CONSTRUCTION

BY ROY E. DAY

# DORNIER DO-28 ELECTRIC TWIN

Would you like to have a good flying sport scale twin that you can take along on your vacation and win the attention of the fellows at the flying field? Then build and fly this 70-inch wingspan Dornier Electric Twin.

**OBJECTIVE OF THE PROJECT**

When I began this project I had three principal objectives. They were to design a sport scale electric model with the following characteristics:

1) A twin using the popular 05 size electric motors.

2) An easily transported model so it could be a "vacation" airplane.

3) A sport scale model of an airplane with comfortable handling characteristics and moderate wing loading.

The airplane I selected was the Dornier DO-28, a 6-8 passenger twin engine high wing monoplane. The high aspect ratio wing promised good lift. The engines mounted on a subwing simplified the power installation and eliminated the problem of disconnecting the motors every time the wing was removed.

Almost everyone, the author included, is intrigued by twins but is fearful of the dreaded "engine out emergency." An electric twin with motors and controller in series with the battery virtually eliminates the possibility of an "engine out."

**DESIGN PARAMETERS**

The model was designed for three controls, no ailerons, which simplified the two-piece wing necessary for easy transport. Also the tail assembly and the landing gear must be easily removable. The basic design ground rule for electrics is that the airframe plus radio should not weigh more than the power system, i.e., the motors plus the batteries. The sizing of the airplane proceeds as follows. The motors selected were the Astro geared 05 cobalts. The battery pack planned was 16 cells of 1200 mAH. The 16 cells give a little added power over the usual 14 (7 per motor) without any danger of harming the cobalt motors. In fact, the DO-28 only draws 20 amps static. Current levels as high as 30 amps can be tolerated by the Astro brushes without any damage.

Power System Weights:

| | | |
|---|---|---|
| 2 geared 05 motors | = | 16 oz. |
| 16 1200 mAH cells | = | 30 oz. |
| Total | = | 46 oz. |

Therefore the all-up flying weight should be 2x46 = 92 oz. Now the total weight budget becomes:

| | |
|---|---|
| Power system | 46 Actual |
| Radio | 8 Actual |
| Airframe w/L.G. | 36 Estimated |
| Covering | 2 Estimated |
| Design Flying Wt. | 92 oz. |

For ease of flying the wing loading is set at 20 oz./ft.$^2$. Now the corresponding wing area is computed by dividing the design weight (oz.) by the desired wing loading—in this case, 92 divided by 20—which gives us a wing area of 4/6 ft.$^2$, or 662 in.$^2$. The design area was rounded to 600 in.$^2$. Based on the aspect ratio of the Dornier, the wing span came out at 70 inches. So now we have all the basic sizing parameters, weight goals and scaling dimensions. The resulting design is shown in the plans and we can now begin construction.

**CONSTRUCTION**

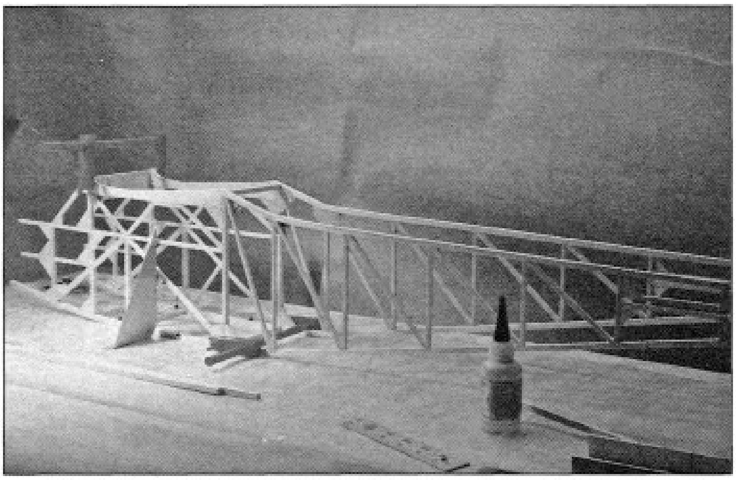
Lightweight construction is particularly important for electrics and essential if we are to meet the ground rules stated. If the weight is not kept in control, we will have another of those overweight/underpowered electrics that stagger about the flying field like a wounded butterfly, provoking snickers. For this plane no epoxy is used, only thick and thin CA glue. Plywood and hardwood are used only in high load areas, such as landing gear mounts, motor mounts, and wing attachments. Increased strength is obtained in some areas by using thin ply doublers on balsa and the liberal use of gussets. Properly fitted gussets of 3/32 balsa can add tremendous strength and stiffness with minimum weight.

**Fuselage**

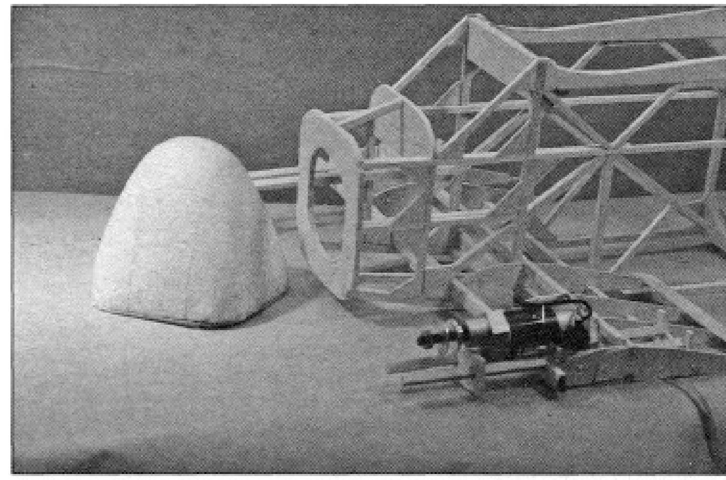
The fuselage is conventional built-up stick construction. The two sides are built over the plans, then joined with the cross members while pinned upright on the board. Use medium weight balsa for the longerons and members in the forward part of the airplane. Lightweight balsa is all you need for the aft structural members. Bend the longerons in carefully to meet F-1. Former F-1 is made from two pieces of medium 3/32 balsa cross-laminated. The result is as strong as lite-ply but lighter.

When the basic structure has been completed and while the fuselage is firmly pinned upright on the board, start the construction of the subwing and motor mounts. Sketch B shows how the spruce spars rest on the 1/4-inch square balsa cross pieces and tie into the fuselage uprights. The thrust line of the motors should be 0-0, along with the wing and horizontal tail. If it is necessary to adjust the thrust line later, it can be easily done by shimming the motors in their beam mounts. I found that no adjustments were necessary.

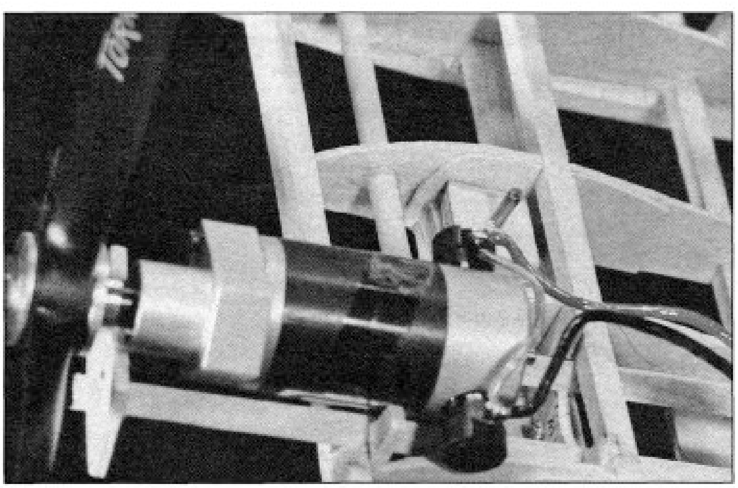
Install all the ribs in the subwing except the one next to the fuselage. Glue it in place after the sides of the fuselage are sheeted. Glue in the leading edge of the subwing, the landing gear, and motor mounts. Before sheeting the subwing, it is a good idea to run the wiring through the soda straw conduit out to the motor mounts. Add 1/16 balsa



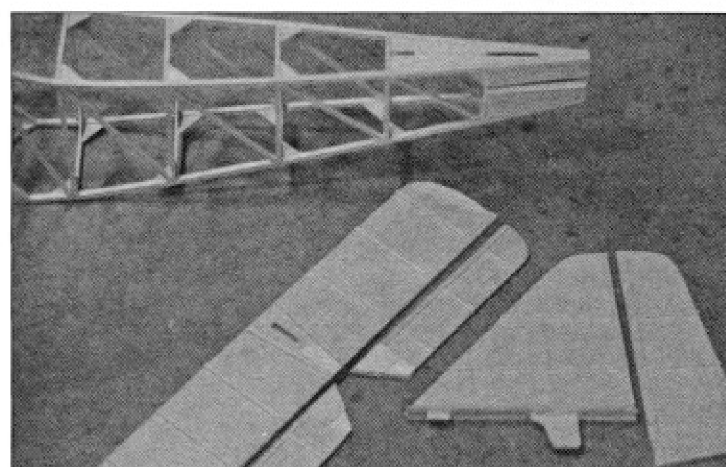
The fuselage sides are built one over the other and joined in the conventional manner as seen here. Use a triangle or combination square to keep the sides exactly perpendicular to the board.



The subwing and motor mounts are built as an integral part of the fuselage. The nose block is foam with a single layer of glass cloth and epoxy, and is held to the finished fuselage with tape to allow equipment access through the forward fuselage former.



Spruce subwing spars and motor bearers, and plywood doublers on the ribs provide the necessary strength and stiffness for landing and thrust loads.



Sheet balsa tail surfaces are light and strong, and the tab-and-slot arrangement automatically brings everything into perfect alignment when assembling at the field.

shear webbing from the motor mount through the fuselage and out to the other motor mount. It's useful to have a 1/2-inch hole in the webbing in the fuselage to allow the controller wiring to pass through to the receiver. The subwing is sheeted top and bottom with 3/32 medium balsa. This is required to give the needed strength for landing loads. Remember, this is a six-pound airplane which may make a lot of dead-stick landings.

The nose was made from styrofoam and given a hard surface by applying one layer of 0.5 oz./yd.$^2$ cloth with laminating epoxy resin. Do not glue the nose on; it is attached with plastic tape when the model is completed. It is very handy to be able to gain access to the front insides of the airplane through the nose opening. Wait until the wing is built to put in the wing attachment structure.

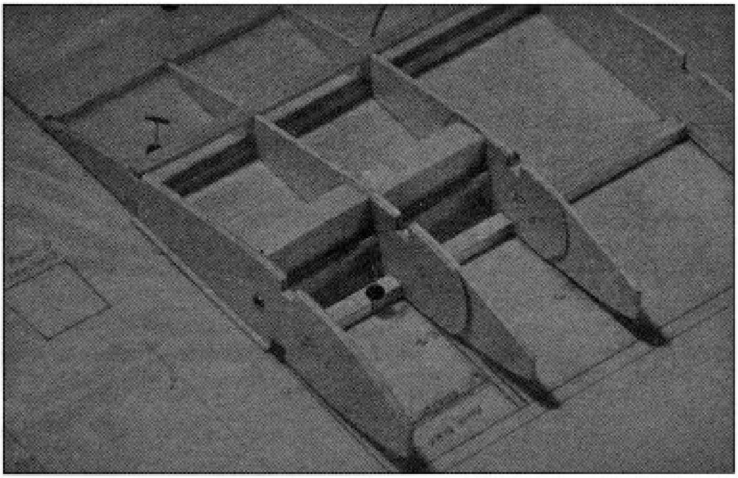
The motor cowls shown in the photographs were made from plastic bottles. You could build them from balsa, 1/64 ply or vacuum-formed plastic. Again, they are attached with plastic tape. Be sure there is adequate airflow through the cowl to cool the motor.

**Wing**

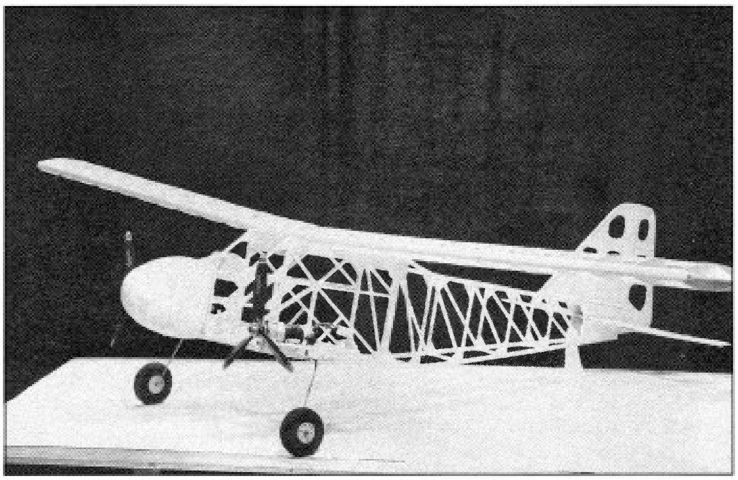
The wing construction is conventional with a music wire/brass tube joiner. The semi-symmetrical ribs are straight from the trailing edge to the lower forward spar cap, so the wing can be built flat on the board. Add the forward bottom sheeting after the wing is removed from the board. Carefully align ribs R-1 and R-2 and insert the brass tube. Be sure you have a snug fit of the 1/2-inch balsa block against the brass tube and between ribs R-1 and R-2. Roughen the brass tube before gluing with thick CA. Build in some washout by shimming the tip trailing edge up 1/4 inch with scrap. Install the shear webs from root to tip on both spars. Add the wing grabber blocks after the wing is removed from the board. For additional strength, glue 1/4-inch wide fiberglass tape on the bottom spar caps.

Although ply rib R-1 should be angled to account for the dihedral, a no-gap fit between wing halves still requires rib R-O because of the bend-radius of the music wire wing joiner. Bend the 1/8-inch music wire joiner so that you get 2-1/2 inches of dihedral at each tip.

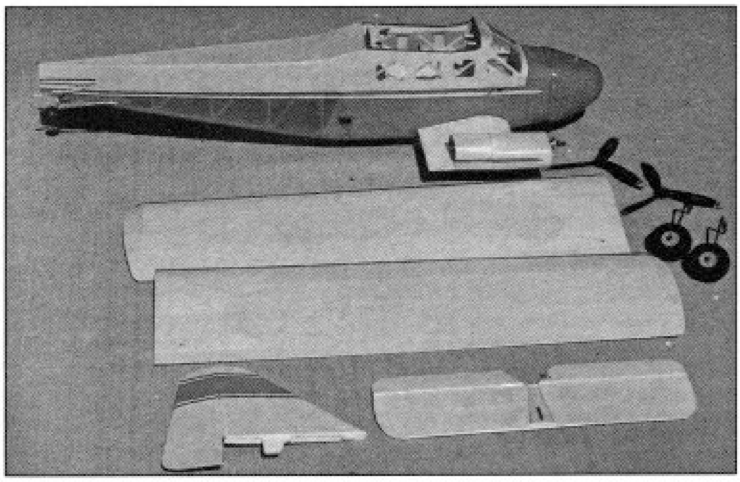
The completed wing can now be aligned on the fuselage and the dowels and nylon hold-down bolts installed. If you are concerned about the 8-32 nylon bolts being strong enough, don't be worried. I have flown six and seven-pound models with 8-32s for years with never an inflight failure. The 8-32s will shear off in case of a crash, however, and may save your wing.



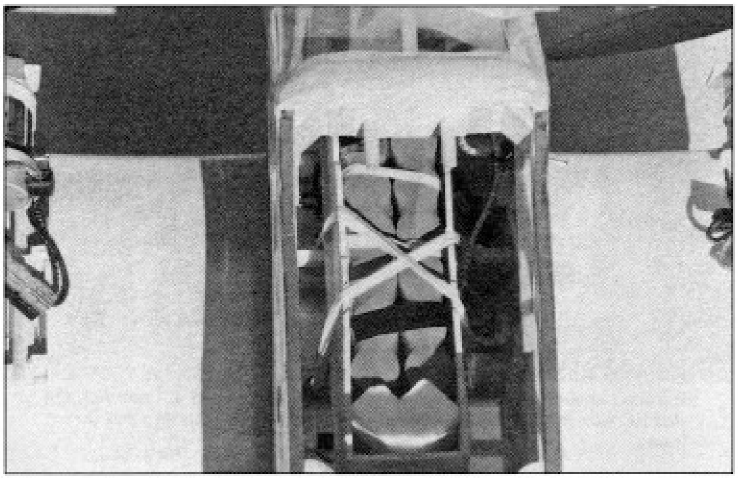
The two-piece wing is joined by a length of music wire inserted into a brass tube in each wing half. Note plywood wing rib doublers and the 1/2" thick tube support blocks.



The completed, uncovered structure as seen here, but sans motors, should weigh in at about 2-1/4 pounds. Finished model comes in at 6 pounds.



The Dornier can be assembled or disassembled at the field in less than 30 minutes. The whole thing packs into a box about the size of a piece of luggage for easy transport. Of course, if you don't plan to take your model traveling with you and if transportation to the field isn't a problem, you can build the wing in one piece and glue the tail surfaces permanently in place, which will cut assembly/disassembly time down to just a couple of minutes.



The 16-cell motor battery fits into a box of 1/8" balsa, which is held in place with a combination of Velcro and rubber bands.

**Tail**

Both the vertical and the horizontal tail are cut from 1/16 medium balsa sheet with strengthening false ribs and "spar" laminations added. Sand the false ribs to give an airfoil shape. The tail surfaces will not be glued but will be attached with plastic tape, so it is important that they have a good snug fit. To give additional support, add 1/2-inch diagonals along the base of the fin on both sides where it sits on the fuselage. Similarly, glue a strip of 1/2-inch balsa diagonal along the bottom of the slit in the fuselage for the horizontal stabilizer. This will give a good firm base and prevent any tail rocking.

**Landing Gear**

The main landing gear is the standard torsion type using 5/32 music wire mounted in landing gear blocks. Easy removal of the gear is therefore achieved for transport. The tail wheel should be driven with a separate pushrod and not connected to the rudder. This saves wear and tear on the rudder hinges and makes it easy to remove the tail.

**Battery Installation**

Before covering the airplane, it's a good idea to figure out where the motor battery will be placed and how to support it. This is also a chance to make a rough balance check, realizing that the motor battery largely determines the C.G. location. One approach is to build a 1/8-inch balsa box to hold the 16 cells. I built cross supports over the subwing leading edge and the subwing rear spar at the same level as the forward spar, which passes through the fuselage. This gave me a good three-beam platform to support the battery box. Strips of Velcro were glued on each crossbeam and on the bottom of the battery box. Then I put in four hold-down hooks for rubber bands to hold the battery box firmly on the Velcro-covered cross-beams. In the case of a hard crash, the battery box will slide (hopefully) forward, impacting the nose block with a minimum of damage. So far the scheme has worked fine. With the battery box on the cross beams, there is space below for the controller and a heat sink on the bottom of the fuselage.

**Covering**

Micafilm was used but any lightweight film covering would be acceptable. The hinges are made from two strips of the covering ironed on full span of the control surfaces. Use your iron to join the covering in the gap. These hinges are strong, light and have no gap.

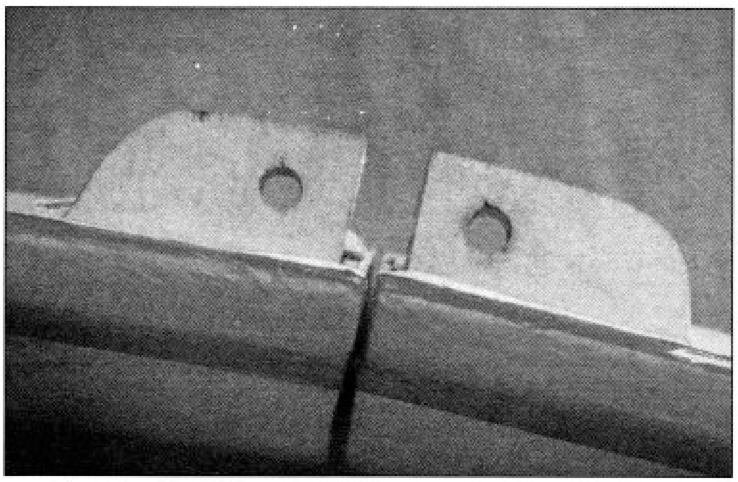
**FLYING**

Besides the usual preparation, three checks are particularly important before the first flight: balance, washout, and radio interference. The C.G. location is more forward than you might expect for a straight wing monoplane. This is caused by the slight destabilizing effect of the subwing. However, the Dornier seems tolerant of + 1/4 inch variations about the nominal C.G. shown on the plans.

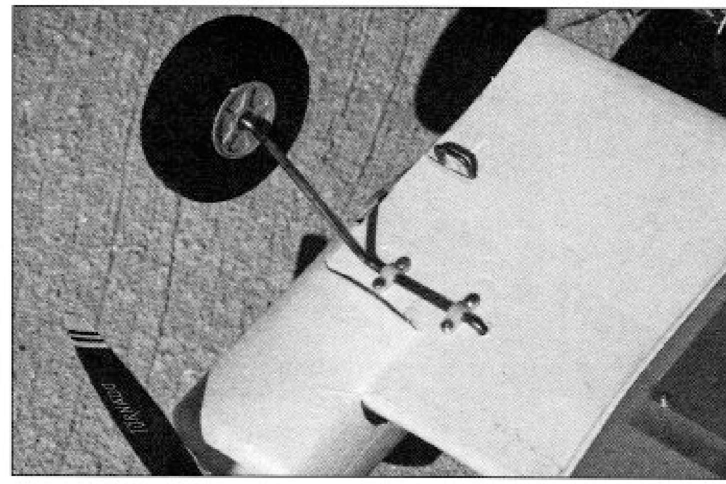
Be sure you have a couple of degrees of washout for a gentle stall. If you didn't build it in, you can still get it with your heat gun by twisting the wing panels. Recommended control surface throws are: rudder: 1 inch, elevator: 1/2 inch.

Make your usual radio check with the transmitter antenna down while someone holds your model with the motors running. Depending on your setup, you may encoun-

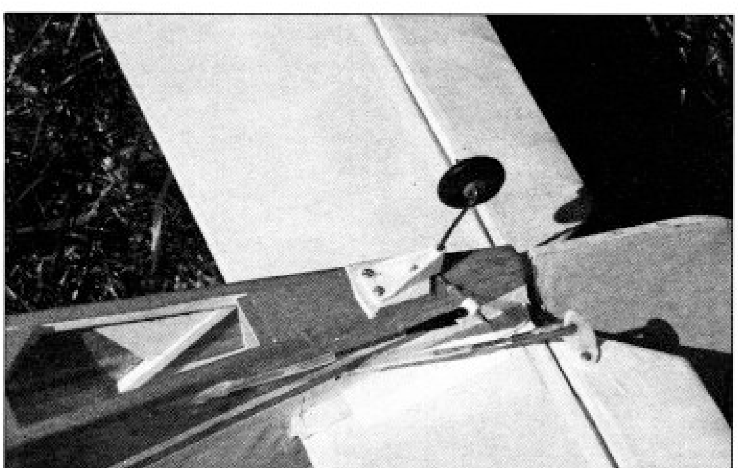
*continued on page 81*



**The two wing attachment dowels in the fuselage slip into these plywood hold-down fittings in the wing leading edges. Trailing edges are secured with 8-32 nylon screws.**



**Nylon retainers hold the landing gear in place . . . easily removed for transport or for straightening, in the event you somehow manage to bend those stiff 5/32" struts.**



**Author recommends using a separate pushrod to the tailwheel to relieve strain on the rudder hinges . . . a good idea, although it does add a bit of extra weight. Battery cooling air exits from the uncovered bottom bay just ahead of the stab.**

**No worries about an "engine out" on this twin! Touch-and-go's and landings are a real pleasure with no tendency to groundloop, thanks to the wide-tread landing gear.**

**PLANS ON NEXT TWO PAGES.**

**DORNIER** *Continued from page 25*

ter interference. I did prior to the first flight and I solved it by inserting a 10 micro henry choke in each of the leads from the controller to the receiver. Bob Kopski described how to make such a choke in his column in *Model Aviation* magazine for December 1989.

The final flying weight of the Dornier with the 16 1200 mAH cells came out at 96 ounces—4 ounces over the design goal, which I consider pretty good. At this weight the wing loading is about 23 ounces per square foot, still acceptable.

The Dornier makes a spirited takeoff and climbout from a grass runway. The wide tread main gear and long tail moment minimize any tendency to ground loop. It is very stable in flight and yet responsive to the controls. Mild aerobatics are possible. The twin geared 05s give a wide range of speed and a sound resembling a "quiet turboprop." Level flights at reduced throttle are about five minutes long. The plane has been flown more than 50 flights with good results and no crashes. Flights have been made with 900 mAH SCRs and 1200 mAH AE 16-cell packs, as well as the 1200 mAH SCRs. The 16-cell 1200 mAH AE pack is 8 ounces lighter than the 1200 mAH SCRs, but it gets hot because the current drain of 15-20 amps is higher than recommended. All in all, the best performance comes from the 16-cell 1200 mAH SCR pack.

If you are looking for a good size sport scale twin that is easy to dismantle and transport, you should try the Dornier DO-28 Electric Twin. ***MB***