

Chapter 13 Flap Controls

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13.1 Introduction

The ES flaps are fully assembled when you receive your kit. Your job is to install the assemblies that connect the flaps to the control. When the ES is at full flaps, the stall speed is reduced by approximately 12 mph.

The ES flap system activates the flaps using a torque tube assembly. The torque tube protrudes from the fuselage through the wing fairings and connects to the flap pushrod assembly which then connects to the flap actuator arm. The actuator arm connects to the slotted flaps in their three hinged locations. The flaps are operated electrically by a 12V electric flap motor. The flap motor drives the torque tube which, on the outboard ends, actuates the flaps.

The flap travel is set by micro switches in Chapter 23 where setting the travel is explained. In this chapter you can actuate the flap motor by simply connecting a 12V battery to the two lead wires. Using this method you can set the flap travel.

Steps to Completion

- Assemble the torque tube.
- Create the torque tube holes.
- Install the bearing blocks.
- Install the flap motor.
- Reinforce the seat belt supports with BID layups.
- Assemble the flap pushrods.
- Adjust the flap travel.

13.2 Parts List

Blueprints needed for this chapter include:

- 3301 – Aft seat configuration
- 3500 – Flap mechanism at BL 27.25
- 3504 – Flap motor installation

Flap torque tube assembly

Item	Part Number	QTY	Description
1)	214-0016	1	Torque tube assembly (includes the following)
2)	214-0014	1	Flap torque tube, left (shorter)
3)	214-0015	1	Flap torque tube, right (longer)
4)	110-0000	4	Bearing blocks
5)	FM-1065A	1	Flap control arm
6)	AN3-10A	8	Bolts (for inboard bearing blocks)
7)	AN3-13A	8	Bolts (for outboard bearing blocks)
8)	AN3-7A	4	Bolts (control arm)
9)	AN365-1032A	20	Locknuts
10)	AN960-10	20	Washers
11)	BSPQ-44	4	Rivets
12)	3164	1	Delrin tube
13)	<u>116-0000</u>	<u>1</u>	<u>Coupler</u>

Flap motor

Item	Part Number	QTY	Description
1)	FL1	1	Flap motor (includes the following)
2)	FLIA	1	Clevis end
3)	FL2	1	Flap switch micro assembly
4)	MS35059-27	1	Electric flap switch
5)	LY1	1	Electric flap relay-12V

Flap motor (Continued)

Item	Part Number	QTY	Description
6)	FL6	1	Flap motor attach bracket
7)	AN3-7A	2	Bolts (for attaching flap motor)
8)	AN960-10	2	Washers (for attaching flap motor)
9)	AN365-1032A	2	Locknuts (for attaching flap motor)

Flap pushrods

Item	Part Number	QTY	Description
1)	3202A	1	Pushrod, stainless - 30” long
2)	F34-14	2	Rod end bearing
3)	AL3201	2	Rod end
4)	AN316-4	4	Check nut
5)	AN3-11A	2	Bolts
6)	AN960-10	4	Washers
7)	AN365-1032A	2	Locknuts
8)	AN470AD4-12	4	Rivets



13.3 Construction Procedures

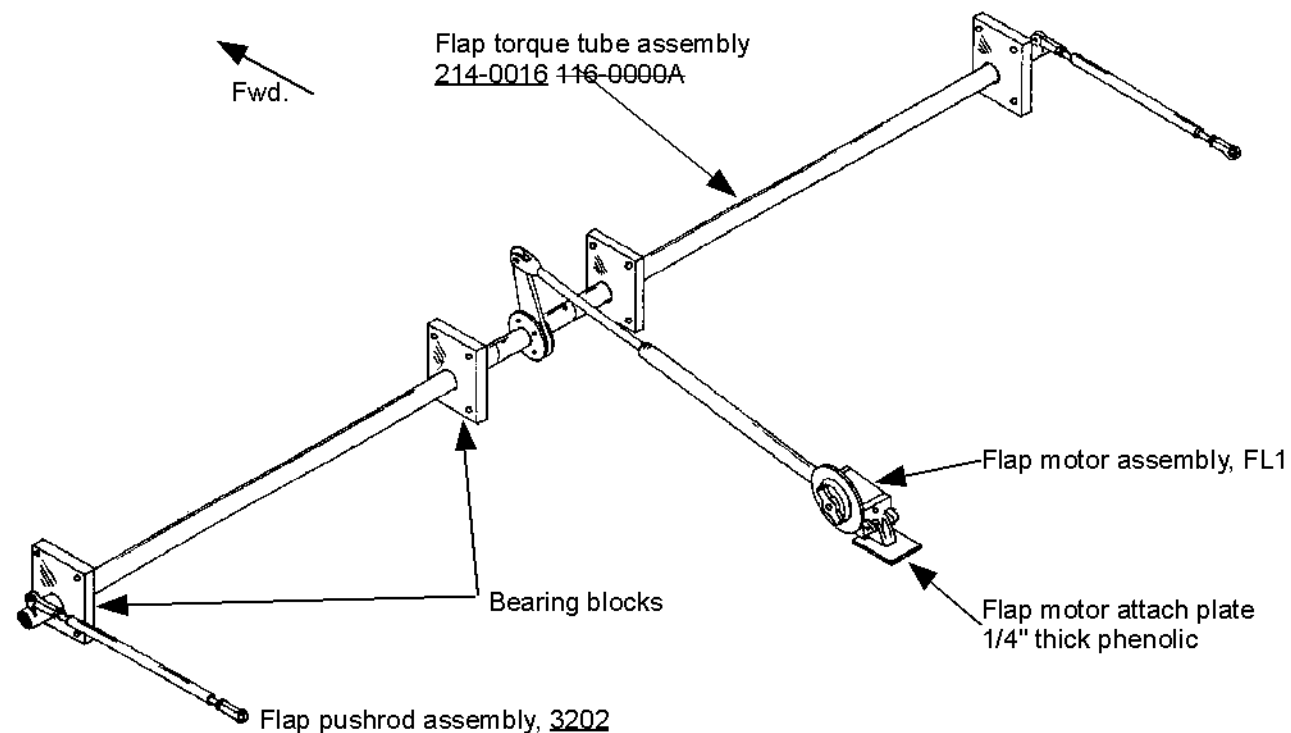
The flap installation consists of several subassemblies. First you will assemble the torque tube and create the holes in the fuselage and wing fairings so the torque tube can be installed. You will also assemble the flap pushrods that connects the torque tube to the flap actuator arm.

The actuator arm that you installed in Chapter 4 *Completing the Ailerons* on page 4.1 connects to the flaps. The flap motor assembly activates the flaps.

Now you will complete three assemblies in this chapter:

- Flap torque tube (214-0016)
- Flap pushrod (3202)
- Flap motor (FL1)

Figure 13.3.0.1 Flap assemblies overview



13.3.A Installing the Flaps' Torque Tube

The wings must be removed in order to install the torque tubes.

The flap torque tube consists of four pieces.

- left side – shorter piece
- right side – longer piece
- center control arm – which is bolted in place between the left and right sides
- coupler – which bolts to the control arm and the left and right torque tubes

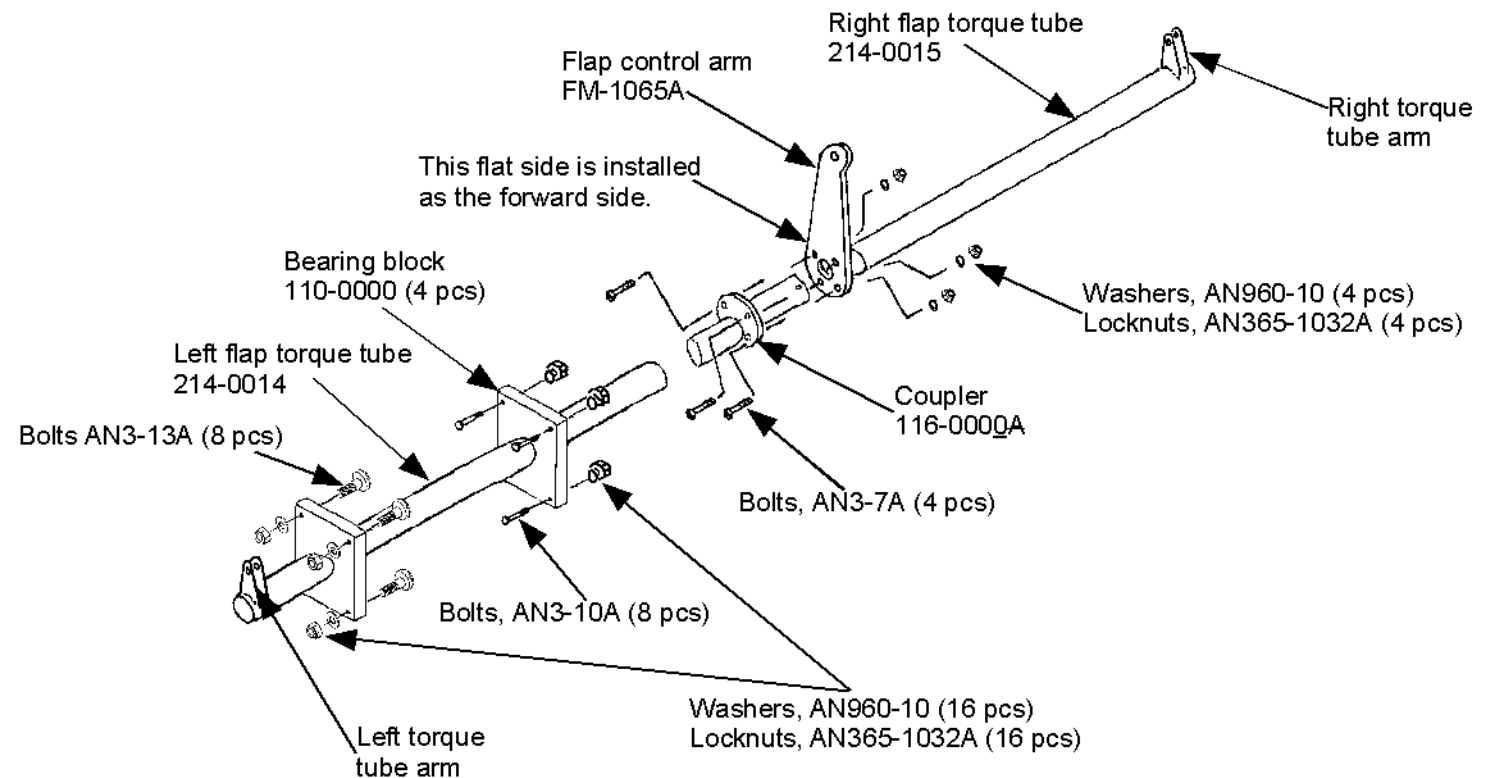
The center of the torque tube is offset 1-1/2" (40 mm) from the fuselage center line. Since the control arm is mounted to the left of the center line, the right side of the torque tube is the longer piece. The torque tube assembly is supported by four bearing blocks.

Installation overview:

- The torque tube is located approximately 2-1/2" (65 mm) aft of the aft shear panel.
- The shorter torque tube is on the left side.
- The outboard ends must be an equal distance from the fuselage center line.
- There are four bearing blocks. The bearing blocks in the wing fairing support ribs are installed first. Then the bearing blocks in the seat supports are installed.

Note: The Delrin guides are not shown in this figure. The delrin guides keep the assembly from shifting left or right.

Figure 13.3.A.1 Flap torque tube



Creating the Torque Tube Alignment Holes

Steps...

1. Draw a vertical line 2-1/2" (65 mm) aft of the aft shear panel on the wing fairing support ribs and the seat supports.
2. Using this vertical line, measure upward 1-1/2" (40 mm) from the bottom of the wing fairing support ribs.
This is the location of the center of the flap torque tubes. Review the location shown in Figure 13.3.A.3.
3. Drill 1/4" (6 mm) pilot holes in the wing fairing support rib only.
4. Drill a 1/2" (12 mm) hole in the side of the fuselage, directly inboard of the pilot hole drilled in the previous step.
5. Locate the holes in the seat supports by sliding a small rod through the holes drilled in the existing holes. Place a level on the rod. Where the rod hits the seat support is the location for the next holes you need to drill. Mark this location.
6. Drill a 1/2" (12 mm) hole in each seat support.
7. Run a string through all six holes.
Slowly enlarge each pilot hole until the string is centered in the hole. Now the string line should run straight.
8. Enlarge each pilot hole to 1-1/2" (38 mm) diameter.
During the enlarging of each hole, make sure you keep the six holes perfectly aligned with the string centered in the hole. If necessary, use the string again to verify that the six holes are in alignment.

WARNING: Do not cut the holes too large. The holes must have a close tolerance to provide maximum support for the bolts securing the bearing blocks.

Figure 13.3.A.2 Locating the pilot holes

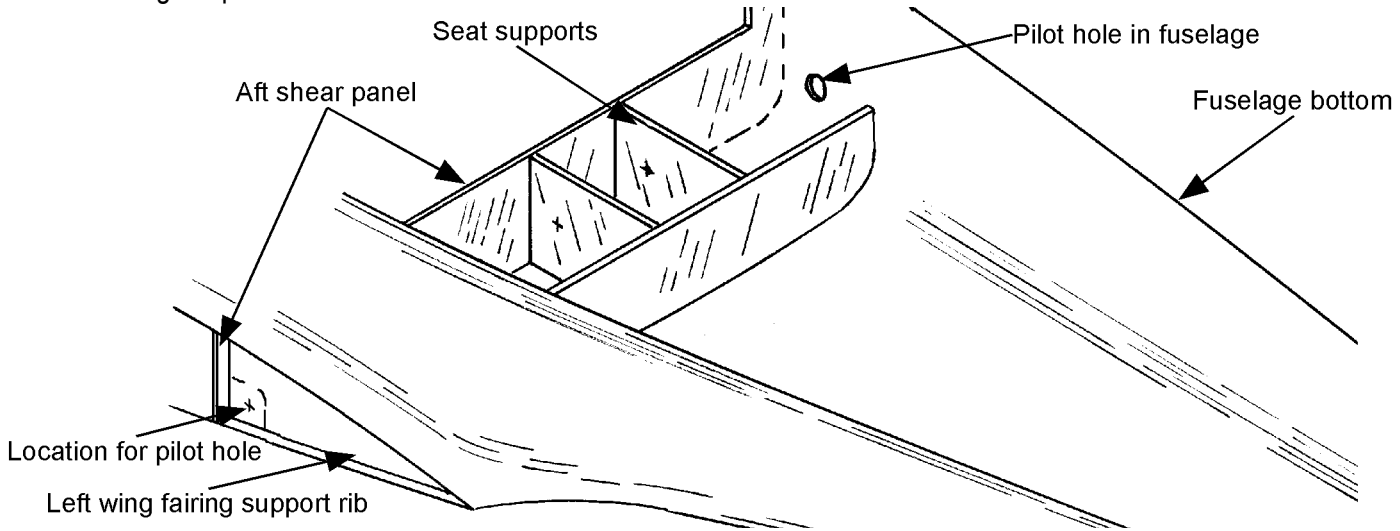
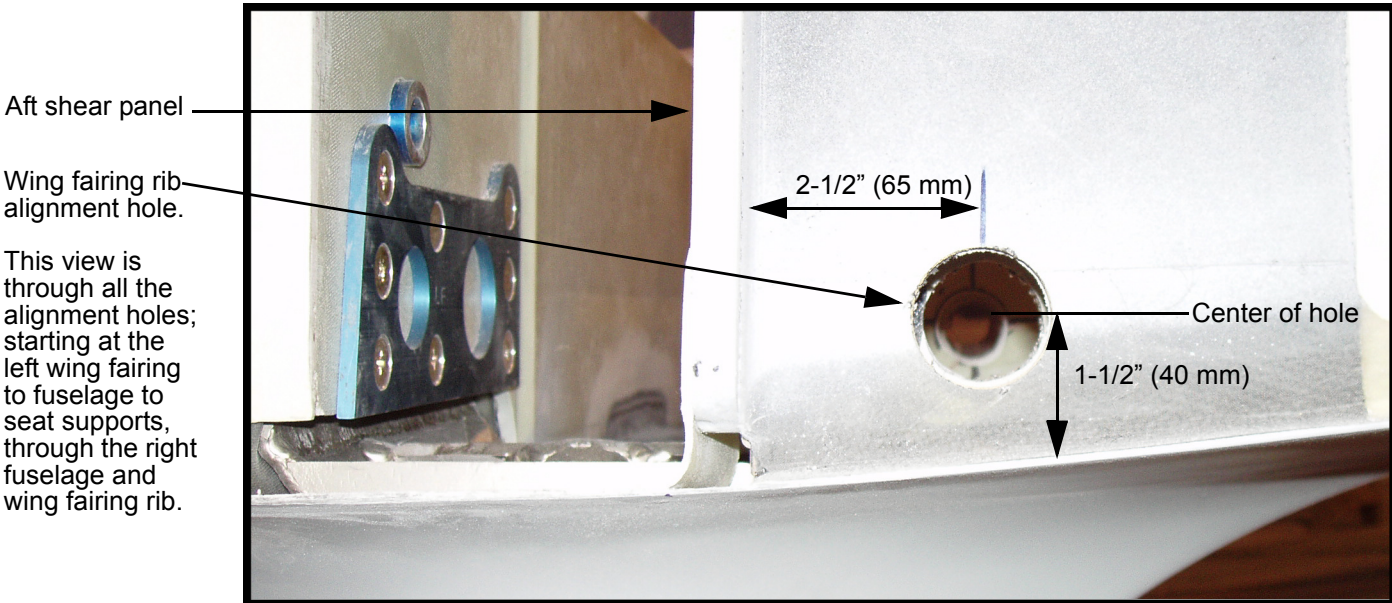


Figure 13.3.A.3 Torque tube alignment holes



Installing the Bearing Blocks

There are four bearing blocks that need to be installed. The blocks are installed in the following locations.

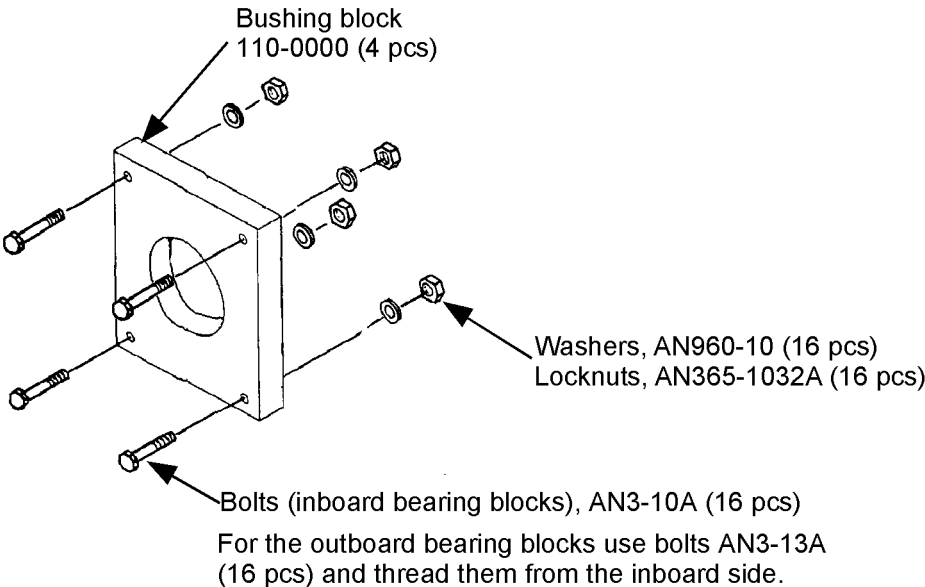
- One on each outboard side of the wing fairing support ribs.
- One on each outboard side of the seat supports.

Steps...

1. Position the bearing blocks (110-0000) on the wing fairing support rib. Center the block on the torque tube alignment hole you created on page 13.5.
 - Center the block 2-1/2" (65 mm) aft of the shear panel and 1-1/2" (40 mm) above the bottom edge of the wing fairing support rib.
2. Clamp the bearing block in place.
3. Use the bearing block's holes to locate and drill holes for the four (AN3-13A) bolts. Install the washers (AN960-10) and the locknuts (AN365-1032A) as shown in Figure 13.3.A.4.

Install the three remaining bearing blocks using these same steps. Make sure you use the AN3-10A bolts for the inboard bearing blocks.

Figure 13.3.A.4 Outboard and inboard bearing block installation



Inserting the Torque Tube

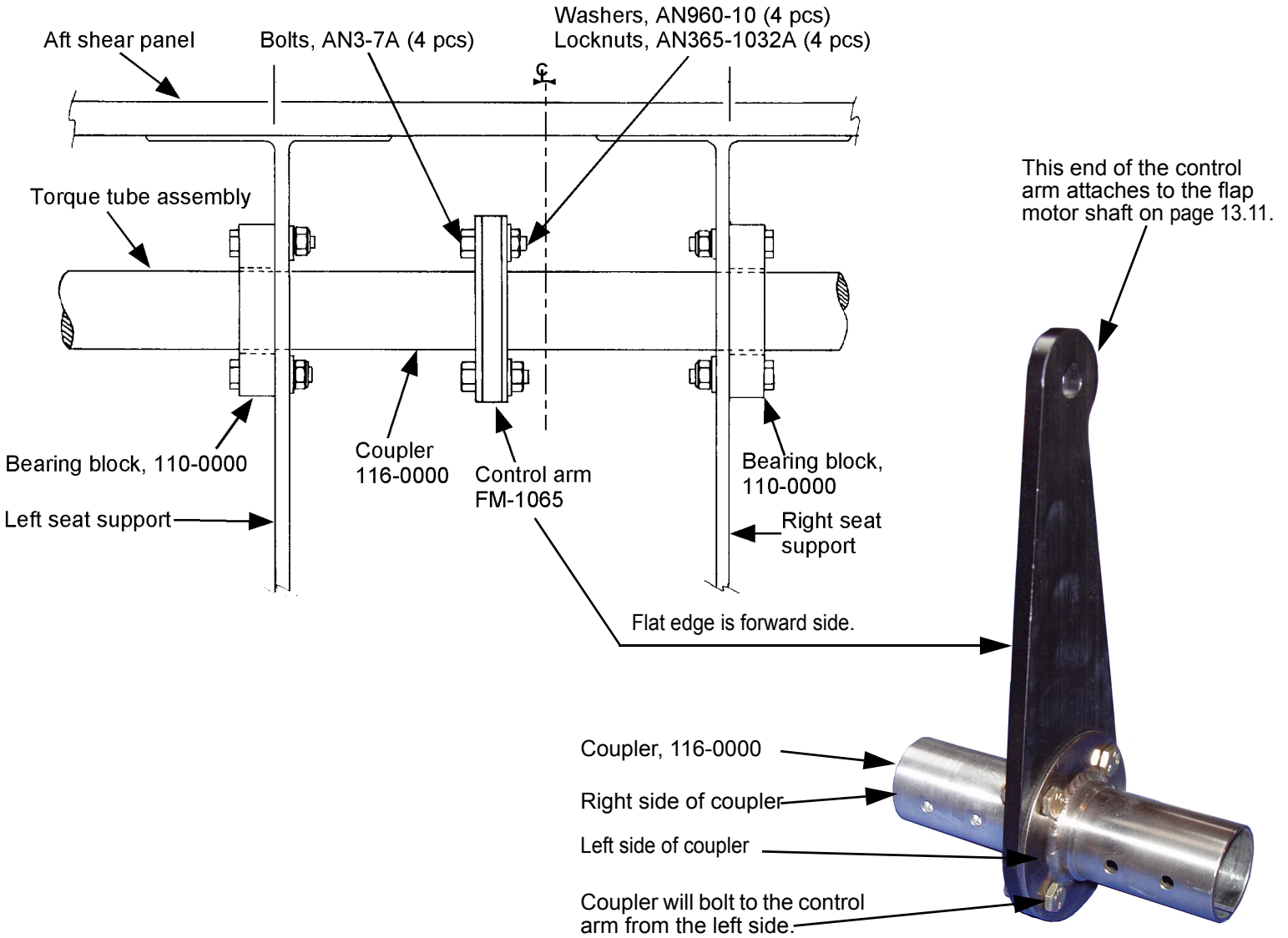
Steps...

1. Insert the coupler (116-0000) through the control arm (FM-1065). Make sure the side of the coupler where the bolts will be inserted is on the left side of the control arm.
2. Bolt the two pieces together using four each of the bolts (AN3-7A) with washers (AN960-10) and locknuts (AN365-1032A).
3. Place the assembled coupler and control arm in its location between the seat supports. Make sure the flat edge of the control arm is forward.
4. Insert each half of the torque tube placing the shorter torque tube (214-0014) on the left side.
Push the torque tubes securely into the control arm assembly.
5. Match drill in four locations, two per side, through the torque tubes and control arm. Insert bolts (AN3-28), using washers (AN960-10) and secure with lock nuts (AN365-1032A).

To check your installation...

Rotate the assembly through its working arc; about 60° of rotation. The assembly should rotate without excess friction. If it does have excess friction, it is most likely a result of a bearing block mounting surface that is not perpendicular to the torque tube. To correct this problem add micro pads to the mounting surface until the bearing block is in a perpendicular position.

Figure 13.3.A.5 Control arm installation



Installing the Delrin Guides

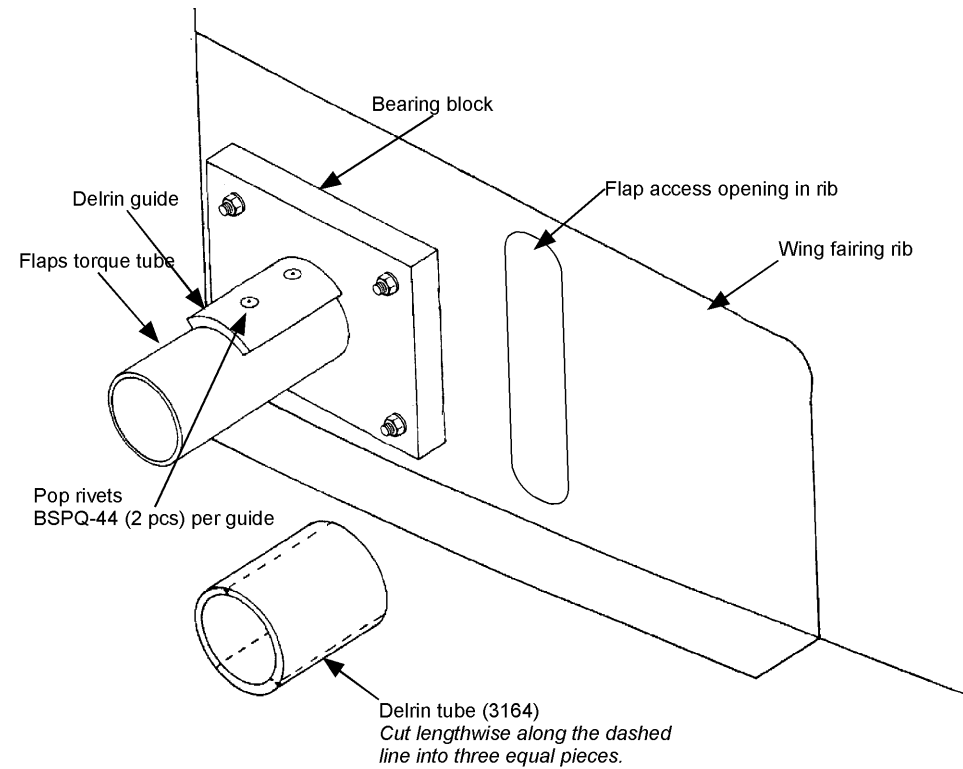
In this section two Delrin guides are installed to secure the torque tube in place. The Delrin guides are installed next to the bearing blocks. See Figure 13.3.A.6. The guides prevent the torque tube assembly from shifting from side to side.

Steps...

1. Cut the 1" (25 mm) piece of delrin tube (3164) into three equal lengthwise pieces.
2. Double check that your torque tube ends are equal distance from the fuselage center line.
3. Place the guide on the torque tube so it is flush against the bearing block and clamp it in position.
4. Drill two 1/8" holes through the guide and the torque tube.
5. Insert two pop rivets (BSPQ-44) in the holes drilled in the previous step. This secures the guide in place.

Repeat these steps to install the second guide.

Figure 13.3.A.6 Delrin guides for the flap torque tube



13.3.B Installing the Flap Motor

The electric flap motor mounts between the seat supports, directly aft of the flap control arm. The flap motor mounts on the two bolts that are bonded to the fuselage floor.

In this section you will also install the BID reinforcements for the seat belt attachment. This BID reinforcement extends over the two bolts that are bonded in.

Bonding in the Attach Bolts

Steps...

1. Decore a 4-1/2 x 2-1/4" (115 x 60 mm) area between the two seat supports on the fuselage floor.
Refer to Figure 13.3.B.1 for measurements and hole locations. They should be centered on the control arm and flush against the bulkhead.
2. Drill two 3/16" (4.5 mm) holes, 1-1/4" (32 mm) apart, centered in the decored area.
3. Decore enough material on the underside of the fuselage so the bolt heads can countersink.
4. Sand the underside and the inside of the fuselage thoroughly.
5. Clean with Acetone.

Reinforce the seat belt supports using the instructions on page 13.10. Then return to the following step.

Steps continued...

6. Scuff up the bolt heads and clean with Acetone.
7. Pot the bolts in place using a wet flox/epoxy mixture or bevel the heads of the bolts so each one has a flat side and pot them in place.
8. Apply 2-BID on the underside of the fuselage, over the bolt heads.

Figure 13.3.B.1 Flap motor attach bolts, side view, potted in fuselage bottom

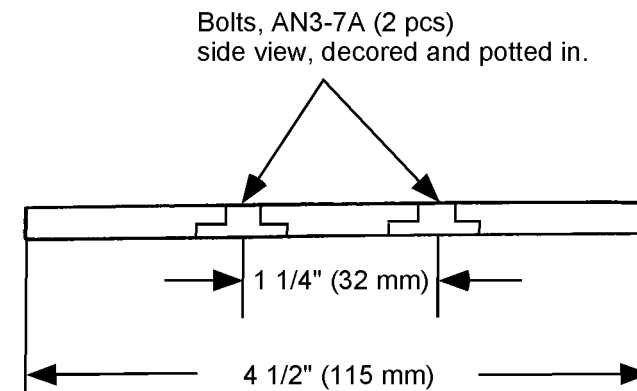
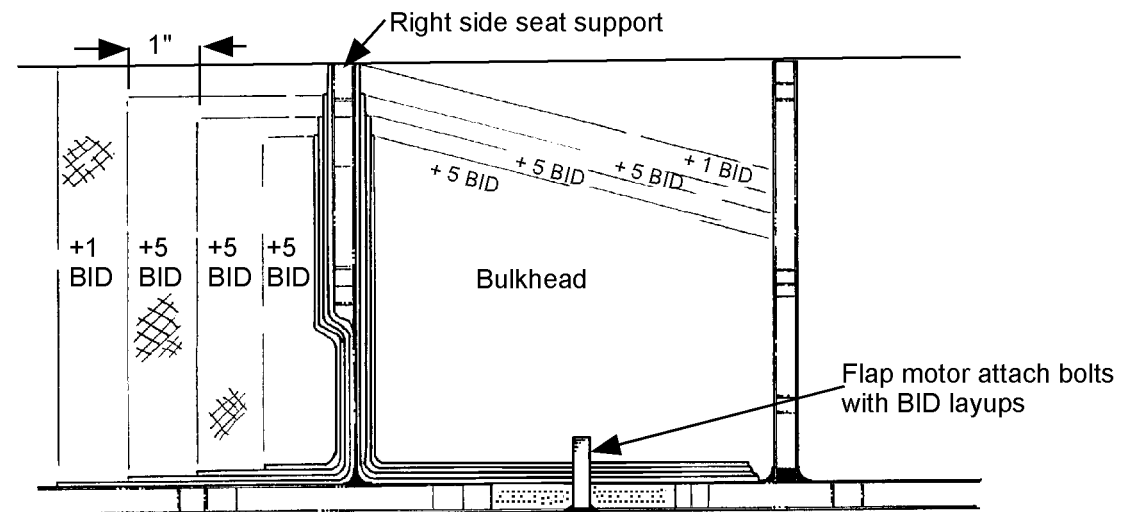


Figure 13.3.B.2 Side view of the seat support and flap motor attach bolts with BID layups



Reinforcing the Seat Belt Supports

Reinforcing the seat belt supports requires large layups. It may be helpful to make a pattern for the BID since these are large layups.

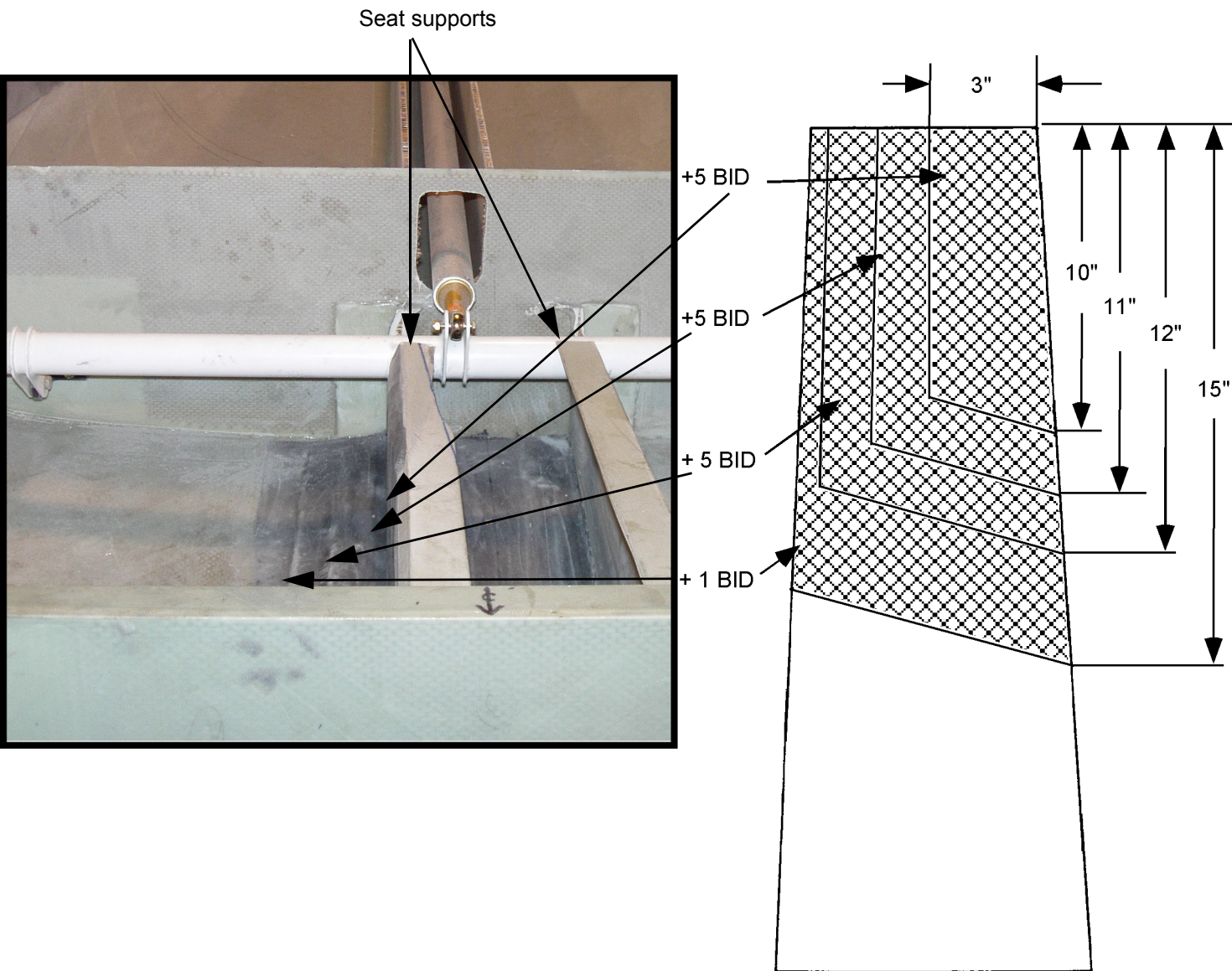
These BID reinforcements will give you a total of 16 additional plies per side in the seat belt attachment area.

Steps...

1. Reinforce the right-side seat support using the layup schedule in Figure 13.3.B.3.
 - Sand all bonding areas and clean with Acetone.
 - Then reinforce the right side seat support rib with 1-BID on both the left and right sides.
 - Next stagger 5-BID reinforcements as shown in Figure 13.3.B.3.
2. Drill holes through the BID for the flap motor attach bolts.

Tip: Avoid getting any resin on the bolt threads since resin will cause them to not thread correctly.

Figure 13.3.B.3 Seat belt reinforcement and layup schedule for the right seat belt support



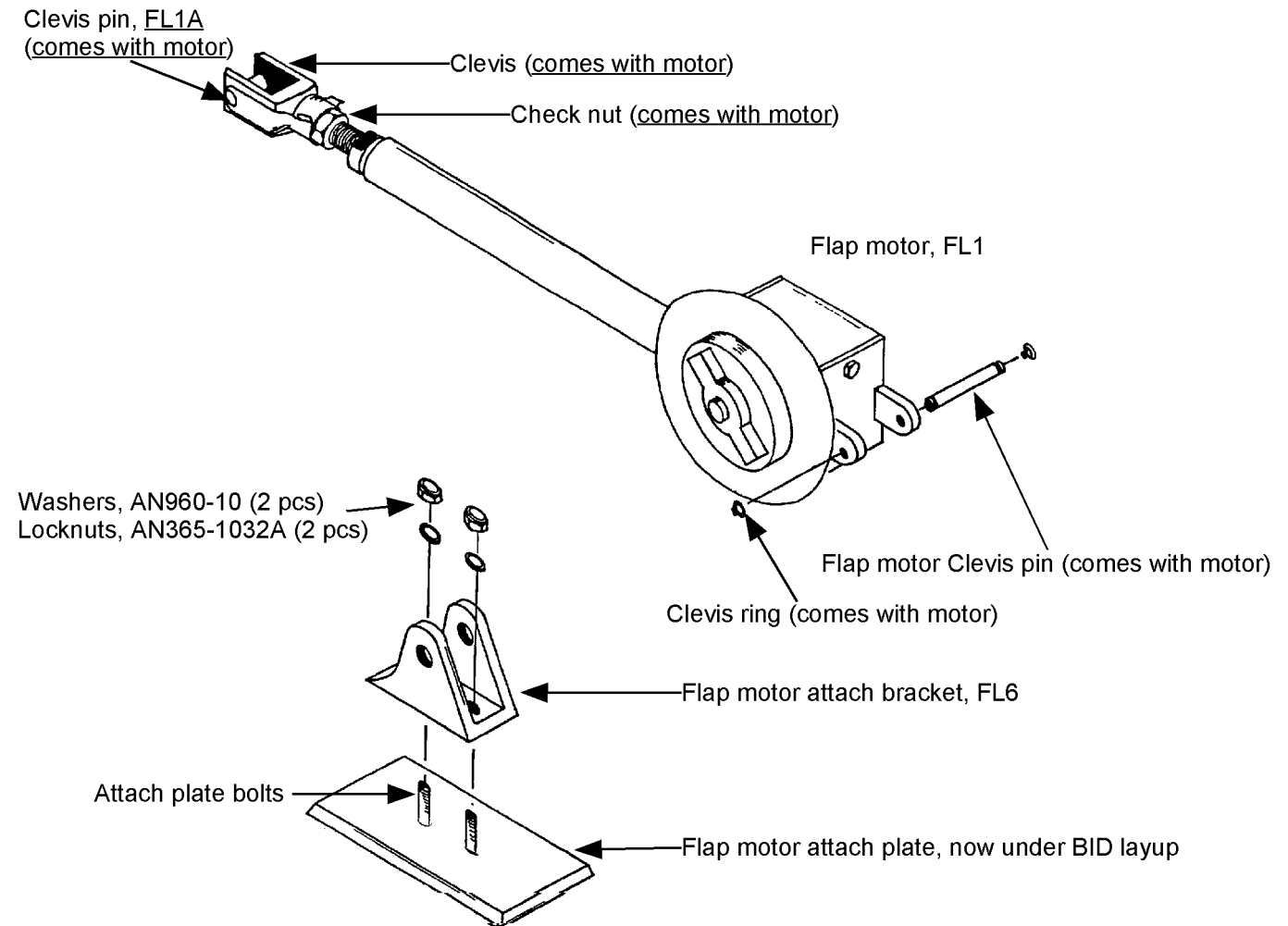
Installing the Flap Motor

Steps...

1. Slide the flap motor attach bracket (FL6) onto the flap motor attach bolts.
2. Secure the bracket on the two bolts using washers (AN960-10) and locknuts (AN365-1032A).
3. Remove the clevis pin from the back of the motor (FL1). You will need to remove the ring clip from the motor's left side.
4. Align the clevis pin holes with the attach bracket holes. Insert the clevis pin through all four holes, and reattach the ring clip on the motor's left side.
Make sure the clip is fully repositioned after installation.
5. Thread the Clevis checknut onto the motor shaft.
6. Align the Clevis with the torque tube control arm and insert a Clevis pin through the three holes.
7. Safety wire the Clevis pin.

Final adjustments will be made later when the wings and flaps are installed.

Figure 13.3.B.4 Installing the flap motor



13.3.C Flap Pushrod Installation

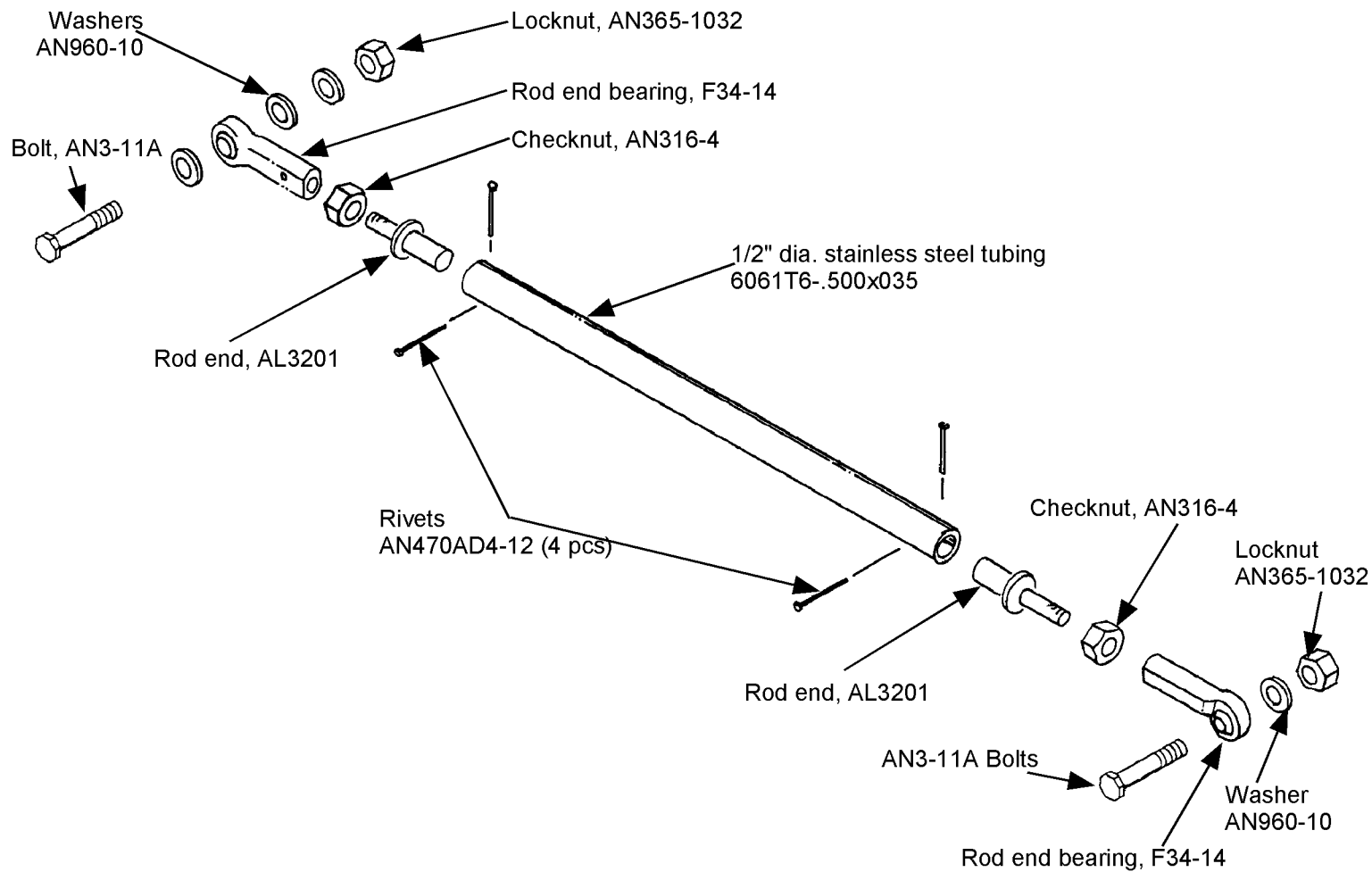
The torque tube that extends from the fuselage and the flap actuator arm are connected by a pushrod. This pushrod is identical to the pushrod in the fuselage that connects the bellcrank to the aileron torque tube except that this one is shorter.



The wings and flaps need to be installed for this step.

~~You will use the optional access opening for the flaps that you created in 9.3.D Creating Access Openings on page 9.13.~~

Figure 13.3.C.1 Flap pushrod assembly



Steps...

1. Prepare to measure the distance between the outboard control arm to the flap actuator arm by doing the following:
 - Set the flaps in the full up position.
 - Fully extend the flap motor to within 1/4" (6 mm) of the aft shear panel. Refer to blueprint 3301.

By making these settings you will measure the maximum length for the pushrod.

2. Measure the distance from the center of the hole of the flap actuator arm to the center of the hole in the arm of the torque tube. Refer to Figure 13.3.C.2.

You should be able to measure this using the flap access opening. See Figure 13.3.A.6 if you have not created this opening.

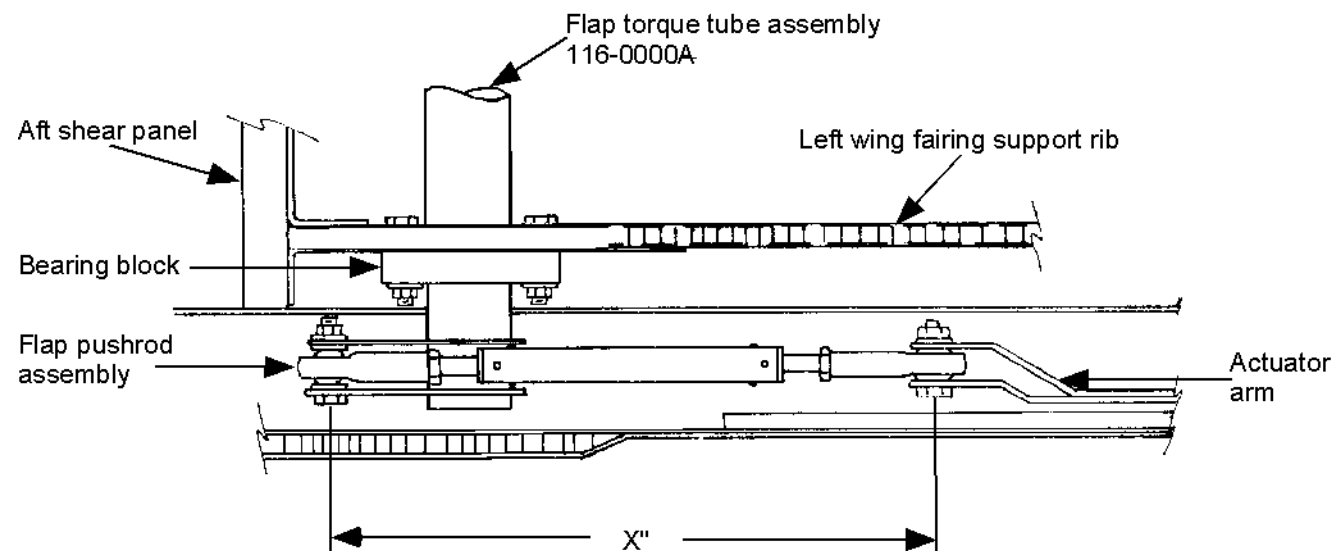
3. Subtract 3.9" (99 mm) from the length you measured in the previous step. The result is the length of the flap pushrod.

The formula for determining the pushrod length is:

$$\text{Length} = X - 3.9" (99 \text{ mm})$$

4. From 1/2" (13 mm) diameter stainless tubing, (6061T6-.500x035) cut two pieces to the length you calculated in the previous step.
5. Fill the rod ends (AL3201) with an epoxy/flox mixture. Later you will drill through this fill. The epoxy/flox fill will prevent the drill from wandering.
6. Measure for the following holes in each end of the tubing:
 - two holes at .2" (5 mm) from the end, opposite each other,
 - two holes at .4" (10 mm) from the end, opposite each other.
7. Drill the four holes on each end.

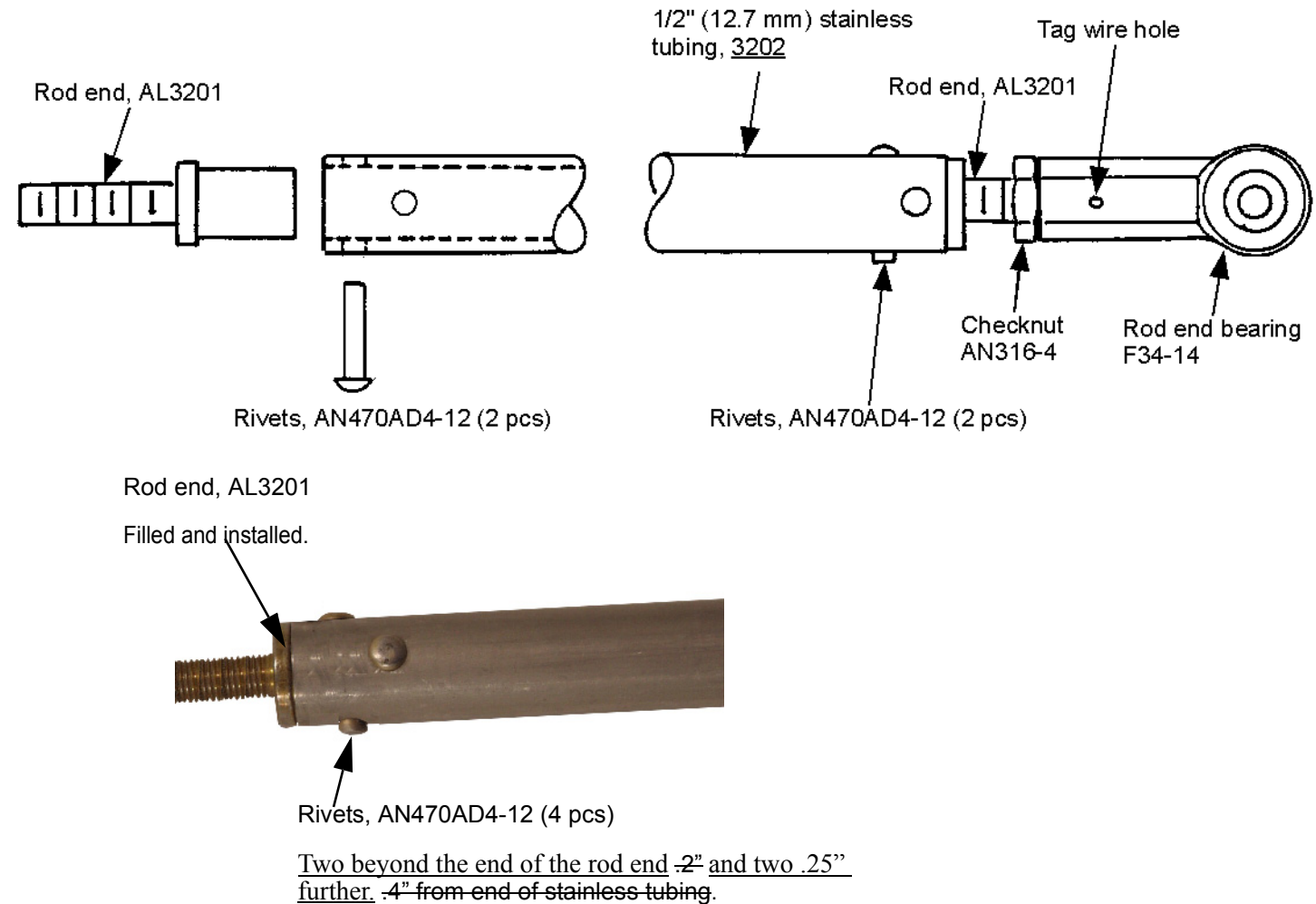
Figure 13.3.C.2 Finding the flap pushrod length



8. Use Loctite 242 on the filled end of the rod end and slide it into the tubing for the final time.
9. Complete the four holes in each end by drilling through the installed rod end.
The holes in the tubing will act as a guide for drilling through the rod end.
10. Install one rivet (AN470AD4-12) at a time using a #30 size drill.
The AN470AD4-12 rivets that are supplied are slightly long. The rivets need to extend 3/16" (5 mm) through the tubing. Or this can be calculated at 1.5 times the rivet diameter.
11. Install a checknut (AN316-4) on each rod end.
12. Install a rod end bearing (F34-14) on each rod end.
13. Install the pushrods using the following:
Torque tube end:
 - bolt (AN3-11A)
 - washers (AN960-10)
 - locknut (AN365-1032)
 Actuator arm end:
 - bolt (AN3-11A)
 - washers (AN960-10)
 - locknut (AN365-1032)

Once you have the pushrods set to the lengths you want, check that the rod end extends past the tag wire hole in the rod end bearing.

Figure 13.3.C.3 Installing the rod ends



13.3.D Adjusting the Flaps

The flaps need to be set to the following:

- left and right flaps are symmetrical,
- the control arm needs to stop 1/4” (6 mm) short of the aft shear panel.

The flaps can be adjusted at three different locations.

- at the rod end connected to the torque tube,
- at the rod end connected to the actuator arm,
- at the checknut on the flap motor shaft.

Steps...

1. Adjust the flaps so they are symmetrical.
Use the short pushrods to adjust as necessary. Check the tag wire holes of the rod end bearings to ensure you have enough threads exposed.
2. Set the micro switches so the control arm stops approximately 1/4” (6 mm) short of the aft shear panel.
Refer to Chapter 24, 24.3.D *Setting the Flap Micro Switches* on page 24.13 for more information.
3. Set the micro switches so the maximum flap deflection is 40°.
Using a Smart level or inclinometer is the easiest method to accomplish this.