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## **Construction Manual for DeHavilland DH.103 Hornet F.1 and F.3**

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### **Materials**

To complete this kit, you will need to provide the following materials:

- 2ea 1/4" x 27" Balsa Triangle (fuselage)
- 1ea 3/16" x 3" x 24" Balsa Sheet (fuselage top skin)
- 3ea 1/16" x 3" x 27" Balsa Sheet (fuselage bottom skin, radiators, nacelle top skin, wing top skins)
- 4ea 1/8" x 3" x 14" Balsa Sheet (nacelle bottom skin)
- 2ea 1/4" x 1/2" x 20" Balsa Stick (wing leading edge)
- 4ea 1/8" x 3/8" x 10" Balsa Stick (ailerons – cut from kit scrap)
- 1ea 1/4" square x 14" Hardwood Stick (motor mounts)
- 2ea 6-32 x 1" Machine Screws with Blind Nuts (nacelle mounting)
- 1ea 10-32 x 1-1/2 Machine Screw with Blind Nut (wing mounting)
- 2ea 1-1/2" Spinner (Goldberg)
- Hinges (ailerons, elevator)
- 1/16" Music Wire (aileron torque rods)
- 3/32" Aluminum Tubing (aileron torque rod bearings)
- Miscellaneous servo mounting materials and pushrods

### **Power**

The prototype used two 6-volt Speed-400 motors in parallel, Top-Flite 6x3 nylon props, 8-cell 1050KAN battery, and a 30-Amp ESC. With this setup, the amp draw was 21A or 153W. At 75W/pound, performance is excellent!

## Construction

### Wings

#### Wing Skins

- Each wing skin consists of four laser-cut pieces: forward, center and aft. Gently clean up the mating edges of the pieces with 220 grit paper on a sanding block.
- Lay the pieces of a wing skin on a flat board or table, with the outer surface up. Run a length of masking tape along each join line. Turn the assembled skin over, bend the joints open, and run a bead of aliphatic resin or wood glue down each joint.
- Lay the assembled skin back down on the board – masking tape side down. Run a damp paper towel over the joints to remove excess glue. Place a sheet of wax paper over the assembled skin. Then weight it down with another board, books or what have you. Keep the weight on the skin until it is completely dry.

**Tip** – you can prepare and glue all four skins, then build a sandwich of skins and wax paper. Place the weight on top of the sandwich and let it dry.

- When the skins are dry, remove the masking tape. Lay a skin on a flat board with the outer surface up, and sand it smooth with 120 grit paper on a long sanding block. Be sure to keep your sanding motion at a 45 degree angle to the joints and wood grain. Clean the skin with a tack rag.

**Note** – it should not be necessary to sand the inner surfaces of the wing skins. Just be sure to remove any excess glue.

#### Wing Panels

- Pin a lower wing skin to your building board. (The lower skins are the ones with the rib and spar positions etched into them.)
- Glue the leading edge strip in place against the front of the wing skin. Note that the leading edge strip sits on your building board, not on the wing skin.
- Laminate two W15 parts to make a nacelle bolt block.
- Dry fit all the ribs (except W1), the spars, and the nacelle bolt block. Make sure the fronts of the ribs are flush with the leading edge strip, square everything with the etched lines, and use thin CA to glue it all together. Glue the ribs and spars to the wing skin, too.
- Set the root rib W1 in place. The notches in the spars are cut to the correct dihedral angle. When satisfied, glue it. Then glue the root rib doubler W1A in place.
- Set the aileron spars W11 and W12 in position. Note that W12 is slotted for the aileron torque rod. Glue the aileron spars in position.
- Build the aileron torque rod block from W13 and W14, and glue in position.
- Drill a 1/8" hole through the W15 nacelle bolt block and bottom skin. Install a 6-32 blind nut into the nacelle bolt block, open end down toward the bottom skin.

- Using 120 grit paper and a LONG sanding block, sand the top of the wing assembly in preparation for adding the top skin. Make sure that the spars and aileron torque rod block are flush with the rib profiles. Sand a taper into the trailing edge of the bottom skin, so that the trailing edge is about 1/32" thick. DO NOT sand the leading edge strip.
- Now, STOP building and start thinking about how to run the motor and servo wiring.

### Motor and Servo Wiring

- For the motor wiring, twist a pair of red and black wires and cut them about twice as long as you think you'll need. Run them through the holes in W2 and W3, up to the forward hole in the lower wing skin. Tape them in place so that you'll be able to pull them through the hole later.  
**TIP** – the more flexible the wire, the easier it will be to pull it through when the wing is assembled.
- For the servo wiring, run a 9" or longer servo extension through the holes in W2 and W3. Tape the servo connector in place above the servo lead hole in the lower wing skin. Remember you want to pull the connector through the hole later, so DON'T use duct tape here!

### Top Wing Skin

- Fit the top skin in place but DON'T GLUE IT just yet. Figure out where you want the motor wires and aileron servo lead to come through the skin and make 1/4" holes in the top skin for them.
- Apply a thin bead of Pro-Bond or aliphatic resin to the tops of the ribs and spars and along the top of the leading and trailing edges. Pull the motor wires and aileron servo lead up through the top skin. Then lay the top skin in place and pin it firmly to the ribs and spars. Let the wing assembly dry.
- Using a sharp #11 blade, cut a slot in root rib W1 for the wing bolt. Don't cut through W1A.
- Laminate three pieces of W16 to make a wing tip block. Glue the wing tip block to the wing.
- Sand the wing to its final shape.
- Repeat these steps with the opposite wing panel.

### Wing Panel Joint

- Use a long sanding block to prepare the root rib faces for joining.
- Join the panels using 15-minute epoxy between the root ribs. Use masking tape to hold the bottom skins flush. With one wing tip flat on the building surface, the other wing tip should be 3-3/8" above the building surface.
- Reinforce the root rib joint by wrapping it with nylon or glass cloth. Saturate the wrap with CA.
- Use a 3/16" drill bit to clear the wing bolt hole.

## Ailerons

- Using a sharp #11 blade, cut the ailerons free from the wings. Use a sanding block to finish the aileron leading edges and the aileron slots in the wing.
- Now cut the aileron torque rod covers free from the bottom skin ONLY!
- Fabricate aileron torque rods from 1/16 music wire with 1/16 aluminum tube bushings. Install the torque rods and glue the bushings to ribs W4 and W5.
- Glue the aileron torque rod covers back in place.
- Mount the aileron servos in place on the bottom wing skin, taking care to mount them well inside the nacelle area.
- Hinge the ailerons to the wings, taking care to capture the torque rods.
- Pull the aileron servo extension leads through the bottom skin and plug them into the servos.
- Connect the servo output arms to the aileron torque rods.

## Fuselage

### Lower fuselage

#### **BE SURE TO MAKE A LEFT SIDE AND A RIGHT SIDE**

- Each fuselage side is made up of two pieces. Glue these pieces together and sand them flat. DO NOT cut out the wing saddle.
- Glue the 1/4" triangle strips along the bottoms of the skins.. Mark the former positions on the insides of the fuselage sides.
- Assemble the lower fuselage upside down (i.e., triangle strips up) over the plan. Glue formers F5, F6, and F8 to the fuselage sides. Measure frequently and use triangles to keep the fuselage sides at 90 degrees to the building surface. Don't cover the belly pan separation cut with F8.
- Next, glue F1 and F2 to the fuselage sides. Make sure you don't cover the belly pan separation cut with F2.
- Install F9, F10, F11 and F12. Note that F11 is notched for the elevator pushrod. Make sure to install it with the notch near the pushrod cutout in the fuselage side.
- Glue the belly pan formers F3 and F7 to the fuselage sides and the triangle strips. DO NOT glue them to the adjacent formers, and do not cover the belly pan separation cuts.
- Use a sanding block to deck sand the fuselage bottom. All formers, triangle strips and fuselage sides should be flush.
- Sheet the bottom of the fuselage with 1/16 balsa with the grain across the fuselage.
- Remove the lower fuselage assembly from the building surface.
- Sand the bottom corners of the fuselage to a uniform 1/4" radius.

## Upper Fuselage

- Assemble the battery box from pieces F13 (2) and F14. The battery box is an integral part of the fuselage structure so make sure that the F13 sides are perpendicular to F14.
- Fit the battery tray to the lower fuselage assembly and glue it in position. Make sure that the open side of the battery tray faces to bottom of the fuselage!
- Glue the servo tray F17 and former F8A in position. Note that the servo tray notches into the battery box and F8A. Make sure that the servo tray is correctly oriented. Also make sure to orient F8A so that the pushrod hole is to the starboard (right) side of the fuselage.
- Glue formers F9A through F12A to the top of the lower fuselage assembly, with F18 between F11A and F12A. You can use small scraps of 1/16" balsa to aid in aligning the formers. Make sure to orient F9A and F10A with the pushrod path as shown on the plan top view.
- Make up and install a 1/16MW elevator pushrod. Tape it to the front of former F8A so that it won't be in the way when finishing the fuselage exterior.
- Glue two each formers F4A, F5A and F6A to the sides of the battery tray. Glue formers F4B, F5B and F6B to the top of the battery box.
- Install fuselage top sub-deck F15.
- Install former F1A and F16.
- Check the battery box corners to make sure that they won't interfere with the fuselage skin. Adjust the chamfer as necessary.
- It's necessary to install the wing to help stabilize the fuselage for the sheeting process. Therefore, don't install the fuselage upper sheeting now.

## Belly pan

- Use a razor saw to cut the belly pan free. Then use a sharp #11 blade to remove the wing cutouts.
- Fit the wing to the fuselage. Don't glue anything yet. When satisfied with the fit, stretch a piece of plastic wrap over the wing center section, and place the wing back into the fuselage cutout.
- Laminate two pieces of plywood WHD to create the wing hold down. Clear the center hole with a 3/16" drill bit.
- Fit the wing hold down between the fuselage sides and line up the bolt hole with the wing bolt hole. Glue the wing hold down in place. Reinforce the joints with scrap 1/4 triangle strip.
- Now fit the wing hold down bolt. We suggest an 8-32 nylon bolt and steel blind nut. Fix the blind nut in the wing hold down first. Then bolt the wing in place.
- Tack glue the belly pan in place, and open a hole in it for access to the wing hold down bolt head.
- When satisfied with the fit of the belly pan and wing, glue the belly pan to the wing permanently.

## Upper Fuselage Sheeting

- Bolt the wing and belly pan to the fuselage.
- Cut and fit a single piece of 1/16 balsa (marked F13 on the plan) to each upper fuselage. Make relief cuts as necessary, and use ammonia and water (or Windex) to allow the balsa to conform to the fuselage shape. When satisfied with the fit, glue the sheet in place.
- Allow the upper fuselage sheeting to dry thoroughly. Then deck sand the sheeting flush with the formers.
- Trim a 3/16 balsa sheet to fit the top rear deck of the fuselage, and glue it in place.
- Trim two 3/16 balsa planks to fit the nose above F16 and glue them in place. Be sure to trim the ends of the planks to match the slope of F4B and F4A. Sand the two planks flush with F1 and F1A.
- Holding FX in position, mark around it to establish the forward fuselage curvature on the ends of the 3/16 balsa planks.
- Use a razor plane to shape the top of the fuselage.
- Fit the vacuum-formed nose cone to FX and glue to the fuselage.
- Finish shaping the fuselage with a sanding block.
- Fit the vacuum-formed canopy but don't glue it on until after the cockpit area is detailed and painted.

## Tail Block

- Make up a T-jig from scrap 1/8 balsa. **This jig will simulate the spacing required for the fin, rudder and horizontal stabilizer.** Tack glue the T-Jig to F18.
- Make up two sets of TB1, laminating six pieces for each.
- Glue the TB1 blocks in place. Glue solid at the front where TB1 meets F11. Tack glue at the rear. Don't glue TB1 solid to the T-jig.
- Make up a single TB2, laminating seven pieces.
- Tack TB2 in place.
- Use a razor plane to shape the TB1s and TB2. Finish them up with a sanding block.
- Remove TB2. Split it in half with a razor. Hollow it out as much as possible using a drum sander. Glue the halves back together.
- Remove the T-jig.

## Empennage

- Choose between the F.1 and F.3 version.
- Make the fin and rudder by gluing R1 and R2 together. If building the F.3 version, glue the dorsal fin to R1.
- Glue the two S1 pieces together to make the horizontal stabilizer.

- Make the elevators by gluing S3 to S2. Join the elevators with a 1/8" hardwood dowel.
- Sand all parts to the desired finish. Slip the finished fin and horizontal stab into position between the TB1 blocks and the fuselage. Mark the covering where the fin and stab intersect the fuselage.
- Remove the fin and stab from the fuselage. Remove the covering from the fin and stab can be glued to the TB1 blocks and the fuselage.
- Hinge the elevators to the stab. Install the 1/32 ply horn in a slot on the port (left) elevator.
- Glue the fin and rudder to the horizontal stabilizer. Glue this assembly into the fuselage.
- Glue tail block TB2 in place.

## Nacelles

### **BE SURE TO BUILD A LEFT-HAND NACELLE AND A RIGHT HAND NACELLE**

- Select one N5INB and one N5OUT. Note that N5INB has a laser-cut dashed line parallel to the long edge. N5INB is the inboard (i.e., next to the fuselage) side. N5OUT is the outboard (i.e., away from the fuselage) side.
- These two N5 pieces are the basic crutch for one nacelle. Sand a bevel into the rear edges of the N5 pieces per the plan top view. Pin the N5 pieces to the building board, over the plan, and glue them together at the rear end of the nacelle.
- Laminate two N1 formers.
- Glue former N1, N2, N3 and N4 to the nacelle crutch. Keep them vertical and make sure to orient them correctly to allow for dihedral. The long side of the former goes on the N5OUT side. The short side of the former must line up with the laser-cut dashed line on N5INB. Note that the formers are not flush with the outer edge of the N5 crutch. This creates a step for attachment of the side sheets.
- Install the two 1/4 square spruce motor mounts. Install the N8 and N9 braces.
- Glue the nacelle hold down N6 into the crutch. Open up the hole with a 1/8" drill.
- Sheet the sides of the nacelle with N7 balsa sheeting.
- True up the N7 sheeting in preparation for installing the bottom sheeting.
- Sheet the bottom of the nacelle with two layers of 1/16 balsa.
- Use a razor plane to shape the nacelle bottom. Finish it off with a sanding block.
- Use a sharp #11 blade to remove the upper section of N5INB along the laser-cut dashed line.
- Trial fit the nacelle to the bottom of the wing. Trim and adjust as necessary for a good fit.

- Use a piece of music wire or thin brass tubing to drill a hole in the nacelle bottom skin, in line with the hole in N6. This hole gives you access to the nacelle mounting bolt.
- Install a paper tube or plastic drinking straw between N6 and the nacelle bottom sheeting. This tube guides the nacelle mounting bolt into the hole in N6.
- Place plastic wrap around the wing where the nacelle will fit. Bolt the nacelle to the wing with a 6-32 nylon bolt.
- Use the supplied paper patterns to cut top sheeting for the nacelle. Trim to fit and glue the sheeting to N1 and the nacelle crutch N5. DO NOT glue the sheeting to the wing.
- Trim the motor mounts to length and fit the vacuum-formed cowling. You can mount the cowling with small sheet metal screws into the motor mounts. Or, install scrap spruce blocks around the perimeter of N1 and screw into them.
- Pull the motor wiring through the nacelle.
- Install the motor using three plastic tie-wraps. Use a couple of dabs of RTV silicon to fix the motor to the mounts.
- Repeat for the other nacelle.

### **Radiators**

- Stretch some plastic wrap around the fuselage and around the inboard side of the nacelle. This will prevent the radiator from getting glued to them.
- Radiator plans are included on a separate detail sheet.
- Glue the radiator bottom skin RAD BOT to the wing leading edge.
- Glue radiator ribs RR2 and RR3 to the top of the wing and to the radiator base. RR2 should be closely aligned with the fuselage and wing rib R2. RR3 should be closely aligned with the nacelle and wing rib R3.
- Fit the radiator top skin and glue it in place. Sand the leading edge of the top skin flush with the radiator ribs and radiator base. Sand the rear of the top skin flush with the upper wing surface.
- Cut a piece of 1/16 balsa for the radiator nose. Glue it to the radiator ribs, base and top skin.
- Repeat for the opposite wing panel.

## **Finishing Your Hornet**

- We suggest covering the entire model (except the plastic bits) with 1/2-ounce glass cloth and finishing resin for maximum strength. For a lighter weight finish, 'glass' only the bottoms of the nacelles and the fuselage. Use Doculam to cover the remainder.
- Apply a light coat of primer – just enough to fill the weave of the glass – and sand most of it off.
- Paint and decorate the model as desired – see the furnished “Paint and Markings Guides” for more information.

- Finally, seal the entire model with a light coat of Krylon clear.

## Decals

### **CAUTION: You must seal the decals before immersing them in water!**

The decals included in this kit are printed with Epson DuraBrite™ inks on the best inkjet water-slide decal paper available. Follow the steps below to achieve a great looking set of markings on your Hornet.

- Seal the decals with several thin coats of Krylon Crystal Clear™ spray varnish. Make sure you thoroughly cover the ink; this will prevent smears and stains during everyday handling.
- Make sure the surface where the decal is to be applied is smooth and glossy. Matte surfaces will permit tiny air bubbles to be trapped between the surface and the decal, thus spoiling the decal.
- Cut out and trim all the markings that you plan to apply in this session.
- Dip the decal in a bowl of water for about 60 seconds. Using your fingers, gently try to slide the decal off the backing paper. As soon as the decal slides, slide it off the backing paper and onto the model in the desired position. Use a rag or old t-shirt to gently blot excess water from the decal. Allow the decal to dry.

**TIP** – You can practice with bits of decal cut from the copyright notice.

- Spray a coat of Krylon Crystal Clear varnish over the decal.

## Weight and Balance

- The prototype weighed in at 27 ounces unpainted, 34 ounces painted. Hold the weight close to 27 ounces for best performance.
- The Hornet should balance at 3-3/32" behind the leading edge at the center chord. For the first few flights, you may want to move the balance point forward to about 3" (Better a bit nose-heavy than a bit tail-heavy!)

## HELP!

If you have questions or need more help with assembly of the Hornet kit, drop an email to [tom@warbirdkits.com](mailto:tom@warbirdkits.com).