CONSOLIDATED PBY-5 CATALINA MINI-CAT
by Ivan Pettigrew
Construction Notes

After several years successfully flying a 102-inch span model of a Catalina using 16 cells to power two Speed 600 size motors in series, it was decided to design a scaled down version. It has been nicknamed the “MiniCat.” The original plan was reduced to 82% and some small modifications made. Keeping the weight to a minimum by making it a straight flying boat, (no retractable undercarriage for land operation) it was possible to power this model with two GWS Speed 400 geared drive motors wired parallel from an eight cell nicad. The wing loading is 11 oz/sq.ft making it a very tame “Pond Flyer.” It not only floats on the water: it floats in the air as well. With its unique lines, the Catalina is a stately slow flyer. The optional wheels shown in the plan for land operation have not been tried. They are just a suggestion for those who want to fly from land. Othewise the model can be hand launched or flown off a dolly, then landed on its belly on grass. Tip floats should be left up when doing this. The prototype has done a considerable amount of flying, but all of it off water.

The design of the Catalina is quite different from that of most flying boats. It has a huge wing for the size of the fuselage and hull. Unless the model is built very light, the small hull sits very deep in the water. Because of this minimum amount of buoyancy, an overweight model of a Catalina will have great difficulty getting up on the step during take off. That is not the case with light weight models of the Cat.

The construction of the Catalina has some challenges. The stab and elevator are mounted half way up the fin, and this type of tail is more difficult to build than a conventional one. But it has the advantage of keeping the elevator out of spray from the hull, and it doesn’t make the model tail heavy when the wood in the tailplane soaks up water.

The wing floats on the Cat are mounted at the tips instead of part way out on the wing as is the case with most flying boats. If landing and take offs are done with the tip floats down, the long wings make it difficult to keep the tip floats out of the water. It is more difficult with this arrangement than is the case of a conventional design which has wing floats mounted closer in. However, with retractable tip floats, the safe way around this problem is to start retracting the tip floats early in the take off run as soon as aileron control is achieved. Landings can be done with the tip floats up, then they are lowered after touch down as the model slows down on the step. This applies especially to flying in windy conditions. Another advantage of tip floats is in cross wing landings. With the floats up, it is possible to land with the wing on the upwind side lower than the other one, thus correcting for drift. “Step” turns (taxiing at high speed) are easier too with tip floats up. The model can be banked in order to help the turn. It is a good coordination exercise. Use the rudder to control the radius of the turn, and the ailerons to bank the model enough to help the turn, but not so far as to get the inside float in the water. If flying from a small pond in calm conditions, it is possible to take off and land (with floats up) in a circular path in a banked attitude. All kinds of exciting possibilities open up with retractable tip floats.

If a simpler model is desired, the retractable tip floats can be skipped, and fixed ones substituted. They should be mounted with rubber bands or Velcro so that there is some flexibility in the case of a float hitting the water too hard and "digging in." It is better to have a float break loose than tear out a section of the wing where it is mounted.

The wing pylon is the other item that adds to construction time with the Catalina. The pylon fastens to the fuselage with two dowels at the front, and two hold down bolts at the rear. For transportation the pylon is removed from the fuselage with the wing still attached. It is only necessary to remove the wing from the pylon for maintenance or repairs. When fitting the wing (with pylon attached) to the fuselage, it is necessary to connect three pairs of wires that run down through the pylon. The wires carrying current to the motor will be at the front. The others are the wires to the aileron servo and float retract servo. A cover over the nose section (which includes the cockpit area) is removable to allow easy access to the motor battery. It also gives access to the optional removable nose gear.

FUSELAGE

The bulkheads are cut from balsa. Square holes are cut in bulkheads D to I. These bulkheads are then slid on to a pair of 3/16" square balsa rails. When the bulkheads are glued to these rails, the bottom keel running along the centre line can be attached, along with the strips along the upper centre line. Next attach the remaining bulkheads to the upper and lower centreline strips, and the longerons to the side of the fuselage where shown. The sheeting is next applied along the lower part of the side of the fuselage, but the curved upper surface should be left until later when the control pushrods have been installed. The bottom of the hull can now be sheeted. The rear part is straightforward but does not have to be completely covered in the area where the secondary step overlaps the lower surface. When doing the front section from the nose to the main step, start with the outer strips. Note that these are at a different angle from the inboard "V" section of the hull. The concave surface thus formed really helps in reducing spray and getting the model on the step promptly.

Next the cover over the nose section, including the cockpit area, is built, and then the wing pylon. These are built in place, using very thin clear plastic ("cling" or saran wrap) to keep the sections from being glued to the fuselage. The bulkheads are on the light side, so they don't need to be hollowed out, but this can be done in places, and will be necessary of course in the area of the motor battery.

TAIL SECTIONS

These are of conventional construction. The use of a symmetrical airfoil with a deep spar means that there is greater strength than there is with a flat surface. Hence the tail surfaces can be built lighter and are less prone to warping. Keep the tail light. For accuracy in joining the control surfaces, it is best to shape the spars first and hinge them together before starting construction. The rearward position of the elevator horn is important. This is because of the angle of the pushrod. Both sides of the fin should be sheeted with 1/16” sheet balsa from the top of the fuselage up to the elevator platform, since there is considerable stress in this area. A fairing is added as indicated on the plan, and this improves strength as well as appearance where the fin flairs into the top of the fuselage, especially in the area of the fillet at the front of the fin. Light flexible pushrods should be used for the tail surfaces, but they should be supported at various places along the fuselage in order to avoid bowing when pressure is applied to the rods. This problem is taken care of naturally by the bulkheads if they are not hollowed out. .

WING CONSTRUCTION

It will be noticed that the airfoil section changes where the ailerons start. The NASA type leading edge cuff with blunter leading edge is used on the outboard panels. This reduces the risk of tip stall considerably. The (shark tooth) break in the leading edge can be disguised somewhat by putting a fence made from 1/32” ply at this position, but is not necessary. The wing is built in one piece. The basic airfoil is a Selig 7055, but outboard of the aileron break it uses a NACA leading edge cuff to reduce tip stall tendencies. A full depth 3/32” sheet balsa spar is continuous throughout the wing The ribs are cut where they meet the main spar, and are butted to the front and rear surfaces of the spar. Cut the main spar from 3/32” sheet balsa and splice the pieces together over the plan. Notice that the only dihedral is that of the upward sweep on the lower edge of the outer section. This is due to the taper on the spar of the outboard section of the wing. Now glue the 1/8” x 1/8” hardwood strips to the top and bottom surfaces of the spar as indicated. These strips should be bass or spruce.

Cut all the ribs in two at the point where they join the spar. Remove 1/16” from the top and bottom of the nose section of the ribs to allow for the 1/16” sheet covering from the leading edge to the spar. This is done easily with a balsa stripper. Assemble just the rectangular (non tapered) section of the wing first. Pin the spar on its edge over the plan. It is easiest to start by gluing the rear part of each rib in place, then attaching the trailing edge. Next glue the front part of each rib in place and then the first inner strip of 1/8” balsa which forms part of the leading edge. The outer strip of 3/16” sheet that completes the leading edge is not added until the sheeting has been applied to the top and bottom surfaces of the wing from the leading edge back to the main spar. Glue the secondary spar in place on the lower surface of the wing. When the rectangular section of the wing has been completed, one end is propped up a little so that the lower edge of the outboard section of the spar at the other end is flat on the work bench. That section of the wing (the tapered part) is now built in the same manner as the rectangular part, making provision of course for the aileron. Note that the first strip of the leading edge is 3/16” in this section.

When complete, the procedure is repeated to build the tapered outboard section at the other end

Sheeting is now applied to the lower surface of the wing from the leading edge to the main spar. At this point the wiring should be installed for the motors. It will be noted that the wing is still not torsionally strong, meaning that it can easily be twisted. After the sheeting is applied to the upper surface of the same area, the wing will be very rigid and difficult to twist. Hence it is very important, when applying the sheeting to the upper surface, to weight that section of the wing down on a surface that is perfectly flat. There should be no washout from the wing root to the start of the aileron, but from that point to the tip there should be 1/8" washout at the outer end of the lower secondary spar. The remaining strip of 3/16" sheet balsa that forms the leading edge is now glued to the one in place and contoured to shape. Finally sheeting is added to the centre section where indicated. For accuracy in building the ailerons, the 1/8" leading edge of the aileron can be hinged to the wing first, then the ailerons built while attached to the wing. It pays to really work at getting the ailerons to flush fit with the wing so that drag is at a minimum. That is the advantage of fitting the aileron leading edge to the wing first and trimming it to the exact size before building the rest of the aileron.

The tip floats are built up from sheet balsa. A retract servo is best used for operating the tip floats, but because of the light weight of the floats, a standard servo could be used. .

The construction of the nacelles and cowlings is fairly basic. The nose ring of the cowling is like a doughnut, and can be shaped from one piece of thick balsa, or laminations. Provision should be made for cooling air to exit from the motors. This is done by leaving a section of the engine nacelle open under the wing. A triangular piece is left open on the inboard side of the lower nacelle from N-2 to the rear, about ¾" wide at N-2, tapering to a point at the rear.

CONTROL THROWS

These are shown on the plan. Notice the small throw of the elevator. This is important because of its large size. Importance must also be given to the differential in the ailerons, and it will be achieved if the control arm on the aileron servo is made as shown. At the start of the take off run in a flying boat, one of the tip floats will be in the water. It is necessary to lift this float out of the water using ailerons or the model will want to turn in the direction of the float that is dragging in the water. Poor aileron design aggravates this problem in many models because of the adverse yaw that is inherent at larger angles of attack, such as while getting on the step. The down going aileron produces drag which turns the model in the wrong direction. Two things are done in the design of the Catalina to overcome this problem. Frise ailerons are used, but of greater importance, a substantial amount of differential is used in the aileron linkage. At the start of the take off run, while holding up elevator to get on the step, advance the throttle just a small amount at first until the wings are levelled with both tip floats out of the water. When this is under control, advance the throttle further and relax on the up elevator as the model accelerates on the step. With practice this becomes one smooth continuous movement. Along the way the tip floats should be retracted. If you are too busy to do the floats while concentrating on the take off, a small grandson can be taught to put the floats up or down on command, and he feels very important being assigned as Grandpa's co pilot. A very slight amount of up elevator may be necessary at the point of lift off, especially if operating from glassy water.

Do **not** use outboard servos for the ailerons. These would require long leads running along the wing parallel to the motor wiring, and they would be very prone to picking up interference. At the low airspeed of this model, one micro servo is ample to operate the ailerons.

COVERING AND FINISHING

It has been found over the years that film does not stand up to repeated use in water, so the hull and tip floats are best covered with light tissue (silkspan) applied with nitrate dope. The silkspan should be applied to the lower half of fuselage. Be sure to prime the fuselage and tip floats by applying two coats of clear nitrate dope before covering. Added water proofing is also achieved by applying nitrate dope to the inside of the hull. When applying the tissue, first spray it lightly with water and rub it on to the surface while damp. Then brush a coat of dope on to the tissue. It will bleed through the tissue and cement itself to the primed surface below. After it has dried, apply at least one more coat of clear dope. The fuselage should be sanded after each coat of dope is applied, and when a smooth surface has been obtained, the colour should be applied. Krylon spray-can paint is known to be one of the lightest and most suitable for models of this type, but any lacquer spray paint should be suitable. Check for compatibility with the nitrate dope. The good thing about electric models is that the paint does not have to be fuel proof. The wings and tail surfaces are best covered with low temperature film. Mica film used for the lower surface of the wing saves weight and adds strength. It doesn't look as good as film, but under the wing is not so noticeable. Some high temperature films are very strong and shrink considerably. These should be avoided on lightweight airframes. Water seepage into the tail surfaces can be a problem with models flown a lot off water. Water will get into a tail surface through the slightest opening, but if the surface is covered with film, the lack of breathing results in water damage to the structure. The horizontal tail surfaces are the most prone to this problem. It has been found best to use a covering like litespan or coverlite on the lower surface of the stab and elevator. It seems to breathe, and avoids the problem of condensation.

EMERGENCY FLOTATION

With an electric powered model, because of the weight of the batteries and motors, there is not enough flotation to keep the plane on the surface of the water in the event of a crash, or the hull being punctured. Hence it is recommended that blocks of foam board be placed in the fuselage, or even some of the wing bays. The small air sacks used as packing are another option. When asked why the model of the Catalina is so light, the writer often points out the little air sacks in the fuselage and says that they are filled with helium. In the case of several multi motor flying boats that have flown for several years now, fortunately this flotation has never been put to the test. But in earlier years a single motor pylon type flying boat was lost following a crash due to radio failure. On arriving at the crash scene, all that was floating was the wing and part of the tail section that had torn loose. The fuselage, complete with radio gear, motor and battery, was at the bottom of the lake, and had it been a multi motor flying boat, the wing would have probably gone down as well because of the weight of the motors. Flotation is like insurance. You will only need it if you don't have it.

Enjoy building and flying your Catalina. There is not much that can be said about the flying that does not apply to other flying boats. Full power is necessary to get the model on the step, but the power should be applied slowly with elevator full up, at the same time using ailerons to keep the wings level. As soon the model is on the step it will accelerate and back pressure on the stick should be reduced until the elevator is only slightly up. As soon as the model becomes airborne, reduce the amount of up elevator so that a safe climbing speed is attained.

The last part of the landing approach is best done with a small amount of power which is left on right through the landing. If the model skips on touch down, it is because the landing speed is too high. The final part of the approach should be with a small amount of power which is kept on right through the flare. Back pressure should be applied on the elevator until speed is diminished and a slightly nose high attitude is attained. The point of the main step should touch the water first. If this is achieved, the model will not skip or bounce, because the step is behind the CG. If the model is allowed to touch down at a higher speed, it will be flying at less angle of attack. Therefore the forward part of the hull will hit the water first and make the model bounce. In a landing like this, the nose is pushed upwards, increasing the angle of attack of the wing, and the result is an ugly bounce or a series of porpoises. If landed in the right attitude at a slow speed, the Catalina will not skip, even if the touch down is quite hard. After touch down, the elevator should be kept up, as in a three point landing with a tail dragger. The landing run after touch down is most impressive if extended by leaving on the small amount of power that was used for the approach. This also gives more time for the co-pilot to lower the tip floats.

The Catalina likes to be flown with rudder. As with any model with a long wing and no dihedral, there is a tendency for the turns to steepen up. This is controlled by using "opposite" aileron in the turn, but maintaining a small amount of rudder in the direction of the turn. It is similar to flying the slower light planes of a few generations ago, so look for an old time flyer to teach you some coordination if you are one of these new wiz kids who has never learned what a rudder is for. Programming the transmitter to mix rudder with aileron is NOT the way to go. Program the brain and the fingers!

Part of these instructions have been pasted in from those written for the larger Catalina, so there may be some repetitions. But yes, if you came to the conclusion that Low Tech Ivan is getting to the stage in life where he may tell you the same things three times in three minutes, you could be right. Did the old bloke tell you to apply power slowly when taking off and keep the wings level? Ivan Pettigrew

For further details on flying boats, read the page about “Flying Boat Design’ on www.ivansplans.com.

Summary - Mini-Cat PBY-5 Catalina flying boat for Speed 400 motors. August 2004. Scale 1:15. Span 83 in. Wing area 835 sq.in. Length 52 in. Airfoil Selig 7055. NACA type leading edge cuff on outboard sections. Weight with eight CP-1700 SCR nicads is 64 oz. Wing loading 11 oz/sq.ft. Two GWS geared motors “E” series with 3.4:1 reduction wired parallel driving GWS 9x7 three blade props. Static current is 18 amps, 9 amps to each motor, giving 26 ounces thrust. Prop speed 5,200 RPM. Average flight time is 15 minutes. Flies 27 minutes on eight 3,000 mAH NiNH cells. Retractable tip floats. The “Mini-Cat” is to a pond what a “Park Flyer is to a “Park,” so I guess it qualifies as a “Pond Flyer.”

March 2005 update.
The GWS 9x7 three blade props seem to be difficult to find now. The prototype model used to fly with the three blade GWS props which looked very nice, but it now flies with two blade APC 9X6 slow flyer props. The static current draw is slightly less and the performance seems better. This change may not seem consistent with the usual rule of increasing prop diameter when going from a three blade prop to a two blade. The inconsistency here is because of going from one manufacturer to another. The model now has 100 flights on the original motors and they are holding up fine.

April 2005. Alternate Fuselage Construction.
The fuselage construction is not difficult once underway, but the challenging part is getting things together at the beginning. It would be nice to be able to hang the bulkheads in space while the longerons are attached. One way to handle this is to build the fuselage upside down on the building board, over the top of the plan view of the fuselage. The top longeron that runs the length of the fuselage should be tacked to the building board, leaving it in one piece at this stage, and cutting out the part where the pylon fits later on. Next the bulkheads are glued to the longeron at the indicated stations. Now the bottom longeron, or keel, can be glued to the bulkheads and also the side longerons. The structure can now be removed from the building board and the sheeting started. Pick up in the original instructions in the middle of the first paragraph about the fuselage where it says, “The sheeting is next applied along the lower part of the side of the fuselage.”