Chapter 18 Mounting the Vertical Stabilizer and Rudder

18.1 Introduction

The vertical stabilizer and rudder are comprised of two structural skins, a left and a right. In this chapter you will mount the right vertical stabilizer/rudder skin, install all the parts that are in the vertical stabilizer and rudder, create the access openings, and then finish up by balancing and closing the vertical stabilizer/rudder assembly.

Steps to Completion

- Pre-fit the vertical stabilizer/rudder assembly. This pre-fit was initially performed when the horizontal stabilizer was pre-fit. Now this pre-fit needs to be done again with the horizontal stabilizer in place.
- Install the cabin air scoop and the communications/nav. antenna in the vertical stabilizer.
- Create the elevator weldment inspection openings.
- Install the optional trim tab for the rudder.
- Install the rudder taillight and the electrical tubing for the trim tab servo and taillight.
- Balance the rudder.
- Close the vertical stabilizer/rudder by applying the left skin and then cutting it to separate the rudder from the vertical stabilizer.
- Close the rudder's leading edge.

Caution!

Pre-fit the top and bottom fuselage shells and make sure they are level before mounting the vertical stabilizer. See 6.3.C *Setting the Bottom Fuselage to Level* on page 6.6.

A Word about Sanding and Cleaning

The instructions in this chapter refer to preparing a surface or preparing a bonding area. When we recommend preparing a surface or a bonding area, we expect each of the following steps to be completed every time.

1. Sand the area using 40-grit sandpaper.
2. Vacuum all sanded areas.
3. Clean all sanded surfaces with Acetone.

18.2 Parts List

Vertical stabilizer and rudder

Item	Part Number	QTY	Description
1)	1096L	1	Vertical stabilizer - left
2)	1096R	1	Vertical stabilizer - right
3)	1097L	1	Rudder - left
4)	1097R	1	Rudder - right
5)	2096-06	1	Naca scoop/vertical stabilizer closeout with 3” hose flange
6)	1097-07	1	Rudder spar closeout
7)	1108	1	Rudder counterweight
8)	NSF-1	1	NACA air scoop
9)	1344-3		Plastic drain tubing (for scoop)
10)	5052-.250x035		1/4” (6 mm) OD alum. drain tubing scraps (for scoop)
11)	EL-307	2	Aluminum inspection panels
12)	MS24693-S28		Screws (for inspection panel)
13)	AN426A3-5		Rivets (for inspection panel)
14)	MS21_069-06		Nutplates (for inspection panel)

Taillight

Item	Part Number	QTY	Description
1)	LA650	1	Taillight (included in the external lighting accessory kit)
2)	RD-411	1	Taillight mounting plate
3)	AN426A3-5		Rivets

Taillight (Continued)

Item	Part Number	QTY	Description
4)	MS21_069-06		Nutplates
5)	AN515B6R-12		Round-headed screw

Rudder trim tab (parts included in kit)

Item	Part Number	QTY	Description
1)	5-020016	1	Trim tab inspection panel
2)	AN426A3-~~4~~5		Rivets
3)	AN426AD4-5		Rivets, hard
4)	~~K1000-6~~ MS21-069-06		Nutplates
5)	K2000-06		Nutplates, one lug

Trim tab kit TSR-A (optional)

Item	Part Number	QTY	Description
1)	AN426A3-5	16	Rivets
2)	BSC-34	8	Rivets
3)	MS20001	1	Extruded hinge
4)	MS21042-06	8	Locknuts ~~Nutplates~~
5)	MS21_069-06	8	Nutplates
6)	MS24693-S28	14	Screws
7)	PH-125-3x3	1	Phenolic 1/8 x 3 x 3
8)	S4A	1	Servo, electric
9)	TT-01	1	Trim tab actuator arm

18.3 Construction Procedures

Pre-fit the top and bottom fuselage shells and make sure they are level before mounting the vertical stabilizer/rudder assembly. See 6.3.C *Setting the Bottom Fuselage to Level* on page 6.6.

18.3.A Cutting the Horizontal Stabilizer Opening in the Vertical Stabilizer

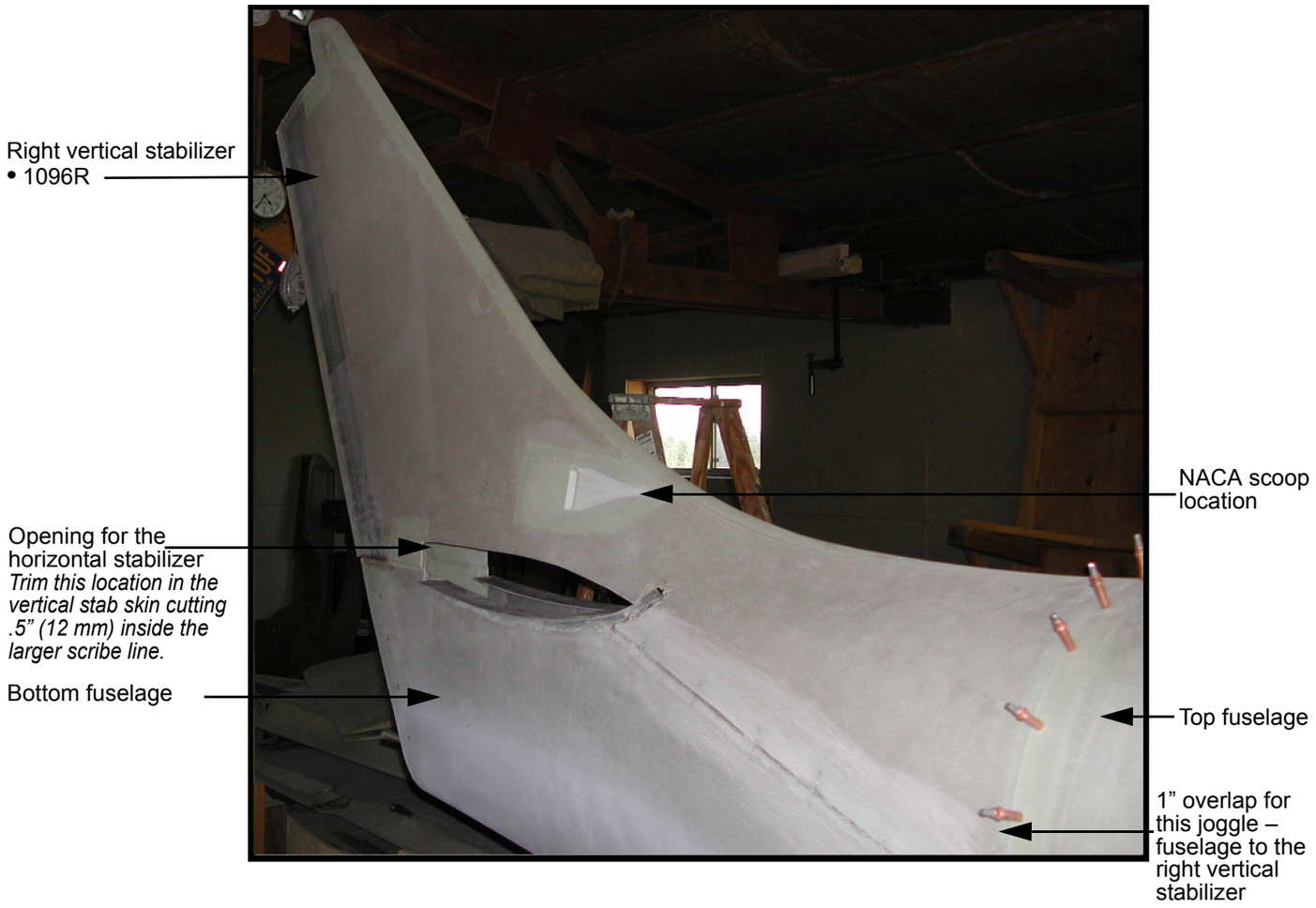
Steps...

- Cut out the opening for the horizontal stabilizer using the scribe marks on the bottom edge on each vertical stabilizer skin (1096L and 1096R).

  The larger scribe line is for the ES. Make this initial cut .5" (12 mm) inside of the larger scribe line. This will leave some extra material for making the final trim after the pre-fit of the vertical stabilizer See Figure 18.3.A.1.

WARNING: The scribe marks on the vertical stabilizer are for reference only. Cut to fit after the vertical stabilizer assembly has been pre-fit to the fuselage.

Figure 18.3.A.1 Trimming the vertical stabilizer to create an opening for the horizontal stabilizer



18.3.B Fitting the Vertical Stabilizer/Rudder Assembly

This is the pre-fit of the vertical stabilizer/rudder assembly.

The fitting goals for the vertical stabilizer/rudder are:

- The bottom of the fuselage and the bottom of the rudder should be flush.
- The vertical stab's forward joggle and the top fuselage's rear joggle need to have a 1" (25 mm) overlap.

Based on the above criteria, you may need to adjust the vertical stabilizer's fit to the fuselage.

Steps...

1. Pre-fit the right vertical stabilizer/rudder assembly by inserting it into the bottom fuselage shell.
2. Fit the left vertical/rudder skin to the right vertical stabilizer/rudder with a few clecos.

   Since the left vertical stabilizer/rudder is still one piece, it creates a template for the right vertical stabilizer/rudder's fit.
3. Check that the vertical stabilizer/rudder assembly's forward joggle fits under the top fuselage shell.
4. Verify the following fits:
   - The vertical stabilizer/rudder bottom is flush with the bottom of the fuselage shell. See Figure 18.3.B.1.
   - The vertical stabilizer's left and right joggles fit over the bottom fuselage joggle.
5. Use a few clecos to finish fitting the vertical stabilizer to the fuselage.
6. Mark the lower edges of the vertical stabilizer to determine where to trim to fit the fuselage.

Figure 18.3.B.1 Fitting the left vertical stabilizer/rudder assembly

Aligning the Vertical Stabilizer to the Fuselage

Both the vertical stabilizer and the fuselage may need trimming in order to achieve a smooth fit. In general, all areas are too big so trimming is usually necessary.

WARNING: The scribe marks on the vertical stabilizer are for reference only. Cut to fit after the vertical stabilizer assembly has been pre-fit to the fuselage.

Steps...

1. Trim along your marks on the lower edges of the vertical stabilizer in order to fit it in the fuselage joggle.

   The fuselage may also need some trimming. See Figure 18.3.B.2 to review the joggle fits of the vertical stabilizer to the top and bottom fuselage shells.
2. Align the vertical stabilizer/rudder assembly.
   - Check the fuselage for level. See 6.3.C *Setting the Bottom Fuselage to Level* on page 6.6.
   - Make sure the fuselage is centered on the center line you marked on the floor in 6.3.D *Pre-fitting the Top and Bottom Fuselage Shells* on page 6.7.
   - Set up a string line or a straight metal fixture above the fuselage, high enough to clear the top of the vertical stabilizer/rudder assembly, that aligns with the center line on the floor and extends to behind the rudder. You will use this line to hang plumb bobs from when aligning the vertical stabilizer

Figure 18.3.B.2 Fitting the vertical stabilizer and fuselage joggles

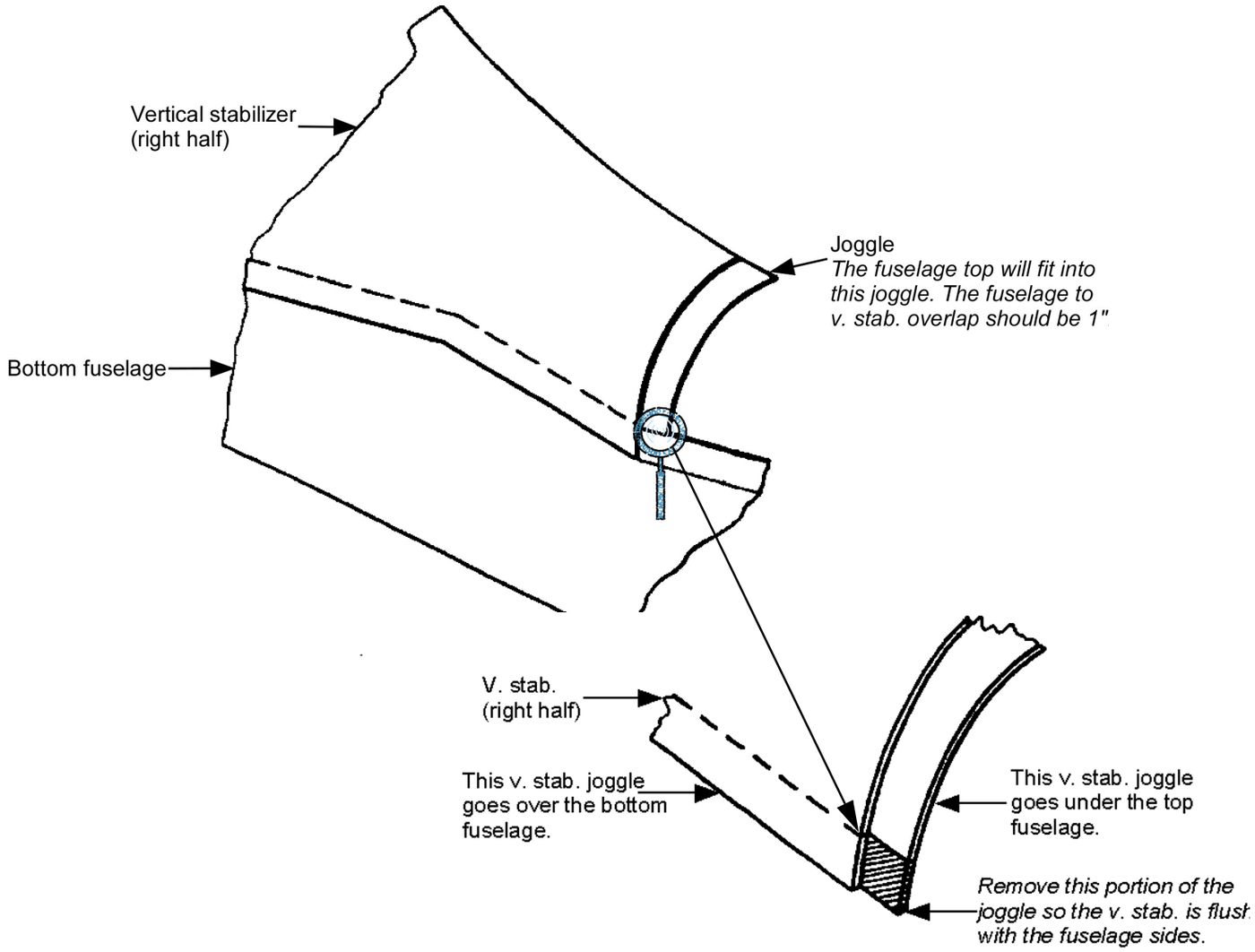
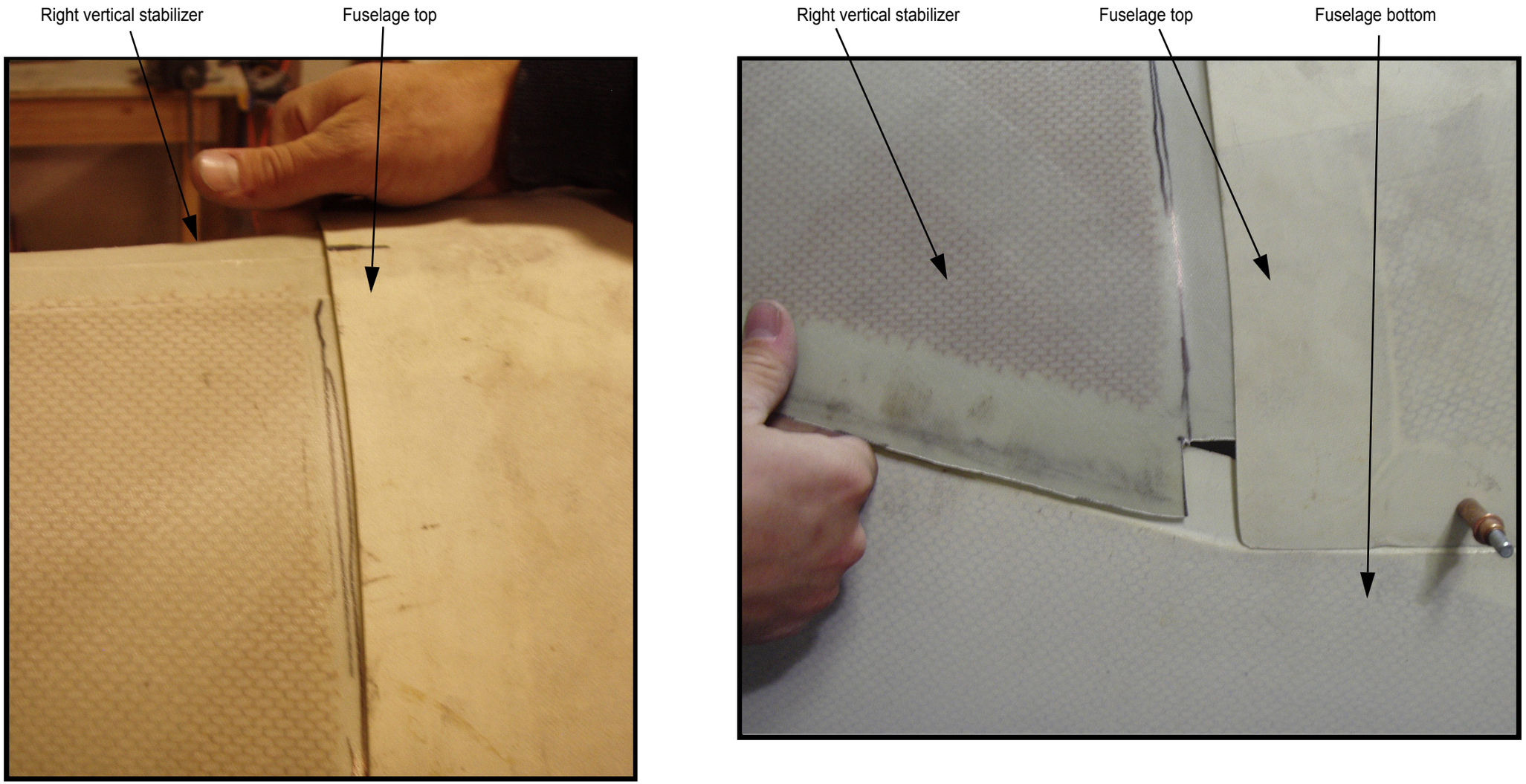


Figure 18.3.B.3 Fitting the fuselage and the vertical stabilizer– two views



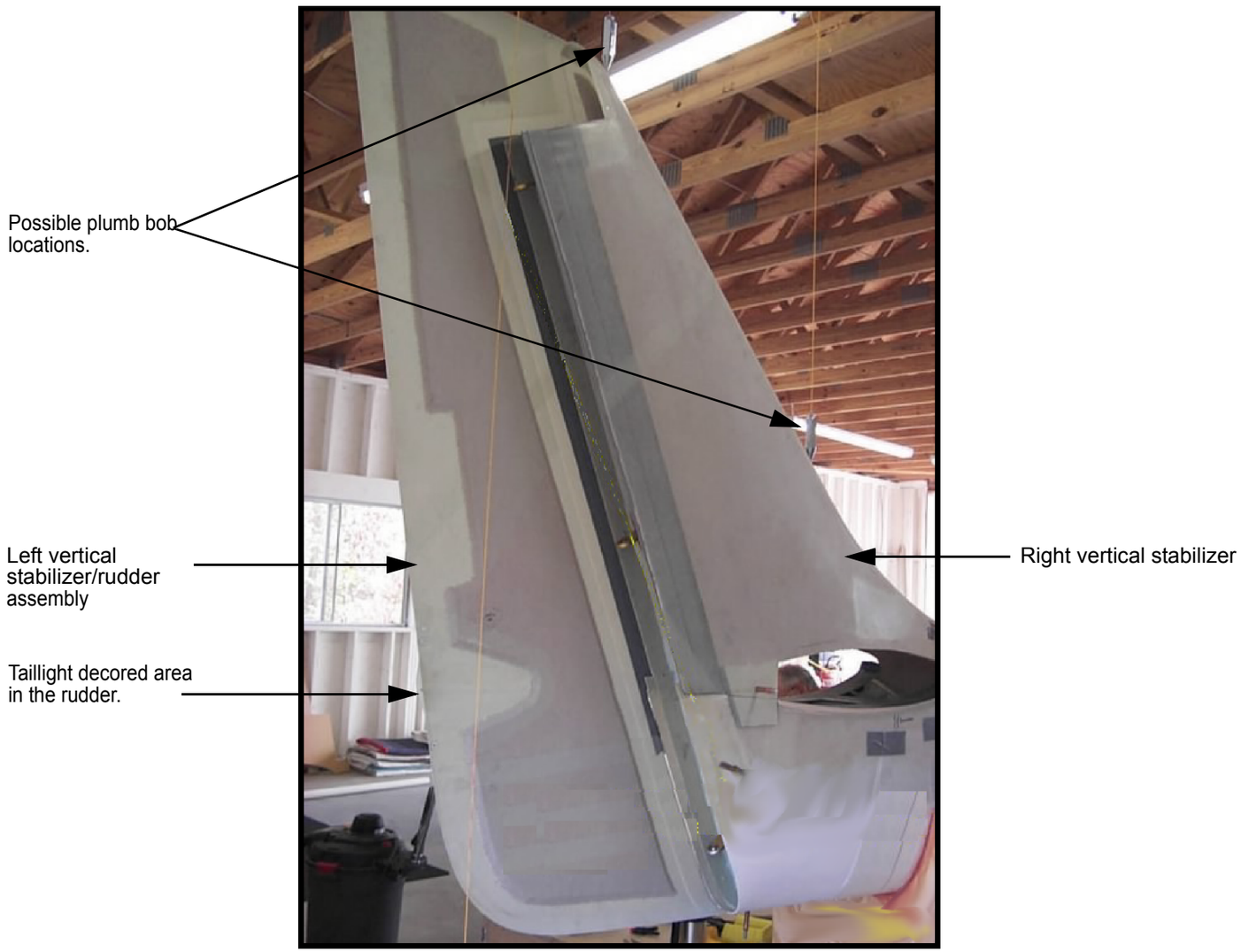
3. Check the vertical stabilizer/rudder assembly for vertical alignment and twist by dropping a plumb bob from the following:
   - rudder T.E.
   - several places along the leading edge
   - top of the vertical stabilizer assembly

   The plumb bob you hang from above the vertical stabilizer/rudder assembly should align the rudder to the fuselage's center line.
4. Push the assembly into position. Use a few Clecos on both sides of the sternpost to hold everything in position for a preliminary fit.

   If necessary add wood supports on the right side to maintain the alignment. The wood can be attached with bondo, duct tape or a strap.
5. Insert clecos every 2-3" (50-75 mm) along the sternpost and fuselage joggles for a final fit.
6. Remove both the left and right vertical stabilizer/rudder assembly in preparation for bonding.

If you are performing this pre-fit for Chapter 17, you can now return to your earlier location Chapter 17 *Pre-fitting and Mounting the Horizontal Stabilizer*. Otherwise continue with the next step.

Figure 18.3.B.4 Checking alignment using a plumb bob



7. Remove the right rudder from the right vertical stabilizer.
8. Clamp the right vertical stabilizer to the fuselage.
9. Insert clecos in the vertical stabilizer-to-fuselage joggles using the holes you drilled for the pre-fit.

   Screws or pop rivets will also work to hold the joggle together if you don't want to clean up your clecos later.
10. Bond the right vertical stabilizer/rudder assembly to the fuselage with Hysol/flox.
11. Attach a straight piece of wood or angle aluminum to the side of the vertical stabilizer to keep the skin straight along the sternpost.

Tip: Recheck the sternpost for vertical alignment. This extra check will prevent assembly difficulties later in the building process.

Steps after cure...

1. Remove the clecos (or screw/pop rivets from the joggle area after the Hysol has cured.
2. Sand and clean the joggle areas.
3. Apply 2-BID in the joggled areas.
4. Apply a thin coat of micro over the joggles.

This exterior area of the right vertical stabilizer/rudder is now ready for body work.

In addition...

You can apply BID to all the internal seam joints of the right vertical stabilizer/rudder assembly before you bond on the left vertical stabilizer.

And now you can apply to the joggle between the fuselage top and the vertical stabilizer, a 2" (50 mm) wide 1-BID on the inside of the fuselage. See Chapter 6, 6.3.L *Closing Out the Fuselage* on page 6.24 for a description of the joggle reinforcements. Also refer to Figure 6.3.L.3 on page 6.25.

Figure 18.3.B.5 Bonding the right vertical stabilizer to the fuselage

18.3.C Installing the Cabin Air Scoop

The ES provides fresh air to the cabin from a single NACA scoop that mounts in the right vertical stabilizer The fresh air travels through scat tubing into the overhead console and blows onto the occupants through four optional eyeball vents. This scoop provides enough airflow to adequately cool four people.

Locating the Scoop

The NACA scoop is installed on the right vertical stabilizer skin.

Steps...

1. Trim the flanges of the NACA scoop so they are 3/4” (19.05 mm) wide.

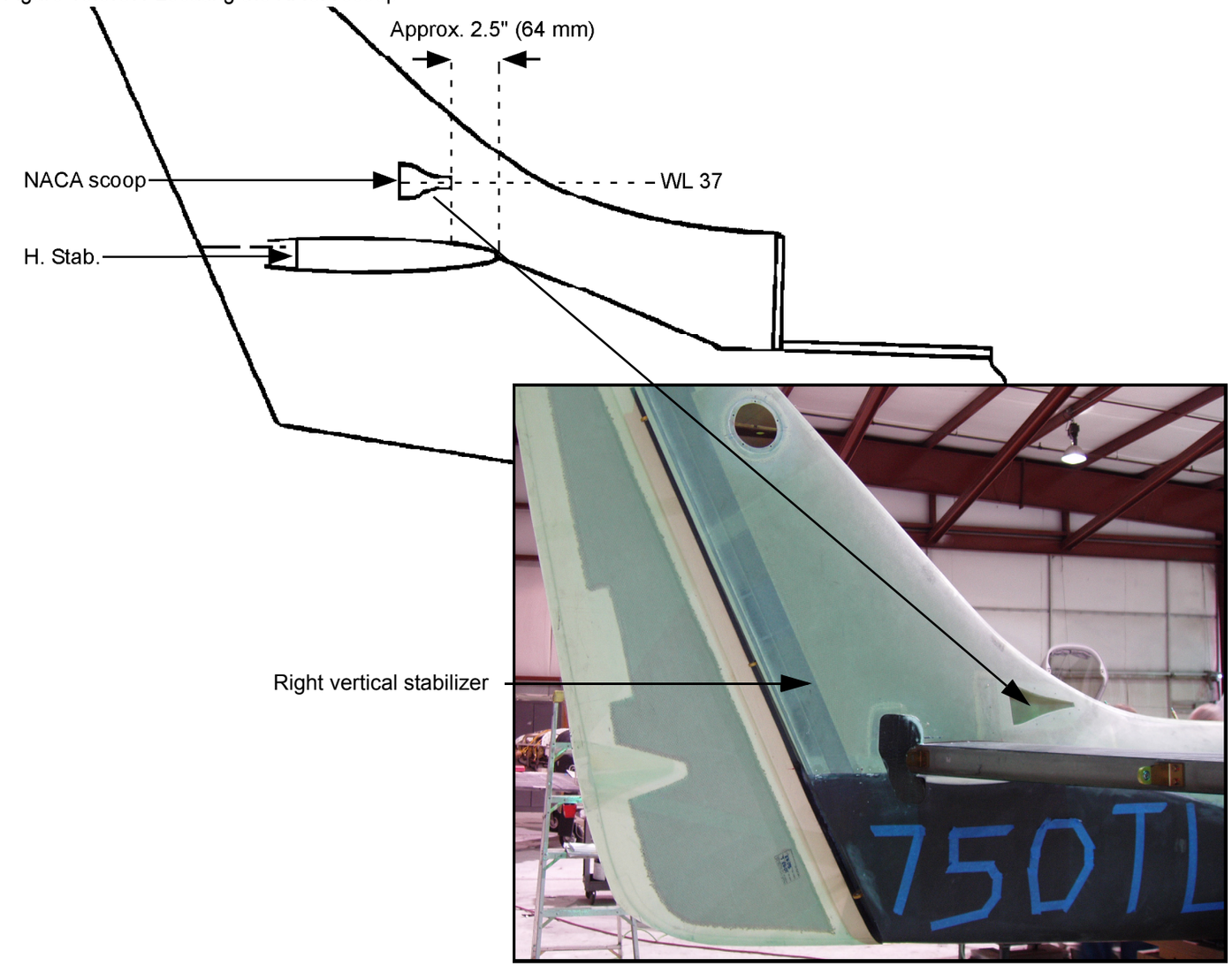
   Trimming the scoop is fairly easy since it is made from ABS plastic.
2. Locate the NACA scoop as shown in Figure 18.3.C.1 and draw a scribe line on the vertical stabilizer skin.

   It should fit into the coreless area of the vertical stabilizer using the dimensions in the figure.

   The exact location is not critical so adjust the location to fit in the coreless area. Use the forward vertical spar web to help locate the scoop.
3. Cut out along the scribe line to create the opening for the scoop.

   Notice that the skin is not trimmed to the aft edge of the NACA scoop. Refer to Figure 18.3.C.2 on page 18.10.

Figure 18.3.C.1 Locating the NACA scoop



4. Locate the scoop and secure it in position with a few Clecos. See Figure 18.3.C.2.
5. Using 40-grit paper, sand the inside of the right vertical stabilizer skin where the NACA scoop will be bonded. Also sand the NACA scoop flanges.

   Note: Do not clean the bonding surfaces of the NACA scoop with Acetone. Acetone will melt the ABS plastic.
6. Bond the NACA scoop in position with Hysol.

   Use the clecos to hold the scoop while it's curing.

Steps after cure...

1. After the Hysol dries, secure the NACA scoop flange to the inside of the right vertical stabilizer skin with 2" (50 mm) wide, 1-BID strips.
2. Trim the NACA scoop on the inside as shown in Figure 18.3.C.3 so air can flow through the scoop.

   The two vertical stabilizer webs will form a plenum chamber for the incoming air, further pressurizing it for its trip to the pilot and passengers.
3. Clean and sand the vertical stabilizer's forward skin and the inside of the vertical stabilizer where the skin will be bonded.

   WARNING: Do not clean the ABS plastic NACA scoop. It is made from ABS plastic and Hysol will tarnish the surface.
4. Bond the web in place with epoxy/micro/flox.

Tip: To prevent bugs or other debris from entering the NACA scoop, stuff a mesh pot scrubber in the opening. Or you can pot a screen in the opening.

Figure 18.3.C.2 Trimming the vertical stabilizer skin for the NACA scoop

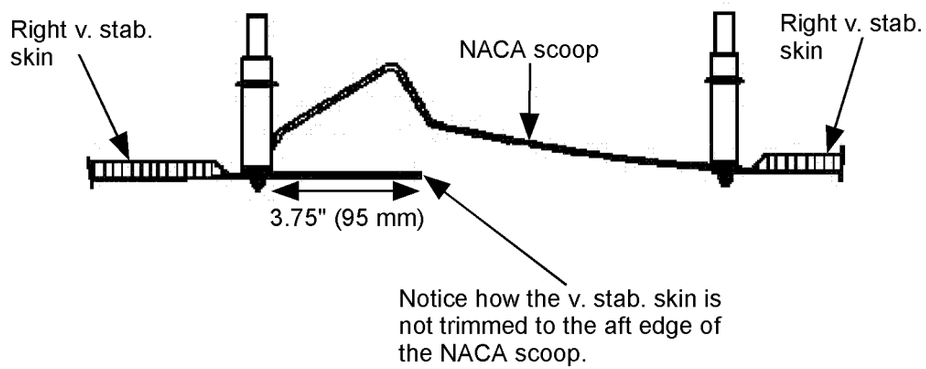
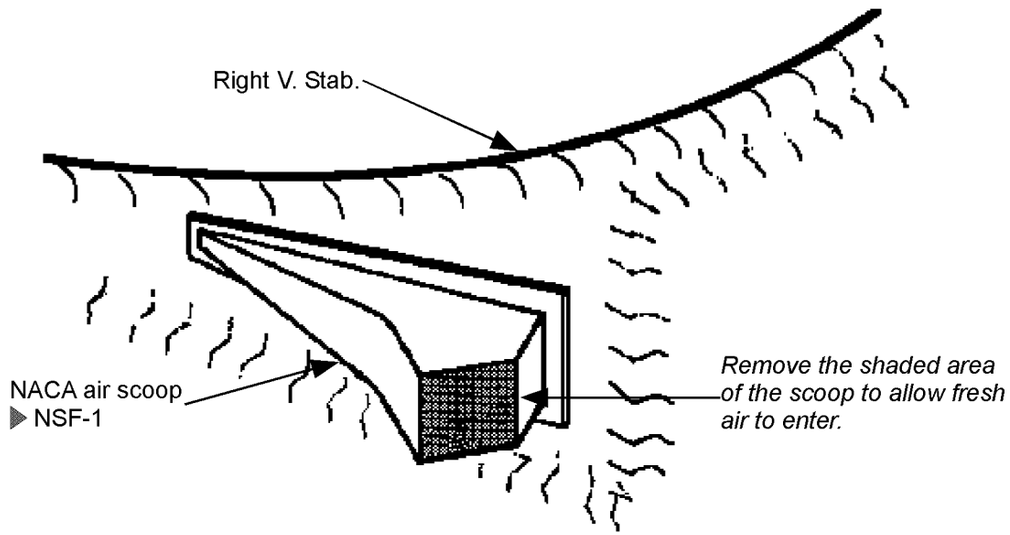


Figure 18.3.C.3 Removing the air-flow opening



Installing the Drain Tubes

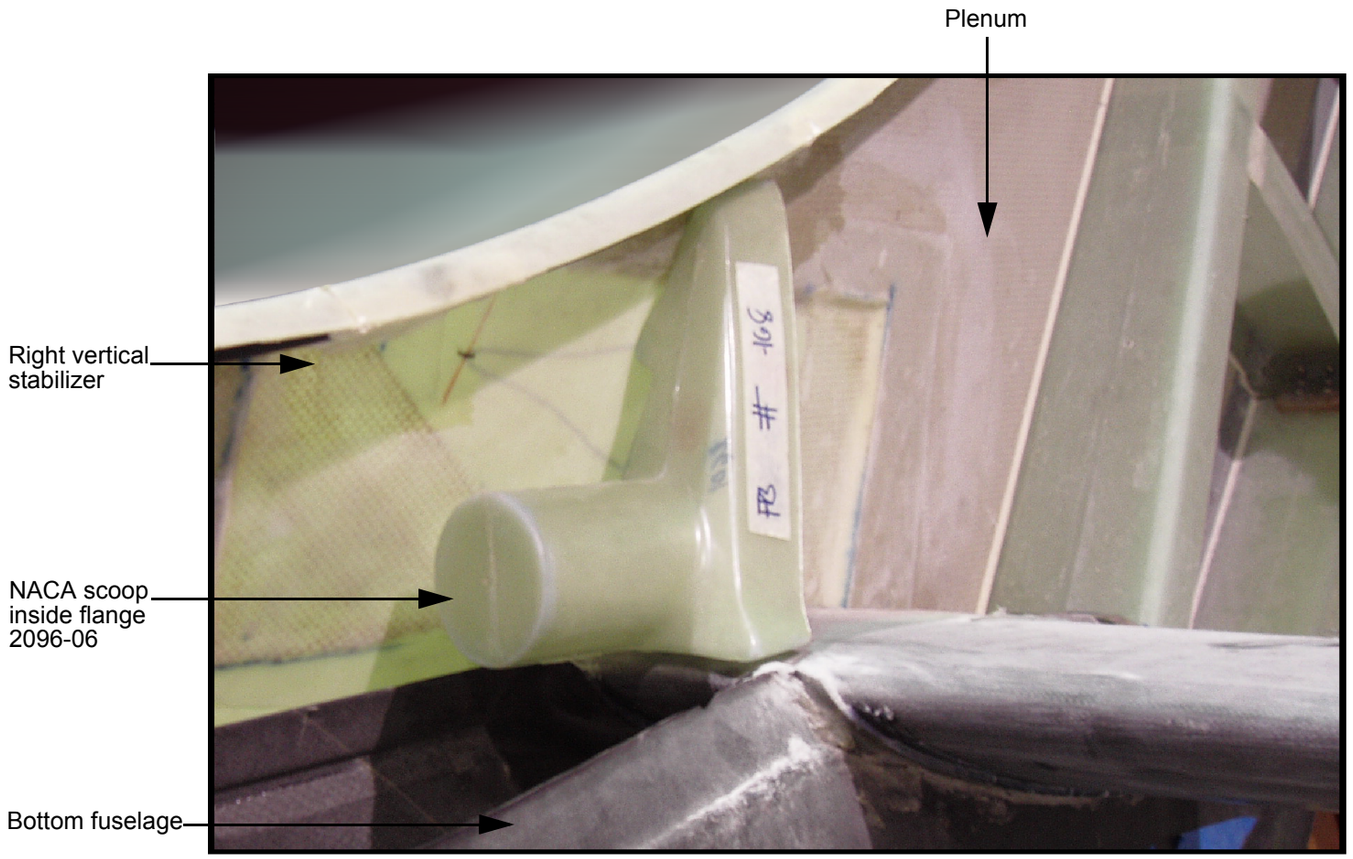
A drain tube must be added at the lowest point of the air plenum chamber. The air plenum chamber is the vertical stabilizer bay formed by the forward and aft vertical stabilizer webs. Water that enters through the NACA scoop can flow out using the drain lines.

Steps...

1. Cut two 3” (75 mm) pieces of 1/4” (6 mm) diameter aluminum tubing from scraps.
2. Grind a hole in the forward web just large enough for the 1/4” (6 mm) diameter tube.
3. Grind a similar hole in the bottom of the fuselage directly under the horizontal stabilizer L.E. as shown in Figure 18.3.C.5.
4. Using 40-grit sandpaper, rough up the bonding surface of the two tubes and secure them into position with epoxy/flox.

   The drain tube should be located at the lowest point of the bay formed by the forward and aft vertical stabilizer webs.

Figure 18.3.C.4 Inside section of the NACA scoop



5. When the flox has cured, bend the tubes as shown in Figure 18.3.C.5 so the clear plastic drain tubing (1344-3) can be routed along the right side of the fuselage.

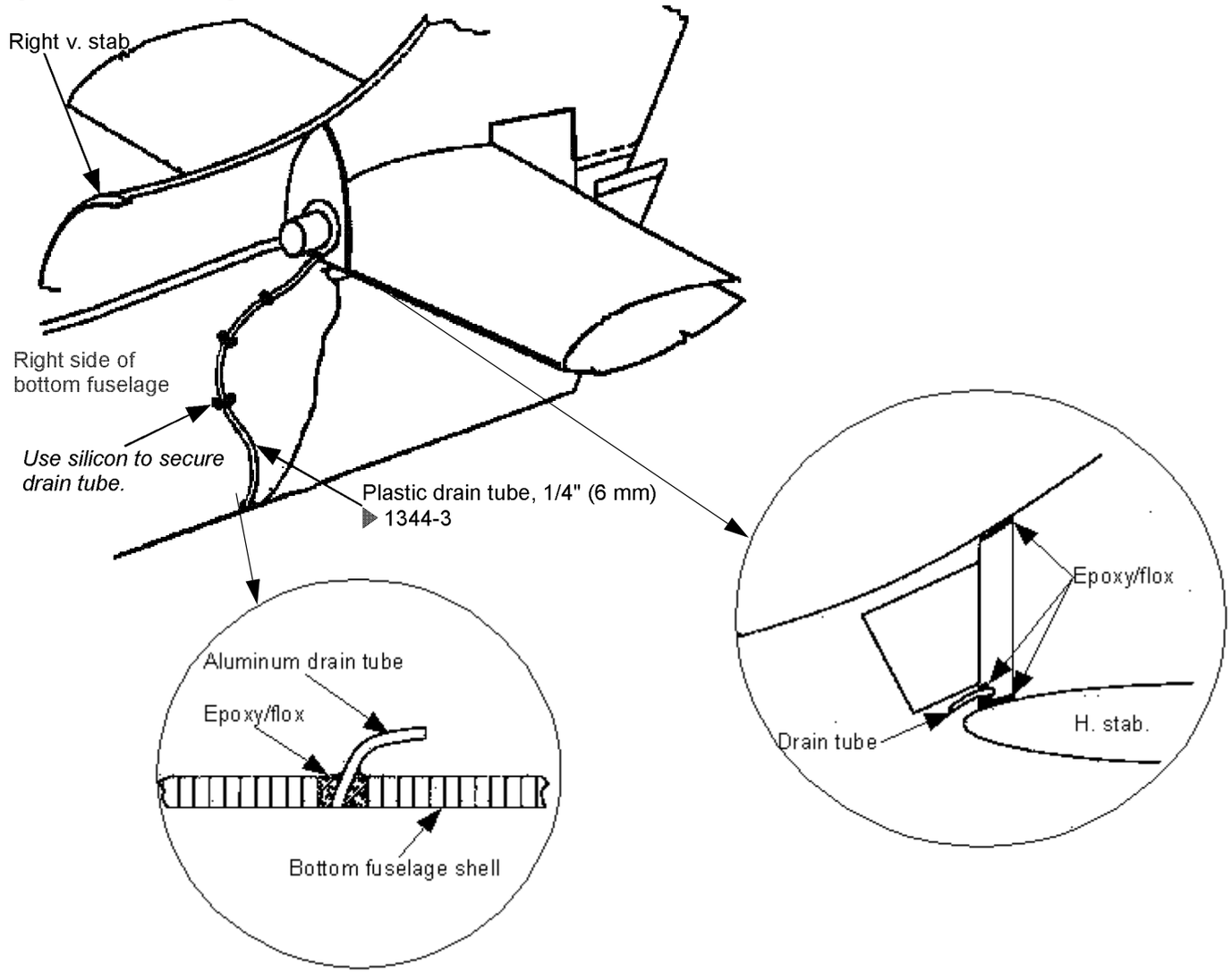
   Routing the drain tube straight down will interfere with the elevator pushrod.

6. Secure the clear plastic tube to the aluminum tubes with a few tie wraps.

   Be sure not to clog the drain tube with dust or adhesive during the rest of the construction. A piece of tape can be used to cover the ends of the drain tubes until construction is finished.

Now complete section 24.3.A *Completing the Fresh Air Vent* to connect the inside section of the Naca scoop to the Scat tubing coming from the cabin.

Figure 18.3.C.5 Installing the drain tube



18.3.D Elevator Weldment Inspection Panels

Inspection panels are necessary for easy removal of the elevators. These panels are located just aft of the horizontal stabilizer where the vertical stabilizer and fuselage meet.

There are two inspection panels, one on each the right and left side of the vertical stabilizer.

Although you have not installed the left skin of the vertical stabilizer, you have completed the pre-fit and the skin has several Cleco holes. The Cleco holes will be used to accurately locate the left vertical stabilizer skin in its final position. They can also be used to perform another pre-fit for the access panel location.

It is much easier to remove the core and add the reinforcement BID for the left panel flange now, before the vertical stabilizer is closed out. Once the vertical stabilizer is closed out, 18.3.I *Closing the Vertical Stabilizer/Rudder Assembly* on page 18.29 you can finish installing the left inspection panel per the instructions in this section.

The following steps are completed in this section:

- Trim and prepare the elevator weldment inspection panel.
- Create the opening for the elevator weldment inspection panel.
- Position the weldment inspection panels and screw in place.
- Create a smooth transition from the fuselage to the inspection panel using epoxy/flox.

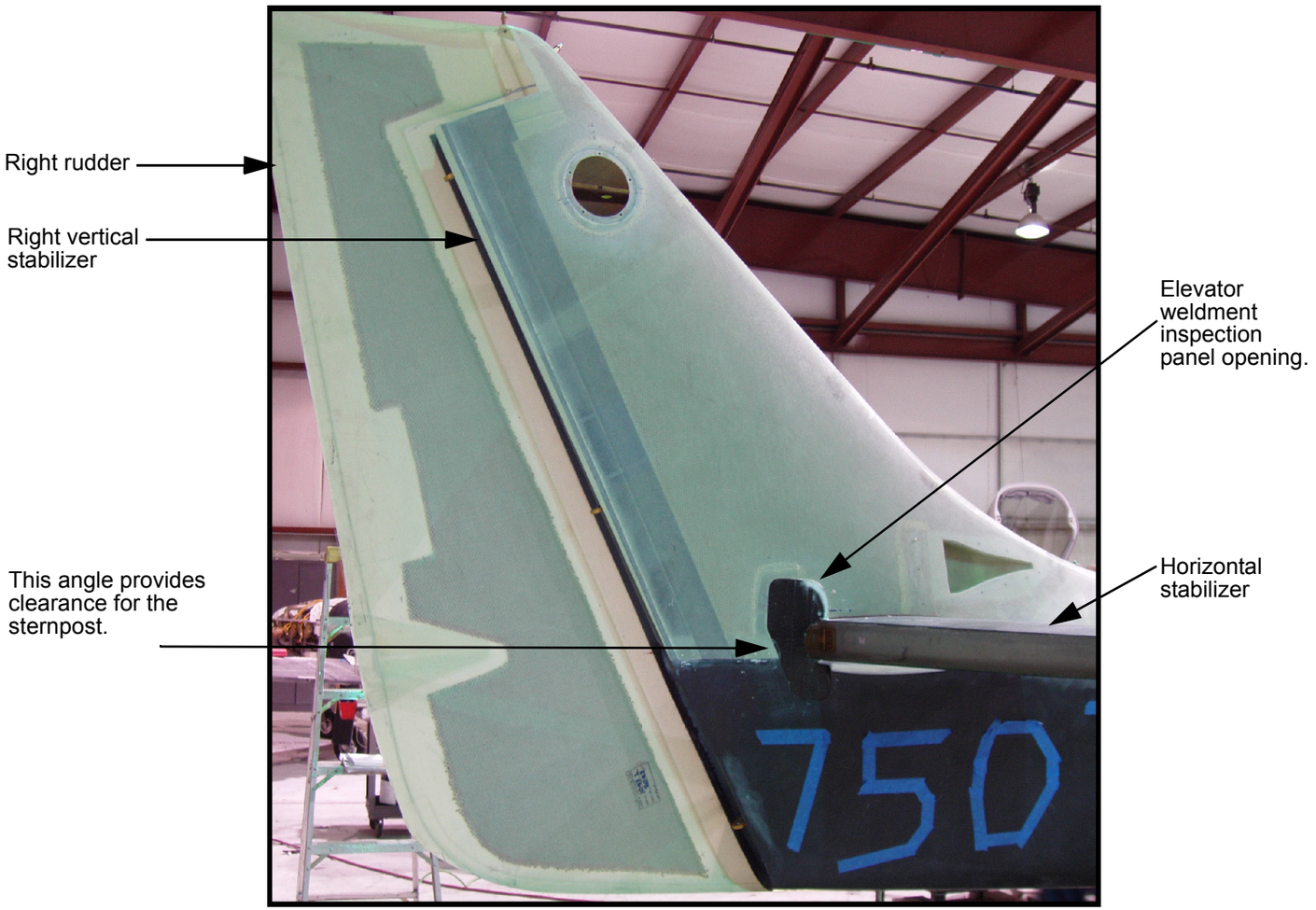
Steps...

1. Starting on the right side of your ES, if necessary, trim the elevator weldment inspection panel (4460) to the shape and dimensions shown in Figure 18.3.D.2.

   Tip: First size and cut both inspection panels before cutting any inspection holes in the vertical stabilizer and bottom fuselage.

2. Position the right inspection panel as shown in Figure 18.3.D.2 and trace an outline of the panel on the outside surface of the vertical stabilizer and bottom fuselage.

Figure 18.3.D.1 Elevator weldment inspection panel location

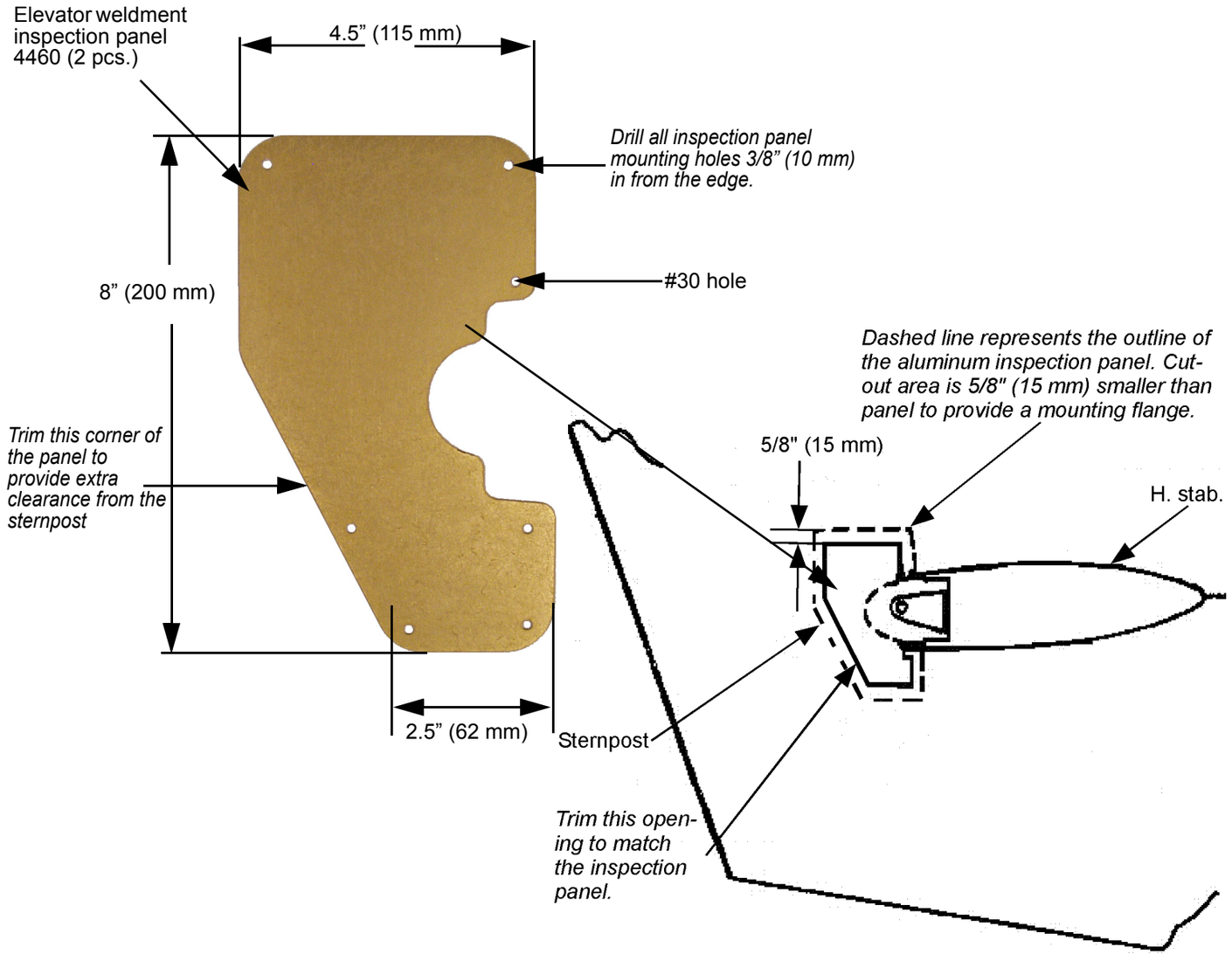


3. Cut the access hole 5/8” (15 mm) inside your outline. This creates the flange for the access panel to mount on.
4. Remove 1” (25 mm) of inner laminate and core from the vertical stabilizer and the bottom fuselage shell.

   When you remove the inner laminate and core, a flange is formed which the inspection panel will mount to. Determine where to cut the core by:

   - Measuring 1” (25 mm) back from the edge of the access hole you cut in step 3.
   - Marking the inside surfaces of the vertical stabilizer and bottom fuselage shell where you will remove the core. Refer to Figure 18.3.D.2 for clarification.
5. Reinforce the flange area by applying 3-BID as shown in Figure 18.3.D.2. Overlap the 3-BID onto the original inner surfaces by 1” (25 mm).
6. Position the inspection panel on the outboard surface of the vertical stabilizer and bottom fuselage shell.
7. Drill #30 holes through the panel and the fuselage where the mounting screws are located.

Figure 18.3.D.2 Trimming and locating the elevator weldment inspection panels

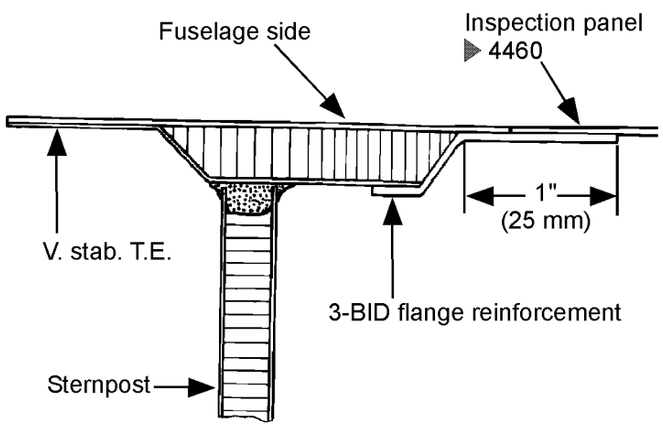


8. Countersink the aluminum inspection panel for the mounting screws, MS24693-S28.
9. Mount the nutplates (MS21-069-06), using rivets (AN426A3-5), to the bottom fuselage shell and vertical stabilizer.
10. Apply release tape to the inspection panel.

    To make the inspection panel appear flush with the surrounding surface, you must fair in the panel with micro.
11. Sand the outer surfaces of the vertical stabilizer and bottom fuselage shell in an area 4-6” (100-150 mm) larger than the inspection panel. Clean these areas with acetone.
12. Screw the inspection panel in place.

    It is a good idea to cover the heads of the screws with pieces of release tape to prevent the slots from filling up with micro.
13. Apply a thick epoxy/micro mixture to the area surrounding the inspection panel. This is the area you sanded in step 11.

Figure 18.3.D.3 Reinforcing the inspection panel flange area

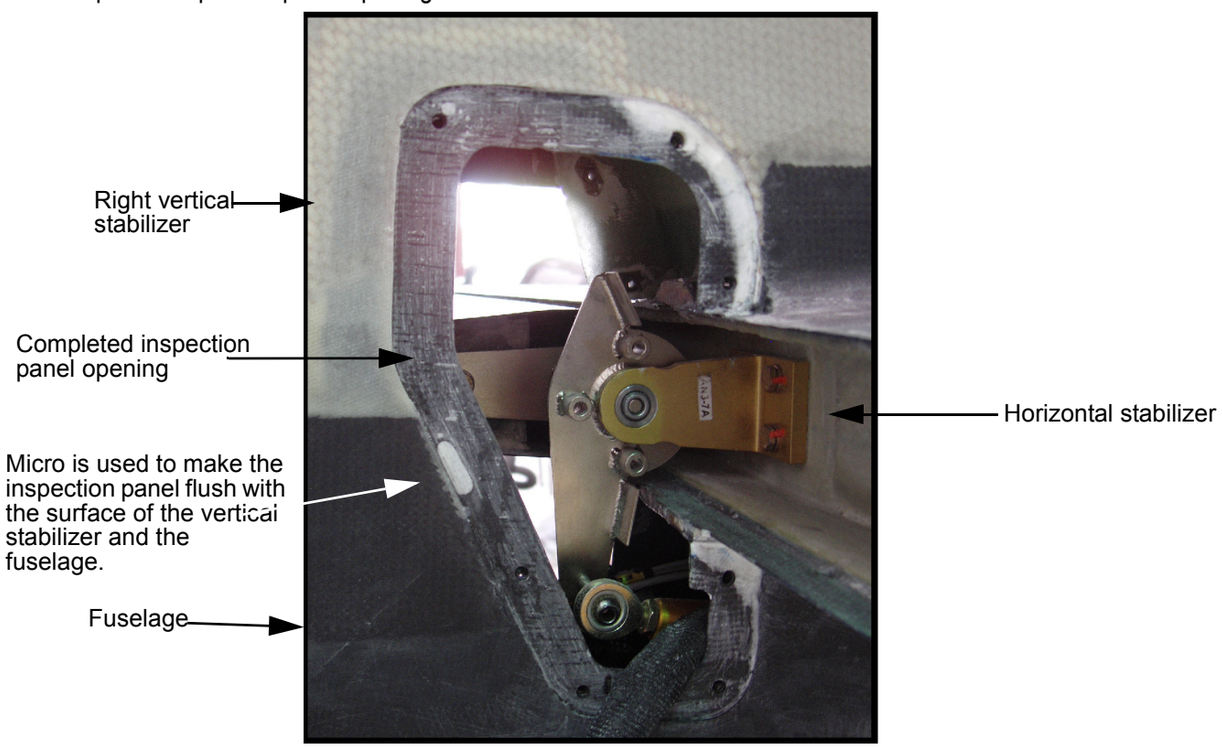


Steps after cure...

1. Sand the micro so there is a smooth transition from the inspection panels to the fuselage surface.
2. Remove the inspection panels and remove the release tape.
3. Sand around the perimeter of the panels.

   Try to get about a .050” (.5 mm) gap between the panels and the micro.

Figure 18.3.D.4 Completed inspection panel opening



18.3.E Installing the Optional Rudder Trim Tab

Your ES airplane can have an optional rudder trim tab. The hardware used in this section is available through KCI, part number TSR-A, the trim/servo rudder assembly which includes a MACS-4 electric servo.

The right rudder skin is cored out for the trim tab and the access panel. The trim tab will be actuated using the electric servo.

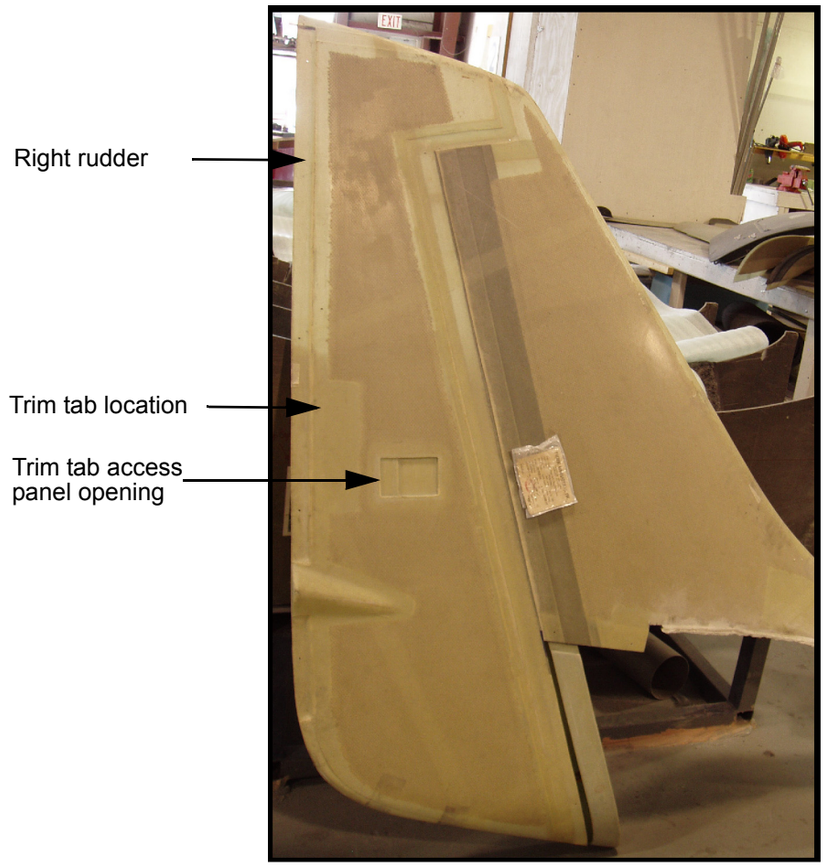
If you do not plan to add the optional rudder trim tab, you need to fill the decored servo area with Clark foam and apply a 2-BID over the foam.

Creating the Trim Tab Access Opening and Mounting the Servo

Steps...

1. Using the access panel (5-020016) as a template, trace an outline of the access panel on the rudder. See Figure 18.3.E.1 for the location of the access panel opening.
2. Cut out the opening.
3. Use instant glue to temporarily mount the MACS-4 servo to the access panel.

Figure 18.3.E.1 Rudder trim tab openings



Click here to view a picture of the trim tab installation.

4. Apply release tape to the flanges of the servo and the exposed access panel (5-020016).

   Refer to the trim tab access panel and servo mounting in Figure 18.3.E.4 for orientation.

5. Temporarily mount the access panel and servo assembly flush with the outside of the rudder skin using tongue depressors.

Click here to view a picture of the access panel and servo location.

Figure 18.3.E.2 Trim tab installation overview

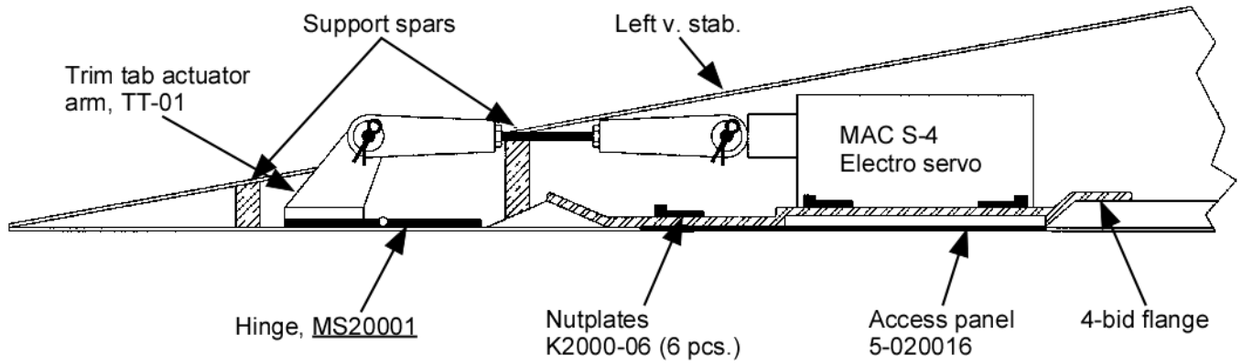
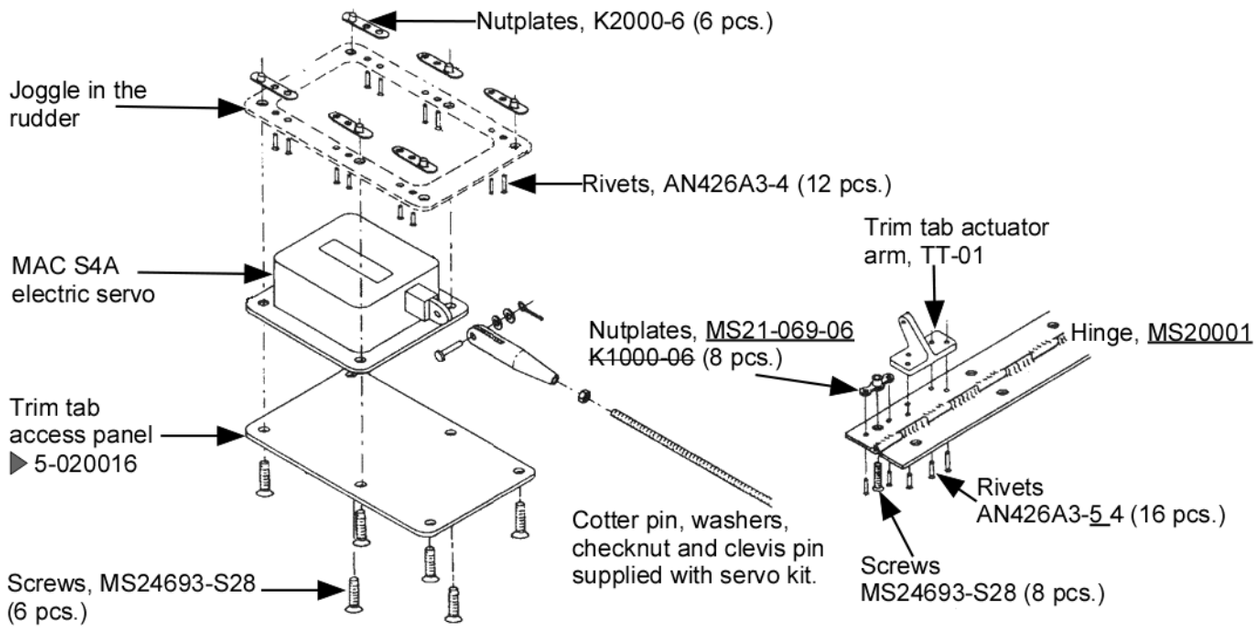


Figure 18.3.E.3 Trim tab access panel installation



6. Make a 4-BID flange that overlaps from the access panel onto the rudder skin 1” (25 mm). See Figure 18.3.E.4.

   The flange created with the 4-BID is referred to as the access panel flange.
7. After the access panel flange has cured pop the access panel, with the mounted servo, loose from the rudder.
8. Clean up the edges of the access panel flange.
9. Place the access panel back in position and match drill six #29 screw holes through the access panel flange as shown in Figure 18.3.E.5.
10. Drill out the matching holes in the servo’s flange.
11. Install six nutplates (K2000-06) in the flange of the access panel.

Figure 18.3.E.4 Side view of the access panel with a completed 4-BID flange

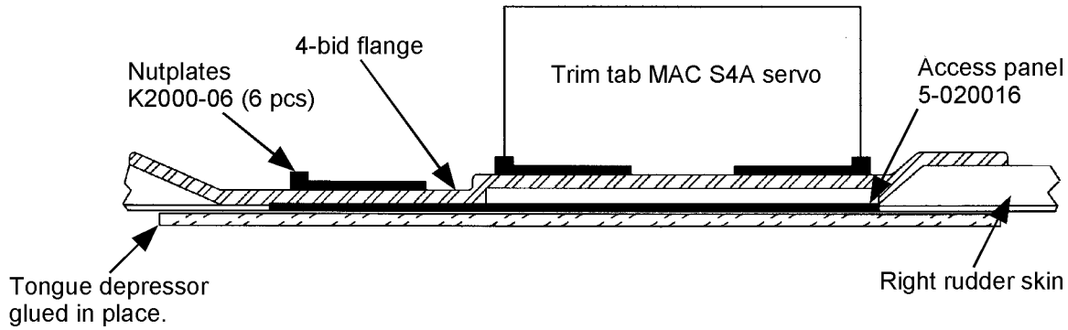
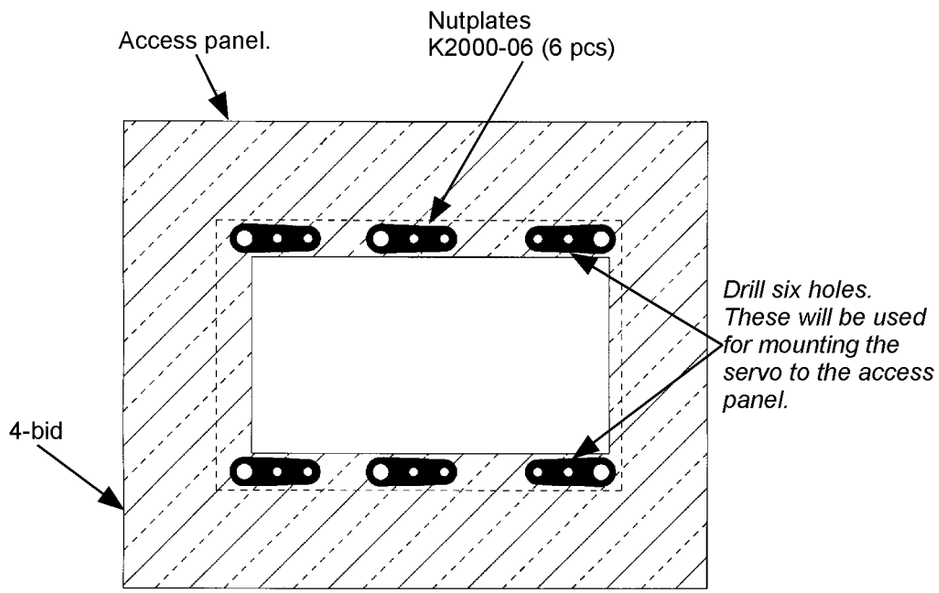


Figure 18.3.E.5 Inside view of the access panel with 4-bid flange and nutplates.



Preparing the Trim Tab's Location

To the rear of the trim tab's access panel is a 5" by 9" (125 by 225 mm) cored-out area at the trailing edge of the rudder. This area is where the trim tab will be installed. See Figure 18.3.E.1 for a picture of the cored-out areas of the rudder.

Steps...

1. Scribe a 4 x 9" (100 x 225 mm) trim tab outline in the cored-out trim tab area.
2. Drill two 1/8" (3 mm) diameter reference holes at the front corners of the cored-out area.

   Use the holes to scribe a trim tab outline on the outside of the rudder skin.
3. Apply a 2" (50 mm) wide 4-BID over the hinge line area, centering it over the two reference holes. See Figure 18.3.E.7.
4. Cut two small trim tab support spars and the four closeouts from 2-ply per side 1/4" (6 mm) prepreg.
5. Clean and sand the bonding area for the spars and bond them in with micro/flox/epoxy.

   Leave a small gap between the closeouts to allow for paint and some clearance. See Figure 18.3.E.7.

Figure 18.3.E.6 Side view of rudder hinge preparation

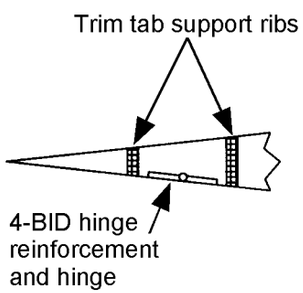
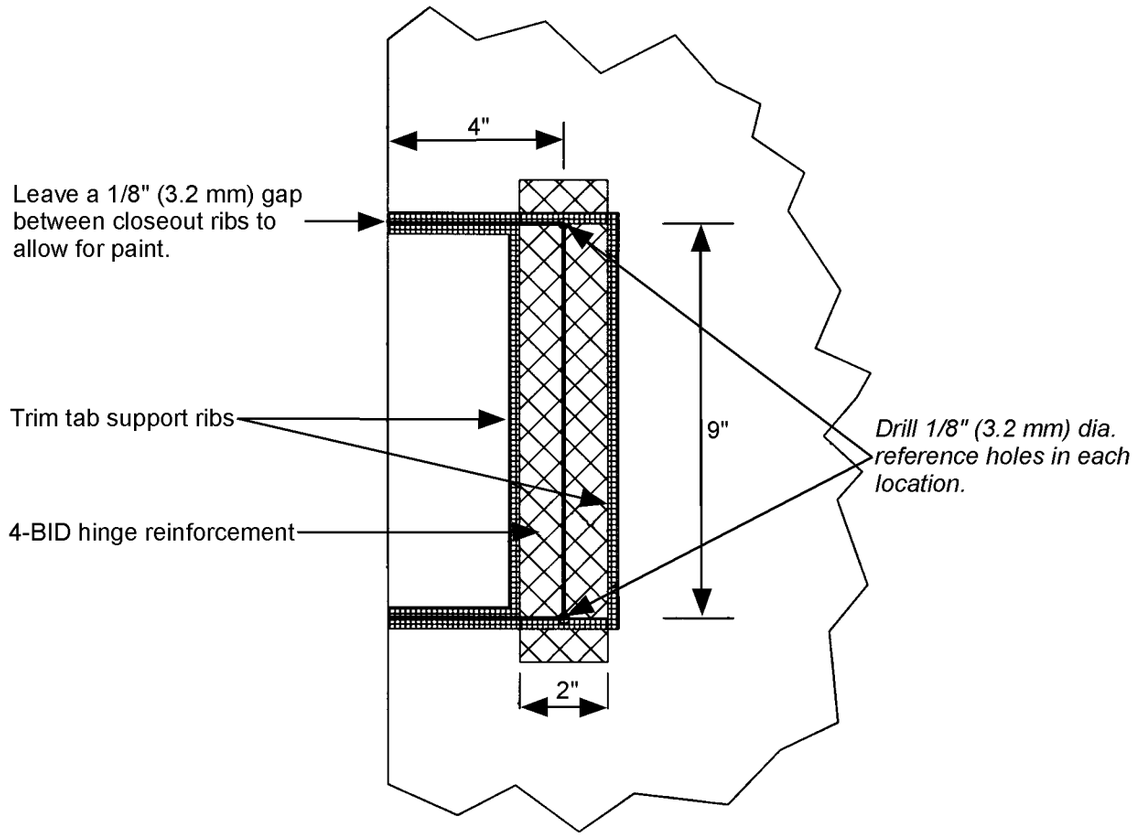


Figure 18.3.E.7 Preparing the trim tab location in the right rudder skin



Now you will perform a final pre-fit of the left side vertical stabilizer/rudder skin.

Steps...

1. Temporarily mount the right rudder by inserting a thin steel rod through the three hinges.
2. Place the left vertical stabilizer/rudder skin against the right.
3. Using a rigid straight edge, align the left vertical stabilizer/rudder skin along the sternpost.

   It may be necessary to put shims between the sternpost and lower fuselage skin to help align to the rudder.
4. Remove the left skin.

Click here to view a picture of the left vertical stabilizer in place with a rigid straight edge used for alignment.

Installing the Trim Tab

Steps...

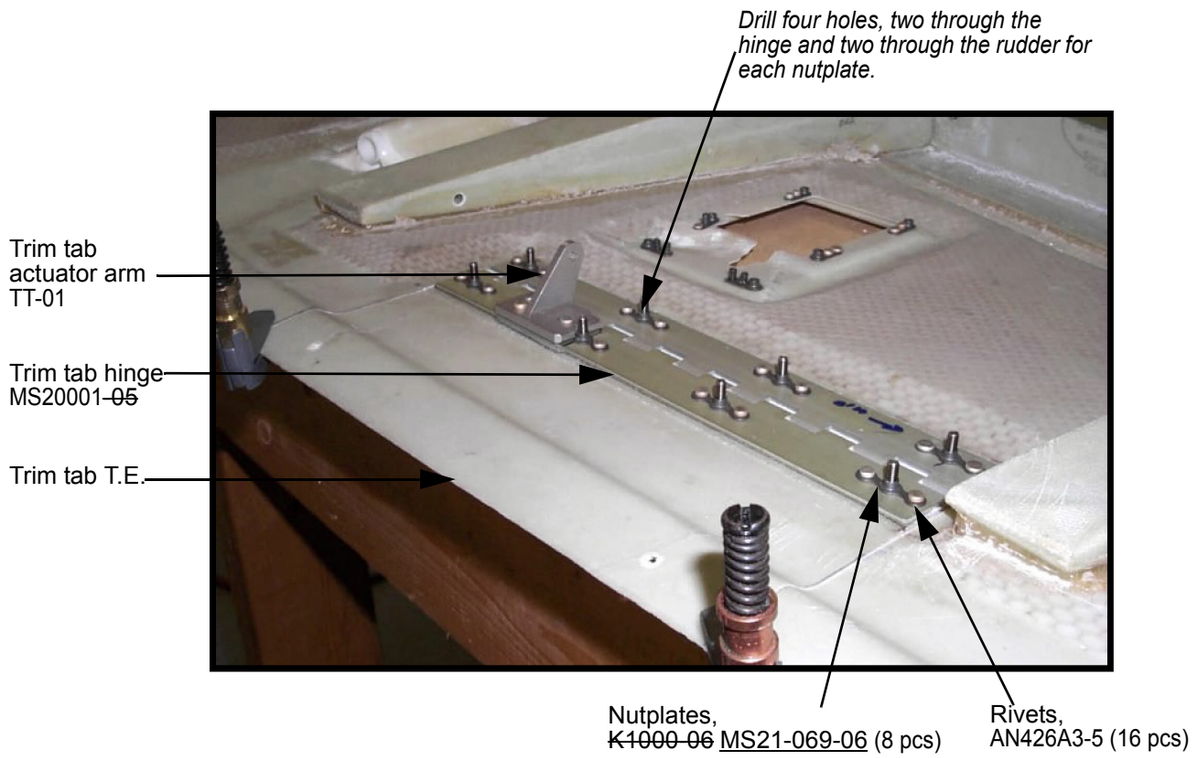
1. Cut out the trim tab area from the rudder between the trim tab spars in the following order:
   - Cut from the T.E. to the reference holes.
   - Then cut down the hinge line.

   Click here to view a picture of the cut away area for the trim tab.
2. Cut an 8” (200 mm) section of extruded hinge material (MS20001-05).

   Cut the hinge pin slightly shorter than the hinge.
3. Insert the pin in the hinge and carefully peen the hinge ends so that the pin is captured.

   Be careful not to crack the hinge when you peen it.

Figure 18.3.E.8 Trim tab hinge and actuator arm placement



4. Install the trim tab hinge to the rudder, on the line between the spars.
5. Locate and drill four #28 holes through the hinge and the rudder.

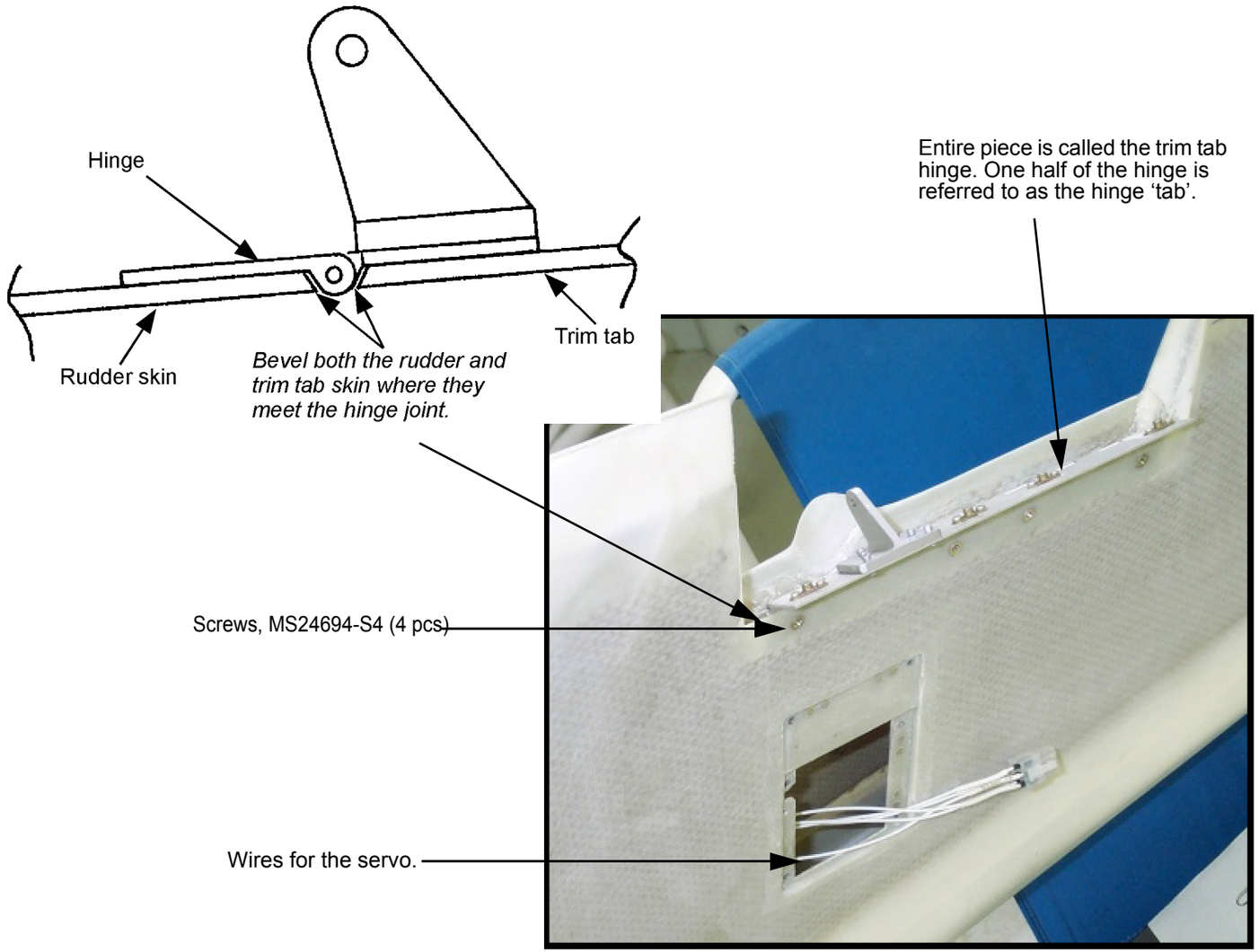
   Make sure the four hole locations will not interfere with the alignment of the actuator arm's connection to the servo push rod.
6. Countersink the four holes.
7. Install the hinge to the rudder using four screws (MS24694-S4)
8. Hold the servo in place. Now hold the actuator arm in place and temporarily align the trim tab actuator arm (TT-01) to the servo push rod. Mark where the actuator arm needs to be installed on the hinge.
9. Create a bevel by sanding where the hinge joint meets the skin.

   Sand the hinge to form a bevel along the hinge line edges. This creates a tighter hinge gap. Refer to Figure 18.3.E.9.

10. Place the trim tab in position using popsicle sticks and instant glue.
11. Apply instant glue to the hinge's tab.
12. Drill four #20 holes through both the trim tab and the hinge, as shown in Figure 18.3.E.9.

    Countersink the holes for the screws.
13. Secure the nutplates (~~K1000-08~~ MS21-069-06) to the hinge using rivets (AN426A3-5).

Figure 18.3.E.9 Side views of the hinge with the bevel locations



Finishing the Trim Tab

To finish the trim tab you will bond the right and left pieces together. You will bond only the trim tab surfaces of the right and left rudder skins.

Steps...

1. Apply epoxy/flox to the trim tab support spar and closeouts.

   Release tape the right rudder spar and closeouts so the left and right rudders will not stick to each other.

   WARNING: You are bonding only the trim tab. Do not apply epoxy/flox to any other surface on the skins.
2. Position the left vertical stabilizer/rudder skin in place and allow the trim tab to bond.

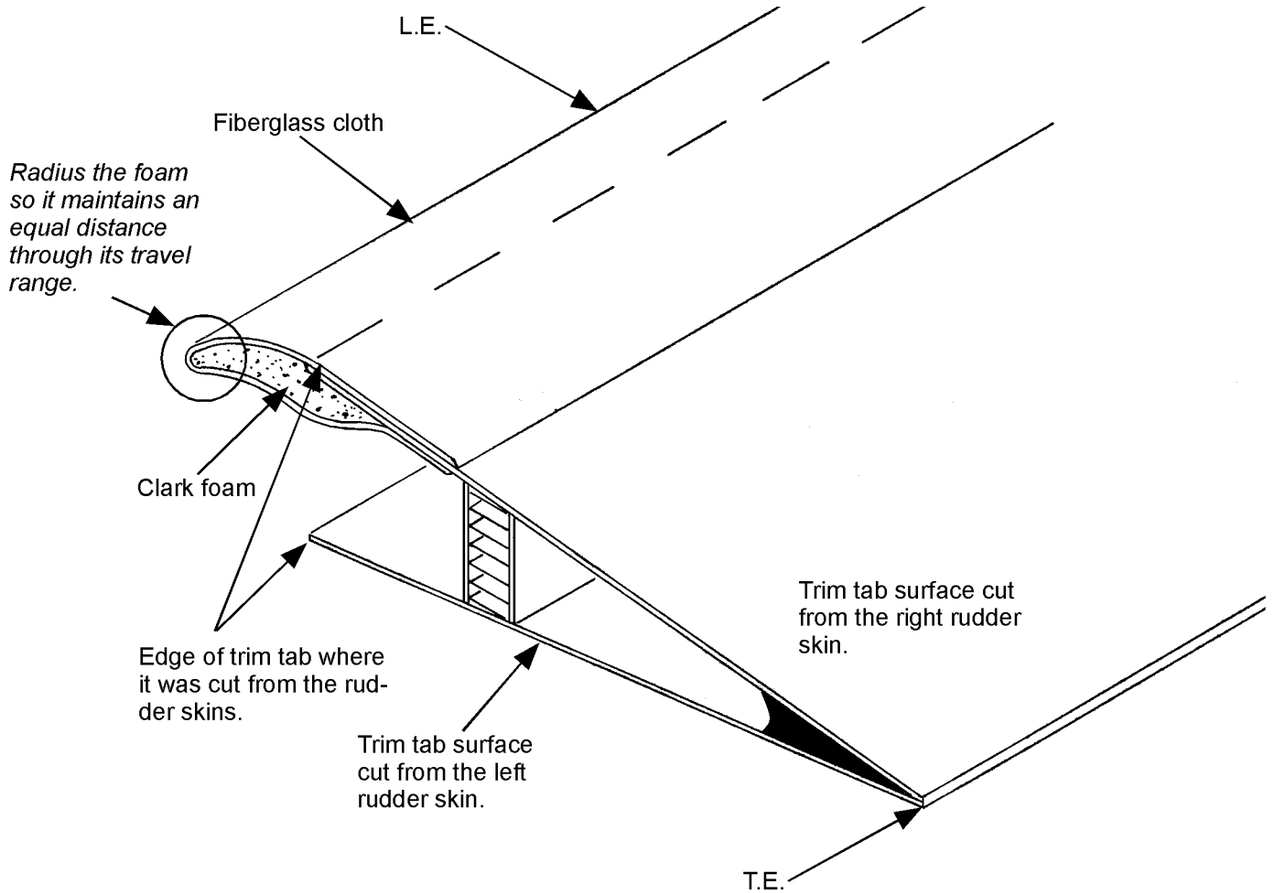
Steps after cure...

1. Remove the trim tab's hinge screws from the right rudder skin only.
2. Remove the left vertical stabilizer/rudder skin.

   The trim tab is bonded to the left skin so it is also removed.
3. Drill small reference holes through the left skin to transfer the trim tab cut out line to the outside of the skin.
4. Mark and then cut the trim tab from the left skin.
5. Cut a piece of Clark foam to form a gap seal for the L.E. of the trim tab.
6. Bond the foam to the trim tab's L.E. and apply epoxy/micro.

   Radius the foam so it maintains an even gap throughout its travel range.
7. Secure the foam to the trim tab with 1-BID of lightweight fiberglass.
8. Smooth and sand the radius with epoxy/micro.
9. Slot the gap seal for clearance and drill two #20 holes for mounting the actuator arm. Use two screws (~~AN960-8~~ MS24693-S28) and locknuts (MS21042-06).See Figure 18.3.E.8 or Figure 18.3.E.9 for possible locations for the actuator arm.

Figure 18.3.E.10 Trim tab L.E. shape



18.3.F Installing the Rudder Taillight

This is a good time to install the taillight in the rudder. Because the wing tip strobes are enclosed, they cannot be seen from aft of the aircraft. In order to be legal, the taillight must be a flashing unit, not just a white position light.

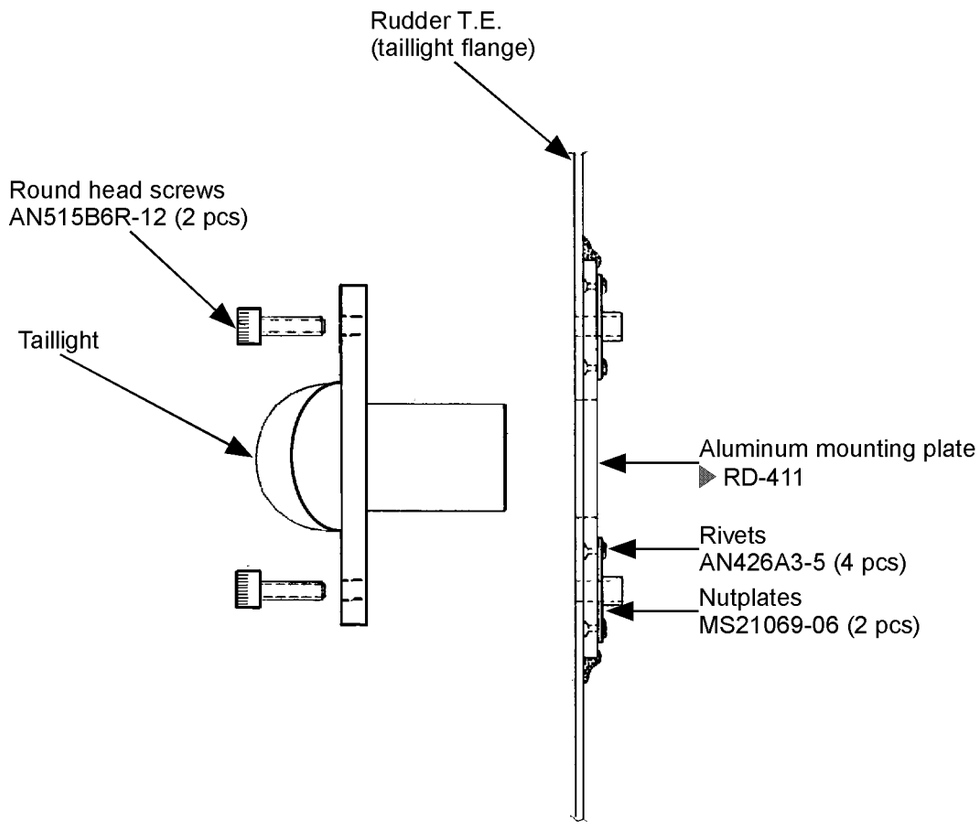
In the light kit, part number LA650, you have a tail position/ strobe light.

Both the left and right rudder skins need to be temporarily installed. See Figure 18.3.B.4 for the taillight location.

Steps...

1. Scuff the surface of the precut .090” (2.3 mm) aluminum mounting plate (RD-411) with 40-grit sandpaper. Clean the plate with acetone.
2. Position the mounting plate against the inner face of the pre-molded light blister in the rudder as shown in Figure 18.3.F.1.
3. Drill #28 holes through the rudder flange. Use the pre-drilled holes in the mounting plate as guides.

Figure 18.3.F.1 Securing the taillight mounting plate to the rudder



4. Remove the mounting plate from the rudder's taillight opening.
5. Secure the nutplates (MS21-069-06) using rivets (AN426A3-5) to the forward face of the mounting plate.

   Secure the nutplates at each mounting screw location as shown in Figure 18.3.F.1.
6. Drill the mounting holes of the mounting plate to a #27 size.

   The mounting holes in the taillight strobe are designed for 4-40 screws. It is necessary to drill the holes out to a #28 size to accommodate the 6-32 screws you will use. Be careful not to damage the unit when drilling.
7. Place the taillight against the aft face of the rudder flange.

   Check the mounting screw holes to verify that they line up properly. You will have to do some trimming on the flange so the taillight can rest on a flat surface.
8. Bond the taillight mounting plate into the rudder using a thick epoxy/flox mixture. Form a fillet behind the aluminum plate for added support.

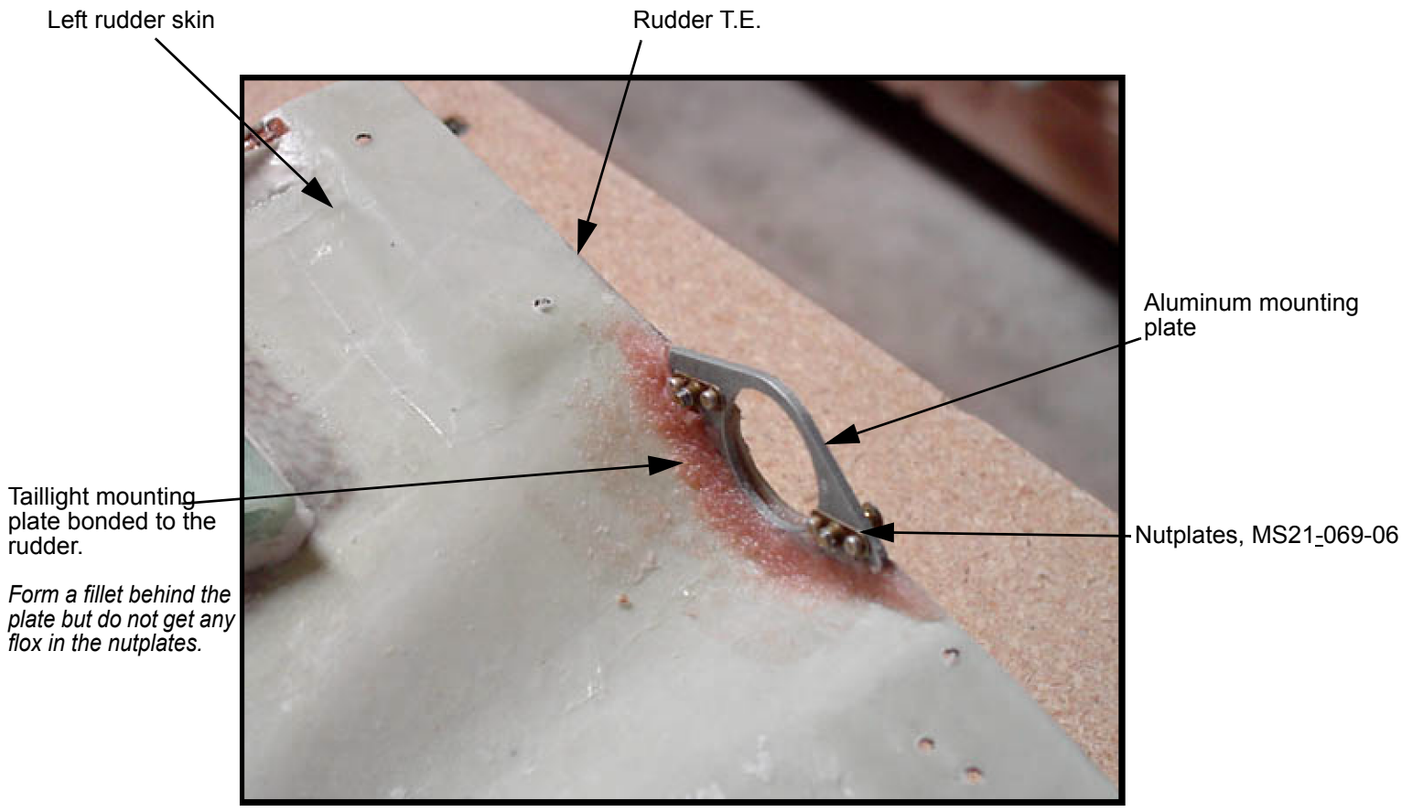
   Tip: Make sure you do not get any flox in the nutplates.

   The aft face of the taillight mounting area can be finished to a flat, even surface after the rudder is closed.

The taillight wires and the trim tab servo wire will run through tubes you install in the rudder in 18.3.G *Venting and Electrical Tubing* on page 18.25.

Do not drill the entrance hole in the sternpost directly forward of the conduit tube. We recommend it is dropped down a few inches to allow room for movement. Make sure you avoid the elevator weldment and pushrods. Minimize the size of the hole through the sternpost. A quick disconnect between the rudder and sternpost is handy for the rudder removal and installation. Make sure there is no possibility of entanglement with any moving parts!

Figure 18.3.F.2 Taillight mounting plate



18.3.G Venting and Electrical Tubing

In this section you will vent the rudder's internal bays. Remember all internal bays must be vented to avoid structural failure.

You will also install the conduit tube in the rudder. This tube is used to run wires from the fuselage to the taillight and the trim tab servo.

Steps...

1. Drill 3/16" (4.5 mm) vent holes through each rib and the spar as shown in Figure 18.3.G.1.

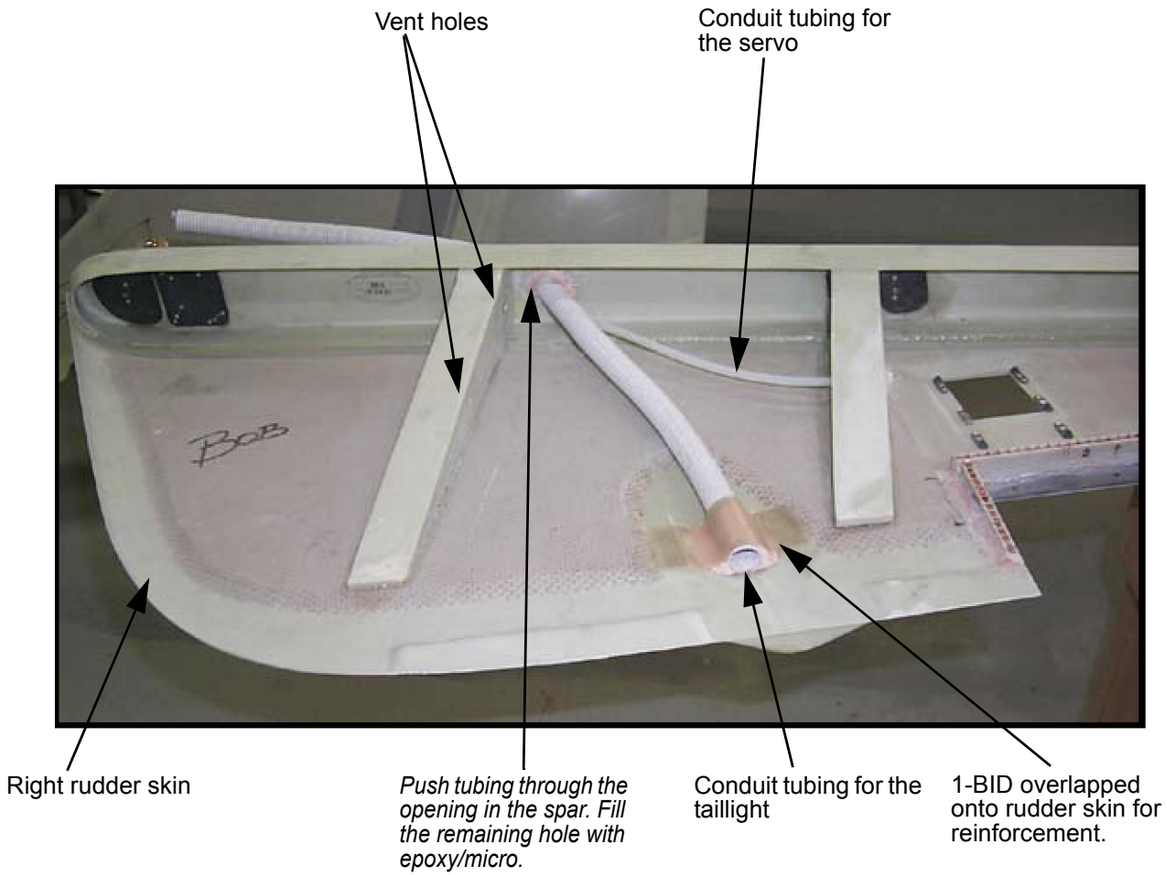
   Be careful that you do not to drill through the hinge locations. Also, do not drill through the skin.

   WARNING: All internal bays must be vented. Failure to vent every bay could result in structural failure due to excessive internal pressure at high altitudes.
2. Drill holes in the rudder for the conduit tubing as shown in Figure 18.3.G.1.
3. Cut the tubing to the correct length, leaving approximately 4" (100 mm) in front of the spar.

   This tubing will be trimmed after the rudder's L.E. is completed. See
4. Sand the tubing and the rudder skin in the bonding areas and clean with acetone.

   You may find it helpful to temporarily put a heavy gauge wire or aluminum tube into the conduit to help hold it in place.

Figure 18.3.G.1 Vent hole locations and tubing locations



5. Fill the hole in the spar with epoxy/micro and push the tube through the holes.
6. Instant glue the tube in place. Form micro radii around the holes and the aft end of the tube.
7. Reinforce the aft 6” (150 mm) of the tube with 1-BID overlapping 1” onto the rudder skin on each side. See Figure 18.3.G.3.

   Tip: The easiest method for applying 1-BID to the tubing is to lay it on dry. Brush resin on the skin and tube where the BID will be applied. Lay the fiberglass on. Brush resin on any dry-spots in the cloth.
8. Apply a 1-BID reinforcement forward of the rudder spar and behind the leading edge where the tube penetrates. See Figure 18.3.G.2.

Figure 18.3.G.2 Conduit tubing through the rudder spar

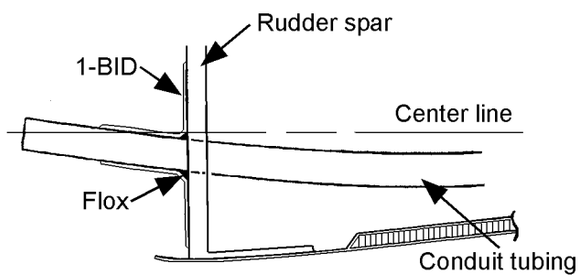


Figure 18.3.G.3 Securing conduit tubing with 1-BID reinforcement

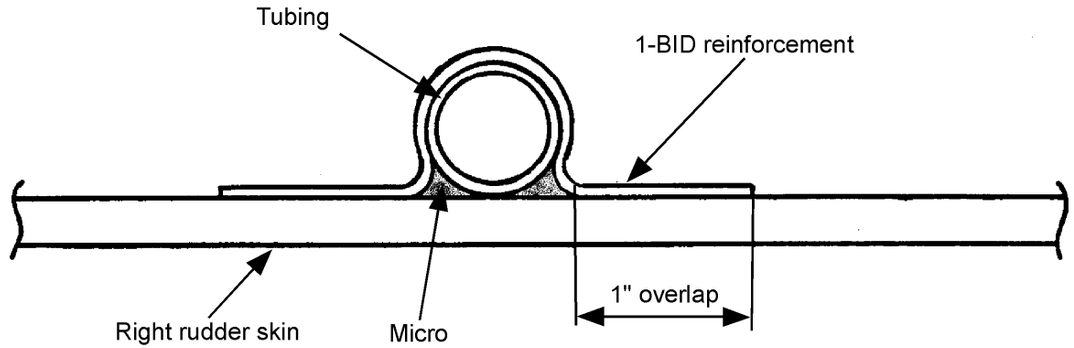
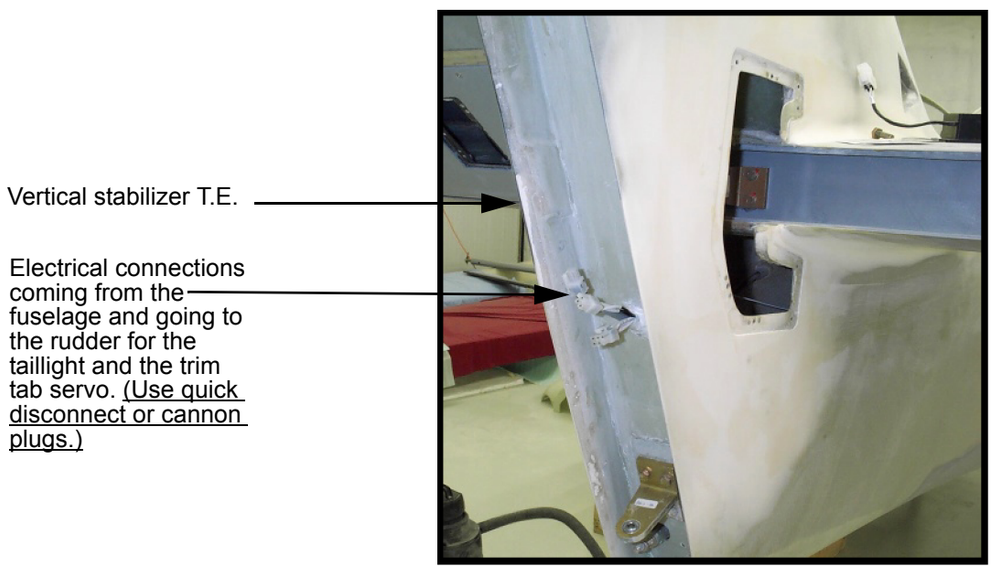


Figure 18.3.G.4 Electrical connections to the rudder



18.3.H Balancing the Rudder

The Lancair rudder is 100% counterbalanced using a pre-molded lead weight (1108). When balancing a control surface such as the rudder, make sure you have installed all the hardware into the rudder such as the trim servo, taillights, wires and tubing, etc.

Since a primer coat will add weight to the rudder, we also recommend that you apply the first coat of primer to the rudder before you balance it. By adding the weight of the primer before counterbalancing, the rudder will more closely simulate its final weight.

The lead counterweight provided in the kit should overbalance the rudder. If you installed a rudder trim tab, you may need to add weight.

Perform an initial balance by taping all of the rudder pieces in place and then balance the rudder. This will determine whether you need to add or remove weight.

Steps...

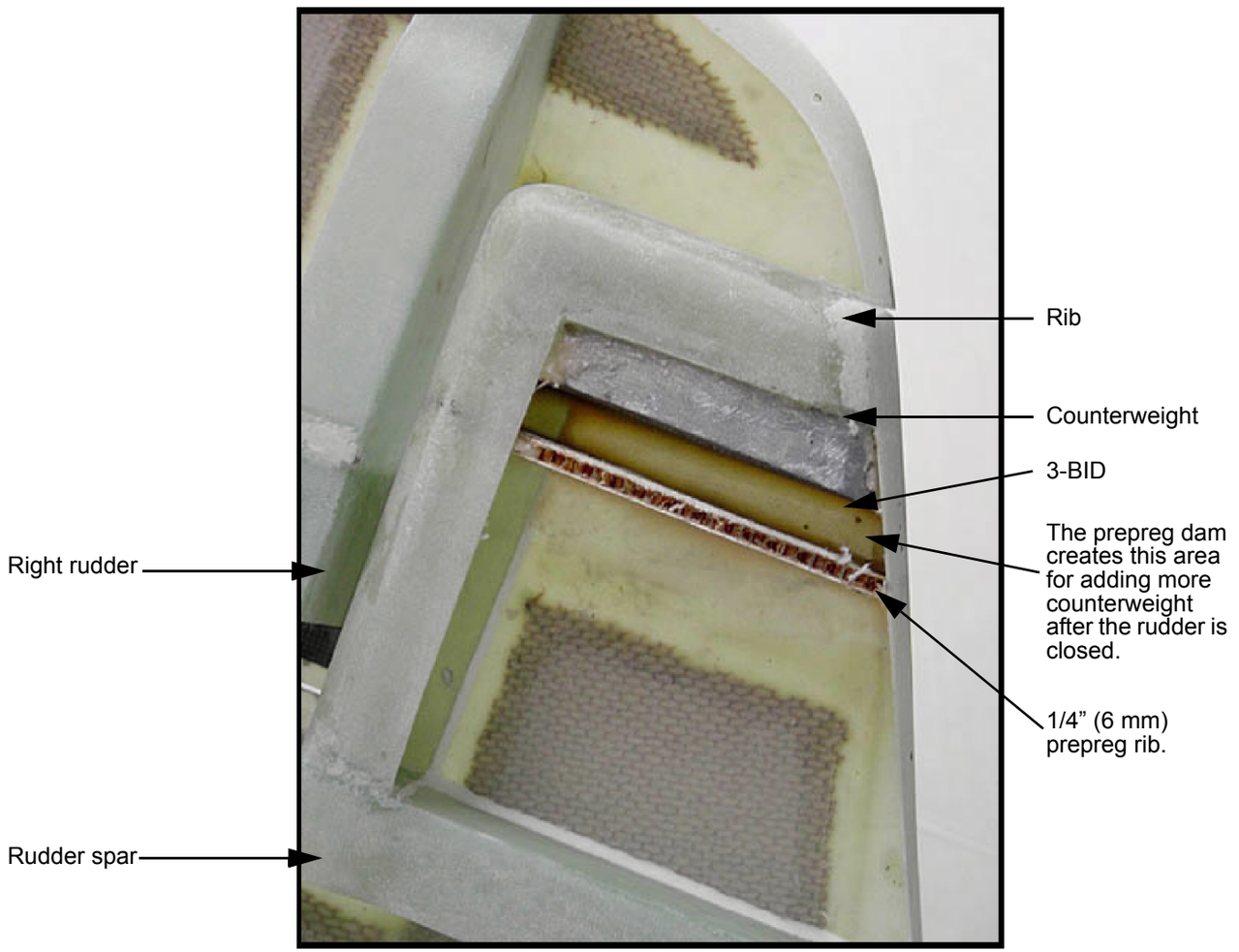
1. Trim the top rib on the rudder counterweight arm as necessary so you can slip the lead weight all the way forward into position.
2. Sand the inside surface of the rudder counterweight arm, where the lead weight will be bonded, with 40-grit sandpaper.

   It is difficult to thoroughly sand this area because of its size, but do the best you can.
3. Clean the sanded area with acetone.
4. Build a rib dam behind the counterweight using 1/4" prepreg.

   Since more weight may be required for the rudder, this rib dam will allow you to add weight after the rudder is closed.
5. Pot the lead weight into the counterweight arm using epoxy/flow.

   Be sure there is flox built up behind the counterweight to prevent it from sliding aft.
6. Add 3-BID to the area between the prepreg dam and the counterweight.

Figure 18.3.H.1 Rudder counterweight floxed into position



7. Fit the left rudder skin to the right rudder to check the fit.
8. Trim the counterweight as necessary so the skins fit smoothly.
9. Construct a simple balancing stand.

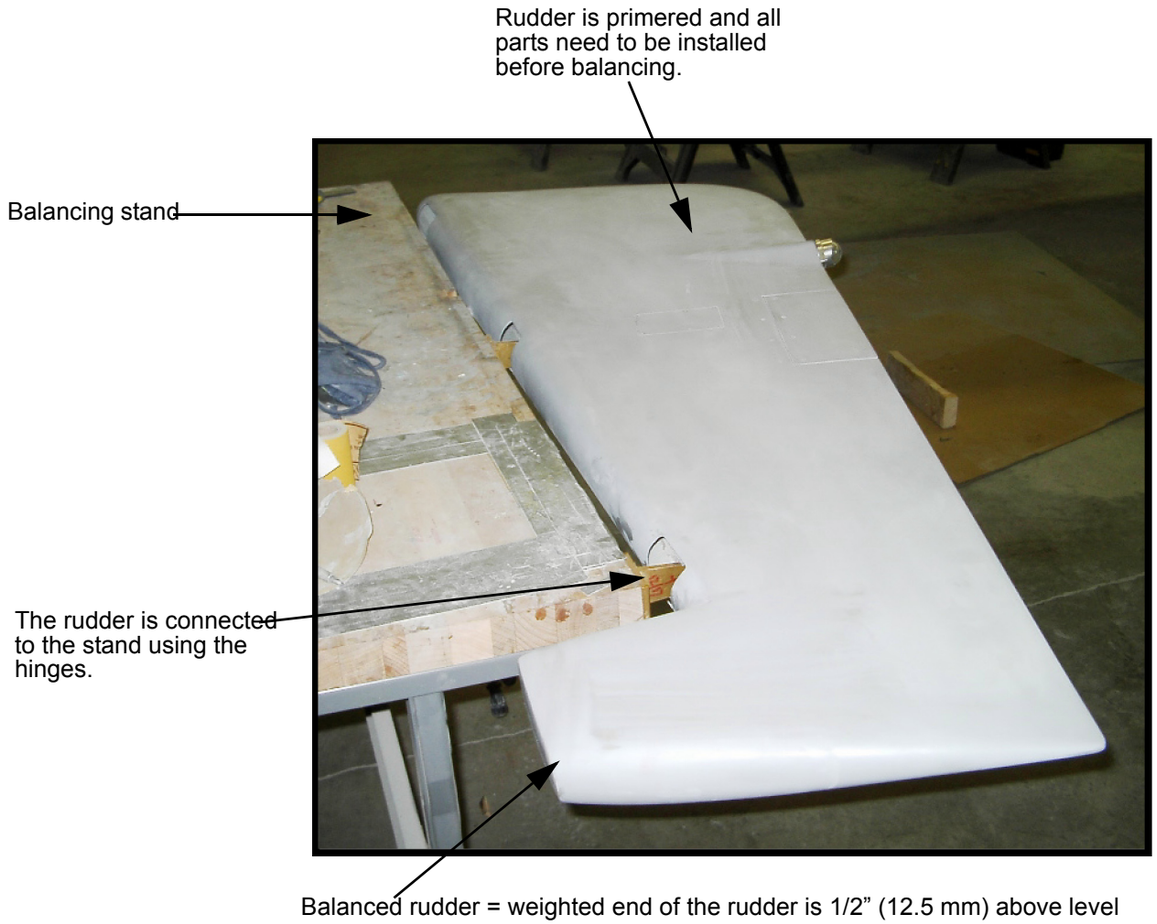
   Rig up a balancing stand on the edge of a bench so the rudder is suspended by its hinge points. Refer to Figure 18.3.H.2 as a reference for making the balancing stand.

   WARNING: Make sure you have primered the rudder before you finish the following two steps for balancing the rudder.
10. Drill out enough lead to balance the rudder.

    Balanced rudder = weighted end of the rudder is 1/2” (12.5 mm) above level

    This will slightly overbalance the rudder to accommodate future paint. You can remove more lead by drilling out the excess at the aft side of the counterweight.
11. Fill the drill holes in the counterweight with epoxy/micro and sand flush.

Figure 18.3.H.2 Rudder balancing stand



18.3.I Closing the Vertical Stabilizer/Rudder Assembly

Before you start the closeout of the vertical stabilizer/rudder make sure you have not left any tools laying on a rib.

Steps...

1. Check the left vertical stabilizer skin to verify that it is straight along the sternpost.
2. Check the right vertical stabilizer/rudder rib caps for a close fit to the left skin by placing small pieces of clay, approximately 1/4" (6 mm) around, in the middle of each rib and every 12" down the length of the spars.

   It is a good idea to use masking tape under the clay to avoid possible contamination of the fiberglass. Leave the clay in place while you do a trial run of the closeout.

   This check is done so that minimum adhesive is used to close the assembly.
3. Put the left vertical stabilizer/rudder skin in place, lightly pressing it against the clay.

   This closeout trial run helps determine where you are going to fasten the two skins together using clecos.

   Drill cleco holes in the left skin if you didn't in the earlier pre-fit in 18.3.B *Fitting the Vertical Stabilizer/Rudder Assembly* on page 18.4.

Recheck...

Now recheck your sternpost clamping technique:

- Use a straight length of square aluminum or similar material along the sternpost. This will provide an even clamping pressure.

Also, recheck the following:

- Verify that the stabilizer is still vertical by checking it to the fuselage center line on the floor.

Option...You can remove the right rudder and bond only the vertical stab surfaces together. After the vertical stabilizer has cured and you have finished all the *Steps after cure...* on page 18.32, you can bond the right rudder onto the left rudder. This option may be easier since you will be working with smaller bonding surfaces by bonding the vertical stabilizer and rudder separately.

Figure 18.3.I.1 Clamping the left vertical stabilizer/rudder skin

4. Mark the left vertical stabilizer/rudder skin a 1/2” (12 mm) in front of the rudder spar.

   WARNING: Do not cut the left rudder from the vertical stabilizer skin until the vertical stabilizer/rudder is closed.

5. Remove the left vertical stabilizer/rudder skin when you are satisfied that your clamps will hold the in position.
6. Remove the skin and check the clay to help plan how much Hysol to use on the rib capstrips.
7. Sand all the bonding surfaces where adhesive will be used to bond the left vertical stabilizer/rudder skin in place.

   Use 40-grit sandpaper for the sanding of the following bonding surfaces:

   - bottom fuselage joggles
   - vertical stabilizer L.E. joggle
   - all of the rib caps
   - corresponding sections of the left vertical stabilizer skin

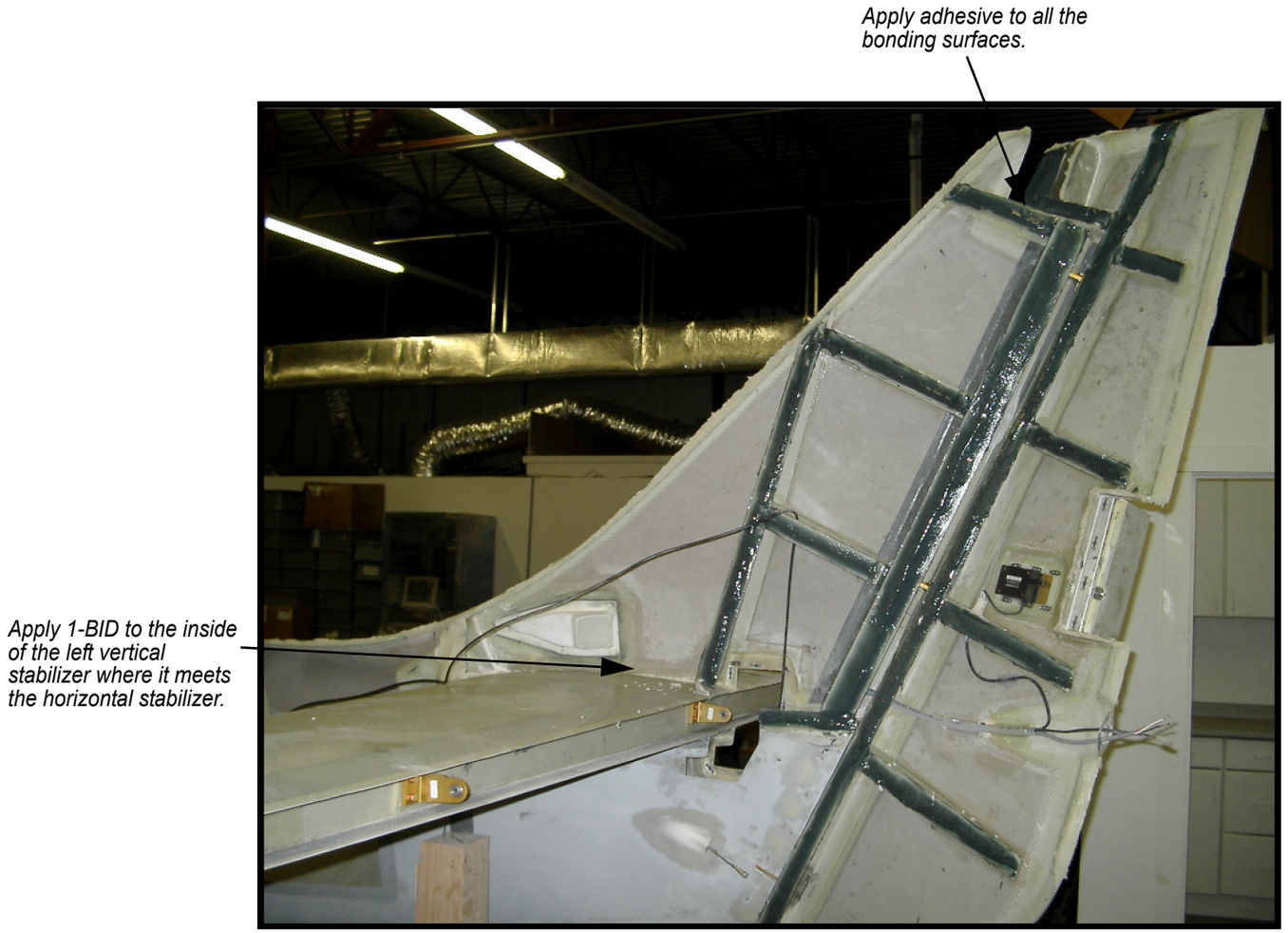
8. Clean all bonding surfaces with acetone.
9. Apply a thin coat of Hysol or epoxy/flox to all bonding surfaces.
10. Place the left skin in position and press against the right skin.

    This will create a print of the bond locations on the left skin.

11. Remove the left skin and spread a thin coat of Hysol/flox or epoxy/flox on all the left skin bonding areas.

    It is preferable that you use the slower hardener.

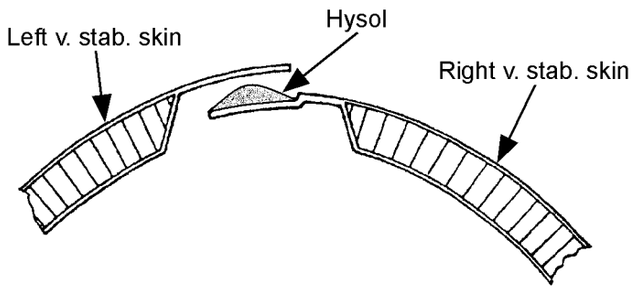
Figure 18.3.I.2 Applying adhesive for the vertical stabilizer/rudder closeout



12. Add a small amount of flox to the Hysol to give it some body. Apply a thicker coat on the rib, web and sternpost capstrips, L.E. joggle, and bottom fuselage joggles.

    Mound up the Hysol toward the center of each bonding surface to avoid trapping any air.

Figure 18.3.I.3 Applying adhesive to the vertical stabilizer's joggle



13. Feed the electrical tubing down through the hole in the rib.
14. Place the left vertical stabilizer/rudder skin in position. Now replace the clecoes and clamps in the locations you decided on in section *Recheck...* on page 18.29.

    Verify that the vertical stabilizer is straight along the sternpost.

Is there good squeeze out of Hysol? Look up through the elevator inspection holes and check for adequate Hysol squeeze out in the bonding areas that are visible.

Figure 18.3.I.4 Applying adhesive to the rudder T.E.

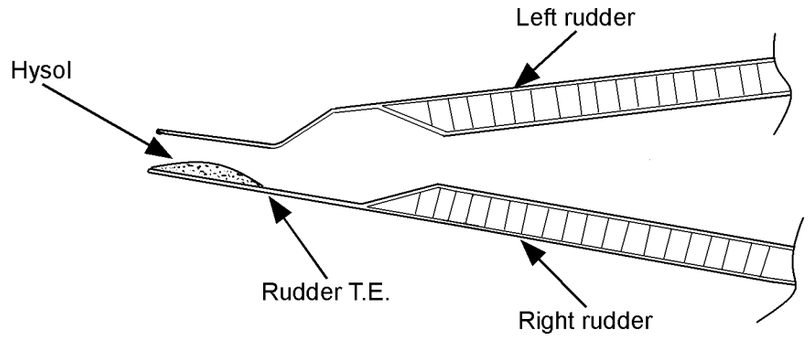
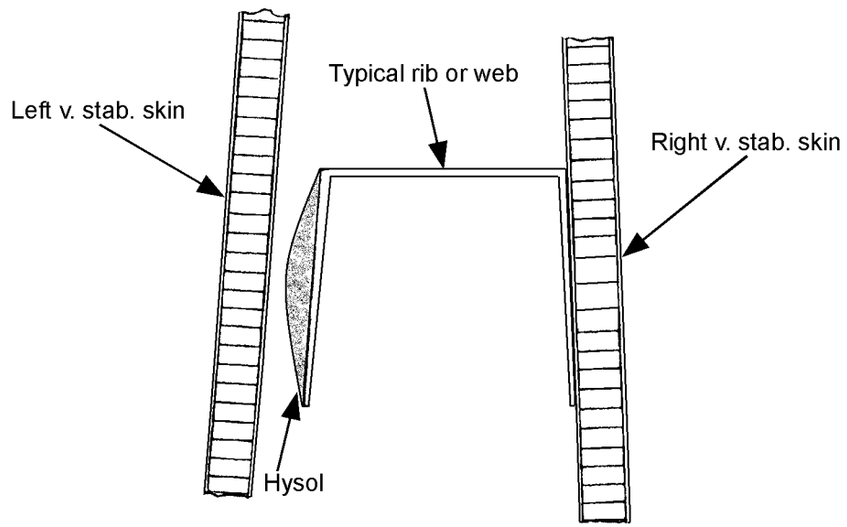


Figure 18.3.I.5 Applying adhesive to the right vertical stab's. ribs and webs.



Steps after cure...

1. Remove the clamps and clecoes after the Hysol has cured.
2. Sand the following areas of the vertical stabilizer/rudder:
   - L.E. of the vertical stabilizer,
   - junction of the vertical stabilizer and bottom fuselage shell,
   - junction of the vertical and horizontal stabilizers.

   Clean all sanded areas with acetone.
3. Apply a 2” (50 mm) wide, 1-BID to the following locations:
   - L.E. of the vertical stabilizer,
   - where the vertical stabilizer and the bottom fuselage shell meet,
   - where left and right vertical stabilizer meet.
4. After the BID tapes cure, fair them into the surrounding surfaces with micro. See Figure 18.3.I.6.

   Note: If you held off on installing the left elevator weldment inspection panel, now is a good time to finish its installation. Add micro to fair in the 1-BID tape and the inspection panel.
5. Apply 2-1/2” (62 mm) wide, 3-BID where the vertical stabilizer joins the top surface of the horizontal stabilizer.
6. Cut the left vertical stab/rudder skin along the line you marked 1/2” in front of the rudder spar.

   Now the rudder is an independent piece, separated from the vertical stabilizer.
7. Remove the rudder and clean up the excess squeeze out along the bonding areas.

Figure 18.3.I.6 Applying 1-BID junction tapes

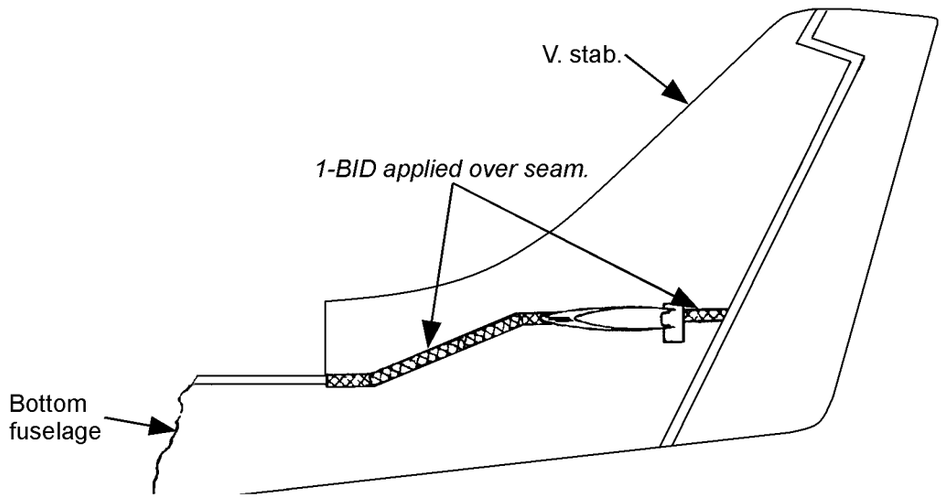


Figure 18.3.I.7 Fairing in the BID tapes

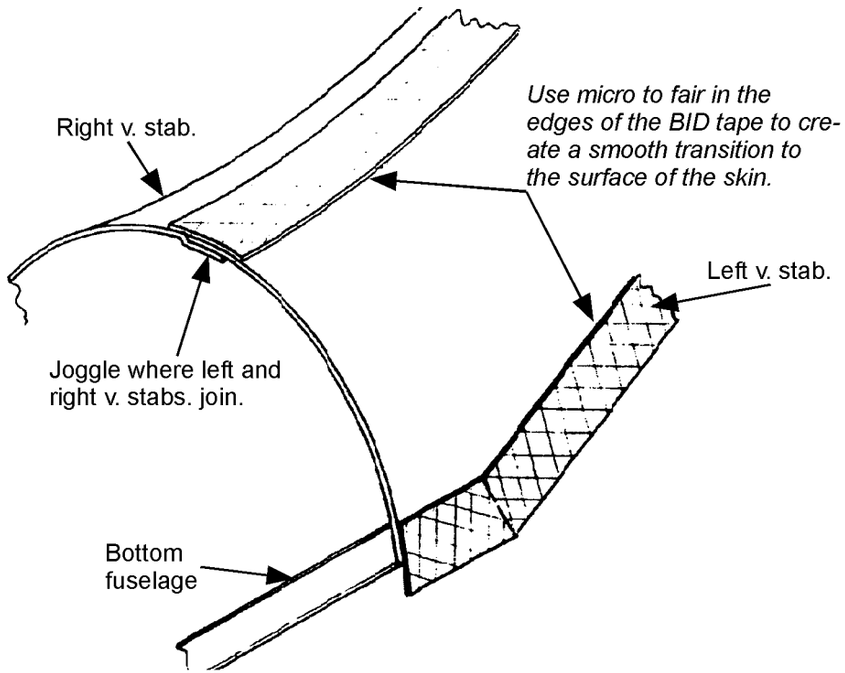
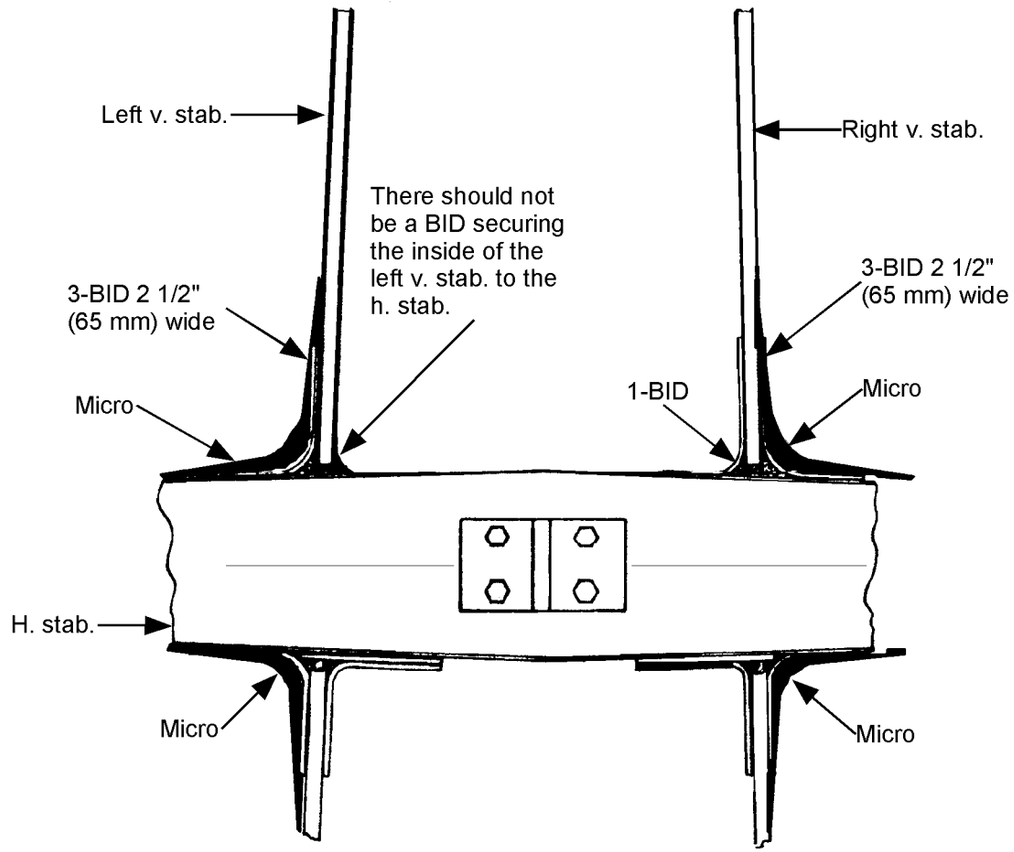


Figure 18.3.I.8 Applying 3-BID tapes at the vertical stabilizer and horizontal stabilizer top junction



18.3.J Closing the Rudder L.E.

The L.E. closeout is not a structural component of the rudder, but it is designed to help create a smooth transition between the vertical stabilizer and the rudder. Since the rudder is a separate component, the rudder spar closeout can be adjusted to create the best possible gap between the vertical stabilizer's T.E. and the rudder's L.E.

The basic guideline for positioning the rudder spar closeout is to center the closeout on the hinge pivot bolt.

Steps...

1. Measure the thickness of the rudder at the hinge and divide by two. Refer to the X at the top of Figure 18.3.J.1.

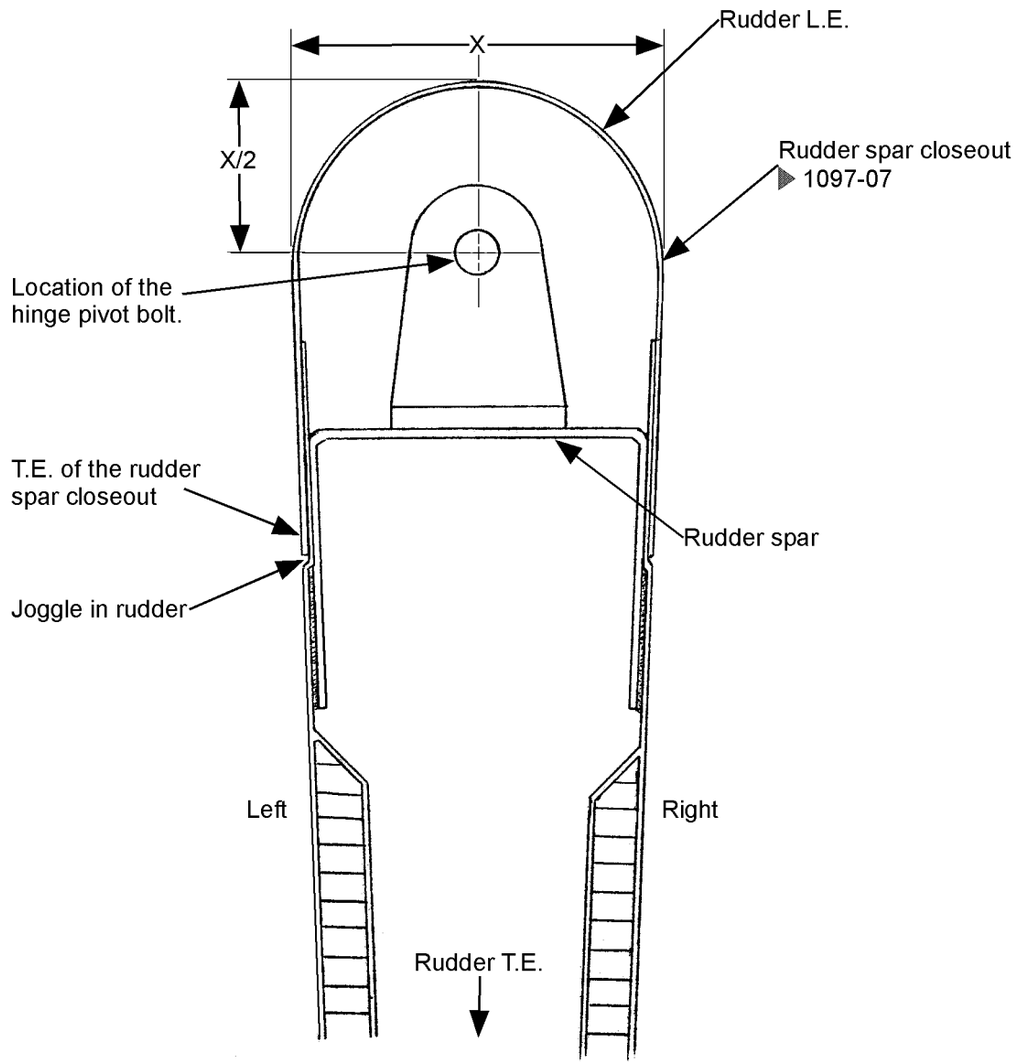
   The result you get is the distance forward of the center of the hinge pivot to the L.E. of the closeout. Refer to the X/2 in Figure 18.3.J.1.
2. Align the bottom of the rudder spar closeout (1097-07) with the bottom of the rudder.

   The closeout's T.E. should fit into the joggle on the outside of the rudder spar.
3. Use a cleco at the top and bottom of the closeout on each side to hold it in position on the rudder.
4. Cut small holes in the rudder spar closeout to allow access to the three hinges. Start small and enlarge the holes as necessary.

   These holes need to be large enough to do the following:
   - slide the rudder into position on the vertical stab,
   - provide access to get a wrench in to secure the hardware.

   Continue to the next page to read the remaining guidelines for the openings.

Figure 18.3.J.1 Rudder L.E. closeout



5. Measure forward, from the aft edge of the closeout joggle on the rudder, and mark a line on the closeout to indicate the location of the T.E. of the vertical stabilizer.

   This line will provide a limit to how far you want to cut the openings for the hinges.

   If the openings can stay forward of this line, they will not be visible when the rudder is in neutral. The opening will need to be larger on one side to provide access for tools to tighten the nuts and bolts.

Figure 18.3.J.2 Example of the shape for the hinge opening on rudder spar closeout

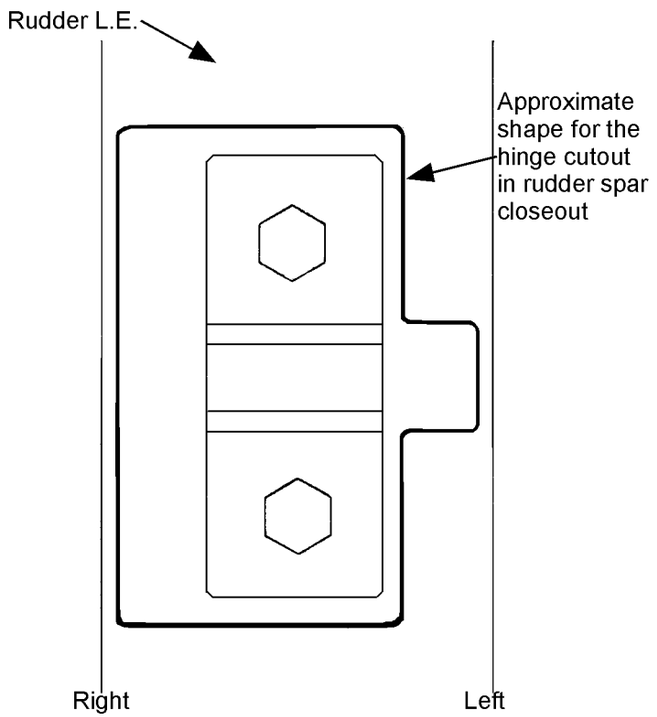


Figure 18.3.J.3 Cutouts for the rudder hinges in the rudder L.E. For an external rudder cable, all three cutouts are this shape.

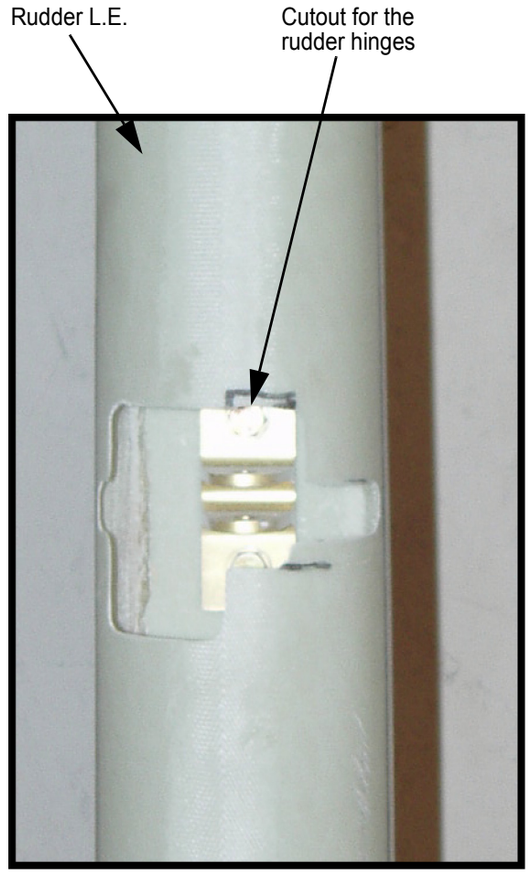
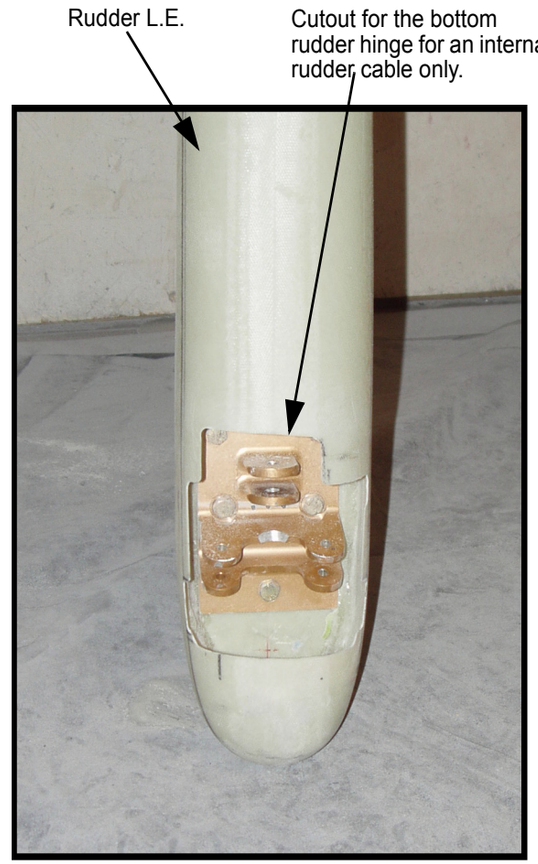


Figure 18.3.J.4 Cutout for the bottom rudder hinge only, and only for an internal rudder cable. The upper two hinge cutouts need to match Figure 18.3.J.3.



Pre-fitting the Rudder Spar Closeout

Now you will perform a final pre-fit of the rudder with the rudder spar closeout temporarily in place.

Steps...

1. Clamp the rudder spar closeout to the rudder.
2. Install the rudder to the vertical stabilizer by inserting a metal rod through the hinges just as you did for the pre-fit in page 18.20.
3. Check the travel and gap of the rudder.

   Adjust the location of the closeout to provide the best gap between the rudder and the vertical stabilizer T.E. Check the gap with the rudder in neutral and at full travel.

   - Gap – Trim to fit joggle. Check through full range of travel.
   - Travel – Refer to *Measuring Rudder Travel* on page 18.39.

Bonding the Rudder Spar Closeout

Now that the pre-fit is completed, you can remove the rudder from the vertical stabilizer and finish the closeout.

Steps...

1. Prepare the bonding surfaces of the closeout and the rudder.
2. Dry fit the parts together using straight edges and clamps similar to how you closed the left vertical stabilizer/ rudder skin onto the right side ribs in 18.3.I *Closing the Vertical Stabilizer/Rudder Assembly* on page 18.29.

   The closeout may be installed one side at a time if desired for ease of installation.
3. Bond the closeout in place using epoxy/flox procedures.

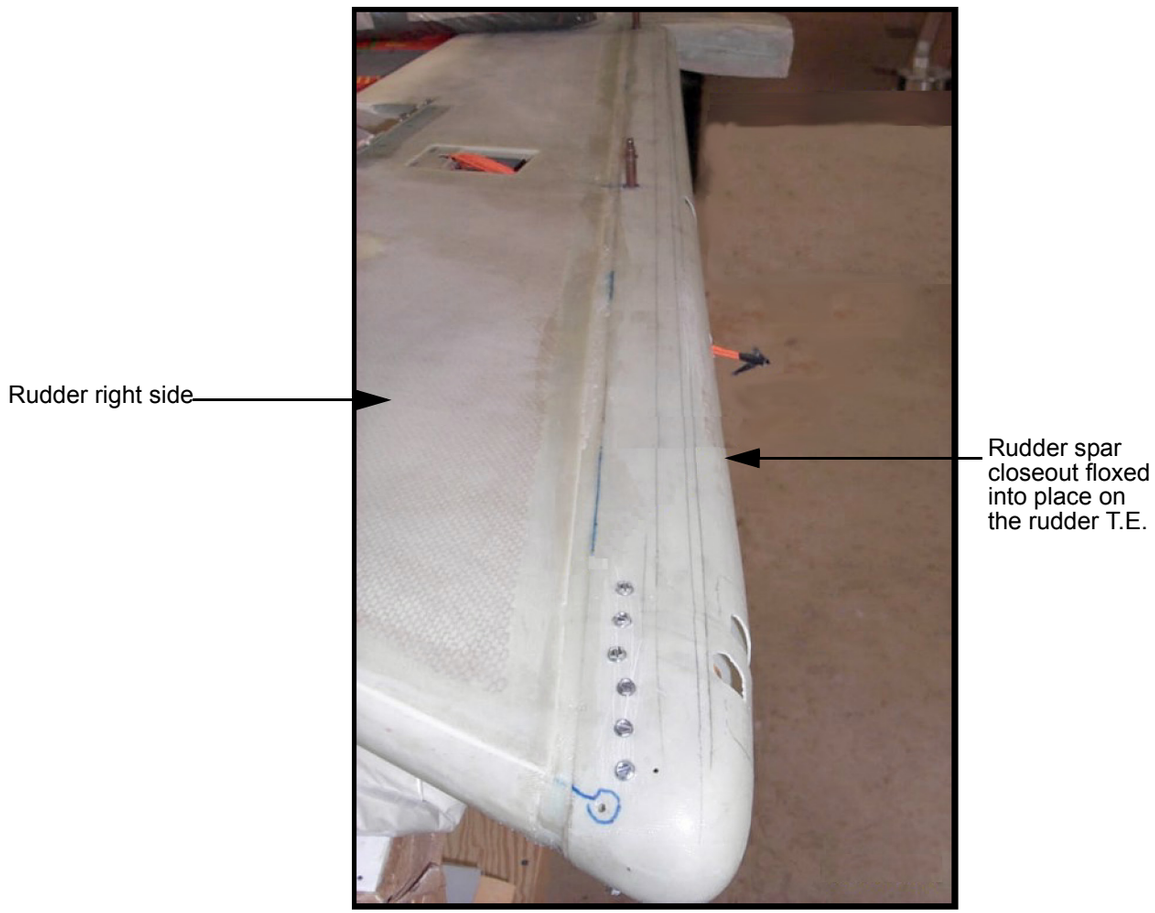
Steps after cure...

- Sand the joint to smooth the transition.

  A 1-BID tape may be installed over the joint if to assist with the body work.

Now you can install the rudder using the instructions in Chapter 12, 12.3.J *Installing the Rudder to the Vertical Stabilizer* on page 12.25.

Figure 18.3.J.5 Bonding the rudder spar closeout to the rudder



18.3.K Creating the Rudder Stops

Note: These rudder stops are for the external rudder mechanism only.

In order to control the rudder's maximum travel to 30°, both left and right, phenolic stops need to installed. Two stops are cut from phenolic and secured to the bottom fuselage.

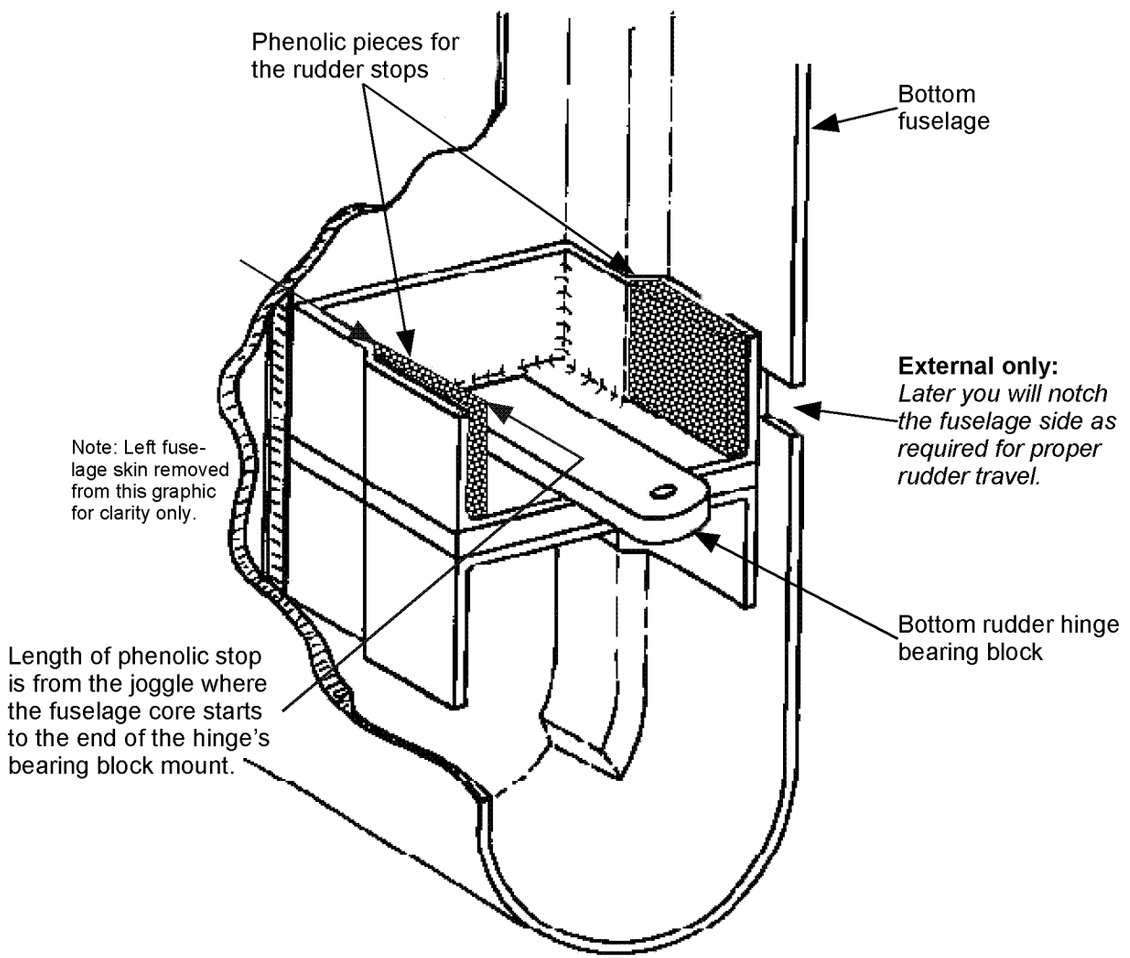
In *Measuring Rudder Travel* on page 18.39 the stops are adjusted for the proper rudder travel.

Steps...

1. Cut two pieces of 1/4" (6.4 mm) thick phenolic, 1-1/2" (37 mm) tall by the length determined by the core position on the inside of the fuselage skin.

   The length will vary depending on the core position in the bottom fuselage skin. Make sure the length allows the phenolic to fit against the inside of the fuselage skin as shown in Figure 18.3.K.1.
2. Round the edges of the phenolic pieces so they fit any previous layups in this area.
3. Sand the phenolic rudder stops on all sides with 40-grit.
4. Sand the areas of the inside fuselage skin and the bearing block mount where the stops will be bonded.
5. Clean all the bonding areas with Acetone.
6. Bond the rudder stops to the fuselage side and the bearing block mount.

Figure 18.3.K.1 Locating and sizing the phenolic rudder stops

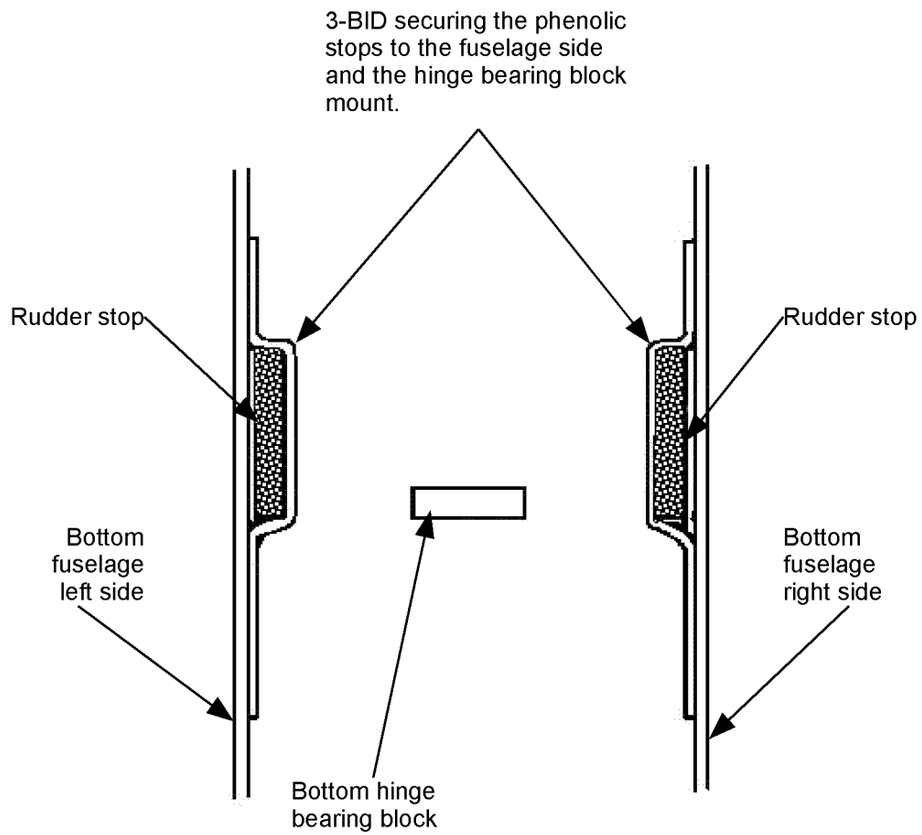


7. Apply 3-BID over the phenolic stops to reinforce the bonds.

   Overlap onto the fuselage sides and the bearing mount by 1" (25 mm).

   Do not apply BID under where the bottom hinge bearing block is located. This would interfere with proper hinge alignment.

Figure 18.3.K.2 Reinforcing the phenolic rudder stops



Measuring Rudder Travel

Full travel for the rudder is 30° to the left and 30° to the right. The control horn needs to strike the phenolic stop in each direction. You may need to adjust the stops for the proper rudder travel.

The following steps will help you easily measure the rudder travel.

Steps...

1. Swing the rudder 30° each way before the control horn hits the rudder stops.

   If the rudder will not swing 30° each way, do the following:

   - Grind or file the phenolic rudder stops. Refer to Figure 18.3.K.1 for the location.
   - Grind the phenolic stops at an angle so the control horn does not hit on a sharp point.

2. Hang a plumb bob from above, in line with the rudder T.E., directly over the fuselage center line.
3. Measure the distance from the tail light fairing on the rudder T.E. to the plumb bob.

   At this location, the T.E. should move about 9-1/8" (230 mm) left and right from the fuselage center line.

Now the elevator to rudder/vertical stabilizer fit can be completed. See Chapter 3, section 3.3.C *Trimming the Elevator to Rudder/Vertical Stabilizer Surface* on page 3.8.

Don't forget to connect the rudder pedals in Chapter 12, section *External Rudder Cable* on page 12.18. For an internal rudder cable, see the handout available through KCI.

Figure 18.3.K.3 Measuring rudder travel