PEAK OF FLIGHT NEWSLETTER

ISSUE 437 | Februrary 21st 2017

IN THIS ISSUE

What's in a range box and why

www.ApogeeRockets.com/Rocket-Kits/Skill-Level-3-Model-Rocket-Kits/EggTosser

Apogee Components, Inc.
Your Source For Rocket Supplies That Will Take You To The "Peak-of-Flight"
3355 Fillmore Ridge Heights Colorado Springs, Colorado 80907-9024 USA
www.ApogeeRockets.com e-mail: orders@apogeerockets.com Phone: 719-535-9335 Fax: 719-534-9050

APOGEE COMPONENTS

What's in a range box and why

By Kris Allen

A key part of rocketry is having the proper supplies necessary to prepare and conduct a launch with the goal of a safe and successful flight. However, as most of us can relate through experience, rocket flights don't always go as planned. The post flight analysis of many failed events often conclude that the likely cause was due to improper preparations, or as some call it "pilot error". Perhaps you or someone you know did not get RSO/LCO approval to fly a rocket without corrections. Or worse, you had to recover the remains of a rocket resulting from improper preparations such as not enough wadding, wrong engine delay, not fixing a loose-fitting nose cone, packing the parachute poorly, or a variety of other reasons. Many of these issues can be avoided by having proper supplies that are well organized in your range box.

The purpose of this article is to share fundamental information regarding tools and supplies you may want to consider having in your range box and why they are useful. It goes beyond the scope of this article to try to discuss every idea, specific use, or advanced rational for including various supplies in your range box. However, keeping in mind the different levels of interest and experience, the ideas and discussion presented should serve helpful because it gives you a good beginning point for preparing a range box, or sparks an idea for an item you had not considered.

The intuitively obvious reason to have a range box is so that you can carry supplies needed at a launch site. But it also should serve to help you organize so that you can find supplies easily making for more time successfully launching rockets and less time searching for hard to find items. My first range box was simply a cardboard box I threw everything into. My next box was a small tackle box that was a little better organized, but I quickly outgrew it and ended up not much better than the cardboard box when it came to organization (or lack thereof). That usually meant dumping things out of the box and then chasing them in the wind or losing them in the grass. Sound familiar? A good range box should not require you to dig excessively through it to get to something that got lost in the bottom (although that still happens sometimes).

Instead, it should have various compartments, dividers, or trays designated for specific items. Further, it should have sufficient space to allow you to add items later while maintaining a sense of organization. Often that means replacing the box with a bigger one or adding more boxes or stackable organizers. Ask most any experienced rocketeer and I'm sure they can tell you how easy it is to outgrow your range box, especially if you get into higher power levels and more complex rockets requiring additional supplies. There are many options for a range box ranging in price, size and design. You may even choose to custom build a range box. Most hardware or tool supply stores offer a broad range of storage totes, tool boxes and organizers.

You may also consider fishing tackle boxes found at sporting supply stores or some combination of several of these. For example, you may have a separate range box for low power, mid power or high power rocket supplies depending on your level of involvement. Or you may have one box for flammable materials such as motors, pyro charges and ignitors and another for general supplies such as parachutes, adhesives, nose cones, etc.

I've even seen suggestions to have a small pocket sized box to protect and carry extra ignitors and motor plugs so you don't have to go all the way back to your prep-table to get one after the one in your rocket fails. How you organize is

Continued on page 3

About this Newsletter

You can subscribe to receive this e-zine FREE at the Apogee Components website **www.ApogeeComponents.com**, or by clicking the link here Newsletter Sign-Up

Newsletter Staff

Writer: Kris Allen
Layout/Cover Artist: Chris Duran
Proofreader: Michelle Mason

What's in a range box and why

Continued from page 2

up to you; the point is the better you are organized, the more time you will enjoy successfully launching rockets. This also means you may need to reorganize after a day in the field so that it is ready for the next use as items tend to get shuffled around.

Part of deciding on the type of range box as well as the size depends on what you intend to carry and how you plan to organize the items. With that said, let's explore many of the fundamental items you should consider.

Launch Equipment:

If you plan to attend a club event, you probably don't need to bring your own launch equipment as the clubs generally provide this. However, if you are not launching at a club event, then you may need a way to carry and organize your launch equipment. This can be cumbersome to carry around given the size of the equipment and all the parts including the launch pad, rod, blast shield, controller and wires, battery, etc. This can also make it easy to forget something. I remember driving out to a rural area where we were permitted to launch rockets to find I was missing my launch rod as I apparently dropped it on the way to load the car and didn't notice. Perhaps if I had kept everything in a dedicated storage box, I would not have had to drive back home to find it. You may also want to consider a fire extinguisher to include with this box or other tools to prepare a safe launch site.

Motors/Motor Adaptors/Spacers:

A proper selection of motors applicable for the different size, weight and model design you intend to fly should be part of your range box **(Figure 1)**. Additionally, the selection of motors should consider different flying conditions. For example, if it's breezy, depending on the rocket design you may need a higher lift off speed to allow the rocket to leave the launch rod in a

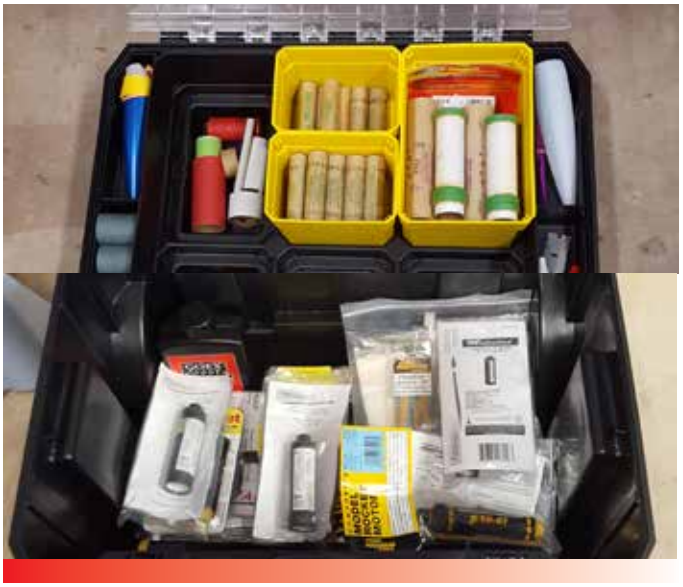


Figure 1: A variety of low and high power motors to select from depending on your needs on the range.

stable manner (above 30 mph). Further, it may weathercock and require a different delay time to properly deploy the parachute. How many times have you seen a rocket heading back down to deploy the parachute at the last possible second but typically ends up with a zippered tube or torn chute? Also, you may choose not to fly the rocket as high due to cloud cover or winds. Flying conditions can affect the choice of motor depending on the design, size, and weight of the rocket. Using a program such as Rocksim with several possible conditions you might expect can help in deciding which motors and delay times should be considered in your range supplies. This is more critical with heavier higher powered rockets, but still important to factor into your

Continued on page 4

www.apogeerockets.com/RockSim/RockSim_Information

What's in a range box and why

Continued from page 3

motor supply. Another reason to have different motors in your supply is if you're involved with a competition flight or the TARC program where you need to achieve a certain flight goal such as altitude or flight time. You may also be flying a multi-staged or cluster rocket and need additional motors in your supply.

Along with the optional motors in your supply, you may need to include motor adaptors or spacers. Adaptors allow you to use a smaller diameter motor in a rocket that was built for a larger diameter motor. For example, a rocket with a 29mm motor tube (with motors ranging from E through I impulse levels) can be adapted to hold a 24mm motor (with motors ranging from C through G impulse levels). Adaptors may be built from Kraft paper tubes and centering rings available in kit form as well as blue tube, plastic or phenolic materials. They may also be purchased as "ready-to-use" which are made from plastic or aluminum. Similarly, spacers allow you to use a shorter motor in place of a longer motor where a motor block is used to retain the forward end of the motor. Spacers can be made of similar materials as motor adaptors cut to various lengths. Since there are several motor sizes between black powder and composite motors, it may be a good idea to include various pre-cut lengths of spacers, and perhaps two of each in case one gets lost or misplaced. Spacers are also useful as a pedestal on the launch pad in case the rocket needs to be spaced away from the blast shield to avoid the igniter from shorting out. Finally, should you need to make a repair, such as a zippered tube or crimped tube, a spacer may be used as a coupler to do a field fix and fly again.

Igniters:

Depending on the type of motor or application, there are different types of igniters that you may need. They are normally included with motors, but often they fail to ignite the motor in which case it is a good idea to have spares. Be prepared to have 2 or 3 igniters fail to ignite a motor due to low voltage battery, improper contact with the motor propellant, broken lead, or simply a bad igniter. Another good reason to have a good supply is so you can help a fellow rocketeer who for some reason or another is in need of an igniter and didn't have their own backup supply. In addition to the igniter, having correct size for the type of motor being used is critical. Low power motors generally use a small short igniter. But as the motor size increases, the igniter length also increases as the igniter must be pushed deeper into the longer motor. Additionally, if you have pyro charges for deployment or secondary ignition such as an air start for a second stage, or other complex flying techniques where an electronic ignition source must

Continued on page 5

What's in a range box and why

Continued from page 4

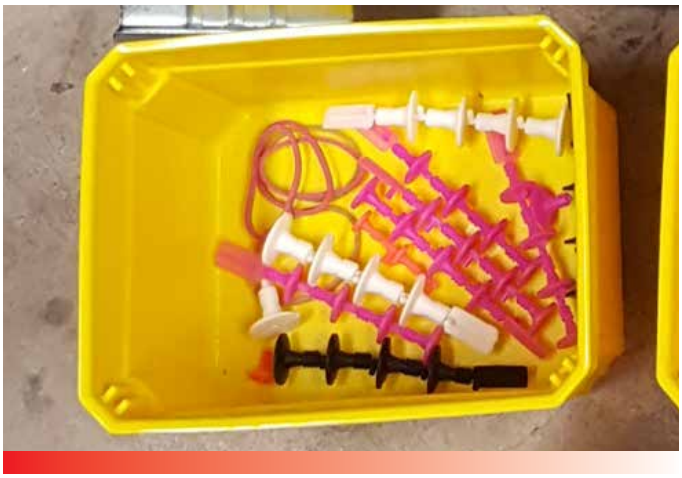


Figure 2: It is helpful to have plenty of spare igniter plugs in your range box.

be used, there may be specific igniters and sizes used. Along with igniters, you should carry spare igniter plugs commonly used with low power. For mid to high power, they may have a rubber band or plastic cap used to hold the igniter in place. A few extras can't hurt to have in your box in case you lose one **(Figure 2)**.

Wadding/Parachute Protection:

There are several ways of protecting the parachute from being damaged by the hot gas from the ejection charge used to deploy the parachute. A disposable recovery wadding that looks like tissue paper or material that looks like insulation commonly called "dog barf" are generally used for low and small diameter mid power rockets. There are also Styrofoam ejection plugs pre-sized for different body tube diameters more common for competition rockets where a stronger ejection is needed to push out a larger parachute. Often at a club launch the dog barf is available, but not always. Therefore, having sufficient wadding in your range box is critical. Be sure it is made of a flame-resistant material. Some wadding looks like toilet paper, but it is chemically treated to make it flame-resistant and should not be substituted with toilet paper or any flammable material. For larger diameter mid and high power rockets, a reusable wadding or parachute protector is used in place of disposable wadding due to the volume it would take to sufficiently protect the parachute. These are generally a Nomex or flame resistant fabric that is wrapped around the parachute. They come in different sizes to accommodate the size of parachute being protected. I keep a couple different sized protectors in my box in case I change parachute sizes. It's also nice to have an extra for that situation when you forgot to

Continued on page 6

Minimum Diameter Motor Retainers!

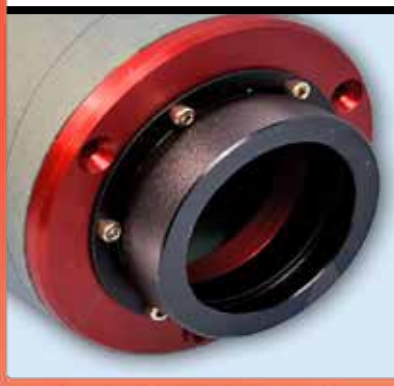
Apogee is your one stop shop for your minimum diameter rockets projects!

- **Fly High**
- **Fly Fast**
- **Impress Your Friends!**

We Have:

- **Minimum Diameter Retainers**
- **Motor Extenders**
- **Threaded Forward Closures**
- **Adapters for Cesaroni Cases**

www.ApogeeRockets.com/Building_Supplies/Motor_Retainers_Hooks



Experienced HPR Builders Use Thrust Plates

- Eliminates Shear Forces on Centering Rings
- Mates with AeroPacks Flanged Engine Retainers
- Fits Standard HPR Tubes, Blue Tubes, and Fiberglass Tubes
- Made from Aircraft Grade Aluminum

https://www.apogeerockets.com/Building_Supplies/Thrust_Plates

What's in a range box and why

Continued from page 5

secure it to the shock cord and upon deployment it floats away to never be seen again (that would never happen, right?).

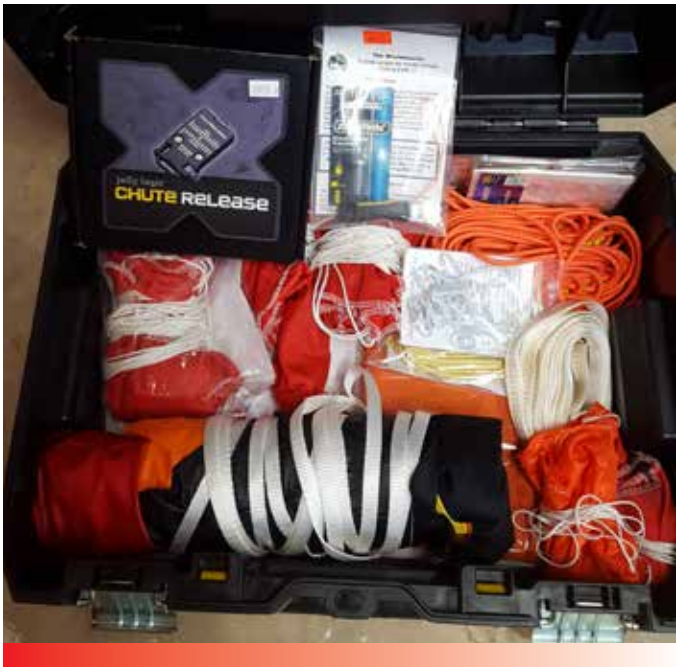


Figure 3: Range box, recovery section including: Chute Release device, extra parachutes, and extra shock cords.

Parachutes:

There are a few key reasons to consider having extra parachutes **(Figure 3)**. First, in case your parachute gets damaged, you can quickly replace it and fly again (assuming no other critical damage to the rocket). Second, if its windy, or you want to launch your rocket to a high altitude, your rocket may drift a long way in which you may want to choose a smaller parachute or even a streamer to allow the rocket to fall back quicker to avoid drifting too far away. Another reason to adjust parachute size may be affected by the size of your launch site. Of course, you don't want it to fall too fast or it may sustain damage or fall at an unsafe speed over spectators.

Side note: For mid to larger sized rockets (BT-60/41.6mm or larger tube diameter), a great consideration that is becoming popular for controlling drift distance while allowing for a soft landing with a larger parachute is the Jolly Logic Chute Release https://www.apogeerockets.com/Electronics-Payloads/Dual-Deployment/Chute-Release. It basically allows the parachute to deploy rolled up allowing the rocket to fall rapidly until it senses a set altitude in which it releases the parachute to fully open **(Figure 3)**.

Tracking Powder:

Besides making for a cool deployment with a puff of bright colored powder, tracking powder is helpful to find a rocket that is launched to near out of sight altitudes **(Figure 4)** https://www.apogeerockets.com/Building_Supplies/Parachutes_Recovery_Equipment/Tracking_Powder/Tracking_Powder_Burst_of_Orange. I launched an Apogee Aspire https://www.apogeerockets.com/Rocket-Kits/Skill-Level-2-Model-Rocket-Kits/Aspire (29mm minimum diameter) with an Apogee Medalist E6-8 motor to an estimated altitude over 2700 feet (Rocksim estimate) and lost sight of it until the deployment and bright orange cloud of tracking powder appeared. The rocket is capable of around a mile high and I certainly would

Figure 4: Tracking powder makes a helpful addition to your range box.

Continued on page 7

Check out our Facebook page
www.facebook.com/ApogeeRockets

What's in a range box and why

Continued from page 6

use tracking powder if I try going that high. I also have used it in lower altitude flights with my kids as they enjoy seeing the orange cloud and it gets people's attention. This is clearly optional, but it's too fun not to have in the range box.

Swivels/Eye Hooks/Quick Links:

These are commonly used to connect the parachute to the nosecone or shock cord to the body tube as they allow the parachute to spin without twisting up the lines and they allow for a quick and easy way to remove or install the parachute or shock cord. They can also adjust your center of gravity depending where they are attached and how heavy they are. Small light weight snap swivels (like those used for fishing) are often used in low power rockets and don't generally affect the center of gravity, but larger stronger ball bearing swivels weighing more than 11 grams along with quick links may be used on mid and high power rockets. Occasionally these can get stressed to the point of failure and should be inspected after every flight. Having extras won't take up much space and may serve you well if you should need one **(Figure 5)**.

Nose Cones:

Occasionally a nose cone may get damaged or even separate from the rocket to never be seen again. Assuming the rest of the rocket is ok, then a simple replacement nosecone can be installed making the rocket quickly ready to fly again. Additionally, you may have a selection of nosecones

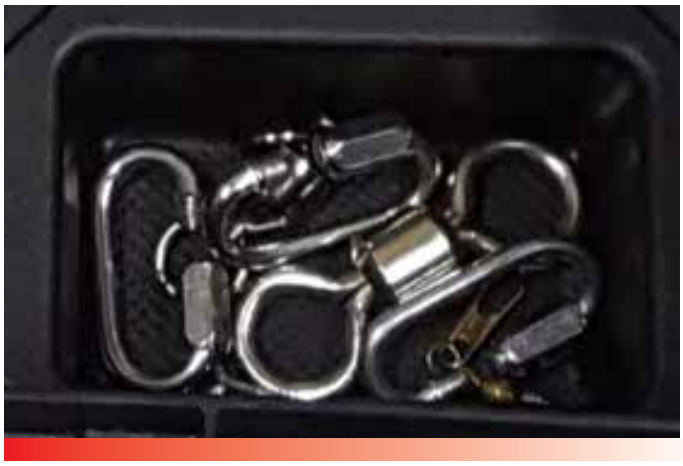


Figure 5: A variety of extra swivels can serve as backup when the need arises.

that you configured with pre-determined amounts of weight added such as clay or BB gun pellets epoxied inside. These would serve to adjust the center of gravity or change the flight characteristics such as for a competition or to limit the altitude. For example, you may have predetermined the need to move the center of gravity forward a specific amount to allow for a bigger heavier motor to be flown. In this case, you can simply change the nose cone with one that was previously set up with the proper amount of weight. This should be done with caution to avoid an over stable rocket that weathercocks or a rocket that becomes too heavy for the motor being flown in which a program such as Rocksim can be used to predetermine the effects of the location and

Continued on page 8

Join Tripoli.org
Mention Apogee Components

Quick-Change Motor Adapters

- **Allows you to use smaller diameter motors in your rocket kits (adds versatility)**
- **Change out motors in seconds**
- **Works with all single-use and re-loadable motors**
- **Four sizes available**

www.ApogeeRockets.com/Building_Supplies/Motor_Mount_Kits_Adapters/Ready-to-use_Motor_Adapters

What's in a range box and why

Continued from page 7

amount of weight you add to the rocket in combination with different motors. You may also want to change to a different shaped nosecone for visual appeal.

Shock Cord:

There are various ways a shock cord can get damaged in which you may need to repair or replace it. For example, the hot gas from the ejection charge can char the cord to the point that it weakens and fails. Using Kevlar material or a shock cord sleeve to protect the cord can keep this from happening. Shock cords can also get twisted excessively and start fraying or get knotted up in which it may be better to replace it than try to detangle it. Or the cord length may need to be changed to affect the performance of the recovery. For example, if you want to help slow the descent rate, a thicker, longer shock cord can act like a streamer and help slow the rocket. A longer cord can also help avoid a zippered tube as it absorbs more of the energy from the nose cone ejection. For these and many other reasons, having extra shock cords of various sizes should be considered.

Figure 6: A variety of glues/epoxy for field repairs

Spare Fins/Balsa/Wood Stock:

Most likely if you have a broken fin that cannot easily and quickly be repaired, you will end up making the repair at home and hopefully have other rockets to fly. But for some hardcore enthusiast, or perhaps at a multi-day event, or possibly with a specific competition rocket, you may want to have spare fins made up or have a sheet of balsa wood in your range box in case you are compelled to make the repair in the field.

Foam Padding/Bubble Wrap:

If you plan to carry a payload such as an altimeter, or science project, you may need to protect it with foam padding or bubble wrap or a similar cushioning material. This can also be used to cushion batteries or other electronics contained in payload or electronics bays. Another nice use is to help protect rockets during transport. This also works well to fill open space in the range box to keep items from shifting around.

Construction Supplies:

Glue - How many times have you recovered your rocket to find damage such as a cracked or broken fin, a cracked nosecone or shock cord attachment, or maybe the body tube got damaged such as a zipper or kink? Depending on the circumstances, you may choose to do a field repair in which you may use superglue or a fast setting epoxy to aid in the repair **(Figure 6)**. The small tubes of superglue are very convenient to carry. These have to be punctured to use and once opened are prone to dry up or even leak. So you may want to keep a couple of them and dispose of the tube after using it to avoid a surprise in your box later on. If using water thin super glue, you should also have eye protection in your box. Another great consideration

Continued on page 9

What's in a range box and why

Continued from page 8

is fast setting epoxy that is available in conveniently sized packs such as the Double/Bubble Extra Fast Epoxy packets offered by Apogee https://www.apogeerockets.com/Building_Supplies/Adhesives/Double_Bubble_Extra_Fast_Epoxy_Packet. These are very handy and simple to use making them well worth having in your range box. Of course, as a precaution anytime you use epoxy, you should have a pair of nitrile or latex gloves to avoid getting it on your skin.

Tape - Masking tape, electrical tape, duct tape and scotch tape all have their uses in the field and are common to a range box. For example, masking tape is commonly used on the shoulder of a loose nosecone to make a snugger fit (but not too snug). It works well to hold a friction fit or minimum diameter motor in place where there is no motor hook. Masking tape may also be used to wrap the ends of a shock cord to help minimize the chance of a tangled parachute. The green or yellow colored automotive masking tape has excellent adhesion and adds the appeal of color. The blue painters tape has a lower adhesive bond and may slip off or peel too easily. Electrical tape is often use to hold pyro charges or to tape over the top of the pyro charge canister. It may also be used to protect wires on electronics. Scotch tape is used for various purposes such as to fix a small tear on a plastic parachute. I've even used it to hold small parts to my prep table when it's windy. Obviously, there can be many uses beyond those described making different types of tape a valuable inclusion to your range box.

Zip Ties - Zip ties are commonly used to secure batteries and wires in place for rockets with electronics. They may also be used to attach altimeters or other equipment. They even come in handy to help tie down the corners of a tarp or awning used to make shade. There's probably a million uses so having a variety of zip ties will most certainly prove useful.

Sandpaper - A small piece of medium grit sandpaper is good to include in case you need to roughen a surface before putting adhesive on it. For example, if a fin were to break off, you may want to clean up the bond area with sandpaper and then glue the fin back on. Or if a tube is zippered and you use super glue to repair it, it may leave a rough texture on the outside of the tube that you may want to smooth out with sandpaper. Many other uses for sandpaper are sure to come up making it worth having this in your supply.

Dowel Rod - A properly sized dowel rod is useful to help push out a stuck motor or to scrape out char from inside a tube. It can also be used to push out a stubborn parachute that got pushed deep down inside the body tube (usually when they were stored that way for some time and need to be pulled out to refresh and refold for flight). You can also put sandpaper on the end of the rod to roughen a hard to reach surface before gluing to another part. Another possible use of the dowel rod is to push clay into a nose cone should you need to add nosecone weight to improve stability of a rocket.

X-Acto Knife - This is important for various uses such as cutting a tube to clean a slight damaged section between the nosecone, cutting balsa to make a replacement fin, cutting shock cord, cutting tape, etc. There are so many needs, it stands as an obvious tool that should be in the box. Spare blades should also be included. Just make sure it is in an easy to find location.

General Tools - There are various needs for having general tools including screwdrivers, pliers, small wrenches or a mon-

Continued on page 10

Need A Parachute? Apogee Has The One You're Looking For!

www.ApogeeRockets.com/Building-Supplies/Parachutes

What's in a range box and why

Continued from page 9

key wrench (crescent wrench), Allen wrenches, sockets, etc **(Figure 7)**. Even a small cordless drill may be considered in case someone needs to drill a vent hole or drill out stuck sheer pins for example. Needle nose plyers are helpful to straighten or bend an engine hook. Allen wrenches to tighten a motor plate retainer. Sockets or wrenches to tighten nuts holding bulkheads to electronics bays. A small flathead screwdriver to tighten the pyro igniter leads to the terminal screws. The list goes on and on making it valuable to include a small tool set dedicated to the range box. Just remember to put your tools back, or get them returned if you loan them out. It's not fun to find a missing tool when you need it.

Figure 7: General tools section of a range box

Advanced Supplies:

Portable Scale - For high power deployment, a small portable scale can be helpful to weigh out or verify the gun powder weights used for pyro charges. For dual deployment, the main and drogue charges often have different amounts of powder depending on the volume of the airframe space being pressurized. Using the scale to double check them before being installed or to weigh out new charges can be good reason to have one. You can get one for a reasonable cost at tool supply companies such as Harbor Freight.

Multi-Meter - This is a useful tool to check continuity on igniters to verify you have a good igniter (for safety's sake, you would do this before installing in a motor or pyro charge). It can also be used to check the battery voltage on your launch system. Finally, for rockets using electronics, it is good for checking power supply voltage so you know there is sufficient charge (sometimes rockets sit on the pad for some time and if the charge is low, the electronics may not have enough voltage to properly operate). There are other helpful uses, but these are the critical needs for which I suggest having one in your range box, especially if using more complex rockets.

Delay Grain Drill - This is a tool used to drill into the delay grain located on the forward end of a motor, allowing you to decrease the amount of time before the ejection charge goes off with the goal of timing it at apogee. This is only applicable to certain mid and high power motors. The only way to adjust delay time for low power is to replace the motor with a dif-

Continued on page 11

Gyro Chaser Helicopter Rocket

- Unique 'transforming' rocket - looks like a normal rocket, but then rotor blades pop out at ejection
- Competition efficiency: high flights and long descent time
- Features curved rotor blades and free-spinning hub, just like those used in international competitions
- Versatile: can use any 18mm diameter motor
- Comes with video instructions for error-free assembly

www.apogeerockets.com/Rocket_Kits/Skill_Level_4_Kits/Gyro_Chaser

What's in a range box and why

Continued from page 10

ferent designed delay time as designated on the motor label. But for the applicable mid and high power motors, this can be a valuable tool to have. There are different tools for different brands of motors that allow for a reasonably accurate and fast method of adjusting the delay timing.

Electronics Support Equipment - This may include various equipment such as an altimeter **(Figure 8)**, batteries or battery chargers. It may also include data cables necessary to connect electronics to a computer to download post flight data or adjust settings on various electronics such as deployment settings. You may want video recording equipment (both hand held or rocket mounted such as the keychain camera offered by Apogee https://www.apogeerockets.com/Electronics_Payloads/Cameras). Or it could include a MicroBeacon used for locating a rocket. For advanced rockets flying to out of sight heights, you may have telemetry equipment or GPS tracking devices included. Because of the sensitivity of many of these devices, consider anti-static and weather-proofing your container or range box used to store the equipment.

Weight Modification Materials - Materials that can be used to modify the weight of a rocket (more common to high power rockets) may be considered as part of your range box supplies. This may be clay that can be pushed into the nosecone, or lead weight that can be epoxied, to adjust the center of gravity to offset the use of a heavier larger motor for example.

Miscellaneous:
A few additional miscellaneous items to consider…

Notebook/pencil or pen - Do you know anyone who wanted to take some notes or fill out a flight card and realized they can't find a pen or pencil or a piece of paper to write on? That never happens. A pad of sticky notes serves well so you can avoid losing pages in the wind or stick the note to your rocket with flight information or with a checklist for example.

Figure 8: Ready-to-use Altimeters

Sealable freezer bag - To put spent motors in, assuming you can't dispose of them properly at the range. My wife doesn't

Continued on page 12

What's in a range box and why

Continued from page 11

like it when I bring the lovely sulfur smell from spent motors back home. So I found if I put them in a freezer bag, I get fewer complaints.

Sunscreen and/or lip balm - I've ventured out to the range a few times to realize I forgot my sunscreen or got dry chapped lips by the end of the day. So keeping these with your range box ensures you will have them on hand.

Baby wipes - How often do you touch the launch rod or blast shield or a spent motor and get black residue on your hands? There may not be a wash room to clean up out in the field, so baby wipes can come in very handy. I've also used them to clean residue off my rockets and launch supplies. Plus, when it's time for lunch, you have a way to wash up the kids.

Happy Hands Cream - Another consideration is to carry some "Happy Hands" cream which is designed to act as a skin barrier which lets you rinse crud off your hands. This is even used to protect your hands from epoxy, super glue and the black soot allowing it to be easily washed off.

First Aid Kit - This may not need to be kept in your range box as it takes up space. But maybe a few band-aids can be kept in your range box so they are readily available just in case. Otherwise, having a first aid kit in your car is well advised.

Summary:

As noted previously, there are many items to consider for your range box depending on your level of involvement. Certainly, far more items can be considered than those covered within the scope of this article. It ranges from a few simple items that can be organized in a small box to highly sophisticated equipment to support high power or complex rockets requiring multiple boxes to keep organized. Despite the level of complexity, you will find that having a properly equipped and well organized range box can go a long way towards accommodating your needs, resulting in a fun and safe day watching your rockets roar off the pad and return successfully.

About the Author

Kris Allen was involved in rocketry as a youth, which supported his interest in math and physics eventually leading to a career as an environmental scientist focused on air quality studies. After being invited to watch a ULA launch along with various levels of High-Power flights, his interest in rocketry was rekindled and caught the attention of his youngest daughter (known for her bright pink rockets). He is Level 1 High-Power Certified and enjoys spending time with his daughter designing, building and flying rockets with plans to support her through the TARC program.

Figure 9: Kris Allen

Join The NAR.org
Mention Apogee Components
NAR