MODEL AVIATION'S Sport Aviator
The e-zine for the new model pilot

SAFETY CONSIDERATIONS for ELECTRIC POWERED FLIGHT
By Bob Aberle

With the ever increasing popularity of electric powered flight, it is important to discuss safety issues since many things are quite different when compared to fuel engine power systems. When we speak of electric power (or simply “electrics”) we must be concerned with the safety aspects of:

1) Motor operation
2) Proper use of batteries to power the electric motors and
3) The charging of those batteries.

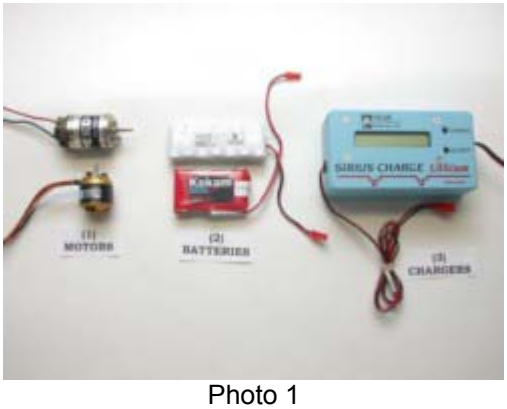

Photo 1

Let’s take each one of these areas pictured in photo 1 and discuss them in terms of safety, at home, at your flying site (field) and while actually flying your aircraft.

MOTOR OPERATION

If you are already a model aircraft enthusiast and are experienced with fueled engines you are going to find electric motors an entirely new experience and one that has much different safety considerations.

With a fueled engine, you must first put fuel in the tank, you must “light-up” the glow plug and finally you must flip or turn over the prop either by hand or with the help of a starter motor. You must do all of this to get your fueled engine to run (operate). Having that fueled engine start up unexpectedly is essentially an *impossible* situation.

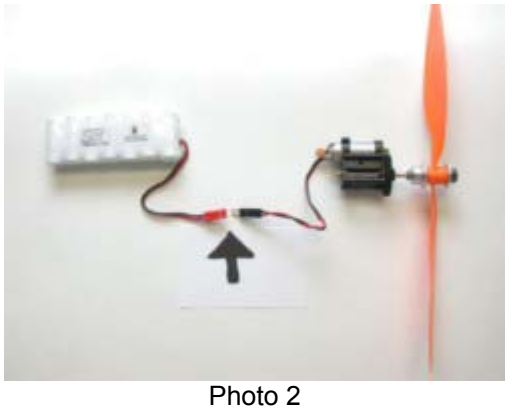

Photo 2

But now consider the electric motor as shown in photo 2. No fuel is required! It runs on electrical energy provided by a battery. The minute the battery is connected to the motor terminals, the motor will begin to run. No fuel priming is necessary and you don’t even have to flip the prop --- it simply starts running!

Keeping this in mind, consider this same electric motor when a prop is attached to its shaft. Connect up the battery, the prop immediately starts turning. If your hand or fingers happen to be in the way you might easily suffer a cut just like you might if you had hit a rotating fan blade. (*Ed. Note: A powerful electric motor like those used in competition aircraft could cause severe injury, including amputation.)*

If your electric motor was loose (not installed on an aircraft or not even mounted on a test stand), the moment that battery is connected it could literally “take off” and jump all around your shop, your workbench, floor, ceiling, whatever! It could easily damage anything in its path and there wouldn’t be much you could do to stop it.

The bottom line to this scenario is to never install a prop on an electric motor that isn’t firmly (rigidly) mounted in place. You must discipline yourself to remove the prop except when running a test or making an actual flight.

Photo 3

That means there should not be a prop on your motor shaft when it is stored in your shop or even when it is being transported to and from your flying field. I realize that not many electric modelers do this, but you should take this suggestion seriously.

Because accidental electric motor start ups are a real possibility, switches were used for many years as a means of arming (and disarming) the entire power system. A single on/off switch inserted into one of the battery wires can prevent power from getting to the motor. In its day, the switch provided good safety insurance. You can still, if you like, add an arming switch to your electric power system today. However, the addition of that switch does cause a certain degree of power loss in the system.

Photo 4

Fortunately most of today's new ESC devices (the throttle control) employ microprocessor chips that can provide several excellent safety features. For example, if your transmitter throttle control stick is set for anything except dead idle, your motor can't start. In other words it won't arm! To make it start you must move the throttle stick all the way down to the idle position. Then, and only then, when you advance the throttle, will the motor start.

Another safety device that was added to the older power systems was the inclusion of a fuse. If the motor got stalled (like after a rough landing with the plane standing on it nose and the prop unable to turn) the fuse would sense the overload (excess current) and open the circuit. A stalled motor, without any protection, could easily ruin a motor and/or ESC and under certain circumstances might even lead to a fire in the system.

But again the fuse, like the switch, did cause a certain loss in the system. Modern ESC design now provides for current overload protection. If the set amount of current is exceeded the motor circuit opens, preventing any more current from flowing into the motor. These same ESC's can also protect against things like over or under voltage and too-high temperatures.

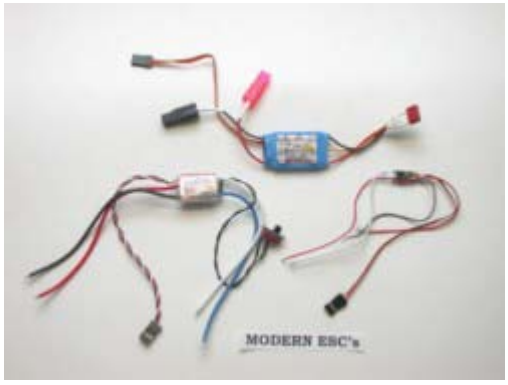

Photo 5

Modern ESC's can also sense when interference is hitting your RC system or when the aircraft might be getting out of radio range and at that point will shut down the motor. This makes for a valuable fail-safe system. It can save an aircraft from a crash and also save it from flying away. It is for that reason that we urge all electric flyers to update to these newer ESC units to add that extra degree of safety.

I've heard that some of our competition electric flyers who use high powered (high current) electric motor systems do resort to a "jumper" connection that enables them to disarm the system when the model is doing anything, except flying. A jumper can be simply one heavy duty connector that plugs into a mating half connector. Then the two pins on the jumper itself are connected together. If you pull out that jumper and place it in your pocket, you electric motor can't start, no matter what.

After having said all of this it is still a good idea to get into the habit of unplugging your battery from your system when finished flying. Despite switches and the like, it is a known fact that some amount of current will be drawn by the ESC, even though the motor isn't operating. It may be a small amount, but over a period of several days, it could take your battery down. This isn't good for any type battery, but it is particularly bad for the Li-Poly battery since each cell should not be allowed to go below 2.5 volts. Failure to observe this precaution could quickly ruin your battery. Not knowing what might happen to that battery when later being charged is why I list this as a "safety consideration".

Photo 6

Another item overlooked so often is the selection of the right connector to do the job at hand and also the correct wire gauge (diameter) to handle the motor current. A connector with too little current capacity or a wire too thin for the application can lead to melted parts and possibly a fire. Yes, your modern ESC should protect you from any of these situations. But it is still a good idea to not let your system get to the point where over current or too-high temperature cut-off becomes necessary. So make sure you have made these right choices (connectors and wire gage) before you even start that motor for the first time.

BATTERIES

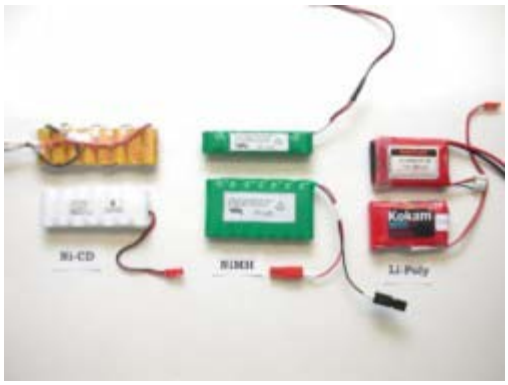

Photo 7

The batteries that we are most interested in for electric powered flight include the old favorite nickel-cadmium (Ni-CD), the newer nickel metal-hydride (NiMH) and the even newer lithium polymer (Li-Poly). The first two types can be treated essentially the same way (charging, testing and application). The Li-Poly batteries are a completely different ball game. They have different cell characteristics and they require a dedicated charger that is totally different from those used to charge Ni-CD and NiMH cells.

From a safety prospective all three batteries can develop problems when subject to shock loads, such as in the crash of an aircraft. Immediately after a crash, the battery pack should be removed from the aircraft. If there is any evidence of physical damage the battery should be safely transported to an authorized battery disposal area. The best way to do this is to have a security case in the trunk of your car which is rated for very high temperatures. I have heard stories where damaged batteries were simply placed inside the trunk of car. While driving home, the battery shorted out and caught fire, which then spread throughout the vehicle. Having a thermally suitable, storage case in your car is a must! You can look up the location of battery disposal facilities on the internet. I have successfully used my local Radio Shack Stores.

(Ed Note: A good, inexpensive, fireproof battery storage container is just a 4 in. by 8 in. x 16 in. decorative cinder block that has one side sealed. These are available at any stone store for about a dollar,)

The subject of batteries and their use with electric powered model aircraft can fill many books. I published a series in 2003 and 2004 in Model Aviation, titled “From the Ground Up”. It was intended for beginners in our hobby and ultimately covered 10 chapters. Chapter Eight was called “Battery Basics” and is available in Sport Aviator’s Pri-Fly Section or by clicking on the title here. This article should add considerably to your understanding of our batteries and as well to their safe use.

One more point and I hope you won’t laugh. I’ve already mentioned the fact that the battery pack should be unplugged when the system is not in use. I will soon be telling you to remove the battery from the plane when recharging. If you do remove the battery, say at your flying field; please don’t put it in your pocket. There have been many instances where the battery terminals shorted out (with the help of loose change or a set of keys) and the result was a “hot pocket” as a minimum, or in some isolated cases a bad burn. So please be careful!

BATTERY CHARGING

Photo 8

Learning to charge your batteries properly is probably the most important safety item associated with electric powered flight. Using the wrong charger, setting the charge current too high or allowing the charger to remain on too long, all can lead to battery damage and, in the worst case, a possible fire. Many of the safety suggestions relating to battery charging apply to any cell you might use including, Ni-CD, NiMH and Li-Poly.

First and foremost, when fast charging a Ni-CD or NiMH cell, or whenever you charge a Li-Poly, you should **not leave the battery pack unattended**. Second and equally important is that any battery pack **should be removed from the model aircraft while it is being charged**.
For both Ni-CD and NiMH batteries, the recommended fast charger is called a “peak detect” type. This type charger will allow full charging of the battery, at which point the charge is automatically terminated. Fast charging Ni-CD cells generally involves a current of 3C or 3 times the rated capacity of the cell. At that rate a fully depleted cell should return to full charge potential in about 20 minutes. That is certainly not a long time to wait and still observe the charging operation.

During this 20 minute period, the battery will likely get warm to very warm. But it should never get so hot that you can’t touch the pack. It is also important that you never charge a hot battery pack. **Always allow the battery to cool down before charging**.

NiMH batteries can be fast charged at a 2C rate which is a little less than when you fast charge Ni-CD cells. At that 2C rate it will take approx. 30 minutes for a fully depleted battery to reach full capacity. **The important safety consideration here is that you set the proper charge current on your charger based on the capacity rating of the cells in the pack**.

Charging Li-Poly batteries must only be done with chargers expressly designed for this purpose. It should state on the charger that it is capable of charging Li-Poly batteries. **Never, ever use a “peak detect” charger to charge a Li-Poly battery**.

Be advised that some commercial chargers can provide several types of charging modes, such that Ni-CD, NiMH and Li-Poly cells can all be charged by the same charger. But to do this you must make the choice and select the correct mode. Making the wrong choice can create a big safety problem!

Li-Poly batteries must be charged at no more than a 1C rate, which means a fully depleted battery might take an hour or more to reach full capacity. One hour might be a long time to stand watch over a charging battery, but be advised that it is a necessary rule that must be followed.

Besides setting the proper charge current you must also (on many Li-Poly chargers) set the correct number of cells being charged. Should you place a two cell pack on the charger and set it accidentally for 4 cells, the cells might be damaged and in extreme cases might even catch fire. When charging Li-Poly cells you are advised to set the battery pack on an insulated surface and have a prescribed fire extinguisher nearby. There are considerable details associated with the

care and application of Li-Poly batteries. Their ability to supply considerable capacity in a relatively light weight package makes them the cell of choice right now for electric powered flight.

To gain these wonderful advantages you must master all the care and charging techniques. Towards that end I published a detailed article titled, **"Introduction to Li-Poly Batteries" that appeared in the May 2004 issue of Model Aviation**. At this writing that article has not been posted to the AMA website under "Exclusive On-Line Features". Hopefully this will be done by the time you read this. But the reference is important and you are urged to look up and read this article.

SUMMARY

There is a lot more to the safe operation of electric powered model aircraft. Much of the safety issues will be learned as you progress with this wonderful clean and quiet source of power. Reading the monthly "electric columns" in Model Aviation will keep you abreast of the latest and safest techniques. Many detailed product reviews and application articles can be found here in Sport Aviator. Most importantly, if you desire to pursue electric powered flight try to look up a local club that specializes in this form of power. There is nothing like learning from the folks who have already done it!