases the coast, can increase the final altitude, and is dropped off before glide. I often crimp a few fishing split shot to the shock cord to add weight to the pod.

There are several things that can be done to strengthen gliders. Spruce is often used for the fuselage to increase its strength, but at a significant weight penalty. Wings can be made of thicker wood, although this increases the weight of the glider. When trying to maximize performance, it becomes important to select the density of the balsa used in your glider. Lighter wood (6#/ft^3) will save weight, while denser balsa (10#/ft^3) is stronger. Use the lighter wood for wings and stabs, the denser for fuselages, which is still lighter than spruce.

You also need to consider the grain of the balsa. "A" grain wood has the grain running perpendicular to the surface. It is very flexible. It is not a good choice for wings, but is excellent for sheeting built up surfaces, or rolling balsa tubes. "C" grain wood has the grain running parallel to the surface. It has a mottled appearance, and is very stiff. It is ideal for wings and stabs. "B" grain is between A and C, and should be used where

stiffness is not an issue, such as fuselages.

The SIG catalog is an excellent reference on the subject of balsa density and grain. The balsa information from an old SIG catalog can be found on the web at http://www.mentornet.org/balsa3.htm.

Higher aspect ratio wings are weaker than low aspect ratio wings. Try redesigning your wing or tail to lower the aspect ratio.

An excellent way to strengthen balsa without adding much weight is to tissue the glider wings. See below.

Two other ways to make lighter wings particularly on large gliders are built up construction, and foam cores. A wing can be built of balsa strips, and covered with tissue or Monokote. This can yield a very strong but lightweight wing. Foam is commonly used in RC models, and can be used in some of the larger gliders (C-D and up) covered with fiberglass or tissue. Uncovered foam from meat trays can be used for some mini-motor designs. These techniques are beyond the scope of this FAQ.

The leading edge of a wing is prone to nicks and dings from running into things. This can be reinforced with a thin strip of spruce, or a thin piece of nylon or Kevlar line glued along the edge.

For the ultimate in strength and low weight, all parts of a glider can be reinforced with composites like fiberglass, carbon fiber or Kevlar. This is applied either with Amberoid or an Epoxy resin.

I learned about composites from a book by Lambie, another by Rutan (yes, THAT Rutan), and from the MIT folks including Mark Drela. Mark set several indoor HLG records, worked on the Deadaelus and other human powered vehicles, and lots of other stuff that used balsa.

Mark's Upstart-4 can be found in the January 1981 issue of Model Aviation on page 52. It was probably one of the first IHLGs to feature carbon fibre.

8.2.13.1 How to tissue a glider

This is an art in itself. You will need some "Japanese" tissue (from SIG or Peck Polymers) and some clear low shrink dope. I have found that SIG Nitrate dope is less likely to warp the wings, and fills the pores faster. The tissue comes in assorted colors to decorate your model. Use 2 colors, with a darker color on the bottom, for visibility in the air, and a lighter color on top for visibility on the ground. Green is a poor choice for the top, but Blue surprisingly looks pretty dark in the sky. A couple primer coats of dope are applied to the balsa surfaces. Another coat is used to stick the tissue down to the balsa. More coats over the tissue soak through and bond the tissue to the balsa, and fill in the pores.

Brett Buck describes Tissuing Glider Wings in a bit more detail: "For MR sized models, Japanese tissue is probably the best commonly available choice. It's available from Peck-Polymers, and many other sources.

To apply, put several coats of just-thinned-enough-to-brush clear dope, Use

SIG Nitrate, Brodak, SIG Lite-Coat, or in a pinch, Aero-gloss. DO NOT use SIG Supercoat - it shrinks too much. Let it dry 4-8 hours between coats, unless you're using Brodak (you only need to wait ~2 hours). When it starts getting getting slightly shiny, that's enough.

Cut the tissue slightly larger than the area you want to cover. The tissue has a grain to it. You can see it, but you will also note that it tears easily along the grain but with great difficulty across the grain. The grain should run along the long ways of the pieces, in this case spanwise. The tissue also has a top and bottom. One side is very shiny and hard looking and the other side is matte finished. Use the tissue shiny-side up.

Lay it down and smooth it out. Use it dry. Start in the middle of the area, and brush a very thin mix of dope and thinner (mostly thinner) from the middle out. It will run through the tissue and soften the underlying layers, sticking the tissue down. Smooth it out as you go, and if there's a wrinkle, put on a lot of thinner to loosen it up, and then lift the tissue and pull out the wrinkle. It's very strong, and difficult to tear, so you don't have to be too gentle. Once the whole area is covered, I like to go back over the entire surface with more thinned dope, let it sit for a few seconds, and then rub it down with a paper towel to really force the tissue into intimate contact with the wood.

If you need to go around a compound curve, wet the tissue with water just in that area, and pull away to stretch it around the curve.

Once you are satisfied with the covering, go around the edges of the piece with 220 sandpaper to sand into the tissue to cut off the excess. This is better than cutting it with a knife, since the slightly fuzzy edges stick down better. Then seal the edges with more dope. Then flip it over and repeat for the other side of the wing.

Once the whole thing is covered on both sides, put on a few coats of 50-50 dope. It will get more and more transparent for the first few coats. 2-3 should be sufficient, but 4-5 will make it very solid and can be rubbed out if you choose.

If the wing warps due to shrinkage, it can be straightened right after a coat of dope when it's soft. Once everything is dry, heat or steam will be required. Beware of heat guns, as dope (particularly nitrate) is highly flammable. For most thin glider wings, steam will work. For thicker wings (like 1/4" balsa") steam will not work. In this case, wrap the wing with a bath towel and then pour boiling water on the towel until it's soaked, let it sit for a few seconds, then twist against the warp for a few minutes. Then take off the towel. I had to do this just last week with my Ecee Thunder wings.

I'm sure others will add to anything I've missed. This is the traditional way of finishing any balsa part. If you want a good finish, this method saves a tremendous about of weight, because trying to fill bare wood grain with filler takes a lot more filler than than trying to fill tiny holes in tissue. Not to mention that the filler inevitably shrinks down into the grain after a while. It also adds a tremendous amount of strength compared to the negligible weight gain.

An alternative material that I prefer in a lot of cases is .2 oz/square yard

graphite matte. This is available from Aerospace composites. Ask for "soft" matte vice "hard" matte. Soft fills more easily. Apply with dope in the same way (except for the water for compound curves). It goes around compound curves much more easily than tissue, and is much stronger. It's about the same weight once it's applied.

For larger models, replacing the jap tissue with various grades of silkspan is preferred. This is particularly true if you have large open areas. It's tougher and heavier than jap tissue and is applied wet. For almost any rocket purpose, OO silkspan is plenty enough, but there are heavier grades GM (Gas Model) or SGM (Super Gas Model). SGM is pretty tough stuff. All tissue-type products add tremendous strength to the part. Iron-on or synthetic coverings like Monokote, Solarfilm, Polyspan (polyester tissue) are all very soft and will not help the rigidity very much at all."

8.2.14 The pod stuck on my boost/glider and the thing crashed. What is wrong?

You've just been shot down by the "Red Baron". If the pop pod stuck, try sanding to loosen things up a bit. Or dust the mating surfaces with powdered graphite, Teflon, or even talcum powder. Check the action of the pop pod when deploying. Streamers or parachutes have a nasty habit of catching on things that you didn't want them to, like glider wings.

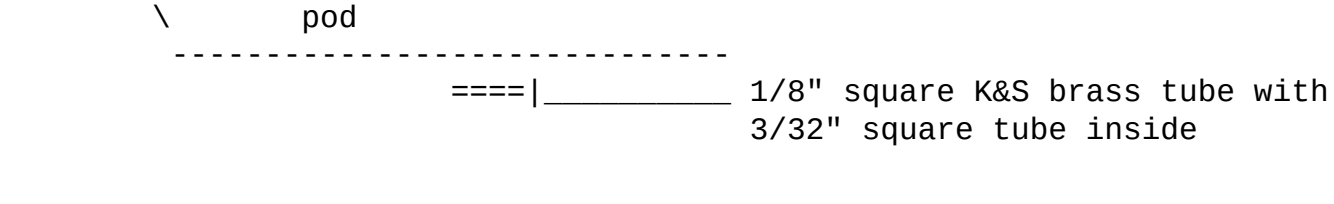
Sometimes fastening the recovery system to the pop pod in a different manner will prevent tangling. I use an external Kevlar line that is glued to the pylon root, but use strapping tape to fasten the line to the end of the tube just below the nose cone so the line is opposite the glider. That seems to help, at least for me. Ballasting the pop pod can also help, especially if ejection occurred long before apogee.

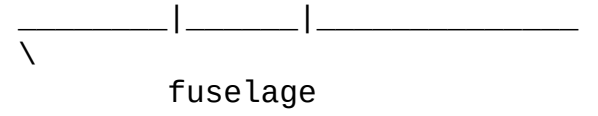
Some pop pod systems are specifically designed to prevent this problem, Try one of them.

One I favor particularly on smaller gliders is to skip the pop pod and go back to a fixed pylon like the old Sky Slash and Falcon. To keep it NAR legal, you tape a small streamer to the motor casing, and wrap it tight before installing the motor. Use a tube that is slightly loose inside to allow for the streamer.

A mid ejection two piece pop pod eliminates the string that is the common cause of the red baron. The down side is another small piece to have to search for.

In the mid 70's Greg "Fat Albert" Stewart published his "Baron Killer" pop pod. It shifts the motor back much like the original Astron Scout, and tumbles down. Small fins on the pop pod keep it legal for competition. He also used nested square brass tubing to attach the pop pod to the glider, a very positive attachment. Danger! bad ASCII art follows:





Another Red Baron proof pop pod is the shotgun cluster pod. Shotgun refers to an over and under or side by side cluster pod arrangement, so named because it looks like the business end of a double barrel shotgun. For B BG you use a cluster of 2 A3-4T motors. The bottom one (i.e. closest to the boom) is ignited on the pad. A 2" piece of thermalite in the nozzle of the top motor is stuck in the exhaust of the first motor. It ignites the second motor just about when the first one burns out. About 3 seconds after that burnout, the first ejection charge fires, separating the pod, but deploying NO recovery system. Thus no red baron. A second later, after the pod has fallen free, the second ejection deploys a chute or streamer. It works very nicely, especially when the alternative is to go to a fatter and heavier motor casing (2 A3s vs a single B4). You can also cluster two motors of different delay, and ignite both at the same time.

You can also have the opposite problem, where the pop pod falls off too soon, sometimes under power. First check the fit. If it is too loose, use tape to make it tighter. This could also happen at launch, where the glider is blown off the pop pod by wind, or just after launch due to a structural failure. Use a Power Tower type launcher to fly a glider and provide additional support for the glider on the pad. Some pop pod hooks, like the molded Apogee hook, are designed to prevent premature glider separation.

8.2.15 My glider glides like the space shuttle (or worse). What is wrong?

Unless you are very good and very lucky, your glider will need several adjustments before it glides well. The process of making these adjustments is called trimming. The goal is to get a glider that transitions quickly and flies smoothly, gently circling overhead. If you are right-handed, you will probably have best luck trimming your glider to circle to the LEFT. If you are left handed, reverse all the following references to left and right.

All trimming is done with the model in glide configuration. For a BG, this means without the pod, For an RG, it means with a spent motor casing installed, and wing, pod, or whatever deployed as it will be in gliding flight.

The first step in trimming is to locate the CG at the proper position. If you are lucky, the instructions or plans will tell you where to locate the CG. If not, you will need to compute the Neutral Point (CP), or use a typical location like 1/3 of the wing chord from the leading edge. Gliders are often tail heavy. Add weight to the nose if necessary to get the glider to balance 10-20% of the wing chord in front of the NP.

All the rest of the trimming should be done by controlled warping of the flying surfaces. Start by getting the model to glide straight, which is much easier if it was built without any warps. In an open area gently toss the glider forward, releasing it with both the wings and fuselage level. Note its action. If the model dives (drops its nose), warp the stab trailing edge UP a bit. If the model stalls (noses up, then suddenly drops, often straight into the ground) warp the trailing edge of the stab DOWN a bit. The best glide us usually right on the edge of a stall.

I like to warp both wing tip trailing edges up to prevent tip stalls, and the center portion of each wing down to increase the wing lift.

Then add a left turn until the model has a slow flat circular glide. Some turn is often added during construction by tilting the wing in the direction of the desired turn, or tilting the stab in the OPPOSITE direction. Turn can be increased by warping the trailing edge of the OPPOSITE wing down a bit. I try to avoid warping the inner wing panel trailing edges up at all, as this can lead to spiral dives. Turn can also be adjusted with the rudder.

For a left roll on boost, warp the left tip of the stab trailing edge up, and the right tip down. This works at high speed, but has little effect at glide speeds. Use wing warp, stab tilt, and a bit of rudder to increase or decrease the turn as needed.

Try a few harder throws. The glider should quickly settle down into a flat gentle circle. Continue adjusting the surfaces until you get this result.

Now you are ready for a serious hand launch. This is an art form in itself. Throw the model up as hard as you can, at a 45 degree angle up and to your right, and with the wing banked at the same 45 degree angle. The model should slowly roll to the left, changing from a right turn to a left turn. If you are lucky, the model will be gently circling 30 or more feet overhead. If not, it probably smacked the ground, so pick it up and try again. Go back and check the trim with a gentle toss, and if all is OK, try again. You may want to vary the angles between 30-60 degrees each, until you find what works best for you and your model.

Now you are ready for the first launch. Pick a reduced power motor, just enough to get the glider to a reasonable altitude, and launch it. Use a power tower as described previously. Carefully observe the boost, transition, and glide. Watch out for a "death dive" where the glider never transitions and comes straight down. This can be fixed with increased stab incidence or warping the trailing edge of the stab up. Also watch for "spiral dive" where the model turns very tightly and crashes into the ground. This is caused by too much turn, or a wing that isn't producing enough lift. Try reducing the turn or warping down the inside edge of the inboard wing.

Continue to adjust the flying surfaces until you get the flight you want. Now move up to the desired motor size, and fly again. Soon you'll need to read the answer to the next question.

Trimming can be very difficult in humid climates! At NARAM-30 in Huntsville I had a hard time trimming my gliders. I'd toss one, then recover it and make an adjustment. Toss it again, and it was better. Pick it up and toss it a third time and it was just like the first toss. ALWAYS made sure that models were well doped before trying to trim them, and do so before going to a humid climate.

Of course, there's my NARAM-42 BGs. After building them, took the pair out to the back yard, and gave each one a couple tosses, just to see how they did. DEAD ON in trim. Spend some time in Canon City futzing around with one, and accomplished nothing but making it worse! Put one in a little thermal (nothing like my ELD model) and easily did 2 minutes on an A8-3. The same

model won B BG at NARAM-44.

Kevin McKiou's trimming advice:

1. Make the dihedral 15 degrees!!!! Last year I had prototype which just would not trim out. It did death dives. It would go inverted at the top of the hand launch (HL) and go inverted into the ground. It did all kinds of crap I could not figure out. The dihedral was set at 12 degrees, which was plenty for spiral stability, but not enough to make it really stable in the transition on a HL. All I did was increase the dihedral to 15 degrees. After that, it was easy to trim. It would roll out like a champ at the top of the HL.

2. Make the distance between the wing 1/4 chord and the tail 1/4 chord about 50% of the wing span. This will be adequate for spiral stability, but not excessive.

3. Make the horizontal stab area between 15% and 20% of the wing area. When I have gone below 15% I have had problems with excessive elevator deflection required. Anything above 20% is unnecessarily draggy.

4. Make the vertical fin area half the horizontal stab area.

5. If you can calculate the neutral point, set up the CG so the glider has a 15% static margin as a starting point. If this works out, fine. It is probably close the the safe minimum. If you can't calculate the static margin, start with the CG at about 40% back from the leading edge at the wing root.

6. Trim the elevator so the glider *just* will not fly in a straight line without stalling, no matter how slow you throw it. Remember to always toss it at a point on the ground about 20 feet in front of you.

7. Now you want to induce a turn. Add about 10 degrees of horizontal stab tilt to the right to induce a left turn. Add about a half gram of clay to the left wing tip to get the turn started. Give it another slow toss slightly down. If it glides into a left turn that is pretty flat, you are very close to perfect. If it turns too fast, remove to tip weight. If it won't break into the turn, add a touch of left rudder.

8. Time to throw it. Throw it up at about a 60 degree angle and tilted slightly to the right. It should arch up, go briefly inverted at the top and roll out in the opposite direction from which you threw it. Give it a real firm throw.

If it kind of slid up and did not arch back, you have the CG too far back. Add half a gram of clay to the nose and go back to step 6.

If it definitely looped back on you, try again with a throw that is a little more horizontal. If you just can't get much height because it wants to loop back (usually into the ground), the CG is too far forward. Remove a bit of nose weight and go back to 6.

If it seemed to launch OK and pretty much stalled at the top

with a really slow roll out, add just a bit more weight to the left wing tip and/or a touch more left rudder.

9. The glide after HL should be a big gentle circle to the left. If you are not getting a turn, but the launch looks good, give it a bit more left rudder. That should help it into the turn. If the model tends to glide too fast in the turn, add a bit more up elevator. If it seems you just can't get everything working quite right between the launch and the turn (e.g., glides fine, but wants to loop on HL) add wash-in to the left wing tip. That is, bend the trailing edge down on the outter 1/4 of the left wing. Now, as the speed builds, the lift of the outter portion of the left wing wing increase more than the rest of the wing and forces it to straighten out the glide a bit, slowing it down. As the model slows, the wing tip weight and rudder will tend to turn the model back into the turn. Now you can back off a bit on the elevator. Use this sparingly. You can over do it and cause the model to tip stall. If the glider builds speed as it glides, with no real recovery in a second or two, the CG is very likely too far back. Add a half gram of clay to the nose and go back to 6.

That's about it. From this point, you will just have to try it, varying each of the parameters to get a feel for what works well. If you work this well, you should get very good hand launches and transitions to glide.

-Kevin McKiou
1994, 1996 US Spacemodeling team member

visit the Vectoraero website (http://members.aol.com/kmckiou) for RC Rocket Glider kits and free plans

visit the US Spacemodeling website (http://www.spacemodeling.org) for info on competition model rocketry.

Comment from Bob: I don't know if Kevin tried anything between 12 and 15, but I've been using 14 for many years. Why 14? Well, it's actually 14.0362... Which is the arctan of .25. It's simple to lay out. Build a right triangle that is 4" on the base, and 1" high. That's a 14 degree angle. I use that guide to build my dihedral joints. It works for Micro Maxx or D sized models.

Here's a crude drawing. If the block is 1" high, then the extension is 4". By making the base of 1/2" plywood you've got a good sized backstop for a sanding block to sand the dihedral bevel into the wing root.

8.2.15.1 How do I trim a Flexie?

Flexies are very different to trim. I refer you to the master, George Gassaway:

From: gcgassaway@aol.com (GCGassaway)

Subject:Re: Newbee Flex-Wing BG questions Date: 12 Jan 1999 06:43:05 GMT

There is a trick to making flex-wings have good pitch stability without having to resort to other tricks such as tails, canards, and weights.

About 20-25% back from the nose, use some very sticky tape such as a strip cut from a band-aid (I use some good old sticky adhesive mylar but that's not easy to find). Use the tape strip to pull the plastic taut into the spar and another piece to pull the plastic taut into the right spar. The remainder behind should be allowed to drape loosely so it billows with air when it glides.

Since you will need to experiment, do not attach the tape down permanently until you get the tautness just right for a good glide trim (I usually only have a small portion lightly stuck to the plastic, with the rest of the tape strip peeled up into the air). After all, if you use the kind of thin plastic as I use (1/4 mil dropcloth) once the tape is down good you will rip the plastic before the tape will come up if you later want to try to adjust the tautness and billow.

When the tautness and billowing are right, the taut front end acts as a built-in canard, sort of like having a flying wing that has elevators on the inboard leading edges instead of on the trailing edges (not that I can think of any real flying wings that were like that). I won't get into it any deeper since it is mostly just a matter of trying it and adjusting it until it glides stably. Once you get in the ballpark, you can tell, though if stalling persists you might need to add a little noseweight too (clay falls off too easily, I often glue a scrap piece of spruce or something else, even a piece of solder, to the nose center spar to move the CG a bit forward). But you can experiment with clay at first to make sure it is a CG problem before gluing anything. Sometimes to get a good stable glide I've allowed one side to billow a bit more than the other, making the flex-wing glide in a turn of about 10 feet in diameter. But too much billow on one side can make it tend to spiral down. Again trial and error in learning will teach far more than I could type about it.

Now, canards can do the job but they add extra complexity and difficulty. Takes a lot less time to find out how to trim by this nose tautness and rear billow method than do any actual design changes....which you would also still have to learn how to trim out anyway.

More flexie trimming information can be found at http://www.wizvax.net/jvincent/sd/sd980102/fw1.html and in NARTS publication NIRA4 "Glider How-To Articles from the Model Rocketeer" for $3.50

8.2.16 My glider never came down and flew away. What is wrong?

If it went in a straight line, you need to re-trim the glider to circle as it glides. Perhaps your field was too small. Find a larger place to fly.

If neither of these is the case, you probably just found a thermal. Air is not static. It moves around due to uneven heating and cooling. A hawk circling overhead, without flapping its wings is in a thermal. When air is heated, it rises. When air is cooled, it sinks. Whatever is in that air goes up or down with it, be it bird, balloon, rocket, or airplane. If the

air is rising faster than the sink rate of your model, the model will rise in the air. In general, this is good, as it allows your model to fly much longer. It stops being good when you lose the model!

This is a "good" problem. It means you've solved most of the problems you've encountered, and have (had?) a pretty good glider. Picking thermals is an art that is beyond this FAQ (but we'll try anyway, shortly). Now we have to find a way to get the glider back. These devices are called dethermalizers (DT) because they are designed to get your model out of a thermal.

This is done by transforming a good glider into a bad glider. There are two parts to this transformation. The first is some sort of timer, to cause the action to occur when you choose. The second is an actuating device that de-stabilizes the glide.

Timers come in several forms. Most common is dethermalizer fuse. This looks more like cotton rope, and burns very slowly, typically 1/4" per minute. By having this fuse burn a string or rubber band, we can actuate a device in flight. Be sure to use a snuffer tube (short piece of brass or aluminum tube the extinguish the burning material) with the fuse, to prevent the fuse from falling free and starting a grass file. Other more sophisticated timers are built from small spring wound motors, or a viscous fluid like STP or silly putty with a piston slowly moving through the fluid

http://www.mindspring.com/~thayer5/ffpages/tips/timer/putty1.gif
http://groups.msn.com/FreeFlightOnline/interestingstuff.msnw?action=ShowPhoto&PhotoID=62
http://homepage.interaccess.com/~ndzied1/Detherm/Open.jpg
http://homepage.interaccess.com/~ndzied1/Detherm/Closed.jpg

Some are even electronic
http://www.geocities.com/rdh82000/Picoalt/index.htm.

There are many actuating devices used. The simplest is a drop weight. Since we often need to add weight to the nose of a glider when trimming, this weight can be dropped, with a string going either to the tail or INSIDE wing (if you go to the outside wing, all you will do is change the glider from a left turn to a right turn, or vice versa). By shifting the weight, the glider will now severely stall (tail), or spiral (inside wing) into the ground.

The "beer can" DT was popular at MIT because of its first step, empty a can of beer! A piece of the aluminum can is deployed as a flap from the INSIDE (turn side) of the fuselage. This acts as a drag break, and causes the glider to slowly spiral down.

Often a DT consists of a flap, either on the wing or stab, that pops up and alters the trim of a glider, causing it to spiral dive or stall. One problem with these is that if not set properly, they can mess up the trim of your glider, eliminating the need for a DT in the first place.

Another problem with many DTs, especially those that produce a stall or gentle spiral, is that in a strong thermal, they may be insufficient to recover the model. Finally, the DT action may bring the glider down so hard that it is damaged on landing.

I like the pop up wing DT used on the Gold Rush (see reference below). The entire wing is hinged, and pops up about 60 degrees. This effectively turns the entire wing into a drag break, sending the fuselage straight down. The model lands nose first, protecting the delicate tail from damage. A variation of this totally cuts the wing loose, except for a string that ties the wing to the tail. The fuselage falls like an arrow, nose first, with the wing fluttering behind. Another nice feature for the serious competitor is that the hinge pin can be removed, making the model very easy to pack for shipping.

8.2.16.1 So how do I find a thermal?

From: Mike Dennett

"Anyone interested in learning about thermals will find some good reading in a copy of Dave Thornburg's "The Old Buzzard's Soaring Book". It describes how model fliers can predict the patterns of thermal activity, and contains lots of easily read material on the behavior of air in general.

http://www.fatlion.com/sailplanes/releases.html

is one source I found that lists them for sale.

Your description of the wind picking up again would indicate to me that the lift is just downwind. The best seat of the pants indicator I have found is the sudden warm, calm period (like you mentioned) that may be first accompanied by a gentle flow of air in the opposite direction of the prevailing breeze depending on its strength. That air is headed upwind to the core of the thermal and then upwards. Good time to toss that hand launch glider right about then. Or push the button. I imagine air headed radially inwards towards the core from all directions, like a great vacuum cleaner nozzle has descended from the sky and is traveling with the prevailing wind direction."

Another article I found is at
http://www.f4bscale.worldonline.co.uk/Thermals.htm

Peter Alway writes in his unique but colorful style: "Bumbling into Thermals: How to make your rocket go up after the parachute opens

It's all connected. The rolling of noodles as your soup comes to a boil, the puffy clouds on a hot summer's day, the fine granulation on the sun's visible surface, the slow grinding of continents, and the miracle of a model rocket drifting up and away, never to be seen again. All are examples of convection, a process that transports heat from the bottom of a fluid upward. One sort of convection, called a thermal, is the key to success in model rocket duration competition.

The NAR sanctions dozens of model rocket meets every year. Each meet offers an assortment of events: spot landing, altitude, craftsmanship, and duration. Duration events are popular because the participants can score them objectively with nothing more than a stopwatch (Actually two watches and two timers to operate them for each flight to improve accuracy and to provide backup in case of a blunder). A contestant in a duration event is

usually worried about three factors: Weight of the model, aerodynamics of the model, and air. Obviously, a lighter model will fall more slowly. Aerodynamics can be as subtle as a glider's airfoil, or as simple as a parachute's diameter. Only after the modeler builds and preps the model does he worry about air.

The holy grail of duration flying is catching a thermal. Thermal is a flier's term for the rising, warm air of a convection cell. You may have seen a convection cell in a pot of soup heating up. As the stove heats the bottom of the pot, the soup at the bottom warms up and expands, becoming less dense than the cold soup above. The heavier cold soup falls to the bottom, and the hot soup at the bottom rises. The soup at the top loses heat to the air, cools, and becomes more dense, the soup at the bottom is heated and becomes less dense, so the process repeats. In fact the process continues steadily; the soup constantly turns over. Depending on the details of the pot and the stove there will be a continuous upwelling of soup in the center of the pot, and a continuous sink at the edges (with my gas stove and a small pot, I actually get an upwelling at the edges and a sink in the middle, but the process is the same).

Even though the sunlight that heats the Earth's atmosphere comes from above, it warms the air near the ground from below. The sunlight passes through clear air unhindered and heats the ground. The warm earth then transmits it's heat to the air. Warm air near the ground heats up, expands, and becomes less dense than the cool air above. The cool air sinks, pushing the warm air up, and creates a convection cycle just like the one in the soup pot. But without noodles, so you can't see it. Your task as a duration modeler is to inject your rocket into the thermal, the warm, rising air in the convection cell.

Not all thermals are created equal. Some are stationary, hanging over dark asphalt roads, parking lots, or roofs. Others roll along with the wind. Some are weak, some are so strong they become 'dust devils' that can pull the hat off your head. Some are tiny, some grow so high that you can see their tops in the form of puffy cumulus clouds. Thermals tend to be weak at dawn, and grow stronger and more frequent on a sunny afternoon.

You have probably felt thermals without realizing it. If you've been out on a hot day, you have probably felt the relief of a cool breeze out of nowhere. That's the down draft of a convection cell, the 'sink' of a thermal. That's exactly what you don't want to launch into. But what do you want to fly into? How can you detect a thermal?

I confess that I'm not the world's best thermal spotter, but I have techniques that are better than flipping a coin, and I have seen some tricks that others use. They are a mix of rendering thermals visible and detecting them by feel.

Some folks use a pole with a ribbon. They attach a 10-20 foot length of audio cassette tape to the end of a 10-foot bamboo pole. As the tape blows in the wind, they will watch for a moment where the wind lifts the tape above the end of the pole. The updraft is a thermal, and that is their signal to launch. I'm not sure that most thermals have really formed at just 10 feet up, but then again, the ribbon-on-a-stick folks tend to beat me in competition.

Some people prefer a bubble machine to put some 'noodles' in the soup of air that surrounds us. The principle is the same'rising bubbles indicate rising air.

Other modelers build little weather stations' a sensitive electronic thermometer connected to a computer that records the pattern of rising and dropping temperatures. When the high is 5 degrees over the low, you've got something, and you launch. Immerse yourself in a combination of these devices and you will learn to see thermals coming.

I've heard of the manly rocketeers who took their shirts off at launches so they could feel the wind at their back and find thermals that way. Naturalists will trust hawks and turkey vultures who love to circle in thermals, feeling them out by the lift and warmth under their wings.

As for me, I use a strategy that is cheap, simple, and modest. I fly with my brother, Bob, in a team called the Bumbling Brothers Flying Circus. While Bob prepares his model and sets it on the pad, I pay attention to wind and heat. It's hard to ignore the wind, but I also notice the little warmings and coolings. Once the model is on the pad, I ask myself 'is it windier than average at this moment?' If it is, we wait. I ask myself 'Is it warmer than average right now?' If it isn't we wait. I rarely wait for more than five minutes. It's a tough call, and I don't always get it right, but eventually, the wind lets up, and I feel warmth.

I have a pet theory that the real lift hits at the end of the calm interval. My theory is that the wind that comes blowing in has to go somewhere, and the only place to go is up. At least one experienced flyer has laughed at that one, so I might be full of nonsense. But at more organized contests where everyone flies from a rack controlled by an RSO, that's a moot point, because the process of getting the model off the ground can take so much time that you are almost always at the end of the calm interval.
I'm ready, you call to the RSO

Modeler's ready on pad five.

Timers ready?

Yeah we're ready.

OK, pad is ready with a an A8 is that an A8-3?

Yes it's an A8-3. I'm ready! you answer as you nervously feel a little gust coming.

OK, ready on pad five. Oops do we have continuity oh the switch was on pad four. We have continuity now. Timers ready? Yes we're ready

Modeler ready?

Yes! Yes! Fly it now! The breeze is starting to pick up is it starting to cool down? Oh Kay. A eight three on pad five. Ready?

You can feel the thermal rolling past.

Fiiiivveee. Fffooooouurrrr. Threeeeeeeeee. Twooooooooo

How can anyone count backwards so slowly! I'm losing my air

Ooooonnneeeee. Zeeeeeerrrrrooooo. Llllllaaaaaauuuuucccchhhhhh!

Whoosh. Pop. Unfurl Unfurl Unfurl Blossom.

It is satisfying to see a big silver parachute pulsate like a jellyfish as it opens in a thermal--It's going up!

I love to watch a model rise on a parachute. It's almost like watching a hot air balloon in flight. Sometimes the model goes forever, or at least it rises until it is out of sight. I have seen parachute models disappear into the bases of clouds. I have seen them float for half an hour. I will never forget Bob Kaplow's NARAM egglofter that hung for half an hour over the Pennsylvania mountains (coincidentally formed by the ancient collision of crustal plates propelled by convection currents in the Earth's mantle) before flying away beyond the horizon. Boost-gliders also can stay up for many minutes under a thermal. Even a streamer model will catch a little lift off a thermal and stay up longer than you might expect.

Thermals are a wonderful wild card in contest rocketry, though you can't thermal away a model that sinks too fast'you need a light rocket with a lot of wing or parachute area to catch an express elevator in the sky. Also, you have to recover a model in each duration event if you want those miraculous anti-gravity seconds to count.

Every part of model rocketry can be an opening on a new world. Scale modeling has introduced me to the history of spaceflight and a deeper understanding of design. Predicting rocket altitudes as a teenager prepared me for calculus. I have come to see searching for thermals as a way of understanding the motions of invisible air, like those wonderful cool breezes. Recently, while visiting a local nature preserve, I saw a bald eagle flap into the air, and then circle effortlessly upward out of sight. Thanks to my experience finding thermals at rocket duration contests, I could appreciate exactly what he was doing. When you catch your first thermal, you might just feel like that eagle, a master of the air."

8.2.17 Glossary: (with thanks to AstronMike@aol.com)

Airfoil: Cross section shape of the wing surface. Glider wings are rarely symmetrical, and for our models are mostly flat bottomed.

Angle of Attack (AOA): The angle of the mean chord line with respect to the airflow, with zero AOA being defined as the zero lift angle of the wing. More simply, it's the angle the wing hits the air.

Angle of Incidence: The angle between the wing and the thrust line.

Aspect ratio: The ratio of wing span to wing chord. AR = span^2 / area
Higher numbers tend to be more efficient, but can be weaker.

Canard: A glider with the stab in front of the wing. These usually have very good stall characteristics. They appear to be built "backwards".

Chord: The maximum front to back length of the wing, usually the root where it is attached to the fuselage. Also used Root chord, Tip chord.

Decalage: The amount of angle that the stabilizer is tilted from the angle of the wing. This angle is usually slightly negative, either leading edge down or trailing edge up. Used to give a very slight up elevator pitch to the glider and help it recover from dives.

Dihedral: The amount the wingtips are raised from the wing root. Used to keep the model roll stable in glide. A typical free flight model will have about 15 degrees of dihedral, or about 1" for each 8" of span. Trihedral is when you have three wing sections, the center section being horizontal. Polyhedral is when you have four or more wing sections at different angles. Anhedral is when the tips are pointed down, occasionally found on the stab.

Dive: When the nose of the glide drops in flight.

Fuselage: The glider body, usually a stick.

Incidence: see Decalage.

Laminar: smooth air flow over a wing with no disturbances. Not turbulent.

Lift: Upward force created by airflow as it passes over the wing.

Neutral Point: Is the glider CP.

Pitch: The rotational axis where the nose moves up or down. If you make a "gun" with your hand, then extend your middle finger straight out, you have the three axis of a glider. The middle finger is the pitch axis. The index finger is the roll axis. And the thumb is the yaw axis.

Reynolds number: A dimensionless number which describes the type of airflow over a wing, also used to scale wings for wind tunnel testing. The formula for it is: Re=density(air)*velocity*length(chord)/viscosity(air). Re for our models typically are under a million and are considered the very low Reynolds number region.

Roll: The rotational axis where the glider leans towards one side or the other.

Span: The distance from one wing tip to the other.

Stabilizer (stab): the horizontal part of the tail.

Stall: When a wing suddenly loses lift. When this happens, the glider will first nose up, then the nose will rapidly drop and dive.

Sweep: The amount the leading edge of the wing angles back from the wing root. Sometimes the sweep will be negative, and the tip is actually swept forward.

Tail spin: An antiquated term for what we refer to now as a "spiral dive". It is not related to a stall or spin in any way. When this model suffers a problem, it typically is a spiral dive, which can result from grossly unequal angles of incidence between the tip sections on either side, or

excess noseweight, or both. (RobEdmonds)

Washin: The amount the wing trailing edge is bent down. This increases the lift of this portion of the wing.

Washout: The amount the wing trailing edge is bent up, relative to the leading edge. Not dihedral, but actual fore/aft warpage, usually to keep whole wing from stalling at once. This decreased the lift of this portion of the wing.

Wing Loading: Ratio of wing area to glider weight.

Xerclod: The name given by the MITrs to the pod hook referred to by Stine as "piece X".

Yaw: The rotational axis where the glider turns left or right.

8.2.18 References: (kits, books, publications, catalogs)

Kits:

ARG		Floater 30
		Floater 60
Apogee		Maxima pod hook
		End burning composite motors
		[Apogee carries some Edmonds and Holverson glider kits]
Eclipse		???
Edmonds		CiCi
		Deltie
		Deltie-C
		Deltie Thunder
		Ecee
		Ecee Thunder
		Geminee
		Geminee Thunder
		Ivee
		Ivee-C
		Tinee
Estes	[Refer to the JimZ web site for out of production plans http://www.dars.org/JimZ]	
	#2075	ARV Condor
	#2097	Manta
	#1284	Space Shuttle
	#2086	Tomcat
	#2112	TransWing
Holverson		Silver Hawk Flying Wing BG 13 mm
		Swinger Swing Wing RG 18 mm
		Zoomie Flying Wing BG 13 mm
MRC		Thermal Hawk

Nano Rocketry	tba	
QCR	Auta Sight FWs	
	Easy Slide RGs	
	Folded Wing RGs	
	Never Loop BGs	
	[QCR carries some Edmonds kits]	
	Dethermalizer kit	
Quest	#3002	Aurora
	#3006	Flat Cat
Shecter	Hornet Boost-Glider	
	Shadowcat with Parasite Boost-Glider	
Vaughn	Buzzard	

Rocket Plans:

Dozens of classic kits and plans from old Estes and Centuri catalogs and newsletters are available on the JimZ web site at http://www.dars.org/JimZ

Name	Class		Source
Barber	A BG	Pop Pod	SR Sep/Oct 1996
Beaker	B BG	Canard Pop Pod	NARTS #NIRA1 $3
Challenger 1	A BG	Pop Pod	NARTS #NIRA2 $3
Confederate Angle	A BG	Pop Pod	NARTS #NIRA2 $3
Czech Micro Glider	micro	Fixed Pod	http://members.aol.com/GCGassaway/GENERAL/Czechmicroglider.GIF
D-Light	D BG	Pop Pod	SR Nov/Dec 1997
Dragonfly	A BG	Pop Pod	JimZ
Eiger	4 BG	Fixed Pod	http://www.nar.org/competition/plans/pdf/eiger25.pdf
Filly Willy Flim Flam	B RG	No moving parts	NARTS #NIRA2 $3
Flanigan Flyer	B BG	Pop Pod	NARTS #MIT-CN $5
Fly Baby	C BG	Pop Pod	NARTS #NIRA2 $3 http://www.nar.org/competition/plans/pdf/flybaby.pdf
Flying Jenny	A BG	BiPlane	JimZ
Fish & Chips	2 BG	Pop Pod	NARTS #MIT-CN $5
Gull	C RG	Swing Wing	http://www.nar.org/competition/plans/pdf/gull.pdf
High Performance Sparrow	A BG	Pop Pod	NARTS #MIT-CN $5
Icarus X	B BG	Pop Pod	NARTS #NIRA2 $3
Jabberwock 15	A RG	Slide Wing T	http://www.nar.org/competition/plans/pdf/jabberwock15.pdf
Julie Bird 7	A RG	Slide Wing Box	http://www.nar.org/competition/plans/pdf/juliebird7.pdf
Lumb Duck	B RG	Slide Wing T	NARTS #MIT-CN $5
Lumb Duck 4	B RG	Slide Wing T	MR 3/80 pg 8-9
Manta (CMR)	C BG	Pop Pod	SR 3/97 pg31
Millenium Falcon	A BG	Fixed Pod	NARTS #NIRA1 $3
Nighthawk	A BG	Flying Wing	JimZ

Nocturne	B RG	Slide Wing T	http://www.nar.org/competition/plans/pdf/nocturne.pdf	
Nymph	2 RG	Slide Pod	NARTS #MIT-CN $5 http://www.nar.org/competition/plans/pdf/nymph.pdf	
Olympia 67	4 BG	Fixed Pod	http://www.nar.org/competition/plans/pdf/olympia67.pdf	
Opel	-	FlexWing	MR 2/80 pg6-7	
Parksley Eagle	A BG	Pop Pod	NARTS #NIRA1 $3	
Pterodactyl	F BG	Parasite	JimZ	
Rebel	A RG	Slide Wing Box	Apogee 12/75	
Rocky Mountain Canary	A BG	Pop Pod	MR 3/79 pg6-8	http://www.nar.org/competition/plans/pdf/rockymtcanary2.pdf
Seagull 25	A RG	Slide Wing Box	http://www.nar.org/competition/plans/pdf/seagull25.pdf	
Seattle Special	B RG	Slide Wing Box	NARTS #NIRA1 $3	
Spittoon	B BG	Pop Pod	NARTS #NIRA2 $3	
Status-4	A RG	Slide Wing T	SR Winter 1995	http://www.nar.org/competition/plans/pdf/status4.pdf
Stiletto-B	B RG	Slide Wing T	http://www.nar.org/competition/plans/pdf/stilet-b.pdf	
Stiletto-C	C RG	Slide Wing T	http://www.nar.org/competition/plans/pdf/stilet-c.pdf	
Stiletto-D	D RG	Slide Wing T	AmSpam May 1985 http://members.aol.com/RBGliders/Stiletto_D.htm	
Stinger	B BG		AS 7/90 pg23-25	
Swift	B BG	Pop Pod	JimZ	
Tapeworm	F BG	InternalParasite	NARTS #NIRA1 $3	
Turnup	A BG	Pop Pod	SR Fall 1995	http://www.nar.org/competition/plans/pdf/turnup.pdf
Vincent	4 BG	Pop Pod	http://www.nar.org/competition/plans/pdf/gnatrecordholder.pdf	
Wasp	A BG	Pop Pod	MR 12/70	
Wolf	C BG		SR Summer 96 pg29-30	
Wun	B BG	Pop Pod	NARTS #NIRA2 $3	
Xebec 3A	A RG	Pop Elevator	http://www.nar.org/competition/plans/pdf/xebec3a.pdf	
XP-2B	B RG	Swing Wing	http://www.nar.org/competition/plans/pdf/xp-2b.pdf	
XP-2C	C RG	Swing Wing	MR 1/80 pg6-7	http://www.nar.org/competition/plans/pdf/xp-2c.pdf
XP-3	C RG	Swing Wing	AmSpam 7/92 pg21 & NARAM92 pg24	

HLG Plans:

Name	Source	Size	Type	By
Arriba:	MA 5/94 p??#759	??	Catap	Jean Andrews.
Athena *	FF 11/90 p17 $3	24"	HLG	Mark Sexton #
Big Shooter	FF 01/95 p6	18"	Catap	Bienenstein
Bolo	FF 10/94 p5	18"	OHLG	
Built-Up-Glider	NFFS $3		HLG	John Thornhill
CalCat IV	FF 12/94 p19	17"	Catap	Calvert

Canned Heat *	NFFS $4		Jetex	Don Chancey
Catelliptic	FF 10/97 p13	18"	OHLG	Bennett
Catharsis	BH-151	16"		Bill Hannah
Challenger	MA 8/85 p67	18"		
Class A Glider	FF 12/99 p4	12"		Midwest kit
Class B Glider	FF 12/99 p4	19"		Midwest kit
Coot VI	NFFS $3	19"	IHLG	Mike & Stan Stoy

flapper

Copper Head	FF 11/98 p12 $3	19"		Stan Buddenholm
Crowbar 13	FF 06/95 p17	13"	Catap	Sonesen
Drifter 13	FF 01/00 p5 $3	13"	Catap	DeShields
Drifter 18	FF 03/98 p19 $3	18"	Catap	DeShields
Flash *	NFFS $3	17"	HLG	Fast Richard Mathis
Flip	#FF-14	14"		SIG kit $3.95
Fluf-Duf *	NFFS $3		IHLG	Dan Belieff
Fly Baby	FF 03/91 p7	14"	B BG	Russell
Fly Hi	NFFS $3	HLG		
Gil's Glider	FF 03/98 p5	12"	Canard	Coughlin
Gold Rush	MA 5/86 p64	24"		
Good IHLG	NFFS $3		IHLG	Don Bal
Heat SeekerMkIV	NFFS $4		Jetex	Kem Whiting
Jet Tube	NFFS $4		Jetex	Richard Woods
Jupiter Moon	FF 10/00 p5 $3	21"	HLG	Edward R Berray
Little Shooter	FF 01/95 p5	12"	Catap	Bienenstein
Lo Tech	FF 05/86 p7	14"	IHLG	Mike Reves flap
Lunchbox	FF 06/86 p3	9"	OHLG	Oldencamp
Lynn-2	FF 06/91 p15 $3	20"	HLG	Kimball
MIG-29:	MA 4/92 p??#713	13"	Catapult	
Mach Box	BH-129	11"	Jetex50	
Max Flyer *	NFFS $3	??	HLG	Ray Harper
Max Pak	FF 10/96 p5	32"	Catap	Primbs
Merlin 2	NFFS $3	18"	HLG	Wiese (Campbell's kits)
Micro-Mini Pearl	NFFS $4	26"	Jetex	Stan Smith #
Nickel Glider	FF 01/93 p21	13"	IHLG	Johnson
One Up	FF 05/88 p5	18"	Catap	Lorbeicki
Padre's Passtime	FF 11/97 p23	20"	Catap	Johnson
Paper Glider	BH-193			Jetex
Paragon	MB6/77p60 #6773	18"		
Pig Skin	FF 11/98 p13 $3	18"	HLG	Stan Buddenbohm
Pigeon	#FF-13	12"	SIG kit	$3.95
Plane Jane	NFFS $3		HLG	Mark Valerius
Polly *	FF 01/97 p14 $3	18"	OHLG	Bill Blanchard MA May 1979

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Priceless Fun	FF 02/98 p18	12"	toy	Billings egg crate lid
Punk Rocket	FF 06/97 p5	18"	Jetex	Tomasch
Quantum 20	FF 12/97 p8	20"	IHLG	Surtees MA 5/98 #853
RPG	FF 10/95 p15	15"	Catap	Sonesen
Rain Crow II:	MA 1/83 #394	??	OHLG	
Roll Out	MA ?/?? #201	18"	OHLG	pop-up dethermalizer
Roscoe 18	MA 5/86 p60#509	18"	OHLG	DT
Semi Pro	MA 1/76 p22#124	17.5"	OHLG	pop tail DT
Shockwave *	NFFS $3	??	HLG	Lueken
Sir Gruntalot	FF 05/98 p12	24"		Stalick
Slow Poker III	FF 12/96 p7	24"	IHLG	Budenholm MA 6/92 #716
Stealth Glider:	MA 5/91 #688	10"	Catap	foam/balsa combo.
Step Two	FF 04/91 p26	15"	HLG	Edmondson

Stomper	MA 5/86 p60#510	18"	OHLG	DT
Sub Sweep	FF 05/88 p6	12"	Catap	Markos
Super Sweep 22	NFFS $3	22"	IHLG	Wittman
Suz Too	NFFS $4	??	Jetex	Lewis
Sweepette	NFFS $3	??	HLG	Lee Hines
Sweepette 18	NFFS J82	18"		
Sweepette 19	NFFS $3	19"	HLG	Lee Hines
Tern II:	MA 5/93 #736	18"	OHLG	
Texas Bo-Weevil	NFFS $3	17"	HLG	Don Chancey
Thermal Piglet	Campbell kit	18"	Campbell's Kits	
Thermic 20	FF 12/98 p5	17"	HLG	Jetco kit
Thiszit	FF 01/01 p5	9"	Catap	Crosetto
Tiny Piglet	NFFS $3	??	HLG	Campbell
Upstart-4	MA 1/81	??	IHLG	Drela
US Kid	NFFS $3	??	HLG	Tom Peadon
WS-III	NFFS $3	??	HLG	Joe Wagner
Wasp VI	NFFS J85	??	OHLG	Mike Stoy MA 8/81 p57 #343
Z-21	FF 11/98 p13 $3	21"	HLG	Stan Buddenbohm
Zenith	MA 12/91p61#705	18"	OHLG	pop wing DT
Zweibox	NFFS $3	??	HLG	John Odenkamp
~	BH-121			

NFFS plans can be ordered from http://www.freeflight.org/ Most are $3.
* = NFFS Model of the Year winners

AMA plans can be ordered via http://www.modelaircraft.org/Plans/plansnew.htm
Most HLG plans are a single sheet priced at 3.75.

Books:

"Airfoils at Low Speeds" Selig, Donovan, Frasier SoarTech #8 1989 $20 SoarTech Publications, 1504 N. Horseshoe Cir., Virginia Beach VA 23451 herkstok@aol.com Also see Dr. Selig's web site at http://amber.aae.uiuc.edu/~m-selig/

"Flying Hand Launched Gliders" John Kaufmann, William Morrow 1974 Now available in reprint from NFFS Publications see below for address or http://www.freeflight.org/ $10 members $12 non
[IMHO an EXCELLENT reference on building and trimming HLGs - rgk]

"Handbook of Model Rocketry", G. Harry Stine, Wiley 1994,

"Hey, kid, ya wanna build a model airplane?", Bill Warner, 1991 TAB books ISBN 0-8306-1040-5.

"Model Aircraft Aerodynamics." by Martin Simons, Argus Press (U.K.), Third Edition 1994; (probably)

"Model Rocket Design and Construction", Tim Van Milligan, Kalmbach 1995 tvm@apogeerockets.com http://www.ApogeeRockets.com

"Throw it out of sight", Lawrence F. Abrams Dillon Press Minneapolis MN 55415 ISBN 0-87518-247-X 629.133

[anyone know the title or source for this oldie???], Bill Winter,

1951

[Many tool and woodworking books can be found in any public library #684.08-.09; aeronautics books are usually around #629.133]

Publications:

NARTREK, c/o Lew Proudfoot 310 Dover Court Allen, TX 75002 lewis_proudfoot@comsys.rockwell.com or Dr40Lew@aol.com

NARTS, P.O. Box 1482, Saugus, MA 01906 narts@nar.org http://www.nar.org/NARTS

NFFS digest, 3317 Pine Timbers Dr. Johnson City, TN 37604 $20/year txtimer@tricon.net or http://www.freeflight.org/

NFFS plans, 203 Chevro Lane, Bellevue, NE 68005 hsperzel@aol.com or http://www.freeflight.org/

NFFS publications, P O Box 7967, Baltimore MD 21221 rmclinden@earthlink.net or http://www.freeflight.org/

Zaic yearbooks, Model Aero Publications, P O Box 135, Northridge, CA 91343

URLs:

http://www.monmouth.com/~jsd/fly/how/htm/title.html how planes fly
http://www.nesail.com/trimhlg.htm trimming HLGs
http://naca.larc.nasa.gov/cit.html NACA bibliography
http://amber.aae.uiuc.edu/~m-selig/ads/coord_database.html Airfoil database
http://www.iit.edu/~kallend/rock.html John Kallend's rocket page
http://aeromodel.com/scat Southern California FF

Catalogs:

Aerospace Specialty Products arspecprod@aol.com http://www.asp-rocketry.com

ARG, 130 Matheson Blvd East #10, Mississauga, Ontario, Canada L4Z1Y6 (905)501-0456 70711.133@compuserve.com

Apogee Components Inc., 1431 Territory Trail, Colorado Springs, CO 80919-3323 (719) 548-5075 tvm@apogeerockets.com http://www.ApogeeRockets.com

Campbell's Custom Kits, P.O.Box 5996, Lake Worth FL 33461 305-968-1045
HLG Kits for Polly, Sweepette, Boll Weevil, and others
Or perhaps P.O.Box 3104, Muncie, Indiana 47307 -- (765)289-7753;
e-mail: souper30@gte.net.

Eclipse Components, 570 Buckeye Dr, Colorado Springs, CO 80919
(719) 598-6105 102100.1566@compuserve.com

Edmonds Aerospace, 13326 Preuit Place, Herndon, VA 22070,
(703)471-9313 RobEdmonds@aol.com
http://Members.aol.com/RobEdmonds/Edmonds.html

Holverson Designs, Inc., 25075 Co hwy L20, Soldier, Iowa 51572
holvrson@pionet.net http://www.pionet.net/~holvrson

Model Research Labs, 25108 Marguerite #160, Mission Viejo, CA 92692
regency@pacbell.net http://www.modelresearchlabs.com/

QCR, 7021 Forest View Drive, Springfield, VA 22150
http://www.cybertravelog.com/qcr

Rogue Aerospace Corporation aero@roguelight.com
http://www.roguelight.com

SIG, 401 S Front St, Montezuma, IA 50171 (800)247-5008
flysig@netins.net http://www.sigmfg.com/

Shecter Rockets, 20505 E Clear Spring Ct. Walnut CA 91789-3887 ($1)
fred.e.shecter@alum.mit.edu http://www.geocities.com/fredeshecter/PrdctInf.doc

Vaughn Brothers Rocketry JerryVBR@tcsn.net
http://www.vaughnbrothers.com

VectorAero KMcKiou@aol.com

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 9: Competition and Records

Posted: November 16, 2001

Last modified: November 16, 2001

9.0 Introduction

Short of actually flying and friendly spying, there is a surprising amount that can be learned about the competition game from the usenet. While doing the research on Deja/Google, it became apparent to me that there are really no FAQs in the game of competition. Instead, there is the occasional question followed by some pretty good answers.

My thanks to Buzz McDermott for getting this started and to Wolfram von Kiparski who maintained the FAQs before me. Best wishes to the person who will be making the next update. Most importantly, thanks to all those who are unafraid to ask.

9.1 Are there any manufacturers making kits specifically designed for competition?

Some of the competition kit OEMs and component manufacturers include:

Apogee Components	http://www.apogeerockets.com/
Balsa Machining Service	http://user.mc.net/~bms/
Edmonds Aerospace	http://members.aol.com/RobEdmonds/Edmonds.html
Pratt Hobbies	http://www.pratthobbies.com/
Qualified Competition Rockets	http://www.cybertravelog.com/qcr/
Totally Tubular	http://www.buyrockets.com/buyrockets/tt.html

In addition is a *wide* listing of competition kit resellers and scale kit OEM's, too many to properly include here.

9.2 What are the major categories of competition model rocketry?

The NAR sanctions model rocketry contests throughout the USA, and throughout the year. The contest year runs from July 1 - June 30. The final contest for a given contest year is NARAM, usually held in

August, after the end of the contest year. The complete list of event and rules for model rocketry may be found in the NAR "United States Model Rocket Sporting Code," also known as the 'Pink Book.' It is available free to NAR members, and may be ordered from NARTS. Some of the event types are:

Altitude (1/4A - G) - The purpose is to get the maximum altitude from a model using a specified class of engine.

Streamer Duration (1/4A - G) - The purpose is to get the maximum flight duration from a model with a specified engine type using streamer recovery.

Parachute Duration (1/4A - C) - The purpose is to get the maximum flight duration from a model using a specified motor type.

Eggloft Altitude/Duration (B - G) - In this event the competitor must launch either one to two large raw hen's eggs, depending on engine type and specific event, and recover it/them, intact, crack-free. The goal is either to reach the highest altitude or have the longest duration flight, depending on the event.

Rocket Glider and Boost Glider Duration (1/4A - G) - In these events the competitor launches a glider using a rocket engine and tries to achieve the longest flight duration of the glider. In boost glider the pod containing the motor may be ejected and recovered separately. In rocket glider all parts, including the expended engine, must stay with the model. Rocket glider is considered to be the more difficult event because the model must be both a rocket and a glider without loosing any parts. The CG and CP requirements for the two phases of flight are very different. See Part 08 of this FAQ.

Helicopter Duration (1/4A - G) - In these events the model ascends as a rocket. Rotor arms then extend by some mechanism and the rocket slowly descends like a helicopter which has lost power.

Payload Altitude (A - G) - In these events the competitor must launch one or more standard NAR payloads (1 ounce each of fine sand) and recover the model. The number of payloads increases with larger engine sizes.

SuperRoc Altitude/Duration (1/4A - G) - These events are for rockets that have a minimum and maximum length requirement based on engine class (0.25 - 4.5 meters). There are both altitude and duration variations. The trick to these events is that the model may not bend or crimp during flight.

Scale Events (also see scaleroc@yahoogroups.com) - These are craftsmanship events where competitors build scale models of real military or commercial rockets. Fine craftsmanship is emphasized.

* Scale: exact replicas of rockets, with major scale dimensions verified by judges.

* Sport Scale: adherence to scale is judged from a distance of 1 meter.

* Peanut Scale: Sport Scale for small models (<30cm long or <2cm dia.)

* Giant Scale: Sport Scale for large models (>100cm long or >10cm dia.)

* Super Scale: must include a scale launcher as well as model of rocket; judged same as scale

* Space Systems: Sport Scale model and optional launch complex. Model must complete a predetermined mission with the purpose of duplicating in miniature the full-scale operation of the prototype.

Plastic Model Conversion (PMC) - This event is either loved or hated. Competitors enter plastic models of rockets or other aero-vehicles that have been converted to fly as model rockets.

Precision Events - These include spot landing, random duration, predicted duration, precision duration, and predicted altitude.

Drag Race - Multi-round, elimination tournament where contestants gets points for:
* FIRST lift off
* LOWEST altitude
* LAST to land

Research and Development - A non-flying event where contestants enter results of research projects. Entries are judged for completeness, contribution to rocketry knowledge, degree of difficulty, etc.

The Tripoli "Member's Handbook" currently lists competitive events for high power models. These events are basically altitude record setting events within a given motor power range (F through O).

9.3 Strategy & Tactics - What are some good events to try when first getting into competition? Any 'sage' advice?

9.3.a From Buzz McDermott

I just started competition this year. I must have asked 30 experienced competitors where to start. I got 30 COMPLETELY DIFFERENT ANSWERS!! They ranged from 'keep it REAL simple' to 'try everything'. Here is a summary of the most prevalent advice. It seems to have worked for me.

- Competition requires a large stable of rockets, given all the possible events and engine categories; start with some of the simpler ones where a single model might be competitive in more than one event (for example, the same model might be used for 1/2A-A streamer or parachute duration, another model might be competitive in any of A - C streamer or chute duration)

- Try single eggloft (B-C, duration or altitude) before trying the multi-egg categories (such as D or E dual egg).

- Go for a good, qualified flight first; then decide if 'going for broke' is appropriate on your second flight (this is for multi-flight events).

- Get a teammate and enter as a team. There are too many models you need to compete to be able to build all of them your first year. Entering as a team let's you pool time, talent, experience, and models.

- Don't get discouraged if you aren't immediately competitive. Remember, the main goal is to enjoy yourself and HAVE SOME FUN. If you are new at this, you're going to learn A LOT about rocketry by doing it the fun way.

- KEEP A LOG OF ALL FLIGHTS. RECORD WHAT WORKS AND WHAT DOESN'T. NOTE YOUR FLIGHT TIMES, ALTITUDES, ETC. Your biggest weapon in many events is in being able to predict how your models will perform.

- Make a model preparation checklist for each event (i.e., a detailed, step-by-step list of everything necessary to prep the model). Use this list for your first few competitions. Comp models are often prepared a little differently from sport models. The difference between winning and losing is often just attention to detail, or lack of it, in the heat of competition.

9.3.b From Mark Bundick

Note: This is a condensed version of some competition strategies for individual and team competitors, written by Mark 'Bunny' Bundick and posted to r.m.r. Check the r.m.r archive server for the complete posting. The full posting points out that there are many ways to win, and the following is just what has worked for some individuals.

Some Individual Competition Strategies:

(a) Read the Pink Book. If you don't know the rules for the event, you can't know how to win and how to improve. Figure out the scoring for each event, how many flights are allowed, required number of returned flights, the reasons for disqualification, etc. Reading the rules will also give you some insights into how the contest will be run. Start with the general rules then review the event-specific rules.

(b) Practice for all events where your experience is low. If you already know how to fly parachute duration (PD), don't waste time practicing that at your club's sport launch. Instead, suppose you don't do well in streamer duration (SD). Build a couple different SD models with different streamers, and fly each of them at least a couple of times BEFORE the contest. Take a notebook to the field and write down what happened, or at least write it down after you get back home. Such notebooks can be the lifeblood of your competition model and strategy development.

(c) Improve one event a year. At the start of the season, it helps if you pick one of your weak events for special attention during the year. Review the existing models and strategies for the event, look over the competition carefully during the contest year, and practice this key event each and every sport launch or test flying session you attend.

(d) Strive for consistent flights. Rob Justis, my old teammate from the 70's, always reviewed our DQ's after the meet and separated them into "DQ's for the right reason" i.e no return, and "DQ's for the wrong reason", i.e. separation. We strove to avoid the latter obviously. This made us terribly consistent, and with today's "two flights count" rule, this is even more important.

(e) Fly all the events. Sounds simple, but many people don't do this. You don't have to win the event, but if you don't fly it, you're sure to get behind because you're conceding flight points right off the bat to your competition. Over the course of a contest year, you can concede 10% of your yearly total this way.

(f) Concentrate on events with high individual event weighing factors (WF). If you have to choose events to fly, or are short of preparation time for some of the scheduled events, prepare for and fly the highest WF events first. Simple again right? But how many people go to a contest and fly PD first thing in the AM cause the wind is calm, and ignore BG which has a WF two to three times that of PD?

(g) Refine, don't abandon, your models and strategies. Rarely do you get super performance improvements from forgetting all you know to adopt a totally different strategy. I've seen so many people hop onto a design when it didn't fit their flying style and then get burned. They switch because some guy had a super performance at a contest, so he must have the "Holy Grail" of models. Right after Tom Beach placed highly at a NARAM with a flexie RG, I saw lots of folks try them, and crash. Tom had lots of flexie experience that helped, and when regular BG flyers tried to adopt his style without the background, BOOM! If you're serious about switching to a completely different model, say from swing wings to slide wing rocket gliders, then take the time to practice, practice, practice and build up the background in the new method. There are no quick fixes to the winner's circle.

(h) Pick your contests carefully. If you can't fly helicopter duration (HD) all that well, and the next regional you plan to attend has two HD events, find another contest! Sometimes, this isn't possible. But if two contests compete for your participation at the same time, take the one that has more of your "strong" events.

(i) Casting Your Bread: Share what you've learned with others. A three time national champion who shall remain nameless positively stomped every challenger in his sight. But his desire for keeping secrets and his unwillingness to share left him with few friends, and after a brief time, he left our hobby, poorer himself and leaving our hobby poorer for failing to let us learn from him. The benefits of making new friends and sharing far outweigh any short term competitive advantage you might think you have from being secretive. As a quotation I once read went "We have all drunk from wells we did not dig and been warmed by fires we did not build." So go ahead. Cast your bread on the waters. You won't be sorry.

Hope this provides you competition types some food for thought. I'd love to hear from anyone with comments, questions, brickbats, etc.

9.3.c From Dan Wolf

...I am amazed at the number of people who attend a NARAM as their FIRST contest and expect to have any kind of chance of placing. NARAM is, after all, the National Championships. It would be like an expansion team in football winning the Super Bowl or at least making the playoffs. It isn't going to happen and unless the person has done some other kind of preparation, it shouldn't. That's one of the reasons there are NAR sanctioned contests held all over the country within a reasonable drive of most people. Novices should start out competing at the local, open and then regional meet levels. Chances are if they do, two things will happen. First, they will win something. The meets are smaller and the competition not nearly as tough as at NARAM. Second, they will learn a lot about competition strategy,

what works, what doesn't, etc. I attended probably about a dozen contests before I attended a NARAM. I recall years ago asking people at contests if they were going to go to NARAM and hearing, "No, I'm not ready yet." We all knew that we had to pay our dues before working ourselves up to the majors.

Today, more and more, people don't want to toil away at the local, open and regional levels to work themselves up into NARAM quality competitors. For many, NARAM IS there introduction to competition. I think the idea of a novice division, at least at NARAM, thus has some merit, if that's what it takes to bring NARAMs back to the 300 competitor attendance level.

9.4 Specifics

9.4.a Getting Jump Started

From Jeff Vincent:

>I need a set of competition rocket plans Altitude, Streamer, Parachute can
>anyone suggest a site or a rocket for these events

Generally speaking, these events are fairly simple, and thus you don't see as many plans published. Many simple kits ("3FNC" - 3 fins and a nose cone) can be adapted to these events.

In general, you want a minimum diameter model (same tube diameter as engine), at least 10:1 length: diameter (more if necessary to hold your recovery device). Rounded nose cone. Three trapezoidal fins with approximate dimensions: root - 1.5 dia, tip - 0.75 dia, span - 2 dia (dia equals tube diameter). Checking stability before flying (finding the CP with VCP for instance) is a good idea.

The duration models will have a thin shock cord (squid line or kevlar) attached to one fin root (aka external shock cord). Launch guidance can be provided by a tower or launch rod, piston launching optional. Finishing should be minimal to give a smooth surface with minimal added weight. Streamer will be a mylar streamer, ranging from 3x30" to 8x80" (or more). Thicker, stiffer mylar is usually better, pleats ironed into the unattached end of the streamer help. Parachute will be thin dry-cleaners bag or painter's drop cloth (0.25 mil or so), with 8-16 light shroud lines, colored with magic marker, and dusted with talcum powder. 'Chute sizes range from 12" to maybe 30" (chosen as much for maximum duration as for feasability of recovery).

The altitude models will have a very slick finish (I use an automotive primer polished with fine steel wool on a drill-lathe). Definitely an internal shock cord as conventional models. Launch guidance should be a tower, and a piston launcher is recommended for black powder motors. Recovery by a small (for fast descent) but visible mylar streamer (go more for length than width). Use powdered chalk or dry tempera paint as tracking powder (provides a "mark" for the trackers at ejection). In small diameter models, placing the TP in a paper pouch aids deployment.

If you want to specify engine class, I can be more specific on model and recovery device sizes. Also, some companies (QCR comes to mind) offer good kits (provides plans and saves you the trouble of

chasing down parts from diverse sources).

9.4.b What is a 'piston' launcher? Does it really help?

From Roger Wilfong:

Pistons offer several advantages and a couple of hassles.

+ 1) They eliminate the need for launch lugs and therefore reduce drag.

+ 2) They keep ignition leads from fouling in glider wings.

+ 3) They can increase lift off velocity (see below).

+ 4) They recover an otherwise lost portion of the whoosh generator's impulse.

- 1) They require additional maintenance.

- 2) Ignition can be a hassle.

A launch piston is usually made of cylinder of 12-18" of BT-5 or PT-13 and a fixed piston made of an old 13mm motor casing or brass tubing. In practice, the support shaft is attached to a tripod or other launcher, an igniter is inserted into the tubing on the top of the piston. The bottom 1/4" of the motor in the model is friction fitted to the top of the piston tube and lowered onto the igniter (I use 2-3 short pieces of thin 1/4" masking tape across the joint of the piston/body tube to reinforce the friction fit - actually I've found it easier to use a looser fit and the masking tape than to get just the right friction fit). The micro clips of a launch controller are attached to the bare ends of the zip cord. When the motor ignites, exhaust gas pressurizes the cylinder and pushes the piston down. Since the piston is fixed, the effect is that the cylinder is pushed up. When the stop ring at the bottom of the cylinder hits the bottom of the head, the cylinder stops and the model pops off the cylinder.

In effect the piston has acted as the launch lug for the fist 12-18" of motion.

Roger's Piston Theory (developed through observation and tinkering, it is not based on a mathematical analysis):

For performance events, pistons offer an advantage over launch lugs or towers primarily because they convert an otherwise unusable portion of motors total impulse into motion. There is a startup time at the beginning of the burn where the motor is not producing enough thrust to lift the rocket - it is this portion of the burn that the piston is making use of.

Since the piston gets the model moving before the motor generates enough thrust to lift the model, it is possible that at the instant of separation, the motor may no be developing sufficient thrust to keep accelerating the model and the model may decelerate for the next few feet after leaving the launcher. This is not a problem for PD/SD models and most gliders - they are typically light enough that the piston

has accelerated them to a high enough speed for the fins to work properly; however, it can be a real problem for payloaders and egglofters (I have seen egglofters almost come to a stand still after leaving a short piston). So for heavier models, a piston/tower combination provides additional guidance and helps prevent tip off.

The tower is of only small advantage with SD/PD models; however, it can help if there are other disturbing forces at separation that could cause the model to tip.

Because they affect the gas flow during the ignition of the motor, pistons don't work well with composite motors. My experience has been that composites either cato or chuff when used with a piston. (If someone has worked out using a composite on a piston, how did you get it to work?)

Pistons are a real advantage in any performance event. For eggloft and payload, they typically allow you to use the next longest delay. For instance, a B6-2 is needed for a conventional eggloft model. On an 18" piston, a B6-4 ejects at apogee. Earlier I referred to using a piston on a Big Bertha - an A8-3 gives a marginal flight without the piston; with the piston, ejection is at apogee.

There are a couple of variations and modifications to conventional pistons that can further enhance their performance. The diameter of the head (6, 13, 18 and 24mm) is one parameter to play with. Jeff Vincent and Chuck Weiss presented a floating head piston as an R&D project at NARAM-28 that further increased performance.

9.4.c Wire Loops

From Jack Hagerty:

...There was a great debate a few years back as to the amount of parasitic aero drag that comes from a launch lug (hence tower launchers, pop-off lugs, etc.). The lug essentially stagnates and looks like a solid piece only with turbulence inside. A friend of mine who's an aero engineer with NASA at Dryden told me that if you can keep the length/diameter ratio short, then the air will pass through with very little drag. "How short?" I asked. "About 1/4," he said. That means in order to have no drag, the lug length has to be less than 1/4 of the diameter. For a 1/8" rod this means a length of no more than 1/32". This is, of course, impossible using a conventional fiber lug, but 1/32" is .031"...

9.4.d Pop Lugs - A CMR pop lug described

From Fred Schecter:

A long lug (2 inches at least) or two smaller pieces of lug glued to along standoff (the standoff is long in length, but does not stand off from the rocket very far).

The standoff has bent/formed music wire epoxied to the top and bottom. The bottom piece forms a little "U" shape that captures the lower lip of the rocket body tube. The top piece is a flattened "V" (almost a point) and it is angled slightly toward the rocket. This top piece is inserted through a tiny hole in the body tube.

The entire rocket can sit on the lug while on the rod (that's why you have the lower "U"). You apply a few wraps of masking tape to the top of the launch rod and when the rocket takes off, it slides up the rod until the lug hits the tape, The lug stops ("POPS OFF") but the rocket keeps going straight since it has built up enough speed to fly stably.

The top pin MUST FIT SNUG!!!!! Otherwise it will pop off at ignition. That would be bad.

9.4.e Flying Naked

From Dan Wolf:

>I am putting together a few rockets with competition in mind, and
>having never been to a rocket competition before, I have a few questions.
>
>Do people generally paint competition rockets? If so, what kind of
>paint is used, and does performance increase due to smoother surfaces
>or decrease due to added weight?
>
>And if people don't paint their competition rockets, do they generally
>seal the fins for more laminar flow (this assumes balsa instead of
>G10).
>
>Finally, what about gliders? Do people paint/dope them or just seal
>them, or neither?

Many competition rockets these days go unpainted, particularly in duration events where the models often end up thermaling away. Also, a lot depends on the materials used. Fiberglass and vellum body tube rockets are rarely painted (although sometimes fiberglass models are made with colored die added to the resin). Blackshaft tubing is still used somewhat and it is usually not painted. If the body tube is a conventional Estes type, some competitors will color it with "Magic Marker" if anything. For duration, the preference is to go for reduced weight other than a smoother finish. For altitude, the trick is to do both. Fins on unpainted rockets are often flown unfinished, or finsihed with a couple of coats of clear dope (sanded smooth).

Gliders are rarely painted these days. Either magic marker is used to color them, particularly the underside of the wings (black marker) for visibility. Or, the glider is tissued with lightweight tissue (ie. Jap tissue). This adds strength with a minimal weight penalty and also increases visibility and makes it easier to trim (the tissued stab surfaces can be more easily warped into position on the field).

9.4.f Regarding Streamers

9.4.f.1 Streamers Part 1

From John DeMar:

> What are some of the ways that you have used to attach mylar streamers
> to Kevlar shock cord? The mylar tears really easily so I am afraid to
> punch a hole in it. Also any suggestions on folding the streamer? Is
> this legal in NAR competitions? The "pink book" rules seem rather vague.
> I would like to enter a streamer duration contest for fun, but I haven't
> done streamers before. Any suggestions would be most appreciated.

To attach the Kevlar shock cord to the streamer, use a piece of thin steel wire (music wire) or nylon fishing line. Tape this about 1/2" from the end, parallel to the end (ie: 5" long wire for a 5" wide streamer). Fold the end over the wire and tape again. Then, punch a small hole just above the wire and reinforce the hole with strong tape. Tie the kevlar through the whole and around the internal wire with a couple of strong knots. Put a touch of CyA glue on the knot if you'd like to make sure it doesn't come off.

The "pink book" doesn't say anything about folding, but you need to use a single continuous piece of streamer material. Folding has been the subject of many NAR R&D reports and everyone has their own ideas on what is best. For small streamers, A 1/2" accordian fold for about 1/2 the length works well for me. This can be rolled up nicely into a 13mm tube.

For larger streamers, some people have had good luck with a slight zig-zag fold for most of the length, but it needs a bigger body tube. The goal of this type of fold is to get a draggier whipping action.

9.4.f.2 Streamers Part 2

From Kevin Kuczek:

First I reinforce the end I plan to tie the streamer onto with 1/2" mylar tape (from ASP) folded over so you have 1/4" on each side. Next, I tie a small 1" loop in the kevlar, pass a piece of clear packaging tape through the loop then apply it to a corner on the streamer- one half of the packaging tape gets applied to one side,the other half to the opposite side. Need to made sure you get the packaging tape that stretches and is can't be torn vs. the mylar/polyester type that does not stretch and is easy to tear.

9.4.f.3 Streamers Part 3

From Bob Kaplow:

...folding and pleating the streamer is legal. In fact it's standard practice. But quarter mil and even half mil parachute mylar just doesn't pleat well. For best results, you need to find about 1 mil mylar. The old Ed LaCroix Apogee used to sell it. I don't know of a current source. If any one else does, please say so.

The heavier mylar doesn't tear as easy as the quarter mil stuff. What I do with either mylar or tissue (I still use drafting tissue for most of my competition streamers) is to tape the Kevlar to the streamer at a 45 degree angle from one corner. Use the magic yellow tape that Ring Rocketry sells. I tie several knots in the Kevlar first, to keep it from pulling out, and if possible, fray the Kevlar end to increase the contact area.

I also reinforce both the leading edge and the side of the streamer at the attachment point with another piece of tape. And for the tissue, I also put a piece of tape on the BACK side, to prevent it from tearing through the tissue.

I use a very long Kevlar shock cord, longer than the streamer. I also bungee it with a piece of sewing elastic that is designed to break in use. That absorbs the ejection energy. Replace after every flight.

9.4.f.4 Streamers Part 4

From George Gassaway:

>>>I'm planning on doing some tests on optimizing streamer duration. The conventional wisdom favors micafilm, with 1/2" to 3/4" accordian pleats over 3/4 length. I would like to investigate different materials and pleating techniques. If you have other materials or techniques you favor, I would appreciate hearing about them, so that my tests can be as complete as possible.<<<

Well, as for folding techniques, sure. There's a fold I call "Scorpion's Tail", because the streamer deflects to one side, curled sort of like an attacking Scorpion. The theory is that by the streamer being curled like that, the upper part grabs into the air and flaps around more than an accordion fold does.

The best thing is how relatively easy it is to do compared to making accordion folds. Roll the streamer up on a 1/4-3/8" diameter dowel, then squash it flat and iron it to set the folds. Now for really small diameter models it's not so easy to do that, you'd need less than 1/4" dowel to do a streamer for an 11mm diameter model, since once it's flattened and so forth it would be too big to fit inside the tube. But you get the idea.

And to add another kink, literally, is the idea for double-scorpion fold. Before rolling the streamer up, first fold the top 6" or 12" down, and then do the rolling and flattening. The result is an "S" curve to the streamer.

Another fold, long-forgotten, was the helix fold that Ken Mizoi had a lot of luck with. He did a normal accordion type of fold, and then with it folded up he did a diagonal fold from say the upper left to lower right corner as seen with the whole streamer folded up (NOT deployed). That made the streamer have a helical twist to it when deployed.

I suspect that the optimum fold is out there somewhere that might involve quite and odd mix of the above. Say a double-scorpion fold at the top with an accordion helical fold? And whatever is perfect for one streamer material probably would not work so well for another type and may tend to be very size and mass-specific. So, be sure to identify exactly what kind of model would be used, and base the test streamer sizes and simulated model mass (or actual models) accordingly.

9.4.g Super Roc Duration

From George Gassaway

>>>>I've got a competition coming up soon with... super-roc duration. Any suggestions on what's worked well for you in the past....<<<<

Just remember it's DURATION. So, don't go building something that is on the edge structurally as is typical in Superroc Altitude, this event is not typically won by the highest-flying model.

So, more main body diameter for a long length, less smaller diameter stuff on top. The more of a very small diameter tube you have on top, the more it can deflect like a canard to either make the model go off course or simply make it buckle/shred on boost. Just no reason to get that close to the edge for Duration.

Also it helps to have room to store a decent sized chute. After all this is not a Superroc event that happens to be timed, it is an interesting mix of superroc with Parachute Duration. Don't overlook the Parachute Duration part of it. Well, OK, technically you can use any recovery system for Superroc Duration but parachute recovery is the most practical way to go.

9.4.h Flex Wings

From George Gassaway:

(Note - This really belongs in the glider FAQs but over there, may end up missing ;-)

>>>I'm not getting enough billowing in back (that is, the covering is not loose enough), with the result that the thing dives (not enough incidence between front and back). How do I cut and mount the covering in such a way that it's tight in front but loose in back?..."<<<

Well, ready to learn? :-)

I was fortunate that early on when I used to apply the plastic to spars by stitching it on, something about the process made it tight in front but billowed in the back. Later when using thinned contact cement to attach the plastic to the spars, and laying the plastic down tight across a building board, it didn't produce the same effect.

The trick I use to force the correct amount of billow is to use some very sticky but thin and flexible tape. Originally that was the CMR adhesive mylar, but that's been gone for a long time now (Ah yes, there is adhesive mylar around the hobby but none that is as thin and sticky as CMR's was). So I use strips cut from band-aids (also that's what I use to apply shroud lines that I used to use CMR adhesive mylar for).

I apply a small strip to the top of the plastic, near the edge of a side spar, at around 1/4 of the distance back from the nose. So for a flex-wing with 12" spars, that would be about 3". I use the tape to pull the plastic taut, towards the spar, so that the front part of the plastic is taut but the rear part billows. The amount of billow at the rear depends on how much you make the front taut using this method.

BTW - first prepare the area for the tape, by wiping away from that area any talcum powder you may already have applied to the plastic. I do the left and right side, but do not stick the other side of the tape

down until after making some test glides to see if the billow is about right. By the other side of the tape, what I mean is that once you are sure the tautness is right, then you'll curl the tape completely over the spar and stick the tape to the bottom side of the plastic. But as I say, do not do that yet, as it is almost impossible to peel the tape off to make adjustments later.

So, just test glide it indoors. If it stalls a lot, try adding a bit of noseweight. However usualy a LOT of stalling indicates there is too much billow, so you'll need to adjust the tautness. If it glides OK, try the acid test. Hold it almost straight down and let go. If it starts to pull out of a dive, then you're OK. If it flutters and dives down, then you'll have to try increasing the tautness.

Keep making adjustments until "you learn how to do it, or something like that".

When it is right, then curl the tape around the spar and stick it to the bottom of the plastic too. And give it all another dusting of talcum powder so that any stray adhesive won't stick to anything it should not be sticking to.

9.4.i.1 Tracking Powder Part 1

From Kevin Kuczek:

> Can someone tell me what "tracking powder" is made of? Can it be added to a
> single use motor to help in seeing the ejection? I have seen references for
> it but nothing to explain what it is.

The BEST tracking powder is epoxy paint pigment. It is used by all US team FAI altitude and scale altitude flyers. Better than chalk, better than powdered tempura. When deployed, the clouds are very, very dense and most importantly, linger for a few seconds so that trackers have a greater chance of homing in on it. You can purchase at www.dayglo.com. It's not cheap by any means, but the results are well worth it.

9.4.i.2 Tracking Powder Part 2 (How to Pack It)

From Jeff Vincent:

>... but WHERE do you put the stuff? In the ejection charge or in a cup somewhere...?

Conventional wisdom is to just dump it in, between the wadding and the recovery device (that way when you see the cloud, you know your 'chute is out, even if you can't see it). As you get into smaller models (18mm tube diameter or smaller), skin friction (with the inner tube wall) starts to become a problem.

My practice is to make a small pouch with the old MRC wadding (consistency is similar to silkspan). You will form the pouch around a dowel just a bit smaller than the tube ID. Cut a piece wide enough to make just over one revolution around the tube. Wrap the wadding around the dowel, fold over the bottom end, slide it most of the way into the body tube, *then* remove the dowel. While holding onto the top edge of the pouch, fill it with tracking powder. Once full, crimp/twist the upper end shut, drop into the tube, and load your recovery device.

9.4.j Packing Large Chutes

From Wolfram v. Kiparski:

> What do most of you feel is the best way to fold 0.5 and 0.25 mil mylar
> 'chutes? I am primarily interested in strategies for low opening shock
> for Egglofters.

On a flat surface dusted liberally with talcum powder, lay out your parachute flat. Dust it with talcum powder. Fold it in half to make a semicircle. Make sure the shroud lines are lined up on top of each other. Dust with talcum powder again. Remember, before you fold, dust with powder. Now take one "corner" of the semicircle, and fold the chute halfway. You're not folding it in half again! If one "corner" is at 0 degrees, and the other is at 180 degrees, bring one corner over to 90 degrees - halfway. Now carefully flip the whole chute over, and fold the other "corner" over like you did on the other side. Examine it until you notice that you have folded the chute into an "S" shape. See? Repeat this process again and again until you can't stand it any longer. Remember to dust with powder before folding. When you are finished folding, the whole chute should be folded in zig-zag pleats. The object of doing this is so that no folds are trapped inside of another fold. To finish up, fold the chute lengthwise two or three times, and wrap the shroud lines carefully around the bundle. Parachutes folded this way open very quickly when released. Try it at home a few times to get the hang of it. Practice.

This technique was taught to me by Chuck Weiss. I later read an article in an old "Model Rocketeer" written by Chris Tavares that described the same technique.

9.4.k Tandems

From Jeff Vincent, Chas Russell & Brett Buck:

(Note - This one belongs with the Gliders, is not a FAQ, but sorta interesting)

> >>What ever became of the practice of epoxying a
> >>mini-motor (13mm) into the top of a standard size (18mm)
> >>booster motor to kick it into the next impulse range?
> >>Example - C6-0 with an A3-4T sustainer.

Verboten within a year or so of its origin (late '70s). Thus the "do not permanently attach anything to a casing" rule in the Pink Book.

"Tandems" got their start in California, as far as I know, in the ' '70,s. A couple of guys in the Bay area were flying the Estes Skyraider on a D12-0/D12-7 epoxied together in a BT-50. Really were neat. Static testing showed that some performance increase was obtained from all of the extra mass eroded from the booster motor. However, the fine people in Penrose (fine compared to the current crew) decided that tandems did not meet the test of using the product "as intended". Read liability issues. The NAR concurred and the tandems had a short lived history. The later availability of composites made the point essentially moot. I had flown a few prior to the boom being lowered..

... my cohorts and I were flying tandems in 73-74 time frame in central Kentucky (about when Centuri Mini-Engines first came out). Never heard of mixed tandems, though, like a C6-0/A3-4T. I always figured that using the wrong sized nozzle for the upper engine - a C6 nozzle is much bigger than an A3 - wuoldn't work. . Plenty of people had the idea of weakly gluing them together for conventional staging, since they telescope so nicely. I assume that one failure to separate would plant the idea.

I guess now that we can glue stuff to motor casings again, tandems are A-OK ;-).

9.4.l Helicopter design

From Tim Van Milligan:

> I've been meaning to ask for a long time, why does everyone use front-hinged
> blades? It would seem that the struggle to pull them out against the aero
> would be enough of a disincentive that people would start hinging them at the
> back instead.

It really doesn't matter where the hinge is. The basic problem with rear-mounted hinges is strength. That is; they need to be made stronger than front-mounted blades.

With rear mounted blades, it is likely that the model will deploy when the rocket is moving in a forward direction. This really aids the deployment. But when the speed is high (like when the model is arcing over), the forces on the blades can be very significant. This may cause them to snap off. The higher the aspect ratio, the greater the problem. The Estes Skywinder, which I designed, solves this problem by having a strong hinge, and flexible blades.

I've made balsa wood versions of the skywinder (see the photograph in the Model Rocket Design and Construction book on page 87). But when flying this model, it is really necessary to make sure it doesn't arc over, and that the blades deploy near apogee.

As you mentioned, front mounted blades have the opposite problem. If the model is moving forward, the blades have a struggle to open against the airflow that is trying to hold them down. They also need to be flown so that they don't arc over and deploy near apogee. To solve this problem, what I like to do is have the model separate (but still held together by a shock cord), so that it will instantly slow down so that the blades can open when the model is traveling slower.

So basically, it depends on your own preferences. But when you design the model, you need to make sure that it can safely deploy when it is arcing over.

9.4.m Optimal Thrust (very shortened version of a hotly debated topic)

From Alan Jones:

OPTIMAL THRUST

To a very good approximation, optimal thrust for a model rocket (or HPR rocket) is T = 2W. That is, you thrust at maximum (ideally just an impulse) until you reach the velocity where drag = weight, thrust at 2W until fuel is exhausted, and coast to appogee. The interesting part is that the optimal sustaining thrust level is not very dependant on Cd.

9.5 Aside from hanging around 'old timers', how can I learn more about competition strategies and techniques without re-inventing the wheel many times over?

The best place to start looking would be the NAR Technical Services (NARTS) catalog. NARTS has several documents of particular interest to competitors. The NARTS catalog can be browsed at the NAR web site - http://www.nar.org/ Look for the NARTS catalog, and when browsing through it, look for these titles:

US Record Setting Designs

CMASS Plan Book

MIT Competition Notebook

Journals of the MIT Rocket Society...

Proceedings of the MIT Model Rocket Conventions...

NAR Technical Reviews, Volumes 1 - 7

Boost Glider Analysis-"A Free Flight Method For Boost Glider Analysis."

Streamer Duration Optimization

Basic Design Rules for Boost and Rocket Gliders

Another great place to find information is on the internet where you can do keyword searches at places such as Deja/Google. Be sure and check out the various on-line club newsletters available as the various contest reports also contain useful information.

9.6 Tripoli Altitude Records

Tripoli altititude competition records can be viewed using your web browser at:

http://www.tripoli.org/

Buzzing through the Tripoli web site, it appears that the organization has been refining the events to

include Open, Hybrid, Restricted and Large Rocket altitude categories. Gone are the duration (makes good sense) and cluster events.

9.7 NAR Competition Records

NAR competition records can be viewed using your web browser at:

http://www.nar.org/

9.8 Some Unofficial High Power Altitude Attempts

Some of the high power records come by way of a posting from Chip Wuerz (dlw@engr.ucf.edu). Chip is part of the University of Central Florida's high altitude rocketry project. Additional information has been taken from several issues of _Tripolitan_/_High Power Rocketry_ magazine.

(Ed. Note - Not quite sure how to handle these so I'm just leaving them in. These records have been since beaten but given the advances in technology, the following recognition seems noteworthy)

* * Some current records for NON-METALLIC NON-PROFESSIONAL Rockets: * *

---Top altitude holders:

Altitude:	27,576 (altitude by Adept altimeter)
Set by:	Pius Morozumi
Event:	Black Rock V, Black Rock Dry Lakebed
Date:	July 16-18, 1993
Altitude:	24,771 feet (11.7% tracking error)
Set by:	Chuck Rogers and Corey Kline
Event:	Lucerne Dry Lake Bed, Lucerne, Ca.
Date	June 1989, USXRL-89
Altitude:	24,662 (tracking error unknown)
Set by:	Tom Binford
Event:	LDRS XI, Black Rock Dry Lake Bed, Nevada
Date:	August 16, 1992
Altitude:	22,211 feet (5.3% tracking error)
Set by:	University of Central Florida
Event:	LDRS X, Black Rock Dry Lake Bed, Gerlach, NV.
Date:	August 1991

-- Highest tracked flight at LDRS-X / BALLS 1, Second all-time highest track of a non-metallic high power rocket.

University of Central Florida's research project and altitude attempt to break the current high-power rocketry altitude record of 24,771 feet set by the KLINE/ROGERS team in 1989. Altitude attempt had been based on 3850 NS L-engine, new Vulcan L-750 engines deliver 3,000 (now known to be less from motor testing results) newton seconds. In an attempt to make up power loss and to provide margin on the goal altitude of 25,000 feet, the upper stage was delay-staged by several seconds. Altitude predictions computer simulation program predicted 28,500 feet. Upper stage flew substantial trajectory, reaching apogee nearly 2 miles downrange. Rocket used microprocessors / timer-controlled staging and ejection, on-board flight data measurement package, and a radio beacon system to locate upper stage. Track was accomplished using red carpenters chalk. Both stages were recovered.

9.9 Biggest Non-metallic Rocket Flights

Rocket:	Down Right Ignorant
Weight:	800 pounds +
Set by:	Dennis Lamonthe, Chuck Sackett, and Mike Ward
Where:	BlackRock Dry Lake Bed, Gerlach, NV.
When:	August 17, 1992, FireBALLS experimental launch
What:	Super scale based on Esoteric rocket designed by Ron Schultz
Height:	34' 7"
Diameter:	24"
Power:	1 O-class custom motor 5 Energon L1100 motors 8 ISP K1100 motors (around 76,000 NS total impulse)
Materials:	24" fiberglass tubes for main body tube 1/8" aluminum plates for coupler bases and fin mounting boxes 1/2" aluminum plate for motor thrust plate 2x5" oak boards for tube coupler assemblies 2x5" pine boards for body tube strengthening plywood centering rings 3/4" birch fins 14" paper tubing for upper body tube hard resin/fiberglass nose cone (originally a sounding rocket nose cone shroud)

(Note: The definition of 'non-metallic' traditionally has meant 'no substantial metal components' as well as no structural components being metal. DRI appears to push that definition to its absolute limit, or a little beyond.

9.10 Other Non-professional Flights of Note

Rocket:	Frank Kosdon metal rocket
Date:	LDRS XII
Where:	Argonia, Kansas
When:	15 August 1993
Power:	Kosdon non-certified O10000 (that's O-10,000)
Materials:	All metal rocket with custom manufactured motor
Altitude:	35,407 feet AGL; closed optical track

(Notes: This is a special-case flight. The rocket does not follow the rules for high power because metallic rockets are expressly prohibited by both the NAR and Tripoli. It also uses a custom made motor. The motor was made by a manufacturer with other high power motors certified by Tripoli. It was pre-manufactured and solid propellant, within the total NS limits of high power consumer rockets.

Tripoli does not recognize this flight, or any other flight, for altitude record purposes unless a successful deployment of the recovery system is observed or the rocket can be recovered to show successful recovery system deployment.

9.11 Some other highest verified altitudes

For the most current list of highest flying altitude records, stop by www.tripoli.org for the list maintained by Robert (Bobby) Gormley.

9.12 The Best of the BMWQF

From Bob Kaplow:

(Note - This isn't really a FAQ but a favorite of mine. AE)

The all time classic has to be Bob Sanford's Best MidWest Qualified Flight winner at NARAM-29. We were flying B Eggloft (don't recall off hand if it was altitude or duration). He came to the checkin desk with a model and pre-taped motor. All the Check in officer (Ric Gaff) could see because of the tape was the "6-2", but being a nice guy, Ric let him thru, and wrote "B6-2" on the flight card. Well, the model just barely cleared the rod and pranged. Upon post flight examination, under the tape where the "B" should have been was...

"1/2A"!

9.13 Do's and Don'ts

(Overheard from John DeMar and Bob Kaplow):

* Don't forget to remove the masking tape that you used to hold down your helicopter rotors while attaching the thread. Makes it real hard for those rotors to deploy!

... and it's cousin, the tape on the BG pod, and the rubber band on the chute. Also don't forget to hook up the rubber band on the HD / BG / RG or it won't deploy at all.

* Don't open an egglofter OVER the check-in table.

...But don't bother with a bag either. If the egg breaks, the bag usually breaks too. Better concentrate your efforts on not breaking the egg than in controlling the mess. Besides, a bag just says that you don't have faith in your abilities.

* Don't let Apogee Blackshaft(tm) tubing land on aluminum bleachers, especially 2.5 meters of it coming down sideways. Especially at NARAM!

...Never paint a superroc black. The black warps in the sun. A 6' long banana shaped rocket flies a banana shaped arc thru the sky, often intersecting with the ground plane :-(

* Don't run after long-drifting models through dairy farm fields without looking down occassionally. There are obvious obstacles (eyu!), but the old barbed wire across the shins is more painful!

And the random holes can really twist an ankle.

And never go anywhere where there is something that wants to EAT YOU! In Florida at NARAM-24, this includes both fire ants and gators.

* Don't miss a chance to argue with Pink Book Lawyers, especially when your boost glider carries 20ft of igniter cables with it, lands on the ground still attached to the clips. Yes, it leave the launcher and an official flight! ;)

What? *ME* argue with someone over the rules? You must be mistaken!

* Don't forget sunscreen.

...and now that the hairline is receding, the hat. Sunglasses too. And bug repellent where appropriate.

* Don't catch models that must be allowed to land (eggloft, payload, scale, pmc). Worse, don't let some other urchin catch yours, then fall on it. DO be right there when it lands, so you can grab it the instant it is down. I've had several rockets damaged when they blew across the field after landing, including a HPR model at Danville that used the tube as a shovel, filling up with 2' of mud after dragging itself across state lines!

* Don't fly your NARAM models in that local contest a month earlier. I remember a contest at the Michigan Space Center in 1987. I lost 4 models that weekend that were ALL needed for NARAM. One was a record setting D RG that I flew in B RG, but thermalled away anyway. Another was a B ELD

model that was last seen going up! Things that you just don't expect to lose at all.

* Don't fly an F7 in ANYTHING! If it doesn't blow up it will be unstable!

* Don't even bother entering PMC!

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 10: High Power Rocketry

Posted: November 17, 1998

Last modified: November 17, 1998

Review: A High Power rocket is a model weighing more than 1500 grams (3.3 lb) or containing more than 125 grams of propellant or containing any motor with more than 62.5 grams of propellant.

10.1 I'm a successful model rocketeer. What do I need to get into HPR?

When this question was posted to r.m.r a while back, these were the predominant suggestions and tips:

- Start with E/F/G kits with 29mm motor mounts from Estes/NCR, LOC or Aerotech. These should be the easiest to build.
- Read and become familiar with the NAR and/or Tripoli High Power Safety Code(s)
- Get familiar with and use expendable motors before jumping into reloadable technology.
- Join a high power club if possible (local NAR section or Tripoli prefecture).
- Be very careful of the construction differences between model and high power rockets. You HAVE to build higher power rockets to be more sturdy than model rockets (see the next question).
- If not already a member, join both the NAR and Tripoli (if you can afford high power rocketry, you can afford to join and support both these organizations).

10.2 What are the major differences between model and high power rockets, besides size and engines? Are they built differently?

Above and beyond all else, high power rockets are built much stronger than standard model rockets. This is due to the higher speeds and acceleration achieved by these models. Some of the construction

differences are:

- High power rockets have stronger, thicker body tubes
- They have MUCH stronger engine mounts, bonded using epoxy rather than white or yellow glue
- Engine mount rings, adapter rings, etc., are typically made from 1/8" or thicker aircraft plywood, fiberglass, or phenolic sheet, rather than paper or balsa.
- Fins are typically made from plywood, fiberglass, phenolic, or waferglass, not balsa; Thick balsa fins have been used on H/I powered models, but they have to be reinforced with fiberglass/epoxy laminate.
- Fins are often mounted into slots in the body tube with Through The Wall (TTW) mounting. Most common and recommended method is glued TTW and directly onto the motor tube.
- Parachutes are larger and typically made from some type of fabric (plastic chutes are not strong enough, usually)
- Heavy elastic shock cords with steel braid or Kevlar shock line are used rather than rubber for shock cords, and these are typically epoxied to the motor mount or a bulkhead
- Positive motor retension systems (clips, bolts, etc.) are important, as HPR reload casings start to get pretty expensive

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10.3 How do I get high power certified?

There are two organizations which may certify you to purchase and use high power rocket motors. These are the National Association of Rocketry and the Tripoli Rocketry Association. Note that you must be a member of the organization to certify for high power with that organization. Once certified, both organizations recognize the certification of the other, but this may change in the future.

As of April, 1996, new NAR certification procedures have gone into effect.

Current NAR procedures:

- For Level 1 certification (the first step) one must fly an H or I powered rocket successfully, and have it witnessed by two senior NAR members, one of which must be high power certified. Fill out the proper form, have it signed by the witnesses, and send it in to NAR HQ.

  NOTE: NFPA 1127 allows an uncertified individual to purchase a single H or I motor for certification purposes.

- For Level 2 certification (the next step up) one must take and pass a written exam, and then successfully fly a J/K/L powered rocket. Questions for the examination come from a pool of questions that are available for review prior to taking the test.

- The NAR does not currently certify to Level 3 (M and up).

Tripoli certification procedures are scheduled to change on 1 Sep 1996.

At that time there will be three (3) high power certification levels:

- Level 1, allowing single motor H and I flights. No clusters or staging.
- Level II, allowing up through L motors, staging, clustering and hybrids.
- Level III, unlimited, allowing M power and up.

A written test will be required for Level II certification, in addition to the certification flight. Level III certification requirements will require pre-flight approval and review from the Tripoli Advisory Board.

10.4 What is a 'reloadable' motor. Are they worth the price? Are they legal?

A reloadable rocket motor is a metal cylinder with screw-on end pieces. Solid propellant and time delay are purchased separately from the motor casing, in 'reload kits'. These kits contain all of the expendable, non-reusable materials for a single flight. The cost of the reload is significantly less than the cost of an expendable motor (when talking about F sizes and up). Quite a number of reloadable motors and reload are now certified by NAR or Tripoli. Refer to the approved motor lists of each organization to see exactly which motors are currently certified.

YOU MUST BE A CERTIFIED MEMBER OF A QUALIFIED ORGANIZATION TO PURCHASE OR USE RELOADABLE HIGH POWER MOTORS. See section 3.1.9, below, for information on becoming certified to use high power reloadable motors.

WARNING: IT IS HIGHLY RECOMMENDED BY r.m.r CONSENSUS THAT YOU DO NOT ASSEMBLE AND/OR PREP A RELOADABLE-TYPE MOTOR UNTIL JUST PRIOR TO ITS USE (I.E., ON THE FLYING FIELD). * UNDER NO CIRCUMSTANCES SHOULD ASSEMBLED RELOADABLE MOTORS BE STORED WITH IGNITERS INSTALLED ***

10.5 What are these different 'types' of composite motors I hear about (White Lightning, Black Jack, Smokey Sam, etc.)?

These are all manufacturers' names for various formulations of 'stuff' they have added to the propellants to get specific pyrotechnic effects.

Black Jack (Aerotech): low(er) average thrust engine which produces a dense, dark exhaust to aid in tracking. Also has a distinctive roar. Note: BJ motors have a slow thrust buildup and long ignition time. Take care when using this type of motor in a cluster. Also play close attention to the manufacturer's Maximum Recommended Liftoff Weight (MRLOW).

Blue Thunder (Aerotech): high level average thrust engines with a bright violet-blue flame and very little visible exhaust. Designed for high thrust, high acceleration lift-offs. Ignites quickly. Very fast thrust build-up.

Firestarter (US Rockets): low impulse composite formulation which produces large numbers of sparks.

Hellfire (Vulcan): a high thrust motor which produces a bright red flame.

Smokey Sam (Vulcan): produces a dark exhaust to aid in tracking.

Silver Streak (Rocketflite/MRED): produces a fine shower of white sparks during boost (these are actually black powder motors). VERY fast ignition and thrust buildup.
White Lightning (Aerotech): medium average thrust engine producing a bright white flame and distinctive roar. Ignites quickly. Moderately quick thrust buildup.

10.6 What's an FAA waiver? Which rocket flights require one?

An FAA waiver is official permission by the Federal Aviation Administration allowing the launching of rockets exceeding a certain size. The rules appear in FAR 101.
FAR 101 is on the web: http://www.faa.gov/avr/afs/fars/far-101.txt

The following are the relevant sections of FAR 101, regulating the launching of model and high power rockets.

---------- FAR 101 Subpart A--General ----------

Sec. 101.1 Applicability.

(a) This part prescribes rules governing the operation in the United States, of the following:
(3) Any unmanned rocket except:
(i) Aerial firework displays; and,
(ii) Model rockets:
(a) Using not more than four ounces of propellant;
(b) Using a slow-burning propellant;
(c) Made of paper, wood, or breakable plastic, containing no substantial metal parts and weighing not more than 16 ounces, including the propellant;
and
(d) Operated in a manner that does not create a hazard to persons, property, or other aircraft.

[Doc. No. 1580, 28 FR 6721, June 29, 1963, as amended by Amdt. 101-1, 29 FR 46, Jan. 3, 1964; Amdt. 101-3, 35 FR 8213, May 26, 1970]

Sec. 101.3 Waivers.

No person may conduct operations that require a deviation from this part except under a certificate of waiver issued by the Administrator.

[Doc. No. 1580, 28 FR 6721, June 29, 1963]

Sec. 101.5 Operations in prohibited or restricted areas.

No person may operate a moored balloon, kite, unmanned rocket, or unmanned free balloon in a prohibited or restricted area unless he has permission from the using or controlling agency, as appropriate.

[Amdt. 101-1, 29 FR 46, Jan. 3, 1964]

Sec. 101.7 Hazardous operations.

(a) No person may operate any moored balloon, kite, unmanned rocket, or unmanned free balloon in a manner that creates a hazard to other persons, or their property.
(b) No person operating any moored balloon, kite, unmanned rocket, or unmanned free balloon may allow an object to be dropped therefrom, if such action creates a hazard to other persons or their property.

(Sec. 6(c), Department of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 12800, Amdt. 101-4, 39 FR 22252, June 21, 1974]

---------- FAR 101, Subpart C--Unmanned Rockets ----------

Source: Docket No. 1580, 28 FR 6722, June 29, 1963, unless otherwise noted.

Sec. 101.21 Applicability.

This subpart applies to the operation of unmanned rockets. However, a person operating an unmanned rocket within a restricted area must comply only with Sec. 101.23(g) and with additional limitations imposed by the using or controlling agency, as appropriate.

Sec. 101.22 Special provisions for large model rockets.

Persons operating model rockets that use not more than 125 grams of propellant; that are made of paper, wood, or breakable plastic; that contain no substantial metal parts, and that weigh not more than 1,500 grams, including the propellant, need not comply with Sec. 101.23 (b), (c), (g), and (h), provided:
(a) That person complies with all provisions of Sec. 101.25; and
(b) The operation is not conducted within 5 miles of an airport runway or other landing area unless the information required in Sec. 101.25 is also provided to the manager of that airport.

[Amdt. 101-6, 59 FR 50393, Oct. 3, 1994]

Sec. 101.23 Operating limitations.

No person may operate an unmanned rocket--
(a) In a manner that creates a collision hazard with other aircraft;
(b) In controlled airspace;
(c) Within five miles of the boundary of any airport;
(d) At any altitude where clouds or obscuring phenomena of more than five-tenths coverage prevails;
(e) At any altitude where the horizontal visibility is less than five miles;
(f) Into any cloud;
(g) Within 1,500 feet of any person or property that is not associated with the operations; or
(h) Between sunset and sunrise.

(Sec. 6(c), Department of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 1580, 28 FR 6722, June 29, 1963, as amended by Amdt. 101-4, 39 FR 22252, June 21, 1974]

Sec. 101.25 Notice requirements.

No person may operate an unmanned rocket unless that person gives the following information to the FAA ATC facility nearest to the place of intended operation no less than 24 hours prior to and no more than 48 hours prior to beginning the operation:

(a) The names and addresses of the operators; except when there are multiple participants at a single event, the name and address of the person so designated as the event launch coordinator, whose duties include coordination of the required launch data estimates and coordinating the launch event;
(b) The estimated number of rockets to be operated;
(c) The estimated size and the estimated weight of each rocket; and
(d) The estimated highest altitude or flight level to which each rocket will be operated.
(e) The location of the operation.
(f) The date, time, and duration of the operation.
(g) Any other pertinent information requested by the ATC facility.

[Doc. No. 1580, 28 FR 6722, June 29, 1963, as amended by Amdt. 101-6, 59 FR 50393, Oct. 3, 1994]

10.7 OK. I want to fly some high power rockets. How do I get an FAA waiver?

A downloadable, printable copy of
Form 7711-2, Application for Certificate of Waiver, is available at:

http://www.faa.gov/avr/afs/Waiver.htm

From: jsvrc@edison.rc.rit.edu (J A Stephen Viggiano)
I'd like to share with those interested what is involved in applying for an FAA Waiver. It's not a particularly difficult procedure, and the FAA personnel I have dealt with are courteous, professional, and helpful. Don't be scared of the bureaucratic red tape, there isn't a whole lot of it.

You can get the forms from the Flight Standards District Office (the "Fizz-Doe") at any airport with air traffic control. Phone the tower and ask for Flight Standards. Tell them you're interested in launching rockets, and need an Application for Waiver, FAA Form 7711-2. They should know what you want. While you've got them on the phone, ask for the address of the Regional office. You will probably have to file your application with them, so it will help to know where it has to go!

Now, you take a field trip. Get in your car, and drive to the airport. Not the passenger terminal, the part where all the private general aviation planes are parked. There should be a place there for pilots to pay for fuel, buy toothbrushes and other sundry items, including section maps. Ask them for the map which includes your launch site. If you're not near a section boundary, it should be the same map which includes the airport. (It will also be the most popular map there, and they may be out of stock.)-: We're covered by the Detroit section map, for example. Never mind that it's a few states away, and New York is closer, that's just the way they carve things up. It costs about $3, and it's fun to look at and try to decipher.

Locate your launch site on the section map. Are there any airports within 5 miles? If so, you'll need a waiver of Section 101.23(c), which addresses your proximity to an airport, in addition to waiver of Section 101.23(b), which covers controlled airspace. You type these section numbers on line 4 of the application. Lines 1, 2, and 3 are your name, address, telephone number, and all that David Copperfield crap, as Salinger called it.

Line 5 asks for a detailed description of what you want to do. I usually put something like the following:

> Normal operations of Model and High Impulse Rockets
> weighing more than 16 ounces (but less than 80 ounces)
> in accordance with the National Association of Rocketry
> Safety Codes (please see attached).

Line 6 asks for the location. If you've got the lattitude and longitude to the second, use them. Otherwise, you can refer to a copy of the portion section map, like this:

> On the grounds of and directly above the National Warplane
> Museum, Geneseo, NY (please see attached portion of Detroit
> section map).

You can then copy that portion of the section map, circle the launch site in red or some other color, and write the legend, "Area of Proposed Operations." (Remember, these folks talk in Bureaucratese.)

In either case, this is the line on which you request altitude. Again, in FAA patois, "No operation under this waiver will exceed 5000 feet AGL" are the magic words which have worked for us (along with "please" and "thank you"). If you can read the altitude of the terrain on the section map, you can add this to the requested altitude above ground level to arrive at the altitude above Mean Sea Level (MSL), which might be appreciated by the person processing your application.

On Line 7 you give your starting and ending dates and times, and any rain dates. It's not necessary (nor is it desirable) to use Zulu (Greenwich Mean) Time, but these folks use that "hundred hour" jazz that Colonel Blake on M*A*S*H hated so much. Make sure to indicate what time zone you're referencing, for example "1030 EDT".

Lines 8 through 14 pertain to airshows and the like, so just put an "N/A" or two there to let them know these areas aren't blank because of an omission. You sign on Line 15, and have an opportunity to say a little something about how you're going to be running things. I usually write in the following, under "Remarks":

> All operations will be conducted in accordance with the NAR Safety Codes and shall be under the control of an experienced Range Safety / Launch Control Officer. A spotter will watch for aircraft entering the operations area, and will temporarily suspend operations in this contingency.

Make three copies. Keep one for yourself, send your original and two of the copies to the Regional Office. Attach three copies of both Safety Codes, because the Model Rocket Safety Code covers rockets which will be under the terms of the waiver. Also attach three copies of the germane portion of the section map, if that's how you're indicating where you are going to fly. Include a short letter of transmittal.

After having some scares about the last two applications I sent in, next time I plan to include a receipt postcard. I'm going to put my address on the address side, and on the other side it will say:

> Received _____ (date) an Application for Certificate of Waiver or Authorization, FAA Form 7711-2, at this office. For further information, please contact _____ (name) at _____ (telephone number, extension).

Bureaucrats see these things all the time, and they know what to do with them.

Mail off this packet to the FAA Regional Office, to the attention of Flight Standards (I think!). You need to apply at least 30 days (the form says 45 days, so be sure) in advance. If you don't hear back from them in two or three weeks, give them a call. We had to do this twice; once the form was lost, and another time it was just in the "in" basket.

If all goes according to plan, you should get back your application, all the other stuff you sent (talk about carrying coals to Newcastle!), and the Magic Certificate of Waiver! There will be a few strings attached. You should be instructed to inform the nearest ATC, and possibly an Automated Flight Information Service, a certain time before you start, in order to "activate" your waiver. You'll probably be instructed to contact them when you're done, too. Usually these things are not a big deal, but sometimes you get a person who doesn't know why you're bothering them. Just tell them that you're carrying out instructions from the Regional Office to give a Notice to Airmen, pursuant to the terms of your Certificate of Waiver. A little official-sounding talk will make them feel right at home.

Of course, you have to make sure all fliers are familiar with the terms and conditions of your waiver, because it's your butt that's on the

line, too. It is a standing MARS policy that the waiver certificate and application are available for inspection by all fliers.

After the launch, I usually send a letter to the person who sent me the Certificate of Waiver, thanking them for their help, and letting them know we had a safe and enjoyable time. It helps grease the skids for the next waiver you want, besides being common courtesy.

It's not hard to obtain a waiver if you make your application in a professional manner, and conduct your activities likewise. There's no fee, but there is some effort involved. Finally, keep in mind that the people working on your application are people, and as such they respond to being treated courteously and professionally. I hope you find the process relatively simple and painless.

10.8 Is high power rocketry legal in every state, if the proper forms are obtained?

No. Even with an FAA waiver, HPR is NOT legal in every state. Check with your local fire marshal for requirements/restrictions in your area. The NAR and Tripoli are actively working to get state restrictions on model and HPR removed.

10.9 Where do I find out the proper way to use HPR rockets and motors? I'm familiar with the NAR Model Rocketry Sporting Code. Is there an HPR equivalent?

Both the NAR and Tripoli have HPR safety codes. The two organizations are working together to produce a consistent safety code to be presented to the NFPA. These codes specify minimum launch field sizes, minimum distance to keep from launchers, etc. The NAR High Power Rocket Safety Code has been published in Sport Rocketry, and is on their web site. The Tripoli safety code is published in their Members handbook, which is sent to all new Tripoli members.
EVERYONE WANTING TO GET INVOLVED IN HPR IS STRONGLY URGED TO JOIN ONE OR BOTH OF THESE ORGANIZATIONS. There are legal restrictions to buying high power motors. Only certified members of 'legally qualified' organizations may purchase them. If you want to fly high power you need to be a member of either the NAR or Tripoli.

The High Power Safety Codes for both the NAR and Tripoli are based on the NFPA 1127 guidelines. Both organizations recognize the others safety code, motor certifications, and HPR user certifications.

10.10 What are some good kits to build when first getting into high power rocketry (assuming I have all of the basic model rocketry skills)?

Popular rec.models.rockets vote:
LOC Graduator

From: cdt@pdp.sw.stratus.com (C. D. Tavares)
AAA Penn. Crude

From: kaplowro@hccompare.com (Bob Kaplow)
- Avoid any kit with plastic fins or internal parts.
- Avoid phenolic tubes, thick cardboard tubes are more familiar and easy to work with
- For Large Model Rockets, try a LOC Graduator or Rocket R&D/THOY Hornet
- For a High Power rocket try a LOC IV or EZI-65, or a Rocket R&D/THOY Falcon

From: JCook@Epoch.C (Jim Cook):
LOC kits are a good introduction into high power - they are strong (banging it several times for emphasis on the table).

From: bmcdermo@ix.netcom.com (Buzz McDermott)
If you have never flown anything bigger than an Estes or FSI D motor, I would recommend building one or more E-G kits before tackling H power and up. When you go for your NAR or TRA certification, choose a rocket where G and H motors are the low end or mid-range power options. Going with a rocket where your chosen motor is at the high end or above the rocket's recommended power range is more likely to fail by over-stressing the design. Bigger, slower high power rockets are less stressed and more likely to succeed. In the case of NAR certification, this gets you a rocket good for multiple certification levels. I like the following (any are good NAR or TRA certification rockets):

LOC Mini Magg, 38mm mount	(G-I motors)
LOC EZI-65, 54mm mount	(G-I motors)
THOY (Rocket R&D) Falcon, 54mm mount	(H-J motors)

From: mike_forman@cjnetworks.com (Mike Forman)
I bought, built, flew and certified on a PML Io. Very nice kit. I glassed the tube, and would bet it's as close to bulletproof as you could get and still be legal to fly as a hpr. I posted a review of the Io here, and you could probably go to dejanews' archive and retrieve it. Great rocket, great flights, easy to build.

From: marku@netins.net (Mark U.)
My favorite 4 in. rocket is the THOY/R&D Falcon. In stock configuration it easily will handle H-J and, if beefed up, a K is not out of the question. My second choice would be a PML Quasar this will fly nicely on a H-I motors.

10.11 When is a Federal Low Explosives Permit required?

NOTE: As of 1997, the BATF will be formally clarifying their interpretation of what high power rocket motors require a Federal Low Explosives Users Permit (LEUP). At the time that this is written (Jan. 9, 1997) it appears that reloadable motor propellant segments less than 62.5 grams in mass will require a LEUP if their intended use

is to assemble a motor that has more than 62.5 grams of propellant. Furthermore, LEUP fees may be raised. At the time of this writing, these changes are not yet in effect. The National Association of Rocketry and Tripoli Rocketry Association are working together to see what can be done to protect the interests of high power rocketry enthusiasts, and will be keeping their members informed of the latest developments.

The following are excerpts from a joint communique issued by the High Power Rocket Manufacturers and Dealers Association and the Tripoli Rocketry Association to the high-power rocket community on 25 April 1994. It was posted to CompuServe by Michael Platt, president of the HPRMDA.

[Based on informal clarifications from the BATF, it is our belief that:]

(a) single-use model rocket motors containing no more than 62.5 grams of propellant are exempt from Federal licensing and storage requirements;

(b) reloadable rocket motor products are also exempt from Federal licensing and storage requirements, provided that the mass of each propellant grain is no more than 62.5 grams, and has received a DOT shipping designation as Explosive 1.4, but may not be made available to children;

(c) any single-use motor containing propellant mass greater than 62.5 grams, or any reloadable rocket motor product containing a propellant grain which weighs more than 62.5 grams, is subject to Federal licensing and storage requirements.

Users (e.g. consumers, flyers) of high-power rocket motors and reload kits as described in item (c) above, are subject to Federal, and possibly state and local, permit requirements for the purchase and storage of explosives. On the Federal level, this involves obtaining an explosive user permit from BATF, at a cost of $20 for the first year, and $10 for each subsequent three-year period. An important exception to the Federal requirement for a user permit is if the user were to purchase a motor or reload kit in his state of residence as defined by BATF, and either (a) use the motor or reload kit at the site of purchase (e.g. a launch), or (b) transport it to an approved storage facility located within the boundaries of said state.

Everyone--manufacturers, dealers (distributors), users--who stores (as defined by the BATF) a high-power rocket motor or reload kit as described in item (c) above is subject to Federal, and possibly state and local, requirements for the storage of explosives. All storage of a high-power rocket motor or reload kit must be in accordance with Federal explosive storage requirements, even if a Federal license/permit is not required for purchase. There are no exceptions to this rule.

A document with questions and answers about the BATF and rocketry is available at the sunsite archive:

http://sunsite.unc.edu/pub/archives/rec.models.rockets/BATF/batfqa.txt

Instructions for filling out a LEUP are available on the Rocket Science web site:

http://www.scsn.net/users/rockets/LEUP_consumer.html

10.12 How do I get an LEUP? Are there any requirements?

The following is an excerpt from the June 1994 'Tripoli Report'. Since this deals with Federal Law and not Tripoli rules, I do not believe that there is any violation of Tripoli by-laws in doing this.

Q: How would a person qualify for a Federal user's permit?
A: The chief, firearms and explosives licensing center, will approve a properly completed application if the applicant:

1) Is 21 years of age or older,
2) Is not a person to whom distribution of an affected high-power rocket commodity is prohibited under the Act (Federal law),
3) Has not willfully violated any provisions of the Act,
4) Has not knowingly withheld any information or has not made any false or ficticious statement intended or likely to deceive concerning the application,
5) Has storage for the class (low explosive) of an affected high-power rocket commodity, as describedon the application, unless he establishes that his operations to be conducted will not require the storage of an affected high-power rocket commodity.
6) Is familiar with and understands all published state laws and local ordinances relating to affected high-power rocket communications in which he intends to conduct operations.

ATF Form 5400.13/5400.16 must be filed to obtain a permit.

From: bmcdermo@ix.netcom.com (Buzz McDermott)
You may obtain a users permit with or without a storage magazine. If your primary reason for the permit is to be able to buy HPR motors at out of state launches, then you don't need a home storage magazine. If you do have a home storage magazine, remember to keep the proper records for all motors added to and removed from the magazine.

Michael Platt has indicated willingness to help anyone who has any questions regarding the proper filling out of the permits. He may be reached at 70233.255@CompuServe.COM.

10.13 How is thermalite affected by the ATF regulatory enforcement?

From: 70233.255@CompuServe.COM (Michael Platt)
Thermalite is a brand name for igniter cord. Purchase and storage of igniter cord is regulated by BATF. Purchase and/or storage of igniter cord, IN ANY QUANTITY, requires an explosive license and an approved storage facility, i.e. an explosive magazine. This includes thermalite in any length, including the one inch lengths commonly included with motors produced by various manufacturers. The only exception to this would be the purchase by a user for immediate use in the state where he/she resides.

10.14 How can I get the Orange Book (explaining the ATF explosive laws and regulations) and the proper LEUP forms?

Scanned copies of the BATF non-copyrighted book titled, "ATF - Explosived Law and Regulation," were generously provided by Tom Perigrin and Doug Caskey. See:

http://mercury.aichem.arizona.edu/~tip/legal/Orange.html
http://members.aol.com/RocketWeb/atf/orange.htm

Call your regional BATF office and ask for the Orange Book, and an application for a Federal Low Explosives Users Permit. Remember that you want a Users permit (there are several other types of permits). The regional office will mail these to you at no charge. The documentation you receive will indicate where the filled in forms and payment should be remitted.

10.15 Just what is a 'hybrid' rocket motor? Who makes them?

From: kevinr5053@aol.com (Kevin Reed)

A hybrid motor as sold for model rocketry uses a solid fuel grain and a liquid oxidizer -- in the case of commercial model motors, nitrous oxide. A composite motor uses a solid oxidizer -- ammonium perchlorate -- mixed with a rubber binder/fuel to make a unified solid grain.

I can't think of any 24mm hybrids on the market; the smallest, I think, has an "I" rating and fits into a 54mm mount.

There are two companies currently manufacturing them commercially, Aerotech and Hypertek. One system loads the oxidizer tank before loading the motor in the rocket, while the other fills the tank after the rocket is in launch position.

Hybrids have a couple of advantages over composites: one is that there is virtually no fire hazard transporting or storing the motor: without the oxidizer in direct contact with it, the fuel grain is almost inert. It is also not covered bythe same DOT shipping restrictions, because the tanks are DOT certified and the fuel grain poses no environmental or fire hazard.

[Editor's note: The Jan 1996 issue of High Power Rocketry magazine has an excellent article comparing the Hypertek and Aerotech hybrid systems.]

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 11: High Power Construction and Finishing Tips

Posted: November 17, 1998

Last modified: November 17, 1998

This section includes tips and suggestions on various topics having to do with construction and finishing techniques for High Power rockets. Many of the same techniques may be used with Large Model Rockets, as well. Readers are encouraged to read the North Coast Rocketry technical reports on HPR construction and finishing techniques (available from NARTS and other sources).

[Note: This portion of the FAQ is maintained by Jerry Irvine (jjirvine@cyberg8t.com). All comments and suggestions should be sent to him.]

11.1 Do you have any tips for cutting and sealing fins used on HPR rockets?

From: utidjian@remarque.berkeley.edu (David M.V. Utidjian):
To fill the grain in balsa fins and fill in the spirals in body tubes use epoxy. I use HOBBYPOXY "Smooth 'n' Easy" Epoxy finishing resin. For fins it does the trick in one coat... and sands easily... and adds strength to the fins. I use those disposable brushes with the metal handles and brush on a single coat after a preliminary sanding. I then use auto body primer filler in gray and red-brown from spray cans for the entire model. This gives very thin and even coats. I alternate the colors of the coats to show where the low and high spots are. My last sanding before paint is done with 400 grit wet/dry paper and I do this wet... being careful not to get any inside the body tube. [Another good coating-type epoxy is PIC 'Coating Poxy'...Buzz]
[NOTE: This is not for kids or the inexperienced!! This technique is used in HPR where the added weight is not a penalty: Buzz]

From Bob Turner (NAR member, not on net):
Bob Turner (the DARS NAR section advisor) suggests using alcohol in

smoothing 'coating' type epoxies. The PIC 'Coating Poxy' instructions suggest using your fingers to 'burnish' any surfaces (i.e., fins) filled with the coating poxy. Bob suggests using a VERY soft cloth which has been dipped in alcohol to rub the fins after about 30 minutes (or whenever the epoxy starts to set and is just slightly sticky to the touch). [I followed Bob's suggestion and got MUCH smoother fins over the hand/finger burnishing method...Buzz]

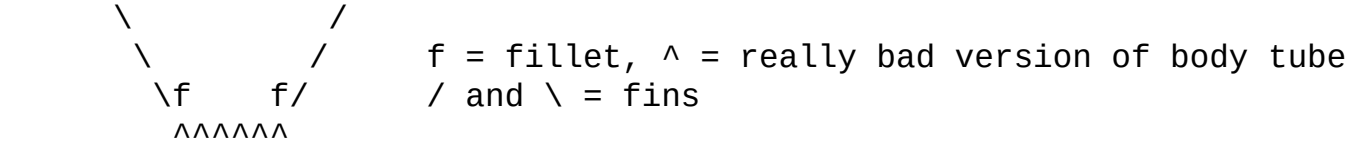
From: jack@rml.com (Jack Hagerty):
When sanding fins, or any other balsa part that you want to be all uniform, stack the parts together, even them up the best you can (you'll be surprised at how uneven those die-cut pieces are!) on the root edge and drive a couple of straight pins through them to hold the stack in registration while sanding. For larger fins, anything over about 2 sq in, use three pins. I find that the pins that come in shirts are just about the right size. The small holes that are left when you remove the pins are easily filled during the sealing/filling step.

From: kaplowro@hccompare.com (Bob Kaplow)
I've found two handy tools for sanding big rockets. 3M makes these sponge-like sanding pads. They are great for conforming to the curves of tubes, nose cones, fillets, etc., and make quick work of fillers. The second is a palm sander, just like Norm uses on TV. Big rockets call for heavy duty solutions. Save the belt sander for airfoiling the fins during construction.

Condensed thread on filleting fins; many contributors:
First, ALWAYS fillet high power fin joints, even fins mounted TTW to the motor mount. This will add strength and improve the aerodynamics of the model. The suggestions for filleting material include:
* 5 - 30 minute thick epoxies
* 30 minute (or longer) thin epoxy mixed with micro-balloons until it has a thick, paste-like consistency; let it thicken some prior to using it
* SIG Epoxilite (warning: this got very mixed reviews)

Always keep a bottle of rubbing alcohol handy when working with epoxy. Dip your finger in the alcohol and run it along the fillet to smooth out the bumps. It was mentioned that a pure epoxy 'topcoat' was necessary on top of the epoxy/micro balloon mixture, although using an alcohol-soaked finger to smooth the micro-balloons might eliminate the topcoat requirement.

Use 30 minute epoxy with microballoons added. Let it sit for a few minutes in the pot so it thickens, and then apply it. The microballoons make it much less runny, so you don't have to keep watching the fillet to make sure it's not dripping or running around the edges. Also do one side of two fins at a time:



11.2 How do you keep in a high power motor in its mount, but still alow for the numerous lengths in which HPR motors are sold?

From: billn@hpcvaac.cv.hp.com (Bill Nelson)

I make a clip similar to the ones used on model rockets - however, I do not pierce the motor mount tube - I place the front end of the retainer over the front of the tube. It is epoxied/taped in place, just like with a model rocket. I do not rely on spring pressure to hold the clip over the end of the engine. I use several turns of strapping tape - wrapped around the engine or motor mount and the retainer clip. So far, I have never had a problem with an ejected engine.

From: JCook@Epoch.COM (Jim Cook)

Some folks at NARAM 33 suggested drilling a small hole in the side of the flange of the rear nozzle retaining ring [of an ISP reloadable motor casing] to tie the casing to the model. Some might claim this to be "modification of rocket motors not approved by the mfg." I had though I heard Aerotech was going to start doing this themselves, but I haven't seen anything yet.

From: neil@boi.hp.com (Neil Pyke)

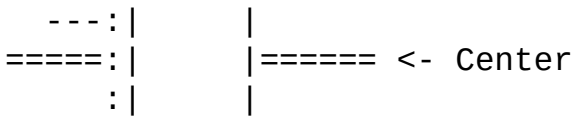
I've built #8-32 "t-nuts" into my last couple of rockets and then made sheet metal brackets to hold the motor in. I drill two holes, 180 degrees apart, in the aft centering ring and then press and glue the t-nut into the hole. The screw holds the bracket to the centering ring and I bend the bracket so it hooks over the end of the motor. The t-nut works great but I've made my brackets too wimpy. Those that saw me wandering around just past the flight line at LDRS a couple weeks ago, looking for my ejected motor, will know that I have not perfected my application of this design.

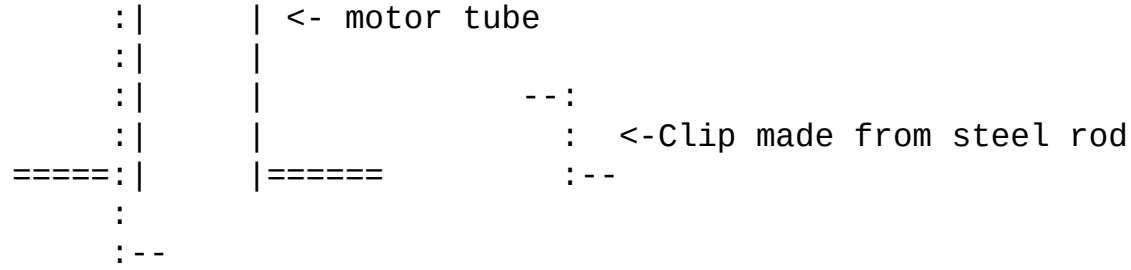
From: Roger.Wilfong@umich.edu (A. Roger Wilfong)

I've used a similar technique with t-nuts and had no problems - yet. I've also tried a coarse thread sheet metal type screw (I'm not sure what they're really called - the threading is about twice as coarse as a regular sheet metal screw) screwed into the rear centering ring at three locations. The centering ring needs to be plywood and you need to carefully drill the correct sized pilot hole for the screw. After 'tapping' the screw into the hole, I took it out and ran a small amount of thin CA into the hole for reinforcement - let the CA set before you put the screw back in the hole or you won't get it out again. This has worked on RMS-29 and while it is not as strong as the T-nuts, so far it has been more reliable than masking tape.

From: soc1070@vx.cis.umn.edu (Tim Harincar)

On the 2 29mm birds I've constructed, I use a clip and a thurst ring. It works like this:





The steel rod has two opposite 90 degree bends, and is run through the centerings and along the motor tube. The idea is to spread the force of ejecting along the top centering ring and to the rest of the motor mount, instead of making the clip do the work. Also, on larger tubes, you can design this so that the clip swivels into place, instead of using spring tension.

The clip then extends 1/4" to 1/2" beyond the end of the tube. You then use this space for the motor thrust ring. The thrust ring is then added to the end of motor. I just usually wind the end of my motor with a bunch of turns of masking tape, but I've heard of people epoxying some other type of ring to the end of the motor.

From: waltr@netcom.com (Walt Rosenberg)

You use a "thrust ring" - several wraps of masking tape on the nozzel end of the motor. This prevents the motor from going up the mount.

Of course, if you use re-loadables (ISP, AeroTech), the nozzel enclosure is latger than the O.D. of the motor mount - in this case, just the tape to keep it from coming out. Of course there are several methods used to keep the motor from kicking - screws and washers, screws and hooks, retaining rings, etc. placed over the ridge on the nozzel end of the motor.

From: pstemari@well.sf.ca.us (Paul J. Ste. Marie)

Typically what you do is wind a ring of masking tape at the end of the whoosh generator of the same thickness as the engine mount tube. This serves as a block to keep the engine from sliding up into the rocket under thrust. Typical widths of tape to use are:

.25"	1/4A-B
.5"	C-E
.75"	F-H
1.0"	H-I
1.5"	I-J
2.0"	J-K

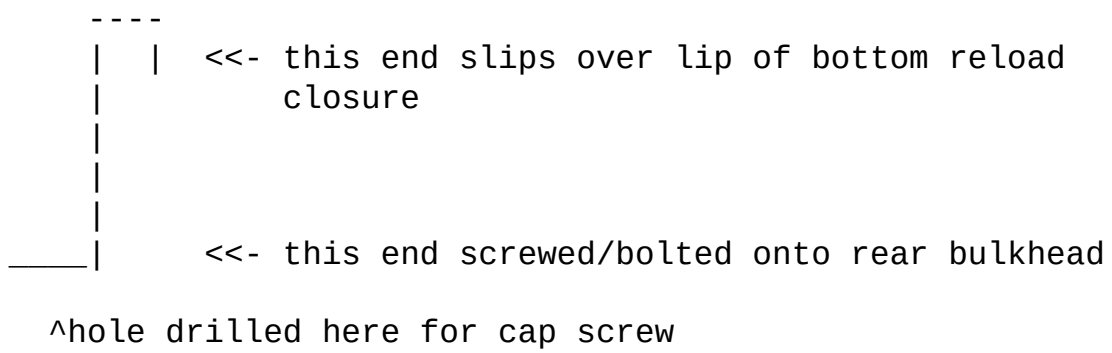
From: waltr@netcom.com (Walt Rosenberg)

[Referring to the use of different tape widths, above]

1.5" for I-J and 2.0" for J-K may be too wide. You are now going to move the center of gravity further back. You may introduce instability. I've never used more than 3/4" for all my high power launches (H-K).

From: kaplowro@hccompare.com (Bob Kaplow)

My [retainer] hooks look like this:



The top of the hook wraps over and around the reload closure lip, and can't push out like an Estes clip. Hooks ARE brass. I use stainless cap screws to hold the clips in place - cap screws stay on the end of the tool, unlike other screws. I use T-nuts installed on the back side of the rear centering ring, or threaded brass inserts to retro-fit older rockets.

11.3 Custom Decals for High Power Rockets

The techniques described here could also be used for model rockets. The decals made this way tend to be large and `thick', so this info has been included in the High Power section.

From: soc1070@vx.cis.umn.edu (Tim Harincar):

As a computer graphics person, I have done quite a bit of experimenting with laser printers and making my own rocket art. I mostly stick with clear sticky-back type stocks, they are the cheapest and most available.

I use Fasson brand, and I think its 1.5 or 2 mil. thick. It works good for large models but is a little thick for small scale stuff. It curls right out of the laser while it cools. Don't worry, though. It doesn't distort. This stuff is typically available at most quick print shops. Typically its called Crack 'N Peel.

Toner chips very easily off of the smooth finish, so be careful and as soon as you can, spray on an over coat of clear flat enamel or lacquer. I tape the sheet down to cardboard then spray, Leave it for a day or so. This also makes it lie flat.

I know that blank water transfer stock is available, but its about $3 for an 8.5 x 11 sheet. Use same method as above to preserve the image. This is usually available at model railroad shops.

I have never seen the dry-transfer stuff, but I know its pretty popular with the railroad folks. (that is, the pre-printed stuff).

One other option that I have wanted to try is the heat-transfer colors. Once you have a laser image, you lay a piece of special colored film over the image and heat either with an iron or re-run the sheet through the laser and let the fuser do the work. The color then attaches to the toner.

Most of these colors are metallic, but there are some standard, non-

metallic colors as well. Letraset was the first company to market the color transfer stuff.

11.4 I've had several rocket body tubes ruined by the shock cord tearing into the body tube at ejection and making long slits. How can I prevent this?

Many of us have recovered our rockets only to find that shock line has slit ('zippered') the body tube. This happens most often when a very thin shock line is used or when the rocket is traveling very fast when the tubes separate. The following suggestions have been offered to prevent this from happening:

From: barrett@powder.add.itg.ti.com (Stu Barrett)

I built a LOC Caliber a year or so ago. I installed a LOC ejection baffel at the top of the motor mount tube and that worked great. However, I'm in the process of enhancing my model so that it uses the "anti-zipper" technique that is described in the Mar/Apr [1993] issue of HPRM. It combines a fool proof mechanism to eliminate the dredded "zipper effect" and also has a nice effect that no wadding is needed.

11.5 Estes 'toilet paper' recovery wadding strikes me as a bit wrong for HPR rockets. What are some alternatives?

From: jack@rml.com (Jack Hagerty)

Just go down to your local building supply store and get a bale of cellulose wall insulation. This is just shredded newspaper treated in the same fire supressant [as Estes recovery wadding]. A $5 bag will give you enough wadding to last years!

From: jsvrc@rc.rit.edu (J A Stephen Viggiano)

In order to avoid fallout, you might want to put the engine in *before* the [cellulose] wadding, or, for smaller rockets, a sheet or two of regular wadding underneath the fluffy stuff.

Wayne Anthony uses cabbage leaves (you get more leaves per head [than lettuce], and they seem to be a little tougher than lettuce), and I've heard of people using grass.

From: bmcdermo@ix.netcom.com (Buzz McDermott)

I use acoustic speaker insulation. I costs #3 - $5 per bag at Radio Shack. It's reusable, and one bag generally lasts me for dozens of flights. [*Editor's note: This material is not necessarilly bio-degadable or environment friendy. Do not use this type of recovery wadding at any field where remnants might be ingested by live animals. It will kill them. Also, consider tethering fiberglass to shock line to prevent loss.*]

11.6 What are the differences between the various HPR body tube materials used by the most HPR manufacturers?

The most common one is that material used by Estes and later by other suppliers such as U.S. Rockets, LOC Precision, AeroTech, Launch Pad, etc. This material is a spiral wound virgin kraft tube. Virgin kraft is stiffer than recycled kraft and can much more easily withstand flight stresses at a given thickness than recycled tubes as commonly found in household goods.

This material typically has an outer wrapper of "glassine" which makes the tube smooth and accepts paint more easily. It also covers up the thicker tube spirals of the underlayers and makes removing tube spirals with a couple applications of sanding sealer practical.

Another common tube material is that used primarily by Public Missles. It is a spiral wound paper with phenolic resin impregnated into it. This has several advantages such as higher ultimate strength in aero-applications, more waterproof out of the box and being fairly stiff. However this material is also susceptible to cracking due to impacts and has been known to crack during routine slow landings under overadequate parachutes.

A really good material for HPR is used only by Dynacom and U.S. Rockets and is known as G-10 fiberglass. There are several practical variants of this material. One can use either cloth wound or filament wound and the G-10 refers to one supplier's particular classification of a resin they use. Even they use a dozen different resins. Among the glass's uses are "e-glass" and "s-glass". Since one is both more expensive and stronger in ultimate fail tests it is often used as motor casing material. However for airframe applications, cheaper and thinner is better.

Other good but less common materials include cloth wound phenolic impregnated, paper convolute wound phenolic impregnated, exotic composites of kevlar, graphite, etc.

A very common material used (at one's own peril) is recycled paper style tubes such as mailing tubes, paper towel rolls, etc. These must be over 1/8" thick to even be used for HPR at all. Even then they are easy to damage and "unroll" on landing as they typically do not use glue except on the edges. Rocket specific tubes are glued across the entire surface of the superior virgin kraft material.

Plastic tubes can be used but the bonding problems of motor mounts and fins have resulted in these having virtually no adoption among serious model or high power rocketeers. Motor mount tubes must have an insulative element as plastic motor tubes would quickly become the permanent owner of a motor casing.

11.7 How can I strengthen my thick paper (i.e., LOC type) body tubes?

Various composite construction techniques may be employed to strengthen paper body tubes. These same techniques may be used to build scratch body tubes as well. An excellent article on composite construction techniques appeared in the XXXXXXXXXX issue of High Power Rocketry magazine. Another

article dealing with strengthening HPR rockets appeared in the XXXXXXXXX issue.

The two most practical methods for strengthening the paper body tubes used by LOC, THOY, etc. are 1) reinforce the tube with couplers for most of its length and 2) wrap the tube with some type of reinforcing layer.

The first option produces a strong tube, but has the drawbacks of high cost (at $2-4 per coupler) and high weight.

The most common material used with the second option is fiberglass cloth. Two ounce cloth is good for use on 2.5 to 4 inch diamter tubes. Five ounce cloth might be used for larger tubes. R.m.r posters have recommended several techniques for applying the fiberglass. Here are two of them:

From: bmcdermo@ix.netcom.com (Buzz McDermott)

1. Sand the tube with 320 grit sandpaper to slightly roughen its surface.
2. Mark a straight line down the length of the tube.
3. Lay out the fiberglass cloth on a flat, smooth surface. Use a square/ straight edge and a SINGLE EDGED RAZOR BLADE to cut the fabric to a rectangle, allowing for at least 1" overlap around the diameter and off each end of the tube to be covered.
4. Lay out and tape together enough wax paper on the floor of your garage, basement,etc., to be larger than the fiberglass cloth in all dimensions. Lay the cloth on the wax paper. Tape the wax paper to the floor (but NOT to the glass cloth).
5. LIGHTLY spray one side of the cloth with 3M 77 adhesive. I mean to put on a QUICK, VERY LIGHT coating of adheasive.
6. Lay the tube down on one edge of the fiberglass, using the line on the tube as a guide to get the tube straight along the glass cloth.
7. SLOWLY roll the tube along the cloth, working out wrinkles with your fingers. The 3M 77 should lightly tack the cloth to the body tube.
8. Once the cloth is on the tube, use thin *orderless* CA to seal the overlap and edges along fin slots and ends of the tube. Using a plastic bag over one hand gently rub the CA into the cloth. Also CA any wrinkles that are left. When the CA dries you can use the single edge razor to trim off excess cloth at the ends, feather sand the overlap joint (with 320 grit), cut out fin slot openings, and sand down or slice off any wrinkles in the cloth.
9. Brush on 20 minute 'finish cure' epoxy. Bob Smith 'Coating Poxy' and Hobby Poxy 'Smooth N Easy' are good choices. Completely cover the entire cloth surface. Be sure and gently work the epoxy into the cloth. You want the cloth soaked and the epoxy soaking into the body tube.
10. About an hour after you finish, the epoxy should be getting real 'tacky'. Soak some rubbing alcohol into a clean, lint free cloth and use that to lightly 'buff' the epoxy. This will help smooth the coating and get rid of air bubbles.
11. After 24 hours, sand with 240 grit wet-or-wry, WET, until smooth. You are now ready to prime.

Two additional notes:

1. With lighter cloth (3/4 up to 2 oz), I sometimes soak cyano into the

entire cloth surface. I then sand with 320 grit VERY LIGHTLY. I find I use much less epoxy and end up with a lighter rocket. This is a good technique when weight is critical.

2. Always were latex gloves when working with epoxy. People do develop nasty reactions to this stuff over time.

From wolf@netheaven.com (Wolfram v.Kiparski)

When using 3/4 oz. cloth, I find it easiest to first paint epoxy (thinned with a little laquer thinnner) on the body tube and then lay the cloth onto the tube. The cloth readily "wets out" when it touches the epoxy, and adheres to the tube without curling up. The cloth can be gently arranged and gently brushed to smooth out the wrinkles as you wrap it around the tube. Extra epoxy can be dabbed on as needed.

For 3/4 oz. cloth:

1. Cut the cloth to size first. Cut the cloth slightly oversize so that it is a little longer than the tube, and will overlap if wrapped around the tube.

2. Mix your favorite epoxy and add about 5% laquer thinner. Paint this onto your body tube with a china bristle brush. I use a 1.5 inch brush. Thinning the epoxy makes it spread easier, and will help keep lightweight cloth from distorting and wrinkling. It will also cause you to use less epoxy.

3. While the epoxy is still "wet," drape one end of the cloth onto the body tube. Use your brush to smooth the cloth out. Brushing in only one direction will help avoid wrinkles. Roll the tube slightly as you smooth the cloth onto the epoxy-covered tube. The cloth will pick up enough epoxy to wet-out. If it doesn't, add a dab of epoxy to help it along. You can free both hands by placing the body tube over a long wooden rod like the kind used for closet hanger rods. Support the rod at both ends kind of like a giant toilet paper dispenser.

4. 3/4 oz. cloth will stick to the body tube and tend not to lift up before the epoxy has cured. Be careful not to brush too vigorously when overlaping the cloth as you finish applying it. You might wrinkle the bottom layer of the overlap, and experience a great deal of frustration.

5. After the epoxy has cured, lightly wet sand with 220 grit sandpaper. Fill in any low spots with spot putty and sand smooth.
A few coats of primer will fill in the weave of 3/4 oz. cloth, especially if you lightly wet sand with 320 grit between coats.

With a little practice, this technique is easy to do, and adhesives other than epoxy are not required.

From: dave@ddave.com ('Dangerous' Dave)

[Dave had the following comments about the above described technique. Dave

is an expert in the use of composites, fiberglass and laminating techniques]

When the glass is fully cured, you can sand the lap joint till it feathers into the ajoining surface. Any irregularities can then be filled with a polyester filler (Bondo) and spot putty to blend the surface so that it is unnoticable.

Don't use an adhesive to tack the glass in place. It will prevent the resin from soaking into the fabric and will effect the physicals of your epoxy. Cut your fabric to size allow and inch or so overlap that you can trim off later. Wet your surface and then drape the fabric on to it. Then stipple the resin into the fabric with a china bristle brush. Don't use a paintbrush that is made from synthetics, i.e.: nylon, polyester, ect.. The epoxy and/or your cleaning solvent will disolve your brush and it may react with the resin.

Be sure and read my Safety Document on handling composite materials before you do any of this.

You will get your best adhesion by completely removing the glassine. Since resin can't penetrate it and will not bond well, you must remove it in order to take advantage of any strength gains you get from applying glass.

Visit my web and ftp sites for some more info on laying glass. FibreGlast at: http://www.fibreglast.com has a very good section on composite techniques.

[*Editor's note: If you're going to work with fiberglass, epoxies, or carbon fiber, check out DDave's web page, http://www.ddave.com/*].

11.8 Is there any way to retrofit my existing rockets to have some type of positive retention system?

From: billn@PEAK.ORG (Bill Nelson):

Well, you can reinforce the aft ring a bit, then use the screw-in threaded connectors that are available.

From: silent1@ix.netcom.com (The Silent Observer):

Drill a hole on each side, and install a Molly (R) or similar "drive fastener" or expansion fastener -- the kind used for hollow walls and doors. Do this with a dowel or motor casing in the motor tube, so the little metal "legs" on the fastener don't punch through the tube; you'll find these are about as strong as a blind nut, install from the front, don't cost much more (if at all), accept standard threads (and come with a screw!), and look neater. One thing to watch, though; the threads in the fastener strip pretty readily (they're aluminum) and they're the devil to remove if you do strip one.

From: jsivier@ux1.cso.uiuc.edu (Jonathan Sivier):

I retrofitted blind nuts on a couple of my rockets using the anchor bolts that are available at most hardware stores. These are a metal tube with

threads on the inside and slits along part of their length. You drill a hole in your bulkhead, push the bolt unit through and tighten the bolt. As it tightens the tube expands at the slits to push against the back of the bulkhead. It also has a lip on the front so the anchor is firmly, uh, anchored. :-) With a little epoxy under the lip it becomes a very strong mount for motor retention devices. They have different sizes for different thicknesses of material, from 1/8" up. They may take up a bit more room than the blind nuts, but if the rocket is already built they are a great way to make this improvement.

From: kaplowro@hccompare.com (Bob Kaplow):
Use threaded brass inserts, and a drop of thin CA to keep them in. They don't have the large lip on the back, so it won't be as strong, but my first 3-4 HPR models were done this way. Now I put blind nuts (also called T nuts) in all my larger rockets. I even use them in motor mounts where I have the room. DuBro makes some VERY SMALL 6-32 T-nuts that fit most adapters that have a plywood ring. I've yet to come up with a retainer for the heavy cardboard tube style adapters.

From: c72500@aol.com (Gary ??, C72500)
If you have already assembled the rocket, look for a "thinsert" and installer tool. This is basically a threaded rivet -- drill a hole in the centering ring, put nose of tool (wiith insert threaded on) and squeeze - permanently installed threaded insert! I have used this to retrofit every rocket I have built, and have yet to lose an insert or a motor. Installer and inserts are available through a company called Northern via catalog - runs about $13.

11.9 All these high power motors are different sizes. How do I hold them in? What do I use for a motor block and where should I put it?

From: jackson@sn3.jsc.nasa.gov (Al Jackson)
For mounting and retaining HPR motors I have this suggestion, especially with PML models. See if you can let a good one inch of motor mount protrude from bottom of model. Then when using a reload motor, besides using a tape friction fit, put a wrapping of strapping tape around the end enclosure and wrapped also around the piece of motor mount sticking out.

From: jjirvine@aol.com (Jerry Irvine)
Perhaps i'm just tired of seeing people reinvent the wheel to non-round shapes, but I have found that:

1. There is no need for thrust rings inside rockets of any power or weight. The application of a masking tape thrust ring on the nozzle end of the motor of adequate width for motor thrust is always adequate, to the point where a fiberglass or metal one is better.
   a. 1/4" wide masking tape is often used for 1/4A-F motors with thrust levels under 40 newtons.
   b. 1/2" wide masking tape is often used for 1/4A-J motors with thrust under 200 newtons.
   c. 3/4" wide masking tape is often used for F-K motors with thrust under 600 newtons.

d. 1" up to 1000 newtons, 1.5" up to 2000 newtons, then above that a structural ring at the rear of the motor.

2. With the above system one can add an external motor hook with NO protruding rear thrust block, extended out the rear the exact width of the masking tape you most prefer. The hook should typically be metallic and bonded to the outside with epoxy for maximum strength and instead of protruding hooks, they can fan out to the side for better bonding strength.

From: kaplowro@hccompare.com (Bob Kaplow):

You want to install blind nuts on the BACK side of the aft centering ring, before the mount is installed in the rocket. That way it can't pull thru. [Epoxy a little around them] to hold them in place when not bolted in. The screws go into these threaded holes, and hold in whatever clip you are using. I personally prefer cap screws and an allen wrench to machine screws and a flat blade screwdriver. The allen wrench holds the screw while I'm installing it at a funny angle.

From: bmcdermo@ix.netcom.com (Buzz mcDermott):

You can use blind nuts (also called T-nuts), available from many hobby shops and most hardware stores. Two or three size 4-40 work fine for up to 38mm motor mounts. For anything bigger I would use two or three size 6-32 nutes. For three and four motor clusters that don't have a central motor you can expoxy a balsa or spruce strip into the central gap between the motors. Drill a 1 inch deep hole in the exposed end of the strip appropriate for epoxying in a 2.5 inch length of 1/8" threaded rod. Use a washer and nut to retain all three or four motors from a central point.

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 12: Ignition and Launch System Tips

Posted: February 11, 1997

Last modified: January 9, 1997

[Note: This portion of the FAQ is maintained by Jerry Irvine (jjirvine@cyberg8t.com). All comments and suggestions should be sent to him.]

12.1 Copperhead, squib, electric match, thermalite, flash bulb. What are all these types of igniters, how much current do they require, and when are they used?

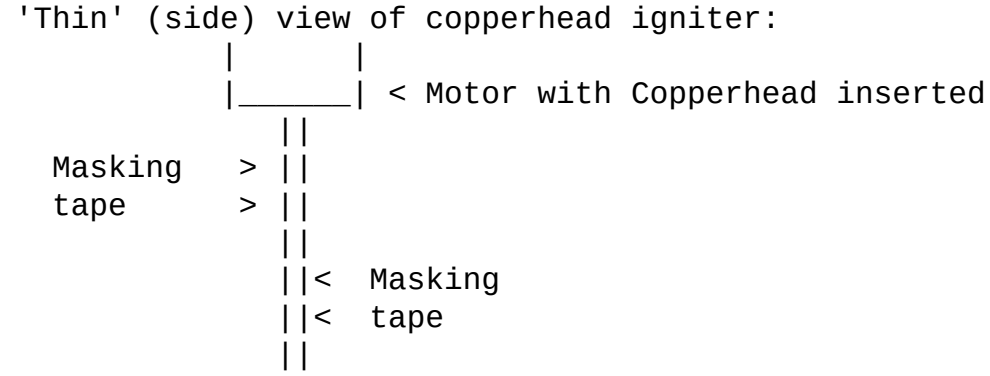
Copperhead	used to ignite single composite motors; not good for clustering. They will light most black powder motors. Requires strong 12V current source.
Electric Match	a type of electric igniter requiring little current to ignite. As little as 200ma of current will set them off. Used for igniting high power motors and motor clusters.
Thermalite	a type of fuse used extensively in pyrotechnic applications. May be ignited by nichrome wire or flash bulb. Plain thermalite ignited by nichrome wire is often used in black powder clusters.
Firestar	Igniter kit which has proven popular in general use and is easily shippable. Uses low or high current (6-12v) depending on which bridge wire you dip in the partially pre-mixed solution you buy.
Flashbulb/thermalite	some types of camera flashbulbs ignite with very little current (typically as little as 50ma) and burn very hot. These are used to ignite a piece of thermalite fuse

	running into the motor. Used for igniting high power motors and all forms of clusters.
Magnelite	medium to high current requirements. Sold by Rocketflite to ignite Silver Streak motors. Works well to ignite single high power motors. These are magnesium tipped igniters that burn at a very high temperature.

In general, almost any current source from a 1.5V 'C' battery up might ignite a flash bulb or electric match. For the other igniters, a 12V system capable of delivering several amps of current to the igniter is required.

12.2 How do those 'Copperhead' igniters work? They only have one wire?

Copperhead igniters are actually two strips of copper wire with a thin mylar insulating layer between them. To use these with regular alligator clips you need to use masking tape to insulate opposite sides of the igniter from each clip.



Attach one alligator clip at each masking tape point, so that each clip only makes contact with one (opposite) side of the igniter.

The Quest 'Tiger Tail' igniters are the same type of igniters as Copperheads. They come with a special 'wrapper' with openings for alligator clips.

NOTE: Copperhead igniters require a 12 volt ignition system.

12.3 I've heard that Copperhead igniters are 'unreliable' for igniting HPR motors. Is that true?

Many HPR flyers do not like the Copperhead igniter, prefering alternatives when they can be found. It is certain that Copperhead igniters are not a good choice for igniting clusters. However, some have found the Copperhead to be a reliable igniter for single-motor HPR rockets.

From: dcrcep@mizzou1.missouri.edu (Elmer M. Price)

> Hi Folks: I have a comment on the reliability of Copperhead ignitors. Our small group has had no problems with these, once we figured out the best way to use them. So, in spite of all the negative comments, we actually really like these things. We have launched composites up to and

including I-sized motors with great reliability. For example, two weeks ago, two of us (at the excellent St. Louis launch), launched two I284 birds, one I161, one I211, two H123 and a few F's and G's. We had 100% ignitor success.

O.K. So what do we do to achieve such reliability? First, open the reload pack and assemble the motor in the usual manner. Second, find the Copperhead that came with the reload kit and THROW IT AWAY. What we use are Copperheads which we purchase separately. These arrive from the dealer (like Magnum) in a nice package and the ignitors are not all beat up and crimped and bent to heck like the ones which are provided in the reload kit. We feel this is an important point. Second, since the H and I (and larger) motors are a bit more difficult to light, we modify the new Copperhead as follows (this idea came from RMR): take a slug of white lightning propellant (we use the slug from a D9) and cut a very small sliver (and I mean small, about 1/16 inch square and about 1/2 inch long). Tape this sliver (Fred from our group optimized this point) to the Copperhead by overlapping the bottom half of the pyrogen on the Copperhead with the top half of the sliver. Use a small strip of masking tape to attach the sliver to the copper below the pyrogen. The point here is to ensure the tape is below the area where the pyrogen and the sliver overlap. This is important because if the tape is higher up the ignitor, the sliver may fall off of the Copperhead and lead to a chuff (ignition too far aft).

This modification is not necessary for G and smaller motors, since the pyrogen is in close proximity (or touching) the propellant.

And this was added by: bday@fly.HiWAAY.net (Brian Day)

I've also gotten *MUCH* better reliability from Copperheads by not using the red plastic cap over the nozzle, and just using a small piece of masking tape to hold the igniter in place. This technique doesn't crimp the Copperhead like the plastic cap does. Since doing this, I've gone from roughly 50% reliability to darned near 100%.

Oh yeah, someone else on rmr recently suggested clipping off the pyrogen part of an old, crummy Copperhead and using it to augment another one, like you do with your sliver of propellant. Beats throwing it away...

Finally, regarding the red caps provided with Aerotech motors for holding in the igniters,

From: Bob Kunz (bkunz@boi.hp.com)

You do know that one is supposed to provide a vent in the red cap? I would presume this is to allow some leakage of pressure but enough to get the white/blue/black propellant to ignite. Typically, I find that the red cap is blown through when I recover the rocket. Only once was it blown off at the launch pad. So far in about a dozen launches on RMS 24/80, I've had no failures. But sure those are small grains compared to some of the 54mm stuff.

From: curcio@telerama.lm.com (Larry Curico)

Copper Head igniters have acquired reputations for unreliability. I'm wondering if the problem is in the igniters or in the red nozzle caps, which blow off during most Copper Head failures. IMHO, it's the sudden release in pressure that makes ignition fail - by disrupting the

newly forming flame. When I use a piece of masking tape instead of a cap, I don't seem to have the problem.

Editor's note (jjirvine@cyberg8t.com):
As of 11-96 Aerotech has made some efforts to eliminate the microshort problem which is an artifact of the Coppercrap manufacturing process. They have tried making versions with thicker insulator layers. While they are more fragile and subject to peeling, they are more reliable than before. Time will tell.

12.4 Do you have any specific suggestions or tips for an ignition power sources? Can I use my old Estes ignition system with composite models?

The Estes, Quest and other model rocket launch systems are fine for most model rockets. If you do a lot of flying there have been some suggestions posted to the net. If you are trying to launch cluster models with solar igniters you will need more 'juice' than 4 AA batteries can provide. This is also true of clustered Copperhead type igniters.

From: cdt@sw.stratus.com (C. D. Tavares)
A motorcycle gel cell, however, will last a long, long time. Our club uses a gel-cell the size of three VHS tapes to launch 120 rockets over six hours, and it comes home at about 80% charge.

From: billn@hpcvaac.cv.hp.com (Bill Nelson)
I bought a 12 volt motorcycle battery for about $20. I only need to recharge it 3 or 4 times a year. I have adapted all my launch controllers to allow usage of the battery.

12.5 WARNING: Be very careful using any ignition system with 'flashbulb' or electric match type igniters.

Many (most?) launch ignition systems are not 'flashbulb safe'. Just arming the circuit (i.e., doing a continuity check) will fire the flashbulbs and ignite the motor. If you plan to use flashbulb ignition often, you might consider investing in a 'flashbulb safe' ignition system.

From J.COOK@ens.prime.com (Jim Cook):
A lot of launch systems use a light bulb to do a continuity check. The current through the light bulb is enough to set off flash bulbs (They require only milliamps to fire).

Remember that electric matches may ignite on any amount of current above 200 miliamps. Flashbulbs may ignite with as little as 50 miliamps of current.

12.6 The ignition of rockets by other than electrical means is banned by both the NAR and Tripoli safety codes and should not be used.

There was a fairly lengthy discussion in r.m.r about the use of hand-lit fuse to launch rockets. Although there was an advocate of this method the

consensus opinion of the net was that the NAR and Tripoli safety codes made good sense, hand-lit fuse igniters were unsafe, and electrical ignition (even if igniting fuse by electrical means) should be used for all activities. Hand-lit fuses are also against most state laws.

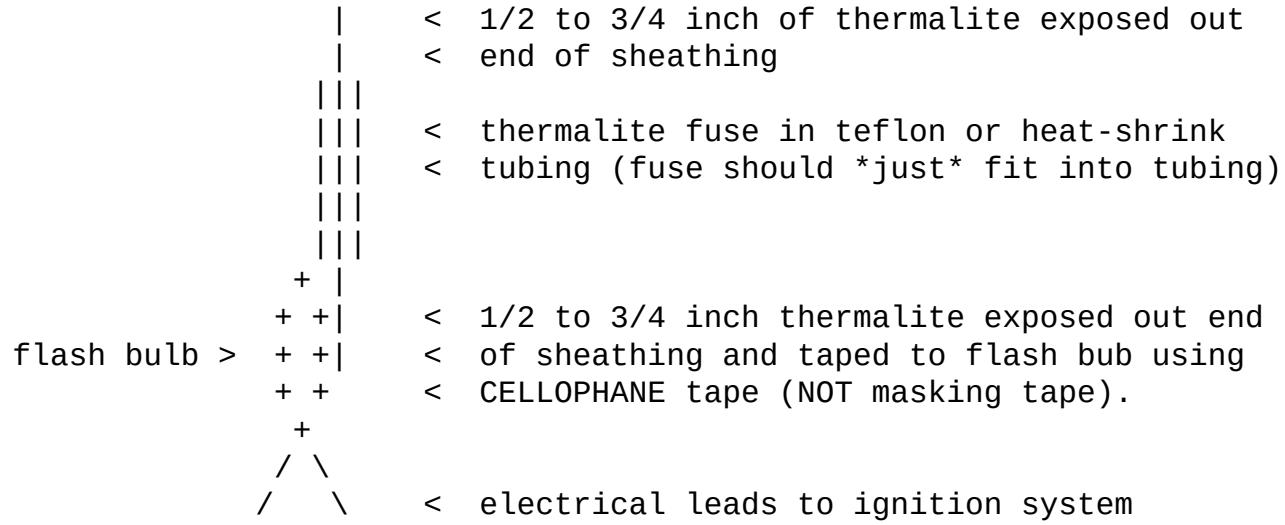
While it is theoretically safe and practical, it goes against the principal of self regulation which has made model rocketry legal and available natonwide and worldwide. Just don't do it.

12.7 What is thermalite fuse and how is it involved in igniting rocket motors?

Thermalite is a type of fuse that has been used in the pyrotechnics industry for a number of years. It comes in three burn rates, identifiable by the color of the fuse wrapping:

Color	Type	Burn Rate	Usage
Pink	Slow	20 sec/foot	Flashbulb ignition
Green	Medium	10/sec/foot	Ignition enhancer
White	Fast	5 sec/foot	Not used much in rocketry

The burn rates are approximate and vary with humidity, temperature, age of fuse, etc. The numbers also correspond to burn rates of exposed thermalite. When enclosed in heat-shrink or teflon tubing, all three types burn at an equally fast rate. A typical usage for thermalite is in a flash bulb igniter:



The fuse is sheathed except for about 3/4" at each end. The sheathed fuse is inserted into the motor and must be long enough for the exposed end to go all the way up through the core and out the bottom of the motor. Composite motors are ignited at the top of the core (nearest the delay charge). The sheathing on the fuse is to keep from igniting the motor anywhere but the correct location. The other end of the fuse is tape to a hot-burning flash bulb. The flash is then attached to the ignition system and ignited in the normal fashion. This lights the thermalite fuse, which then ignites the motor.

This is the ignition method of choice for clustered composite motors (in any number above 1) and large clusters of black powder motors.

WARNING: Flash bulbs require VERY LITTLE current to set them off. Read

the warnings in 12.5, above.

NOTE: Thermalite is clasified by the BATF as a 'Class B Low Explosive'. Out of state purchase, interstate transport, and personal storage of *any* amount of thermalite fuse requires a Federal Low Explosives User Permit. Refer to the section on 'High Power Rocketry' for more details on LEUPs.

This is a change of prior enforcement practice and this material was widely available as a Class C item for decades. We will see how long this will last. Several advocates of easy access have suggested that short lengths of under 12" should be exempt from LEUP and shipping restrictions, especially those pieces included as stock igniters with MR and HPR motors from the factory.

Thermalite is one of those magic and critical substances to rocketry.

12.8 How do you ignite second stage composite motors? Can I use a black powder booster for the first stage to ignite the second (as I do with multi-state A-D rockets)?

Upper stages of composite powered models may be ignited by electrical means or thermalite fuse. North Coast Rocketry has a Technical Report covering this subject. Excellent articles have also appeared in **Sport Rocketry/AmSpam** and HPRM magazines.

You cannot use a black powder booster to ignite a composite upper stage. The gasses from a BP booster will not properly ignite a composite. There are composite boosters on the market. These boosters are all 'plugged' and so cannot ignite any type of upper stage motor. Composite motors are mostly 'core burners' with the core running the entire length of the fuel grain. A composite core burner set up like a BP booster would ignite a BP upper stage too soon.

There are several issues involved in igniting upper stage composite motors. (1) A timing method must be provided to delay ignition until the appropriate time, (2) power source for the igniter is required and (3) the igniter itself must be provided and be capable of igniting high power motors. Whatever method of ignition is chosen, all 3 criteria must be met.

Timing Methods ....

Several methods of timing have been developed and used. The earliest and cheapest timing method is to use a length of unsheathed thermalite fuse. The fuse is typically ignited by the exhaust from the first stage motor. The fuse is long enough to allow for the first stage motor burn time and any desired post-burnout coast. The last portion of the fuse is sheathed and inserted into the upper stage motor to act as the igniter. The problem with this method is that not all thermalite burns at the same rate. Also, the same batch of thermalite will burn at different rates depending on the altitude, temperature and humidity at the time and place of launch.

Mercury switches were another early method of 'timing' upper stage

ignition. A mercury switch is a small glass bulb with an enclosed drop of mercury. Two wires run out the top of the bulb. When the switch is tilted or decelerated the mercury rolls forward to make contact with the two wires and close the circuit. This results in a closed circuit when the booster motor stops firing and the rocket begins to decelerate. The ignition circuit would be set up so that power is provided to the igniter when the mercury switch closes. EXTREME care must be exercised when using mercury switches. Tilting the rocket closes the switch, so provisions for disarming the circuit must be included. After the rocket is placed on the pad and the circuit armed, any sudden movement of the rocket could set of the second stage.

Bob Weisbe uploaded plans for a mercury switch-based staging system that he used in a converted Estes Terrier-Sandhawk kit. The URL for these plans is:

http://sunsite.unc.edu/pub/archives/rec.models.rockets/PLANS/terrier_sandhawk.ps

The next generation of upper stage ignition systems were based on electronic timers of various types, both analog and digital. The timer was set for the appropriate time (first stage burn time + inter-stage delay, if any). A contact switch, usually kept open by the launch rod, would often be used to initiate the timer. As the rocket leaves the launch rod the timer is started. After the preset time interval the timer closes the circuit allowing power to the igniter. Again, great care must be taken with these devices. If the contact switch is allowed to close prior to the rocket lifting off the 2nd stage could ignite while the rocket is still on the pad and there are people around.

Another form of early timing device was based on photo-electric sensors. A sensor would be placed in a position such that light could get through the booster motor tube after all of the fuel was spent. When the sensor detects light the power circuit is closed.

Remote control has been used to initiate firing sequence in mutli-stage rockets. This method has the advantage that the 2nd stage isn't ignited unless a human being takes positive action, while the rocket is in the air. It also requires an R/C transmitter, receiver, etc.

Some newer devices are out based on acceleration detection. These are sometimes combined with timers. Liftoff acceleration is detected. This either starts a timer or enables a deceleration sensor. At the specified time interval, or when deceleration is detected, the power circuit is closed.

Power Sources ...

Two forms of electric power are commonly used, capacitors and batteries. A capacitor is typically charged from an external source just before liftoff. The timing device then closes the circuit at the proper time and the capacitor discharges, firing the igniter. One disadvantage of this method is that the capacitor charge slowly bleeds off, meaning that the rocket may not sit on the pad a long time after preping and still reliably ignite the upper stage(s).

All forms of small batteries have been used, depending on the power

requirements. Common batteries for igniting a single, low power igniter are 9V transistor and 12V alkaline lighter batteries.

Timed thermalite fuse ignited by exhaust from the booster requires no power.

Igniters ...

Multi-stage rockets generally have a limited current source for igniting upper stages, so very low power igniters are used. Two common igeiters are electric matches and flash bulb/thermalite fuse. Both of these igniters are described elsewhere in this document.

Readers are encouraged to review the NCR technical reports and rocketry magazine articles on composite multi-staging.

A document describing igniters, and how one can make ignitors using thermalite and nichrome wire is available on the sunsite archive at:

http://sunsite.unc.edu/pub/archives/rec.models.rockets/ARTICLES/igniter_talk.txt

Illustrations for this document are also available for downloading:

http://sunsite.unc.edu/pub/archives/rec.models.rockets/ARTICLES/igniter_talk_figures.ps

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12.9 What is 'flash in the pan' ignition and for what is it useful in rocketry?

From: jjirvine@cyberg8t.com (Jerry Irvine)

[*Editor's note: This is paraphrased from Jerry's postings*]

Flash in the pan ignition is used to ignite clusters of small black powder rocket motors. It consists of a thin layer of black powder on a paper plate under the motor nozles. The powder is ignited via a regular model rocket igniter, such as an Estes Solar igniter. When the power ignites, the burning particles and hot gasses from the 'flash' ignite the motors.

It is used to ignite clusters of 7-469 motors and reduces the number of igniters needed to one.

12.10 I would like to perfect a method for reliable ignition of clustered multi-stage rockets. Any suggestions or tips?

From: Leviathan@nighthawk.medtechnet.com (Leviathan)

So would everyone else... but there's always that chance that something may fail when staging and/or clustering... and probably double the chance when staging & clustering. Therefore, my best advice to anyone attempting (large?) projects requiring staging/clustering is to invest in some sort of recovery system such as the Adept altimeters with deployment. In the case of staging... if the upper motor fails to ignite the altimeter will still deploy the upper stage chute(s) SAFELY with NO damage to the rocket. In a case were you're clustering and a motor (or 2, or 3....) fails to

ignite in the cluster, and the rocket WILL fail to reach a safe altitude - or more precisely now WILL have a delay time that is TOO LONG - again the altimeter will SAFELY deploy the chute(s). IMO it's a small price to pay to protect a much larger investment of the rocket itself. As a matter of fact in my current project - a 1/4 scale 3 stage Argo D4/Javelin - each stage will carry it's own altimeter with the 3rd stage carrying the Adept OBC2 recording altimeter. Not only will this provide for dual deployment of each stage's recovery system, it should provide protection against failure of the 2nd and/or 3rd stage ignition. I also plan on carrying a Pratt system aboard to provide redundant back up.

From: John Dunbar (jdunbar@csd.sgi.com)

I really recommend the teflon sheathing method of thermalite.

Now you can try using a flash pan to get that first stage bohemian going. Its just a nice circular pan, with fine black powder in it. Just order a can from your local gun shop, they can ship US postal to your front door without a single eyelash batting on the face of a BATF agent. You stick those engine down into the power with a thermalite whick protruding from the engine, and WHOOSH...

The more parts you have to worry about, the greater the likelihood that something is going go terribly wrong. Now if you don't care, and just want to do it for fun, GO FOR IT, otherwise think of ONE BIG MOTOR for the first stage and one smaller, yet BIG MOTOR, for the second. Do not rely on mercury switches for high power ... thats a NO NO. Instead, use timers in a way that causes the second stage to start its ignition while the first is still under power. Now you can drag separate, and that's fine to, but make sure your bird is flying straight and true, or it will be doodoo!

Technical reports on this subject are available from NARTS and California Rocketry (see part02 of this FAQ):

California Rocketry report AIR-3

North Coast report NCTRA1 (from NARTS)

12.11 How do I cluster rocket motors? When igniting a cluster of rocket motors, should the igniters be wired in parallel or in series? Why?

The advent of composite model rocket motors in 'standard' black power sizes (18 and 24mm) has led to an increase in the use of composite motors in cluster rockets. Mixed black powder/composite clusters are also becoming popular. In particular, clusters of 3 or 4 composite motors, or a composite core motor with outboard black powder motors, are being seen more. These offer special ignition challenges. The old black powder techniques don't work when composite motors are involved. The most common method for clustering Estes type black powder motors is to use multiple Solar igniters and clip whips. Flash bulb to sheathed thermalite is the most common composite ignition method. Although flash bulb ignition has been used for years, there have been safety concerns over its use. Here are some suggestions from rmr posters:

From PeteAlway@aol.com (Peter Alway):

I cluster black powder motors with Solar igniters wired in parallel and a car battery for power. I stuff igniters with little balls of tissue paper wadding to insure they stay in place. My general rule is only to cluster with a technique I use regularly for single-engine models, as reliability has more to do with experience and my current state of skill than with the particular technique. [*Editor's note: Estes plastic plugs work well in place of tissue wads. The igniter plugs can be reused several times, as well.*]

From: glenn@lightning.nsc.com (Glenn Newell)

My technique for clustering composite motors is to use equal length pieces of thermalite with 1/16" heat shrink tubing as a sleeve. I leave about a 1/2" unsheathed in the motor and about one inch unsheathed on the other end (I don't shrink the heat shrink, it just happened to be around and the right size). I tape all the ends together around a single solar igniter. No flashbulb problems here!

From: billn@hpcvaac.cv.hp.com (Bill Nelson)

I prefer to use a short section of Thermalite, with igniter wires, inserted into each motor - the wires are taped to the motor for security. There is no need for an igniter for the Thermalite. Simply remove the cloth wrap, and all but one of the spiral metal wires. Wrap the end of one wire to one end of the thermalite and the end of the other wire to the other end. You can use anything from about 22 gauge wire (if it will fit in the grain slot) to about 28 gauge. The free ends connect to the controller ignition wires. When the relay closes, the Thermalite wire wrap is essentially vaporized instantly. I have never seen the Thermalite fail to ignite.

From: burkefj@kodiak.ee.washington.edu (Frank J. Burke)

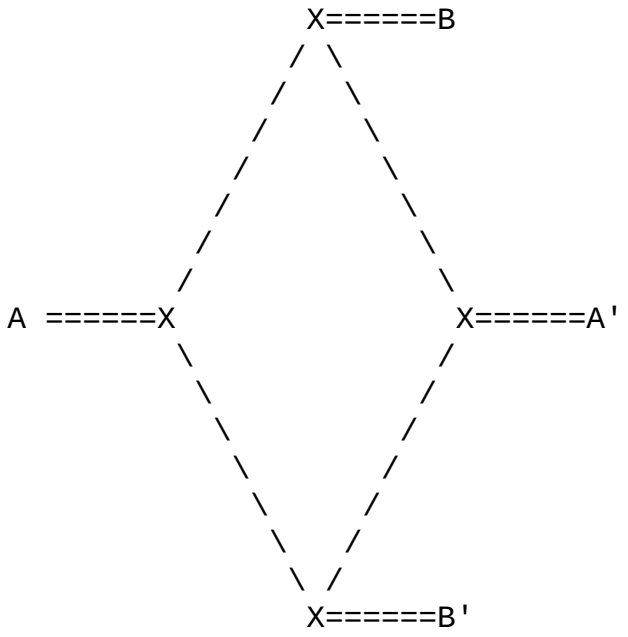
The main reason for using parallel igniters is that as one ignites, the others are still in the circuit. As one igniter breaks in a series circuit the circuit is broken and the others will not get any more current. It may be that with a 12V system, and low impedance wire, that the current provided is high enough that they flash so fast that it doesn't matter.... I have never had a failure with parallel circuits. I ... prefer using a parallel system, knowing the limitations, using a meter to verify that the igniters are "good" before using them, and using good connections when wiring them up.

From: buzzman@netcom.com (Buzz McDermott)

The biggest concern with wiring cluster igniters in series is that one igniter might burn through and break the circuit before all of the igniters have fired. Once the circuit is broken, no more igniters will fire.

On the other hand, it was mentioned by several posters that series wiring is extensively used in the explosives and pyrotechnics industries because of the added reliability you get. With series wiring you can verify the complete igniter circuit and you will know if *any* igniter is improperly wired. Also, you would be able to ignite many more (fast igniting) igniters with series wiring, especially if the resistance in the igniter is high.

From: kaplow_r@eisner.decus.org (Bob Kaplow)
For a 4 engine cluster I like to wire the ignitors in a "bridge":



Clips A and A' come from one clip whip. B and B' are from the other whip. I use a manual wire wrap tool for twisting the Solar ignitors together AFTER installing the "earplug" (tm). Be sure your wraps are nice and tight so they all touch where they are supposed to. Having a clip on each joint certainly helps. For multiple wire clipping, I've found that the clips with teeth hold better than the standard micro-clips.

I've used this several times now on 4xD12 in a BT-80 rocket with 100% success.

Editors Note:
The bottom-line-consensus of the 'net' seems to favor parallel wiring for most clusters of 7 or fewer motors, using a 12V (or more) launch system capable of dumping plenty of amps to the igniters. This generally means a relay based system with the primary ignition power source close to the launch pad.

Readers are also directed to check out the NCR Technical Reports #1 & #2, on black powder and composite clustering, respectively. Although they are a few years old, they still contain valuable information.

12.12 I am new to rocketry. I was wondering whether anyone has tried using waterproof wicks instead of igniters to ignite a rocket engine.

The main application for Green fuse in rocketry is as an auxuliary delay when a timer is not available and Thermalite is too fast burning. Green Visco fuse burns about 30 seconds per foot.

From: kaplowro@hccompare.com
"Green" fuse isn't reliable, and unless electrically ignited via remote

control (difficult) isn't legal. To use fuse and a match is a violation of the safety code, and most state local regulations.

buzzman@netcom.com (Buzz McDermott) adds to the above:
The most common way to use 'green' fuse or Jetex wick to ignite a model rocket motor is to cut a fair length, insert it in the motor, light it with a match, and RUN!. As Bob stated, it's against EVERYONE's safety code to do that. The answer to 'why' is simple. Once you light the fuse you've lost all control over launching the rocket. If a breeze kicks it over just before ignition you end up launching a land shark. You can't stop the launch if you notice a plane come out of nowhere and fly right overhead. You can't stop the launch if a little kid comes out of nowhere and runs up to your rocket. ...on top of all this, the stuff just really work all that well for rocket ignition...

12.13 The alligator clips on my launch system have worn out. What should I use to replace them?

From: msjohnso@KS.Symbios.COM (Mark Johnson)
RatShack is fine for clips...and they have a wide collection of sizes. My suggestion, having been-there-done-that and replaced clips on several controllers almost annually, is NOT to buy the little 3/4 inch copper clips. They're too delicate for my tastes. Instead, I get the chrome plated ones about 1 1/4 inches long, preferably with the little plastic grips on the "handles." These are bigger and thus easier to manipulate while wearing gloves, or when your hands are cold and unsteady.

If you use your launch system frequently, I recommend at least annual replacement of the clips. This is more true of a club system than an individual one, but remember that you take your choice of corrosives with model rocket motors -- black powder leaves just a bit of sulfuric acid in its wake, and composites drop hydrochloric. The clip bodies of copper micro-clips will hold up OK, but the spring that holds the jaws shut is steel and will eventually corrode away, as you've seen.

12.14 Other Ignition Tips:

From: dwade@jarthur.claremont.edu (Doug Wade)
[concerning adapting launch controllers to 12V car batteries ...]
Speaking of which, I took my Aerotech launch setup, lopped off the igniter attachment, and the place where it attaches to the battery, put amp plugs on either end, put a plug on the battery, and made some alligator clips in various configurations for launching Estes stuff. This means that I can switch batteries and igniter style in basically no time at all. It's not a lot of work, and it makes life easier. If you have the urge to do this kind of thing, make sure that you get plugs that can handle it. A 12V motorcycle battery (Mine was about $40 but it's pretty nice) can put out something like 15A for a short period of time...

From: cdt@rocket.sw.stratus.com C.D. Tavares
[concerning an ongoing discussion about blast deflectors]
I've had first hand experiences with several types of metals. I've never

found a piece of aluminum that was worth dog-doo as a deflector. In the higher engine ranges, even steel will give you problems, especially with maintenance. Stainless isn't much help, since it still cruds up.

What we use are discarded grinding wheels. Fireproof, non-conductive, free, plentiful, large, and pre-drilled. The only negative on these is that when an engine catos they tend to lose large chunks or crack in half. This happens to us maybe three times per year, but as I say, they're free and they're plentiful.

From: kaplowro@hccompare.com (Bob Kaplow)

Use clay flower pots for blast deflectors. Get Stainless steel for launch rods from welding or metal supply houses.

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 13: International Rocketry

Posted: November 17, 1998

Last modified: November 17, 1998

The majority of the r.m.r FAQ is oriented towards consumer rocketry in the United States. This part of the FAQ is for rocketry in other parts of the world. These sections will be expanded as information is received.

13.1 Rocketry in Australia

This portion of the FAQ was prepared and submitted by Rob Masters, rdm@perv.metapro.com.au. Rob asked that the usual disclaimers to use this information at your own risk, etc., be passed on to the readers of this FAQ. Corrections should be sent to Rob, who will see that they are incorporated and passed on the the FAQ editor.

13.1.1 What rules apply to model rocketry in Australia?

The C.A.A. RULE (Paraphrased from regulation 295):
No model may be flown over 300' without a waiver from the CAA. Only matters relating to airsafety shall be considered in granting a waiver. Further, you may not launch at all within 5km of an aerodrome (airfield or airport). Also, some states have explicit age restrictions (ie Queensland - Minimum age 18yo), and fire restrictions (Qld again, must have local fire marshall approval). You should also respect fire bans as a matter of safety, courtesy and good public relations.

Other than this, you should follow the standard _model_ rocketry rules of the NAR, and note that only engines up to "D" class are available.

13.1.2. What are good sources of model rocketry kits/wg's/parts, etc?

To date, all model rocketry components are imported through DAWN TRADING, who the distribute to the local retailers. Note that because of their policies, it is not possible to buy individual components for kits in Australia. The Designer's Special component set is, however, available. Currently only Estes and MRC kits are imported. Local retailers are most R/C retailers and some gaming shops.

13.1.3 Are there any regular rocket contests, launches, clubs, etc?

There is at least one national-level body now in Australia. It covers both model rocket and HPR levels. The body is :

Australian Rocketry Association
PO Box 125
Oaklands Park SA 5046

EMAIL: dasakko@cs.adelaide.edu.au (David Sakko, Vice President)

Membership is $25 per annum, and an additional $10 per annum per additional family member. Minimum age is 8yo and membership includes insurance, a quarterly newsletter, ID card, and guide book.
Sport Rocketry is available through them at $40 (surface) or $92 (air) per annum.

The association is also working with the CAA, state governments and the AFPA to standardise regulations and to obtain better flying conditions.

Also, there is at least one model aircraft club that welcomes, but does not cover, model rocket launches. For the scale modellers, there is also an active Astronautical Society, who can provide a lot of information, and are well worth joining if you are interested in the world of the "big stuff" as well.

13.1.4 Info on amateur groups/activities (such as AusRoc) in the Australia.

As has been covered in news stories, there is a University-based team who are working on an amateur rocket (AusRoc), who have so far had two spectacular failures, and one partial success.
For more on the AusRoc project, contact The Australian Space Research Institute. If you would like to join the Australian Space Research Institute write to:

ASRI Ltd.
PO Box 184
Ryde NSW 2112
Australia

The annual fee is AUS$25 for students and pensioners and AUS$100 for normal membership. If you live overseas write for membership costs.

All member funds are used to support ASRI programs. Membership allows you to:

* Vote at meetings
* Stand for election to the ASRI board of directors
* Receive of all ASRI newsletters and journals
* Provide payloads for Sighter (83 mm) and Zuni (127 mm) rockets

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13.2 Rocketry in Canada

3. Regs: HPR is class H-O. G's now available. HPR launch sites require certification by Transport Canada. HPR certification done by CAR.

This section is still under construction and currently has no Canadian editor responsible for its contents. Most of the information contained in this section was obtained from the CAR World Wide Web page and several issues of **High Power Rocketry** magazine.

13.2.1 Are there any national organizations to which I can join in Canada? What services do they offer?

Canadian Association of Rocketry (CAR)
c/o Garth Illerbrun
5927-18th Ave. N.E.
Calgary, Alberta
AB T1Y 1N9
Canada
Email address:
quixote@cadvision.com
WWW: http://www.rmc.ca/~rea/car.htm

Canadian equivalent to N.A.R.
- High power certification (required for G power and up)
- Dues: $30/year CDN
- $1M liability insurance for rocketry activities included
- Yearly national sport launch (Sullivan Lake)

Calgary Rocketry Association (CRA)
fansonb@cadvision.com (Brian Fanson, current CRA president)

13.2.2 What kinds of rockets (model and/or high power) are legal to fly in Canada?

At the present time, A-G powered model rockets, with launch weights up to one pound, are legal to fly in most parts of Canada. H powered rockets and up, as well as rockets weighing more than one pound at liftoff, are considered 'High Power.' HPR launch sites require certification by Transport Canada. HPR certification is done by CAR.

13.2.3 Are there any High Power launches at all in Canada?

There is an annual high power launch in Canada. It is the 'Sullivan Lake High Power' launch. There will be others since HPR is now legal, but regulated, in Canada.

For more information on this launch contact Garth Illerbrun (quixote@cadvision.com) at the CAR address.

13.2.4 What kinds of rocket motors are available for purchase in Canada?

All of the Estes A-D black powder rocket motor line and the Aerotech single-use, composite motors from D through G are now available for purchase.

13.2.5 Are there any Canadian mail order houses where I can purchase model rocket kits, motors and supplies?

Ralph's Hobby Shop
668 Kingston Road
Toronto, ONT
Canada M4E 1R4
(416) 690-4204
email: ralphs.hobby@sympatico.ca

Advertises Estes, MRC and LOC, as well as modeling and ignition supplies

La Maison de L'Astronomie
7974 St-Hubert
Montreal, QUE
Canada H2R 2P3
(514) 279-0063

Offers rocketry supplies from Estes, Aerotech, Flight Systems, LOC, Rocketman, Public Missiles, Adept, and more
Kits, motors, videos, books - everything
contact for catalogs and price lists

Suborbital Technologies
c/o Brian Fanson
179 Midlawn Close S.E.
Calgary, Alberta
Canada T2X 1A7
(403) 256-7293
email: fansonb@cadvision.com

Estes, Aerotech, NCR, Launch Pad rocketry kits, motors, supplies

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13.3 Rocketry in the United Kingdom

http://www.gbnet.net/orgs/staar
http://www.gbnet.net/orgs/seds

13.3.1 Is model rocketry legal in the UK?

As far as we can tell, there are no laws in the UK which *directly* govern model rocketry in the UK. For the time being, with model rocketry only in its infancy (10yrs or so) there is little need for unnecessary regulation so long as model rocketeers follow 'commonsense guidelines'.

13.3.2 What size model rockets can be flown?

Again, as far as we can tell, there are no rules which define maximum sizes, weights, total impulses etc. Most model rockets that can be bought from model shops will take a maximum of 3 D-Class Estes motors, either clustered or multistaged. There appears not to be an equivalent of an FAA Waiver for launching rockets greater than a defined maximum. However, all of the HPR enthusiasts I know do contact the CAA (Civil Aviation Authority) if they wish to launch over approximately 3000ft.

13.3.3 What model rockets are available?

The complete Estes range of kits and motors are available (not Estes E15). The Estes range is imported/distributed by Ripmax Ltd (See addresses below). Recently, a range of 'Launch Pad' kits has been made available by mail order from a company called Advanced Rocket Components (See addresses below). These will fly on Estes D and Aerotech E15/E30 engines. I do not know of any other source of rocketry components in the UK.

13.3.4 What types of engines are available?

Estes engines are the only commercially available brand of model rocketry motors available in the UK. All sizes from 1/2A to D are available. The price can vary quite wildly from one store to another. Typical prices in London are about GBP4.00 for 3 C/D Class. (Prices can vary from 3 to 5 GBP!)

Larger motors such as Aerotech etc.. are not available.

13.3.5 Where can I buy model rockets?

In general, it is the smaller independent model shops that sell model rocketry supplies, however, larger chains such as Beatties and Hamleys have been known to stock them. A number of 'kite and juggling' shops also sell Estes products too - quite interesting! (See address list below).

13.3.6 Are there any events/competitions?

There is only one event that I have come across, which is the "International Rocket Weekend", which is held near Largs, Scotland. This is run by STAAR Research (See addresses below) and is held on the August Bank Holiday every year (Note that Scotland does not have a Public Holiday, only England and Wales!).

There are no formal rules and regulations like the NAR, Tripoli etc. The basic rules and events are laid out beforehand, but often change to suit the interests of those attending. The event is aimed at promoting model rocketry in the UK, and often has a number of beginners. There are also many 'open/experimental' sessions for the more experienced.

The most important thing is that everyone enjoys themselves.

13.3.7 Are there any clubs?

The following is the list of clubs/organisations that I have come across. [I will try to establish full contact details ASAP]

- STAAR Research, Ayrshire.
  Refer to WWW Page:- http://www.gbnet.net/orgs/staar/

- Southern England Rocket Flyers (SERFS), Southampton.

- Middlesex Advanced Rocketry Society (MARS), Middlesex. (HPR Group)

- London Area Rocket Flyers Society - contact John Lister (john@listers.demon.co.uk)

- Beatties of London Model Rocketry Club.

- Essex, Hornchurch - contact Peter Barrett (101540.3142@compuserve.com)

- British Space Modelling Association
  Mr. Stuart Lodge
  25 Huntingdon Drive
  Castle Donington
  Derby DE74 2SR
  UNITED KINGDOM
  Tel: 44 1332 850329

- Thrust (The Rockect Club of Central England)
  email: thrust@bidesign.demon.co.uk

13.3.8 What are addresses of some of the shops that carry model rocketry?

RIPMAX Ltd. Tel. 0181-804 8272
Ripmax Corner Fax. 0181-804 1217
Green St.
Enfield
EN3 7SJ

Chart Hobbies Tel. 01903 773170 (On Estes Catalogue back page)
Chart House Fax. 01903 782152
Station Road
East Preston
West Sussex
Littlehampton
BN16 3AG

Hamleys Tel.
Regent St. Fax.

London

The Kite Store
Neal St.
Covent Garden
London

Advanced Rocket Components Tel. 0151-928 4874
7 Sandy Road
Seaforth
Liverpool
Merseyside
L21 3TN

13.3.9 What are some of the rocket clubs in the U.K., and do they have any problems getting permission to fly their rockets?

From: rosborne@cadence.com (Richard Osborne)

Well groups like AspireSpace (http://www.gbnet.net/orgs/aspire/) and MARS (Middlesex Amateur Rocketry Society) in Southern England fly vehicles up to K power without problem. They do always inform the CAA first, to ensure a NOTAM is issued, but apart from that, there never seems to be any problem, even with the police. Maybe certain areas of the UK are more touchy about model rocketry than others.

I don`t think STAAR Research (http://www.gbnet.net/orgs/staar/) has any problems with their numerous HPR launches in Scotland either.

I don`t know about the other UK group called SERFS.

13.4 Rocketry in South Africa

This section is still under construction. The following hobby shop address has been submitted to the FAQ.

Rocketeers — Model rocketry and high power kits, engines, and supplies
Box 7032
Roodeport
SOUTH AFRICA 1715
+27 (0)11 475 0880

There is a web page for the South Africa Amateur Rocket Club (SAMROC) organization. This web page may be viewed at:

http://www.samroc.org.za/

This looks to be a pretty complete web page, explaining the state of hobby rocketry in S.A., listing addresses of rocketry suppliers in the country, and giving amail addresses for further information. There are also pictures from SAMROC launches and a launch schedule.

13.5 Rocketry in New Zealand

This portion of the FAQ has been archived until the New Zealanders can agree on what should be stated here. The editor does not know anything about rocketry in New Zealand, and is in no position to arbitrate the dispute.

Questions regarding this section can be directed to both:

Lindsay Gordon (lindsay.gordon@stonebow.otago.ac.nz)

Gerry Munden (gamlnz@iprolink.co.nz)

13.6 Rocketry in Germany

Written by Stefan Wimmer (sw@cellware.de)

Germany is well-known for its many legal regulations. Consumer rocketry is no exception to that rule: rockets, rocket motors and launches are covered by several laws (Luftfahrtgesetz, Luftverkehrordnung, Sprengstoffgesetz...). The most stringent legal regulation are concerning the motors which are covered by the German explosives law (Sprengstoffgesetz, SprenG). To understand why they are so restrictive you have to know, that they passed legislation in the 70s during the active phase of the Baader-Meinhof terrorists (btw. one of their declared aims was to cause the creation of so many legal restrictions, that personal freedom would be strangled to a breaking point causing a revolution against the system. Well, they almost reached the first part....).
Rockets and rocket motors are considered to be a potential base for destructive devices and therefore limited to useless (unfortunately not only for this purpose) power levels. As if terrorists bother with model rocketry stuff - ever heard of an I-powered hand grenade, or such??

13.6.1 German Explosives Law

The German explosives legislation is divided into several sections:

The 'Sprengstoffgesetz' (SprengG),
the '1. and 2. Verordnung zum SprengG' (1.und 2. SprengV), and
the according 'Verwaltungsrichtlinien'.

For rocketeers the most important parts are paragraph 27 of the SprengG and the 1. and 2. SprengV which regulate handling and storage of pyrotechnic devices. The 'Verwaltungsrichtlinien' are also very interesting because they define, how the office people will (have to) react to inquiries.

The SprengG divides Pyrotechnic devices into 6 different classes:

- Class I (very small fireworks)
  These (eg. sparklers) may be bought and used throughout the year, even by children. No rockets are allowed in class I.

- Class II (small fireworks)
  These are the common end-of-the-year fireworks. May be bought by adults during the last three days of the year, and may only be used on 31st of December and 1st of January.

- Class III (medium fireworks) and
- Class IV (big fireworks)
  may be bought and used only by licensed people (license according to paragraph 7, 20 or 27 of the German explosives law).
  Storage has to be done in approved storage places.

- Class T1 (small technical pyrotechnic devices)
  These may be bought by adults and used by people of at least 14 years (under adult supervision from 14-17) throughout the year. Limitation for rocket motors in this class is 20g of propellant. That's why German rocketeers are usually stuck with A/B/C motors.

- Class T2 (big technical pyrotechnic devices)
  Everything that is not considered display fireworks and anything too big to be class T1. For rocket motors this means anything with more than 20g of propellant AND also clustering and staging of T1 motors. (!!!). So if you plan to launch eg. an Estes Commanche, get your T2-license first!

All pyrotechnic devices except class IV have to be approved by the 'Bundesanstalt fuer Materielforschung und -Pruefung' (BAM). In order to get approved, the device and the contained pyrotechnic compounds have to pass a number of tests to assure stability in storage, safety in handling and use, and quality of the products. The manufacturer will have to demonstrate acceptible quality control practices to be sure that subsequent production runs of the product will equal the tested ones. From time to time, additional samples have to be sent to the BAM for quality assurance verification.

13.6.2 German Aviation Regulations

The most relevant parts of the German aviation legislation are paragraph 16 of the 'Luftverkehrsordnung' (LuftVO) (which defines when to ask for a waiver and what information has to be provided in order to get a waiver) and Paragraph 37 of the 'Luftverkehrsgesetz' (LuftVG) (which demands that model aircraft up to 20kg has to have an insurance good for 2.5 mio DM per accident. If you plan bigger rockets: The next category is aircraft up to 1200kg and requires a 5 mio DM insurance.)

If you plan to get a distinct area registered as your 'Raketenflugplatz' get

a copy of the 'Richtlinien fuer die Genehmigung von Raketenplaetzen.'
Read it, and decide if you can meet the requirements.

13.6.3 What Rockets and Motors can I buy and use in Germany?

Some hobby shops with a good flyers' supply sell Estes and Quest model kits. There are even some genuine German manufactures whose parts and kits occasionally show up at stores. Most suppliers and manufacturers sell their products by mailorder too.

T1 motors:
Currently there is a range of Estes A,B and C motors available at the same stores. The greatest variety is from Estes. They cost about DM 8-12 for a 3-pack. A8-3, B4-4 and C6-3 motors are also available from a German manufacturer (Moog-Nico) and sell for DM 22-35 in packets of 10.
In some places you can also get the brave old HELD1000, which is basically a C2-0 originally intended for boost gliders. All these motors are BAM-T1 and can be bought, stored, and used without problems.

T2 motors:
There are several motors listed in the addendum of the German explosives law, but most of them are out of production (eg. some FSI motors). There are some remaining HELD5000, but the last batch was manufactured in '88 and depending on transport and storage conditions, they have degraded by now.
One member of the RAMOG (address in the Club/Address section), Mr. Maurer, sells a manufacturer-reloadable motor, the BC360. It is a double-base propellant motor with 360Ns. The (filled) casing is about DM 350 (may have changed by now) and a refill is around DM 70 plus S&H.
There is also a BC1800, but it is not yet BAM certified.
There are some more motors to come, but they are still in the process of design and/or BAM certification. Please check with the DERA or the RAMOG for more current information!

Last fall we (the DERA people) discovered, that the Estes D12-5 has its BAM-T2 classification, but only when it comes through a certain importer and with a prescribed German text on the motors and packages (this is part of the BAM certification and published in the explosives law word by word).
We then found out that this importer is out of busines :-((
After some negotiations we found a pyrotechnician who is willing (kind of ;-)) to take over the importing part. Then we contacted Estes for the customized (German) motors. Status: Our batch of motors will be manufactured sometimes in August'96. It will then take some time to cure/pack and get them to Germany and through the customs. By then we should be able to calculate the price. Please contact the DERA for availability.

If you wish to get a motor approved by the BAM be warned: It is possible but costly both in time and expenses.
First you must have a complete list of chemical ingredients of the pyrotechnic compounds. Try to get that from a foreign manufacturer!
(The author (and others) once tried that with Aerotech - without success.)
Then the BAM needs several sample devices in order to test the stability sensitivity of the pyrotechnic materials, and the consistency of the

device's performance. Third they need proof (not an affirmation) of the quality control system of the manufaturer, and that QC is done on a regular basis by trained staff. If you can't get this, some of the BAM people want to inspect the manufacturers site(s). They must be sure (by law) that all subsequently manufactured devices are of the same quality as the ones submitted for the tests. And remember: YOU will be charged for all expenses they have. If you got through all that, be aware that the BAM will occasionally request more samples for further testing to determine if the motors continue to meet approval criteria.

The whole procedure is no big deal for a manufacturer who sees a market, but it's hard to do for private people.

13.6.4 Clustering and Staging

As mentioned above: Clustering and staging of motors requires a T2 license in Germany. Even if you cluster/stage 'only' T1 motors!
And don't forget to get the required waiver according to paragraph 16 LuftVO.

13.6.5 Can I make my own rocket motors?

Making your own rocket motors is not recommended.
It's completely illegal without the appropriate permissions and licenses.

First of all, you need a pyrotechnics manufacturing license ("Hersteller-Schein"). After you got this, you need a site and more licenses from several offices (Arbeitssicherheit, Bauamt, Umweltschutz etc.) before you can start to plan the several separate buildings needed for storage of the components, different procedures (grinding, mixing, filling, pressing etc.), and storage of the finished products.
And don't forget about the (in this case very costly) insurance.

All in all, manufacturing your own rocket motors is nothing you would want to burden yourself with. Even if you got your manufacturer's license, you are still not allowed to USE the products you made unless they have got their BAM approval for class I, II or T1/T2!!

Bureaucracy rules!

13.6.6 Can I use rocket motors made for display fireworks?

Rocket motors used in big display fireworks usually belong to class IV fireworks (as everything that is not BAM-approved, such as foreign motors) and are limited to people with the appropriate license. Even worse:
if you stuff such a motor in a model rocket, it is automatically considered display fireworks and requires a (costly) announcement to the appropriate officials like any other display firework.

13.6.7 Importing Rockets, Parts and Motors

There is no real problem with importing rocketry stuff from foreign countries as long as no pyrotechnics are involved. What you have to keep in mind is that every shipment from abroad will have to pass the customs clearance where you'll be charged the 15% 'Einfuhrumsatzsteuer' and the customs (5-8%) which vary on the type of goods you're importing. The author found out that there is a 'Zoll-Warengruppen-Nummer' 8802 6000 000 for 'suborbitale Raumfahrzeuge und deren Teile' (suborbital spacecraft) which model and high power rockets undoubtedly are ;-)) (The author likes the looks at the office he always gets when the people there look up the number in their books.)
This way you get off with only 5.1% customs (which btw. will be computed on the whole sum of the bill, including shipping and handling costs!). To ease the procedure, have the sender glue a copy of the bill to the outside of the box in an envelope marked with 'Rechnung'. Have him write the 'Warengruppen-Nummer' on the bill too.
Even after adding up S&H and the 20.1% to pay, there are some occasions when you can get Estes and other stuff cheaper from the USA than you'd ever get it in Germany. Not to speak of all the HPR stuff which is very unlikely to show up in a German store at all.

*** BEWARE OF IMPORTING FOREIGN MOTORS!!! ***

Every box from abroad will be opened as it passes the German border. You might be asked to show your license at the customs office when you try to pick up your goods. If you don't have a license, then you're in trouble!
Non-BAM-approved pyrotechnics are ALWAYS considered class IV fireworks. The goods will be destroyed and you will be charged with both the cost of destruction and a fine. Offenses against the explosives law are considered criminal offenses, and there is even a chance to go to jail for it!
Foreign dealers will not know about that and send you whatever you order. BUT IT'S YOU WHO HAS TO BEAR THE CONSEQUENCES!

13.6.8 Where can I launch my Rockets?

There are several rules which have to be obeyed:

First, you must be at least 8 km away (as the crow flies, Luftlinie) from any airport.

Second, you must have permission from the landowner to launch. (not where your rocket is going to land but it helps to take that into account too).
It helps to launch from public ground like publically accessible field paths, because there you only have to ask the next available representative of the public, who is usually yourself. ;-)
The 1m zone on either side of small streets connecting small villages is usually considered a public area. If there is no traffic and enough room to park your car, then you can set up your launch equipment there too. But take care not to irritate occasional bypassers!

Third, you have to stay underneath the surveyed airspace with your T1 powered rockets. Usually it begins at 300m AGL but that varies from place to place. In Germany there are many "Tiefflüggebiete" (low flying areas) used by the military who don't like "missiles" crossing their flight path! Check with your local "Flugsicherungsdienst" (the German FAA) if in doubt. A good idea is to buy a 'Luftkarten' of the area in question and check for restrictions.
If you chose to fly T2 powered birds, you ALWAYS need a "Luftraumfreigabe" (waiver), no matter how high your rocket is going to fly!

13.6.9 Where can I launch rockets with bigger motors?

If you really want to legally get into high power or experimental rocketry, you first will have to get a license to buy, store, and transport class IV fireworks. There is no way around this since everything without any kind of BAM approval (like foreign motors) will be considered to be class IV fireworks.

Once you are licensed, you must contact a military base, where they may have some kind of shooting range, and ask the authorities for permission to occasionally using their range for 'test flights.' Usually, this will be impossible because of 'duds' (Blindgaenger) laying around there.

If you do get the permission, then you can apply for a waiver (Luftraumfreigabe) for the dates when you are allowed to fly. Most shooting ranges will already have a restricted airspace (gesperrter Luftraum) which only has to be activated for the time of your launches.

If you have made it this far, the you are one of the luckiest rocketeers in Germany, because the 'normal' explosives law isn't valid on military properties. But you still need to take precautions that your rocket will not leave the range. If it does, then there could be trouble again. And don't forget: posession and transport of non-BAM-approved motors is restricted to licensed people!

If you are living near Berlin (or are willing to travel for your launches), you can contact the DERA, since we are already in the process of getting a launch range on a military base. Negotiations look good so far (09/96) although there will be a fee.

13.6.10 What Insurance do I need?

For T1 powered rockets, you shouldn't need a special liability insurance. But some insurances explicitely exclude rocketry in the fine print of their contracts. To be sure check this before your first launch! Ask for inclusion or change the company if necessary!

T2 powered rockets are considered 'normal aircrafts' and the appropriate regulations of the 'Luftrecht' rule: Aircraft up to ..kg weight

(ready-to-launch) must have a liability assurance good for DM 2,500,000 per accident. All aircrafts are insured via the "Deutscher Luftpool." Ask the insurance company about this kind of insurance.

Probably the best alternative is to join a club where the insurance is included in the dues.

13.6.11 Addresses of Rocketry-related Clubs

DERA e.V.
(Deutsche Experimental-Raketen Arbeitsgruppe)
c/o Dr. Hans-Peter Boehme
Saarstr. 19
12161 Berlin
030 / 859 997-58
or:
DERA e.V.
c/o Stefan Wimmer
Wiesener Str. 23
12101 Berlin
Tel/Fax: 030 / 789 12 97

RAMOG (Raketen Modellsport Gruppe)
c/o Herbert Gruendler
Edenbergen
Talblick 7
86368 Gersthofen
08230 / 1451

Dara Raketen Modell Sport Gruppe
V. Schoenfelder
Koenigswinterer St. 522-524
53227 Bonn-Oberkassel
0228 / 45 51 02

Deutscher Aero-Club e.V.
Postfach 1361
63131 Heusenstamm

Modellflug Club 1990
Thierfeld-Hartenstein e.V.
Sparte Raketenflug
Siegfried Goerner
Jablonecer Str. 8
08062 Zwickau
037578 / 6021

Raketen-Hobby-Gruppe
Vaihingen-Enz
Karl-Heinz Gulich
Steinhaldenweg 5
71663 Vaihingen-Enz
07042 / 92125

Munich Model Rocket Association (MMV)
Postfach 20 07 38
D-80007
Muenchen, Germany
email: mmv@gmx.net
www: http://mmv.home.pages.de

Raketen-Modellsportclub Juri Gagarin
Berlin e.V.
Gottfried Tittmann
Platz der Vereinten Nationen 8
10249 Berlin
030 / 426 04 34

RMV 82 e.V.
Duerenhofstr. 35
90478 Nuernberg
0911 / 46 30 37

Raketen Sport Club Dietfurt
Christian Freihart

Raketen-Sport-Club Muenchen
Bernhard Irler

Im Kellergarten 1
92345 Dietfurt
08464 / 1428

Sankt-Anna-Str. 19
8.... Muenchen
089 / 22 66 01

Wasa R.V.
Peter Wolf
Peter-Bernhard-Str. 14
83329 St. Leonhard
08681 / 895

Raketen Sport Freunde
Manfred Fronhoefer
Kelheimer Str. 3a
92339 Beilngries
08461 / 1336

Check out Oliver Missbach's website:
http://www.missbach.com/euroc.htm

Rec.Models.Rockets FAQ
(Frequently Asked Questions)

Part 14: Amateur Rocketry

Posted: September 25, 1997

Last modified: September 25, 1997

14.1 DISCLAIMER:

The following information does not constitute an endorsement of amateur rocketry in any way, shape, or form by the editor(s) of this FAQ, or the general readership of rec.models.rockets.
Due to the number of requests for information on this form of rocketry, the following information is provided.
Pursue at your own risk.

14.2 How do I make my own rocket motors?

NOTICE:

Many among the readership have an interest in the subject, and discussion threads about amateur rocketry activities always appear.
Even though the name of the newsgroup, rec.models.rockets, suggests that the newsgroup is for model rockets only, this is not entirely true. High power rocketry is a favorite topic among r.m.r. denizens. And similarly, amateur rocketry is also discussed, albeit in a limited way.
However, questions like:

"What should I mix together so that I can make my own rocket motors?"

are **STRONGLY DISCOURAGED**. Discussion about rocket motor design and fabrication is beyond the scope of rec.models.rockets. Most of the participants of rec.models.rockets buy commercially available model and high power rocket motors for use in their rockets. Few have the expertise to instruct you on the intricacies of rocket motor design and construction, and most likely will not instruct you on rec.models.rockets.
Rocket motor construction is a non-trivial task. It is a task that goes

much beyond merely having a propellant formula with which to use.
You need to know much more than you might initially suspect, and even
then you might make a mistake and get seriously injured or even killed.
Even knowledgable professionals have been known to have accidents.
If you are having difficulty obtaining commercially manufactured rocket
motors, and think that you can simply make your own, please think about it
more, and please give these warnings some serious consideration. Inquire
as to the availability of commercially manufactured motors. Check out the
list of manufacturers in Part 2 of the FAQ.

From (billw@puli.cisco.com)

"I suppose that an article on cheap model rocketry would not be complete without at least some comment on the sorts of advertisements that read "build your own rocket engines for only pennies apiece." While I personally am not the sort of person who would categorically condemn those people interested in making their own rocket motors, I do feel that model rocket motors are one of the places where you do get your money's worth. While it may be possible to build your own motors using only a few cents worth of chemicals, there is a lot left unsaid. Some of these unvoiced gotchas include:

1) In order to get to the pennies each price range, you have to buy your chemicals in large amounts, so your out-of-pocket expenses are high.
2) You have to make or buy various special tools for making the motors.
3) You'll need assorted amounts of safety equipment and test fixtures, beyond the actual construction tools.
4) You'll need a relatively large land area for your testing.
5) You'll probably be engaging in what the local police will consider illegal activities, both in making your motors, and in using them. It doesn't take much of a lawyer's time to cancel out your savings!
6) The finished "cheap" motors are unlikely to have delay or ejection charges, and will vary a great deal from motor to motor in performance.

"I'm also interested in amateur pyrotechnics, and recently bought a copy of "The Best of American Fireworks News, Volume 2." There are a couple of excerpts in there that are particularly telling. One article mentions using commercial A8-3 rocket engines as a "quick and easy way" to make skyrockets. This is followed up by another comment that includes:

> "I have made rocket engines from scratch for years, but
> have just recently discovered that the time savings,
> reliability, and better performance of commercial engines
> make them a viable alternative."

"These are discouraging remarks for the would-be motor maker, but the most important reason NOT to make your own motors is implied in item (5) above - "Model Rocketry" enjoys certain legal exemptions because it has shown itself to be an exceptionally safe hobby over the years. If you make your own motors, you are no longer protected under those exemptions - you are no longer participating in "Model Rocketry". If you happen to have or cause a major accident, the press won't be clued in to this distinction, so aside from the people who actually got hurt, the reputation of the hobby will be damaged, and we'll be another step closer to having model rocketry outlawed."

Have you read Part 1 of the FAQ yet? Here are a few repeat items to consider:

From Buzz McDermott (buzzman@netcom.com)

"Finally, the editor of this document wishes to get on his soapbox for just one moment and add the term 'stupid rocketry' to cover all those who attempt to casually produce their own rocket fuel and/or motors without the benefit of very serious study, and implementation, of the processes involved and safety measures required. Especially note that this comment is NOT aimed at serious amateur rocketry organizations, college level research, etc. End of soapbox."

In summary:

The bottom line is that rec.models.rockets is primarily a newsgroup for discussing *consumer* rocketry (which covers model rocketry and high power rocketry). Some amateur issues are discussed, but these are not the primary focus of the group. Manufacturing your own rocket motors can be a very dangerous thing to do, unless done properly, and with extreme care. The odds are you will not make motors that are of any higher quality, total impulse, reliability, or cost less than pre-manufactured consumer rocket motors.

It is the opinion of the editor(s) of this FAQ that you should NOT try to manufacture your own motors. If, however, you insist on partaking in amateur rocketry, then the editor(s) of this FAQ urge you to get in contact with an established amateur rocketry group for guidance and assistance.

14.3 My primary interest is in amateur rocketry. Where can I find information about amateur rocketry?

Aside from going to college and earning an aerospace engineering degree, there are organizations dedicated to the serious pursuit of research and development in the field of amateur rocketry. The editor suggests contacting one of the organizations listed below. These suggestions are not endorsements, and the author of Part 14 of the FAQ is personally unfamiliar with these organizations.

Mojave Rocket and Technical Society
WWW: http://www.mrts.com

Pacific Rocket Society
1825 North Oxnard Blvd., Suite 24
Oxnard, CA 93030
email: cyberplex@aol.com
WWW: http://www.asesur.com/prs

Well-established amateur rocketry association. Established in 1946.

Reaction Research Society
P.O. Box 90306
World Way Postal Center
Los Angeles, CA 90009

Well-established amateur rocketry association.

WWW: http://www.rrs.org

14.4 Amateur rocketry on the Internet

REC.MODELS.ROCKETS

In case you haven't read any other part of the FAQ yet, amateur rocketry on the Internet IS NOT rec.models.rockets. Read Parts 1 and 14 of this FAQ.

REC.PYROTECHNICS

Questions related to rocket motor propellant formulation, rocket motor construction, etc. should be posted on rec.pyrotechnics. Discussion threads about these subjects always appear there.

AMROCNET MAILING LIST

The AmRocNet mailing list is for the discussion of all aspects of "amateur rocket and motor construction". This includes discussions relating to amateur rocket designs, making motors, safety, laws, events, experiences, news, reviews, commentary and other items which could be described as of general interest to amateur rocket people.
To join the AmRocNet mailing list send the following Email:

-----<begin sample Email to listproc>-----

To: <listproc@vnet.net>
Subject: .

subscribe amrocnet Your Real Name

-----<end sample Email to listproc>-----

WORLD WIDE WEB

From Tim Patterson (monoply@primenet.com):
I have recently created a new rocketry web page. It has info and links regarding High Power solids, amateur liquids and other interesting stuff. Check it out at: http://www.primenet.com/~monoply

How to Design, Build and Test Small Liquid-Fuel Rocket Engines
is a small (66 pages) booklet published by ROCKETLAB in 1967. As such, it is somewhat dated, but is nonetheless interesting. You can read it at:

http://www.im.lcs.mit.edu/rocket/

Tom Peregrin's Pyrotechnic Web page
Tom routinely contributes to rec.models.rockets whenever

pyrotechnic issues arise.
http://mercury.aichem.arizona.edu/~tip/pyro.html

Greg Gallacci's Pyrotechnic Journal
http://psychserve.psych.washington.edu/pyro.htm

Blue Sky
a website devoted to composite rocket motor making
http://www.tiac.net/users/bluesky/rockets/

Tom Dimok's Pyrotechnic Web Page
loads of links, information, and advice
http://tad1.cit.cornell.edu/Tom/Pyro/MyPyro.html

14.5 Manufacturers, suppliers, publishers, and consultants

The following addresses do not constitute an endorsement of amateur rocketry in any way, shape, or form by the editor(s) of this FAQ, or the general readership of rec.models.rockets. Due to the number of requests for information on this form of rocketry the following addresses are provided as potential sources for more information. Pursue at your own risk.

Aerocon
P.O. Box 432
Los Gatos, CA 95031
(408) 450-0704

Information on hybrid rockets parachutes, books, liquid motors, and more...
Catalog - $2.00

Commonwealth Displays, Inc.
12649 Dix
Southgate, MI 48195
(313) 282-1055
email: hdhg18a@aol.com
WWW: http://www.commonwealth.net/rockets/cdi.html

Chemicals for rocket engine production
Catalog: $3

CP Technologies
4010A South Poplar, Suite 23
Casper, WY 82601
(307) 265-8755
email: 71137.2336@compuserve.com
http://ourworld.compuserve.com/homepages/jwickman/homepage.htm

Data on making your own rocket motors
Catalog: free

Digatek
Suite 200
2723 West Butler Drive
Phoenix, AZ 85051
71231.1200@compuserve.com

black powder and composite propellant formulas and motor making information

Catalog - FREE

Firefox Enterprises

Pyrotechnic supplies, amateur

P.O. Box 5366
Pocatello, ID 83202
(208) 237-1976
http://bf.axxess.net/pages/firefox/

rocketry supplies.

Catalog $3.00

Gas Dynamics Lab
P.O. Box 465
Watkinsville, GA 30677
jelanier@bellsouth.net
http://personal.lig.bellsouth.net/~jelanier

publishes a book on rocket motor design

Journal of Pyrotechnics
1775 Blair Road
Whitewater, CO 81527
(970) 245-0692
71061.2066@compuserve.com

technical journal on pyrotechnics published twice yearly

Prodyne, Inc.
P.O. Box 10826
Ogden, UT 84412-2806

Solid rocket motor fuel grains, chemicals, processing equipment.
Catalog: $2.00

Propulsion Systems, Inc.
Amateur Rocketry Division
P.O.Box 130077
Edmond, OK 73013
(405) 478-5806

Books, software, chemicals, and hardware for composite propellant motor design and fabrication.
Catalog - $3.00

Rogers Aeroscience
P.O. Box 10065
Lancaster CA 93584-0065
(818) 349-4825
email: 70574.2257@compuserve.com

PC software for rocket flight prediction includes drag modeling thru the hypersonic regime;
* free info *

Rosenfield Consulting Services
1955 South Palm Street, Suite 15
Las Vegas, NV 89104
(702) 641-9478 (voice)
(702) 641-1883 (fax)
email: 73624.224@CompuServe.COM

Consulting service for fuel formulations, gov't approval processes, etc.

FREE brochure and price list

RPS
207 Lewis Drive
Richmond, KY 40475

Rocket motor kits, tooling, and info on making rocket motors
Catalog: $2.00

Skylighter, Inc.
PO Box 480-W
Round Hill, VA 20142-0480
(540) 554-4543
(540) 554-2849 (Fax)
Custservice@skylighter.com (Email)
http://www.skylighter.com

Pyrotechnic supplies
chemicals, books, equipment, supplies, etc.

Catalog - $3.00 (USA)
(see website)

Systems Solaire 4414 Notre Dame Chomeday, Laval, Quebec CANADA H7W-1T6	Plans for an amateur rocket motor which utilizes gasoline as the fuel source.
Teleflite Corporation 11620 Kitching Street Moreno Valley, CA 92387-9978 David G. Sleeter (sleete19@mail.idt.net)	Information and supplies for making your own rocket motors Catalog: $2.00
