

SECTION 6: EMPENNAGE

BUILDING THE HORIZONTAL STABILIZER

The assembly of the horizontal stab and following references are shown on DWG 3.

REAR SPAR ASSEMBLY

- ❑ Use a file or Scotchbrite wheel to "break" the edges of the HS-609PP (See Sec E-E). Lay the HS-609PP rear spar reinforcement bars inside the HS-603PP spar channels and check to see that the faces rest against one another when the holes are aligned. If the bend of the channel tends to lift the edge of the bar, use a coarse Vixen file to round the edge of HS-609PP to fit. Round the ends of the HS-609PP bars as shown in Rear View.
- ❑ Smooth the edges and surfaces of the HS-609PPs to a satin finish equivalent to that left by 400 grit wet/dry sandpaper, removing all the milling and file marks (See "Edge Finishing", Section 5.2).
- ❑ The pre-punched holes used to attach HS-603PP to HS-609PP are slightly undersized, and must be "final drilled" to the correct size. Cleco and drill every second or third hole, drill #30, then move the clecos and drill #30 all the remaining holes.
- ❑ Carefully locate the holes that attach HS-708 to the rear spar assembly (it is the eighth hole from the end of HS-609PP) and enlarge it to #21 (See Rear View).
- ❑ Cleco the HS-412PP Hinge Brackets to the rear spar assembly and final drill #30 through the holes common to the hinge brackets and web of the rear spar.
- ❑ Cleco the HS-00716A Nested Spar Doublers and HS-00717A Hinge Brackets to the rear spar assembly and final drill #30 through the holes common to the hinge brackets, nested spar doubler, and web of the rear spar.
- ❑ There are two HS-411PP brackets, but only HS-411BPP is pre-punched for the VA-146 attach holes (See Exploded Iso View). Clamp HS-411APP and HS-411BPP around the VA-146 bearing and cleco the assembly to the spar.
- ❑ Using HS-411BPP as a drill guide match drill and cleco the aft four VA-146 attach holes.
- ❑ Remove the assembly from the spar and match drill the forward two VA-146 attach holes.
- ❑ Deburr the parts, prime VA-146 if desired, then rivet them together (the -5 rivet is the correct length, see Section 5.4). This sort of one at a time priming makes having a spray can self etching primer nice.
- ❑ Cleco the HS-411 assembly back to the spar. Drill/enlarge the bolt holes that will attach the HS-411 assembly to the spar to #12.
- ❑ Mark all the parts in the rear spar assembly so they can be returned to their previous positions. Use a "Sharpie" pen or equivalent for all marks on aluminum, but in this case the ink will be lost if you clean the parts for priming.

FRONT SPAR ASSEMBLY

- ❑ Separate the two HS-00001 spar doublers and draw the rivet lines as shown in the HS-00001 Detail View.
- ❑ Place the two HS-702 front spar channels on a work table, end to end, with the flanges facing down. Cleco HS-710 reinforcement angle, HS-714 splice angle to the two HS-702 spar channels.
- ❑ HS-702 has been designed for use on an RV-8 and will require extra trimming for use on an RV-7. In order for the spar to be bent to match the HS-710 and HS-714, the spar flanges inboard of the bend line must be removed.
- ❑ Lay the spar on the workbench with the flanges facing up and mark the bend line on the spar as shown in the HS-702 Front Spar Tab Detail.

- ❑ Drill a #30 relief hole 1/8" inboard of the bend line and centered on the bend radius of the flange (See HS-702 Front Spar Tab Detail and HS-702 Front Spar Tab Detail). Turn the spar over and enlarge this hole to 1/4" using a unibit.
- ❑ Trim the inboard ends of the HS-702 flanges as shown in the HS-702 Front Spar Tab Detail. Be sure to only trim the flanges down to about halfway along the bend. Flatten the remainder of the bend.
- ❑ Bend the tab as shown in HS-702 Front Spar Tab Detail using a hand seamer or blocks of wood.
- ❑ Clamp the HS-00001 spar doublers to the HS-702 spar channels. Position the top edge of the doublers flush with the top edge of the spar channels. Position the doublers left and right from the center line of the horizontal stab as shown in View B-B. Match-Drill #30 the inboard holes shown in Vew A-A. Cleco the doublers to the spar.
- ❑ Drill/match-drill all the holes inboard of the HS-00006/HS-00005 rib attach points (See View A-A). DO NOT drill the holes that will attach the HS-00006 and HS-00005 ribs or the holes outboard of the bend line. The holes outboard of the bends will be drilled later, after the bends are made. Also see Figure 6-6.
- ❑ Remove HS-710, HS-714 and HS-00001 from the two HS-702 spar channels. Taper the ends of HS-710 and HS-714 (See HS-710/HS-714 Taper Detail).
- ❑ Bend the outboard ends of HS-710, HS-714 (See View B-B). Clamp the aluminum angle between wood blocks in a vise and bend with a mallet. Use a simple cardboard template to check the angle.
- ❑ Refer to View A-A for the rivet pattern at the center of the front spar. Note that the center four rivets are AN426AD4 rivets with the flush heads aft. Dimple HS-702 and countersink HS-710 and HS-714 (See "Countersinking", Section 5.5).

PREPARING THE RIBS

- ❑ Notch the aft end of the HS-00006 ribs to fit around HS-714 and HS-710 (See HS-00006 Trim Detail). Make sure to make one left and one right.
- ❑ Prepare the HS-00006, HS-00005, HS-706, HS-707 and HS-708 ribs (See "Fluting and Straightening Ribs and Bulkheads" and "Edge Finishing", Section 5.13 & 5.2).

DRILLING THE HORIZONTAL STABILIZER

- ❑ Choose which ribs will be used on the right and which will be used on the left then mark them.
- ❑ Using the dimensions given in SEC D-D, mark the hole locations on the centerline of the aft side of the aft flange of HS-00006. These holes attach HS-00006 to the forward spar assembly and HS-00005. Make a light mark with a center punch to keep the drill bit from wandering then pilot drill the holes to #40.
- ❑ Draw a centerline on the forward side of the forward flange of HS-00005.
- ❑ Select the left side HS-702, HS-603PP, HS-706, HS-707 and HS-708 and cleco them together.
- ❑ Drill all HS-706, HS-707, HS-708 rib to spar attach holes to #30 (except the HS-708 and HS-603PP holes)
- ❑ Un-cleco, deburr holes, clean out chips and re-cleco.
- ❑ Cleco on the HS-601PP skin.
- ❑ Enlarge the HS-708 to HS-603PP holes to #21.
- ❑ Cleco HS-00001, HS-710 and HS-714 to HS-702.
- ❑ Slip the HS-00006 and HS-00005 ribs into place and mark the approximate hole locations on the top and bottom rib flanges with a pen using the holes in the skin as a guide.

- ❑ Remove the HS-00006 and HS-00005 ribs and flute as necessary between the rivet hole marks.
- ❑ Reinstall the HS-00006 and HS-00005 ribs. Clamp HS-00006 to the HS-601PP skin and spar assembly.
- ❑ Match Drill #30 and cleco the aft flange of HS-00005 rib to HS-603PP spar, using the holes in the spar as a drill guide. Remove HS-00005, clean out any chips.
- ❑ Match Drill #40 the holes in the aft flange of the HS-00006 rib to HS-702 and HS-00001.
- ❑ Mark and drill #40 the two holes common to the HS-00001, HS-702, HS-710 or HS-714 on the forward side of the spar bars, keeping the holes in line with the holes in the aft flange of the HS-00006. See SEC D-D.
- ❑ Reinstall HS-00005. Align the centerline line drawn on the forward flange to the previously drilled holes in the spar assembly and HS-00006 rib. Clamp the rib in place, making sure it fits tightly against HS-00001. Next, cleco the aft flange of the HS-00005 rib to the aft spar. Finally clamp the top and bottom flanges to the HS-601PP skin. Finally, Match-drill the holes in the forward flange of the HS-00005 rib.
- ❑ Cleco the HS-00716A doublers to the rear spar.
- ❑ Cleco the ribs and spar assembly together.
- ❑ Beginning at the rear spar and working forward, match drill the holes in the HS-601PP skins to the HS-00005 rib.
- ❑ Be sure that the front flange of HS-00005, HS-702, HS-710 and HS-714, HS-00001 and the aft flange of HS-00006 are pulled up tight. Re-clamp the upper and lower flanges of HS-00006 to HS-601PP.
- ❑ Drill to final size or match drill all the remaining holes attaching the HS-601PP skin. The suggested drilling sequence begins at the intersection of the HS-708 center rib and the rear spar and proceeds both up along the rib and outward toward the tip. Put clecos in every second or third hole as you drill them.
- ❑ Remove the skin and drill the remaining holes in HS-714, HS-710 and HS-00001. Remove HS-710, HS-714 and HS-00001.
- ❑ Repeat the above steps for the right side.

PREPARING THE HORIZONTAL STABILIZER PARTS FOR ASSEMBLY

- ❑ Mark and disassemble all parts.
- ❑ Deburr all the holes in both the skin and the skeleton (See “Hole Deburring”, Section 5.2).
- ❑ Dimple the understructure using a pneumatic or hand squeezer. Dimple the rivet holes in the skins using a C-frame dimpling tool (See Section 3).
- ❑ Smooth the edges of the parts (See “Edge Finishing”, Section 5.2).
- ❑ Prime all parts as required (See “Priming”, Section 5.1). The HS-609PP rear spar reinforcement bars, HS-710 reinforcement angle and HS-714 splice angle are not made of Alclad material, so before riveting, they must be primed.

RIVETING THE HORIZONTAL STABILIZER

- ❑ Locate the rivet holes in the rear spar that will attach the HS-706, HS-708 and HS-00005 ribs and the HS-412PP hinge brackets. Put tape over them to prevent accidentally riveting these holes before the ribs are attached.
- ❑ Rivet the HS-609PP bars to the HS-603PP spar channels. The rivet callout is correct on the plans. See Section 5.4. This can be accomplished with either a gun, pneumatic or hand squeezer. You may find it takes a bit of "grunt" to set -4 rivets with a hand squeezer.
- ❑ Rivet the HS-412PP hinge brackets to the rear spar.

- ❑ Rivet the HS-00717A hinge brackets and HS-00716A doubler to the rear spar.
- ❑ Bolt the HS-411PP center bearing to the spar (See Torque Value Chart, Section 5.20).
- ❑ Rivet HS-710 and HS-714 and HS-00001 to the HS-702 front spars. Remember the flush rivets in the center of the assembly (See View A-A and Section D-D.)
- ❑ Rivet HS-00006 and HS-00005 to the front spar assembly. The ribs may be gently flexed out of the way to allow better access during riveting.
- ❑ Lay the HS-601PP skin marked for the left side down on a clean surface. Use foam padding if desired.
- ❑ Cleco then rivet HS-707 to the top side of the skin.
- ❑ Cleco HS-706 to the skin. Temporarily cleco HS-708 to HS-601PP and the aft flange of HS-707 to help hold the skin tight against HS-707, then rivet the bottom side of HS-707 to HS-601PP. Remove HS-708.
- ❑ Cleco the forward spar assembly to HS-706, HS-707 and HS-601PP, then cleco on HS-708.
- ❑ Blind rivet HS-702 to HS-707 and HS-708.
- ❑ Rivet HS-702 to HS-706.
- ❑ Rivet HS-702 and HS-708 to HS-601PP.
- ❑ Repeat the above steps for the right side then cleco on the rear spar assembly
- ❑ Rivet the rear spar assembly, HS-00006, HS-00005, and HS-706 to HS-601PP. These holes can all be reached by a hand squeezer.
- ❑ Blind rivet the rear spar assembly to HS-708.

Congratulations! You've finished the first major sub-assembly on your new airplane.

BUILDING THE VERTICAL STABILIZER

The assembly of the vertical stab and following references can be found on DWG 6. Construction of the vertical stabilizer is very similar to the horizontal stabilizer.

DRILLING THE VERTICAL STABILIZER

- ❑ Cleco the VS-808PP spar doubler to the VS-803PP rear spar. Then cleco on the hinge brackets VS-410PP, VS-411PP and VS-412PP (See Exploded Iso View).
- ❑ The VS-410PP hinge brackets have two holes missing from the pattern. Use the holes in the spar channel and spar doubler as drill guides and back-drill the entire six-hole pattern through the upper VS-410PP only. The corner holes in the lower VS-410PP will be drilled for bolts later, in assembly with the fuselage (See DWG 27/27A).
- ❑ Prepare the ribs VS-704, VS-705, VS-706 and VS-707 (See “Edge Finishing”, “Fluting and Straightening Ribs and Bulkheads”, Section 5.2 & 5.13).
- ❑ Cleco the ribs to the front and rear spars.
- ❑ Final drill #30 VS-808PP, VS-410PP, VS-411PP and VS 412PP to VS-803PP.
- ❑ Drill all rib to spar attach holes to #30.

- ❑ Cleco on the VS-801PP / VS-901 skin.
- ❑ Drill / match drill to final size all the holes attaching the VS-801PP / VS-901 skin.
- ❑ Mark the location and orientation of VS-803PP, VS-411PP and VS-412PP. Disassemble, de-burr, dimple, machine countersink and prime parts as desired (See “Countersinking”, “Dimpling”, “Hole Deburring” and “Priming”, Section 5.1, 5.2, & 5.5).
- ❑ Note as shown on DWG 27/27A the lower portion of the rear spar must lay flush against the F-712/812 bulkhead assembly. Therefore the rivets in this region must be flush on the forward side of the rear spar that mates to the F-712/812 bulkhead (See Rear View, SEC A-A and “Countersinking and Dimpling”, Section 5.5).

FINISHING THE VERTICAL STABILIZER

- ❑ Cleco VS-803PP to VS-808PP, VS-410PP, VS-411PP and VS-412PP together. Then tape over the holes that will attach VS-704, VS-706 and VS-707.
- ❑ Rivet the rear spar together remembering the flush rivets on the lower rear spar.
- ❑ Rivet VS-704, VS-705, VS-706 and VS-707 ribs to the front spar.
- ❑ Cleco on the VS-801PP / VS-901 skin.
- ❑ Rivet on the skin. Begin at the intersection of VS-707 and VS-702 and work towards the tip, then restart at the same place and rivet along the front spar toward the root and along the VS-707 rib starting at the front and riveting toward the rear spar.
- ❑ Cleco on the rear spar assembly and install the remaining rivets along the rear spar and end ribs with a squeezer.
- ❑ Blind rivet the rear spar assembly to VS-707.

BUILDING THE RUDDER

FITTING THE STIFFENERS TO THE RUDDER SKIN

- ❑ Pre-punched holes in the R-915 rudder stiffeners match corresponding pre-punched holes in the R-901-L and R-901-R rudder skins.
- ❑ Trim individual stiffeners from strips consisting of two stiffeners. See diagram on DWG 7. Shorten all the stiffeners (except the lowest) by trimming the excess from the forward end. Use the pre-punched hole pattern in the rudder skins to determine the correct amount of trim. See note on DWG 7.
- ❑ Before you begin actually drilling stiffeners and skins, be sure that you are placing the stiffeners on the inside surfaces of the right and left rudder skins. Study the exploded isometric view on DWG 7.
- ❑ Match drill the stiffeners to the rudder skins. Having a tabletop you don't mind drilling into will make the job easier. You can drill through the part right into the table. A cleco run into the hole in the table will not hold the part up off the surface.
- ❑ Disassemble and deburr the holes. BE VERY CAREFUL deburring the thin R-901 rudder skins -- it doesn't take much pressure or over-enthusiasm (one turn is usually plenty) to ruin a hole in 0.016 aluminum. You do not want to be left with a knife-edged hole when you are done.
- ❑ Because 0.016 is too thin to machine countersink, it must be dimple countersunk. Use a C-frame deep-throat dimpler/riveter as shown in Section 3. Remember that the pressure needed to dimple 0.016 is quite low.
- ❑ Dimple the stiffeners and skin, and prime the parts if you choose. Now you are ready to rivet the skin and stiffeners together. BACK-RIVETING is the best technique here. See Section 5.6. Be sure you fully set the aft rivet in each stiffener...if you leave these standing too tall, they will interfere with the opposite skin when the rudder is assembled.
- ❑ When back-riveting, the flush head rivets are taped in place with Van's Special Riveting tape (See VAN'S ACCESSORIES CATALOG), Mylar, or Scotch 811 tape (masking or regular Scotch tape does not work well.) The flush heads are placed on a flat, smooth plate of steel or hard aluminum. A small flat, cupped, or special sliding-sleeve set is used to make the shop head. If you are careful to keep the bucking surface clean, this

method almost ensures clean, well-set rivets.

BUILDING THE RUDDER SKELETON

- ❑ Cleco R-904 Bottom Rib to the R-902 Spar. Enlarge the 0.125 hole in the center of the forward flange of R-904 to 3/8 using the hole in R-902 as a drill guide.
- ❑ Fabricate R-917 Shim per DWG 7.
- ❑ Use a 3/8 bolt to fasten the R-405PD rudder horn squarely on the rudder spar and final drill the four holes through the upper edge of the rudder horn to #30 using the pre-punched holes in the spar as a drill guide.
- ❑ Cleco the rudder horn to the R-904 bottom rib to check the fit. If necessary radius the top of the rudder horn so it nests nicely in the radius of the rib flange.
- ❑ Cleco the R-904 bottom rib and R-405PD rudder horn to the R-902 rudder spar. Slide the R-917 shim into place between the rudder spar and rudder horn and drill to #30. Use the pre-punched holes in the spar as a guide.
- ❑ Cleco the R-606PP, R-607PP, and R-608PP reinforcement plates to the R-902 rudder spar. NOTE that the R-606PP lower reinforcement plate goes on the forward (flange side) of the spar web, while the R-607PP and R-608PP plates go on the rear.
- ❑ Flute the R-903 tip rib and R-912 counterbalance rib. Use a ruler along the holes to make sure they are straight. Use a hand seamer to adjust the flanges square to the web.
- ❑ Cleco the tip rib and the counterbalance rib to the top of the spar and drill to #30.
- ❑ Cleco the R-913 counterbalance skin to the R-903 tip rib and R-912 counterbalance rib. Match drill #40 the counterbalance skin to the ribs using the pre-punched holes in the R-913 counterbalance skin as a drill guide.
- ❑ Cleco the R-901R&L rudder skins to the ribs and spar. Fit the R-916 rudder trailing edge and cleco it in place. Drill all remaining holes in the rudder to final size.
- ❑ Trim the excess material from R-710 rudder brace. Fit the R-710 between R-405PD and R-904. Cleco the aft edge of R-710 to the bottom of R-904 and drill #30. Match drill through the forward edge of R-710 using the holes in R-405PD as a drill guide.
- ❑ Make the R-918 rudder bottom attachment strips shown on DWG 7 and clamp them in place. Drill them to the skeleton, using the existing holes as drill guides.
- ❑ Disassemble the rudder and deburr all the holes. Dimple the skin, spar and ribs.
- ❑ The aft three 3/32 holes in the upper edge of R-901-L and R-901-R should be drilled to #30 and dimpled. These holes will later be used to attach the R-909 rudder tip. While the holes could be opened up to #30 when drilling the tip to the rudder, it would be nearly impossible to dimple the skins because the rudder is so narrow at that location.
- ❑ Drill the E-614-020 counterweight to the R-912 counterbalance rib. The forward tooling hole on the R-912 rib matches with the forward hole on the counterweight. Use the aft hole in the counterweight to match drill into R-912. Remove the counterweight and machine countersink the holes for a #10 countersunk screw. De burr the holes in the counterbalance rib and dimple for a #10 countersunk screw.
- ❑ Although the rudder and elevator spars are 0.032 and could technically be machine countersunk, we strongly recommend that these parts be dimpled. Be careful that the dimple dies do not drag along the web of the spar and gouge it. It may be necessary to grind a flat side on the dies to obtain the necessary clearance.
- ❑ The trailing edges of both the left and right R-901 skins are dimple countersunk and both sides of the R-916 rudder trailing edge are machine countersunk. These rivets will be double flush. The shop head actually turns out looking pretty nice when it is driven into a dimple. Prime all the components desired.

RIVETING THE RUDDER

- ❑ Install the reinforcement plates and platenuts on the spar.
- ❑ Rivet the R-904 rib and associated parts.
- ❑ Rivet the R-912 counterbalance rib to the R-902 spar. Then rivet the R-913 counterbalance skin to the counterbalance rib, but not the spar. Install the E-614-020 counterweight (see exploded view on DWG 7).
- ❑ Cleco both skins to the spar.
- ❑ There are six rivets on each side that join the R-901 skins and the R-913 counterbalance skin and three that join the rib, counterbalance skin and spar. The aft end of the R-913 counterbalance skin will lay *under* the R-901 rudder skin. Set these, then rivet on the R-903 tip rib. Blind rivets are used for the first time here. They are simple to set with a hand pop-riveting tool, but they are difficult to drill out. Make sure that the heads of the

rivets are firmly against the rib before setting.

- ❑ Rivet the skin to the skeleton. A rivet squeezer will reach almost all the rivets, depending on the throat depth. In the narrow spaces at the end of the ribs a narrow bucking bar will be necessary. If one isn't available, these holes may be enlarged to 7/64" and MK-319-BS blind rivets may be substituted for the last one or two AN rivets. Both rivets have heads that fit the same dimple.
- ❑ The trailing edge is the last in the sequence. Building a truly straight trailing edge is one of the more difficult things to do in the empennage kit. Take your time and work as precisely as possible. A wavy or bowed trailing edge doesn't look good, and in more extreme cases will affect the flying qualities of the airplane. Strive to build a trailing edge that does not vary more than 0.100" from a straight line.
- ❑ One way to help keep the trailing edge straight is to bond the components together before setting the rivets. The bonding agent can be fuel tank sealant or any good epoxy with a 30 minute working time.
- ❑ Trailing edges are riveted with "double-flush" rivets. These are standard rivets, but instead of setting the shop head on a flat surface, it is set in a dimple and ends up flush with the skin surface. However, a double flush rivet will not look the same on both sides. The factory flush head will set almost perfectly flat. The finished shop head will be flush with the skin, but it will not fill the dimple completely...it's been described as "an acorn sitting in a dimple." Do not fall in the trap of trying to use a longer rivet and "fill the hole." The rivet will bend over instead of setting properly.
- ❑ Begin by using one of the skins as a guide and drill the trailing edge pattern of holes into a rigid, straight piece of aluminum angle. Cleco the trailing edge together, with both skins and the AEX wedge clecoed to the angle and check the alignment. The angle should hold the trailing edge straight. Because the rudder tapers in thickness, the trailing edge cannot simply be clamped to the table. Lay the rudder with the trailing edge and clecoed angle off the edge of the table so it can remain straight.
- ❑ Disassemble the trailing edge and clean the surface completely, using the directions for cleaning the fuel tank components in Section 7. Mix (follow the mixing directions on the can) and apply tank sealant thinly and evenly to both surfaces of the AEX wedge and cleco the trailing edge together, including the alignment angle. Wipe away any sealant that squeezes out and make sure that the parts fit tightly. There should be no globs of sealant holding the skin and wedge apart, for instance.
- ❑ Check the alignment once more, and set the assembly aside. Let the sealant cure for a couple of days. After curing, remove the angle and the clecos.
- ❑ Insert rivets into the trailing edge holes with the manufactured head on the top side. Tape all the rivets in place and flip the rudder over. Put blocks on either side of the back-riveting plate, so the rudder can stay flat as it slides over the plate. Weight the rudder down to the worksurface so it remains straight while riveting.
- ❑ Back-rivet about every tenth rivet just enough to to lock everything in place...don't set the rivets all the way just yet.
- ❑ Back-rivet the rest of the trailing edge rivets, but for now, set the rivets only about halfway. Set every fifth or sixth rivet and check constantly to see that the trailing edge is not bending one way or the other. If the rivets are set fully in only one direction it can leave a "hook" in the trailing edge. Start with the rivet set parallel to the rivet and tilt it to set the rivet flush to the skin as the rivet sets.
- ❑ Flip the rudder over and set the trailing edge rivets to the final size with a mushroom set, again checking constantly.
- ❑ A little finesse will produce a nice double flush joint, but you must constantly guard against bowing the trailing edge.

COMPLETING THE LEADING EDGE OF THE RUDDER

- ❑ Before the rudder can be installed on the vertical stabilizer, its leading edge must be formed. The object here is to achieve a smoothly curved surface that fits neatly between the skin overhang of the stabilizer. Simply pulling the overhanging skins together results in an angle or crease where they cross the edge of the spar (See Rolled Leading Edges", Section 5.9)
- ❑ Rivet the leading edge together. Blind rivets are used here. They are simple to set with a hand pop-riveting tool, but they are difficult to drill out. Make sure that the heads of the rivets are firmly against the rudder skin before squeezing. See the Rudder Leading Edge Detail on DWG 7.

BUILDING THE ELEVATORS

The assembly of the left elevator is shown on DWG 4. The assembly of the right elevator is shown on DWG 5. The elevators are built much like the rudder. The elevators are balanced surfaces, having lead weights forward of the hinge lines to counteract the weight of the structure behind it. This improves the control "feel" and helps prevent flutter. The major difference between elevators and the rudder is the installation of a trim tab in the left elevator. This need not be an especially difficult task, but it does require careful attention to detail. The majority of builder mistakes on the empennage are made on the left elevator and trim tab. Fair warning! Because of the complication of the trim tab, we'll leave it to last and start with the right elevator.

PREPARING THE ELEVATOR SKINS

TRIMMING THE STIFFENERS

- ❑ The E-701-L/R elevator skins and E-720 (A-L) elevator skin stiffeners are provided with pre-punched holes. The various E-720 stiffeners are snipped from the pre-punched lengths of aluminum angle. The double notch in the edge denotes the overall length of the stiffener. Use aviation snips to cut from center to center of the guide holes (See E-720 Trim Detail, DWG 5).
- ❑ Trim the flange of the stiffener (surface perpendicular to the skin) to fit inside the tapered elevator. Single notches on the edge of the stiffener note the beginning points of these trim cuts. Trim the stiffeners and clean up the edges with a file and the Scotchbrite wheel (See E-720 Trim Detail, DWG 5).
- ❑ Make stiffeners E-720J, E-720K and E-720L from the existing E-720D, E-720E and E-720F (See E-720 Trim Detail and Note 1, DWG 5). Set aside stiffeners for use in the left elevator assembly.
- ❑ Drill the stiffeners to the E-701-L/R skins. Drill E-615PP to E-701-L. Disassemble parts then, deburr, dimple and prime as desired (See "Edge Finishing", "Hole Deburring", "Dimpling" and "Priming", Section 5.2, 5.5 & 5.1). Dimple the #6 screw holes and rivet the K-1100-06 platenuts to the E-615PP.
- ❑ Back rivet the stiffeners to the E-701-L/R skins (See "Back Riveting", Section 5.6).
- ❑ Back rivet E-615PP to E-701-L.
- ❑ Bend the trailing edge of the elevator (See "Folded Trailing Edges", Section 5.7). Remember do not add the sealant to the trailing edge until just prior to assembly.

PREPARING THE RIGHT ELEVATOR

- ❑ Separate the E-00001A & B hinge doublers.
- ❑ Use a file to radius the top and bottom edges of the E-00001A outboard hinge doubler to nest against the spar radii.
- ❑ Cleco and drill the E-610PP and E-611PP reinforcement plates, E-00001A & B hinge doublers and corresponding platenuts to the E-702 spar.
- ❑ Prepare the E-703 end ribs and E-704 counterbalance ribs (See "Edge Finishing" and "Fluting", Section 5.2 & 5.13).
- ❑ Cleco and drill the E-703 end rib to the E-704 counterbalance rib then cleco and drill them to E-702. Remove the ribs from the spar.
- ❑ Place the E-714 counterweight on the forward end of E-703 and E-704 as shown (See View F-F, DWG 5).
- ❑ Cleco the E-713 counterbalance skin to E-703 and E-704, ovetop of E-714. The step in the front face of E-714 should butt against the outboard edge of E-713.
- ❑ Use the two holes in the forward face of E-713 as a guide and drill #12 the holes for the screws that will hold E-714 in place. Use a drilling lubricant when drilling the lead E-714's.
- ❑ Un-cleco E-713, remove and set aside E-714, re-cleco on E-713 to E-703 and E-704. Then cleco the E-703, E-

704, E-713 subassembly to E-702.

- ❑ Cleco the E-709 root rib right to E-702.
- ❑ Final drill #40, E-709 to E-702.
- ❑ Cleco E-701-R to the understructure. Note that E-701-R lays on top of E-713.
- ❑ Remove the clecos connecting E-709 to the E-702 then cleco and drill the WD-605-1-R elevator horn to E-702 and E-709.
- ❑ Drill the E-701-R skin to the understructure.
- ❑ Disassemble the elevator.
- ❑ Dimple E-713 for the screw heads that will attach E-714 (See “Dimpling”, Section 5.5).
- ❑ Machine countersink E-714 for the dimples in E-713 (See “Countersinking”, Section 5.5).
- ❑ Machine countersink the E-709 attach holes on the forward face of E-702 (See “Countersinking”, Section 5.5). E-709 and E-702 will be riveted together with flush head rivets, so that the WD-605-1-R elevator horn can be mounted flush with the forward face of the E-702 spar.
- ❑ Bevel the inboard and aft edges of E-713 locally where E-713 overlaps the spar and rib flanges to provide a smooth transition between the counterbalance skin and the E-701-R elevator skin.
- ❑ Deburr, dimple and prime the parts as desired (See “Deburring”, “Dimpling” and “Priming”, Section 5.2, 5.5 & 5.1).

RIVETING THE RIGHT ELEVATOR (See “Riveting”, Section 5.4)

- ❑ Rivet E-703 to E-704.
- ❑ Rivet E-610PP, E-611PP, E-00001A & B and platenuts to E-702.
- ❑ Rivet E-709 to E-702 (flush heads forward).
- ❑ Rivet E-703/E-704 to E-702.
- ❑ Rivet WD-605-1-R to E-702 and E-709.
- ❑ Rivet E-713 to E-701, two rivets on the top and two rivets on the bottom (assembling this way eliminates the need for blind rivets).
- ❑ Loosely place E-714 in place nested inside E-713 with screws partially inserted.
- ❑ Insert the elevator skeleton into E-701-R/E-713 beginning at the front end of E-703/E-704 and then rotating the root end aft into proper position.
- ❑ Cleco and rivet E-701-R and E-713 to the understructure.
- ❑ Finish attaching E-714.

PREPARING THE LEFT ELEVATOR

The left elevator is similar to the right elevator, the only difference is the use of the E-615PP trim access reinforcing plate, supporting the trim cable or servo, and the E-606PP trim spar.

- ❑ Use a file to radius the top and bottom edges of the E-00001A outboard hinge doubler to nest against the spar radius.

- ❑ Cleco and drill the E-610PP and E-611PP reinforcement plates, E-00001A & B hinge doublers and corresponding platenuts to the E-702 spar.
- ❑ E-704 counterbalance rib then cleco and drill them to E-702. Remove the ribs from the spar.
- ❑ Place the E-714 counterweight on the forward end of E-703 and E-704 as shown (See View F-F, DWG 5). Cleco the E-713 counterbalance skin to E-703 and E-704, overtop of E-714. The step in the front face of E-714 should butt against the outboard edge of E-713.
- ❑ Use the two holes in the forward face of E-713 as a guide and drill #12 the holes for the screws that will hold E-714 in place. Use a drilling lubricant when drilling the lead E-714’s.
- ❑ Un-cleco E-713, remove and set aside E-714, re-cleco on E-713 to E-703 and E-704. Then cleco the E-703, E-704, E-713 subassembly to E-702.
- ❑ Cleco the E-705 root rib left to E-702.
- ❑ Final drill #40, E-705 to E-702.
- ❑ Cleco E-701-L to the understructure. Note that E-701-L lays on top of E-713.
- ❑ Remove the clecos connecting E-705 to the E-702 then cleco and drill the WD-605-1-L elevator horn to E-702 and E-705.
- ❑ Cleco and final drill E-606PP to E-705 (at the root end of the E-606PP spar).
- ❑ Drill the E-701-L skin to the understructure.
- ❑ Disassemble the elevator. Deburr, dimple and prime the parts as desired (See “Deburring”, “Dimpling” and “Priming”, Section 5.2, 5.5 & 5.1).
- ❑ Dimple E-713 for the screw heads that will attach E-714 (See “Dimpling”, Section 5.5).
- ❑ Machine countersink E-714 for the dimples in E-713 (See “Countersinking”, Section 5.5).
- ❑ Machine countersink the top flange of E-606PP to accept the dimples in the E-701-L skin (See “Countersinking”, Section 5.5). Dimple the bottom flange of E-606PP.
- ❑ Machine countersink for the rivets that attach E-705 to E-606PP, the flush head can go on either the forward face of E-705 or aft face of E-606PP.
- ❑ Machine countersink the E-705 attach holes on the forward face of E-702 (See “Countersinking”, Section 5.5). E-705 and E-702 will be riveted together with flush head rivets, so that the WD-605-1-L elevator horn can be mounted flush with the forward face of the E-702 spar.
- ❑ Bevel the inboard and aft edges of E-713 locally where E-713 overlaps the spar and rib flanges to provide a smooth transition between the counterbalance skin and the E-701-L elevator skin.
- ❑ See DWG 4 for details of the trim system you have chosen. It is easier to install the necessary parts while access is still available to the inside of the skin. Note that the WD-415 trim cable anchor, related snap bushings and the manual trim cable will be sent in the finish kit.

BENDING THE LEFT ELEVATOR TABS

- ❑ Before the elevator is riveted together, the tabs that close the elevator at the trim tab cutout must be bent. Begin by removing any vinyl from the tabs and outboard of the tabs where the bending blocks will touch the skin surface (the vinyl allows the blocks to shift while bending the tabs).

- ❑ Lay a square reference along the trailing edge of E-701-L in the trim tab cutout (where E-606PP attaches). Mark the bend line perpendicular to the aft edge of the E-701-L trim tab cutout. While bending the tabs the bending blocks will move away from the bend line (outboard). Compensate for this by offsetting the bend line approx. 1/32 inboard from the desired bend location.
- ❑ Fabricate a set of bending blocks from particleboard or wood. The taper of the inside block should approximate the completed bend angle of the E-701-L elevator skin. Clamp the skin and blocks to the edge of a table (See Figure 6-1). Use double-sided tape between the mating surfaces of the bending blocks and the E-701-L skin, to prevent the wedge shaped blocks from slipping.
- ❑ Note that the upper tab overlaps the lower one so the joint sheds water. Bend the bottom tab down using the face of a block of wood, working progressively back and forth across the tab (See Figure 6-2). Finish the bend by using a flush set and a rivet gun turned down low (See Figure 6-3). Work the rivet gun across the entire tab without stopping.
- ❑ With the block still clamped in place repeat the above steps to bend the upper tab up and over the bottom tab.

RIVETING THE LEFT ELEVATOR (See “Riveting”, Section 5.4)

- ❑ Rivet E-703 to E-704.
- ❑ Rivet E-610PP, E-611PP, E-00001A & B and platenuts to E-702.
- ❑ Rivet E-705 to E-702 (flush heads forward).
- ❑ Rivet E-703/E-704 to E-702.
- ❑ Rivet WD-605-1-L to E-702 and E-705.
- ❑ Rivet E-713 to E-701, two rivets on the top and two rivets on the bottom (assembling this way eliminates the need for blind rivets).
- ❑ Loosely place E-714 in place nested inside E-713 with screws partially inserted.
- ❑ Insert the elevator skeleton into E-701-L/E-713 beginning at the front end of E-703/E-704 and then rotating the root end aft into proper position.
- ❑ Cleco and rivet E-701-L and E-713 to the understructure.
- ❑ Rivet E-606PP to E-701-L along the bottom flange only. Leave the top flange unriveted at this point for installation of the trim tab hinge. Rivet E-606PP to E-705.
- ❑ Finish attaching E-714.

BUILDING THE TRIM TAB

- ❑ Complete the trailing edge bend of the E-619-1-020 trim tab skin (See “Folded Trailing Edges”, Section 5.7).
- ❑ Fabricate a set of bending blocks from wood or particleboard (See Figure 6-1,6-2,6-3 and 6-4). Note that the upper block hooks over the lower block to prevent the wedge shaped blocks from slipping. The taper of the inside block should approximate the completed bend angle of the trim tab skin.
- ❑ Remove the vinyl from the ends of the trim tab and mark bend lines on the tab (See Trim Tab Bend Detail, DWG 4). While bending the tabs the bending blocks will move away from the bend line (toward the center of the trim tab). Compensate for this by offsetting the bend line approx. 1/32 from the desired bend location.
- ❑ Clamp the inboard end of the tab with the bending blocks to the edge of a table (See Figure 6-1) Use double-sided tape between the mating surfaces of the bending blocks and the trim tab skin to help prevent the wedge shaped blocks from slipping.

- ❑ Bend the bottom tab down using the face of a block of wood, working progressively back and forth across the tab (See Figure 6-2). Finish the bend by using a flush set and a rivet gun turned down low (See Figure 6-3). Work the rivet gun across the entire tab without stopping.
- ❑ With the block still clamped in place repeat the above steps to bend the upper tab up and over the bottom tab (See Figure 6-4).
- ❑ Repeat the above steps for the outboard tabs.
- ❑ Cleco E-607PP to the inside bottom surface of E-619PP-1-020.
- ❑ Clamp E-718 to E-717 and run a clevis pin through the clevis pin attach hole for alignment. Cleco the E-717 outboard horn to the trim tab skin. Using the holes in E-718 as a drill guide, match drill E-718 to E-619-1-020 and E-607PP.
- ❑ Use the dimensions given on DWG 4 to position and clamp E-721 to the top flange of E-607PP. Mark the inboard edge of E-619PP-1-020 and E-607PP on E-721.
- ❑ Drill the remaining holes attaching E-619PP-1-020 to the bottom flange of E-607PP. Drill the holes attaching E-619PP-1-020 to the top flange of E-607PP and E-721.
- ❑ Disassemble the trim tab.
- ❑ Machine countersink the top of the E-607PP trim tab spar to accept the dimples in the trim tab skin (See “Countersinking”, Section 5.5). Dimple the bottom flange of E-607PP.
- ❑ Trim off the excess material from the E-717 outboard trim tab horn and the E-718 inboard trim tab horn depending on the type of trim system used (See Manual Trim Assembly or Electric Trim Assembly, DWG 4).
- ❑ Trim the inboard edge of the aft portion of the E-721 trim tab hinge.
- ❑ Prepare the parts (See “Edge Finishing”, “Deburring”, “Dimpling” and “Priming”, Section 5.2, 5.5 & 5.1).
- ❑ Cleco the trim tab back together.
- ❑ Rivet the bottom of E-619-1-020 to the bottom flange of E-607PP, E-717 and E-718.
- ❑ Remove the clecos along the top flange of E-606PP and clamp E-721 to the upper flange of E-606PP and the aft edge of E-701-L.
- ❑ Adjust the position of the hinge on the elevator so that the inboard and trailing edges of the trim tab are aligned with the corresponding edges on the elevator (The trailing edge being more critical than the inboard edge). Use a long straight edge to aid in aligning the trailing edge.
- ❑ Match drill and cleco the forward portion of E-721 #40 using the holes in E-701-L and E-606PP as a drill guide.
- ❑ Mark the inboard edge of the E-701-L skin on E-721.
- ❑ Remove E-721 and trim the inboard end to match the inboard edge of the E-701-L skin.
- ❑ Re-cleco the tab hinge and trim tab assembly onto the elevator.
- ❑ Sight down the trailing edge of the elevator, with the trim tab in trail. If the tab has any twist and does not continue the straight line of the elevator trailing edge, now is the time to correct it. Even with the clecos installed, there is enough play in the holes to gently twist the tab as necessary to align it perfectly. When the tab fits, use tape or a second pair of hands to hold it, and drill the folded ends of the inboard tabs.
- ❑ With a pair of clecos in the inboard tabs, and a couple of reference marks for alignment, remove the trim tab from the elevator.

- ❑ Carefully maintaining the alignment, set the rivets on the top of the trim tab.
- ❑ Set the blind rivets in the ends of the trim tab, making sure they don't interfere with the rivets in the inboard tabs of the elevator.
- ❑ Rivet the forward (elevator) half of E-721 to the elevator.
- ❑ Install and bend the trim tab hinge-pin and secure as shown on DWG 4, View A-A. The hinge pin supplied is too short to do this now. You will receive longer pins with the fuselage kit.

FINISHING THE ELEVATORS

- ❑ Roll and rivet the leading edges (See “Rolled Leading Edges”, Section 5.9).
- ❑ Install the rod end bearings as shown (See Detail D, DWG 5).
- ❑ Make a preliminary check to see that the elevator will swing through its full up and down travel without any interference's (See “Flight Controls”, Section 15). Travel is best measured with a protractor or an electronic "smart level". It will probably be necessary to remove the bottom flange of HS-603PP to allow the elevator horns enough swing. DO NOT remove any of the HS-609PP bar!
- ❑ Align the trailing edge on the extended chord line of the stabilizer: "in trail." The counterbalance arm should align evenly with the stabilizer. Secure the elevator in this position.
- ❑ Fabricate a “drill bushing” with an outside diameter of 1/4" and an 3/32" inside diameter. Any small metal tube can be used. The bushing will protect the VA-146 hinge bearing from the drill bit and act as a drill guide to locate and drill the hole in WD-605-1-R for the bolt that attaches the horn to the center bracket.
- ❑ Insert the drill bushing into the HS-411PP hinge bracket/bearing assembly. Using the drill bushing as a drill guide, pilot drill WD-605-1-R to #40.
- ❑ Remove the elevator from the horizontal stabilizer and carefully drill the hole in the WD-605-1-R horn to final size.
- ❑ Repeat the above steps for the left elevator assembly.
- ❑ At this point the E-714 counterweights will overbalance the elevators. Final adjustments are made after the elevators are complete and painted. It is impossible to make the elevator balance exactly until is finished. The best approach is probably to leave the counterweights a little heavy, then drill the inboard side of the counterweight with a series of small holes until the elevator balances. A correctly balanced elevator will remain "in trail".
- ❑ Install the elevators on the horizontal stabilizer and make a check for alignment. There should be no binding in the hinge line.

INSTALLING FIBERGLASS TIPS

You can add the fiberglass tips to the completed empennage now or you may chose to wait and do all the fiberglass work at a later stage. Fiberglass is abrasive and will dull your countersink.

After dimpling the skins and machine countersinking the fiberglass, the tips are attached with CS4-4 “pop” rivets. Installing the rudder and elevator tips first will make it easier to fit and trim the tips of the horizontal and vertical.

Figure 6-5 details ideas on closing the open ended tips.

Note: On the RV-7 only, wait to install the fiberglass rudder bottom until the rudder is fit to the fuselage. It may need to be modified to clear the tail spring.

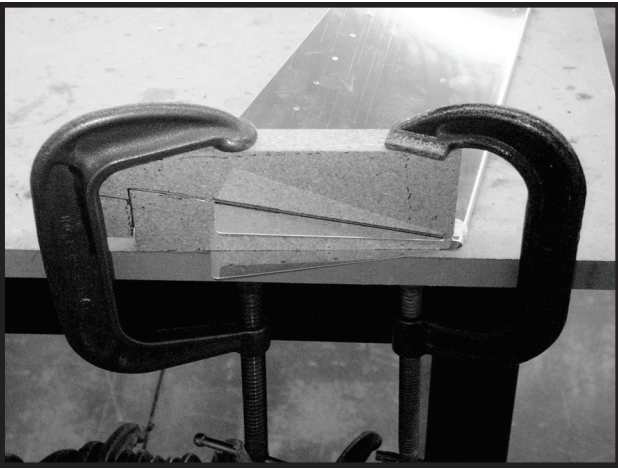


Figure 6-1

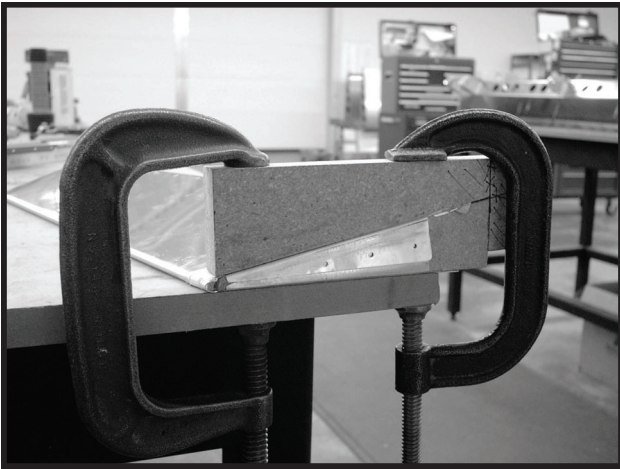


Figure 6-4

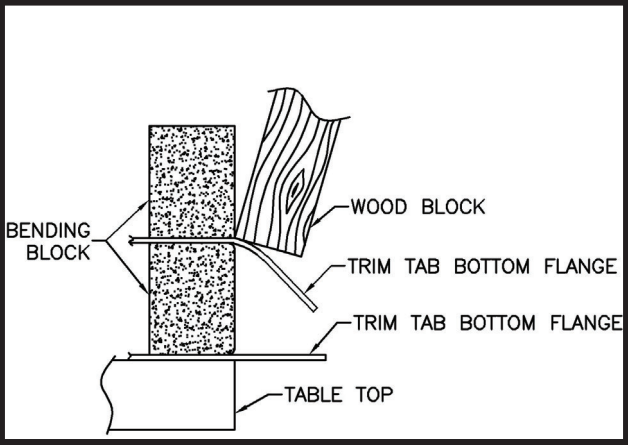


Figure 6-2



Figure 6-3

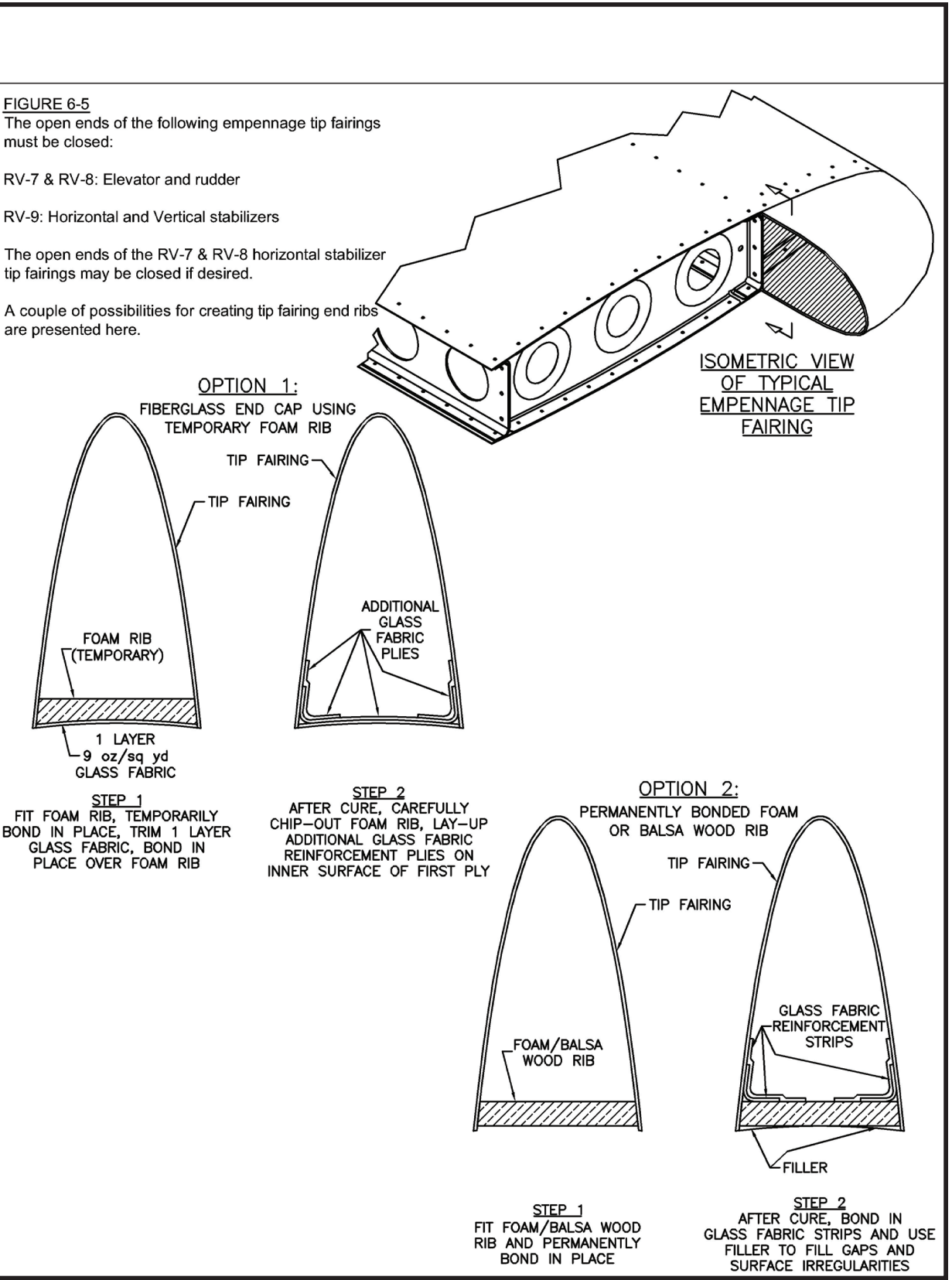
FIGURE 6-5
The open ends of the following empennage tip fairings must be closed:

RV-7 & RV-8: Elevator and rudder

RV-9: Horizontal and Vertical stabilizers

The open ends of the RV-7 & RV-8 horizontal stabilizer tip fairings may be closed if desired.

A couple of possibilities for creating tip fairing end ribs are presented here.



NOTES

NOTES