Alkaline vs NiMH Receiver Packs

"More than most want to know about batteries"

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The International RC Laser class rules adopted on June 7, 2011 and the proposed AMYA/US RC laser class rules for onboard batteries; *The boat shall be powered by either 4 ea alkaline AA cells, or 4 or 5 ea NiCad or Nickel Metal Hydride rechargeable AA cells*. The purpose of this article is to explain the implications of this rule on your choice of battery cells to power your receiver and servos in the boat.

First off we will only be talking about AA battery cells. A typical AA battery cell's capacity is 2000 mAh (milli-amp-hour). This theoretically means that a typical AA cell can supply 2000 mA (milli-amps) or 2 amps for 1 hour. This 2000 mAh capacity is about the same for both rechargeable and non-rechargeable cells. Understanding the mAh battery capacity is important for a more complete understanding of the following points.

Alkaline AA cells are the type of cell we are most familiar with. They have a nominal voltage of 1.5 V (volts) per cell. Nominal voltage is NOT the actual voltage of the battery. A brand new AA alkaline cell will measure 1.6 V or higher depending upon the temperature of the battery and the current demand. The nominal voltage is what a user can expect the voltage of this battery to be in normal operation. Thus we talk about a 4 cell pack of alkaline batteries producing a nominal voltage of 6.0 V. In reality a fresh 4-cell alkaline pack produces more than 6.4 volts.

Rechargeable NiCad or Nickel Metal Hydride (NiMH) cells have a nominal voltage of 1.2 V per cell. I'm not going to talk about NiCad cells as the predominate rechargeable cell is NiMH. A 5-cell NiMH pack produces a nominal voltage of 6.0 V, the same as a 4-cell alkaline pack. Similarly a fresh rechargeable 5-cell pack has an actual voltage typically in excess of 6.6 V. In normal operation both the 4-cell alkaline and a 5-cell rechargeable NiMH pack will decay similarly in voltage as they are used. In normal use neither pack has a voltage advantage, both packs will produce the same torque and speed in the servos and both packs will have no problem keeping the receiver running. (**Don't use a 4-cell rechargeable NiMH pack as the nominal voltage is 4.8 V and you will not get the same performance as a 5-cell pack.**) So what should you use in your RC Laser, a 4-cell alkaline pack or a 5-cell NiMH pack?

The simplest solution is to use 4 alkaline cells in the battery carrier that came with your boat. (Replace this battery carrier frequently as it easily corrodes resulting in a serious voltage drop.) Don't believe the bunny, there is no difference between generic alkaline cells and the name brand cells. With the name brand cells you are

just paying for the advertising. With any alkaline cell just pay attention to the expiration date on the package, all cells slowly self-discharge in storage. An old unused cell will not have the same beginning voltage as a new unused cell. Watch the sales, Radio Shack regularly has a 2 for 1 sale on their 18+ cell battery packs. This comes out to be little over $0.30 per cell or $1.22 for a 4-cell pack. You should be easily able to easily get 2-3 or more sailing sessions between replacements. For a regatta that counts, just replace the cells because $1.22 will not break the bank. Store your extra AA cells in the freezer and they will last a very long time without decaying in voltage.

The advantages of using alkaline cells are that it is simple cheap solution. You don't have to remember to charge your batteries and are always ready to go sailing. Alkaline cells also have a very slow self-discharge rate so don't have to worry about your pack just sitting between periods of non-use. The primary disadvantage of using alkaline cells is the poor design of the battery carrier. The contacts at the ends of the carrier are cheap and easily corrode in a humid environment. The contacts also are easily bent and can make a poor connection with the individual cells. The solution is to always have a spare battery carrier available. They are cheap, Hobby King has them for around a dollar, not counting shipping

Unfortunately too many people ignore the simple solution and jump into using a rechargeable NiMH pack without understanding the implications. A 5-cell NiMH rechargeable pack has no performance advantages and has many charging implications that must be fully understood to get trouble free operation. There are several "flavors" of 5-cell NiMH packs available with various quoted capacities ranging upwards to 2700 mAH. Don't believe any number over 2000 mAH as these numbers are commonly inflated. The high mAH cells are also very prone to severe self-discharge. Even the best NiMH AA cells can expect to loose 10% of their capacity through self-discharge within 24 hours of storage from when they were charged. This implies that you really want to charge your batteries within 24 hours of when you want to go sailing. This is one of the most severe disadvantages of using a rechargeable pack, you need to know when you are going sailing and plan your charging accordingly. For casual sailing you can extend out the period between charging and sailing by a few days. Don't get in the habit of charging your batteries immediately after sailing, unless you know you are sailing again soon.

To discuss charging in a little more detail we need to go back to the battery capacity, which is typically noted as "C". The most common & cheapest way of charging is by using a simple wall-wart charger (those little cheap chargers that plug directly into the wall outlet and become bumps on the wall). These simple and dumb chargers simply supply a nearly constant current of between C/10 and C/20, where 10 and 20 are in hours. Thus the wall-wart charger designed for a AA NiMH cell with a C=2000 mAH typically puts out between 100-200 mA of current. This means that a completely depleted battery is charged in between 10-20 hours. It also turns out that a typical 2000 mAh NiMH cell can take a charge current of C/10 for longer than 10 hours with little to no detrimental effects. Thus your partially depleted pack can

be charged safely overnight. Regardless, it is not good practice to leave batteries on charge for more than 12 hours. Using a rechargeable pack and a wall-wart type charger it means that you need to start charging the night before you plan on sailing. This can be a big inconvenience and a problem if you forget to charge the night before sailing.

This leads us into fast charging. Don't listen to the old-timers. Modern NiMH batteries actually prefer fast charging over slow overnight charging at C/10 rates. To fast charge you need a smart charger. This is a charger which charges at a constant current, but monitors the battery voltage and detects when the pack voltage peaks. Good smart charges also monitor how much is being put back into the battery in terms of mAH. As NiMH packs become over charged the voltage starts to drop and the excess energy in the battery is converted to heat. The maximum charge current is a function of the cell design. I normally charge my NiMH AA cells at a C/2 rate, or 1 amp. I have found that with the AA cells that charging at C/1, or 2 amps tends to heat the cells and the capacity put back into the cell is not as much as charging at C/2. With fast charging at a C/2 rate you can still typically be fully charged within about 30 minutes since you rarely have a completely depleted pack.

The advantage of using AA rechargeable batteries means you don't need to keep a supply of alkaline cells around. You don't need to worry about the cheap battery carrier and its poor contacts. Keeping two packs ready to go means you can sail a full day's regatta in heavy wind and easily swap out packs during lunch with no worry about loosing juice. The disadvantage of rechargeable packs relate to charging the packs. With dumb wall-wart type chargers you much charge overnight before sailing. To fast charge the pack you must make the investment in a smart charger and fully understand how to use it. The big advantage of a smart charger is you know exactly how much capacity you are putting back into the pack. Experience will soon tell you when the capacity you put in does not match what it should be. This is the beginning signs of a bad pack. I also typically completely cycle my pack a couple of times a year by using the discharge/charge function on the charger and make a note of the battery's total capacity. Once the total capacity starts dropping, I know it is time to take the pack out of service. This is something that cannot be done with a dumb wall-wart charger. How many times at the pond have you heard the comment, "my battery is flat, but I charged it overnight last night." This is a sure sign of a bad pack with limited capacity. Rechargeable batteries do not last forever.

In summary, I would strongly recommend using alkaline cells to new sailors and those who do not sail that frequently. For dedicated sailors I would recommend rechargeable 5 cell packs, but only if you plan on using a smart fast charger. I personally feel that you are asking for trouble if you use a dumb wall-wart type charger unless you replace your packs annually.