The LUNAR Handbook

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Introduction

The LUNAR handbook has been prepared by the members of LUNAR (the Livermore Unit of the National Association of Rocketry) as a resource for all club members new and old. If you are new to the hobby of model rocketry, this handbook will answer many of your questions about what model rocketry is, how to obtain and build model rockets and how to fly them using the club launch facilities. Old hands at model rocketry can use this handbook as a handy source of club information, including contact information, launch procedures, engine certifications and high-power launch procedures.

The contents of the LUNAR Handbook is subject to change as new sections are added and old sections are revised. If you have the urge to write a section for this handbook, please let us know (see authors) and we will get it included.

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Welcome to LUNAR

LUNAR is Section #534 of the Livermore Unit of the National Association of Rocketry (NAR). Lunar is located in Livermore, California, about fifty miles southeast of San Francisco. Lunar is a nonprofit club organized for the purposes of youth education and community involvement, though it is much more than a youth group. Membership in LUNAR is open to rocketry hobbyists of all ages to further the sport and science of hobby rocketry within the NAR and Tripoli Safety Codes. These codes have allowed hundreds of millions of model rocket launches by hobbyists since the late 1950's without any serious injuries.

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LUNAR Contacts

The most current list of LUNAR's officers is maintained on the LUNAR website at:

http://www.lunar.org/contacts.shtml

If you have questions about model rockets or the LUNAR model rocket club, these are the phone numbers and e-mail addresses of the people you should contact. Another good source of information is the LUNAR'clips journal and the LUNAR mailing lists.

The LUNAR'clips journal is issued approximately 6 times a year in paper and electronic copy. All back issues of the 'clips are available on the LUNAR website at:

http://www.lunar.org/docs/LUNARclips/LUNARclips.shtml

The lunar mailing lists are available to get club information over the Internet and to engage in rocketry discussions. Signing up for the mailing lists is described on the LUNAR website at:

http://www.lunar.org/docs/lists/lists.shtml

While e-mail is the best way to correspond with the club members and officers, you can also leave a message on the answering machine at the LUNAR hotline.

You should call the LUNAR Hotline to verify the date of the next meeting or launch, especially if you will be driving a long distance. We try to stick to the published calendar, but other events at the launch site occasionally force us to reschedule. On launch days, the Hotline recording is always updated at 7:00 am to reflect the Go/No-go status of the launch. On days with questionable weather, it is especially important to call the Hotline to get the latest information.

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LUNAR Membership

We try to keep membership affordable to encourage participation, especially by families and kids. Despite the high value of the club's equipment and the expense of the NAR insurance coverage, the minimum adult dues are only $15/year.

The basic annual dues are:

Low-power flight cards (A through E motors)	$0.25
Mid-power flight cards (F and G motors)	$0.50
High-power flight cards (H and above motors)	$1.00

Nonmember daily walk on fee	$5.00
§Adult member dues (18 and over)	$15.00
§Senior member dues (15-17)	$9.00
§Junior member dues (12-14)	$6.00
§Youth member dues (11 and under)	$3.00

§Dues paid after May 1 are discounted 33%. Dues paid after September 1 are discounted 66%.

A special category of "Contributing Member" has been created to provide an incentive for enhanced financial support by those who can afford it.

Because applying for membership involves sending in dues (and in the case of junior/senior members, parental signature on the permission slip), the membership application is designed to be sent by regular mail.

Copies of the membership application are available from the Registration Manager at any LUNAR launch. In fact, you can fill it out and turn it in there, saving yourself a stamp. Electronic copies of the membership form are available in PDF format at the LUNAR web site.

http://www.lunar.org/membership.shtml

Membership cards are usually available at the subsequent launch following receipt of the application.

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LUNAR Meetings

The meetings are held at the LARPD Rec Center at 4266 Eighth St. near the center of Livermore. Consult the meeting directions to see how to get there.

Currently, LUNAR club meetings are held every other month on the Wednesday before the scheduled monthly launch. The meeting schedule is on the LUNAR website.

http://www.lunar.org/calendar.shtml#meetings

Most meetings consist of a brief business meeting followed by a presentation from a featured speaker or discussions of rocketry topics. The presentation is often given by club members and/or aerospace experts on some aspect of rocketry, ranging from simple building tips to advanced science and engineering principles.

Over the next year, we plan to hold a series of "Contest Build" meetings. At that meeting, building the type of rocket appropriate for the next month's contest will be demonstrated and flown at the weekend launch. This should give people interested in participating in the upcoming contest a month to build their rocket.

If you have a good idea or contact for a presentation, contact the club president or any of the other club officers to get it scheduled.

Election of club officers is performed at the first meeting of the calendar year (often in January or February).

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LUNAR Launches

LUNAR launches are held on the LARPD practice soccer field closest to the Livermore Rodeo grounds in Robertson Park (N 37° 40.10′, W 121° 45.36′). Directions to the launches are on the LUNAR website.

http://www.lunar.org/events.shtml#launch-directions

Our monthly launches are generally held on the third Saturday of the month, unless preempted by other civic events. Day launches are generally held from 8:30 a.m. to 12:30 p.m. Night launches are from 4:00-10:00 p.m. Competition launches often result in expanded hours of operation. Also, occasional special launches are scheduled.

In the winter, we fly at Snow Ranch, 30 miles east of Stockton on highway 4. There we have a level 2 field with a 15,000 foot ceiling. We currently allow up to L motors on that field.

The schedule of launches is on the LUNAR Website.

http://www.lunar.org/calendar.shtml#launches

History of LUNAR

Started by Bill Orvis

In the spring of 1992 Jack Toeppen and I (Bill Orvis) were teaching a GATE class at Arroyo Seco elementary school. The class was an after school enrichment class called *Flying Things*. During the course of this class, we flew everything from balloons to airplanes to, you guessed it, model rockets. When we taught the class, only one person in the whole city of Livermore had a permit to launch model rockets. The city fire marshal used to give a permit to whomever wanted one, but an incident where someone was launching rockets in the flight path of the Livermore airport ended that practice. Currently, the city requires a large liability insurance policy before it will issue a permit and at the time only Bob Wong working with the 4H club and LLNL had one.

Luckily, it was not difficult to convince Bob Wong to spend a Saturday morning with you so the kids could launch their rockets. We set-up in the gravel pit back of the old Livermore police station and started burning engines. A small audience gathered after a while as joggers and strollers out for a morning walk or run stopped by to watch. Of course, this pleased the students to no end as they started showing off their creations.

About half way through the launch, a gentleman strolled over from the police station and wanted to know what we were up to. As I explained who we were and what we were doing, he became more and more interested. It seems that he had done this in his childhood and wanted his kids to be able to do the same, but didn't realize that there was anywhere local that it was legal to launch. I had to break the news to him that it was only legal to launch when you could convince Bob Wong to take a day off of his from his busy schedule and oversee the launch. The gentleman was a police officer named Mark Weiss who eventually became the first president of LUNAR.

I had to get back to launch operations, as I had only one launch pad and a line of impatient kids that wanted to get in just one more flight. As I flew rockets, Mark, Jack and Bob started discussing what could be done to make it easier to fly rockets in the city, and what would spread the responsibility around so that Bob would not have to go to every launch.

The story gets picked up here by Jack Hagerty.

During the late '80s, Bill Orvis (our current equipment manager) was teaching GATE classes in town here and Mark Weiss (LUNAR #1 and our first president) was doing the same. Mark was also working through the Police Athletic League (PAL) and other outreach programs as part of his job with the police force (he was a Sergeant at the time). Shortly after (1991), I was just getting back into the hobby after an 18 year absence. I joined the NAR, and went to my first NARAM (Las Vegas, 1992). While there, I talked to NAR Secretary Chris Tavares about what it would take to start a NAR section in Livermore and he got me rolling. At the same time, Mark was thinking that there was enough interest in rocketry that Livermore could have an ongoing program rather than just special classes a couple of times a year. Mark's idea was to organize it under the Kiwanis umbrella (another one of his activities) to cover basic expenses and insurance.

Mark is a better organizer than I and as I was filling out NAR paperwork he was building a sawhorse launcher and controller box. He set up the first demo launch for September '92 and put announcements in the local newspapers and with fliers. My father-in-law saw one of the articles and told me about it. Naturally I was thrilled, and showed up with my Titan IIIB-Agena to impress the crowd. I impressed them, all right. It CATO'd in front of everyone!

We held our first business meeting to try and pull a club together in October, and another launch (just to keep things rolling) in November. We really didn't get things organized to start holding regular launches until the Spring of '93. We stumbled our way through the rest of the year building equipment and developing procedures. The equipment was all designed and built by Warren Massey (LUNAR #007), and it's still in use; although we updated the controller about five years ago. Since the middle of '93 we have held a launch every single month with the exception of weather cancellations and last September (2001).

Sponsors
Livermore Kiwanis club sponsorship of club from 1992-1997??
early sponsorship of Hobby Haven
early meetings at Hobby Haven indoor race track; moved to Hobby Haven retail store

Progression of launch sites
-- Gardella Greens 1992-199?
-- Robert Livermore Park 199?-present
-- Snow Ranch 2004 - present

Historical (histerical) list of club officers

What Are Model Rockets

The hobby of model rocketry got its start in the late 1950s at the beginning of the "space race". Many people, inspired by the fiery boosters carrying the first satellites into orbit tried to emulate that activity by making their own rockets. These amateur rockets tended to be made of steel pipes filled with explosive chemicals and were more likely to blow off a finger or hand than to fly. Anyone who has seen the movie *October Sky* has an idea of what amateur rocketry was like before the advent of model rocketry. If you have seen the movie, keep in mind, that is not model rocketry.

***October Sky* is not model rocketry!!!**

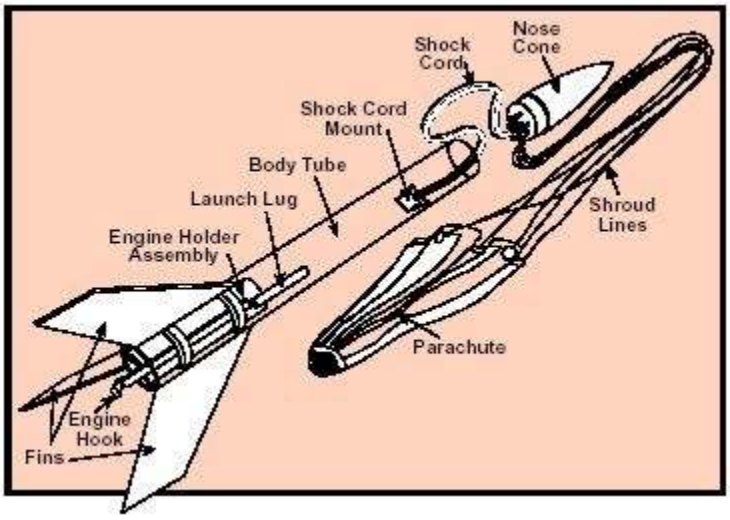
Model rocketry was started as an alternative to this amateur rocketry, to give the enthusiastic amateurs a rocket they could fly that was not likely to kill them in the process.

Model rockets are light weight, rocket powered vehicles, made of paper, balsa wood and thin plastic castings. They use professionally manufactured, single use engines made of paper tubes

with clay nozzles or plastic. These engines are less flammable than cans of model airplane fuel. A few newer, reusable engine casings are made of metal, but they are carefully constructed to blow out the end plugs instead of blowing off fingers.

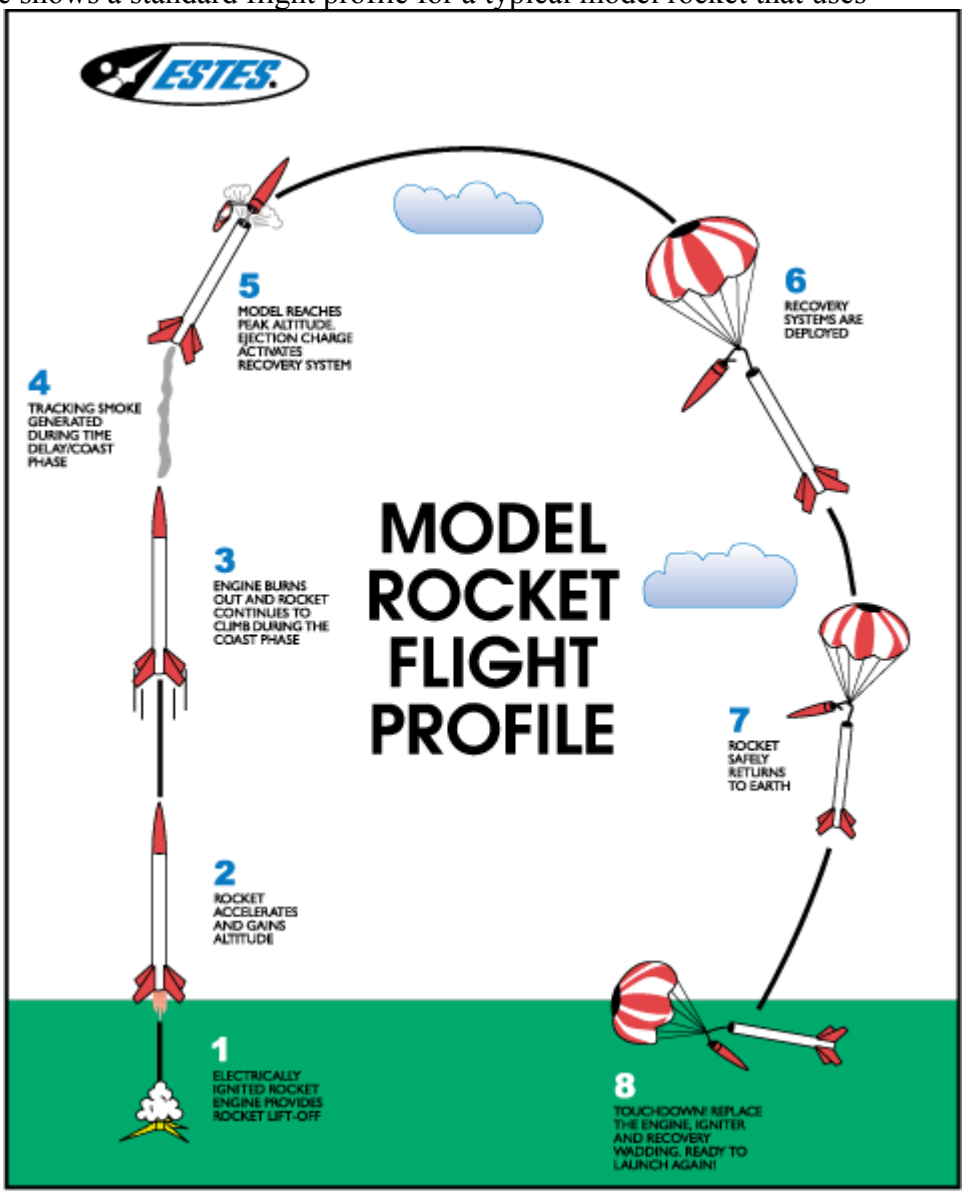
The Estes Alpha shown here is a good example of a first model rocket. It is 12 inches tall, 1 inch in diameter and weighs 0.8 oz without an engine.

Model rockets all have a recovery system that changes the configuration of the rocket when it reaches the peak of its trajectory. The configuration is changed so that as the rocket returns to earth it does not do so as a ballistic vehicle. The configuration is changed by either making the rocket unstable (popping off the nose cone) so that it tumbles, using a parachute or streamer to slow it down, or by changing it into a glider.



This shows the basic design of a simple Estes rocket (from the Estes Model Rocketry Technical Manual).

The following image shows a standard flight profile for a typical model rocket that uses parachute recovery.



Model rocketry is actually broken down into two ranges.

- Model Rocketry
- High-Power Model Rocketry

The separation of Model Rocketry and High-Power Model rocketry is based on total weight, the total combined impulse of all the engines, the average thrust of a single motor, and the use of large amounts of metal in the airframe. Exceeding any of the following limits makes a flight high-power.

- 1,500 grams (53 ounces) liftoff weight.

- A single motor with an impulse of 160 Newton-seconds (36 pound-seconds) (a low end H motor).
- A combination of motors with a combined impulse of 320 Newton-seconds (71.9 pound-seconds) (three G motors).
- A single motor with an average thrust of more than 80 Newtons (18 pounds).
- The airframe includes any parts of ductile metal. This does not apply to metal clips and screws.

See the section on Rocket Motors for a description of total impulse and engine sizes. Most model rockets weigh considerably less than the limits, and are more in the range of 100 to 300 grams (5 to 10 oz) using engines with 5 to 20 Newton seconds (1.12 to 4.48 pound-seconds) of total impulse.

How Safe are Model Rockets

Model rockets are relatively safe when compared to similar activities such as flying model airplanes. A box of model rocket engines is considerably less flammable than a similar sized can of model airplane fuel. While model rockets move fast, they do not move anywhere near as fast as the tip of the propeller of a model airplane. While the risk is not large it is possible to hurt yourself with a model rocket if you are not careful.

The greatest risk from model rockets is a high-speed, human-rocket collision. Even if a rocket weighs only a few ounces, it is going to do some damage if it hits you at 200 miles per hour. If you are traveling at 200 miles per hour and manage to hit a stationary model rocket, we will cart you off to the hospital, refund your membership dues, and ask you to not return. There is just so much we can do for you and we would prefer to not have you around breaking up our rockets. On the other hand, we will do our best to prevent a fast moving rocket from hitting you, but we do need your help. You must pay attention while a rocket is in the air and you must follow the NAR safety codes.

There are two situations where you are at risk of being hit by a high-speed, model rocket: during boost phase and during recovery. Human-rocket interactions during boost phase are very rare because any rocket failures are localized to the area of the pad and the rocket is directed in the upward direction using a launch wire. Both of these things tend to keep the rockets away from the spectators during the boost phase. This does not mean that there are no failures during the initial boost, only that they are relatively rare. The most common causes for initial boost failures involve underpowered rockets, partial engine failures and inopportune gusts of wind. All three of these causes can result in a rocket flying horizontally instead of vertically. To protect yourself from these flights, pay attention during launch and be prepared to duck and cover if a lawn shark heads in your direction.

The second situation where you might be hit by a high speed model rocket is where the rocket's recovery system has failed and the rocket is returning to the earth in a ballistic configuration.

This can happen if the engine ejects from the rocket instead of deploying a parachute or streamer, or if a second stage engine fails to ignite (or ignites late). A rocket returning from a high altitude in a ballistic configuration can reach very high speeds. If a slow second stage engine finally starts to burn after the rocket has started for the ground, it can get moving even faster. Again, the best protection is to pay attention during the launch so that a lawn dart does not drop in on you unannounced.

Fire from model rockets is generally not a problem as the fuel is completely burned in a few seconds, leaving only a slightly hot paper engine casing. On the other hand, if you ignite an engine while holding it in your hand it is definitely going to hurt. It is also not an allowed model rocket configuration as you most likely weigh more than the 53 ounce maximum. Explosions from model rockets are also not a problem as the paper engines are designed to blow out their end plugs before dangerous explosive pressures are reached.

If you use common sense, pay attention, and follow the NAR safety code you will be able to have many successful flights without sustaining any injuries. Safety is the hallmark of a good model rocket program and is scrupulously practiced by LUNAR.

What Are High-Power Model Rockets

The major differences between model rockets and high-power model rockets are total propulsion power in the engines and the total weight of the rocket. A high power model rocket is any rocket that,

- Weighs more than 1,500 grams (53 ounces) at lift-off including the engines
- Has a single rocket motor that produces more than 320 Newton-seconds (71.9 pound-seconds) of total impulse (A single H motor or larger)
- Has several motors that exceed 320 Newton-seconds (71.9 pound-seconds) of total impulse (3 G motors).

A high-power model rocket may use engines with up to 40,960 Newton-seconds (9,204 pound-seconds) of total impulse.

Like model rockets, high power rockets are typically made of paper and balsa wood, but more commonly are made of fiberglass, plastic, plywood, and carbon fiber composites. These stronger materials are needed to support the stresses induced by the larger, heavier rockets and engines.

High power rocket engines cannot be purchased over the counter, but must be purchased by adults certified by the National Association of Rocketry to receive high-power rocket engines. There are also more regulations concerning transport and storage of high-power rocket engines required by the state and federal government.

High power rockets must be flown in compliance with the High Power Rocket Safety Code.

Launching high power rockets requires more preparation than launching model rockets. Not only is a larger field needed, but FAA clearance must be arranged well in advance of the launch date. There are also state and federal regulatory issues to be addressed. LUNAR has members who are licensed to receive and store high-power rocket engines and to oversee launches involving them. One of these members must be in attendance before you can obtain engines and fly high-power rockets.

Certification-what it is and how to get certified.

Storage and transport of engines.

Other high power issues.

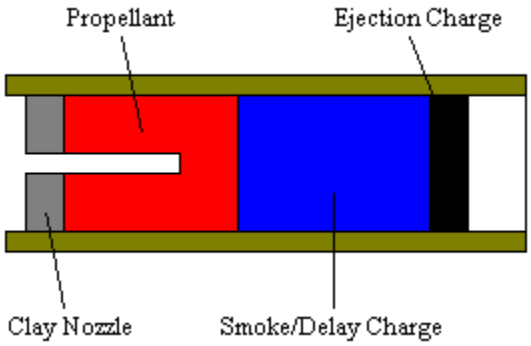
All About Rocket Engines

There are essentially two different types of commercial model rocket engines, black powder and composite. One new type of engine uses a combination of liquid nitro (racing car stuff) and cellulose as the rocket fuel. This combination engine is being designed to overcome the problems with shipping larger engines containing flamable fuel.

Black Powder Engines

The most commonly used small model rocket engines are the black powder engines such as the one shown below. These are the "traditional" model rocket engines that have been in production since the 50's.

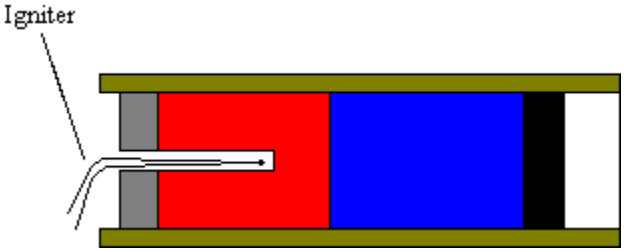
Black powder model rocket engines are made of a paper tube with a clay nozzle, a solid pellet of black powder propellant, a smoke/delay charge, and an ejection charge as shown in this figure.



Cut-away design of a model rocket engine.

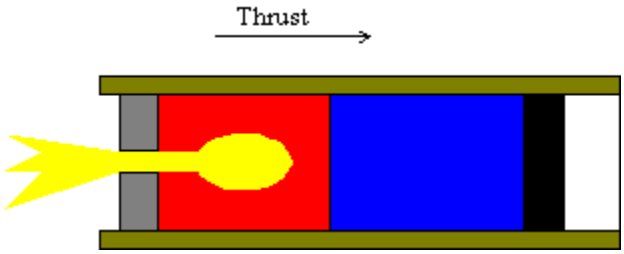
Booster engines are similar but lack the Smoke/Delay and ejection charge.

A model rocket engine is ignited by inserting an igniter in the clay nozzle putting it in contact with the propellant. At launch, an electric current is driven through the igniter, causing it so explode, igniting the propellant.



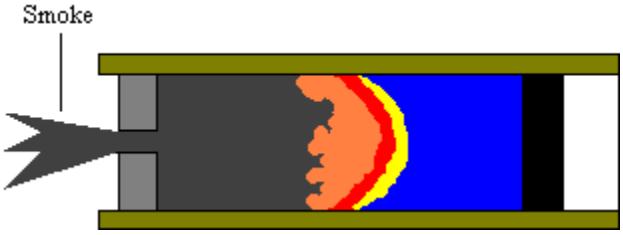
An engine with an igniter inserted in the engine nozzle.

When the engine is ignited, the propellant burns, ejecting high-pressure gas out of the nozzle and producing thrust in the opposite direction.



Thrust comes from burning the propellant.

When the propellant is completely consumed, the smoke/timer charge burns producing a smoke trail. The timer charge performs two tasks. First, it provides a smoke trail to help you follow the flight. Second, it lets the rocket coast to its maximum height before activating the ejection charge.



A smoke/delay charge burns after the propellant is consumed.

When the smoke/timer charge is exhausted, the ejection charge fires, which pressurizes the rocket body and deploys a parachute or other recovery device.


When the burn reaches the ejection charge, a small explosion deploys the recovery system.

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Composite Engines

Composite model rocket engines are made from a high temperature plastic and the fuel is a pellet of a rubber like material similar to that used in the Space Shuttle booster engines. The fuel in a composite engine is about three times as powerful as black powder so engines of equivalent power can be made in a smaller size.

A typical composite motor.

The internals of the composite engines are much the same as the black powder motors except that the nozzle and body of the engine is molded from a high-temperature plastic. The engine body contains the fuel, a smoke/timer charge, and the ejection charge.

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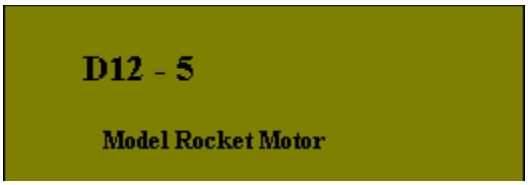
Understanding Model Rocket Motor Codes

Model rocket engines are marked with a three character code that specifies the approximate operating characteristics of the motor. The code consists of a letter and two numbers such as D12-5.



A D12-5 model rocket motor.

The letter is the total impulse, the first number is the average thrust in Newtons, and the second number is the time delay in seconds to the initiation of the recovery system. Hence, the motor in the figure is a class D total impulse engine with an average thrust of 12 Newtons and a time delay of 5 seconds.

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Total Impulse

The letter indicates the total impulse class of the engine, which is effectively the amount of fuel in the engine. The total impulse is the total momentum change that an engine can impart to a rocket. Total impulse is measured in Newton-seconds (pound-seconds). The standard impulse class for each letter is shown in the following table.

Class	Total Impulse Newton-sec
1/4A	0.000 - 0.625
1/2A	0.626 - 1.25
A	1.260 - 2.50
B	2.510 - 5.00
C	5.010 - 10.0
D	10.01 - 20.0
E	20.01 - 40.0
F	40.01 - 80.0
G	80.01 - 160.0
H	160.01 - 320.0

Most commercial model rocket engines are built to operate at the top impulse level of their class, but this is not a requirement. An engine may actually operate anywhere in its impulse class range.

Note: each engine class is double the impulse of the class below it, so as you increase the class of an engine, you effectively double the amount of fuel each contains and double the amount of momentum it can impart to a rocket.

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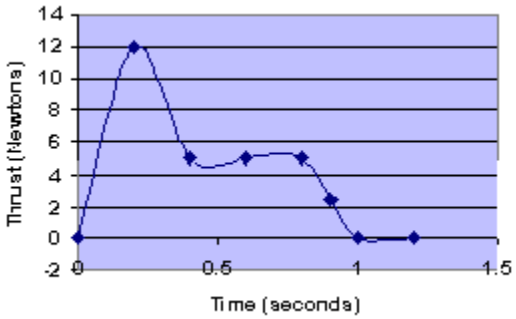
Average Thrust

The number following the letter indicates the average thrust of the engine in Newtons (pounds). Because the amount of fuel in an engine is fixed by the class letter, an engine with higher average thrust burns up its fuel more quickly than one with lower average thrust. As a rule of thumb, the duration of a burn is roughly equal to the total impulse divided by the average thrust. Here is a typical thrust profile for an engine with an average thrust of about 6 Newtons.



Typical engine thrust profile.

A typical engine starts with an initial high thrust for a fraction of a second, which is useful for getting things moving. It then settles down and burns the remainder of the propellant at a relatively constant rate.

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Time Delay

The last number on an engine is the time delay, in seconds, to activation of the recovery system. The propellant in a model rocket typically burns up in about 1 second. At that point, the rocket is still moving upward at a high rate of speed. If you were to activate the parachute at this point it would likely be shreaded. What you want to do is to let the rocket coast up to its highest point and then activate the parachute. The time delay charge is the mechanism for delaying activation of the recovery system until the rocket reaches its highest point. The time delay charge also emits

smoke to make the rocket easier to track. When the smoke charge burns out, it ignites an ejection charge that activates the recovery system.

Note: Some larger models use altimeters to sense when a rocket is at its highest point and electrically fire the ejection charge. The Engine's ejection charge also fires a little bit later as a backup to the altimeter.

Time delays are typically 3 to 8 seconds, with short time delays needed for larger heavier rockets and longer delays needed for lighter ones. Do not use too long of a time delay as it may allow your rocket to impact the ground before activating the recovery system. Such impacts endanger the spectators and are really hard on your rockets.

Rocket motors marked with a time delay of 0 seconds are booster engines. A booster engine is used in the lower stages of a multi-stage rocket and has no time delay and no ejection charge. When the fuel finishes burning there is a flash of flame out the back of the engine that is used to light the next engine in a multi-staged rocket. Only the top stage in a multi-staged rocket needs an engine with a time delay and an ejection charge.

Rocket motors marked with a P instead of a number for the delay charge are "plugged" engines. A plugged engine is similar to a booster but the forward end is plugged so no fire comes out the front when the fuel finishes burning. These are used in some gliders and in situations where you do not want a blast out the front.

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Engine Sizes

Model rocket engines come in several standard sizes so that whenever possible, engines of different total impulse and from different manufacturers may be used in the same rocket. The more common engine sizes are in gray.

Size	Available Impulse Classes	Diameter mm (in)	Length mm (in)
10.5 x 38	1/4A, 1/2A	10.5 (0.41)	38 (1.50)
10.5 x 47	A	10.5 (0.41)	47 (1.85)
10.5 x 89	B	10.5 (0.41)	89 (3.50)
13 x 45 (T mini engines)	1/2A, A	13 (0.5)	45 (1.75)

13 x 50	B	13 (0.5)	50 (1.97)
18 x 50	C	18 (0.69)	50 (1.97)
18 x 70 Standard	A, B, C, D, E	18 (0.69)	70 (2.75)
18 x 77	D	18 (0.69)	77 (3.03)
21 x 95	D, E	21 (0.83)	95 (3.74)
24 x 101	F	24 (0.94)	101 (3.98)
24 x 124	F	24 (0.94)	124 (4.88)
24 x 144	G	24 (0.94)	144 (5.67)
24 x 177	G	24 (0.94)	177 (6.97)
24 x 70	D, E, F	24 (0.94)	70 (2.75)
24 x 89	E	24 (0.94)	89 (3.50)
27 x 114	E	27 (1.06)	114 (4.49)
27 x 152	F	27 (1.06)	152 (5.98)
29 x 124	E, F, G	29 (1.14)	124 (4.88)
29 x 152	F	29 (1.14)	152 (5.98)
29 x 206	G	29 (1.14)	206 (8.11)
29 x 238	H	29 (1.14)	238 (9.37)
29 x 291	H	29 (1.14)	291 (11.46)
29 x 85	F	29 (1.14)	85 (3.35)
29 x 95	F	29 (1.14)	95 (3.74)
29 x 98	F	29 (1.14)	98 (3.86)
32 x 107	F, G	32 (1.26)	107 (4.21)
38 x 250	I	38 (1.50)	250 (9.84)

38 x 258	I	38 (1.50)	258 (10.16)
38 x 314	I	38 (1.50)	314 (12.36)
38 x 370	I	38 (1.50)	370 (14.56)
54 x 250	I	54 (2.13)	250 (9.84)
54 x 326	J	54 (2.13)	326 (12.83)
54 x 403	K	54 (2.13)	403 (15.87)

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NAR Certified Engines

In California, only engines certified by the National Association of Rocketry (NAR) can be flown. They must also be certified by the State of California but NAR certification is needed first. The current list of certified engines is available on the NAR website.

List of NAR certified engines

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Reloadable Engines

Aerotech and Kodson, in an attempt to reduce the cost of a launch have instituted a line of reloadable rocket motors. The motors consist of an aluminum body and end caps. A reload kit obtained from the manufacturer contains a thin cardboard liner, propellant pellets, delay pellet, ejection charge, nozzle and seals. By assembling all these parts, you create a new engine at slightly less cost than a single shot engine. Reloadable engines are not for beginners, but experienced rocketers may find the reduced cost advantageous.

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Installing An Engine

How you install a rocket engine in a rocket depends on the particular rocket. The simplest installation has a wrap of tape placed around the nozzle end of the engine and then the engine is forced into the engine mount. The tape provides a tight fit so the engine won't pop out when the ejection charge fires. A problem with this type of engine mount is that the engines can be difficult to remove after a flight. It is useful to have a three foot piece of hardwood dowel that can be slid down the rocket tube from the front to push the engine out the back.

Another simple installation, is to tape the engine in place. This installation only works if a sufficient amount of the engine mount is accessible so that you can tape to both it and the engine. This method does have the advantage that it is easier to remove an engine after a flight.

Many models have a metal clip that holds the engine in. The clip is pushed to the side, the engine is inserted into its mount and the clip snaps back when the engine is fully inserted. This type of mount also allows easy removal of an engine after a flight.

For some models you do not want the engine to stay with the model but you want it to be ejected when the ejection charge fires. Models of this type include those that employ tumble recovery and those that change to a glider.

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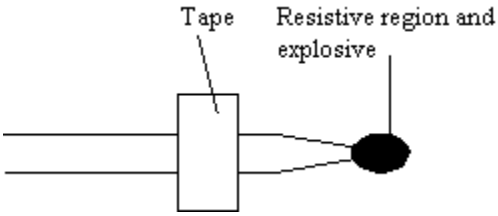
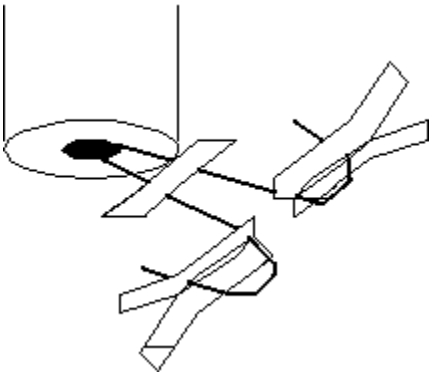
Using Igniters

The simplest igniter consists of a short wire with a high resistivity section in the center that is coated with some explosive. The igniter is inserted in the back of an engine and held in place with a plastic plug or with a small ball of recovery wadding held in with tape.

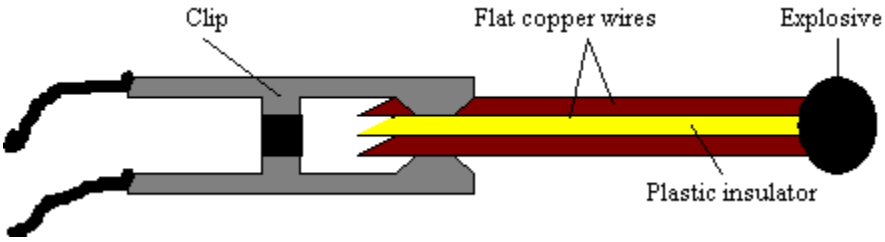


An Estes style igniter.

To launch the rocket, it is placed on the launch wire and the launch controller is attached to the igniter wires with two alligator clips. To fire the rocket, a current is pushed through the wire causing it to heat up and ignite the explosive. The explosive then ignites the engine. Note how the igniter wires are bent into an arc so that the alligator clips can get a better grip on it.


Attaching alligator clips to the igniter.

A different type of igniter is the copperhead. This igniter consists of a strip of plastic with copper on both sides. A small ball of conductive explosive is placed on one end. It is also inserted into an engine, but a special clip is used to attach it to the launch controller. The clip has two wires attached to the two sides of the clip. When the clip is placed on the end of the igniter, the two wires attach to the two copper films. The rocket is fired in the same way, with a current driven through the copper strips that ignites the explosive. We have had a lot of misfires using copperhead igniters. The problem is usually a short across the plastic strip caused by bending or twisting the igniter such that the two copper strips come into contact.



Copperhead igniter system

Igniterman style igniters are made by stripping the insulation off of a quarter inch of two wires and then twisting all but the end of the wires so that the stripped ends are close (about the thickness of a thick sheet of paper) but not touching. This end is then dipped in a flammable conductor that creates a thin film between the two wires. Running a current through the wires and the film causes the film to ignite. After the film dries, the igniter is dipped in a pyrogen mixture. This mixture causes a small explosion that ignites the rocket fuel.


An Igniterman style igniter.

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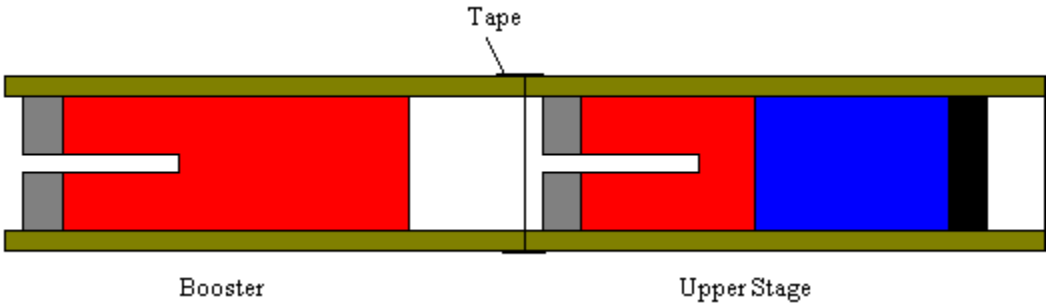
Two-Stage Rockets

In most two state rockets, a booster engine is taped to an upper stage engine. The booster engine has no smoke/delay charge or ejection charge so when the propellant is consumed, the burn blows out the back of the engine, which ignites the second engine and burns through the tape, separating the booster from the upper stage. Note that taping only works for black powder motors.



A booster engine taped to an upper stage engine for a two-stage rocket.

More complicated rockets and rockets that have a composite engine as the upper stage use a timer and an electrical igniter to fire the upper stage.

Building Model Rockets

Building model rockets weather from a kit or from scratch is not a difficult undertaking. Some of the newer kits come with all parts precut, and only have to be glued together to to fly. More traditional kits come as a bag of tubes, balsa sheets, a nosecone, and a parachute. We suggest that you start with a kit, such as one of the simpler Estes kits, to get the feel for what is involved when building rockets. After you are comfortable with building kits, you should consider designing your own.

Model rocket building is a good evening hobby as many of the steps are short but you have to let glue and paint dry before going on to the next step. Unlike plastic model airplanes and cars, a model rocket is not something that you completely build in a single sitting. If you try to work too fast, you will either end up with a mess or your rocket will not be strong and will disassemble itself at the first launch. For example, a paint job needs to dry overnight before applying the next coat. If you don't let it dry, the new coat may soften the previous coat and cause it to sag or run.

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Building Kits

Model rocket kits are probably the easiest way to get started in modelrocketry. While there are some kits that require no or little assembly before flight, you are really not in the hobby until you spend the time to build a rocket that starts as a bag of tubes, balsa sheets, and a nose cone. Part of the thrill of the hobby is spending a lot of time building that perfect rocket and then risking it all by launching it.

A simple kit consists of a paper tube, balsa, plastic, or paper fins, a nosecone, a parachute, a

shock cord, an engine block, and a launch lug.
A kit of parts.

Kits may differ in whether the balsa fins are precut or not or whether the fins are balsa, paper, or plastic. If you must cut out your own fins from a balsa sheet you will have a paper pattern to use to mark the balsa for your cuts. Pay attention to the direction of the grain of the balsa. Most fin patterns have the grain direction marked. The reason for this is that you do not want the grain of the balsa to be parallel to the body tube of the rocket. Balsa breaks easily along the grain but is very strong for breaks across the grain. Because of this, you want the side of the fin that is glued to the body tube to be endgrain so that the attachment to the body tube helps to strengthen the

balsa and prevent splits along the grain.
Fins should be cut so that the grain of the balsa extends away from the body tube.

Lay the pattern on the balsa and draw around it with a pencil or a ball point pen. Use a ruler if necessary to get the straight edges straight. Cut the fin with a hobby knife or scalpel. Use a metal edged ruler to help you cut straight lines.

Sand the fins to shape before you glue them to the body tube. First stack the fins and pin them together with a couple of straight pins. Sand the edges of the fins bundled together like this to get the shape of the fins identical. Remove the pins and separate the fins. Sand the fins to shape, either sharpening or rounding the edges, depending on the model.

Mark the fin locations on the body tube. Most kits come with a fin marking guide. If you do not have a marking guide, wrap a strip of paper around the body tube and mark where the end crosses. Divide the parer into multiple equal sections, depending on how many fins your model has. Put the body tube in the crack of a partially open drawer or in a door frame and extend the fin marks down the side of the rocket.

Lightly sand along the fin marks where the fin attaches to the body tube. This makes the glue adhere much stronger to the body tube. Apply white glue to the edge of the fin and align it along the fin alignment marks. Hold it in place until the fin can hold itself up. Do the same for the rest of the fins. When the glue has hardened run a fillet of glue down the intersection of the fin and the body tube. Smooth it with the tip of a finger. Let the glue dry before rotating the rocket and filleting another fin. If you don't let it dry it will run down the fin when you turn it over.

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Kit Manufacturers

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Local Kit Distributers

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Designing Your Own

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Making Ripstop Nylon Parachutes

by William J. Orvis, LUNAR# 309

After spending hours and hours building and painting your latest rocket, using an inexpensive, plastic parachute is like using paper towels in a fancy French restaurant. But then those nice nylon parachutes cost six or seven dollars, which is often more than you paid for the whole rocket including the paint and glue. In this article, I will show you how to make your own ripstop nylon parachutes for a lot less than seven dollars. Now it does take some time, but making a quality parachute is a creative way to occupy your time while the glue is drying on your model.

Materials

The first thing you need is access to a sewing machine (or someone you can sweet-talk into sewing it for you). You can sew a new parachute by hand, but a machine does a much better and faster job. It does not need to be a fancy machine, just a simple straight stitch is all the capability that is necessary.

The other materials consist of:

1. Light-weight ripstop nylon.
2. Shock cords.
3. Cotton-polyester string.
4. Paraffin (small chunk).

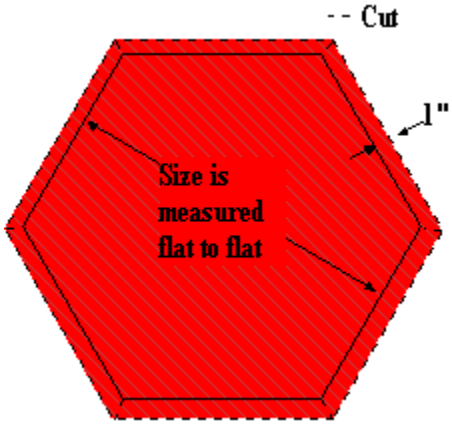
I bought the light-weight ripstop nylon at Dom's Surplus here in Livermore for a couple of dollars a yard. You can make one big (24") or a lot of small parachutes with a yard of ripstop nylon.

For shock cords, go to the sewing section of PayLess or any other drug or department store and get 1/16" round and 1/4" flat elastic. Use the 1/16" stuff on your smaller rockets and the 1/4" elastic on the larger ones. Larger sizes are available for really big rockets. I bought Singer "Knitted Polyester-Spandex" elastic, which costs only a dollar or so per package containing 72" of elastic.

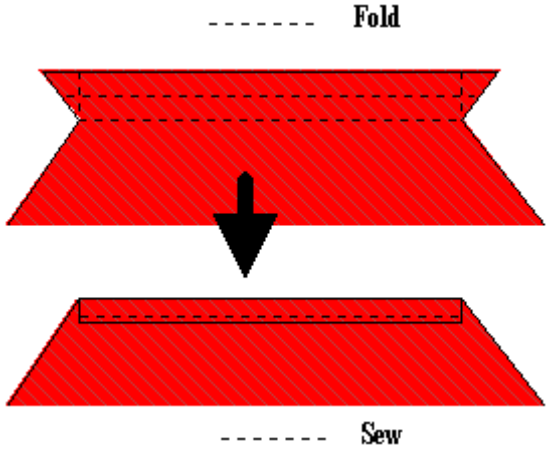
The cotton-polyester string is sold right next to the sewing supplies for a dollar or so per ball and the paraffin you should be able to find in your kitchen or garage. Any hard wax will do if you don't have paraffin (for example, ski wax) and you need only a small amount to wax the string.

Cutting and Sewing

When you have assembled all the parts, the next step is to mark and cut the nylon. First make a hexagonal pattern the size of the parachute you want to make. A 24" parachute would be 24 inches from flat to flat. Place the pattern on the nylon and mark all around the edge. Using a ruler, measure another inch out from the edges of the hexagon and draw another larger hexagon as shown in the figure. Cut out the nylon along this outer hexagon and cut in from the outer hexagon to the inner one at each of the corners.

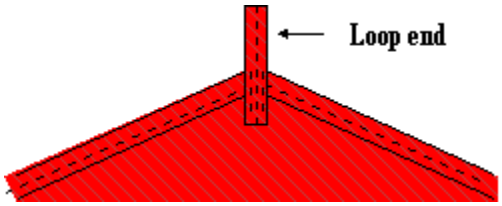


Start with one edge and fold in the small spike of nylon at each corner and fold in the edge of the outer hexagon until it touches the edge of the inner hexagon. Fold this piece over again and pin. Folding the corners in and the edge over twice hides all the cut edges. Sew down this folded over edge to hold it in place. Do the same for the other five edges.



Next, you need to make loops to attach the shroud lines. From the left over scraps, cut a strip of nylon about an inch wide and as long as the scrap piece. You need a total of about 18 inches of this scrap in 3 inch lengths for a 24 inch parachute. Less is needed for smaller parachutes. Leave it as one or more long pieces until after you sew it as it is easier to sew as one long piece than a bunch of short ones. Fold the one inch wide strip in half the long way, then fold it in half again, making a 1/4 inch wide strip. Pin it and sew down the center to hold it in place. Cut a 2 to 3 inch length of this strip and fold it in half the short way. Place the folded strip on one of the corners of the parachute with about half of its length (the loop end) hanging off the edge. Sew this strip down to the parachute with several passes of the sewing machine. Be sure to not sew the loop

closed. Do the same for the other corners. For smaller parachutes, use shorter pieces to make the loops.

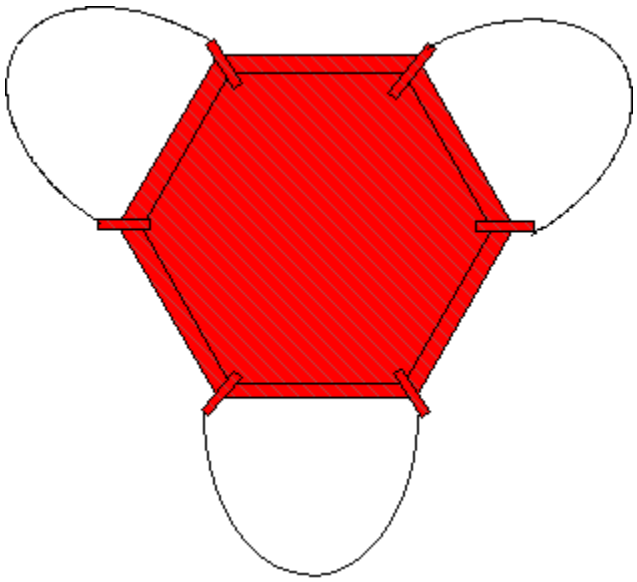


Shroud Lines

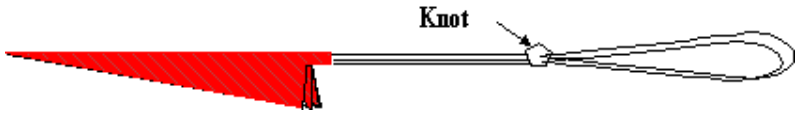
The next step is to make the shroud lines. The shroud lines should be as long as the parachute is wide. That is, a shroud line for a 24 inch parachute should be 24 inches long, measured from there it attaches to the parachute down to where it is gathered together with the other shroud lines.

First cut a length of string that is long enough to make all of the shroud lines. For a 24 inch parachute, this is (6 x 24 =) 144 inches of string. Pull the string across the block of paraffin, pushing it down into the block with your thumb. Do this three or four times to get the string well coated with paraffin. The paraffin stiffens the string a little and helps it stay tightly twisted and less likely to tangle.

Cut the string into three equal lengths, with each length equal to twice the length of a single shroud line. For a 24 inch parachute this would be a 48 inch length. Tie one end of the string to one loop on the parachute. Use a good, non slip knot like a square knot or a bowline. Pull on it to make sure it will not slip. Tie the other end to an adjacent loop on the parachute and test it. Tie the other two strings to the two other pairs of adjacent loops.



Put your finger through the three loops and pull down the center of the parachute. Adjust the strings until all the loops come together and the center of each string is looped over your finger. Pull all the strings together about 3 inches below your finger and tie them together with a single, overhand knot.



Attach It To The Rocket

This finishes the parachute. To use it, slip the looped ends of the shroud line through the loop on a nose cone and pull the parachute through the open loop in the string. Attach the shock cord and you are done. You now have a really nice parachute for less than a commercial one and with enough material left over to make several more.

Information date: March 31, 1998 wjo

LUNAR Low-power Field Procedures

LUNAR provides all the ground equipment for a launch. You need to bring all your own consumables (engines, ignitors, wadding, glue for repairs, food, drinks, sunblock, film, etc.), hobby tools and the rockets. There are drinking fountains and bathrooms at the field. When you first arrive, stake out your setup area. There are a few picnic tables around the park, but they are usually claimed early. You may need to bring your own work surface and chairs, or arrive early to claim part of a table. Otherwise, be prepared to work off the grass.

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Help Setup The Pads

LUNAR is not a service, it is a member participation organization. For that, you need to help out and setting up is probably the biggest job out there. The launch starts at 9:00 a.m. so try to arrive by about 8:00 a.m. to help set-up. If you arrive later and the pads are not yet set-up, walk on over and ask what you can do. Note that you get paid in flight cards for helping to setup.

More information on setting up, tearing down and helping out during the launch is in the Helping Out section.

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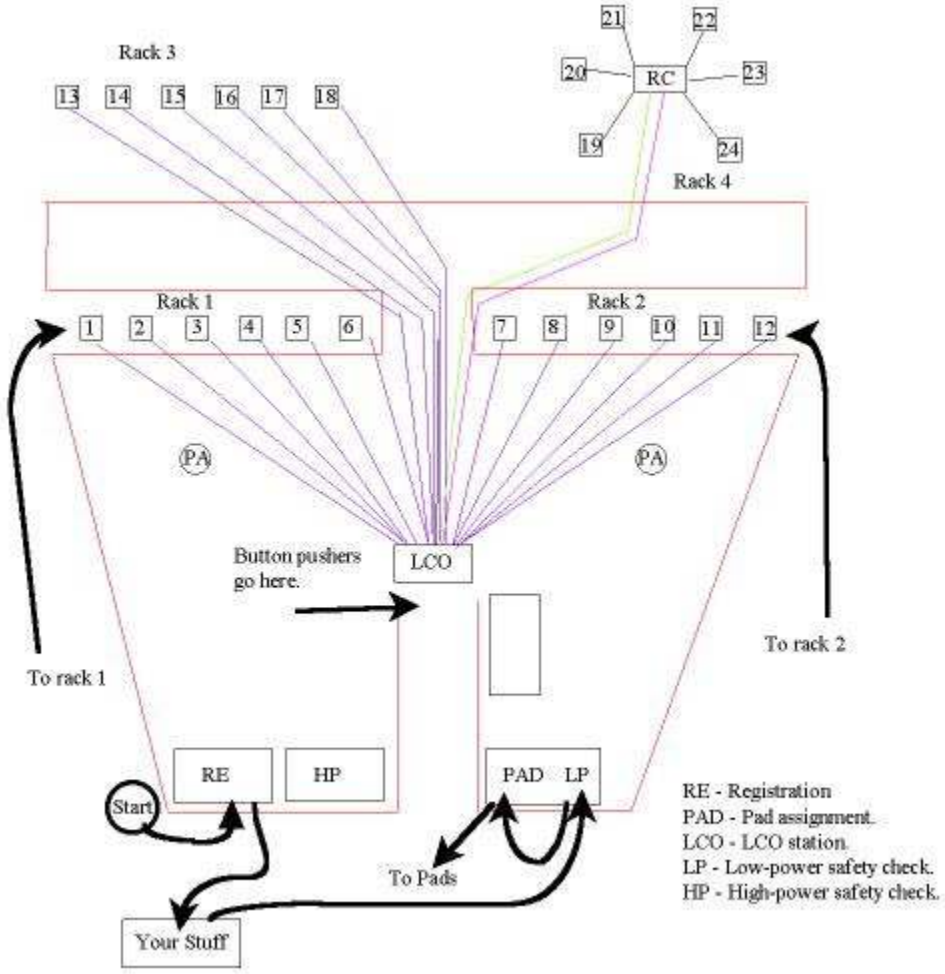
Launching With LUNAR



After things are set-up and you have staked out a spot, follow the arrows in this diagram to get registered, flight cards, safety check and launch.

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Register And Buy Flight Cards

As soon as you get settled, the fliers in your group need to sign up at the registration table. If you want to fly and are not a current member (our membership period follows the calendar year) you need to either join the club, renew your old membership, or pay a walk-on fee.

You will need a flight card for every flight you intend to make. If you need more flight cards, now is a good time to buy them. There are two kinds of flight cards depending on what kind of engines you are using. Regular flight cards are for model rockets (A through E engines) and high-power flight cards are for high-power rockets (F through H engines). The flight card fees go to refurbishing the existing launch pads and building new ones. The LUNAR fee schedule for launching and dues is as follows:

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Prepare Your Model Rocket

The next step is to prepare your rocket for flight. Have it completely ready to go, with the engine and igniter in place, and the recovery system prepped and ready. If you need help, Club members are almost always available to answer any questions you may have about how to do this properly and to lend a hand for emergency repairs or missing parts.

Install An Appropriate Engine

Most model rockets built from kits specify which engines are most appropriate for use in the model. The engines are specified both in terms of engine power and delay time. See the Engines section for more information. In general, use a small engine for the first flight to see how things hold together, you can use larger ones later. Use smaller engines if it is windy so that your rocket comes down somewhere close by. People who launch a two-stage rocket with the biggest engines they have on a windy morning tend to see their rocket floating out into the vineyards, never to be seen again (there's a lot of them out there somewhere.)

Choose an appropriate time delay. Most kits list time delays for each class of engine that allow the rocket to reach its highest point before activating the recovery system. If you use a longer delay, your rocket will arc over and be well on its way to the ground before activating the recovery system. While this might sound kind of cool, you will probably change your mind when the parachute opens at too high a speed and shreds, then the shock cord zippers open the whole side of your rocket, and finally it hits the ground and smashes anything that has not already been shredded or torn. You should add no more than about 2 seconds to the longest delay recommended for your rocket.

Insert the engine and secure it according to the instructions for your rocket. Some rockets have a retaining ring or clip while in others the engine must be must be taped in. Some rockets , such as the Estes Mosquito, are designed to eject the engine at apogee so their engine is installed just tight enough to keep it from falling out during launch but not so tight that it sticks when the ejection charge fires.

Prepare The Recovery System

The next step is to prepare the recovery system. For most smaller rockets, this involves placing two or three loose wads of recovery wadding in the body tube of the rocket. We have found that

three loose balls of wadding about the diameter of the body tube works best. The recovery wadding works like a plunger above the engine that pushes the parachute or streamer out the top of the rocket when the ejection charge fires. The recovery wadding also protects the plastic parachutes from being welded into a solid glob by the hot gases of the ejection charge.

Carefully fold the parachute or streamer. Grab the parachute at its top and at the knot where all the shroud lines come together. Stretch everything out straight and fold the parachute between where the shroud lines attach to make a triangular shape.

First stretch out the parachute and the shroud lines.

Fold the parachute into thirds, being careful to not tangle the shroud lines. Lightly wrap the shroud lines around the parachute to keep them from getting tangled.

Fold the parachute in thirds then lightly wrap the lines around it.

Place the parachute or streamer in the rocket's body tube along with the shock cord and install the nose cone.

Installing The Igniter

Install an igniter in your rocket. Estes type wire igniters are inserted into the bottom of the engine and held in place using a plastic plug. If you do not have a plug, take a small ball of recovery wadding and place it in the engine nozzle. Do not pack it into the nozzle, but just place it in the open end so that it holds the igniter in place. Place a strip of scotch tape over the end of the engine to hold the wadding in place.

After the igniter is in place, bend the two wires into rabbit ear shapes to make them easier to grab onto with the alligator clips on the launcher.

When installing Copperhead igniters, follow the manufacturers instructions. Copperhead igniters have to be installed all the way down to the bottom of the fuel grain. When you insert them, you usually have to feel around inside the nozzle to find the hole in the fuel pellet. Continue sliding the igniter down the hole to the bottom (usually a couple of inches). Use a plastic cap, rubber band or piece of tape to secure the igniter to the bottom of the engine so it cannot slip down and out.

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Fill Out The Flight Card

If you are flying F or larger engines please follow the high-power procedures. These following procedures are for low-power (A through E engines) flights.

You must fill out a flight card for each flight of each rocket. These cards tell the Low-Power Safety Check Officer (LP-SCO) what type of engine is in your rocket and what type of recovery method is employed. They also are used in pad assignments and to tell the Launch Control Officer (LCO) whose name to announce when it's time to fire a particular pad. It's a good idea to bring a pen or pencil to use in filling these out. After the flight, you do not get the flight card back to reuse; it becomes part of our archives.

Fill in the fields as follows.

- Rocket Name - This is the manufacturer's name for a rocket kit or whatever you have named it for a scratch built..
- Manufacturer - The name of the kit manufacturer.
- I want to push the button - Check here if you want to push the button otherwise the LCO will do it.
- Owner/Builder - Who owns/built the rocket.
- Motor(s) by stage - Put the letter-number code for the engines you are using in each stage of the rocket.
- Recovery Method - The method for safely recovering the rocket (parachute, streamer, tumble).
- Comments/Features - List any special features, such as first launch, has gliders and so forth, whatever special item the LCO and the spectators should watch out for. For rockets with known questionable flight profiles, mark here as a heads-up launch.

25¢ Launch Fee

Low Power

¼A - E Flight Card ≤ 40Nsec

Assigned Pad # _____

Rocket Name			I want to push the Button ❑
Manufacturer			
Owner/Builder			
Motor(s) by Stage	1st	2nd	3rd
Recovery Method			
Comment/Features			

Filling out a launch card.

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Get Your Model Rocket Inspected

After your rocket is prepped and your flight card is filled out, take both to the Low-power Safety Check table and have the rocket inspected for safety. Loose or excessively crooked fins or launch lugs, and improperly installed engines or recovery systems are a few of the things that will cause a rocket to be rejected for flight. We will also reject engines that are not NAR or Tripoli certified. If your rocket checks out O.K., the LP-SCO initials your launch card. If not, he shows you what the problem is and asks you to fix it. He may even help you fix the problem if he has time or may point out one of the other club members who can help you out.

Get a Pad Assignment

Next, get into the pad assignment line. When a pad is available, the Pad Assignment Director (PAD) will assign your rocket to a pad. If things are not busy, the LP-SCO may assign you to a pad as soon as he finishes the safety check.

We have four groups or racks of pads:

- Rack 1: pads 1-through-6, Low-Power
- Rack 2: pads 7-through-12 Low-Power
- Rack 3: pads 13 through 18 Low- or High-Power
- Rack 4: pads 19 through 24 High-Power

They are arranged so that we can be loading one rack while launching from another. When the Pad Assignment Director has assigned you to a pad, you must wait until the LCO declares the rack open and available for you to install your rocket on a pad. Do not go near any of the pads in a rack when the rack is closed.

We have found it useful to write the pad number you have just been assigned on the back of your hand. This makes it much more difficult to forget which pad you have been assigned to. It is also useful when you have a large group of children, all launching on different pads.

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Put Your Model Rocket On The Pad

When the pads open up for installing rockets, carry your rocket to its assigned pad and install it. We support many different size rockets and types of igniters, so it may be necessary to change the launch rod or igniter clips on a pad before the rocket can be installed. If the igniter clips have a spent igniter in them (from the previous flight from the pad) please put it in the trash receptacles provided next to the pads. The spent igniters are especially hazardous to the bare feet of other people who use this park. Try to keep the ground clean around the pads.

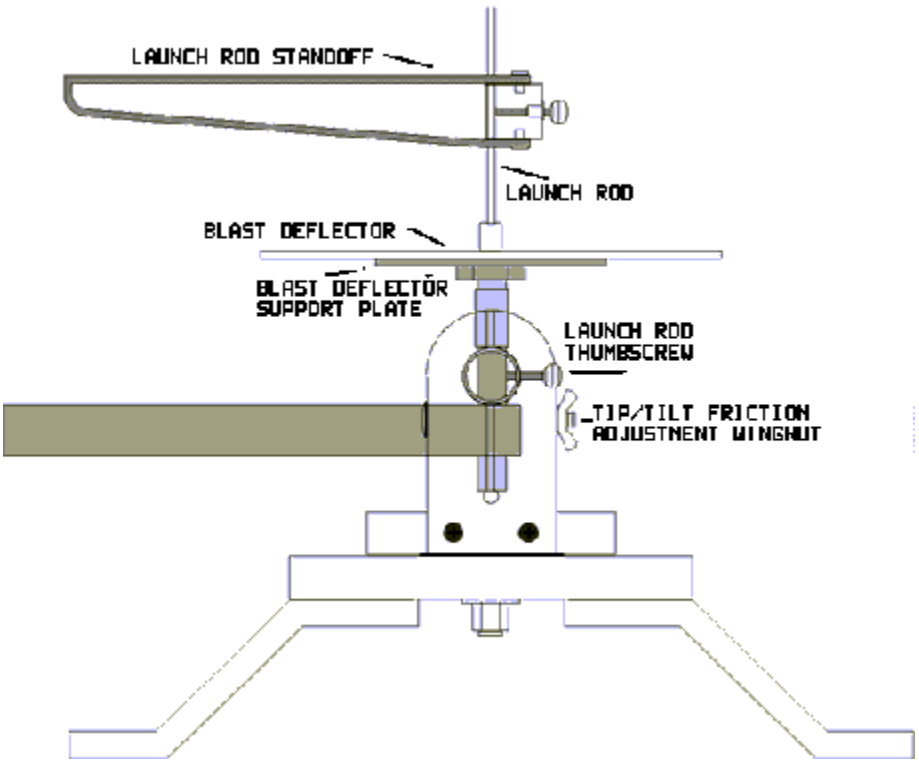
Emphasize eye safety around the ends of the launch rods!

Changing Launch Rods

The launch rod is held in the stand by a thumbscrew located under the blast deflector and opposite the handle used to tilt and rotate the stand. This thumbscrew must be loosened before the launch rod can be removed. Failure to do so may result in a bent launch rod. After the rod is replaced in the stand, the thumbscrew must be tightened again to hold the rod in place. Failure to do so may result in your rocket trying to carry the launch rod along on its flight (we have seen this happen). A gentle tug on the rod after the thumbscrew has been tightened will confirm if you have properly secured the rod. Remove the launch rod standoff from the the old rod (loosen its thumbscrew to do so) and place it on the new rod.

When changing the launch rods make sure the blast deflector is in place before installing the new rod.

Place the old launch rod in the tube provided for idle launch rods. Do not leave it lying on the ground, there it may either be lost or get stepped on and bent.



The launch stand with the blast deflector plate, launch rod and launch-rod standoff.

Please use the proper size of launch rod for the size of the launch lugs on your rocket. If the rod is too small for the lugs, then your rocket is not getting the initial guidance it requires and it may take off in an unpredictable direction. If the rod is too big for the lugs, then the rocket may bind on the rod and not fly at all. When installing the rocket on the launch rod never bend the rod down to meet the rocket. Instead, tip the pad head over (using the handle) until you can reach the end of the rod without bending the rod.

Using The Standoff

The launch rod standoff serves two purposes. The first is to hold your rocket up off the blast deflector where the igniter wires could short. The second is to prevent the suction generated when the rocket blast hits the blast deflector from holding your rocket down and preventing it from launching. Not only does this back blast prevent your rocket from launching, it does bad things to the bottom of your rocket. Attach the standoff to the launch rod about 4 inches above the blast deflector. It should be oriented such that none of its parts are directly in the path of the motor's exhaust and that no parts of the rocket (such as a motor clip) can hang up on it. Also be sure that the igniter clips don't touch it and short out.

Changing Igniter Clips

There are three different styles of igniter clips in use in the club, the common two-clip configuration most often used on single Estes igniters, a special three-clip configuration used with some clustered motors and the Aerotech clip used with Copperhead igniters. Select and use the type of clip that is appropriate for your igniter configuration. To change the igniter clips, simply unplug them from the end of the extension cord. Try to not use the special three-clip cluster configuration for other than two- or three- engine clusters.

Special three-clip configuration used with clustered motors.

There are several ways the common two-clip configuration may be used with the Aerotech Copperhead igniters if you prefer. If you don't know how to do this, ask at a launch or a club meeting and someone will be glad to show you. If you change out a set of igniter clips, remember to place the unused ones back in the milk crate by the idle launch rods. Do not leave unused clips lying on the ground next to the pad.

The alligator clips often look pretty dirty but in spite of the dirty appearance, they do a good job of supplying power to the igniter. Most ignition failures can be traced to other causes such as shorted clips or igniter wires, broken igniters or igniters not in contact with the propellant grain of the motor. If you still believe you need to clean the clips, do so gently using the fine wire brushes in the milk crate by the launch rods.

Cleaning the Aerotech clip requires a special technique. You must fold a sheet of 600-grit sandpaper in half (grit side out) and insert the folded sandpaper into the clip as you would a Copperhead igniter. With the clip closed on the sandpaper, draw the sheet out of the clip to the side. Doing this just once will clean the clip. Doing this more than once will unnecessarily wear the clip. Under no circumstances, while using, inspecting or cleaning the clip should you attempt to "spread open" the clip. To do so will cause the clip's hinge to break. These clips are made to only be squeezed and if you do otherwise, they are going to break.

You will usually find a spent igniter in the clips when you arrive at the pad to load your rocket. Remove the spent igniter and place it in the trash can located at the pad for this purpose. Also pick up any other trash you may find on the ground around the pad such as igniter plugs, wadding, motor caps, etc., and put that in the trash can too (igniter plugs and wadding can be reused). We need to keep the field clean to be allowed to continue to use it.

Attaching The Igniter Clips

When installing any of the clips on the motor igniters try to position the clips and wires out of the line of the motor's exhaust.

Setting Direction And Attitude

When your rocket is on the pad and ready to go, you can set the attitude and direction of the pad. If there is a little wind, angling the rocket into the wind a small amount will make the rocket land closer to the launch pad. To adjust the rocket's attitude on the small pads (pads 1 to 12) grab the metal pipe that extends horizontally out from under the blast deflector. Use this pipe to rotate the pad and to tilt it. Do not tilt any rocket more than 30 degrees from vertical. On the larger pads, loosen the large knob on the side of the Panavice and tilt or rotate the launch rod. Tighten the knob when you are done.

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Launch Your Model Rocket

When it is time for your rocket to be fired, your name and a description of your rocket are announced over the PA system. You may go to the launch controller to launch it yourself, or you may let the LCO do it for you. If there is a problem and your rocket won't launch, the LCO may let you make a quick check of your connections and igniter to see if you can get it off. If there are a lot of people in line to launch, you will be asked to remove your rocket from the pad so the next group can setup and launch. If you must remove your rocket from the pad, be sure to get your Flight Card back from the Pad Assignment Director. You may then fix the problem, get a new pad assignment, and try again. If you are having problems, ask any of the club members and they will be glad to help you.

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Recover Your Model Rocket

After your rocket flies and the recovery system activates, you may go recover your rocket. If your rocket lands in the cordoned-off safety zone, you must wait until the LCO gives permission to cross the yellow string barrier and retrieve it. When you are chasing your rocket as it drifts down (you shouldn't be chasing other people's rockets), please be careful about watching where

you are going, to avoid tripping or running into things. Be especially careful when crossing the street that runs through the park.

If you happen to find someone else's rocket while searching for your own bring it back to the Lost and Found box at the Registration Manager's table. Many lost rockets eventually make it to the Lost and Found so check there often if you are missing one. Never try to catch someone else's rocket before it hits the ground. The odds are that you will miss it and end up walking on the rocket which does a lot more damage than hitting the ground will. This is not speculation, we have seen it happen many times. If you have children with you, make sure they understand this rule.

While at the launch site, pay attention to the announcements made over the P.A. system, and if the LCO calls a "HEADS UP" or sounds the alarm you must stop what you're doing, identify the hazard, and do whatever is necessary to protect yourself and others from it. Not every recovery system works as planned.

LUNAR Mid-power Field Procedures

A mid-power model rocket, for the purposes of our field procedures, is any rocket with an F (>40N-Sec Cluster or Staged) or larger engine but less than an H (160N-Sec). For the most part, the mid-power procedures are similar to the low-power procedures so familiarize yourself with the low power procedures first. The mid-power procedures have the following differences from the low-power procedures.

- You use mid-power flight cards.
- The safety check is done by the High-power Safety Check Officer.
- The safety check is more rigorous.
- You use the mid-power pads (Rack 3).

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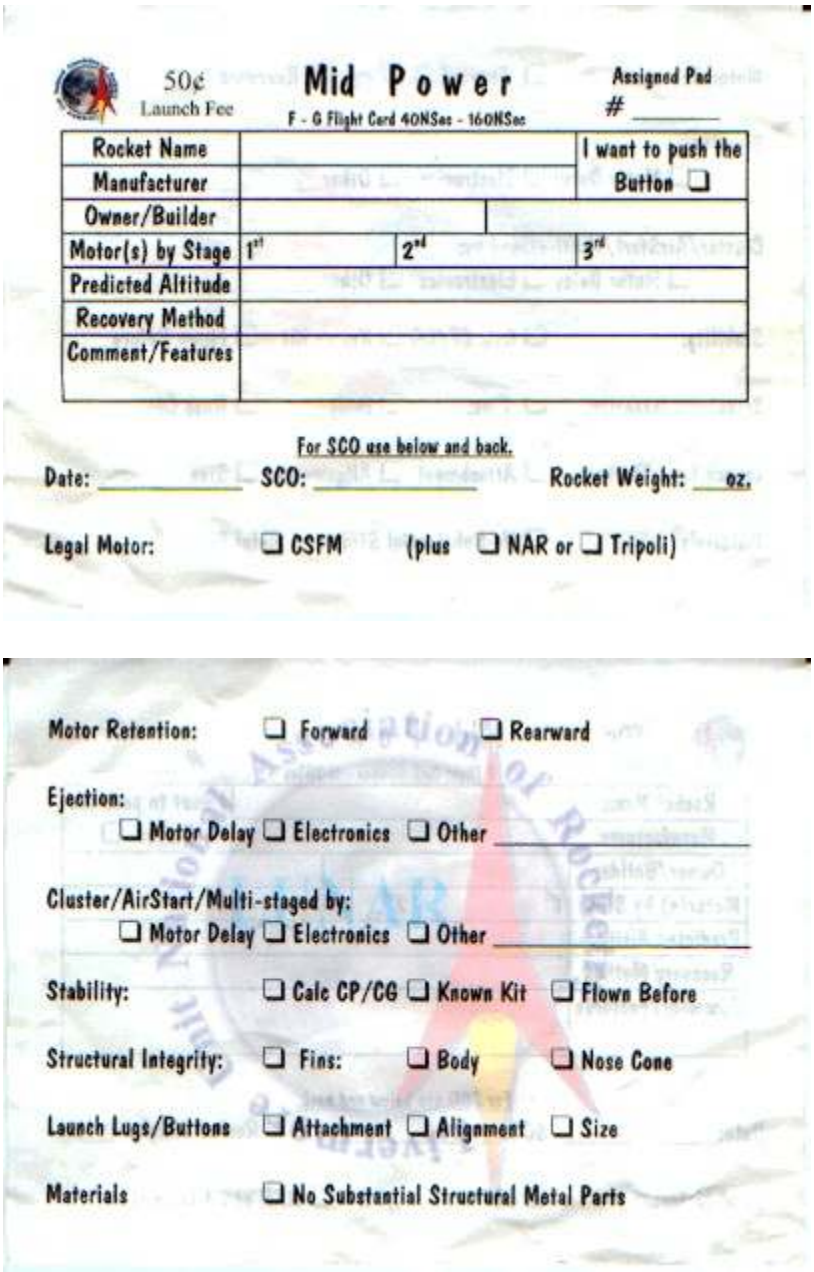
Using the Mid-power Flight Cards

The mid-power flight cards are different from the low-power ones. In addition to places for the rocket name, manufacturer, and engine, they also have places for motor retention, stability criteria, recovery method, and predicted altitude. On the back of the card are checkoffs for all the safety checks made by the HP-SCO.



50¢ Launch Fee

Mid Power

F - G Flight Card 40NSec - 160NSec

Assigned Pad # _____

Rocket Name			I want to push the Button ❑
Manufacturer			
Owner/Builder			
Motor(s) by Stage	1st	2nd	3rd
Predicted Altitude			
Recovery Method			
Comment/Features			

For SCO use below and back.

Date: _____ SCO: _____ Rocket Weight: ___ oz.

Legal Motor: ❑ CSFM (plus ❑ NAR or ❑ Tripoli)

Motor Retention: ❑ Forward ❑ Rearward

Ejection:

❑ Motor Delay ❑ Electronics ❑ Other _____

Cluster/AirStart/Multi-staged by:

❑ Motor Delay ❑ Electronics ❑ Other _____

Stability: ❑ Calc CP/CG ❑ Known Kit ❑ Flown Before

Structural Integrity: ❑ Fins: ❑ Body ❑ Nose Cone

Launch Lugs/Buttons ❑ Attachment ❑ Alignment ❑ Size

Materials ❑ No Substantial Structural Metal Parts

The LUNAR mid-power flight card collects a lot more information about the construction and stability of the rocket. On the back is a checklist for the safety check.

Return to contents.

Mid-power Safety Check

The most serious change in the procedures from those for model rockets is in the safety check. The mid-power procedures are a simplification of the procedures we use for high-power rockets. The safety check is done by the HP-SCO who is an experienced, high-power rocketeer.

The mid-power rules apply to any rocket carrying a total impulse of 40 Newton-seconds but less than 120 N-s. This applies to all F and G motors, or clusters of smaller motors whose total impulse is more than 40 N-s but less than 120 N-s.

Structure Check

The HP-SCO first checks the structural integrity of the rocket, including:

- Attachment of the fins
- Attachment of the engine mount
- Recovery system attachments to nose cone and rocket
- Packing of the parachute
- Fit of the nose cone.

Stability Check

The next step is to check the stability of the rocket. If the rocket is a kit, we will accept that the rocket is stable if built to the kit's specifications. If the rocket is not a kit, the flier will have to present some sort of documentation to show the location of the center of pressure (CP) so it can be compared to the location of the center of gravity (CG). The CG should be at least one caliber (body tube diameter) ahead of the CP to assure good stability. Rockets that do not conform to this rule will need compelling evidence to convince the HP-SCO that they are stable. The RSO has the final say in any dispute over the flight-worthiness of a model.

Engine Check

The next step is to insure that the engine is safe and appropriate for the high-power model being flown. The HP-SCO checks the type of engine and verifies that it is on the list of NAR certified engines. Only engines certified by the California Fire Marshal are allowed at club launches. The HP-SCO weighs the rocket and compares the launch weight to the recommended maximum weight for the engine. The HP-SCO uses an altitude chart to compare the maximum altitude and the appropriateness of the delay.

The altitude charts are in the Appendix. The charts plot the maximum altitude and time to maximum altitude and delay to maximum altitude (time minus propellant burn time) versus launch weight for different engines.

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Pad Assignment

When all safety checks are complete, the HP-SCO checks off the appropriate boxes on the launch card and assigns the rocket a pad by placing the launch card on the clipboard for Rack 3 in the appropriate spot for the pad number assigned to the rocket.

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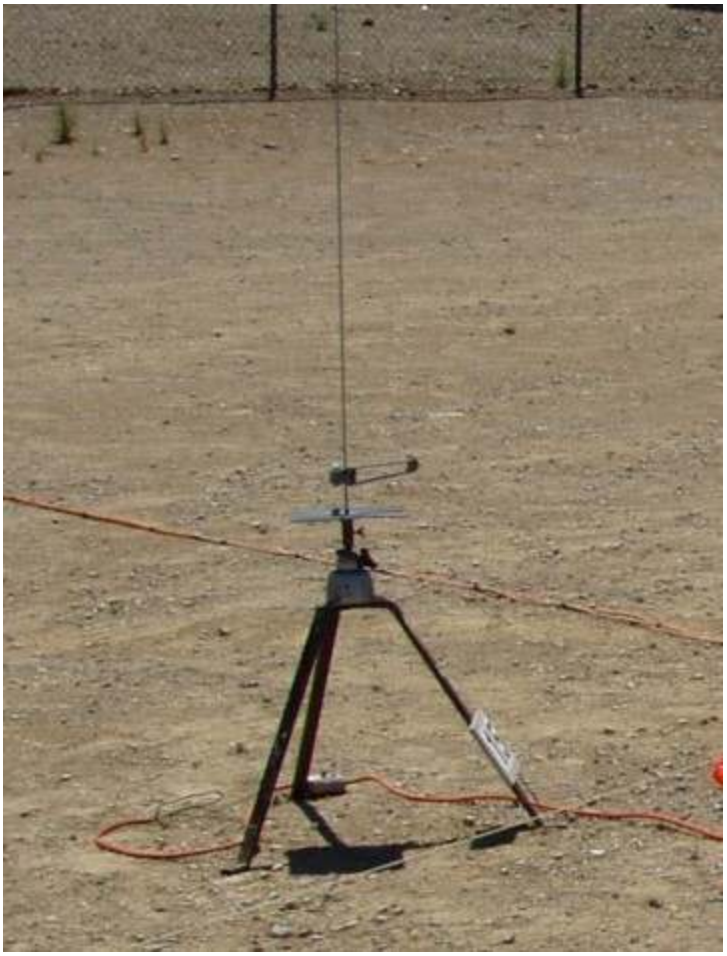
Load Your Rocket on the Pad

When the safety check and pad assignment are complete check to see if the mid-power rack is open for loading. If it is, go over and load your rocket. All sizes of launch rods from 1/8 to 1/2 inch are available, and are stored in the white tube in the center of the pads. We also have two "Black Sky" style launch rails. All the launch rods and rails are completely interchangeable on all the pads.

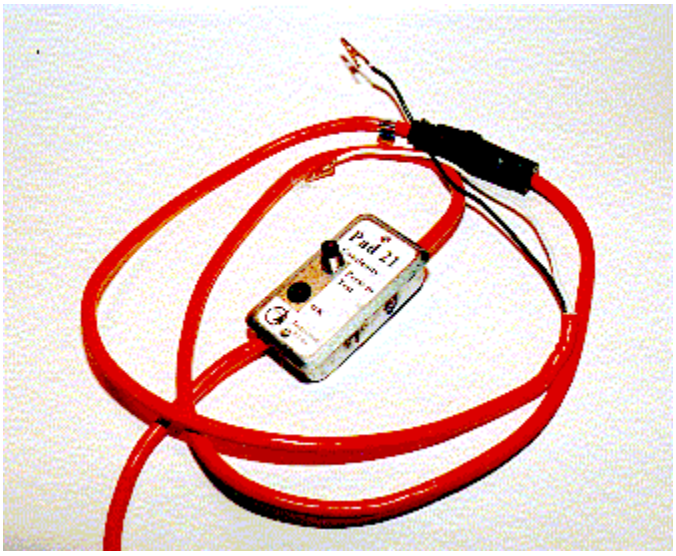
Most of the mid-power launches are from Rack 3 though we may use Rack 4 if the mid-power waiting line gets long and high-power pads are available. One of the mid-power pads from Rack 3 is shown in the following picture. Note that at the top of the tripod is a Panavice (the round silver thing). The Panavice is used to set the angle and direction of the launch rod. It is also used to lower the launch rod down to make it easier to load your rocket on the pad. To operate it, loosen the black knob, tilt the launch rod down until it is horizontal and tighten the knob. Put your rocket on the rod, tilt it back up, and finish preparing your rocket. To set the angle and direction, loosen the knob and tilt the rod down about 30 degrees, rotate it to the desired direction, then set the desired angle and tighten the knob.



One of the Rack 3 mid-power pads.

Inserted in the Panavice is an adapter that the launch rod fits into and that holds up the blast deflector. To change the launch rod, loosen the screw in the adapter and lift it out. Insert a different launch rod, tighten the screw, and move the standoff from the old rod to the new one. Do not leave launch rods laying on the ground as they can get stepped on and bent.

The launch clips are on a short piece of cord and are interchangeable with the cords on all our pads. We have launch clips with two or three alligator clips or with Aerotech Copperhead clips. Choose the clips that fit your igniter. Rack 3 has remote continuity checkers at each of the pads. Pressing the button tests continuity with a 0.5 ma (flashbulb safe) current. If continuity is good you will hear an audible beep and the LED lights.



A remote continuity checker on rack 3 with alligator launch clips attached.

Return to contents.

Launching

When all the pads are loaded, the LCO closes the pads. He then starts charging the remote launch box. A beeper in the box sounds as it charges (it takes about 30 seconds to charge) as a warning to bystanders. Do not go near the pads whenever the box is beeping. If all goes well, the LCO launches your rocket and you get to chase it. If your rocket does not fly for some reason, the LCO may let you go back and try to fix it. If we are busy, he will give you back your launch card and ask you to remove your rocket so that others can launch while you are fixing things.

LUNAR High-power Field Procedures

A high-power model rocket, for the purposes of our field procedures, is any rocket with an H (>120 N-Sec Cluster or Staged) or larger engine. For the most part, the high-power procedures

are similar to the low-power procedures so familiarize yourself with the low power procedures first. The high-power procedures have the following differences from the low-power procedures.

- You use high-power flight cards.
- The safety check is done by the High-power Safety Check Officer.
- The safety check is more rigorous.
- You use the high-power pads (Rack 4 and sometimes Rack 3).
- For H and higher launches a Class III Pyro must be present.

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Class III Pyro

For any use of "H" high-power engines at a club launch, at least one *pyro* must be in attendance. A pyro is a person who holds a California Class III Pyrotechnic Operators license. While this is generally the case it is not guaranteed.

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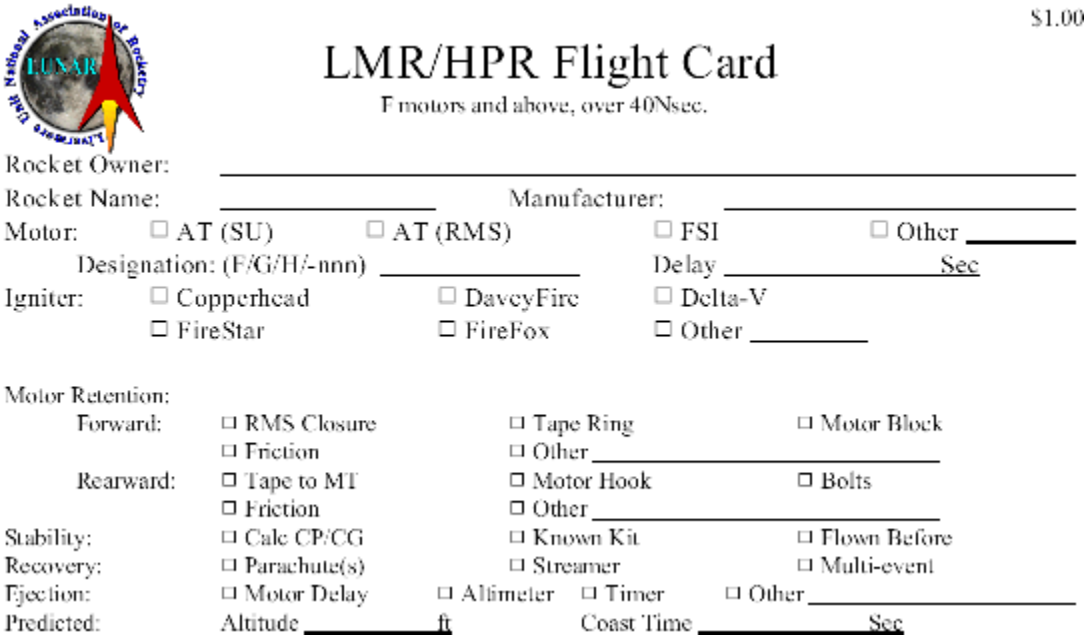
Using the High-power Flight Cards

The high-power flight cards are significantly different from the low-power ones. In addition to places for the rocket name, manufacturer, and engine, they also have places for igniter type, motor retention, stability criteria, recovery method, and projected altitude. On the back of the card are checkoffs for all the safety checks made by the HP-SCO.



$1.00

LMR/HPR Flight Card

F motors and above, over 40Nsec.

Rocket Owner: _____

Rocket Name: _____ Manufacturer: _____

Motor: ☐ AT (SU) ☐ AT (RMS) ☐ FSI ☐ Other _____

Designation: (F/G/H/-nnn) _____ Delay _____ Sec

Igniter: ☐ Copperhead ☐ DaveyFire ☐ Delta-V

☐ FireStar ☐ FireFox ☐ Other _____

Motor Retention:

Forward: ☐ RMS Closure ☐ Tape Ring ☐ Motor Block

☐ Friction ☐ Other _____

Rearward: ☐ Tape to MT ☐ Motor Hook ☐ Bolts

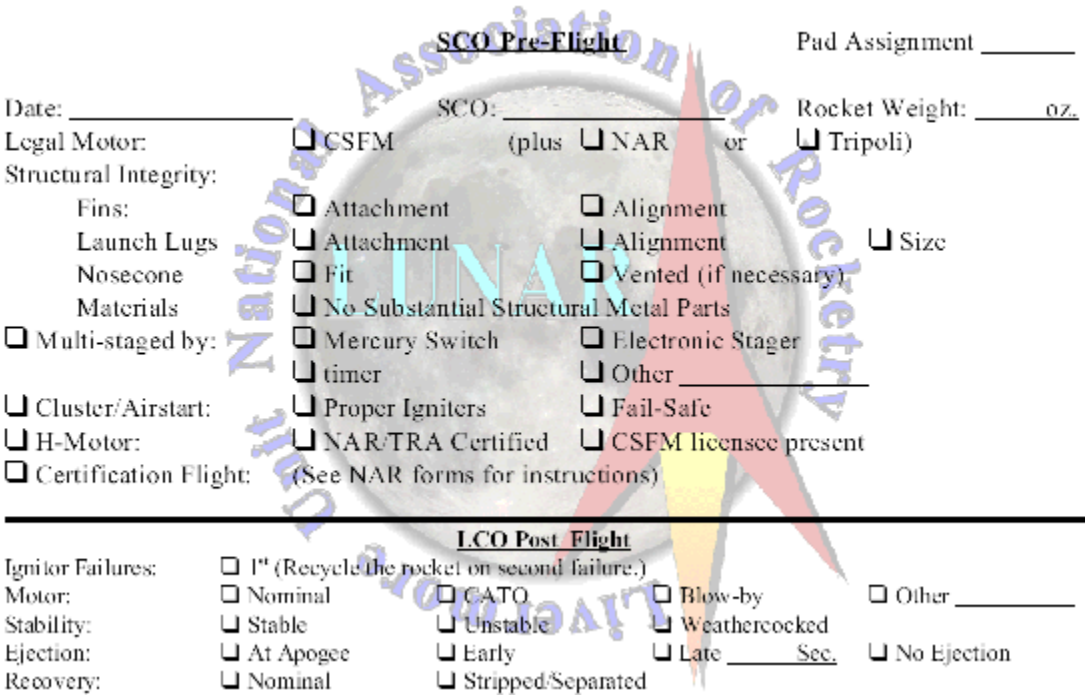
☐ Friction ☐ Other _____

Stability: ☐ Calc CP/CG ☐ Known Kit ☐ Flown Before

Recovery: ☐ Parachute(s) ☐ Streamer ☐ Multi-event

Ejection: ☐ Motor Delay ☐ Altimeter ☐ Timer ☐ Other _____

Predicted: Altitude _____ ft Coast Time _____ Sec



SCO Pre-Flight Pad Assignment _____

Date: _____ SCO: _____ Rocket Weight: _____oz.

Legal Motor: ❑ CSFM (plus ❑ NAR or ❑ Tripoli)

Structural Integrity:

Fins:	❑ Attachment	❑ Alignment	
Launch Lugs	❑ Attachment	❑ Alignment	❑ Size
Nosecone	❑ Fit	❑ Vented (if necessary)	
Materials	❑ No Substantial Structural Metal Parts		
❑ Multi-staged by:	❑ Mercury Switch	❑ Electronic Stager	
	❑ timer	❑ Other _____	
❑ Cluster/Airstart:	❑ Proper Igniters	❑ Fail-Safe	
❑ H-Motor:	❑ NAR/TRA Certified	❑ CSFM licensee present	
❑ Certification Flight:	(See NAR forms for instructions)		

LCO Post Flight

Ignitor Failures:	❑ 1st (Recycle the rocket on second failure.)			
Motor:	❑ Nominal	❑ CATO	❑ Blow-by	❑ Other _____
Stability:	❑ Stable	❑ Unstable	❑ Weathercocked	
Ejection:	❑ At Apogee	❑ Early	❑ Late _____ Sec.	❑ No Ejection
Recovery:	❑ Nominal	❑ Stripped/Separated		

The LUNAR high-power flight card collects a lot more information about the construction and stability of the rocket. On the back is a checklist for the safety check.

Return to contents.

High-power Safety Check

The most serious change in the procedures from those for model rockets is in the safety check. The high-power procedures are based on those used by Tripoli and other clubs that fly a lot of high-power rockets. The safety check is done by the HP-SCO who is an experienced, high-power rocketeer.

The high-power rules apply to any rocket carrying a total impulse of 40 Newton-seconds or more. This applies to all F, G, and H motors, or clusters of smaller motors whose total impulse is more than 40 N-s.

Structure Check

The HP-SCO first checks the structural integrity of the rocket, including:

- Attachment of the fins
- Attachment of the engine mount
- Recovery system attachments to nose cone and rocket
- Packing of the parachute
- Fit of the nose cone.

Stability Check

The next step is to check the stability of the rocket. If the rocket is a kit, we will accept that the rocket is stable if built to the kit's specifications. If the rocket is not a kit, the flier will have to present some sort of documentation to show the location of the center of pressure (CP) so it can be compared to the location of the center of gravity (CG). The CG should be at least one caliber (body tube diameter) ahead of the CP to assure good stability. Rockets that do not conform to this rule will need compelling evidence to convince the HP-SCO that they are stable. The RSO has the final say in any dispute over the flight-worthiness of a model.

Engine Check

The next step is to insure that the engine is safe and appropriate for the high-power model being flown. The HP-SCO checks the type of engine and verifies that it is on the list of NAR certified engines. Only engines certified by the California Fire Marshal are allowed at club launches. The HP-SCO weighs the rocket and compares the launch weight to the recommended maximum weight for the engine. The HP-SCO uses an altitude chart to compare the maximum altitude and the appropriateness of the delay.

The altitude charts are in the Appendix. The charts plot the maximum altitude and time to maximum altitude and delay to maximum altitude (time minus propellant burn time) versus launch weight for different engines.

Electronics Check

For high powered rockets with electronic initiation of upper stages or of the recovery system, the HP-SCO checks the electronics to see that they are in good order. Specifically, the HP-SCO checks the condition of the:

- Altimeter
- Recovery system electronics
- Batteries
- Staging electronics

Heads-Up Launch

All high-power launches are "heads-up" launches.

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Pad Assignment

When all safety checks are complete, the HP-SCO checks off the appropriate boxes on the launch card and assigns the rocket a pad by placing the launch card on the clipboard (for Rack 3) or the flip file (for Rack 4) in the appropriate spot for the pad number assigned to the rocket.

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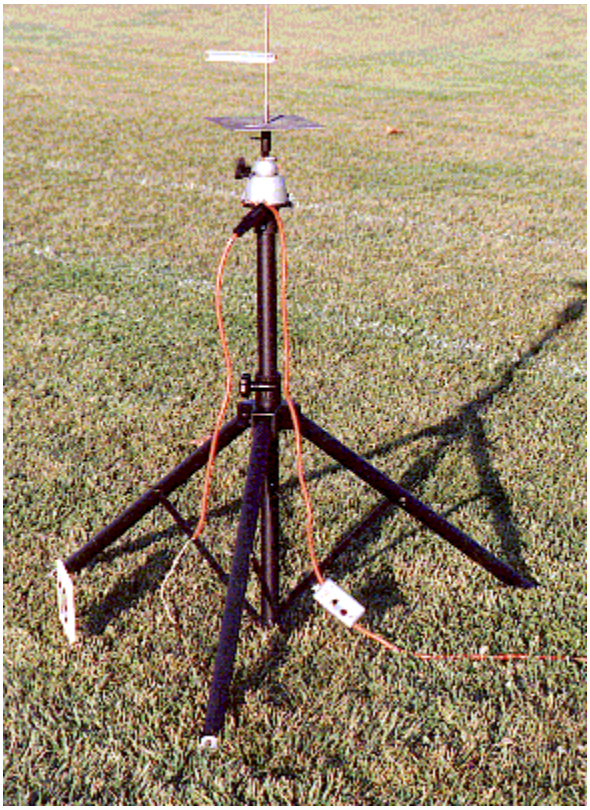
Load Your Rocket on the Pad

When the safety check and pad assignment are complete check to see if the high power rack you have been assigned to is open for loading. If it is, go over and load your rocket. All sizes of launch rods from 1/8 to 1/2 inch are available, and are stored in the white tube in the center of the pads. We also have two “Black Sky” style launch rails. All the launch rods and rails are completely interchangeable on all the pads.

Most of the high power launches are from Rack 4 though we may use Rack 3 if the high power waiting line gets longer than the low power. One of the high power pads from Rack 4 is shown in the following picture. Note that at the top of the tripod is a Panavice (the round silver thing). The Panavice is used to set the angle and direction of the launch rod. It is also used to lower the launch rod down to make it easier to load your rocket on the pad. To operate it, loosen the black knob, tilt the launch rod down until it is horizontal and tighten the knob. Put your rocket on the rod, tilt it back up, and finish preparing your rocket. To set the angle and direction, loosen the knob and tilt the rod down about 30 degrees, rotate it to the desired direction, then set the desired angle and tighten the knob.

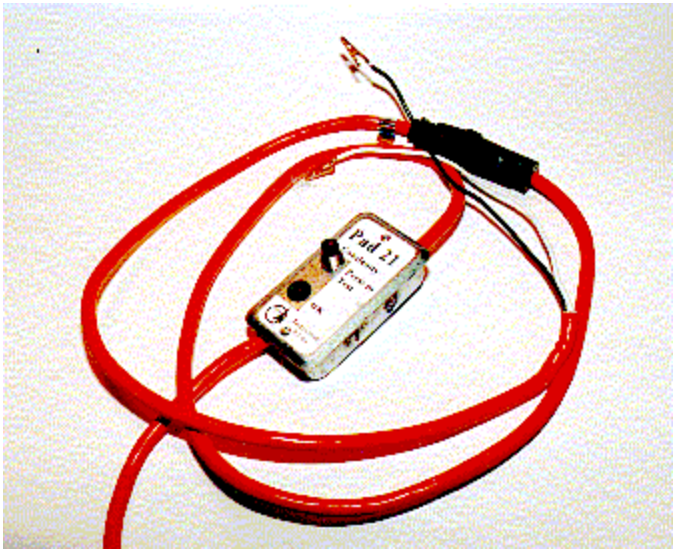


One of the Rack 4 high power pads.

Inserted in the Panavice is an adapter that the launch rod fits into and that holds up the blast deflector. To change the launch rod, loosen the screw in the adapter and lift it out. Insert a

different launch rod, tighten the screw, and move the standoff from the old rod to the new one. Do not leave launch rods laying on the ground as they can get stepped on and bent.

The launch clips are on a short piece of cord and are interchangeable with the cords on all our pads. We have launch clips with two or three alligator clips or with Aerotech Copperhead clips. Choose the clips that fit your igniter. Rack 4 has remote continuity checkers at each of the pads. Pressing the button tests continuity with a 0.5 ma (flashbulb safe) current. If continuity is good you will hear an audible beep and the LED lights.



A remote continuity checker on rack 4 with alligator launch clips attached.

Return to contents.

Launching

When all the pads are loaded, the LCO closes the pads. He then starts charging the remote launch box. A beeper in the box sounds as it charges (it takes about 30 seconds to charge) as a warning to bystanders. Do not go near the pads whenever the box is beeping. If all goes well, the LCO launches your rocket and you get to chase it. If your rocket does not fly for some reason, the LCO may let you go back and try to fix it. If we are busy, he will give you back your launch card and ask you to remove your rocket so that others can launch while you are fixing things.

Helping Out

The LUNAR model rocketry club is not just a service for rocketeers, it is an all-volunteer organization where everyone is expected to help out. Setting up, tearing down, and taking a turn in one of the following positions is a LUNAR membership requirement.

Range Safety Officer (RSO)

Launch Control Officer (LCO)

Low-power Safety Check Officer (LP-SCO)

High-power Safety Check Officer (HP-SCO)

Pad Assignment Director (PAD)

Registration Manager (RM)

Launch Pad Supervisors (LPS)

They are also a lot of fun to do. If you like pushing the button, try LCO for an hour. You get to launch about 50 rockets and you don't have to chase after any of them. Do you like checking out people's new models? The Safety Check Officer gets to do a hands on check of every rocket that flies. Kids like Pad Assignment Director because they get to tell adults what to do.

None of these jobs are very difficult, many can be done by our younger members, and when we all do our fair share they are not a burden. In fact, the ***Go to the Front of the Line*** Gold Card you get for doing these jobs make it well worth while, especially on a busy day. Everyone who does a field job gets a dollar's worth of flight cards as payment. Those who help set up and tear down get the flight cards, but not the Gold Card, since those particular jobs don't take away from flying time. Sign up for jobs on the white board in front of the Safety Check area.

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Setting Up For A Launch

People wanting to help with setup should try to arrive at the field around 8:00 a.m. as we usually try to start flying by 9:00. Go to the trailer where the equipment is being unloaded and say "I want to help", we'll put you to work.

Step one is to start unloading the trailer, especially the center section as it needs to be cleared out to get to the extension cords hanging on the walls.

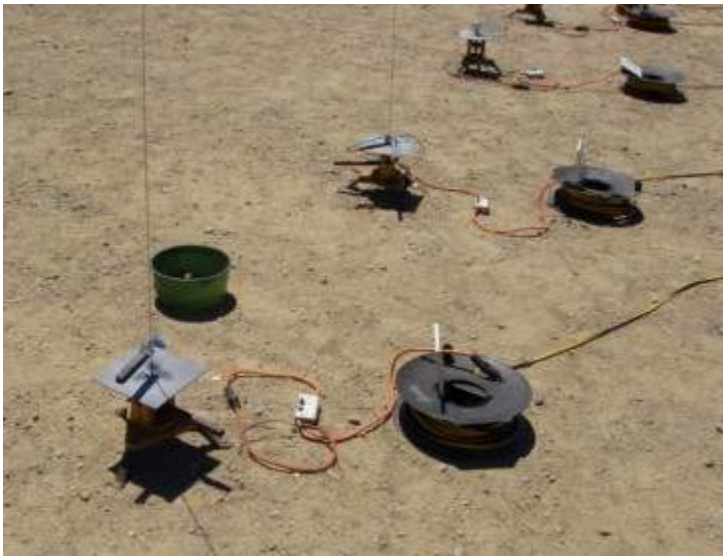
The second step is to set up the LCO Station, which is a collapsible worktable stored at the back of the trailer and the Launch Controller (a red, metal toolbox). The Launch Controller clamps on top of the worktable. Everything else is setup relative to the LCO Station. See the diagram below for the setup. As soon as the LCO Station is in place the rest of the setup can continue.

The LCO Station is a worktable with the Launch Controller on top. Extension cords to all of the pads are plugged into the back of the Launch Controller.

Bring out the extension cords and sort them by number. Numbers 1 through 6 fan out in front of and to the left of the LCO Station out to Rack 1 (pads 1 through 6). Tie (a half hitch) cord number 1 to the cross bar on the front of the worktable and plug it into socket number 1 on the Launch Controller. Unroll it out in front of the LCO Station about 30 degrees to the left of straight ahead. Unroll it almost to the end, leaving a few feet for adjusting the final location. Do the same with cord 2, going from socket 2 on the Launch Controller, roll it out just to the right of cord number 1. End with it about six feet (two big steps) to the right of the end of cord number 1. Continue with cords 3 through 6.

Back of the launch controller with extension cords plugged in.

Fan out of extension cords to rack 1.



Rack 1 with extension cords, launch pads, continuity checkers, and launch clips.

WARNING: Be really careful here to be sure that cord 1 goes in socket 1 and out to pad 1, and so forth for the other cords and pads. Failure to do so could get someone hurt.

Extension cords 7 through 12 fan out in front of and to the right of the LCO Station, out to Rack 2 (pads 7 through 12) in exactly the same manner as cords 1 through 6.

Rack 3 (pads 13 through 18) are the mid-power pads and are directly behind rack 1, but 100 feet farther away. There are two reels marked 13 through 18 that contain a yellow and a gray cable taped together with a single male connector on the end and a female connector on the side of the reel.

A power/control cable reel for pads 13 through 18.

Tie one of these cables around the cross bar on the LCO station and plug it into the matching connector marked 13 through 18 on the back of the launch controller. Be careful when you plug it in. When you have it right, it goes in easy and you can twist the lock ring to hold it. If it does not seem to be going in easy, unplug it and see what is wrong. Make sure there is no dirt or sand in the connector. Unroll this cable down the center of the field between the two banks of low power pads. When the reel is empty, set it down and plug the second reel into the connector on the side of the first. Veer to the left so you end up with the reel near where you want the center of the bank 3 pads.

Carry the Remote Launch Controller (a yellow and black plastic toolbox) out to the end of the cable. Open the tool box and remove all the cables. Plug the matching power and control cable into the matching connector on the side of the second reel. Unwind the six cables and arrange them in a semi-circle around the controller. Be sure to do them in order, going from number 13 on the left around behind the controller and ending with number 18 on the right.

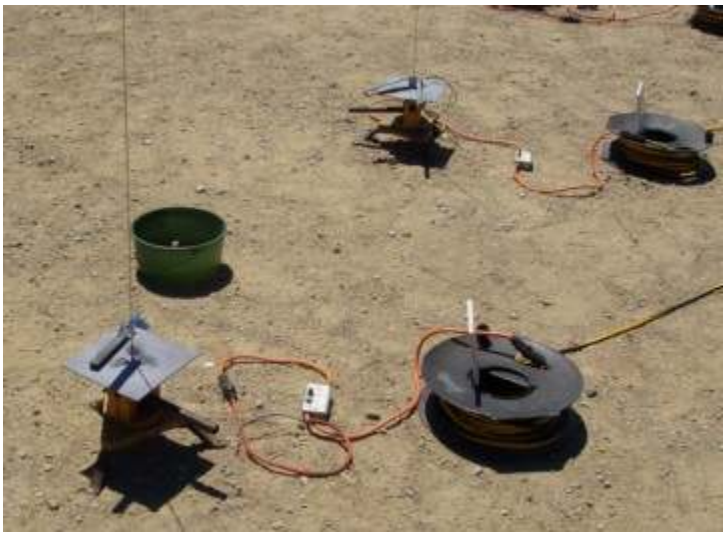
Remote launch controller connected to the power and control reel.

Cables from the remote launch controller fan out to the pads.

Rack 4 (pads 19 through 24) are the high power pads. They are setup exactly the same way as rack 3 except they are behind rack 2. We also have three reels of cable for the high-power pads though we only use the third reel when we are flying at Snow Ranch. Using the third reel places the high-power pads 300 feet from the LCO table. There are two six foot extension cords in the remote launch controller for rack 4. Place these cords on pads 19 and 24 so those pads can be spread out more to make them more visible.

Rack 4 is shown here with the six pads arranged in a circle around the remote Launch Controller.

Next come the pads themselves. Pads 1 through 12 are the small pads which are primarily for low power rockets. Put one pad within reach of the end of each extension cord. Put about six feet (two big steps) between each pad and about 15 feet between pads 6 and 7 (the last pad of Rack 1 and the first pad of Rack 2).



Shown here are pads 1 and 2. In the image you can see the pad, blast deflector, launch rod, and standoff. Connected to the extension cord is a continuity checker and a launch clip. In front of the pad (in the wire reel when the ground is too hard) is the pad number.

The medium sized pads are rack 3 and are setup in much the same way as racks 1 and 2.

Pads 19 through 24 are the black collapsible tripods. Extend the tripod and place one near the end of each cable. Don't tighten the tripod clamps too much. They only need to be snug. There is

a loop on the continuity tester at the end of each cable. Hang that loop on the tripod clamp knob. If the loop is missing tie a half hitch in the cable and loop it over the knob.

Pad 20 is one of the high-power pads. Here you can see the tripod, the Panavice that controls the tilt and angle of the launch rod, the blast deflector, launch rod, and standoff. The continuity tester is on the orange cable that sits by the pad. A pad number is not shown in the picture.

There is a milk crate for each of the 4 racks of pads. They are marked rack 1, rack2, rack3, and rack4. Put this crate near the center of each rack. Each crate contains a fire extinguisher, a blue box with the blast deflectors and pad number signs, assorted igniter clips (both alligator and Copperhead) plus a blue can with some large nails and cleaning supplies (Scotch Brite pads and a small wire brush). Let a club officer know if any of this equipment is missing. Use the nails to fasten the three legs of each pad down to the ground. Put a blast deflector on each pad and stick a pad number in the ground in front of the pad. Put a standoff clamp on each pad. For racks 1 and 2, plug the numbered continuity testers into the extension cord. For all pads, plug an alligator style igniter clip into the continuity testers. Put the green plastic trash tubs within reach of the pads. The extra igniter clips are draped on the spare launch rod tube (described next) to keep them off the ground.

The launch rods are in two large white tubes. Take the long tube out between Racks 3 and 4 and put the short tube between Racks 1 and 2. Each rack of pads gets a launch rod holder. These are smaller tubes about 2 feet long and 3 inches in diameter that keep the launch rods off of the ground so they don't get stepped on. The launch rod holders have small loops on the sides that go

over one of the metal stakes we use to hold up our safety barrier. Put one near the center of each rack of pads. Put 1/8 inch rods in pads 1 through 12, through the hole in the blast deflector and clamp the standoff to the launch rod. Get a few of the 3/16 and 1/4 inch rods from the larger tube and put them in the launch rod holders at Racks 1 and 2. Spread the larger rods between the launch rod holders for the high-power Racks (3 and 4). You don't need to put launch rods on the high power pads as the high power users will pick the rods they need.

This image shows Rack 2 with Rack 3 in the background. Note the white launch rod holder in the center of the image with the orange milk crate to its right.

WARNING: don't leave any of the launch rods laying on the ground. Someone will step on them and bend them all out of shape. Stainless steel rods are very difficult to get straight again after they have been bent. Also, you will piss-off the equipment manager and you really don't want to do that. You might get invited to spend a weekend cleaning and straightening launch rods.

While the pads are being setup, The LCO Station gets setup with the control support table, battery (or power supply), amplifier, microphone, and foot switch. Plug the foot switch into the back of the launch controller and place it on the ground. Plug the power cable into the back of the launch controller. The power cable has two trimmed wires for attachment to the power input connectors on the back of the amplifier. Place the alligator clips near the battery but do not connect them until everything is setup. Plug the microphone into the amplifier and place it in the holder on the LCO table.

Amplifier and battery setup showing the power, speaker, and microphone cables.

Back of the amplifier showing the power cable attached to the top two connectors and the speaker cables connected to the bottom four connectors. The microphone cable is the black one on the top left. The 110V power cable is not used in this setup.

In the same area are the high-power and low-power safety check tables. An electronic scale and engine performance charts go on the high-power safety check table. A small box of repair materials (glue tape, etc.) goes on the low-power safety check table. The white board for job signups goes in front of the safety check tables. The club banner also goes in front of the safety check tables.

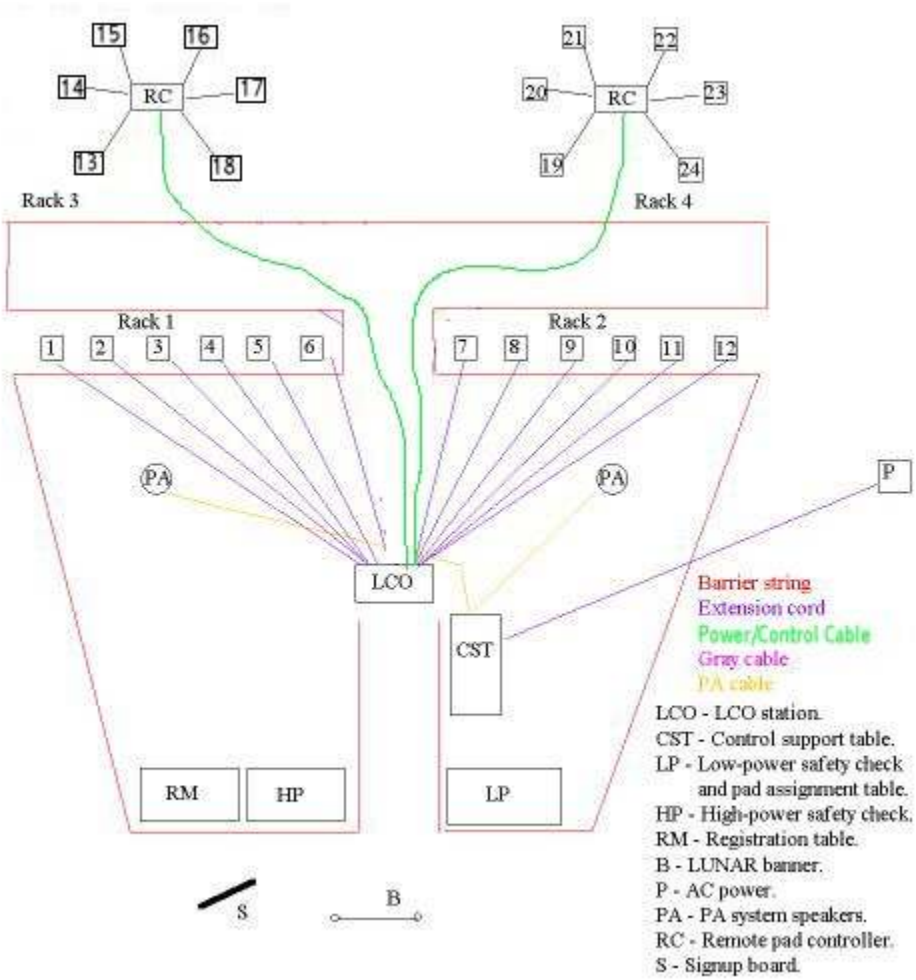
Registration is done on a table next to the high power safety check table. The table needs to be setup with the registration box, sign-in sheets, transaction log and member roster on clipboards, pens, and cash box.

This image shows the table setup. The LCO Station and control support table are on the left. The LP-SCO table is at the center and the HP-SCO and registration tables are on the left.

The speakers for the PA system need to be setup and connected to the amplifier. The speakers are on poles that are held up with three ropes. Use two of the unmarked extension cord reels to connect from the speaker to the amilifier. An adapter goes on the end of the extension cord to allow it to be connected to the speaker connectors on the back of the amplifier. The speaker for the Heads-up siren needs to be plugged into the Launch Controller and rolled out in front of the LCO Station.

The barrier string can be put up as soon as all the pad cords and pads are in place. Put metal stakes (from the wagon) in the ground to make the shape shown in the setup figure. There is a stake pounder made of pipe in the trailer. Put a wooden block on each metal pin. Start and finish unrolling the barrier string at the LCO Station, rotate the support blocks so that the barrier is always to the inside of the stake and pull it fairly tight as you install it.

If it looks like enough people are doing setups, any additional workers can help in the equipment staging area by cleaning the launch rods with the Scotch-Brite pads and cleaning the launch clips with the small wire brushes.



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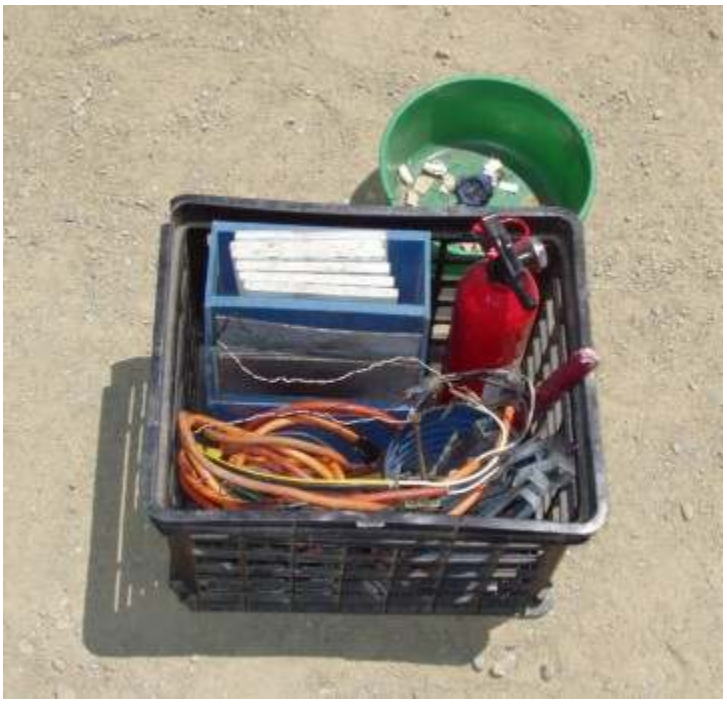
Tearing Down After A Launch

This starts with picking up all the trash from around the pads and placing it in the trash buckets. Then it's just a matter of consolidating all the hardware carrying it over to the pickup area next to the trailer. The pad numbers and blast deflectors go in the blue boxes in their respective slots. The nails and standoffs go in the blue cans. The blue box and can go in the milk crate with the fire extinguisher and the igniter clips are stuffed on top.



A milk crate with the blue box containing the pad numbers and blast deflectors. The blue cans contain the nails and standoffs. The Igniter clips and continuity checkers (racks 1 and 2) are piled on top.

At the mid- and high-power pads, unplug the remote launch controllers from the wire reels, wind up all the wires that go to the pads and stow them in the remote launch controllers. The two, short extension cords at the high-power pads are also stowed in the remote launch controller boxes.

Wires stowed in the remote launch controllers.

When pulling the pads off the ground, pull on the legs next to the spike to avoid breaking the legs off the pads or use the claw hammer to pry them out. After removal don't leave any low profile objects (steel stakes, launch rods, igniter clips, blast deflectors) sitting off by themselves in the grass as they may be overlooked and left behind when we leave.

Filling the trailer is an art. If you do it wrong, it won't fit. Things have to be loaded in order for it all to get in.

Loading the back and sides of the trailer.

As shown above, the launch controller, scales, camping lights, and other small items go in the back of the trailer. On the bottom back are three of the milk crates. The 12 low power pads go on the 12 pegs along the top of each side. The cable reels go on the lower rows of hooks, with the winding knobs towards the wall for the inner reels and towards the inside for the outer reels. The large high-power pad numbers are behind the reels on the left side.

The two launch rod tubes (white) go on the floor with the longer one going under the wooden stool at the back of the trailer. Put the "Open This End" end of the tubes to the back so the equipment manager can get launch rods out without having to unload the trailer. The launch rails go either in the launch rod tubes or go on the floor between them. On the rest of the hangers on the sides go the pipes for the banner, speakers, launch rod tubes and any other long, skinny objects. The pipe hammer for pounding the stakes in the ground goes on the bottom left under the reels. The ball hitch is on the left bottom at the back.

Next comes the stakes and the blue box.

The next step is to back the wagon contiaining the steel stakes into the trailer all the way to the back on the right side. Pile two milk crates on top of it. Put the large, blue box behind the wagon.

Add more boxes.

Put the two small blue boxes on the wagon. Put another milk crate on top of the other crates and the boxes. Put the two, yellow and black remote launch controller boxes on top of the large blue box and the back of the wagon. Push them up against the small blue boxes.

Add the tables.

The four tables and the sign-up board go on top of the launch rod tubes and slide as far back as possible.

Loading the mid-power pads.

The mid power pads slide in a track at the top-center of the trailer and slide all the way to the back.

Loading everything else.

The high power pads slide in on the top-left side. The large black bag of dog barf (fireproof ceiling insulation to use for recovery wadding) goes in under the mid-power pads. The drinking cups go in the orange water container which goes on top of the remote launch controllers. The battery goes on the bottom at the back. The last thing to go in is the folded up launch controller table.

Before closing things up, make sure that the battery is at the back of the trailer so it can be removed and charged. The trailer hitch should also be on the bottom left at the back (unless it is being used to tow the trailer). Close and lock the back.

The trailer is parked in the fenced in area by the back gate of the rodeo grounds. Back the trailer in and sit it on the trailer stand. Open the trailer and put the trailer hitch at the back at the bottom-left side. Close and lock the trailer. Put wheel covers on the two wheels. Close and lock the gate.

Good Job!

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Extra Benefits For Helping

There are special benefits for those that help out at a launch. For those of you who do setup or tear down you receive four free low-power flight cards or one high-power flight card. However, the best benefit are for those who do the RSO, LCO, LP-SCO, HP-SCO, PAD, LPS or RM jobs.

In addition to the flight cards, they get a ***Go to the Front of the Line*** Gold Card. These cards give you the privilege of going straight to the front of the line. Robert Taylor introduced the concept to our launches after his visit to the Tripoli "Hayburner" launch. A Gold Card is good for the whole day, and helps overcome the biggest complaint about doing these jobs, namely that you don't have time to fly if you spend all morning as LCO. Since you can walk to the front of

the line to get a pad assignment, you can quickly get in several flights, even when the line goes clear out to the street.

Meet The LUNAR Launch Coordination Officers

LUNAR launches are coordinated by eight people designated as the Range Safety Officer (RSO), Launch Control Officer (LCO), Low-power and high-power Safety Check Officers (LP-SCO and HP-SCO), Pad Assignment Director (PAD), two Launch Pad Supervisors (LPS), and Registration Manager (RM). You can tell these people by the cool colored vests they wear. We all take turns manning these positions during a launch to spread the burden of making the launches run smoothly. As compensation for spending time as one of these officers (see Helping Out), you get to wear a fancy colored vest with the LUNAR logo on it and your officer title (no, you don't get to take them home with you). We also pass out ***Go to the Front of the Line*** Gold Cards to everyone who participates. While the vests are really cool, the Gold Cards are well worth it on a busy day as you may well get in more launches after spending an hour working than you would just standing in line.

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Meet The Range Safety Officer (RSO)(Red Vest)

Prerequisites: The RSO is an adult 18 years or older, an experienced rocketeer, and is generally one of the senior club members.

The Range Safety Officer has overall responsibility for the safety of the range and can shutdown flying if he deems it necessary. Most often though he depends on the LCO to make good decisions about range safety for each individual launch. The RSO has the final say about the flyability of any model or engine combination.

The RSO usually makes the decision when to switch the "swing" pads (Rack 3) from low power to high power and vice versa, although the LCO can also decide this, based on the relative length of the lines.

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Meet The Launch Control Officer (LCO)(Yellow Vest)

Prerequisites: The LCO is an adult 18 years or older and experienced in club operations.

The Launch Control Officer is responsible for supervising each individual launch and seeing that conditions are safe to do so. This means making sure that pads are not and cannot be armed when people are close by them. It also means looking and listening for aircraft and not launching any rockets when any are within our FAA exclusion zone (currently a cylinder 2 miles in radius and 4,500 feet high).

When the area around a rack of pads is clear, the LCO announces that the "Rack is closed." No one may go near the pads after they have been closed. At this point, the LCO removes the plastic switch protector and tests for continuity by arming one pad at a time and pressing the foot switch. If the beeper beeps, the continuity is good. When launching Rack 4 he must plug the phone plug on the back of the plastic switch protector into the phone jack just above the arming switches before checking for continuity. This begins charging the remote launch controller which takes about 30 seconds, and while he should not try to launch until it is fully charged he can immediately start checking for continuity.

The pads should all be disarmed when the LCO finishes this test. If any of the pads do not have continuity, the LCO opens the Rack by placing the plastic protector back on the switches and tells the owner of the problem rocket to see if he can fix it. When the continuity problem is fixed, the LCO closes the rack again and redoes the continuity test for that rocket.

The LCO is given a clipboard by the Pad Assignment Director or the High-Power Safety Check Officer containing the launch cards for each of the rockets on the rack being launched. The cards contain information about each of the rockets that the LCO uses when announcing the rocket. He next announces the rocket, taking special pains to make everyone aware of any flights labeled as "heads up." He determines if he or the owner is to "push the button" from a check box on the launch card. If you like doing count downs and pushing the button, this is the job for you as most of the rocketeers want to be down range a little to be ready for recovery.

When the button pusher (if any) is in place and it is safe to do so, the LCO arms the correct pad, checks for nearby aircraft and people in the launch pad area. He makes the statement "The range is clear and the sky is clear," listens for anyone yelling "Airplane!" and gives the go-ahead to the button pusher to do the countdown and launch the rocket. When the countdown reaches 2 he steps on the foot switch enabling the launch button which is pressed at 0. Keep the foot switch

down until until the rocket fires or fizzles. The launch controller contains a relay that latches closed when the launch button is pressed to continue supplying power to the rocket until the foot switch is released, even if the launch button is released.

If the rocket flies, the LCO observes the flight and watches for proper operation of the recovery system; if anything goes wrong he calls "heads-up" and turns on the alert siren to make everyone aware of the possible danger.

When all rockets have been launched, the LCO makes sure all switches are off, places the plastic protector over them and announces that the Rack is open for loading or removal if a rocket did not fly. People with failed launches get one chance to fix the problem and try again. If they fail a second time they must remove their rocket from the pads so others can fly. The LCO tells the Pad Assignment Director to return their flight cards so they can fix the problem "off line" and get a new pad assignment.

Note that if things are relatively slow, the LCO may let the owner of a failed rocket in to quickly inspect his rocket and, if it is an easy fix, launch it immediately before letting the next rack in.

The LCO returns the clipboard to the Pad Assignment Director or the High-Power Safety Check Officer depending on who gave it to him.

The LCO also watches the barrier strings and is the only person who may authorize anyone to walk inside the barrier strings (such as to recover a rocket). He needs to watch carefully, especially for our younger members who tend to not see barriers or wires when chasing after their rockets.

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Meet The Low-Power Safety Check Officer (LP-SCO) (Orange Vest)

Prerequisites: The LP-SCO does not need to be an experienced rocketeer but should be at least high-school age, 15 years or more, and have built and flown two or three rockets. If you have never done this job before you can be trained in about 5 minutes.

The LP-SCO inspects all low-power rockets prior to flight to determine if they are safe to fly. If they are judged safe, LP-SCO initials the flight card and gives it back to the rocketeer who then proceeds to the pad assignment line. If we are not busy, the LP-SCO may pass the card directly to the Pad Assignment Director or may do the pad assignments himself if we are short handed.

Low power rockets are any rocket with less than 80 Newton-seconds of impulse. Rockets with A, B, C, D, or E engines qualify as low power and may fly from our low power pads. Rocketeers with larger engines (F, G, or H) must go through the high-power safety check. If, in the opinion of the LP-SCO, the rocket is not safe to fly, he will tell the owner what the problem is and help them out if we are not busy. We have a "fix it" box of glue, tape, and common repair items at the safety check table to use to fix small problems. If we are busy, you can almost always find an experienced rocketeer standing in line who is willing to help the person out. If you are unsure about the safety of a rocket, ask one of the more experienced rocketeers, especially the RSO or the HP-SCO. If the rocketeer disagrees with the LP-SCO's judgment, the RSO has the ultimate authority.

For most rockets the inspection process is fairly simple. The LP-SCO checks to see that the fins and launch lug are securely fastened to the body tube. He checks that the engine is properly installed (i.e. that it is not hanging half out of the rocket because the glue on the engine block set too soon, or that it is not in backwards) and it is secure from either moving forward when thrusting or being ejected during recovery (unless it is supposed to be ejected). While at the engine it is also a good idea to check to see if the igniter wires are possibly shorted together.

Check for a functional recovery system. This can be no more than checking that the nose cone is not too tight or too loose, asking the owner if the recovery system is present, and if he remembered the recovery wadding.

The flight cards of any large rocket which is not rejected but is somewhat questionable in the eyes of the LP-SCO is marked as a "heads up" flight so everyone else will be made aware of the potential for a problem. All scratch built rockets (those not from a kit) on their first flight should be marked as "heads up" flights. Check that the rocket is not too heavy. If it feels heavy, check it on the scale at the HP-SCO table and compare the weight with the maximum allowed for the engine. A table of maximum weights for different engine sizes is at the HP_SCO table.

If the LP-SCO or the owner are still concerned about a questionable, "heads up", low-power rocket they may request that it be flown from the high-power pads to get it farther from the crowd. To do this, pass the flight card to the HP-SCO and ask him to assign it to a high-power pad.

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Meet The Pad Assignment Director (PAD) (Orange Vest)

Prerequisites: The PAD is an ideal job for our youngest members as they can be supervised by the LP-SCO.

The pad assignment director is a relatively easy job that is well suited for our younger members. The PAD makes the launch pad assignments for the low power pads. When a rack of pads has been launched, the PAD gets the clipboard from the LCO, removes the cards for the launched rockets and puts them in the "Used Flight Cards" box. If a rocket did not fly and the LCO is going to give them another chance, leave the card on the clipboard. If the rocketeer has to remove his rocket to try again later, give him his card back. Take the clipboard back to the low power table and assign all the available pads by clipping the rocketeer's launch card on the clip that corresponds to the assigned pad. Be sure the launch card has been initialed by the LP-SCO before assigning a pad.

During slow periods pad assignments are done by the LP-SCO after he finishes checking a rocket.

The PAD is also available to help out the other officers in the launch area, depending on where the need is. If the PAD must leave the LP-SCO table to run an errand, the LP-SCO takes over pad assignments.

NOTE: When a large group of young children, such as Cub Scouts or 4-H, comes up, suggest to their supervisor that we write the pad assignment on the back of the child's hand with a pen. This makes it much easier to remember which pad they are supposed to be on.

As mentioned above, the PAD job is ideal for our younger members as they can be supervised by the LP-SCO. A parent and child can sign up for the LP-SCO and PAD positions for the same hour and work together to do the safety checks and pad assignments (I did it when my daughter was 10 years old and she thought it was great fun).

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Meet The High-Power Safety Check Officer (HP-SCO)(Blue Vest)

Prerequisites: The HP-SCO is an adult, 18 years old or older, with several years of experience and with at least a level 1 certification.

The High-Power Safety Check Officer examines all mid- and high-power rockets, certifies them to fly, and assigns them a pad. Mid-power rockets normally fly from Rack 3 (pads 13 through 18) and high-power rockets from Rack 4 (pads 19 through 24). Note that Rack 3 is the swing

rack which can be used for both low-, mid-, and high-power launches at the discretion of the RSO or LCO.

The mid-power rules apply to any rocket carrying a total impulse of 40 Newton-seconds but less than 120 Newton-seconds. This applies to all F and G motors, or clusters of smaller motors whose total impulse totals more than 40 but less than 120 N-s.

The high-power rules apply for any engine or combination of engines that is greater than 120 N-s (H).

The mid- and high-power flight cards have check-offs for all the following inspections.

Structure Check

The HP-SCO first checks the structural integrity of the rocket, including:

- Attachment of the fins
- Attachment of the engine mount
- Recovery system attachments to nose cone and rocket
- Packing of the parachute
- Fit of the nose cone.

Stability Check

The next step is to check the stability of the rocket. If the rocket is a kit, we will accept that the rocket is stable if built to the kit's specifications. If the rocket is not a kit, the flier will have to present some sort of documentation to show the location of the center of pressure (CP) so it can be compared to the location of the center of gravity (CG). The CG should be at least one caliber (body tube diameter) ahead of the CP to assure good stability. Rockets that do not conform to this rule will need compelling evidence, such as overlarge fins, to convince the HP-SCO that they are stable.

Engine Check

The next step is to insure that the engine is safe and appropriate for the high-power model being flown. The HP-SCO checks the type of engine and verifies that it is on the list of NAR certified engines. Only engines certified by the California Fire Marshal are allowed at club launches. The HP-SCO weighs the rocket and compares the launch weight to the recommended maximum weight for the engine. The HP-SCO uses an altitude chart to compare the maximum altitude and the appropriateness of the delay.

The altitude charts are in the Appendix. The charts plot the maximum altitude and time to maximum altitude and delay to maximum altitude (time minus propellant burn time) versus launch weight for different engines.

Electronics Check

For high powered rockets with electronic initiation of upper stages or of the recovery system, the HP-SCO checks the electronics to see that they are in good order. Specifically, the HP-SCO checks the condition of the:

- Altimeter
- Recovery system electronics
- Batteries
- Staging electronics

Pad Assignment

When all safety checks are complete, check off the appropriate boxes on the launch card and assign the rocket a pad by placing the launch card on the clipboard under the clip for the pad number assigned to the rocket. When the clipboard is full, give it to the LCO to be launched. When the rack is launched, the LCO gives back the clipboard. Note any rockets that are being given a second chance to launch and leave their launch cards on the clipboard. Remove any other launch cards and place them in the "Used Flight Cards" box.

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Meet The Launch Pad Supervisors (LPS) (Light Blue Vest)

Prerequisites: The LPS is a great job for our younger members. The LPS must have some experience setting up rockets on our launch pads and using our launch equipment.

The Launch Pad Supervisor (affectionately known as a "Pad Mother") is a good position for our experienced junior members. There are two LPSs, one for each of the two low power racks. One person can handle both racks, but there is a lot of walking involved as you must walk around the outside of the barrier string to get from one rack to the other. You must not climb over the barrier string and walk across the high power extension cords to get between the racks. Only the LCO may authorize anyone to walk inside the barrier strings.

The LPS basically hangs out around the pads looking cool in his light blue vest. He communicates with the LCO and other LPS using the club-supplied FRS radio (which is issued with the vest and is turned back at the end of shift). Whenever someone needs help or appears to

be having problems, the LPS steps in and helps them out. The most common problems are not knowing how to change a launch rod and how to connect the igniter clips to an igniter.

When helping with an igniter, this is a good time to show new rocketeers how to bend the igniters into two rabbit-ears so the clip can grab across two pieces of wire instead of just one.

One thing to keep in mind as an LPS; show the new rocketeers how to do it but then let them do it. For example, clip one igniter clip on but let them do the other.

When all rockets are ready to go on a rack, the LPS should make a quick check of each rocket to insure that the igniter clips are connected correctly, that the rocket is not sitting flat on the blast deflector and that the rockets do not appear to be ready to hang up on anything. He then lets the LCO know that the Rack is ready to be closed and launched.

During a night launch, the LPS job becomes more important as the LCO cannot see the pad area in the dark. It is the job of the LPS to make sure people stay out of the pad area when it is closed and to let the LCO know about any problems or special cases, such as a rocketeer needing to turn on his lights prior to a launch (this is where the FRS radio really comes in handy). The LPS gets one of the lanterns during the night launch and uses it to give the rocketeers more light while they are attaching their igniter clips. They are very appreciated when they do this as it is very difficult to hold a flashlight and connect an igniter clip at the same time. LPSs should not forget to turn off the lantern when the Rack is closed and the rockets are being launched.

The LPS job can be done by any rocketeer who has launched a few rockets at LUNAR. He needs to know how to change the launch rod and igniter clips on the LUNAR pads and how to put a rocket on a pad and attach the clips to the igniter. While not being a particularly difficult job, the LPS job saves us a lot of time by helping new rocketeers get their rockets on the pad more quickly and by decreasing the number of igniter failures. Also, while specifically intended as a helper to low power fliers, the LPS can also help out at the high power pads as well. While the HP fliers are not, by definition, beginners, they may be new to LUNAR, and unfamiliar with the equipment.

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Meet The Registration Manager (RM) (Green Vest)

Prerequisites: The RM needs to be high-school age at least 15 years old or older who understands how lunar operates. You can be trained for this position in about 5 minutes and the HP-SCO is there next to you if you have questions.

The Registration Manager watches over the launch sign in sheet, sells flight cards, hands out and receives membership applications, and answers questions about the club. When money is received for flight cards or as membership dues the RM makes change as necessary and records it on a transaction log.

Membership cards, applications, Flight Cards and other information are in the file box. Money and Flight Cards are in the cash box.

When members sign in, the RM stamps their hand with our special "rocket" stamp. When nonmembers present a ***Free First Day of Flying*** card the RM cancels the card by putting their name and date on the card and then stamps their hand. They get to keep the card as a souvenir. Nonmembers who pay the $5.00 walk on fee also get their hands stamped. Flight cards should only be sold to members or nonmembers who have their hands stamped.

The LUNAR fee schedule for launching and dues is as follows:

The RM should generally be at least high school age as they must handle money. The RM needs to know how LUNAR operates and how to launch rockets with LUNAR as they tend to be the first person a new rocketeer gets to talk to. If you cannot answer a question about LUNAR, the HP-SCO (who is at the adjacent table) is generally well versed in the operation of the club and can help you out.

PLANNING A COMPETITION LAUNCH

Whose rocket goes the highest? Stays up the longest? Looks the most realistic?

NAR members have been asking these questions for nearly 40 years -- and answering it almost as long. The NAR was founded in 1957, and the first NAR Annual Meet (NARAM) was held in 1959. Since then, tens of thousands of modelers have participated in sanctioned NAR competition.

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The Pink Book

Rocket competition in the United States is held according to the NAR's US Model Rocket Sporting Code -- or, as it is popularly called, the "Pink Book." The Pink Book describes and gives rules for over 25 different competition events, many of which are further divided according to engine power. The Pink Book is a free benefit of membership in the NAR.

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Types Of Competitions

Competitions are held at five levels:

1. Section - Limited to the members of a single NAR Section.
2. Local - Open to specific neighboring Sections or to any NAR member within a specific geographical area.
3. Open - Similar to Local meets, but must draw a minimum number of competitors, and no more than 75% from the same Section.
4. Regional - Open to all members in two or more states.
5. National - Open to all NAR members. Held annually, in a different area of the country each year.

You can also sanction Record Trials, a popular form of competition at which members compete against the record book instead of each other.

Competitors are divided into three age classifications, corresponding to youth, adolescent, and adult age ranges. Competitors compete only within their own age ranges. In addition, a special classification is available for teams - groups or two or more people flying as a single contestant.

The points that you and your Section earn through competitions throughout the year are added up to determine which of the competitors and Sections at that year's NARAM will go home with one of the National Championship trophies!

Return to contents.

Planning

Return to contents.

Permits

Return to contents.

Certification Of Records

Return to contents.

Awards

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Competition Events

The US Model Rocket Sporting Code prescribes rules for over 25 different rocket competition events. Where appropriate, many of these events are further divided by motor power. For

example, "B (engine) Altitude" is a different event from "F (engine) Altitude," for obvious reasons!

The events fall into four main groupings:

- Altitude Competitions
- Duration Competitions
- Craftsmanship Competitions
- Miscellaneous Competitions

Official US Records can be set in most of these competition events.

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Altitude Competitions

- Altitude - Achieve the highest altitude.
- Super-Roc Altitude - Fly the longest possible rocket to the highest altitude without structural failure. Points are awarded by a formula that takes into account both the length of the rocket and the altitude achieved.
- Predicted Altitude - Fly your rocket as closely as possible to an altitude you predict.
- Set Altitude - Fly your rocket as closely as possible to an altitude chosen by the Contest Director. The altitude is announced in advance of the meet and is the same for everyone.
- Random Altitude - Fly your rocket as closely as possible to an altitude chosen by chance on the day of the meet. The altitude is the same for everyone.
- Cluster Altitude - Achieve the highest altitude possible with a single-stage model using multiple motors.
- Payload - Carry a one-ounce cylinder of sand to the highest possible altitude.
- Egg Lofting Altitude - Carry a fresh hen's egg to the highest possible altitude.
- Dual Egg Lofting Altitude - Carry two fresh hen's eggs to the highest possible altitude.

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Duration Competitions

In general, duration models are not allowed to separate (recover in two or more pieces). This also limits most duration models to being single staged.

- Parachute Duration - Stay aloft the longest with one or more parachutes.
- Streamer Duration - Stay aloft the longest with a single streamer.
- Helicopter Duration - Stay aloft the longest with a model that uses autorotation as the sole recovery device.
- Super-Roc Duration - Stay aloft the longest with the longest possible model. Points are awarded by a formula that takes into account both the length of the rocket and the time aloft.
- Egg Lofting Duration - Stay aloft the longest while carrying a fresh hen's egg.

- Dual Egg Lofting Duration - Stay aloft the longest while carrying two fresh hen's eggs.
- Boost/Glider Duration - Stay aloft the longest with a rocket-boosted glider. The model is allowed to separate and may be multi-staged, since only the glider portion is timed.
- Rocket/Glider Duration - Stay aloft the longest with a rocket-boosted glider. Nothing is allowed to separate -- the entire model must boost vertically, but must return in a stable glide. This challenging event usually requires a model with clever moving parts.
- Flex-Wing Boost/Glider Duration - Same as Boost/Glider, except the glider must use flexible wings.
- Predicted Duration - Stay aloft as closely as possible to a time you predict.
- Set Duration - Stay aloft as closely as possible to a time chosen by the Contest Director. The time is announced in advance of the meet and is the same for everyone.
- Random Duration - Stay aloft as closely as possible to a time chosen by chance on the day of the meet. The time is the same for everyone.

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Craftsmanship Competitions

Except for Scale Altitude, any motor power is allowed.

- Scale - Build and fly an accurate scale model. Supporting data is required. Judges measure and rank the model. The model must make a safe and stable flight.
- Scale Altitude - Fly an accurate scale model to the highest possible altitude. Models are judged as for scale, and an additional factor is awarded for the altitude achieved.
- Super Scale - Same as Scale, but includes a scale launching complex as well.
- Sport Scale - Same as Scale, but the model is not measured. It is judged for conformation and craftsmanship by a team of judges standing at a distance.
- Giant Scale - Same as Sport Scale, except that models cannot be smaller than a given minimum size.
- Peanut Scale - Same as Sport Scale, except that models cannot be larger than a given maximum size.
- Plastic Model Conversion - Construct a common plastic model of a rocket that was not originally manufactured as a flying kit, and convert it to fly in a safe and stable manner. Points are awarded for both craftsmanship and flight qualities.
- Space Systems - A Sport Scale rocket, along with an optional Sport Scale launch complex, must successfully simulate the flight performance and mission of the original prototype.

(Ed: Mention Jack's F/F scale? -- events under development?)

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Miscellaneous Competitions

- Spot Landing - Land your model closest to the spot chosen by the Contest Director. The spot is the same for everyone. Any motor is allowed. This event can be held in three sub-classes: Parachute; Streamer; or Open (any recovery system allowed).

- Drag Race - Two rockets are launched simultaneously through a single switch. The judges award points for the model that achieves first motion, achieves the lowest altitude, and lands last. The winner of each "heat" goes on to fly subsequent heats until an overall winner is determined.
- Radio-Controlled Glider - A combination of Boost/Glider Duration, Set Duration, and Spot Landing. The object is to fly a Radio-Controlled Boost/Glider as close as possible to a time duration set by the Contest Director, while landing it as close as possible to a spot determined by the Contest Director.
- Research and Development - Contestants prepare and present a written research or engineering project. Oral presentations are required of competitors being considered for the top four places.

MODEL ROCKETRY ORGANIZATIONS

******need addresses, phone numbers, etc for all of these *****

NAR, the National Association of Rocketry, of which LUNAR is a section (local chapter).

BayNar, the other NAR section in the San Francisco Bay Area.

ROC, the Rocketry Organization of California, an NAR section in Los Angeles.

AeroPac, the local prefecture of the Tripoli Rocketry Association.

Other NAR sections:

COSROCS in Colorado.

DARS in Texas.

MARS in New York.

LIARS in New York (also a Tripoli prefecture).

NHRC in Texas (also a Tripoli prefecture).

NAR
PO Box 177
Altoona, WI 54720

The National Association of Rocketry is the oldest and largest sport rocketry organization in the world. Since 1957, over 65,000 serious modelers have joined the NAR to take advantage of the fun and excitement of organized rocketry!

Benefits:

- Local Clubs
- Organized Launches and Competitions
    - NARAM, a week-long competition meet (July 25-August 1, 1997, in Tucson AZ);
    - NSL, a three to four-day National Sport Launch (Memorial Day weekend, May 24-25, in Dallas TX)
    - NARCON, our National Convention (March 21-23 in Champaign IL). <Picture>
- Sport Rocketry Magazine
- Liability Insurance
- High-Power Certification
- Conventions
- Technical Services The NAR Technical Services (NARTS) is a source of rocket plans, scale data and photos, technical reports, manuals, books, flight and simulation software and logo membership items.

MODEL ROCKETRY BOOKS AND MAGAZINES

Sport Rocketry

The official journal of the National Association of Rocketry.

Published bi-monthly.

Sport Rocketry features regional launch coverage, "how to" articles, rocket plans, scale data, competition tips, product reviews and much more!

MODEL ROCKETRY INTERNET SITES

LUNAR (the Livermore Unit of the National Association of Rocketry

http://www.lunar.org

Lynn Kissel's LUNAR pages (newsletter, handbook, procedures, etc.)

http://www.starship.org/LUNAR

National Association of Rocketry

http://www.nar.org

BayNar other NAR section in the San Francisco Bay Area

http://www.airaffair.com/Clubs/baynar.html

ROC (the Rocketry Organization of California), an NAR section in Los Angeles

http://www.advradio.com/~jds/roc.html

AeroPac (Association of Experimental Rocketry of the Pacific), the local prefecture of the Tripoli Rocketry Association

http://www.aeropac.org/aeropac

rec.models.rockets, the Usenet newsgroup devoted to model rockets

news:rec.models.rockets

On-line archive for rec.models.rockets

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

rec.models.rockets on-line FAQ (frequently asked questions)

http://dtm-corp.com/~sven/rockets/rmrfaq.toc.html

COSROCS in Colorado

http://www.rmi.net/craftscorner/cosrocs/cosrocs.html

DARS in Texas

http://www.metronet.com/~richards/darshome.htm

MARS in New York

http://nysernet.org/staff/billowens/mars/mars.html

LIARS in New York

http://qa.pica.army.mil/~dkatz/liars.html

NHRC in Texas

http://www.phoenix.net/~rocket/club.html

rocket page at the University of Arizona

http://seds.lpl.arizona.edu/rocket/rocket.html

Transdimensional Gateway

http://www.ior.com/~markcln/tgate.htm

MODEL ROCKET MANUFACTURERS

Aerotech, Aerotech/RMS

Aerotech, Inc.

1955 S. Palm St., Suite. #15

Las Vegas, NV 89104

Voice: 1-702-641-2301

FAX: 1-702-641-1883

Larger rockets (30" to 70" long), Larger engines D through F, reloadable engines.

Apogee

Centuri Engineering Company

Estes

Estes Industries

Dept. 708

1295 H. Street

Penrose, CO 81240

719-372-6565, Ex. 276

Small to medium rockets (4" to 30"), Engines (miniA through E)

Flight Systems, Inc.

Kosdon Truly Recyclable Motors

MRC

North Coast Rocketry

Quest

LAWS, REGULATIONS, AND CODES

Regulation of model rocketry is broken into two classes with different regulations applied to each.

1. Model Rocketry
2. High-Power Model Rocketry

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Model Rocketry

There are generally few regulations applied to model rocketry, with most of those applied at the state and local level. Forty eight states (all but Rhode Island and California) adhere to a common code of regulations for model rocketry known as National Fire Protection Association (NFPA) Code 1122. This code defines the power, weight, and other limits to which a rocket must comply in order to be classified as a "model rocket."

At the Federal level, according to FAR 101.1 model rockets are exempt from FAA regulation, provided they are operated in a manner so as not to pose a hazard to aircraft. The only exception to this rule is that if a model rocket weighs between 454 and 1,500 grams, you must notify the nearest FAA control tower before launching them. Model rocket kits and motors do come under the jurisdiction of the Consumer Product Safety commission where they must satisfy the same basic product safety requirements as toys.

The State of California treats model rockets as a special class of fireworks and requires:

1. You must be at least 14 years old to purchase model rocket engines (1/4A through D class).
2. You must be at least 18 years old to purchase engines larger than D.
3. To launch, you must secure the written or verbal permission of the local fire authority having jurisdiction over the location where you wish to launch.

The City of Livermore requires that you get a permit from the City Fire Marshal and that you have at least a million dollars of liability insurance. There are currently only two permit holders in the city of which LUNAR is one.

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High-Power Rocketry

The second class of rockets are High-Power Model rockets. A rocket is considered high-power if it exceeds any of the following.

- Uses a motor with more than160 Newton-seconds of total impulse (an "H" motor or larger) or uses multiple motors that all together exceed 320 Newton-seconds of total impulse.
- Uses any motor with a thrust of more than 80 Newtons average thrust
- Has a launch weight (including the engines) of more than 1,500 grams
- Includes any airframe parts of fiberglass or ductile metal
- Is powered by a pre-manufactured motor that involves any assembly by the modeler.

High-power model rockets fall under a different code of regulations from those for model rockets. The high-power regulations are known as National Fire Protection Association (NFPA) Code 1127. This is a relatively new code (1995) and so most states have not yet had time to adopt it. You should check your own state's laws before attempting to launch high power rockets.

In addition, high power rockets and motors are directly regulated by the federal government including the FAA and the BATF.

- Before you can purchase engines and fly high-powered model rockets, you must apply for and receive an FAA waiver, The purpose of this waiver is to arrange for air traffic to be routed clear of your flight area.

- You must also apply for and receive a BATF Low Explosives User Permit before taking receipt of any rocket motors exceeding 62.5 grams of propellant. This involves, among other things, constructing a "magazine storage" for the engines that is compliant to federal standards.

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Federal Regulations

The Federal regulations related to Model Rocketry can be found at the following locations.

Return to contents.

BATF

Bureau of Alcohol, Tobacco and Firearms Codes ???

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NFTA

National Fire Protection Association (NFPA) Codes 1122 (for model rocket motors) and 1127 (for high-power rocket motors)

Internet: http://www.wpi.edu/~fpe/nfpa.html

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FAA

Federal Aviation Regulations Part 101 (Section 307, 72 Statute 749, 49 United States Code 1348, "Airspace Control and Facilities," Federal Aviation Act of 1958)

Internet: http://www.faa.gov/avr/afs/fars/far-101.txt

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State of California Regulations

Model Rockets are included in the Health and Safety Codes (HSC), sections 12500 through 13000.

Internet: http://www.jhhw.com/codes/index.html

To obtain a copy of the State of California Model Rocketry Regulations, write to:

California Dept of Forestry and Fire Protection

Office of State Fire Marshal

Prefire Engineering

P.O. Box 944246

Sacramento, CA 94244-2460

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City of Livermore Regulations

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NAR Model Rocket Safety Code (Revision of ?????)

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

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

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

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

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

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

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

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

9. Ignition System. The system I use to launch my model rocket will be remotely controlled and electrically operated. It will contain a launching switch that will return to "off" when released. The system will contain a removable safety interlock in series with the launch switch. All persons will remain at least 15 feet from the model rocket when I am igniting model rocket motors totalling 30 Newton-seconds or less of total impulse and at least 20 feet from the model rocket when I am igniting model rocket motors totalling more than 30 Newton-seconds of total impulse. I will use only electrical igniters

recommended by the motor manufacturer that will ignite model rocket motors within one second of actuation of the launching switch.

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

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

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

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

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

LAUNCH SITE DIMENSIONS

Installed Total Impulse (N-sec)	Equivalent Motor Type	Minimum Site Dimensions (ft.)
0.00 - 1.25	1/4A, 1/2A	50
1.26 - 2.50	A	100
2.51 - 5.00	B	200
5.01 - 10.00	C	400
10.01 - 20.00	D	500
20.01 - 40.00	E	1,000
40.01 - 80.00	F	1,000
80.01 - 160.00	G	1,000

160.01 - 320.00	Two G's	1,500

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NAR High Power Model Rocket Safety Code (Revision of July, 1995)

1. Certification. I will fly high power rockets only when certified to do so by the National Association of Rocketry.

2. Operating Clearances. I will fly high power rockets only in compliance with Federal Aviation Regulations Part 101 (Section 307, 72 Statute 749, 49 United States Code 1348, "Airspace Control and Facilities," Federal Aviation Act of 1958) and all other federal, state, and local laws, rules, regulations, statutes, and ordinances.

3. Materials. My high power rocket will be made of lightweight materials such as paper, wood, rubber, and plastic, or the minimum amount of ductile metal suitable for the power used and the performance of my rocket.

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

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

6. Weight and Power Limits. My rocket will weigh no more than the motor manufacturer's recommended maximum liftoff weight for the motors used, or I will use motors recommended by the manufacturer of the rocket kit. My high power rocket will be propelled by rocket motors that produce no more than 40,960 Newton-seconds (9,204 pound-seconds) of total impulse.

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

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

9. Launch Site. I will launch my high power rocket outdoors in a cleared area, free of tall trees, power lines, buildings, and dry brush and grass. My launcher will be located at least 1,500 feet from any occupied building. My launch site will have minimum dimensions at least as great as those in the Launch Site Dimension Table. As an alternative, the site's minimum dimension will be one-half the maximum altitude of any rocket being flown, or 1,500 feet, whichever is greater. My launcher will be no closer to the edge of the launch site than one-half of the minimum required launch site dimension.

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

11. Ignition System. The system I use to launch my high power rocket will be remotely controlled and electrically operated. It will contain a launching switch that will return to "off" when released. The system will contain a removable safety interlock in series with the launch switch. All persons will remain at a distance from the high power rocket and launcher as determined by the total impulse of the installed rocket motor(s) according to the accompanying Safe Distance Table.

12. Launch Safety. I will ensure that people in the launch area are aware of the pending high power rocket launch and can see the rocket's liftoff before I begin my audible five-second countdown. I will use only electrical igniters recommended by the motor manufacturer that will ignite rocket motors within one second of actuation of the launching switch. If my high power rocket suffers a misfire, I will not allow anyone to approach it or the launcher until I have made certain that the safety interlock has been removed or that the battery has been disconnected from the ignition system. I will wait one minute after a misfire before allowing anyone to approach the launcher.

13.Flying Conditions. I will launch my high power rocket only when the wind is no more than 20 miles per hour and under conditions where the rocket will not fly into clouds or when a flight might be hazardous to people, property, or flying aircraft. Prior to launch, I will verify that no aircraft appear to have flight paths over the launch site.

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

15. Launch Angle. I will not launch my high power rocket so its flight path will carry it against a target. My launch device will be pointed within 20 degrees of vertical. I will never use rocket motors to propel any device horizontally.

16. Recovery Hazards. If a high power rocket becomes entangled in a power line or other dangerous place, I will not attempt to retrieve it. I will not attempt to catch my high-power rocket as it approaches the ground.

LAUNCH SITE DIMENSION TABLE

Total Impulse All Engines (Newton-Seconds)	Equivalent Motor Type	Minimum Site Dimensions (ft.)	Equivalent Dimensions
160.01 - 320.00	H	1,500	
320.01 - 640.00	I	2,500	Half mile
640.01 - 1,280.00	J	5,280	One mile
1,280.01 - 2,560.00	K	5,280	One mile
2,560.01 - 5,120.00	L	10,560	Two miles
5,120.01 - 10,240.00	M	15,840	Three miles
10,240.01 - 20,480.00	N	21,120	Four miles
20,480.01 - 40,960.00	O	26,400	Five miles

SAFE DISTANCE TABLE

Total Impulse All Engines (Newton-Seconds)	Equivalent Motor Type	Minimum Distance From Rocket With Single Motor (ft.)	Minimum Distance From Rocket With Multiple Motors (ft.)
160.01 - 320.00	H	50	100
320.01 - 640.00	I	150	200
640.01 - 1,280.00	J	150	200
1,280.01 - 2,560.00	K	200	300
2,560.01 - 5,120.00	L	300	500
5,120.01 - 10,240.00	M	300	500
10,240.01 - 20,480.00	N	500	1,000
20,480.01 - 40,960.00	O	500	1,000

LUNAR Contacts

Club Officers

Name	Officer	PHONE	E-MAIL
Board Officers			
Craig Saunders	President	(925) 324-2400	president@lunar.org
Jack Hagerty	Past President	(925) 455-1746	past-pres@lunar.org
Tony Cooper	Vice President	(510) 471-3648	vp@lunar.org
Dave Raimondi	Secretary	408.997.2571 (h) 408.742.5173 (w)	secretary@lunar.org
Sheryl Cooper	Treasurer	(510) 471-3648	treasurer@lunar.org
Lee Teicheira	Board Member-at-Large	Home: (925) 672-6341 Cell: (925) 348-3435	bmal1@lunar.org
Richard Hagen	Board Member-at-Large	Home: (510) 339-9864 Work: (510) 553-9132	bmal2@lunar.org
Non-board Officers			
Jack Hagerty	NAR Section Advisor	(925) 455-1746	advisor@lunar.org
Cliff Sojourner	Newsletter editor	(408) 737-9753	newsletter@lunar.org
Tony Cooper	Membership Chair	(510) 471-3648	membership@lunar.org
Jack Hagerty	Hotline	(925) 455-1746	hotline@lunar.org
Charles Winter	High-power		highpower@lunar.org

	Coordinator		
Tom Desmarais	Contest Director	(650) 906-1843	contest@lunar.org
William Orvis	Equipment Manager	(925) 443-8253	equipment@lunar.org
William Orvis	Webmaster	(925) 443-8253	webmaster@lunar.org

LUNAR Calendar for 2006

LUNAR Launch Schedule

Month	Date	Day	Time	Location
Dec	12/3/2005	Saturday	9:00am - 3:00pm	Snow Ranch
Dec	12/17/2005	Saturday	9:00am - 1:00pm	Robertson Park
Jan	1/14/2006 Canceled	Saturday	9:00am - 3:00pm	Snow Ranch
Jan	1/21/2006 Canceled	Saturday	9:00am - 1:00pm	Robertson Park
Feb	2/4/2006 Postponed to 2/11/2006	Saturday	9:00am - 3:00pm	Snow Ranch
Feb	2/18/2006 Canceled	Saturday	9:00am - 1:00pm	Robertson Park
Mar	3/11/2006 Canceled	Saturday	9:00am - 3:00pm	Snow Ranch
Mar	3/18/2006	Saturda	9:00am - 1:00pm	Robertson Park

		y		
Apr	4/1/2006 Canceled	Saturday	9:00am - 3:00pm	Snow Ranch
Apr	4/15/2006 Canceled	Saturday	4:00pm - 10:00pm	Robertson Park Night Launch
May	5/6/2006	Saturday	9:00am - 3:00pm	Snow Ranch tentative
May	5/13/2006 Rescheduled Night Launch	Saturday	4:00pm - 10:00pm	Robertson Park Night Launch
Jun	6/4/2006 Changed	Sunday	9:00am - 1:00pm	Robertson Park
Jul	7/15/2006	Saturday	9:00am - 1:00pm	Robertson Park
Aug	8/19/2006	Saturday	9:00am - 1:00pm	Robertson Park
Sep	9/16/2006	Saturday	9:00am - 1:00pm	Robertson Park Contest Launch
Oct	10/21/2006	Saturday	4:00pm - 10:00pm	Robertson Park Night Launch
Nov	11/4/2006	Saturday	9:00am - 3:00pm	Snow Ranch
Nov	11/18/2006	Saturday	9:00am - 1:00pm	Robertson Park
Dec	12/2/2006	Saturday	9:00am - 3:00pm	Snow Ranch
Dec	12/16/2006	Saturday	9:00am - 1:00pm	Robertson Park

Lunar Meeting Schedule

Month	Date	Day	Time	Agenda
Jan	1/18/2006	Wednesday	7:30pm - 9:30pm	Elections
Mar	3/15/2006	Wednesday	7:30pm - 9:30pm	TBD
May	5/10/2006	Wednesday	7:30pm - 9:30pm	TBD
July	7/12/2006	Wednesday	7:30pm - 9:30pm	TBD
Sept	9/13/2006	Wednesday	7:30pm - 9:30pm	Designing rockets with RockSim
Nov	11/15/2006	Wednesday	7:30pm - 9:30pm	Planning meeting. Care and feeding of Reloadable Motor Systems
Jan	1/?/2007	Wednesday	7:30pm - 9:30pm	Elections. Making Junk Fly

Bylaws

LUNAR - the Livermore Unit of the National Association of Rocketry

by·laws \`bi-,loz\ *n* [ME *bilawe*, prob. fr. (assumed) ON *bylög*, fr. ON *byr* town + *lög* law] : rules adopted by an organization chiefly for the government of its members and the regulation of its affairs

Bylaws last amended: March 15, 2006

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Article 1. Name

The name of this organization shall be LUNAR (the Livermore Unit of the National Association of Rocketry).

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Article 2. Purpose

It shall be the purpose of this Section to

(a) aid and abet the aims and purpose of the NAR in the TriValley region of Alameda County, California,

(b) to supply a safe, educational and legal means of furthering the hobby of model rocketry in accordance with the NAR Standards and Regulations,

(c) to aid and encourage the development of all club members' knowledge and expertise in the area of model rocketry, from basic to advanced technical skills, through educational meetings including guest lecturers, supervised construction meetings and launches and

(d) to engage in other scientific, educational, or related activities as the NAR, the Section, or the Section Board of Directors may from time to time deem necessary or desirable in connection with the foregoing.

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Article 3. Membership

Individual NAR membership is strongly encouraged but not required. A minimum of five persons with individual senior NAR membership and NAR member insurance are required in order for the club to become a sanctioned NAR Section.

Membership categories shall be:

a) Youth Membership; Eleven (11) years of age and under

b) Junior Membership; Twelve (12) to and including fourteen (14) years of age

c) Senior Membership; Fifteen (15) to and including seventeen (17) years of age

d) Adult Membership; Eighteen years of age and older

Membership in category (a) above requires that an adult parent or legal guardian also be an active Section member and sign a parental permission form. All Youth members must be accompanied by an Adult member at all meetings and launches.

Candidates for Junior and Senior membership (categories b and c) must have a parental permission slip signed by an adult parent or legal guardian in order to become Section members.

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Article 4. Dues

Dues shall be paid on a yearly basis, payable in advance. The membership year shall coincide with the calendar year, January 1 through December 31.

Dues are determined by membership category as given below.

- Youth Membership; Three Dollars ($3.00) annually
- Junior Membership; Six Dollars ($6.00) annually
- Senior Membership; Nine Dollars ($9.00) annually
- Adult Membership; Fifteen Dollars ($15.00) annually

Pro Rata Collection of Dues for New or Lapsed Members: Dues for new members joining after the beginning of the year shall be set according to the following schedule:

- 1 January through 30 April: The full annual dues of the appropriate membership category.
- 1 May through 31 August: 2/3 of the annual dues of the appropriate membership category.
- 1 September through 31 December: 1/3 of the annual dues of the appropriate membership category.

This schedule is for the initial dues of the current year only, after which the full dues schedule shall be in effect.

Contributing Membership Plan: Dues income shall be supplemented by a special prefix of "Contributing" for each of the membership categories (as in "Contributing Adult Member") with an annual dues contribution of thirty-five dollars ($35.00) or more.

All dues moneys shall be kept in a General Fund by the Treasurer and shall be paid out by him only on order of the Section Board of Directors. Special assessments may be levied by a majority vote of the members present and voting at any meeting of the section provided notice of such intent is given in writing to each member at least five (5) days preceding such a meeting. These section dues are separate and distinct from any national dues paid to NAR. Individuals NAR membership is strongly encouraged but not required.

Dues income shall be supplemented by a $0.25-per-flight charge for flight cards for rockets in the impulse class of "E" or below, $0.50-per-flight charge for flight cards for rockets in the impulse classes of "F" or "G", and a $1.00-per-flight charge for rockets in the impulse class of "H" or above. Charges for flight cards may be waived by a club officer for a number of situations, including for outreach groups and members who have volunteered for various jobs at Section events.

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Article 5. Meetings

An annual Section meeting (open to all Section business) shall be held during the first quarter of the calendar year. Additional Section meetings shall be held throughout the year as needs and interest require.

All Section meetings at which officers or members of the Board of Directors will be elected, or at which the Bylaws will be amended, require a five day notice to the membership in a form deemed appropriate by the Board of Directors.

Section launches will be held on dates determined at an annual planning meeting held towards the end of the preceding year. The planning meeting shall be held early enough to allow for the timely processing of documents with the launch site land owner and the FAA so as to not delay the start of the following year's launches. A Section launch is not considered a Section meeting.

A quorum of the Section membership must be present in order to hold an official meeting of the Section. A quorum shall consist of five members of the Section.

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Article 6. Board of Directors

The Board of Directors of this section shall consist of the five officers and two members at large all of whom shall be members of the Section and the NAR.

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Article 7. Officers

The officers of this section shall consist of a President, a Vice President, a Secretary, a Treasurer, and a Past President, all of whom shall be members of the Section and the NAR.

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Article 8. Elections

Elections of officers (except Past President) and members of the Board of Directors shall take place at the annual Section meeting. All officers and members of the Board of Directors shall serve a term of one year. Vacancies in offices and on the Board of Directors shall be filled by nomination and election of a Section member to serve the remaining term of office and shall take place at the Section meeting at which the vacancy is announced. Nominations for all elections shall be made from the floor, and the candidate having the largest number of votes shall be elected.

When a President is succeeded, he assumes the office of Past President. If the office of Past President becomes vacant, only former Presidents or Vice Presidents are eligible to fill the office.

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Article 9. Committees

There shall be three standing committees of the Section, plus such additional committees as the Board of Directors may from time to time deem necessary or desirable.

The Standing Committees are as follows:

(a) The Operations Committee shall be in charge of the Section's model rocket range and launch equipment, shall monitor the experimental technical activities of the Section members, and shall act as Safety Inspectors. This Committee shall also be in charge of all arrangements for contests and shall monitor all national record attempts by Section members. The Chairman of this committee shall be a Senior Member of the NAR in good standing and shall act as Range Safety and Control Officer under the NAR Official Standards and Regulations.

(b) The Activities Committee shall be in charge of making all arrangements for all Section meetings, for conducting membership campaigns, and carrying on public relations.

(c) The Education Committee shall be in charge of educating all Section members in the safe and proper procedures of the hobby of model rocketry. This Committee shall be in charge of making all arrangements for presentations or demonstrations at Section meetings by guest lecturers.

(d) The Section President shall be an ex-officio member of all committees.

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Article 10. Amendments

These Bylaws may be amended by a two-thirds vote of those junior, senior and adult Section members present and voting at any official meeting of the Section, providing notice of the pending amendment has been given to the membership at least five days in advance of the meeting in a form deemed appropriate by the Board of Directors. Youth members (age eleven and under) may not vote to amend these Bylaws.

LUNAR Membership

Joining LUNAR

We try to keep membership affordable to encourage participation, especially by families and kids. Despite the high value of the club's equipment and the NAR insurance coverage, the

maximum dues are only $15/year, and a variety of discounts are available. Aside from special rates for young people, we also provide *pro rata* discounts for folks who join late in the year.

The Fees for launching and dues are:

Low-power flight cards (A through E motors)	$0.25
Mid-power flight cards (F and G motors)	$0.50
High-power flight cards (H and above motors)	$1.00
Nonmember daily walk on fee	$5.00
§Adult member dues (18 and over)	$15.00
§Senior member dues (15-17)	$9.00
§Junior member dues (12-14)	$6.00
§Youth member dues (11 and under)	$3.00

§Dues paid after May 1 are discounted 33%. Dues paid after September 1 are discounted 66%.

For those wishing to support the club with an additional contribution, we have the category of:

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Contributing member          $35.00
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Because applying for membership involves sending in dues (and in the case of junior/senior members, parental signature on the permission slip), we have not implemented an online

procedure for joining LUNAR. The membership application is designed to be sent by regular mail. The blank application form is available in hardcopy form at our launches, or online in digital form (PDF):

- Membership Form