

Chapter 12 Brake System and Rudder Controls

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12.1 Introduction

In this chapter you will begin your rudder control system by installing the rudder pedals and the crossover mounting tubes. Later, when you closeout the rudder, you will finish the rudder controls. You will also install the remaining components of the brake system including the brake fluid reservoir, the master cylinders which attach to the rudder pedals and the brake lines.

Directional control on the ground is achieved by differential braking. The entire braking system will be detailed in this chapter, from the firewall mounted reservoir, to the master cylinders attached to each rudder pedal, to finishing the brake system by completing the brake lines.

For information about cutting and bending the aluminum tubing used for portions of the brake lines, see Chapter 2 section 2.3.H *Working with Aluminum Tubing* on page 2.25.

This chapter replaces instructions INS-RD-066.

Steps to Completion

- Install the brake reservoir on the forward side of the firewall.
- Install the pilot’s and the co-pilot’s rudder pedals.
- Install the brake master cylinders to each rudder pedal and the crossover mounting tubes.
- Install the crossover mounting tubes using the firewall brace and the engine mount reinforcements as supports.
- Install all fittings.
- Install the brake lines.
- Adding brake fluid.
- Install either the standard external rudder cable or the optional internal rudder cable.
- Install the rudder to the vertical stabilizer

Caution!

- Always perform the pre-fits that are recommended.
- Practice working with aluminum tubing before starting this chapter.

Before you start this chapter the following must be completed:

- Rudder and vertical stabilizer
- Main gear

12.2 Parts List*

Rudder pedals and pedal mounting

Item	Part Number	QTY	Description
1)	RDP-04	4	Rudder pedals
2)	RDP-02	8	Rudder pedal nylon bushings
3)	RD413-01	1	Aft crossover tube
4)	RD413-02	1	Forward crossover tube
5)	6061-T6 .875x.058		Aluminum tubing (.875 x .058 wall)
6)	BSPQ-44		Rivets, pop
7)	10-19J	4	Master cylinders
8)	AN3-13	4	Bolts
9)	AN310-3	8	Castle nuts
10)	AN3-7	4	Bolts
11)	RDB410-02	2	Rudder bar attach, outboard
12)	RDB410-01-B	1	Rudder bar attach middle, bottom
13)	RDB410-01-T	1	Rudder bar attach middle, top
14)	AN3-30A	6	Bolts
15)	AN960-10	6	Washers
16)	AN365-1032A	6	Locknuts
17)	RD-352	1	Rudder control horn
18)	RDC-18	2	Rudder cable with ends

Brakes

Item	Part Number	QTY	Description
1)	9-42016	1	Brake reservoir
2)	AN3-7A	2	Bolts (reservoir to firewall)
3)	AN365-1032A	2	locknuts (reservoir to firewall)
4)	AN960-10	2	washers (reservoir to firewall)

Brakes (Continued)

Item	Part Number	QTY	Description
5)	AN825-4D	1	T fitting
6)	1069x6x2	1	Hose elbow
7)	44-NSR		1/4" dia. Nylaflow tubing (or hydraulic hose) - customer preference
8)	BL-0210	1	Left pre-made hose
9)	BL-0180	1	Right pre-made hose
10)	269P-03x02	8	Elbow fittings for master cylinders (includes 261UB-03)
11)	71-T-187		Nylaflow tubing 3/16" (4.75 mm) dia.
12)	266P-03x02	2	Connector fittings (includes 261UB-03)
13)	MS21919-DG8	2	Clamp
14)	AN365-1032	2	Locknuts
15)	PH-250	1	1/4" phenolic
16)	MS24694-S54	2	Countersunk head screw
17)	AN816-4D	2	Nipples
18)	AN818-4D	2	Nuts
19)	AN819-4D	2	Sleeves
20)	5052-.250x.035		Aluminum tubing (.25" x .035 wall)

External rudder connections – forward

Item	Part Number	QTY	Description
1)	MS21251	2	Turnbuckle barrel
2)	MS21255-3LS	2	Turnbuckle fork end
3)	MS21255-3RS	2	Turnbuckle fork end
4)	MS212556-1	2	Turnbuckle clip
5)			1/8" (3 mm) cable (flex loop)
6)	AN100-4	2	Cable thimble



Revisions

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Brake System and Rudder Controls

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External rudder connections – forward (Continued)

Item	Part Number	QTY	Description
7)	AN111-4	2	Cable bushing
8)	18-3-M	4	Nicopress sleeves
9)	AN3-6	2	Bolt
10)	AN310-3	2	Castle nut
11)	MS24665-151	2	Cotter pin 1/16”

External rudder connections – aft

Item	Part Number	QTY	Description
1)	AN3-7	2	Bolt
2)	AN960-10L	2	Washer
3)		2	Bushing
4)	AN960-10	2	Washer
5)	AN310-3	2	Castle nut
6)	MS42665-151	2	Cotter pin

Internal rudder (RD-066-B)– optional

Item	Part Number	QTY	Description
1)	103-0012	2	Nut jam 5/16-24, left-handed threads
2)	110-0003	2	Bearing rod end
3)	475-6-09	2	Washer solenoid hyd switch gear
4)	112-0038 6391K-165	1	Bushing, bronze 5/16 ID x 7/16 OD x 3/4 long
5)	106-0012 90295A-160	2	Washer, flat nylon
6)	AN155-46S	2	Turnbuckle barrel
7)	AN170-46LS	2	Turnbuckle eye end
8)	AN3-11A	2	Bolt
9)	AN3-12A	4	Bolt
10)	AN316-4	4	Nut, thin check

Internal rudder (RD-066-B)– optional (Continued)

Item	Part Number	QTY	Description
11)	AN316-5	4	Nut, thin check
12)	AN3-20A	3	Bolt
13)	AN365-1032A	7	Nut, elastic stop
14)	AN365-524A	1	Nut, elastic stop
15)	AN470AD4-10	10	Rivets, hard
16)	AN490HT-8P	4	Rod end, threaded
17)	AN5-10A	2	Bolt
18)	AN5-16A	1	Bolt
19)	AN960-10	7	Washer, flat
20)	AN960-516	4	Washer, flat
21)	AN960-516L	1	Washer, flat thin
22)	B-5/16-18-1.00	2	Bolt
23)	F34-14AU	4	Bearing rod end
24)	MS21042-3	2	Nut, all metal stop
25)	N-5/16-18	2	Nut, jam steel hex
26)	RD-066-01	1	Hinge lower
27)	RD-066-03	1	Bracket stop
28)	RD-066-04	1	Block mounting
29)	RD-066-05	1	Arm pivot 2/Helicoil
30)	PH-250-8x10	1	Phenolic, 14x8x10
31)	6061T6-500x035	4’	Tubing, alum 1/2x.035 rigid

Parking brake – optional

Item	Part Number	QTY	Description
1)	PV-1-A	1	Valve parking brake assembly from MATCO

For parts required for connecting the rudder’s hinges to the vertical stabilizer, see page 12.25.



12.3 Construction Procedures

12.3.A Overview of the ES Brake System

The schematic in Figure 12.3.A.1 provides an overview of the brake system for your ES FastBuild kit. The brake lines shown in the schematic are not the exact routing of the lines, instead they portray the connections.

Overview of the Master Cylinder Connections

The pilot's master cylinders:

- Upper ports – connects to the "T" fitting on the firewall
- Lower ports – connects to the upper ports of the co-pilot's master cylinders

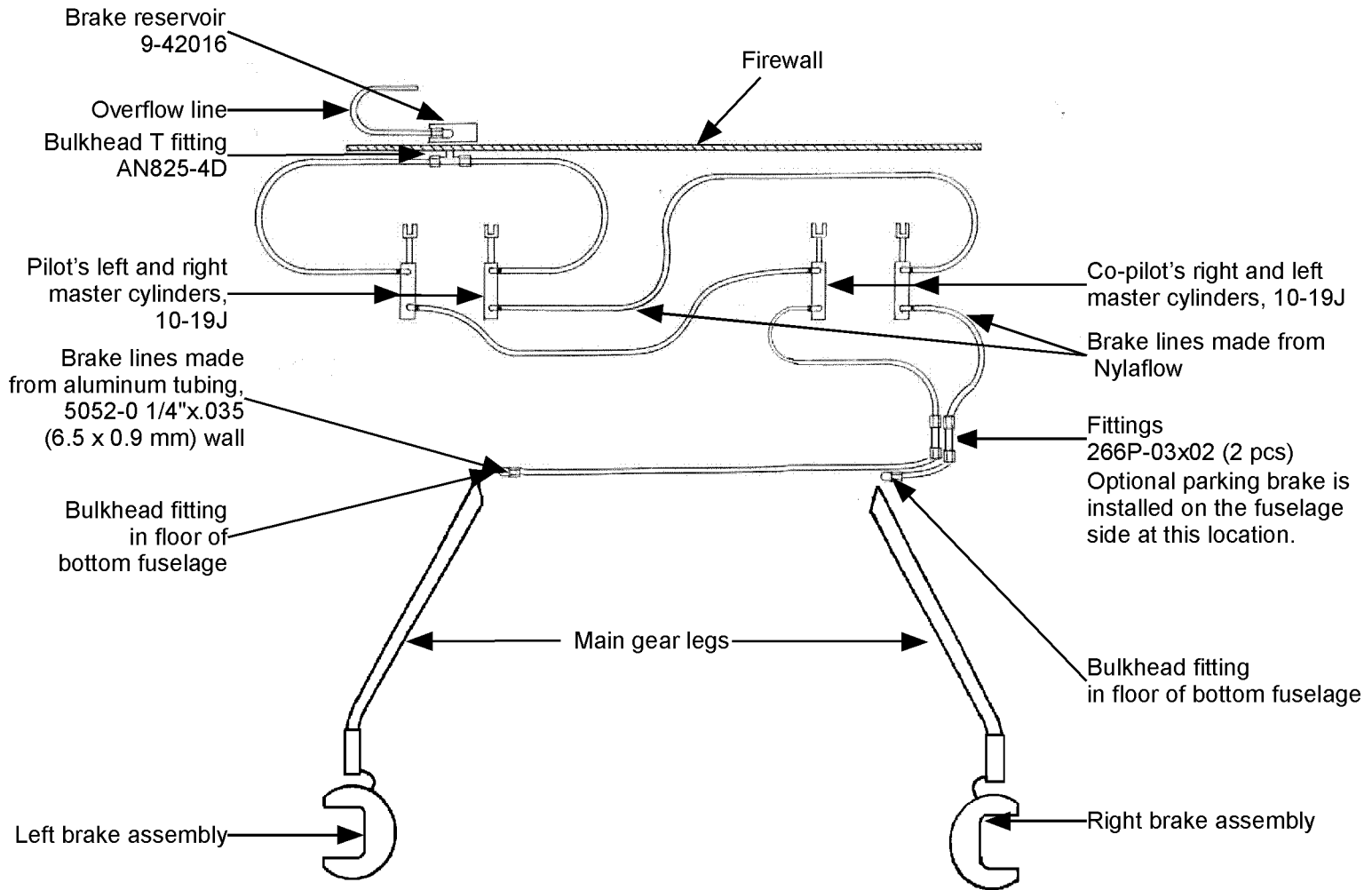
The co-pilot's master cylinders:

- Upper ports – connects to the lower ports of the pilot's master cylinders
- Lower ports – connects to the bulkhead fittings

Optional parking brake

If you decide to add the optional parking brake you need to order part number PV-1-A which contains the instructions for the installation.

Figure 12.3.A.1 Brake system schematic (all parts below the dashed line were installed in Chapter 11)



12.3.B Positioning and Installing the Brake Reservoir

A brake reservoir is mounted to the forward face of the firewall. This reservoir is used to fill and replace fluid in the brake system. The reservoir is positioned above the rest of the brake system so refilling will not create air bubbles.

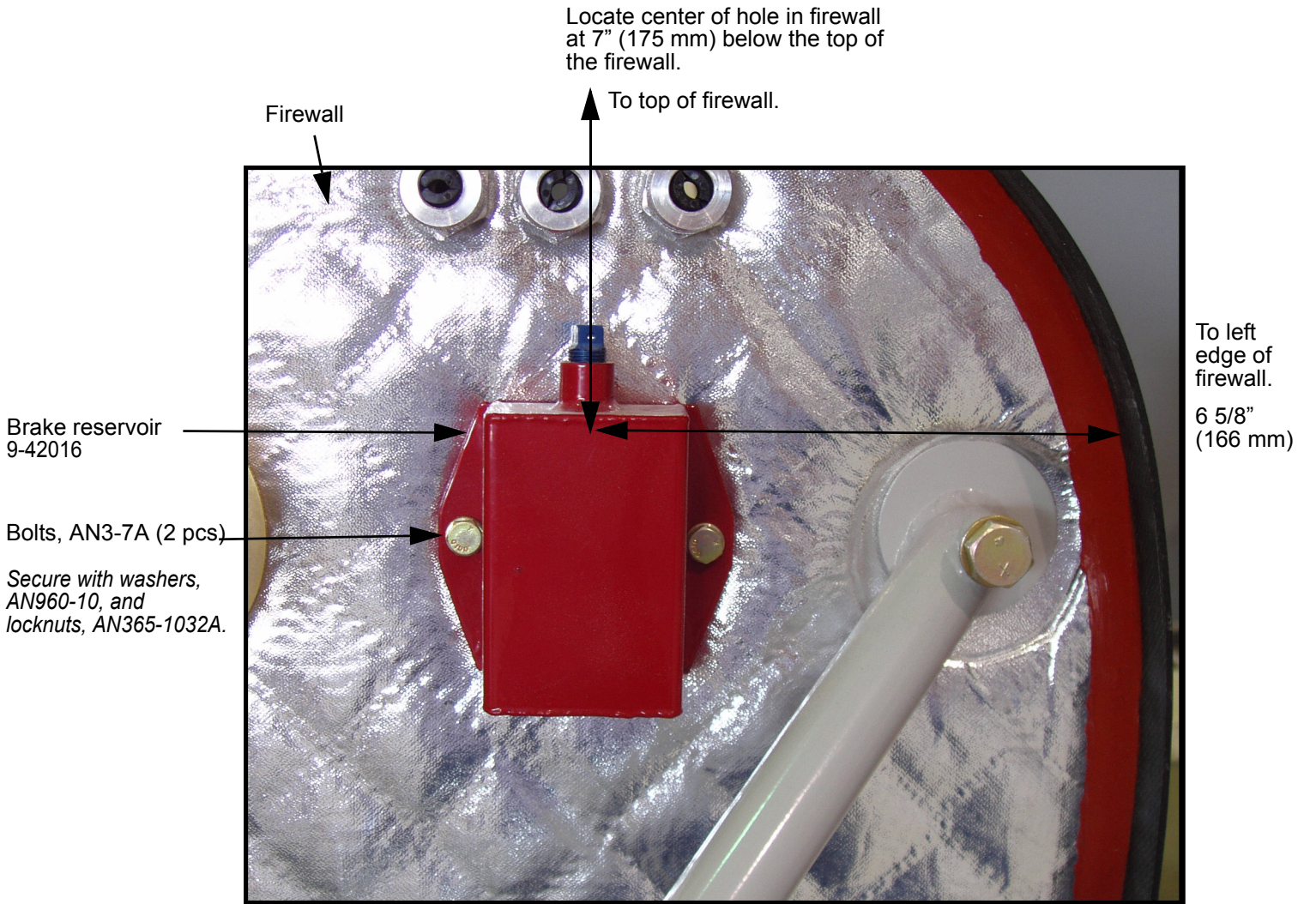
Steps...

1. Position the brake reservoir (9-42016) on the forward face of the firewall as shown in Figure 12.3.B.1.
The threaded holes in the reservoir are the same size, so there is no specific up and down orientation.
2. Use the predrilled mounting holes in the reservoir flanges as guides to drill 3/16" diameter holes through the firewall.
3. Remove 1/4" (6 mm) of core around the perimeter of the two holes you just drilled in the firewall.
4. Secure the brake reservoir to the firewall with two AN3-7A bolts, AN960-10 washers and AN365-1032A locknuts.

To view the layout of the firewall, see Figure 21.2.0.1 on page 21.7.

Note: For ease of servicing your airplane, install an overflow tube on the brake reservoir. See 12.3.F *Installing the Brake Fittings* on page 12.11 for more information.

Figure 12.3.B.1 Brake reservoir on forward side of firewall



12.3.C Installing the Rudder Pedals

The four rudder pedals provided in your kit are all identical. There are not specific left or right pedals. You will install two pedals to the right crossover mounting tube (RD413-01) and two pedals to the left crossover mounting tube (RD413-02).

Steps...

1. Push two nylon bushings (RDP-02) into the rear opening of each rudder pedal (RDP-04) as shown in Figure 12.3.C.1.

Notice that the shoulders of these bushings are not flush against the castings because of the angled surface of the rudder pedal.

2. Cut four pieces of aluminum tubing 1-5/16" (33 mm) long. (6061-T6 .875" dia. x .058" wall (22 x 1.5 mm))

These pieces need to fit between the RDP-02 bushings with a little side-to-side slop. You should have plenty of leftover aluminum tubing scraps for making these pieces.

3. Slide the following onto each rudder pedal crossover mounting tube:
 - one pilot rudder pedal and one co-pilot rudder pedal
 - one piece of the aluminum tubing for each rudder pedal

The aluminum tubing piece needs to install between the nylon bushings (RDP-02).

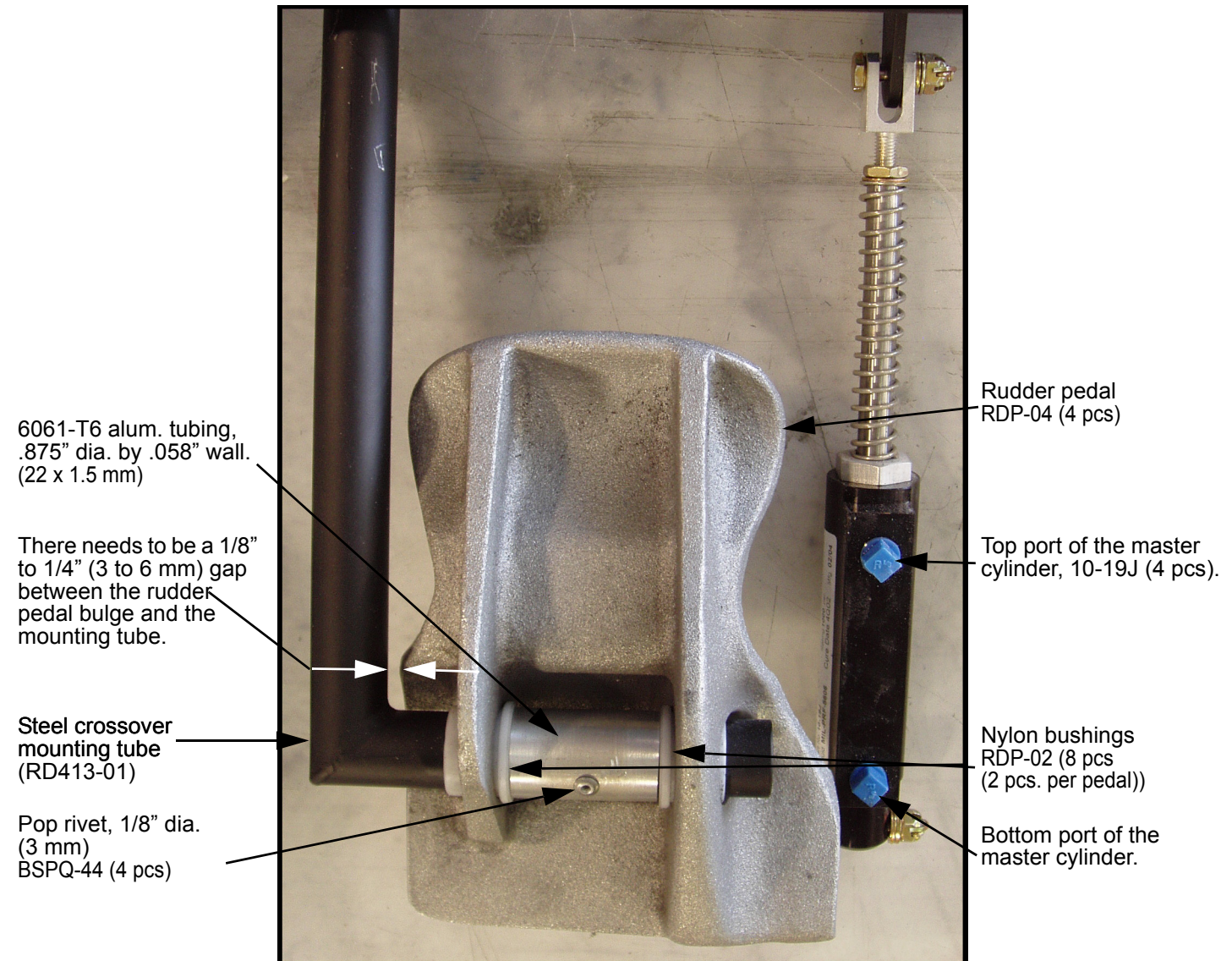
4. Properly position the rudder pedal on the crossover mounting tube. Align the pedal so the top bulge is 1/8-1/4" (3-6 mm) away from the vertical section of the crossover mounting tube as shown in Figure 12.3.C.1.

5. Secure the piece of aluminum tube to the rudder pedal mounts using a single 1/8" (3 mm) dia. pop rivet (BSPQ-44).

This secures the rudder pedals to the horizontal portion of the crossover mounting tube.

Unless you drill out this rivet, which is easy to do, the rudder pedals are permanently secured to the crossover mounting tubes.

Figure 12.3.C.1 Rear view of the rudder pedals with nylon bushings



12.3.D Installing the Brake Master Cylinders

The brake master cylinders are mounted to the rudder pedals and the crossover mounting tubes. When the tops of the rudder pedals are pushed forward for braking, the master cylinders compress hydraulic fluid through the brake lines and into the wheel-mounted brake assemblies. The pistons in the brake assemblies squeeze the brake pads against the disks which creates your braking action.

Steps...

1. Secure the bottom of each master cylinder (10-19J) to the rudder pedal tab with a bolt (AN3-13) and castle nut (AN310-3).
Do not tighten the castle nut so much that the master cylinder cannot rotate.
2. Adjust the upper end of the master cylinder until you can bolt the clevis to the tab on the crossover mounting tube. Make sure the rudder pedal is positioned as shown in Figure 12.3.D.2.
3. Secure the master cylinder clevis to the tab with a bolt (AN3-7) and a castle nut (AN310-3).
There are not any washers between the clevis and the tab. This leaves some slop in the connection to avoid stressing the master cylinder. Too much stress on the master cylinder can cause a misalignment.

Figure 12.3.D.1 Side view for adjusting the rudder pedal angle

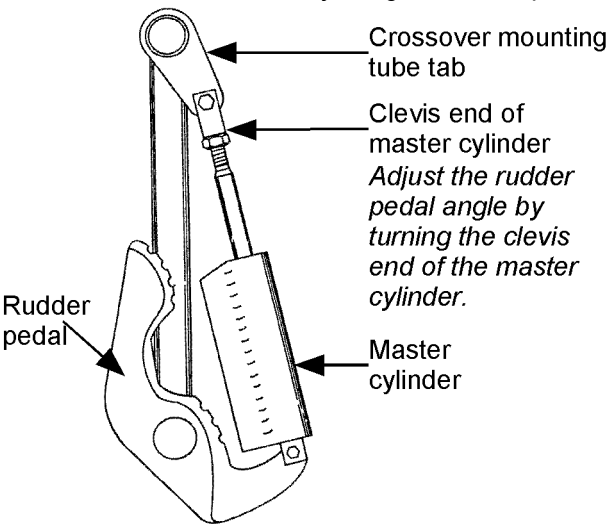
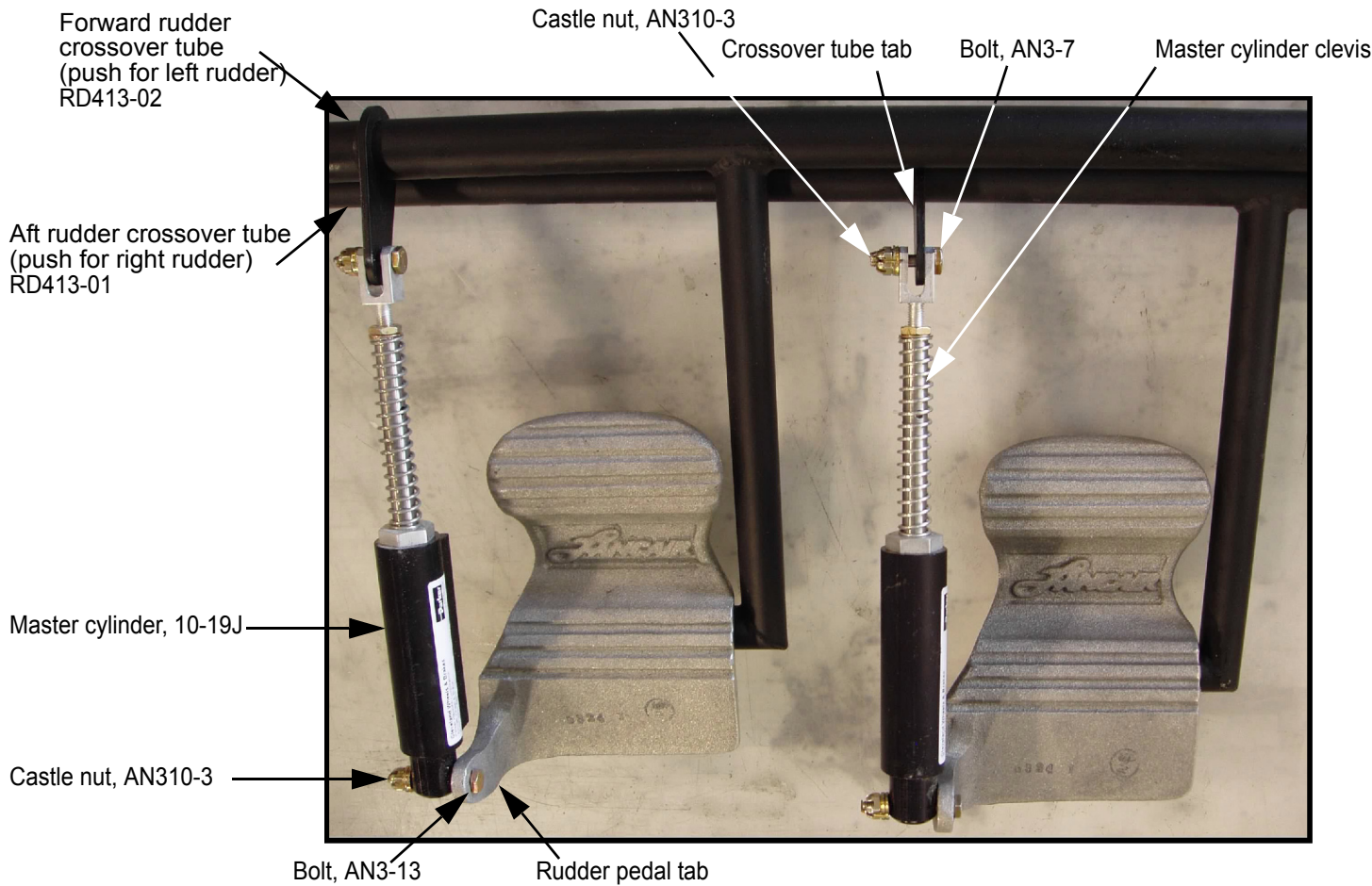


Figure 12.3.D.2 Brake master cylinder installation



12.3.E Installing the Crossover Mounting Tubes

Now you have two crossover mounting tubes, each with two pedals installed. In this section you will install the crossover tubes into the fuselage. The crossover mounting tubes are installed in the following configuration:

- Crossover tube with the left pedals mounted is installed in the forward position.
- Crossover tube with the right pedals mounted is installed in the aft position.

The crossovers are supported by three Delrin plastic mounts. The center bearing mount is in two pieces while the right and left mounts are single pieces.

Steps...

1. Insert the crossover mounting tubes into the outer bearing mounts (RDB410-02). Make sure your tubes are positioned as displayed in Figure 12.3.E.2.
The holes in the bearing mounts are not centered. The wider part of the bearing mounts should be up.
2. Move each crossover tube around in its hole in the bearing mount. If it binds in the hole, remove the tube and sand the hole in the mount so it is slightly larger.
3. Insert the top portion of the middle bearing mount (RDB410-01-T) over the center of the two crossover mounting tubes.
The lower part of the center bearing mount is installed later so you can leave it off for now.

Figure 12.3.E.1 Rudder crossover mounting tubes

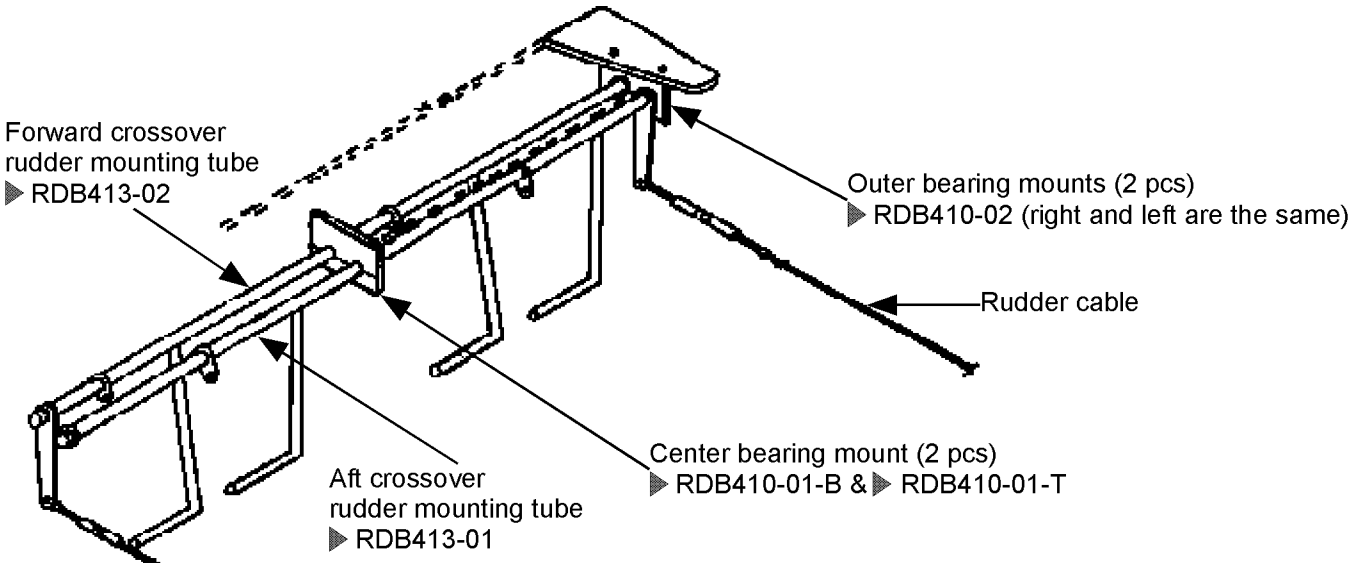
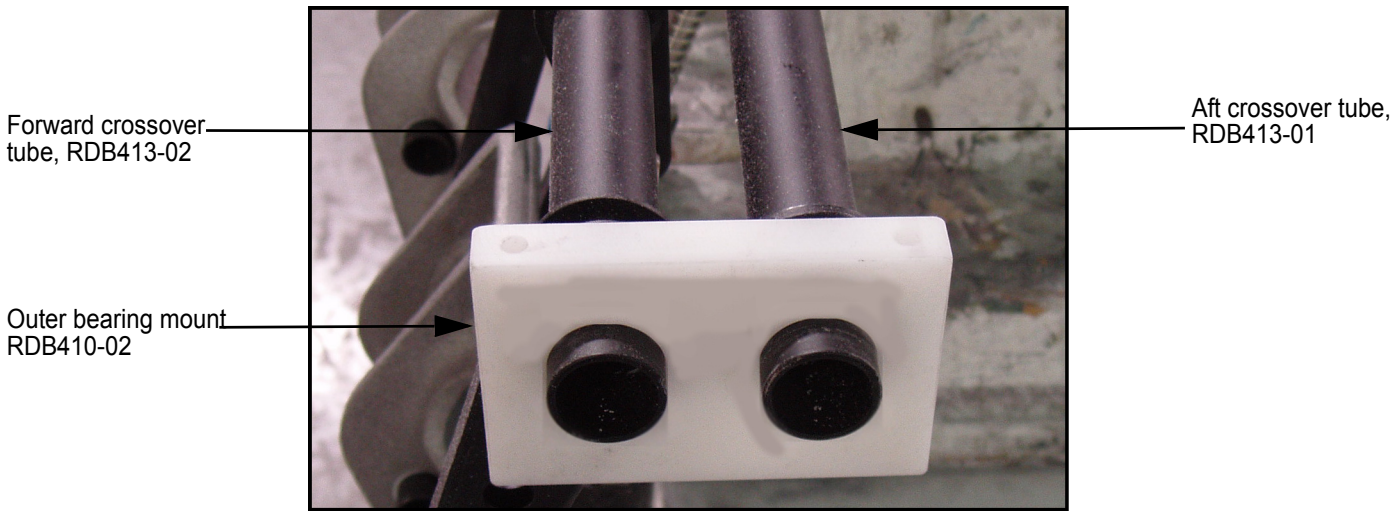
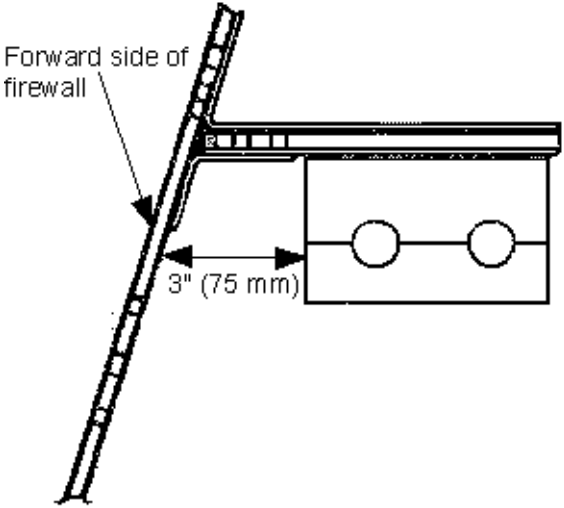


Figure 12.3.E.2 Side bearing mounts for the rudder crossover tubes



4. Adjust the rudder crossover tube assembly so the forward holes of the bearing mounts are located 3" (75 mm) aft of the firewall. Use clamps on the inboard and outboard bearing mounts to hold them in place while adjusting.

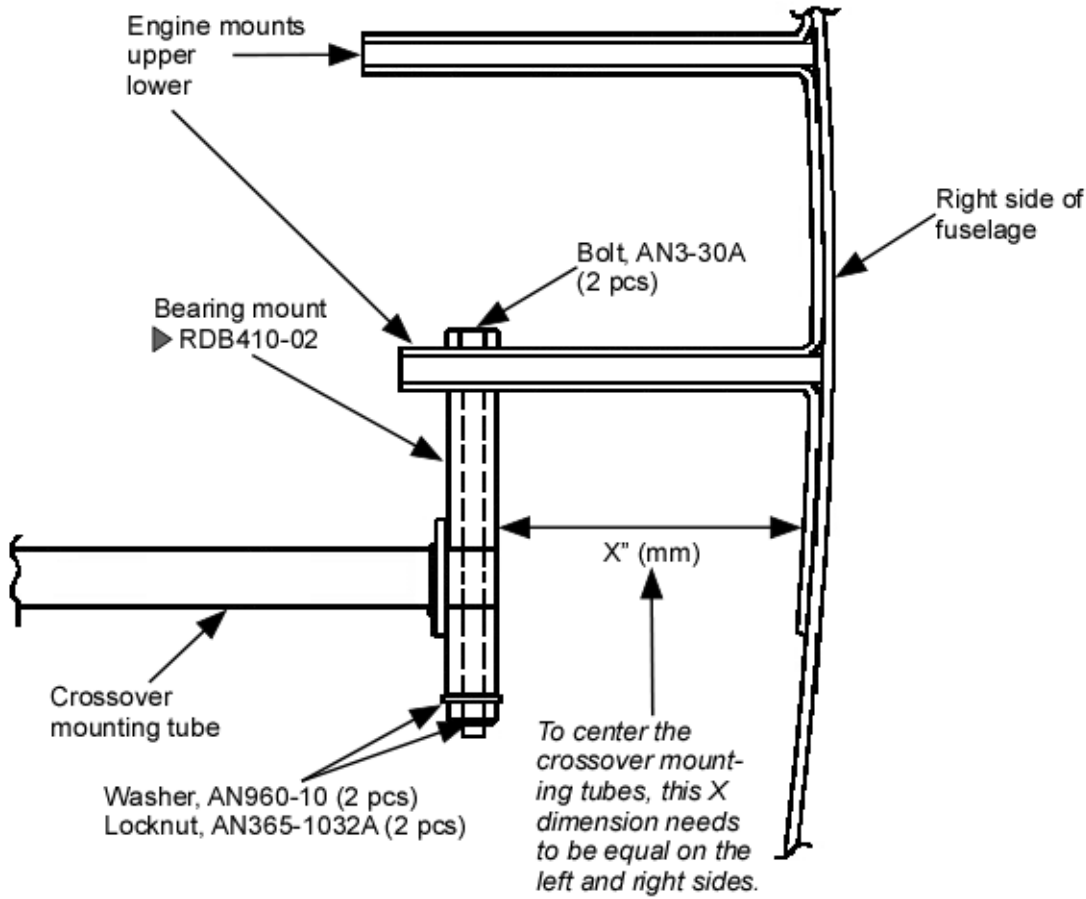
Figure 12.3.E.3 Bearing mount location aft of firewall



5. Center the rudder crossover tube assembly with an equal distance from the following:
- Distance from the left bearing mount to the fuselage = distance from the right bearing mount to the fuselage side. See Figure 12.3.E.4.

Tip: If there is a gap between the firewall brace and the center bearing mount, use a piece of phenolic or a fiberglass shim to fill the gap. The center bearing mount must be positioned directly underneath the phenolic hardpoint. If, for some reason, there is a gap beneath the left and right bearing mounts you will also need to fill these gaps.

Figure 12.3.E.4 Installing the side bearing mounts for the crossover mounting tubes



6. Using the pre-drilled holes in the bearing mounts as guides, drill mounting holes for the inboard and outboard bearing mounts.

An angle drill is required to drill #12 (3/16" or 4.75 mm) mounting holes up through the engine mount reinforcements.

The best method for drilling is:

- Use an angle drill with a long #12 bit.
- Run the bit up through the bearing mounts.
- Spot drill at the four hole locations in the engine mount reinforcements.
- Remove the pedal assembly and bearing mounts, then drill all the way through the engine mount reinforcements.
- Do not drill the two holes for the avionics shelf through the firewall brace yet.

7. Reposition the rudder pedal assembly and secure the left and right bearing mounts to the engine mount reinforcements.

Use bolts (AN3-30A) with washers (AN960-10) and locknuts (AN365-1032A).

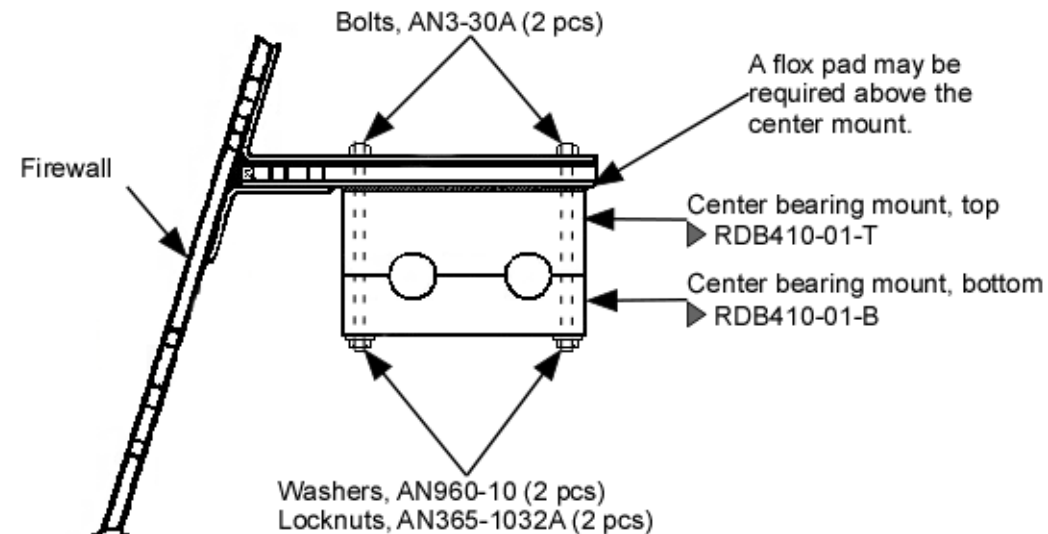
8. Use the center bearing mount as a guide to drill two #12 holes through the firewall brace. Make sure you drill through the phenolic insert.
9. Add the bottom center bearing mount and secure the entire center bearing mount to the firewall brace with bolts (AN3-30A) with washers (AN960-10) and locknuts (AN365-1032A).

Your rudder pedal crossover mounting tubes should both move freely when they are bolted into the bearing mounts. There can be a small amount of friction in the system.

If the crossover tubes seem to bind excessively, one of the bearing mounts may be slightly off-center. In this situation check the following:

- Do another flox release to bring the off-center bearing mount into alignment.
- Verify that all the bearing mount holes are horizontally aligned. This may mean moving a mount slightly closer to the firewall or slightly further aft of the firewall.

Figure 12.3.E.5 Installing the center bearing mount for the crossover mounting tubes



12.3.F Installing the Brake Fittings

In this section you will install all the fittings for the brake lines. This includes:

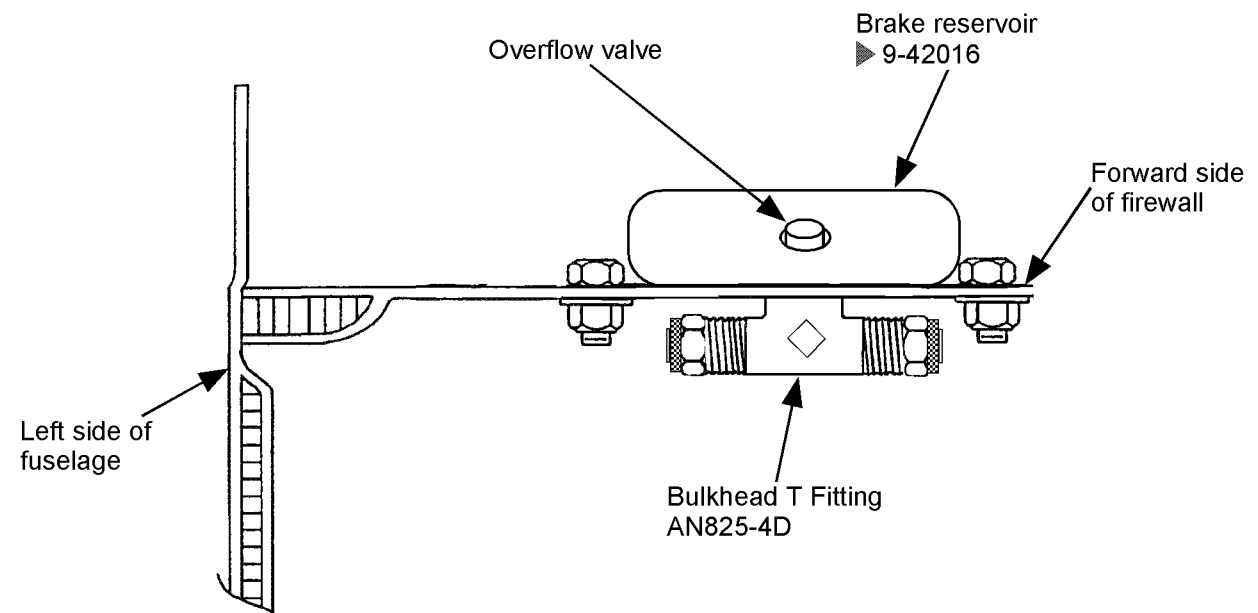
- A bulkhead “T” fitting installed in the firewall,
- A hose elbow on the top of the brake reservoir,
- And the master cylinder fittings.

Steps...

1. Install a bulkhead “T” fitting (AN825-4D) on the back fitting of the brake reservoir where it protrudes through the firewall. Refer to Figure 12.3.F.1.
Tip: Later the right-hand portion of this hardpoint location can be used for the optional vacuum line fittings.
2. Screw a hose elbow (1069x6x2) into the top of the brake reservoir.
3. Connect a length of 1/4" I.D Nylaflo tubing (44-NSR) (or make an aluminum line) to the hose elbow to direct any overflow or discharge to the bottom of the cowling in the exhaust tunnel area.

The brake system is now complete from the firewall forward.

Figure 12.3.F.1 Firewall forward brake assembly, top view



12.3.G Installing the Brake Lines

The brake system uses both aluminum tubing and flexible plastic line (or nylaflow) to connect the master cylinders to the bulkhead fittings. Remember that the two bulkhead fittings were installed in the side of the fuselage in the Chapter 11 section *Preparing for the Brake Installation* on page 11.12.

To connect the firewall bulkhead "T" fitting to the pilot's side master cylinders, premade flexible hoses are provided in your kit.

Tip: You For information on cutting, flaring and joining aluminum tubing see 2.3.H Working with Aluminum Tubing 2.25.

Steps...

1. Connect one flexible hose to each side of the bulkhead "T" fitting you installed in 12.3.F *Installing the Brake Fittings* on page 12.11.

2. Screw an elbow fitting, 269P-03x02, into each master cylinder port.

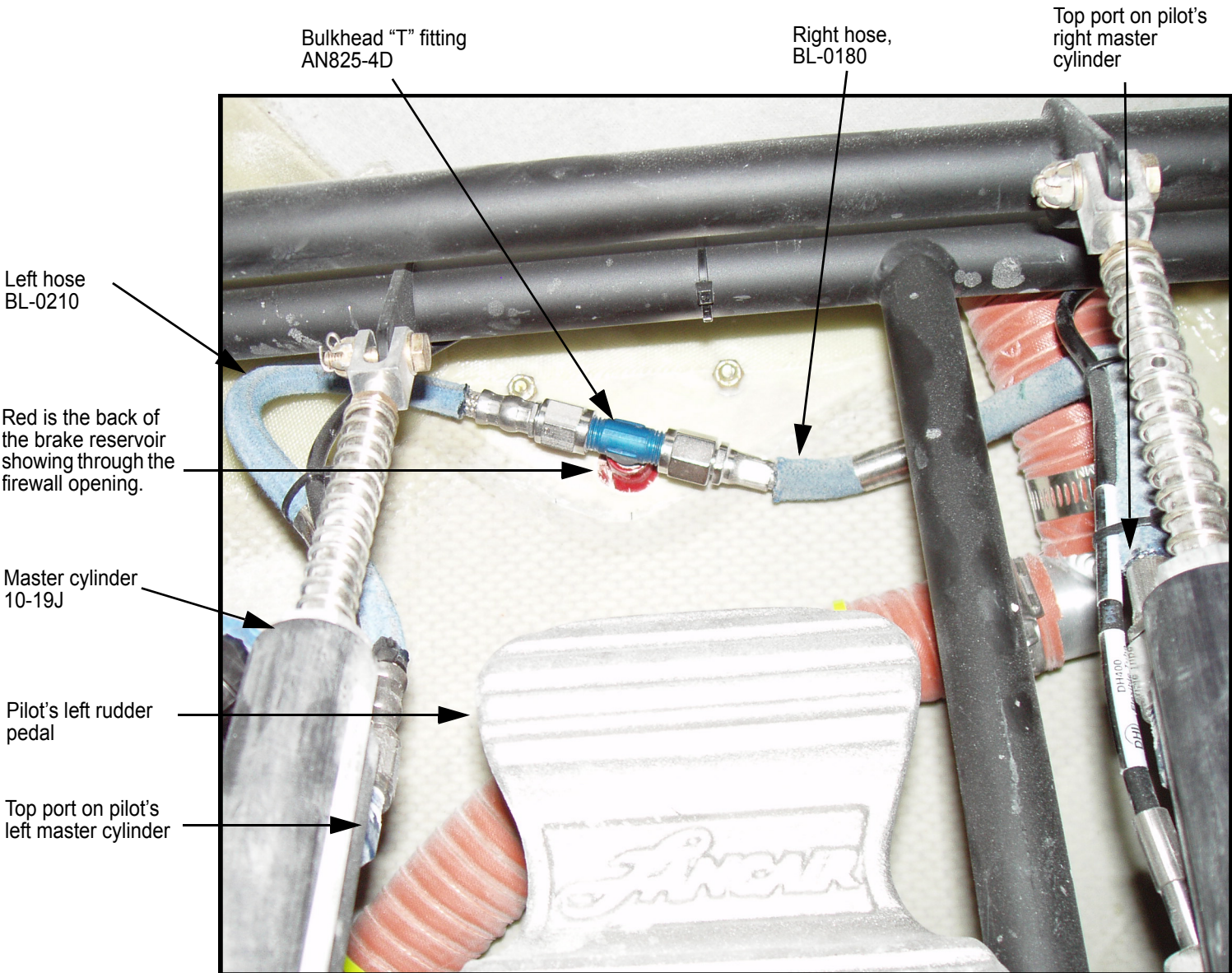
There are eight master cylinder ports; the four pilot ports and the four co-pilot ports. There are two ports per master cylinder, a top and a bottom. Always remove the blue plugs before making connections.

3. Connect the left hose coming from the "T" fitting to the *top* port of the pilot's master cylinder on the *left* rudder pedal.

Tip: Remember the connections are always made with the *left* connected to the *left* and the *right* connected to the *right*.

4. Next connect the right hose coming from the "T" fitting to the *top* port of the pilot's master cylinder on the *right* rudder pedal.

Figure 12.3.G.1 Connecting the firewall T fitting to the master cylinders



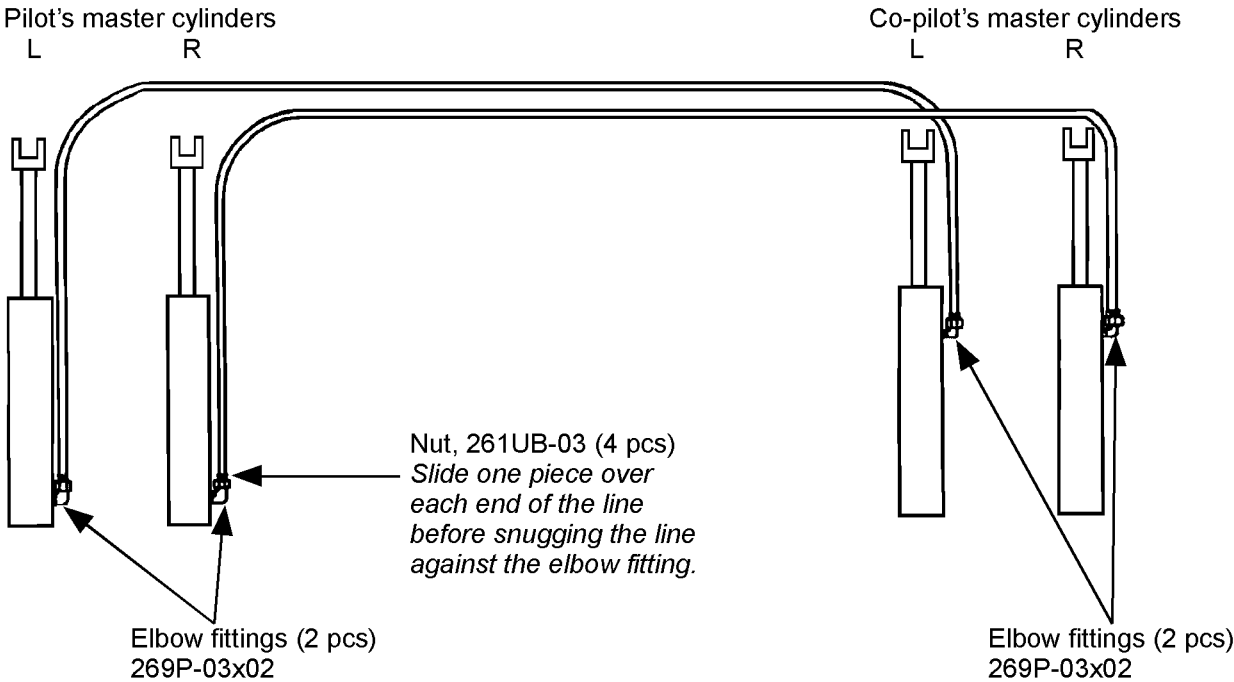
Next you will connect the pilot's *bottom* ports to the co-pilot's *top* ports. Always connect the left rudder on the pilot's side to the left rudder on the co-pilot's side, and the right rudder to the right rudder.

Steps...

1. Cut two lengths of 3/16" (4.75 mm) Nylaflo (71-T-187) tubing.
Cut the tubing long enough so it will allow the rudder pedals to reach full travel.
2. Slide two nuts (261UB-03), one onto each end, of the nylaflo tubing.
Usually the 261UB-03 nuts are included with the 269P-03x02 elbow fittings.
3. Snug the tubing up to the pilot's *right* side master cylinder *bottom* elbow fitting and the other end to the co-pilot's *right* side master cylinder *top* elbow fitting.
4. Slide the nut down the tubing and over the elbow fitting on the master cylinder.
5. Tighten the nut so the nut threads onto the fitting. As it tightens it will expand and grab the end of the Nylaflo tubing.

Repeat these steps for connecting the pilot's *left* master cylinder to the co-pilot's *left* side.

Figure 12.3.G.2 Connecting the pilot and co-pilot master cylinders



Now, from the co-pilot's master cylinders, the brake lines will run aft to the brake assemblies.

Note: All blue and black lines shown in these photographs can be replaced with nylaflow lines. Nylaflow will perform just as well.

Steps...

1. Cut two more lengths of Nylaflow tubing to connect the co-pilot's master cylinders to the fittings already installed on the right side of the fuselage.
2. Slide a nut, 261UB-03, over one end of each section of Nylaflow. Connect this end to the bottom port of the co-pilot's master cylinders.
3. Slide the same nut over the other ends and connect this end of the Nylaflow to the 266P-03x02 fittings on the fuselage side.
4. Secure all four of the nuts.

Figure 12.3.G.3 Connecting the co-pilot's master cylinders

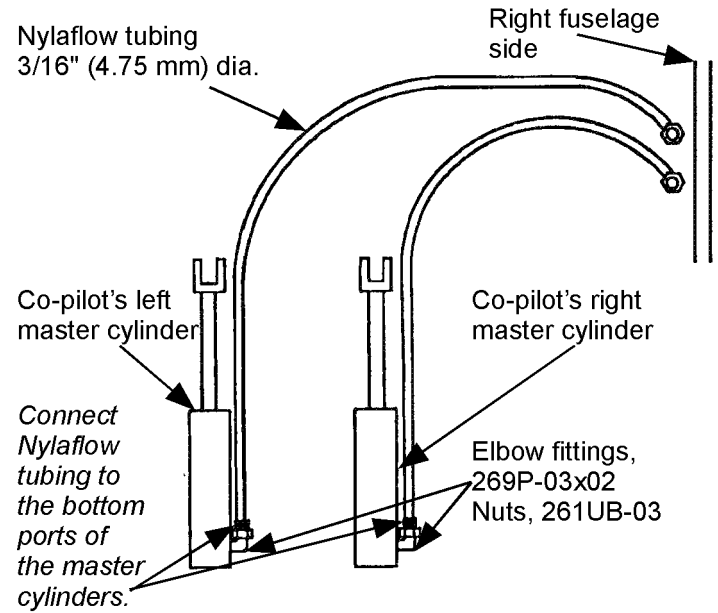
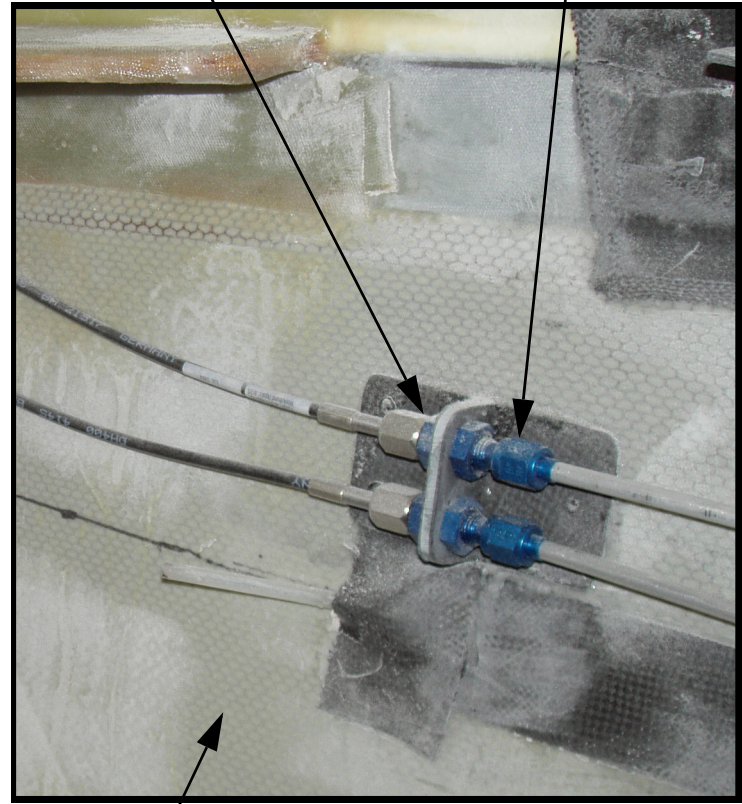


Figure 12.3.G.4 Connecting the brake lines at the fuselage unions

Connections to the fuselage side are:

Fittings, 266P-03x02
Nuts, 261UB-03

Slide the nut, AN818-4D and the sleeve, AN819-4D, over the aluminum tubing before flaring the end.



Right fuselage side

Note: To install the optional parking brake, order part number PV-1-A.

Figure 12.3.G.5 Optional parking brake



5. Secure the fittings to the fuselage side with MS21919-DG8 clamps. Refer to Figure 12.3.G.6.
 - Use a 1/4" (6 mm) thick phenolic scrap and cut it to .75" x .75" (20 mm x 20 mm).
 - Bevel the edges of the phenolic.
 - Drill a hole through the phenolic and counter sink the screw, MS24694-S54.
 - Bond the phenolic to the fuselage side with the screw head against the fuselage.
 - Apply a 1-BID over the phenolic.

The screw will be firmly set in position.

Note: There are other methods of securing tubes and fittings to the fuselage sides. Click-bond fasteners also work well. Or you can decore the area, pot in an AN-3 bolt and do a 4-BID layup over the decored area.

6. Slide the clamp over the screw. Secure using locknut AN365-1032.

7. Measure the length of tubing you will need and cut.

Aluminum tubing (1/4" diameter x .035" wall, 5052-0) is used for the brake lines from the 266P-03x02 fittings aft to the bulkhead fittings.

The approximate lengths are:

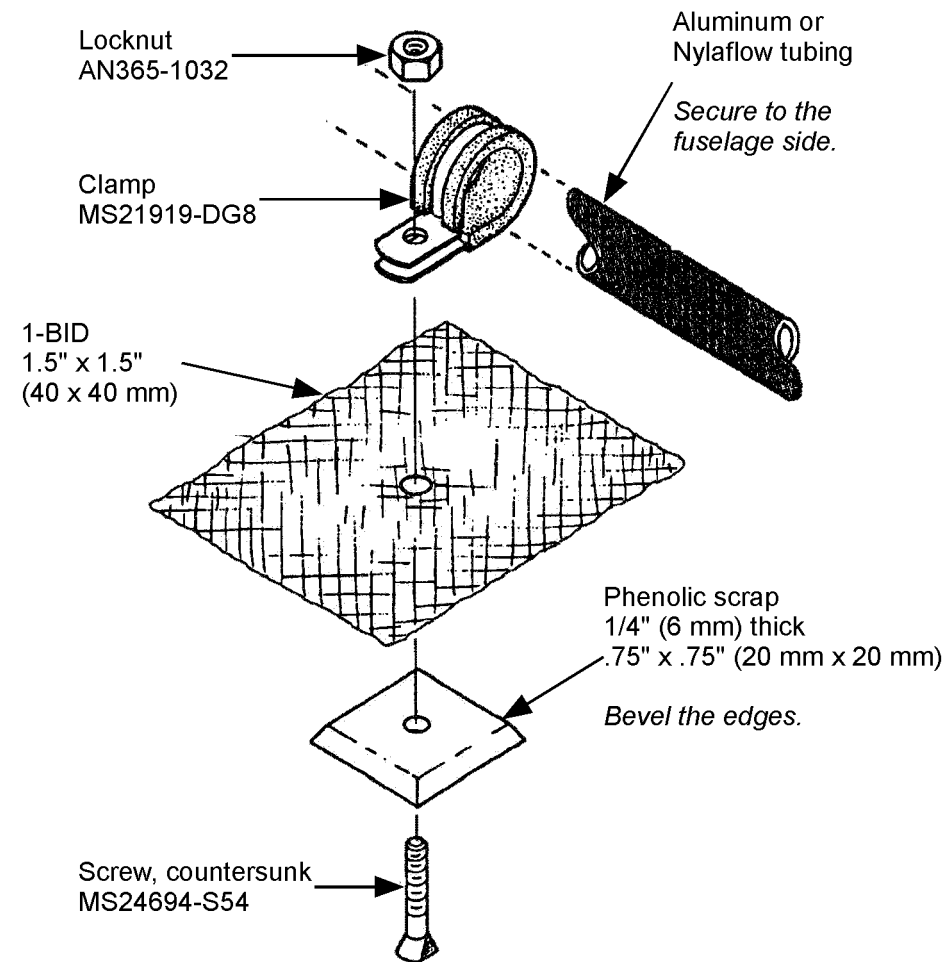
- left brake line = 85" long or just over 7' (2.13 meters)
- right brake line = 130" long or about 11' (3.35 meters)

This will leave you plenty of extra to trim. Refer to Figure 12.3.G.7.

Plan how you are going to run the brake lines before you start the installation. Avoid interference with the control stick and the rudder cables.

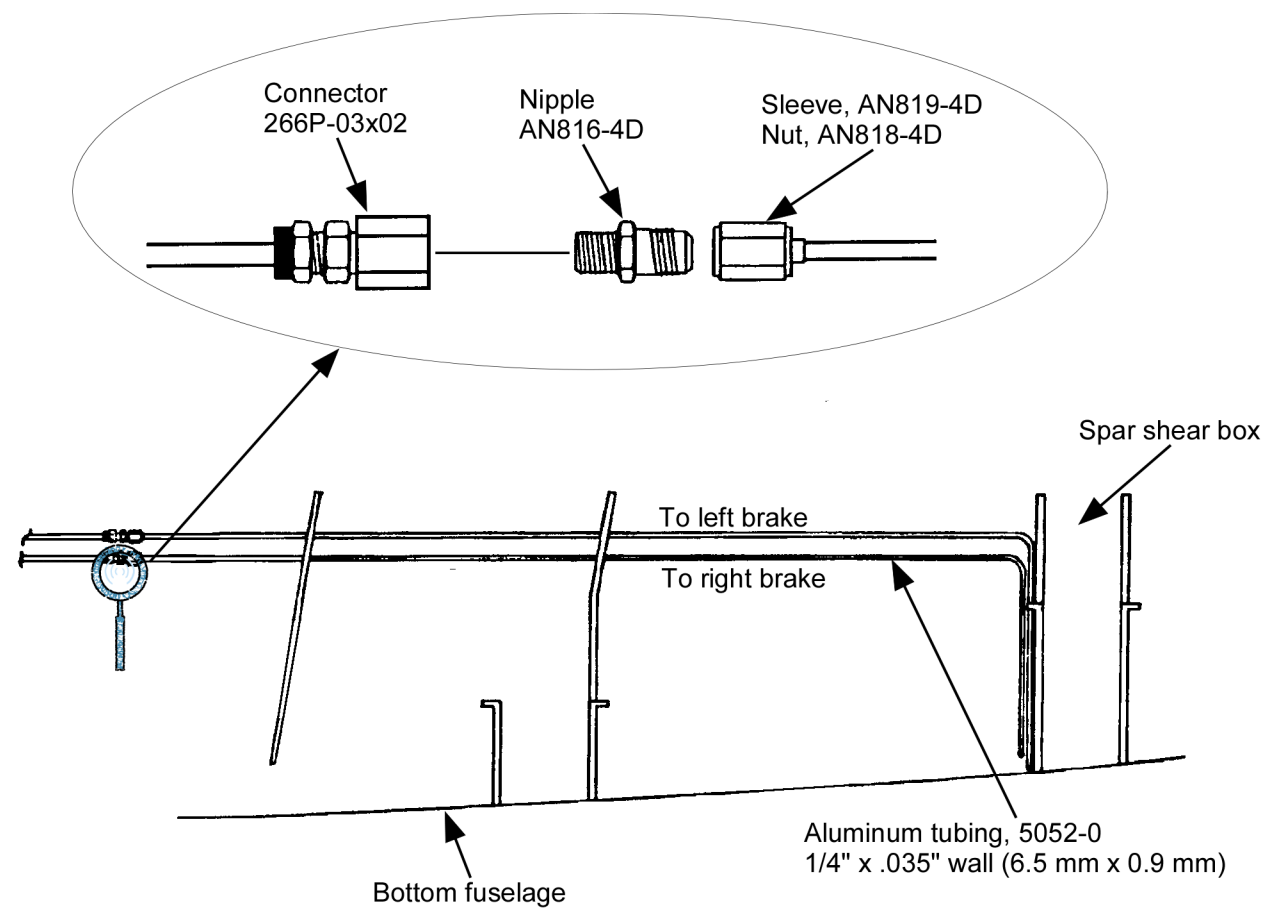
Grind holes in the fuselage side supports as required to run the brake line.

Figure 12.3.G.6 Securing hoses or fittings to the fuselage



8. Connect the connector fitting, 266P-03x02, to the aluminum tubing using a nipple, AN816-4D. Refer to Figure 12.3.G.7. Slide a nut, AN818-4D, and the sleeve, AN819-4D sleeve over the aluminum tube prior to flaring.
9. Flare the end of the tubing. If you need to review the flaring method, see Chapter 2, *Tube Flaring* on page 2.25.
10. Run the tubing to the bulkhead fittings on the forward side of the shear panel. Bend the tubing as needed. Make sure the left tube is running to the left rudder pedal and the right tube to the right ruder pedal.
11. Cut off any excess aluminum tubing and flare the end again if necessary.
12. Secure the aluminum tube to the bulkhead fittings by sliding the sleeve snugly against the bulkhead fitting. Then slide the nut against the sleeve and tighten. The sleeve and nut were slipped onto the aluminum tubing before you flared the end. See Figure 12.3.H.1 for a picture of the bulkhead fitting.

Figure 12.3.G.7 Aluminum through the cabin



12.3.H Filling the Brake System with Brake Fluid

To finish the brake system, you will fill the system with brake fluid and bleed the air from the system. The standard fluid for both hydraulic and brake systems is the MIL-H-5606 type and is available from Aircraft Spruce and Specialty or your local FBO.

Steps...

1. Fill the brake reservoir with fluid.
2. Loosen the bleeder valves on the bottom of the brake assemblies.
3. Pump the pilot's brakes until the system begins to fill, then close the bleeder valves.
Have a friend pump up and hold the brakes until the lines are pressurized. This will remove all the air from the brake system.
4. Crack open the bleeder valve for a moment to release the air.
Quickly close the valve in order to avoid allowing air back into the system.

Repeat these last two steps until there is no air visible in the Nylaflo lines and the brakes feel normal.

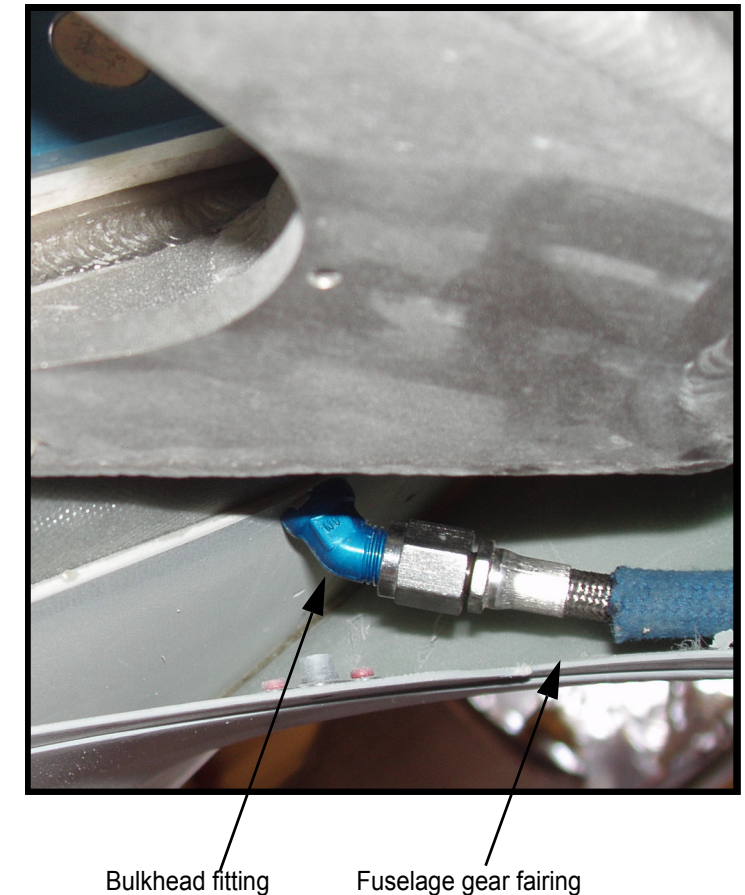
- PUMP
- HOLD VALVE OPEN
- CLOSE VALVE

Remember to refill the reservoir as the fluid fills the lines and master cylinders. It is hard to get every little air bubble out of the lines, but this is normal and should not affect brake performance if the air is kept to a minimum. Your brake system is now complete.

Figure 12.3.H.1 Bulkhead fitting for brake lines from inside the fuselage.



Figure 12.3.H.2 Right bulkhead fitting from exterior of fuselage



12.3.I Overview of the External Rudder Cable Installation

There are two methods for connecting the rudder pedals to the rudder control horn, the external or the internal. The standard connection method is for an external rudder connection and it is included with your kit. The internal rudder connection is an optional method and it is available through KCI.

External Rudder Cable

The schematic in Figure 12.3.I.1 provides an overview of the rudder cable layout. For the external rudder cables there are two, 1/8" (3 mm) diameter cables connecting the rudder pedals to the rudder control horn. The cables are routed through Nyloseal tubing that is bonded to the interior of the fuselage sides. The Nylaseal tubes are labeled "Dayco Imperial Nyloseal Tubing 44-NH-1/4-NSF."

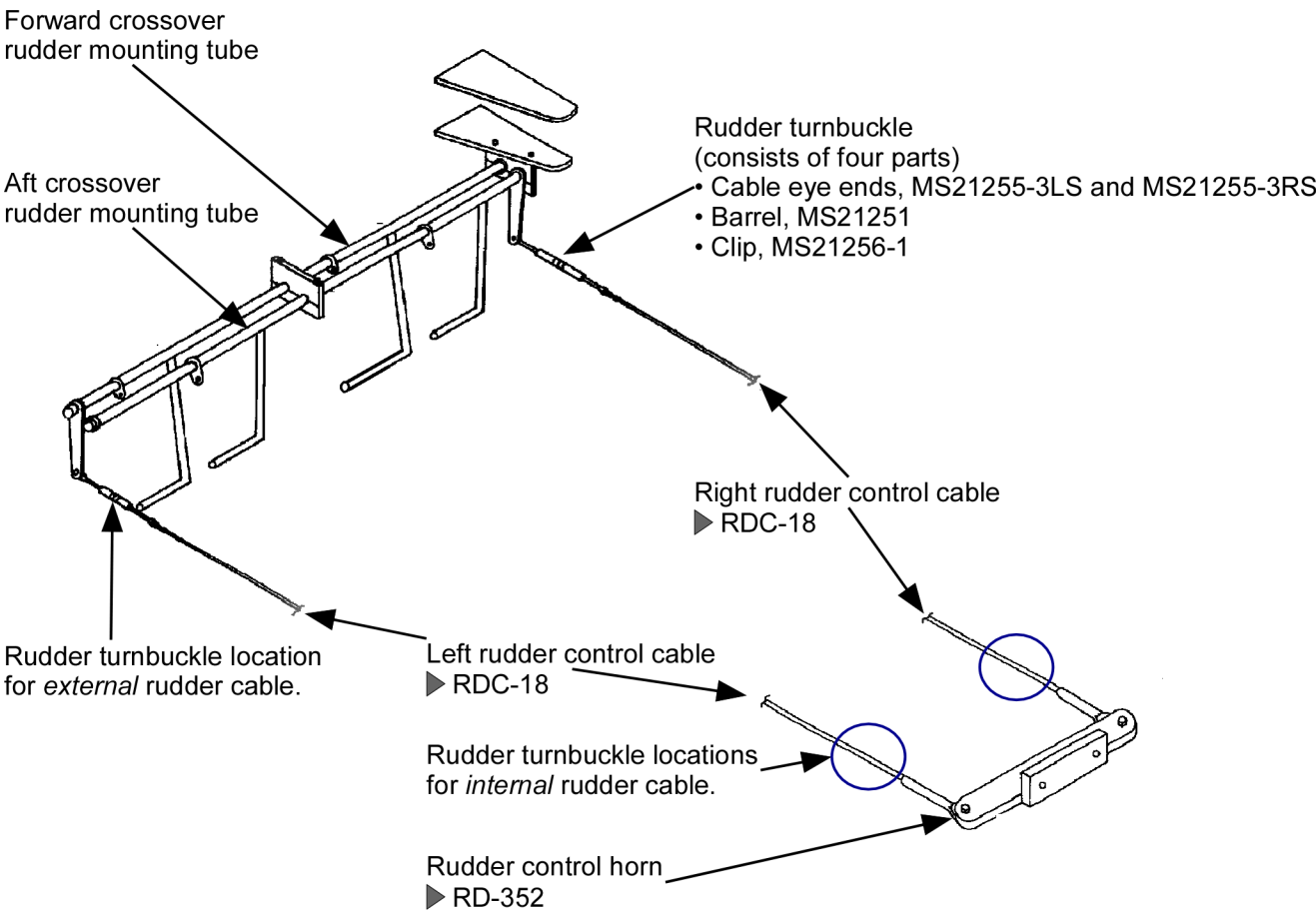
Overview of the Connections

Each rudder cable will have the following connections:

- Rudder control horn – connects the aft end of the rudder cable to the rudder control horn.
- Turnbuckle – connects the forward end of the rudder cable to the rudder crossover mounting tubes.

Tip: If you are installing an internal rudder cable, the two turnbuckles are swapped to the rear so you will have easier access for making future adjustments.

Figure 12.3.I.1 Rudder cable layout



Steps...

1. Grind an oblong hole in both sides of the fuselage, 8" (200 mm) forward of the rudder actuator arm as shown in Figure 12.3.I.2 and Figure 12.3.I.3.
Grind the holes at angles so the nylaflow cable housing can smoothly transition through each side of the fuselage.
2. Grind transit holes through the FS 244 and 185 bulkheads as shown in Figure 12.3.I.4 and Figure 12.3.I.5. The holes should be just large enough for the nylaflow housing.

Figure 12.3.I.2 Nylaflow housing passing through fuselage side

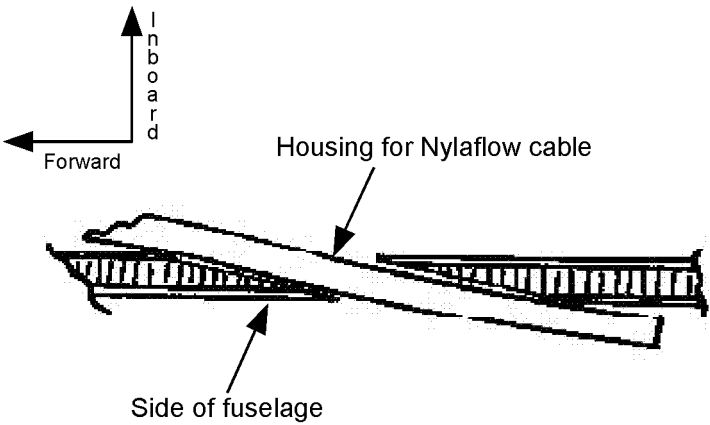


Figure 12.3.I.3 Transit hole sizing and location

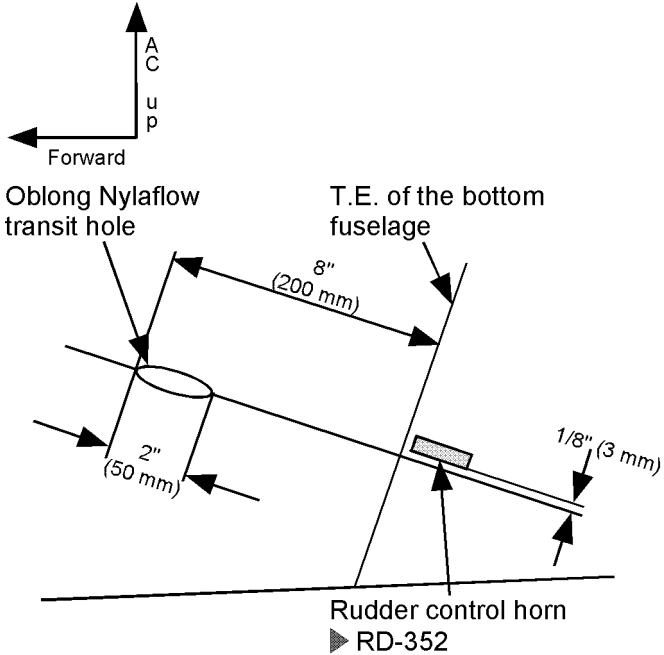


Figure 12.3.I.4 Transit holes in FS185 bulkhead

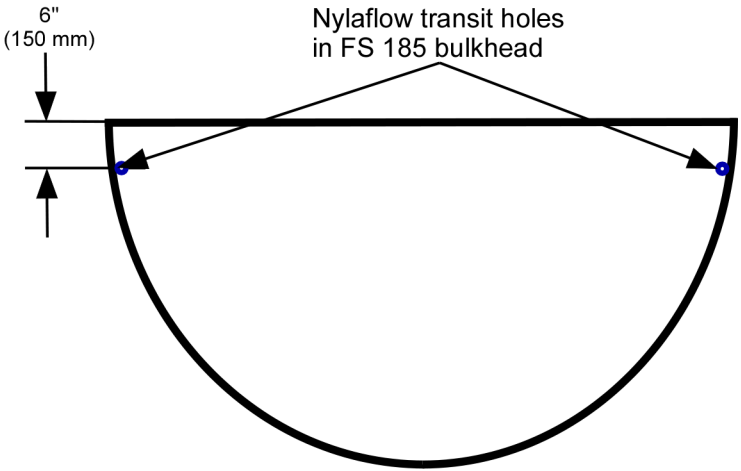
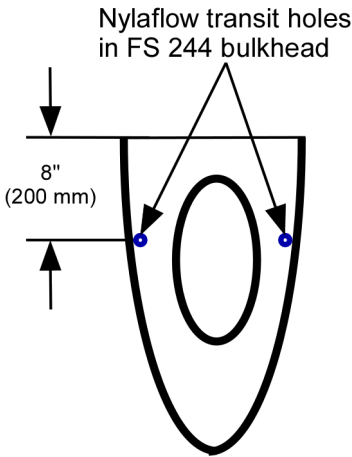


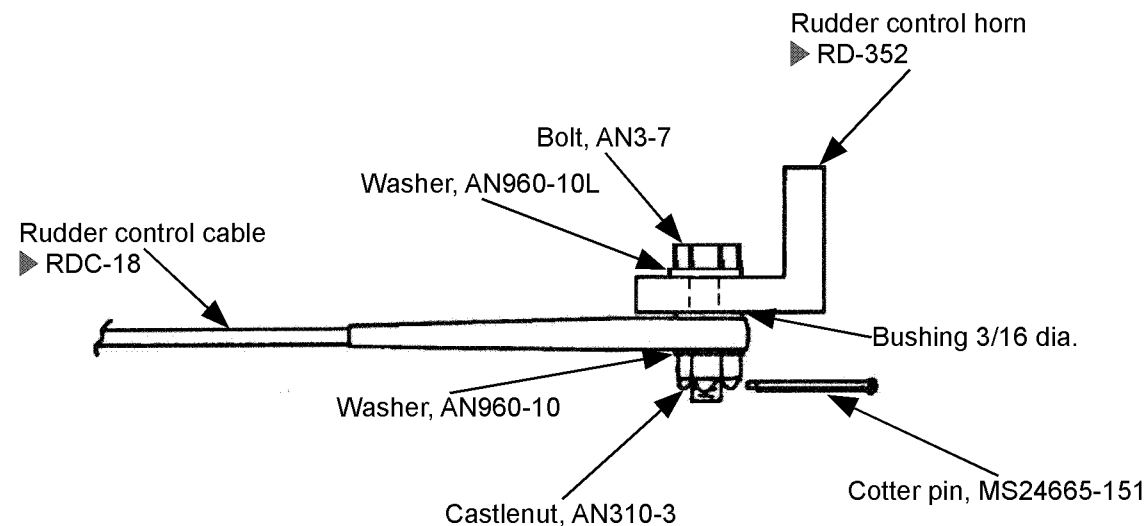
Figure 12.3.I.5 Transit holes in FS 244 bulkhead



3. Insert the rudder cables (RDC-18) into the nylaflow housings. The factory-swagged eye-end terminals are the aft ends of the cables.
4. Secure the eye-end terminals of the rudder cables to the rudder control horn (RD-352). Use AN3-7 bolts with a washer (AN960-10L) between the bolt and control horn. Place a 3/16" diameter bushing between the washer and the rudder cable. Add a washer (AN960-10), a castle nut (AN310-3) and a cotter pin (MS24665-151).

Tip: Do not tighten the castle nut so much that the eye-end cable terminal will not rotate. Snug up the castle nut just enough so there is no slop in the eye end, then use the cotter pin to secure the nut.

Figure 12.3.I.6 Securing the rudder cable to the control horn



5. Clamp the rudder in the neutral position.
Use a "C" clamp and a couple pieces of wood on both sides of the counterweight to avoid crushing the rudder skin.
6. Position the left and right rudder pedals in neutral.
7. Make two wood spacers to brace the rudder pedals and use a few drops of instant glue to hold the spacers in place.

The rudder cables are connected to the crossover tubes using turnbuckles. The rudder pedal position can be adjusted by adjusting the turnbuckle. If it becomes necessary to make an adjustment to the rudder pedal position, you will be able to make it at any time.

Figure 12.3.1.7 Neutral position for the crossover tubes

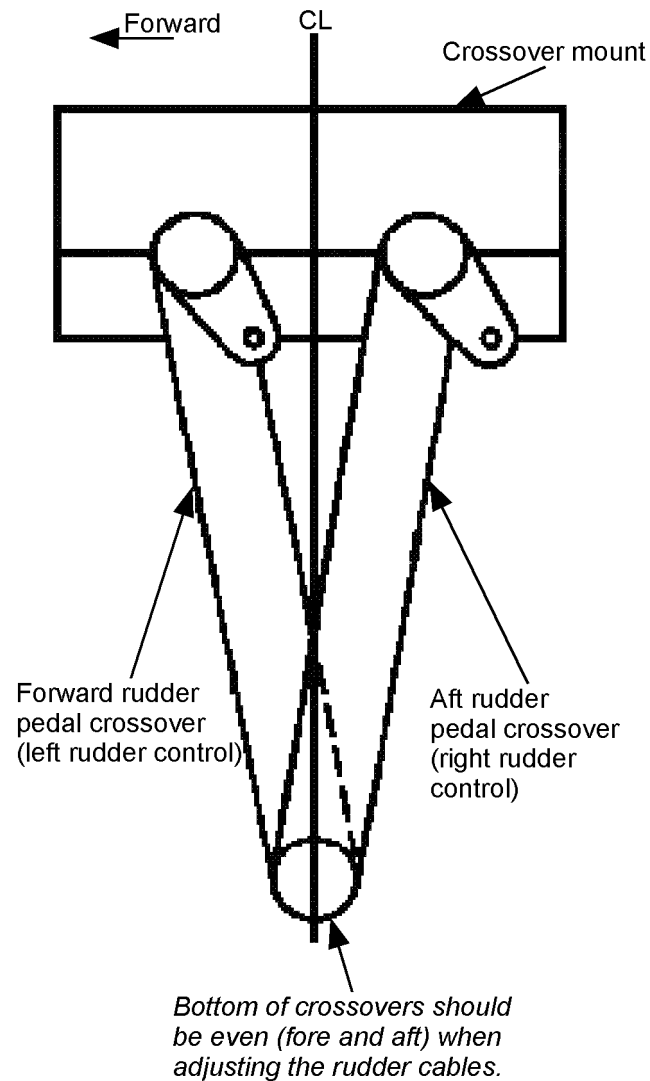


Figure 12.3.1.8 Rudder pedals in neutral



8. Assemble the turnbuckles using the following parts:

- barrel – MS21251
- cable-eye end – MS21255-3LS
- cable-eye end – MS21255-3RS

Don't insert the locking clips (MS21256-1) yet as they are hard to remove without damaging.

9. Thread the rudder cables through the Nicopress sleeves (18-3-M) and insert the cable thimbles (AN100-4) onto the cable-eye ends (MS21255-3LS).

Do not crimp the Nicopress sleeves yet!

10. Assemble the short, flex loop using 1/8" (3 mm) cable by threading it through two Nicopress sleeves as shown in Figure 12.3.I.11.

This small length of cable will relieve the twisting loads from the turnbuckle. Now you can go ahead and crimp the two Nicopress sleeves on the flex loop.

11. Secure the cable bushings (AN111-4) to the crossover arms with bolts (AN3-6), castle nuts (AN310-3) and small cotter pins (MS24665-151).

Do not tighten the castle nuts so much that you bind up the cable bushing. The bushing should be able to rotate.

12. Connect the turnbuckle and pull the slack out of the rudder cables without pulling the rudder pedal bars away from the wood spacer

13. Crimp the last two nicopress sleeves (those at the aft end of the turnbuckle). See Figure 12.3.I.10.

For now, do not insert the clips into the turnbuckle barrels. The clips are hard to remove without bending.

Any additional cable adjustment must be done with the turnbuckles.

Figure 12.3.I.9 Assembling the turnbuckles

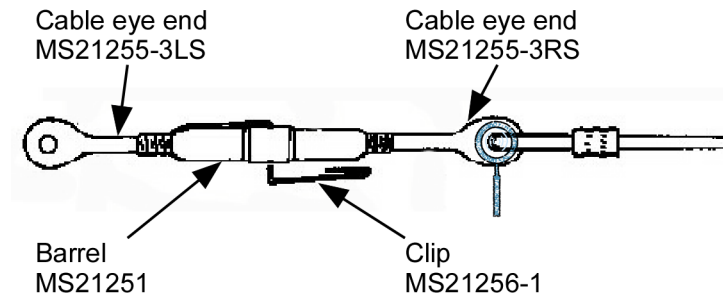


Figure 12.3.I.10 Attaching the turnbuckles to the cable

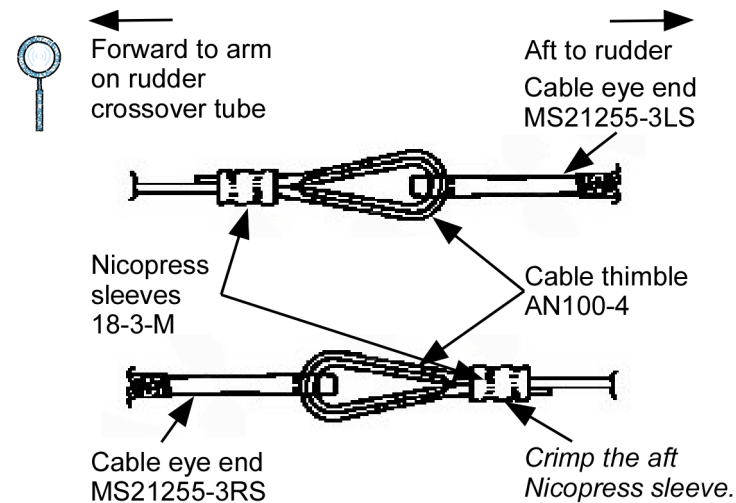


Figure 12.3.I.11 Assembling the flex loops – side view

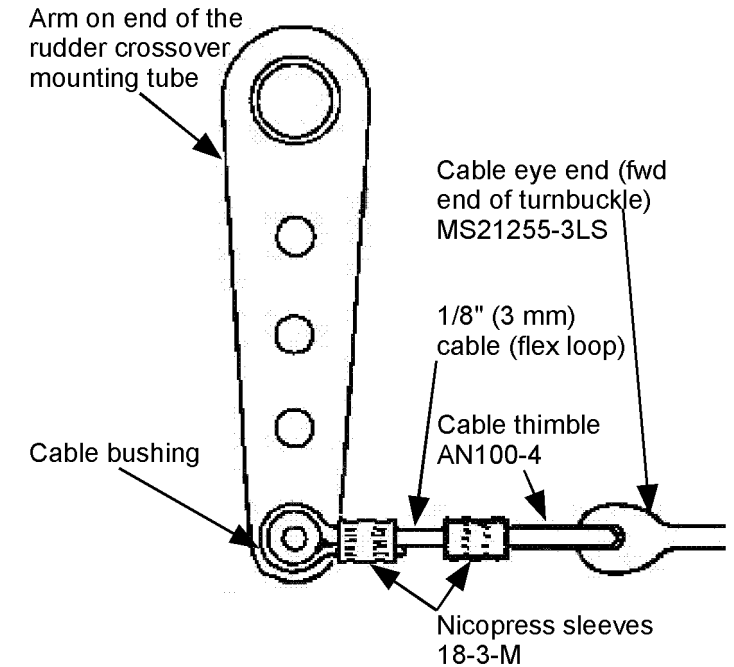


Figure 12.3.I.12 Assembling the flex loops – end view

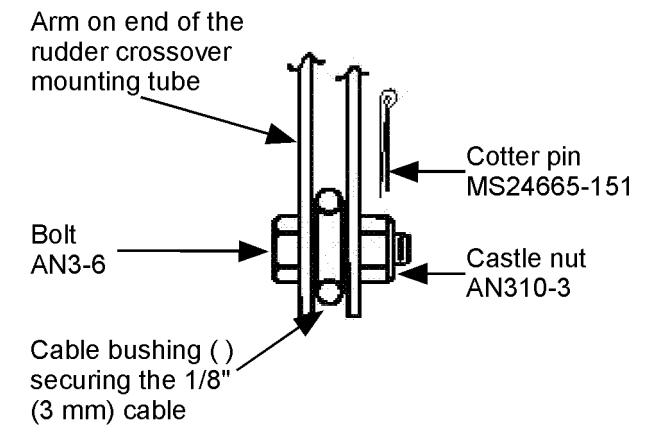


Figure 12.3.I.13 Installed turnbuckle

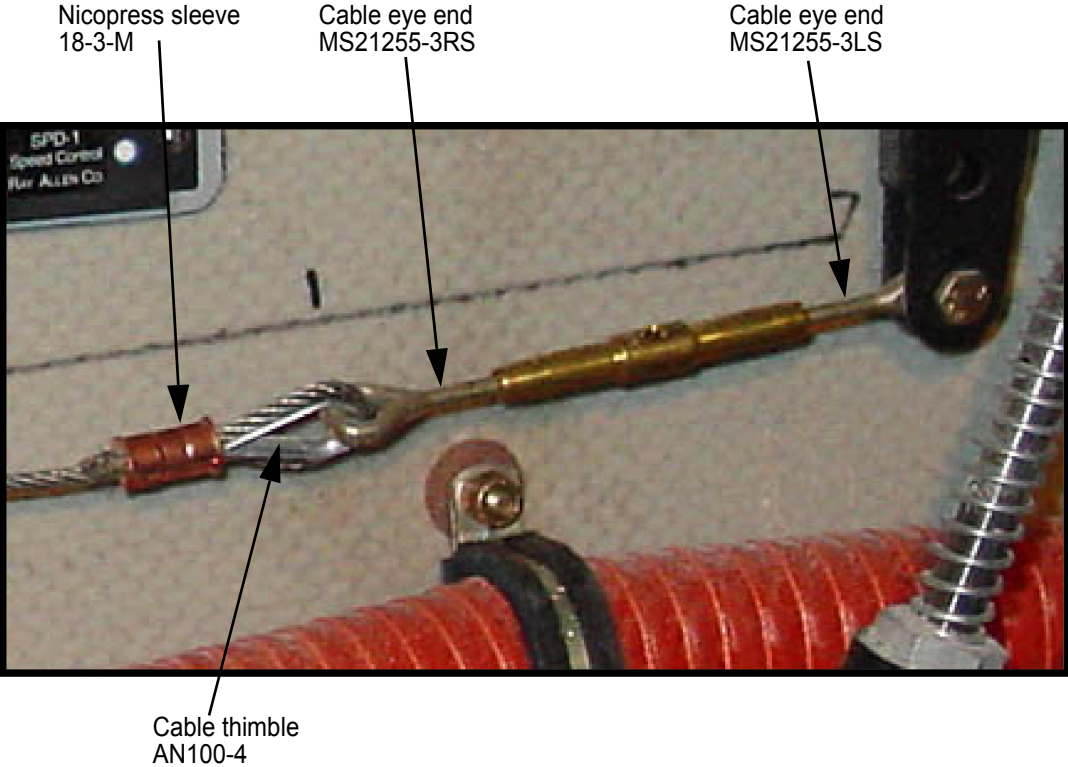
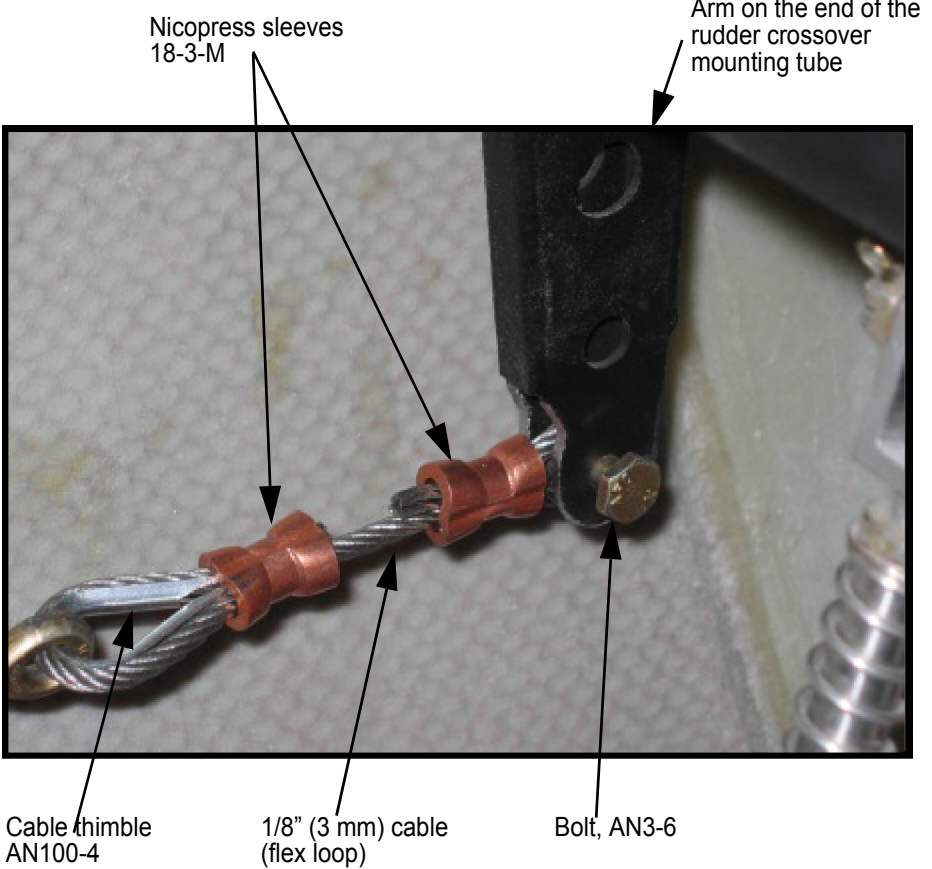


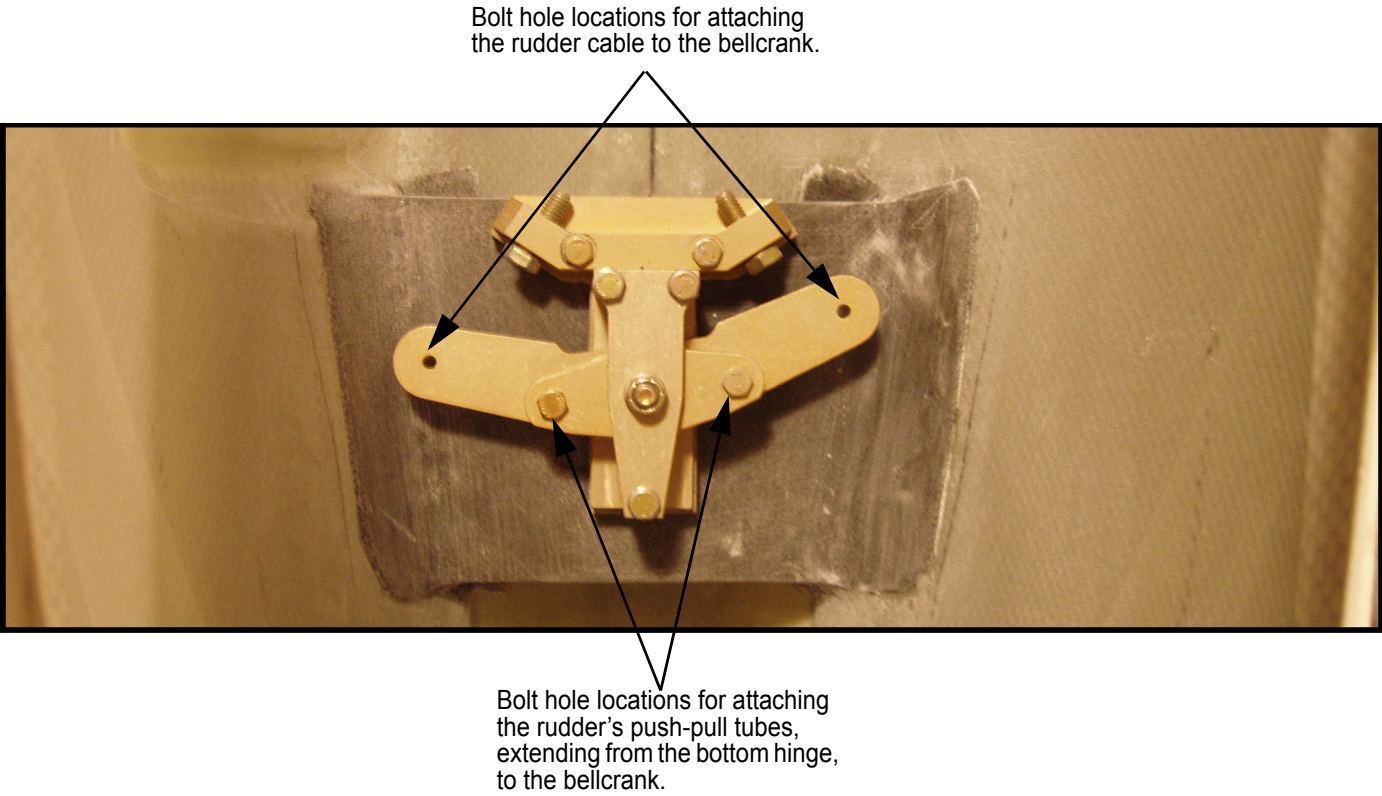
Figure 12.3.I.14 Installed flex loop



Internal Rudder Cable

To install the internal rudder cable, order part number RD-066-B. New instructions are included with the internal rudder kit.

Figure 12.3.I.15 Bellcrank for the internal rudder cable



12.3.J Installing the Rudder to the Vertical Stabilizer

To install the rudder’s three hinges to the vertical stabilizer’s hinges, you need three each of the following parts.

- Bolts AN4-10A
- Washers AN960-416
- Locknuts AN365-428A