Committee - George Whelan 208617, Derek Robertson 821368, Neil Davidson 712458

NEWSLETTER AUGUST 2000

Well boys and girls here we are in the middle of another summer flying season, the weather to date has been very disappointing as has the attendance at the flying events, however after a very constructive EGM hopefully the latter situation will improve.

The committee called an EGM for Tuesday 11th July at the Cove Bay Hotel, the item for discussion being the lack of attendance at the club flying events / nights and what are we going to do about it. The meeting was well attended with 14 members turning up and some very constructive discussion took place. The main outcome was: -

1) To carry on with the scheduled ADS club events.
2) Revert back to Tuesday nights at Calder Park.
3) Saturday flying will be organised by a ring around. I will initiate this by listening to Dyce ATIS at about 11:00 for the weather and if the wind is less than 10 knots it will be flying at Calder Park. If the wind is ten knots or greater I will decide on a suitable slope and phone the first member on the ring around list with instructions as to where to fly. He / she will then phone the next member on the list and pass on the information. If the next number does not answer he will go down the list in turn until somebody answers and can pass on the message. The current ring around list is the members who turned up to the EGM. If you want to join the list contact a committee member and you will be added. Your commitment is to pass on the message to the next number even if you don't intend to fly yourself.

I think it is a good idea to have occasional social evenings at some hostelry during the summer season to keep members in touch with what is going on, and I know from the evenings we had in the winter there is always some interesting debates. Watch this space for future details.

This month's bumper edition surfed from the net starts with a Stan Yeo article on slope flying in stronger winds. Then we have a brief description on hand towing, although it talks about F3J it is equally applicable to general towing.
The next section is the first half of a compilation on the maintenance of batteries, the part about using a domestic timer is a good idea for regular flyers, these timers are available for less than £10 for a pack of three.
Finally this months model is a proof of concept 2M design by Mark Drela. Mark is an aeronautics engineer so you would expect him to know his business, this model has been very competitive on the U.S. 2M competition circuit and I am sure some of the technology can be transferred to our models.

FORTHCOMMING EVENTS

5TH - 7TH August	Scottish glider nats at Mossmorran	Dave Bradbury on 01592 782906 for info.
13th August	Club barbecue at Calder Park.	
17th September	Slope fly in. venue tba.	
10th October	Bring and Buy. Cove Bay Hotel	
7th November	AGM Cove Bay Hotel.	

Flying in Gales

by Stan Yeo

INTRODUCTION

A lot of modellers, when it comes to judging wind strength tend to over-estimate the speed of the wind and under-estimate their / model's capability to fly in it. On the other hand, some newcomers to slope soaring are completely unrealistic as to the winds their lightweight models can fly in. The purpose of this article is to offer advice on flying in strong winds. Often, once the model has been launched and got away from the slope, out into the 'clean' air, the flying is very exhilarating and a lot of fun; forgetting of course the occasional missed heartbeat.

WHAT IS A STRONG WIND?

How long is a piece of string? The definition of a strong wind will depend on the pilot's ability and the model's capability to fly in it. A novice pilot with a lightweight rudder elevator model would find 10 mph a handful whereas my definition would be nearer 40 mph with the right model. Whilst flight testing the *Wingbat* we were flying in winds gusting up to 60 mph as measured with a Dwyer wind gauge at the top of the slope. This was without ballast on a wing loading of 10.5 ozs./sq. ft. I must admit it was not pleasant. My eyes were watering, we had to remove the frequency pennant to avoid damaging the transmitter aerial and stand, leaning into wind, with one foot in front of the other, to prevent being blown over. Others have been certified for less!! It is all down to model selection and experience. This does not mean the inexperienced should not fly in strong winds, just that they should seek the help of a suitably experienced flyer when doing so. How else are they going to get experienced?

MODEL SELECTION

Model selection depends mainly on structural strength and how clean aerodynamically the model is. Obviously a lightweight open structure thermal soarer is not going to be suitable, neither is a boxy, draggy, rudder elevator slope trainer. The thermal soarer is out because it is unlikely to be structurally strong enough whilst the slope trainer is out because it is has too much built in drag. On the slope trainer the flying speed can be increased by adding ballast and moving the Balance Point forward but this is at the expense of Glide Angle. There is a point where the Glide Angle becomes so steep that the lift produced by the slope is insufficient to keep the model airborne.

Most modern intermediate models of modest wing loading (greater than 10 ozs./sq.ft) can cope, unballasted, with winds up to 35 mph. They may require a little nose weight to increase pitch stability and a small amount of down trim but that is all. A typical wing loading for my models is 10 - 12 ozs/sq.ft and I never ballast to cope with strong winds. On rudder elevator models I occasionally add a small amount of nose weight but this is only to desensitise the model for the inexperienced pilot as the increased flying speed increases control response.

THE WIND ON THE HILL

For most slope soaring hills there is an optimum wind speed. Below this speed and the lift decreases, above it and the lift gets flattened resulting in a lift 'ceiling'. This is particularly noticeable on coastal sites overlooking the sea. The reason is the air above the hill has got inertia and the faster the air is travelling the more inertia it has got. The air that is being deflected upwards by the hill has got to overcome this inertia so the higher the wind speed the more difficult it becomes and hence the apparent lift ceiling. On inland sites this phenomena is less apparent because the terrain in front of the hill disturbs the air giving it less straight line inertia.

This 'flattening' of the air as it passes over the hill also causes the wind speed to increase because the free-stream air and the hill are acting as a venturi. With a venturi, if the cross-sectional area is decreased, then the speed of the fluid passing through it increases pro-rata, consequently the wind speed at the top of the hill is at its greatest. If we were able to measure the wind speed 50 metres out from the hill we would find that it was considerably less than at the top of the hill. Likewise if the wind speed were measured halfway down the hill we would get a similar result.

When flying your models, irrespective of the wind conditions, this venturi effect is not only present on the top of the hill but on the sides as well. If you are unfortunate enough to allow the model to drift downwind and off to the side of the hill it will be doubly difficult to penetrate back to the main part of the slope. Not only will the wind speed be higher but there is the added complication of no lift. It is often advisable in these circumstances to cut your losses and land as best you can on the side of the hill. Continuing to attempt to regain a position in front of the slope could result in a long walk and/or a severely damaged model. It is wise to formulate a plan for this and other possible eventualities by exploring the flying site. Construct a mental picture in your mind of the airflow above and around the hill, identify possible landing areas and think through all the options should you get caught out.

MODEL PREPARATION

There is very little model preparation that can be done except to check that the structure is intact and there are no loose bits of covering that can be torn off by the wind. Flying in windy conditions is a rigorous test of the model and any weaknesses in the structure will be cruelly examined. If you intend flying a basic trainer / intermediate model then move the balance point forward by up to 10% of the mean chord. The more 'draggy' the model the more forward the balance point. To make headway in strong winds the model must fly faster than the speed of the wind. There are two ways this can be achieved. One is to apply down elevator trim the other is to move the balance point forward. In the first instant a small amount of down trim can be used to increase the model's flying speed but a point is soon reached when using more down trim just results in a steeper nose down flying attitude (dive) without an increase in forward speed. Some of this deterioration in glide angle is due to the design of the model and the increase in drag that accompanies an increase in speed but some of it is due to extra drag being generated by the down elevator. If the balance point is moved forward then some of this down elevator can be removed allowing the model to fly more efficiently. Moving the balance point forward has a secondary effect, it makes the model more stable in pitch. Not a bad thing considering the stronger the wind the more turbulent the air will be.

FLYING

The first golden rule, for the inexperienced, when flying in windy weather is never turn downwind, always turn into wind. Likewise, aerobatics should always be exited with the model pointing into wind i.e. away from the slope. There are three potential problems when flying downwind:

1. The ground speed of the model is very high which means any accident is likely to be serious.
2. The flying speed of the model is invariably too slow because the pilot is alarmed at how fast the model is travelling relative to the ground. This results in poor control response and the model flying in a semi-stalled condition waiting to be fully stalled when the controls are used.
3. The model always gets blown back further than intended leaving the pilot with the difficult, often impossible task, of regaining lost ground.

As soon as the model is not pointing directly into wind it will drift back towards the slope. This has to be taken into account when carrying out aerobatic manoeuvres by starting them well away from the slope, both horizontally and vertically. There is safety in height and distance!! Obviously if you keep the model pointing into wind and it's flying speed is greater than the wind speed then eventually it will disappear to the horizon. To prevent this happening fly the model cross wind and allow it to drift back towards the slope making sure that the turn at the end of the cross wind leg is into wind. The model will be describing an elongated figure '8' if it's flight path is viewed from above.

For the more experienced and those with adequate supervision try a full 360 degree turn. The turn must be started well out and be well co-ordinated. Up elevator must be used to prevent the speed building up in the turn. Any excess speed will result in a 'zoom' climb when the model is returned to a level attitude, into wind. This leads onto the second golden rule of flying in windy weather, ***never let the wind see the underside of the model***. Presenting the underside of the model to the wind will result in a deep stall and the model being blown back towards the slope out of control.

Spins are a manoeuvre that require plenty of horizontal and vertical space between the model and the hill. During a spin the model loses height rapidly but gets blown back towards the hill. Normally the airspace in front of and below hill provides an additional safety margin during aerobatics should the recovery not go as intended but in the case of the spin this area is not always available due to the model's drift into the slope. When recovering from a spin ensure that the model recovers facing into wind. This is achieved by anticipating how long the spin continues after the control sticks have been neutralised i.e. if the models takes a further half turn to recover from a spin then neutralise the control sticks when you can see the top of the model.

LANDING

Yes I know the phases of flight are launch, bomb around and land but in preparing for a flight I assess the conditions first, think about the landing and then launch the model. Launching the model without a landing plan is a recipe for disaster, particularly in marginal conditions. Landing and landing techniques is a complete article in its own right. There is not space in this article to discuss anything but the basics and highlight some of the potential problems.

The object is to land the model safely with no damage. To do this the model must land in a level attitude, into wind with the minimum of forward ground speed. Some sites will permit you to adopt a conventional rectangular landing approach whilst others may require that the model is 'belly flopped' onto the side of the hill. Whatever the method do not attempt to land unless you are confident in your ability to succeed. If you are not confident get a more experienced modeller to land the model for you. This does not guarantee success but it does reduce the odds!

As advised earlier in this article, unless you are familiar with the site take a stroll around it. Identify suitable landing areas and try to imagine the prevailing conditions. Locate any possible obstructions and decide how they are going to affect your approach. Before attempting to land carry out several practice runs to assess the conditions. It may be that the wind is so strong that the normal circuit has to be replaced with a crosswind drift back towards the hill until the model is in suitable position where upon it is pointed into wind and 'driven' onto (not into!) the ground. These are all options that must be considered.

Finally, when the model has touched down do not relax but be prepared for the wind to try and re-launch it. Hold in down elevator and keep yours eyes locked on the model. Over the years I have seen a number of models become airborne again after the pilot has put the transmitter down thinking the model has landed safely. Rudder elevator models are particularly prone to this so get someone to hold the transmitter for you whilst you retrieve the model.

LAUNCHING

Having decided how you are going or not going to land as the case may be you can now think about launching the model. As mentioned previously the wind is at it's strongest on top of the hill and it's lightest at the bottom. The objective, on launching the model, is to get it out and away from the hill as quickly as possible and into the good soaring air in front of the hill. To do this the model must be 'driven' forward, away from the slope, against the wind. The method I use is to 'contour fly' the hill by flying the model down the hill, a few feet off the ground, then pushing out, away from the hill, slowly converting the excess speed to height without losing ground by allowing the wind to get underneath the model. Any tendency for the nose to rise must be countered by re-applying the down elevator. Do not worry about the model being low as the model will soon gain height and assume a more normal position in the sky.

When launching the model go a quarter way down the hill where the wind is not so strong. If possible solicit the help of an experienced modeller to release the model. Carry out final radio / trim checks and apply a small amount of extra down elevator trim. Get your assistant to *gently* launch the model in a slight nose down attitude. Be prepared for anything to happen! With any luck the model will sail away from the slope without any problems but if it does not the model is more likely to leap into the air and get blown backwards than dive into the ground. Diving into the ground from the launch is not usually too much of a problem but leaping into the air requires a cool nerve and a steady hand if an accident is to be avoided.

On cliff sites it is not possible to go down the hill to launch the model or advisable to contour fly the hill! Instead dive away from the cliff face at an angle of 20 to 30 degrees and recover as before. Flying at cliff sites can be quite disconcerting, as the frequency pennant ribbon often points out to sea due to the 'curl-over' at the cliff edge. This curl-over must be taken into account when landing. Where possible, it is advisable to go a long way back to avoid the turbulence.

SUMMARY

In reading through this article I am conscious of three things:

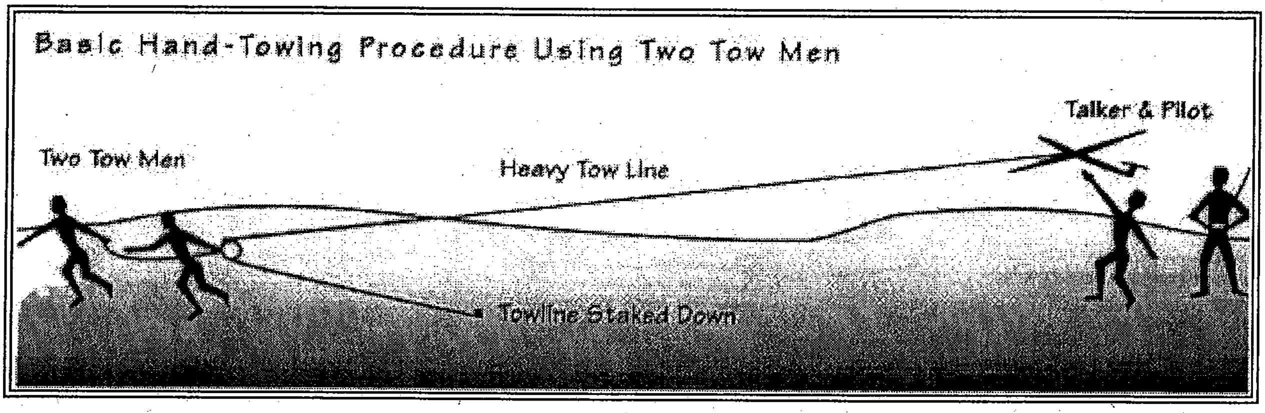
1. A cautious approach.
2. There is a lot of material to absorb.
3. The experience needed for this type of flying.

The cautious approach is advocated because models are expensive, take a long time to build and are easily trashed. I would hate to think how many modellers are lost to the hobby each year because their models are needlessly wrecked. The only way to avoid this is by modellers gaining the necessary knowledge and experience under the supervision of suitably experienced flyers. This means plenty of background reading and flying whenever possible. See you in the next storm force 9!

Hand Towing

Michael Lachowski - reprinted courtesy of Model Airplane News

Hand towing is easy, enjoyable, and it makes for great competition. This month, I'll tell you what you need to start hand towing and how to tow easily even in calm air.



Hand towing is an interesting way to launch sailplanes. Many people think that hand towing requires substantial athletic abilities, but actually, it's quite easy. You've probably launched an airplane on a high-start. You stretch the high-start and throw the sailplane. To hand tow, you don't need to pull anymore than on the high-start pulls, so strength isn't much of a problem. With a good breeze, you can keep the model on the high-start by flying from side to side. The high-start stretch stays uniform, and the end of the line doesn't move. It works the same way for hand towing. With a breeze and a line with some stretch, you can stay on the line while the tow man stands in one place.

The official name for hand tow sailplane contests is F3J. This event is a man-on-man thermal duration contest. Flying is done in groups, and you fly as long as possible in a 10 minute working window. You don't want to fly more than 10 minutes, because there's a 30 point penalty for exceeding the time limit, and landing points don't count if you land after the 10-minute working time. F3J Rules evolved from the British Open Class soaring rules, and they include a 100 point spot landing on a FAI-style graduated landing tape. (This includes a 15-meter spot landing. Landing within 1 meter is worth 100 points, within 2 meters is worth 95 points, and this decreases to 30 points at 15 meters.) After several qualifying rounds, the top pilots fly in one group for two fly-off rounds, which are 15 minutes long. Scores from the qualifying rounds don't count in the final standings, so the objective is to get into the fly-off rounds. This is a different philosophy from that of AMA-style contests.

EQUIPMENT

You'll need one or two models and some tow lines for F3J. Model selection is interesting, because you'll want two different models to suit the time of day and the lift conditions during the fly-off. In good lift conditions, you'll need to launch as quickly as possible to maximize your flight time. If the lift is really good, a 2-meter design is perfect. During the early morning and in fly-offs, a larger model is more suitable.

High performance is important, so a large, high-aspect-ratio model is a good choice. The original British Association of Radio Control Soarers (BARCS) Open Class rules allowed a generous "in/out" type of landing, so some pilots used models with spans as large as 16 feet.

This is a little too large to land well on a FAI spot landing, and it's impossible on an AMA spot landing, so you shouldn't see too many 16-foot-span models at F3J contests. Some of the larger AMA thermal duration ships would perform quite well in F3J. They are light, strong enough for hand towing, and they land very well.

Use monofilament line for the towline. It stretches more than braided lines. If you're flying a gas bag, such as an Olympic, you can use line as light as 40-pound test. The lighter line has more stretch and less drag during tow. For larger models and stronger wind, consider line up to 150-pound test. I normally use 120-pound test line, and I use the 150 for stronger winds. More than 100 pounds of pull from the model is needed to break a 150-pound test line. A strong wind can make it a challenge to hold on to the line. The official line length is 150 meters, and you can launch that high on a good tow.

Here are two ways to store the line: the cheapest way is to buy one of those orange spools designed to roll up electrical power cords. (Some fliers use these spools for winding high-starts.) Or, buy a hand winch that's designed to rewind quickly and store the towline. Graupner makes one (I bought my hand winch from Slegers International.)

COMMUNICATIONS

Communications between the tow man and the pilot are critical. You'll need to establish two signals: one to tension the line and one to start towing. Raising a hand might be a signal to tension the line, and lifting a leg is a good signal to start running. Allow the tow man to build some line tension before you throw the model. You should throw it firmly to avoid stalling at the start of the launch. The model will rise just as if it was launched from a high-start. Plan your release from the tow line before you fly over the tow man's head. You can get a respectable zoom from a hand tow in wind, but start it much earlier than you would with a winch launch.

TOWING TRICKS

What do you do when the weather is calm? Even high-start launches are bad when there isn't any wind during launch. I have an easy solution to that problem... use a pulley system. Instead of running with the end of the towline, stake it to the ground. The line runs through a pulley with a handle. The tow man runs with this pulley to tow the model. For every foot the tow man moves, the model moves forward by 2 feet. The pulley system doubles the speed, so you don't have to run as fast, and almost anyone can provide a good tow even in calm conditions.

The disadvantage of this technique is that you reduce the length of the line. The increased line tension accelerates the model upward during the tow and the increased velocity more than compensates for the loss in line length. You can easily launch a 2-meter model in calm air in 15 seconds. For the really aggressive types, the pulley tow can be used in wind. Use a strong model, strong line, and two tow men to pull. The Germans used this technique to launch their F3B models at Interglide '92.

Hand towing is easy, and it requires very little special equipment. Contests are easy to organize, because everyone supplies his own launch equipment. Get some club members, and give it a try. Flying in groups is always more fun, not to mention some one-on-one flying.

The Black Wire Disease - What's the Cause?

The black wire syndrome is an occurance in battery packs (Ni-Cds) where the negative wire becomes corroded (turns from shinny copper to blue-black). This is the result of either a shorted cell in the pack, the normal wearout failure mode of Ni-Cds, or cell reversal when a pack is left under load for an extended period. The sealing mechanism of a Ni-Cd cell depends to some degree on maintaining a potential across the seal interface. Once this potential goes to zero the cell undergoes what is called creep leakage. With other cells in a pack at some potential above zero the leakage (electrolyte) is "driven" along the negative lead. It can travel for some distance making the wire impossible to solder and at the same time greatly reducing its ability to carry current and even worse, makes the wire somewhat brittle. A switch left on in a plane or transmitter for several months can cause this creepage to go all the way to the switch itself, destroying the battery lead as well as the switch harness. There is no cure. The effected lead, connector, switch harness must be replaced.

This leakage creep takes time so periodic inspection of the packs, making sure that there are no shorted cells insures against the problem. The cells should also be inspected for any evidence of white powder (electrolyte mixed with carbon dioxide in the air to form potassium carbonate). In humid conditions this can revert back to mobile electrolyte free to creep along the negative lead. Some "salting" as this white powder is referred to, does not necessarily mean that the cell has leaked. There may have been some slight amount of residual electrolyte left on the cell during the manufacturing process. This can be removed with simple household vinegar and then washed with water after which it is dried by applying a little warmth from your heat gun.

Fast Charging - Will it harm my packs?

First, let's define "fast charge". The industry standard is any charge rate that will charge the cells in 1 hour or less.

This fast charge capability thing is very interesting. Almost all ni-cds manufactured today for R/C systems can accept fast charge (up to C rate, that's the rate at which you can charge the cells in approximately one hour). Cells that are specifically sold as fast chargeable go through another step in the process. This step involves charging a sample from the production lot and then measuring the end of charge voltage. Cells with the highest end of charge voltage are then analysed for internal pressure. If the internal pressure is acceptable, that is not above a preset limit, the whole production lot is "blessed" as being fast chargeable. Of course this adds a finite amount of cost to the cell as they must be "formed" prior to being ship in order to be fast chargeable.

Cells not destined for fast charge applications are shipped "unformed" by some manufacturers. Forming the cell is the process of the first charge after it is assembled. Nothing more nothing less. When you charge your R/C system packs for the first time you are "forming" them. This is why you see the instructions telling you to charge the packs for 16 to 24 hours before you first use the system. Some manufacturers ship all their cells in the formed condition as part of their manufacturing process.

So in most instances you are safe fast charging the R/C packs (transmitter or receiver) on the market if you first make sure they get a good first cycle formation charge - 24 hours at the slow rate. Where the problems arise is that some of the fast charge systems available are a little sloppy when it comes to terminating the fast charge, or they are pushing the cells too hard (higher than the C rate charge) and then damage occurs. As a rule of thumb if you packs are not getting hot (slightly warm is OK) you are not damaging them in the fast charge process. When pushing too much current into cells not designed to accept it there is the risk of driving the cells above 1.6 volts (the hydrogen over voltage point) and electrolysing the water in the electrolyte and generating hydrogen. This is a cumulative event and repeated fast charge at these rates will result in sufficient accumulation of hydrogen to cause the cells to vent. When they do vent there is a chance that the chemical balance will be disturbed and the cell capacity will fade. Understand that the pack may not be fully charged when the fast charge terminates. It is a good practice, if you are going to fast charge frequently, to top off the packs using the slow charger. This will bring all cells to the same state of charge and "balance" the pack. Otherwise the cell that is not fully charged will be the limiting cell on the next discharge. This continues until there is a major unbalance in the pack and one cell can be driven into reverse (if you don't crash first).

Ni-Cd Life - or why is down so quick?

While volumes have been written on this subject I would like to relate it to the specific application of R/C, separating fact from fiction and enabling the R/C fraternity to focus on more serious issues of the day, like convincing your wife it's too foggy to clean the pool so you're going flying while the field is not so crowded.

The primary failure mode of Ni-Cd cells (outside of user abuse) is separator deterioration. This will occur in all Ni-Cd batteries as they age. The separator breaks down allowing the plates (electrodes) to touch and short out the battery. Millions of testing hours on thousands of cells has established the mean time to failure of a single cell to be 8 years for cells/batteries maintained at 25C (77F). Higher temperatures will significantly reduce these numbers. Mean time to failure means the time that it takes for half the cells in a given population to fail. As the cells are built into packs the mean time to failure decreases. For a 4-cell receiver pack the mean time to failure comes out to be 5.7 years while an 8-cell transmitter pack falls to 4.8 years. Now it is completely possible that the average R/C modeller doesn't want to tempt statistics to the point where half of his battery packs should have failed. A more reasonable number would be the expected time for 0.1% of his batteries to fail. The number comes out to 58 weeks for a receiver pack and 49 weeks for a transmitter pack. For the more adventurous willing to live with 1 failure in a hundred, he can stretch his receiver pack to 103 weeks and his transmitter to 87 weeks. Does this mean that he should rush out and buy new packs at these intervals? Not really. Proper battery monitoring, while it may not significantly increase life, will give you ample warning that your pack should be considered for replacement. Remember, normal failure is the deterioration of the separator system. As the separator deteriorates (oxidises) self-discharge rate of the battery increases significantly. A pack that looses 15% or more capacity over a week of open circuit stand is at risk. A pack that looses 10% overnight should be used for ballast only. Check your pack with a cycler or some technique that gives you the amount of capacity available immediately after charge and then (after fully charging again) after a rest period of 5 to 7 days. (NO, this isn't MEMORY!). Doing this at least quarterly (if you are fortunate enough to live where you have a flying season longer than 3 months) will greatly increase your odds of crashing by some other defect than battery failure.

The number of cycles you put on your battery is secondary in the life equation, again, assuming you don't abuse them by high rate over charge, vibration or exposure to high temperature. I know of very few people that totally exhaust their battery packs while flying (at least not as a matter of course) so the packs see a full discharge and the risk of cell reversal is nil. Tests have demonstrated that hundreds of cycles of reversal where 140% of the rated capacity is taken out in a driven discharge resulted in a capacity loss that was barely measurable. Many multi speed power tools use the technique of tapping the battery for speed control with no adverse effects on the battery. A single cell can be discharged through a load to zero volts without damage. In fact this is a good way to determine if a cell has suffered from separator deterioration. A cell discharged to zero volts will recover to over 1-volt open circuit if left to stand. Those that will not are approaching the steep part of the failure curve and could be a crash waiting to happen.

Bottom line: the number of full charge/discharge cycles that can be accumulated by today's Ni-Cd technology is in the 400 to 500 cycle range. Of course partial discharges seen in the R/C application can extend the use cycles to significantly more than this. It doesn't take a battery expert to figure out the amount of flying time you can accumulate on 500 full discharges. We are talking in excess of 1000 hours. If you put in a full two hours a week in the air every week year round, you would be well into the next century before you reached 500 cycles. Separator failure or old age will probably do you in before you run up 500 cycles. Meticulously recording the number of discharge cycles to establish a replacement schedule can be a study in futility and should be left to the electric R/C indoor microfilm pylon set. Don't worry about reversal. If you have left your switch on overnight or for even a couple of days, just give the pack a good long slow charge using your regular charger supplied with the system for 48 hours and you will probably be OK. It would be prudent to run a capacity check cycle after such an incident just to make sure.

Long-term overcharge, leaving your packs plugged in to the charger supplied with the system, while considered an acceptable practice for many consumer applications can contribute to a reduction in battery life. First, as a battery goes into overcharge, oxygen is generated on the positive electrode and then recombined on the negative electrode. This oxygen rich atmosphere only accelerates the oxidation of the separator. As the oxygen is recombined on the negative it generates heat. We all know how to make a chemical reaction speed up, turn up the heat.

One further phenomenon recently brought to light after years of testing is that of cadmium migration. This is a transfer of cadmium metal through the porous separator structure to form a conductive bridge between the electrodes. In simple terms a high resistance short which causes the cell to self discharge, shunts charging current to where the cell takes longer to charge and ultimately, if left of continue, become a hard short which, if happens during a period when batteries are part of, or contributing to the direction of an airborne operation, result in a rapid depletion of model resources. The same testing reference also confirms that the same amount of charge put into the battery in a short period significantly reduces the cadmium migration. Therefore using a simple appliance timer to switch your charger on for about an hour a day minimises the overcharge and yet maintains the packs at peak charge should an airborne operation be called for at any time. For the experimenter, a charger designed to charge the battery at C rate (1 hour rate) run at a 10 to one duty cycle (on 0.1 second, off 1 second) is more effective than charging continuously at the C/10 (10 hour rate common to most system chargers) and will enhance battery life. For a maintenance charge a 25 to 1 duty cycle is recommended. This pulse charge is better than even a very low trickle charge for maintaining the battery as cadmium migration is driven by passing current through the separator (charging) over a period of time. The rate of cadmium migration does not seem to increase proportionally to the current density, leaving us with the conclusion that getting the job done (replacing charge loss through inherent self discharge) quickly by a pulse of charge current is better than dragging it out with a long sustained overcharge. While this gives battery a break it will probably give rise to a new generation of exotic (expensive) chargers focusing on the dreaded cadmium migration phenomena (hereafter referred to as CMP, people only take three letter problems seriously) and leave the dreaded memory effect (DME) alone for awhile. Just remember that you can do the same thing with a $5.00 timer and spend the savings on a subscription to your favourite R/C magazine, RCM.

Storing the battery is no big deal. Living in Florida where there are no cool (damp, dark, mouldy) basement work shops, I store my batteries in the refrigerator on off flying season (July 3rd 9:30 AM to July 4th 7:00 AM). Those living in Northern climates don't really have anything to worry about (there must be some advantage) but should remember about the trunks of cars and what happens to batteries you leave them in there when you are visiting us for a winter flying vacation.

Looking at the battery voltage after several months of storage is an excellent way to pick out a weak cell (use straight pins to probe each cell). If a cell voltage after several months drops noticeably below any of the others, beware. You have a potential problem and the pack should be relegated to some benign surface application. While we are on the subject of measuring battery voltage, consider getting one of the little digital voltmeters available through electronic hobby outlets. They give you a precise reading and are well worth the modest investment. Second piece of advice. Don't listen to the R/C car guys when it comes to batteries, they have never experienced the thrill of real rip roaring, crank shaft bending, dirt in the transmitter, kind of crash and as a consequence take liberties with batteries that would make Leclanche and Volta turn over in their graves to say nothing about causing me just a little heart burn when they get me cornered in "technical" conversations.

Negative Pulse Charge, or "Burp" Charging

Fact or Fiction?

The concept of applying a short discharge pulse during the charge cycle sometimes referred to as "reflex charging" or "burp charging", has been with late 60s with patents by W. Burkett & J. Bigbee [3,597,673" Rapid charging of batteries and W. Burkett & R. Jackson [3,614,583 "Rapid charging of batteries"] and assigned to the McCulloch Corporation.

Burkett, an individual with great drive and somewhat uninhibited by the lack of any test substantive test data, enlisted the help of a Professor at Stanford to come up with a reason why the negative pulse charge technique did what Burkett claimed. This individual, striving for academic elegance, came up with the hypothesis that the negative pulse may have stripped away the gas bubbles on the plates and thereby enhanced the charge efficiency and reduced the temperature and pressure build up. He stated it was like burping a baby. Burkett liked the sound of this and it became his theme in promoting the concept. The fact that he was a prolific writer did not detract him from his quest, as he had his concept published in numerous trade magazines and technical journals hungry for a charging break through in the emerging market of cordless products.

After the patent was awarded he took it to General Electric, then the leading Ni-Cd manufacturer in the US, where it was analysed in detail. General Electric disappointed Burkett when, after extensive testing, they could find no conclusive evidence that the negative pulse offered any advantage. Burkett then proceeded to find other interested parties that would be less critical, and take his word for the phenomena. He sustained the venture for several years mostly by obtaining government contracts to further study the effect of the negative pulse technique for both sealed and vented Ni-Cd systems.

With the expiration of the patents many saw the opportunity to make a great deal of money from the ignorance of battery users and thus it has proliferated in many variations and forms. General Electric, confronted by battery customers who had bought into the Burkett scheme of charging, tested and retested the concept as each new variation was presented. The results were the same in each instance. It has never been demonstrated to have any advantage over conventional charging, either on charge efficiency, the performance or the life of the battery. While many claims have been attributed to this technique, none have ever been substantiated in the laboratory. Fortunately it does not harm the battery in any way and since the concept makes for a rather elegant marketing technifact, it has been adopted as a way to promote the sale of charging systems by numerous companies in which marketing dominates technology.

The reflex chargers are for the customer that cannot separate marketing from sound engineering and feels compelled to perpetuate this hoax while providing a healthy income for its proponents. If reflex charging had any merits that would enhance the performance of batteries the battery manufactures would be supporting it with vigour as would the major suppliers of battery powered products. Since is does no harm to the battery, the battery manufacturers are reluctant to focus on the pointlessness of some customers that insist on using it and risk a technical confrontation that would embarrass the proponents and jeopardise sales.

Using a Timer Can Improve Battery Life

One of the failure modes in Ni-Cd cells is shorting. While many things can contribute to shorting one of the significant contributors is cadmium migration through the separator where it forms a conductive bridge, ultimately shorting the cell

Cadmium migration is a function of the time the charge current is flowing through the battery and less a function of the level of current. Therefore we have found that high pulses of charge current to maintain the charge state are better than a steady low rate (trickle) current. This is very difficult to quantify as their are many other factors contributing to the life equation but improvements in battery life of 10 to 20 percent by pulse charging Vs trickle are not unrealistic.

Therefore we have found the sustaining a pack at the fully charged state by way of pulsing the charge is better than a continuous trickle charge.

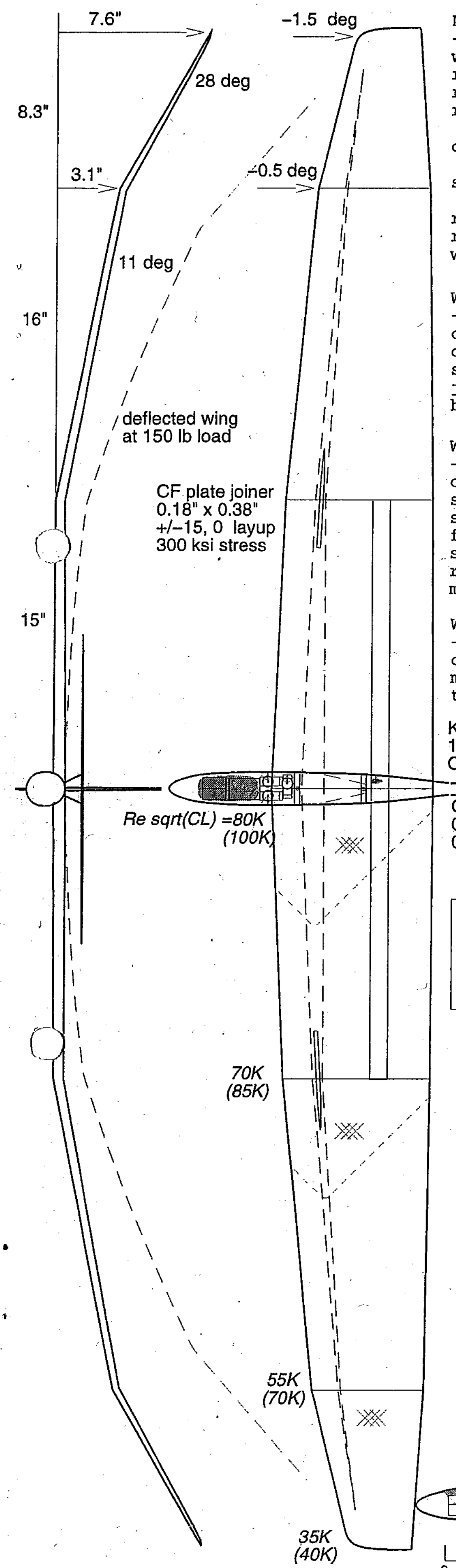
Some charges employ this technique. You can do the essentially the same thing rather simply and at a very low cost.

Simply connect your regular wall module charger that came with your system to an appliance timer. Intermatic makes a good unit for around $5.00. Set the trigger pins on the timer so that it is on for 1 hour a day. When you return from a flying session turn the timer wheel so that the on off triggers come up in 14 to 16 hours. Then turn the timer knob to on. This will give your pack a full charge and then a sustaining charge for 1 hour a day. The battery can be left in this manner for a long time between flights and still be maintained at a fully charged state with minimal overcharge.

If you only fly a couple of flights, you can just set the timer so that you get 6 or 8 hrs before you go into the 1 hr.day mode. If we assume a normal 2-hr flight time for a system and you only fly 20 minutes. Then the charge you need to return is 20/120 times 16 hours, or about 3 hours.

It is good to know what your system consumes in the way of energy per minute of flight. This can be determined by first charging a pack and then discharging it on a cycler to determine how much capacity it has - fully charged. Then recharge and go fly. Record your system on time and immediately discharge the pack when you return home. This will tell you how much capacity you have left. Let's say you fly for 40 minutes and when you discharge the pack you get 390 mAh. From your initial discharge from a fully charge pack you got 585 mAh. This would mean that you discharged 195 mAh in the 40 minutes you flew or about 5 mAh/min. From this you would know that your pack is good for 116 minutes of flight time.

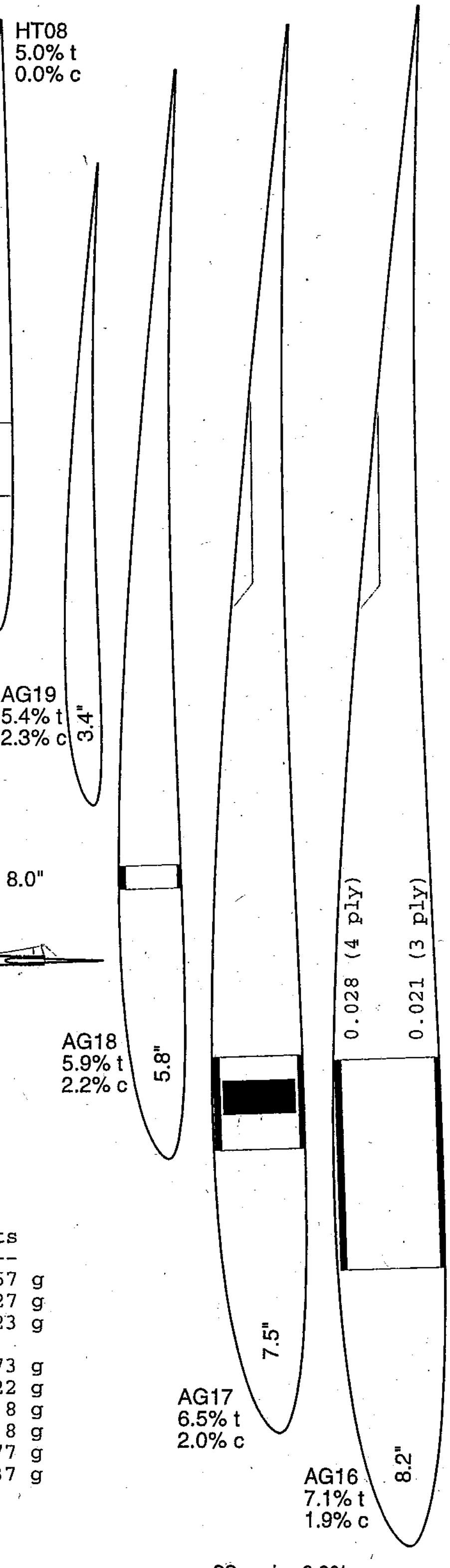
The system usage will vary, depending on your flying style, size of the plane and number of servos used.

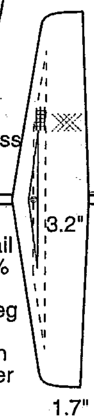



```
Design Loads
------------
wing lift        150 lb @ 57 m/s
root bend.mom.  1400 lb-in
root cap load   2500 lb
root cap area  0.036 in^2 top
               0.027 in^2 bot
cap stress        88 ksi  top
                 118 ksi  bot
skin stress       12 ksi (shear)

root torsion      25 lb-in
root skin th.  0.006 in
wing skin shear  725 psi

Wing spar weights
-----------------
caps   46 g (prepreg uni CF)
core   20 g (5 lb endgrain balsa)
skin   20 g (+/-45 3oz CF cloth)
join   18 g (prepreg CF plate)
boxes   8 g (basswood, CF cloth)

Wing structure weights
----------------------
core   70 g (2.2 lb foam)
skin  130 g (1,2,3 x 1.5oz glass)
spar  115 g
fill   25 g (microballoons+flox)
spoi   15 g (co-cured foam/glass)
ribs   10 g (vertical grain balsa)
misc   13 g

Wing panel weights
------------------
center  224 g
mids    125 g
tips     28 g
```

Kevlar fuselage shell 1.85oz 4 layers, CF reinforcements

CF boom 0.55" -> 0.32" ID 0.022" wall





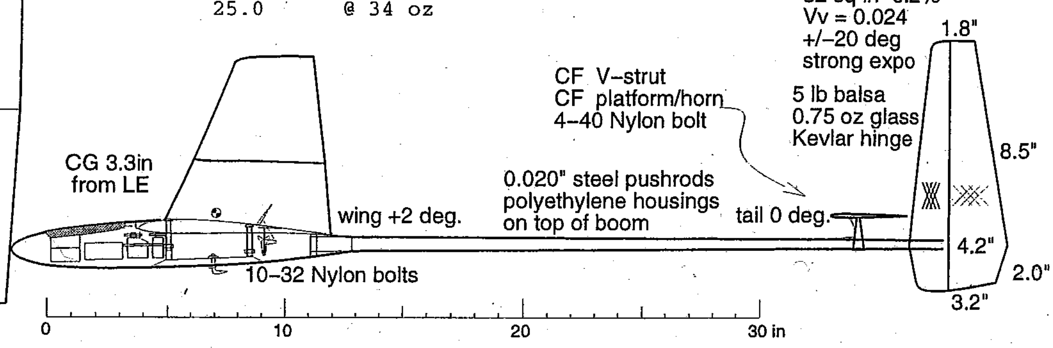
All-moving tail
39 sq in 7.5%
Vh = 0.33
-17 ... +10 deg
strong expo
-6 deg mix-in
with full spoiler

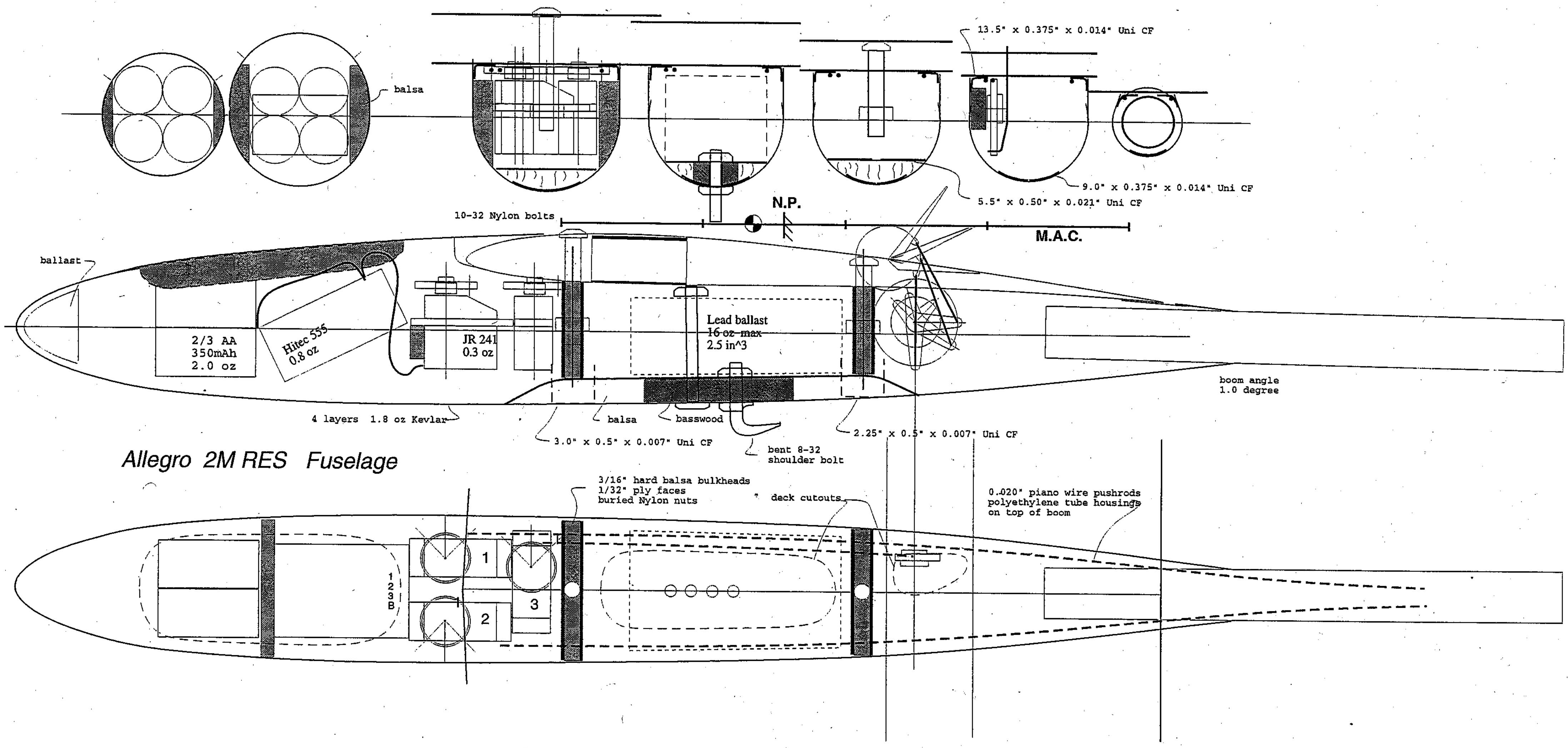
Allegro
2-meter RES
Mark Drela 30 Mar 00

```
mass = 22 oz
     = 34 oz ballasted
m/A  = 6.1 oz/ft^2   @ 22 oz
     = 9.4 oz/ft^2   @ 34 oz
area = 520 sq in
span = 78.6 in
A.R. = 11.9
CL = 0.9 max
   = 0.7 min sink
   = 0.5 max L/D
   = 0.1 min
min sink = 0.95 ft/s @ 22 oz
           1.20 ft/s @ 34 oz
max L/D  = 21.5      @ 22 oz
           25.0      @ 34 oz
```

```
Item weights
------------
350mAh      57 g
3 JR241     27 g
Hitec 555   23 g

      fuse   73 g
      boom   22 g
      stab    8 g
      rudd    8 g
      wing  377 g
      ball   37 g
```

32 sq in 6.2%
Vv = 0.024
+/-20 deg
strong expo





Allegro 2M RES Fuselage
balsa
13.5" x 0.375" x 0.014" Uni CF
9.0" x 0.375" x 0.014" Uni CF
5.5" x 0.50" x 0.021" Uni CF
10-32 Nylon bolts
N.P.
M.A.C.
ballast
2/3 AA
350mAh
2.0 oz
Hitec 555
0.8 oz
JR 241
0.3 oz
Lead ballast
16 oz max
2.5 in^3
boom angle
1.0 degree
4 layers 1.8 oz Kevlar
balsa
basswood
3.0" x 0.5" x 0.007" Uni CF
2.25" x 0.5" x 0.007" Uni CF
bent 8-32
shoulder bolt
3/16" hard balsa bulkheads
1/32" ply faces
buried Nylon nuts
deck cutouts
0.020" piano wire pushrods
polyethylene tube housings
on top of boom
1
2
3
B