R/C Sportflyer
February, 2006

Next Meeting at First Baptist Church of Grandview – Thursday, February 2 at 6:*45 p.m.*

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Club Web Site: www.rcsportflyers.com

The Radio Control Sport Flyers fly from Stamm Field, located near the south-east corner of Longview Park, operated by the Jackson County Parks Department. For information about the Parks department, visit their web site at: http://www.jacksongov.org/rec.shtml For the calendar of parks events: http://www.jacksongov.org/rec_ce.shtml

Minutes of the January 5, 2006 Meeting

Attendance: 11 Members were present.

New Business

A motion was made and passed to approve the December 1, 2005 Minutes.

A motion was made and passed to accept the Treasure's Report.

Committee Reports: No reports.

Park Association Update

Dave Klaus provided an update of his discussions with the Association Representatives of the other clubs and Club Officers. It was agreed by the various parties that there seems to be some misconceptions and misunderstandings regarding the duties and responsibilities of the Association Representatives, and how they are to interact with the member Clubs. Meetings will be scheduled in the near future between the Club Officers and Representatives to discuss duties, responsibilities, and communication.

Other Items

A suggestion was made that we consider relocating our indoor meetings to a facility where it would be possible to incorporate activities into the meeting such as flying.

As suggestion was also made to seek guest speakers for the meetings.

Please send any comments or suggestions to President Tom Stein at SteinT@umkc.edu

A request was made to publish the upcoming meeting agenda and raffle prize.

The Club Officers are also seeking input regarding the possibility of a Club Auction or Swap Meet. Comments and suggestions would be appreciated.

Calendar of Events – Models

Feb 2	RCSF Club Meeting – at First Baptist Church of Grandview
Feb 4	RCSF Informal Fun Fly
Apr 8-9	KC Flying Circuits Fun Fly at MILF on Front Street, check their web site.
June 3	RCSF Open Fun-Fly
Sept 23	RCSF Club Picnic

Calendar of Events – Full Scale

July 24 - 30, 2006 EAA Oshkosh Fly-In

The article below is another one from one of the best minds on batteries, Red Scholefield. It's from his web site, http://www.rcbatteryclinic.com/.

May 2002 R/C Modeler

A Useful Tool
ESV's - How And Why They Work

By Robert S. Hoff

Next to pilot error, the most likely cause of crashes of R/C models is lack of charge in the transmitter or flight battery. This kind of failure can largely be prevented by the use of a loading ESV (Expanded-Scale Voltmeter). As long as they have been around, I suspect that many modelers do not really understand why and how ESV's work.

What Is An ESV?

The first ESV's were instruments with moving-needle meters that accurately measured NiCd battery voltage by providing an expanded scale for accuracy in the range of interest. They impose a current load and were used to decide whether or not a NiCd battery had enough charge to continue flying safely. The best ones impose a constant-current load. Some of the new ESV's use digital meters that provide the desired accuracy without an expanded scale, and some have LED (light emitting diode) readout. Some are flight box instruments that are plugged into the flight or transmitter battery charge receptacles and some are small on-board instruments with an LED readout. Shown in the photo are two good examples of ESV's, one with a moving needle readout and one with an LED readout. The one on the left is sold by Ace Hobby Distributor and the one on the right is sold by Maxx Products, Inc.

A voltmeter that does not apply a load to the battery should not be used, because the voltage of an unloaded NiCd battery is not a good measure of its charge condition. Many transmitters have a diode in series with the charging circuit and their batteries should not be loaded through the charging receptacle (see your operating manual). Most modern transmitters have a built-in voltmeter that provides an estimate of battery charge condition when the transmitter is turned on, so the most common application of an ESV is for checking flight batteries.

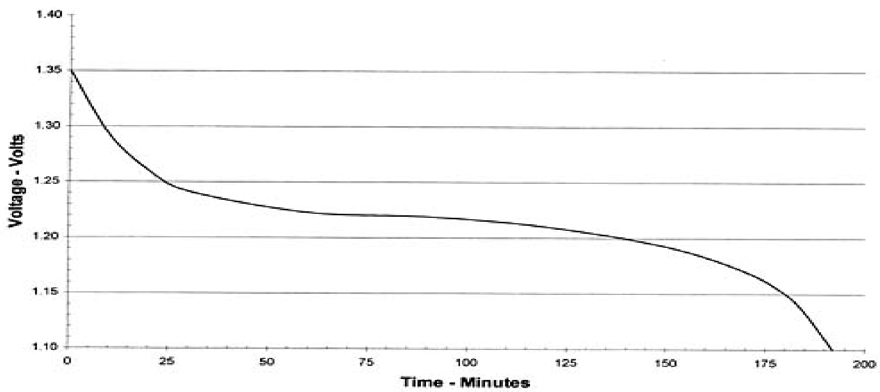
Why Use An ESV?

The primary use of an ESV is to estimate how much of a battery's full-charge capacity has been used so a decision can be made as to whether it has enough charge remaining to continue flying safely, but there's more to it than that. An ESV will detect a shorted or open cell in a battery by indicating a low voltage. An ESV will also detect whether or not you actually charged your battery as intended. You probably have heard, "I put it on charge last night. I don't know what happened."

Why ESV's Work

Determining the state of charge of a NiCd battery by making measurements of the voltage with an ESV is simple, but an explanation of why it works is somewhat complicated. The idea that the state of charge can be estimated by measuring voltage under a load is based on the fact that all NiCd cells, when discharged at a constant current, exhibit a voltage-vs-time characteristic the same shape as that of Figure 1.

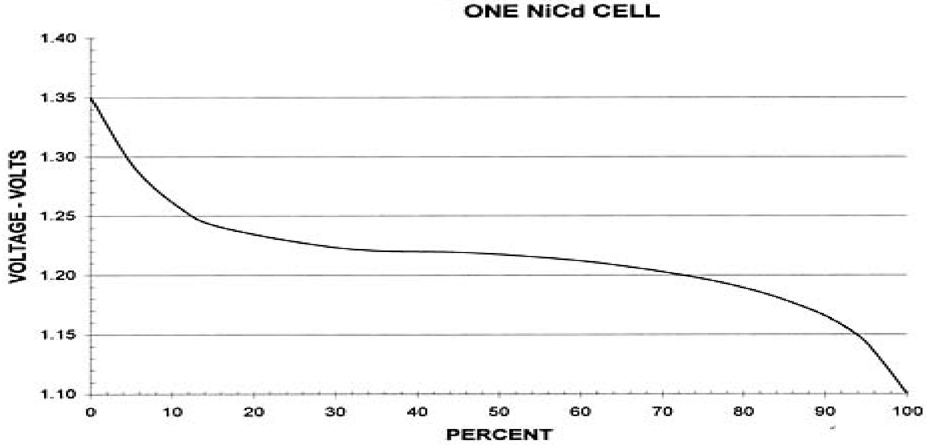
Figure 1 - DISCHARGE CURVE FOR ONE 600 mAh CELL



This particular discharge curve was obtained by plotting voltage and time of a 600 mAh AA-size cell under a 200 mA load. All NiCd battery discharge curves under constant-current load have the shape of Figure 1, regardless of the capacity or voltage of the battery or the load on it. The useful life of a NiCd cell (time to reach 1.1 volts) depends on the size of the cell and the load applied. The discharge curves of a battery made up of more than one cell is the same as that for one of the cells except that the voltage readings will be multiplied by the number of cells.

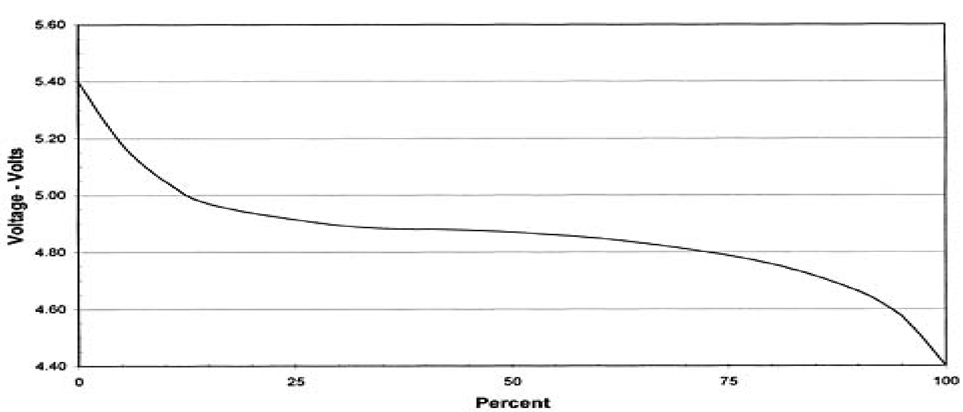
If the times at the measured voltage points on a discharge curve are divided by the time at end of life, all discharge curves become essentially the same and look like Figure 2 on which voltage is plotted versus percent of discharge capacity used. Under limited conditions, Figure 2 is a universal discharge curve.

FIGURE 2 - PERCENT CHARGE USED
ONE NiCd CELL



On Figure 3 I have multiplied the voltage readings seen on Figure 2 by four to show the discharge characteristic of a 4-cell battery. It applies to any 4-cell battery discharged at any constant current rate.

FIGURE 3   PERCENT CHARGE USED, 600 mAh NiCd BATTERY



The curves move downward slightly as load increases because of lead and battery internal resistance, but the difference is small if the constant discharge current is less than about .5C. This would be 300 milliamperes for a 600 mAh battery and 600 milliamperes for a 1200 mAh battery. The general practice in R/C modeling is to operate batteries at an actual average discharge rate of less than .5C in order to obtain a reasonable battery life.

How To Use An ESV

There are two approaches to using an ESV to estimate the state of charge of a fully-charged battery that has been discharged for a period of time. It is not necessary that the current drain prior to the voltage measurement be constant. Both require plugging the ESV into the battery charging receptacle as soon as practicable after landing.

The first involves making the fly-don't-fly decision by observing the color of the scale or LED's at the part of the scale where the reading falls and making the decision indicated. Typically, the scales of ESV's are divided into color zones. The scale on my Ace Voltmaster II ESV for a 4-cell battery is green above 4.8 volts ("OK to Fly"), yellow between 4.75 and 4.8 volts ("Use Caution"), and red below 4.75 volts ("Charge Battery"). When an ESV has an LED readout, the LED's are usually colored to indicate the zones. Referring to Figure 3, 4.8 volts indicates 72.9 percent capacity used and 4.75 volts indicates that 80.7 percent has been used. Other manufacturers may recommend different decision voltages, depending on their risk management philosophy.

The second is a little more trouble but allows you to determine the level of remaining charge at which you will decide not to fly. It goes this way:

(1) Plot a curve like Figure 3 after multiplying the voltage values shown on Figure 2 by the number of cells in the battery.

(2) Measure the battery voltage with your loading ESV.

(3) Decide at what percent of charge used you will stop flying, 80% or any other value you choose. The automobile gas gauge analogy applies here. It is prudent to drive or fly until the gauge shows approximately 1/4-Full, and then fill your tank or charge your battery.

(4) Look on the graph made in step (1) and read off the percent of full charge used. If you got a reading of 4.75 volts, it would mean that 80.7 percent of full charge has been used.

Some ESV's have the option of a load in the vicinity of 500 mA. If all the discharge curves were exactly alike, we would be fully justified in measuring voltage of any battery at a single constant load current, but because of the effect of internal resistance, we can reduce estimating error by using the higher load when the actual discharge rate approaches .5C.

Using an ESV for estimating percent of charge used is not very accurate for two reasons: First, most ESV's cost in the range of $12 to $50 and are not precision instruments. Second, you can see by looking at Figure 3 that, because of the flatness of the curve, a small error in the voltage reading would make a large error in percent capacity used, except near the beginning and ending of the curve where the slope is greater.

Batteries are like automobile gas tanks. When our battery or gas gauge reads half-full or more, we're not too concerned about accuracy. We begin to be concerned when the tank or battery is near empty. It is fortunate that estimating battery capacity used with an ESV is more accurate near the end of its life.

Minimize Errors

Another source of error in using an ESV to estimate the remaining capacity of a battery installed in a plane with an ESV is lead resistance, and when you measure voltage. Battery voltage will increase slightly with time after you stop flying. You should make the measurement as soon as you can after landing.

You can minimize errors involved in making the measurement by using your ESV to plot a voltage vs. time discharge curve like Figure 1 for your own particular battery and wiring, and using it to derive a discharge curve like Figure 3 for use in estimating the percent of charge used.

To do this, charge the battery, plug the ESV into the charging jack, and measure voltage every 10 to 20 minutes until voltage drops to 1.1 volts per cell. Divide each time reading by the life of the battery in minutes and plot a curve like Figure 3. Doing this is more important if your ESV is one of the cheaper ones ($12-$15). The load they provide is resistive so the discharge current is not exactly constant-current. They are also less likely to have accurate meters.

Making A Decision To Fly

In practice, the way an ESV should be used is to measure the voltage when you take the battery off charge to make sure that charging took place and to check for failed cells; measure it again at the field before your first flight to make sure the switch was not left on; and measure periodically thereafter until the voltage drops to a value at which you have previously decided to stop, and at this point stop flying. Stopping at the 80% point makes use of about 4/5 of the total charge of the battery and generally proves to be sufficiently conservative to keep the average flier out of trouble.

Estimate Remaining Flying Time

This leads to the question, how can you estimate remaining safe flying time after you have flown for a period of time and battery voltage has dropped to near 1.2 volts per cell? Clearly, an ESV will not tell you how many minutes of flight you have remaining, just as an automobile gas gauge does not tell you how many more miles you can drive before you have to fill the tank.

For those who are of an experimental mind, remaining flying time can be estimated by conducting an experiment with your plane in which a cycler is used to determine how much charge remained after a flying session. The detailed procedure, not original with me, is as follows:

(1) Start by determining the average current drawn by your radio in your plane. To do this, charge the battery and use a cycler to measure its full charge capacity (CFC) in mAh.

(2) Recharge.

(3) Go to the field the same day the battery is taken off charge. Fly the plane for 45 minutes or more total, flying as you would normally fly. Keep track of the total time in minutes that the plane is in the air.

(4) Take the plane home and use a cycler to measure the remaining battery capacity in mAh.

These data will allow you to calculate the charge in mAh used during your flying session. Since you know how many minutes you flew, you can calculate the mAh used per minute. Knowing the full-charge capacity of your battery in mAh, you can estimate the total flying time for a full charge, dividing this capacity by the mAh/per minute used by your plane. When you go out to fly, keep track of how many minutes you have flown and how many minutes you have left, remembering to leave a margin for safety.

A year or so ago my son used the above process to determine the average current drawn by his 60-size STIK sport plane with five servos (two for ailerons) using an O.S. 60 engine and a Futaba radio with a 600 mAh airborne battery. The average current drain was found to be 268 mA.

With this plane/battery combination and using 80% of the capacity of a 600 mAh battery, one should expect about 1.8 hours of flying time from a fully-charged battery.

Is all this worth doing by the average flier? My opinion is no. It's probably not worth the risk to try to squeeze the last few minutes of flying from a battery. To maintain a high comfort level, one should go to the next larger battery or be prepared to recharge at the field from your car battery. The difference in weight between a Sanyo 1000 mAh and a 600 mAh 4-cell battery is only about 2.28 oz.

Summing Up

To sum up, you might be getting by without using an ESV by charging your battery before every flying session, and flying for a total time that represents less than half of the capacity of your battery. It is like driving a car with a broken fuel gauge. Such a practice limits your flying time and is a gamble that will someday bite you. You can avoid the risk by buying or building and using an ESV.

Application To NiMH Batteries

While I was in the process of writing this article, I began to wonder how useful an ESV designed for use with NiCd batteries would be in estimating the percentage of charge used from Nickel-Metal Hydride (NiMH) batteries that some are beginning to use because of their high gravimetric energy density. For a given weight they have a capacity of approximately twice that of a NiCd battery.

On contacting Sanyo, I learned that NiMH cells have voltage and discharge curves very similar to those of NiCd batteries. The small difference between cell voltages at the same percentage of discharge makes it unwise to go by the color zones on your ESV. What you should do to use existing ESV's safely with NiMH batteries is to run a voltage vs. time discharge curve like Figure 1 using your ESV as described earlier in this article, construct a voltage vs. percent of full charge used curve like Figure 3, and make your charge/fly decision based on reaching a voltage representing the percent discharge point you have chosen to stop.

Voltage and capacity are not the only differences between NiCd and NiMH batteries. Before deciding to use NiMH batteries, be sure to look into their special requirements and limitations.

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