

CHAPTER 12: RUDDER CONTROLS

REVISIONS

From time to time, revisions to this assembly manual may be deemed necessary. When such revisions are made, you should immediately replace all outdated pages with the revised pages. Discard the out dated pages. Note that on the lower right corner of each page is a "revision date". Initial printings will have the number "0" printed and the printing date. All subsequent revisions will have the revision number followed by the date of that revision. When such revisions are made, a "table of revisions" page will also be issued. This page (or pages) should be inserted in front of the opening page (this page) of each affected chapter. A new "table of revisions" page will accompany any revision made to a chapter.

Arrows

Most drawings will have arrows to show which direction the parts are facing, unless the drawing itself makes that very obvious. "A/C UP" refers to the direction that would be up if the part were installed in a plane sitting in the upright position. In most cases the part shown will be oriented in the same position as the part itself will be placed during that particular assembly step. However, time goes on and changes are made, so careful attention should be paid to the orientation arrows. That old cartoon of the guy agonizing over the plans for his canoe, built one end up, one end down, should not happen in real life. Especially to you.

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1. INTRODUCTION

The standard Lancair kits are supplied with pilot side rudder controls only. When flying the Lancair, rudder input is not normally required due to the differential ailerons. Some of our builders desire the rudder controls for the right side, they are available as an option. This chapter will discuss both, the standard installation and the "right rudder control option".

Rudder controls are via stainless steel cables. These cables are run through Nyla-Flow tubing as a guide through the fwd cockpit areas. Rudder pedal assemblies are attached to a sub-floor which will be installed adjacent to each side of the nose wheel well.

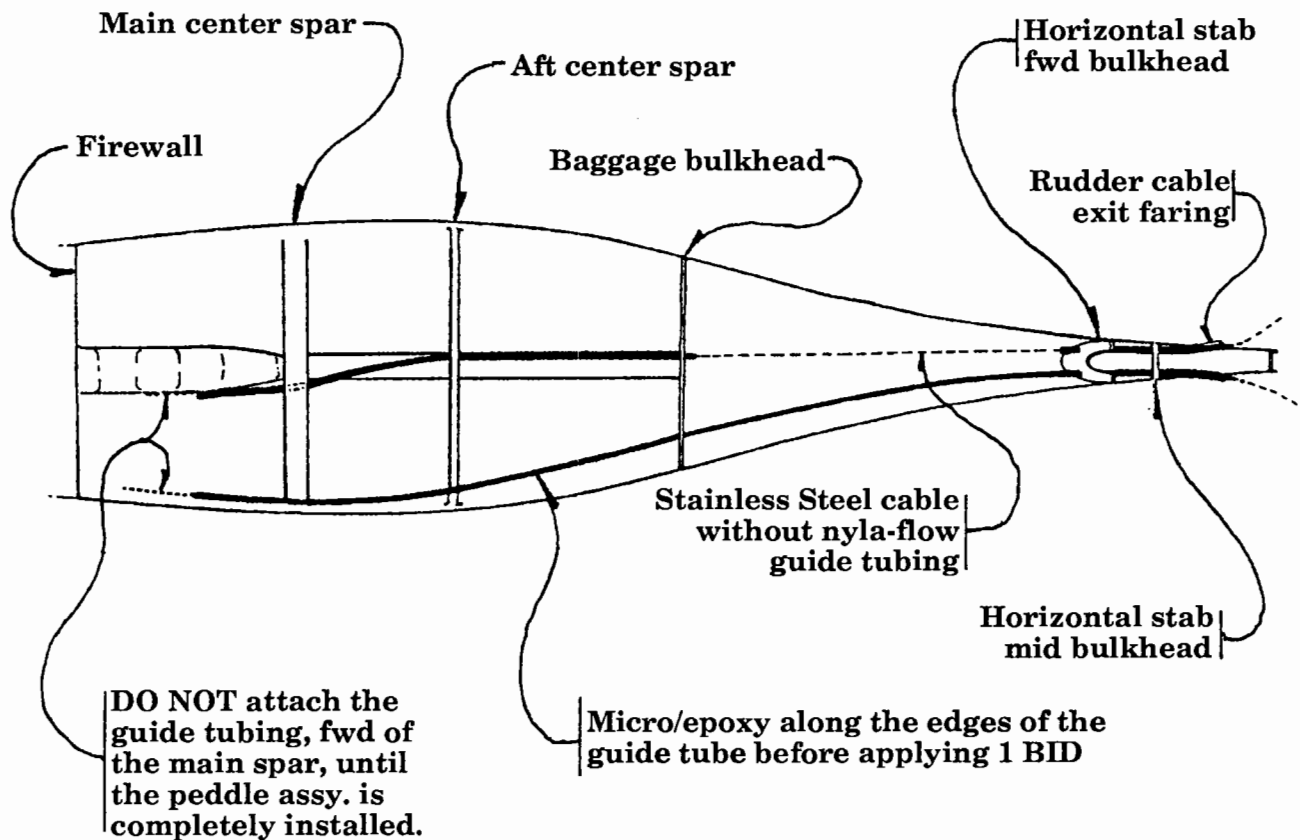
The standard installation is to permanently attach the rudder pedal assemblies to the fwd sub floor. An optional installation which allows for ground repositioning of the rudder pedal assemblies is also possible and will be shown.

READ THIS CHAPTER IN ITS ENTIRETY, BEFORE PROCEEDING WITH THE CONSTRUCTION.

Rudder Cables - Pilot Side Only

(Overhead view)

Figure 12-1



2. DRAWING LIST

Drawing	Page	Title
12-1	12-2	Rudder cables - pilot side only
12-2	12-7	Rudder cable exit faring
12-3	12-8	Right rudder guide tube
12-4	12-9	Rudder guide-tube routing
12-5	12-12	Guide tube - bulkhead exit
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12-10	12-21	Rudder pedal assembly
12-11	12-22	Rudder pedal system
12-12	12-23	Plywood slide plate
12-13	12-25	Plywood base plate
12-14	12-29	Rudder cable to control horn attachment
12-15	12-33	Rudder cable to pedal bar attach system
12-16	12-33	Brake / spring attach bracket
12-17	12-34	Dual rudder control system
12-18	12-35	Pilot side - dual rudder controls
12-19	12-37	Standoff / fairlead installation
12-20	12-38	Standoff pattern



3. EQUIPMENT REQUIRED - SPECIAL PARTS, TOOLS & SUPPLIES

A. Parts

- Rudder pedal assembly (supplied in kit, or 2, if passenger side is to be installed)

(Refer to list on page 12-19, and drawing 12-10 on page 12-20)

- Countersunk steel pop rivets (not supplied - for adjustable rudder pedal installation only - see page 12-26, step 6)
- Stainless steel rudder cable, with clevis on one end (supplied in kit)
- Stainless steel rudder cable, with thimble type termination (supplied in kit)



12-4

Chapter 12

REV. 0/ 11-1-91

RUDDER CONTROLS

B. Tools

- Ruler or tape measure
- Dremel™ type rotary grinder
- drill motor
- drill bits: 1/4"
3/16"
#12
- Small level or Smart-Level, or compass for measuring degrees of elevation
- Pencil
- Some small weight bags - 5 to 10 lbs., 1 or 2.
- Rivet squeezers
- Bench vise
- Hammer
- Cold chisel, with about a 3/4" blade (see note, page 12-27)
- 2) C-clamps, small
- **NICO PRESS CRIMPER - NOT PLIERS - THEY WILL NOT DO.**



C. Materials & supplies

- epoxy
- flox
- BID cloth
- micro
- 3/16" Nyla-Flow tubing
- sandpaper, assorted grit
- some 1/4" plywood or similar (for adjustable pedal system only)
- Duct tape
- MC or acetone for cleaning
- 1/4" prepreg, foam core, 1 BID per side
- Cardboard for templates
- 3/4" PVC tubing (not supplied)
- Soundproofing material - refer to page 12-16 for details, suggestions
- 1/4" phenolic
- light springs - not supplied - see page 12-31, Note under step 10.



4. PROCEDURE

A. Left foot rudder cable

(Standard - pilot side only installation)

1. Select the rudder cable guide material (3/16" Nyla-Flow tubing). You'll need some means of temporarily attaching this tubing to the inside of the fslg until the fiberglass BID tapes are applied, a hot glue gun works very well for this purpose.
2. The left cable guide will run along the left side of the fslg from the small fairing under the horizontal stab area to approximately FS 15 which is just forward of the main spar (over the wing L.E. fillet). See figure 12-1. Be sure NOT to attach the guide tubing fwd of the main spar.

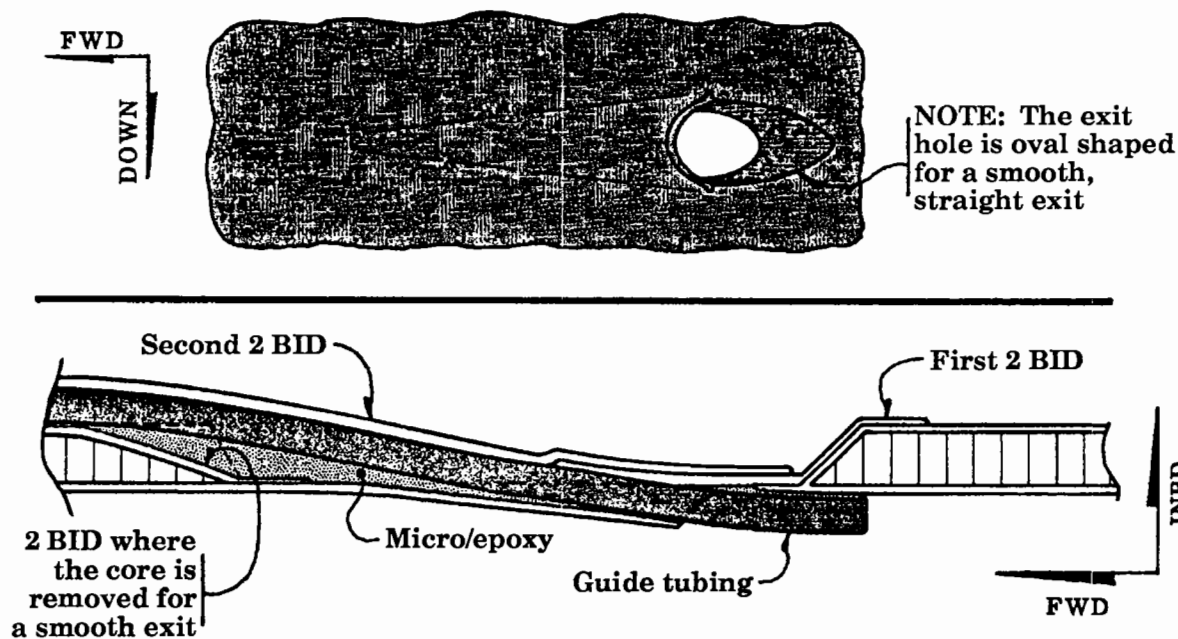
NOTE: Do not permanently attach or trim this guide tube (fwd of the load transfer pad) until the rudder pedal assembly is in position so that a good length and alignment check can be verified.

CAUTION: It is important to run the guide tubing in a smooth transition from fwd to aft along the fslg. If you were to route the guide tubing with sharp turns, the cable would tend to drag along those areas and resistance would increase. This increase resistance would tend to make the rudder control "heavy" and could induce cable guide wear.

The guide tubing will have to make some turns as it progresses along the inside contour of the fslg, but the point is to minimize these turns as much as possible.

Rudder cable exit fairing

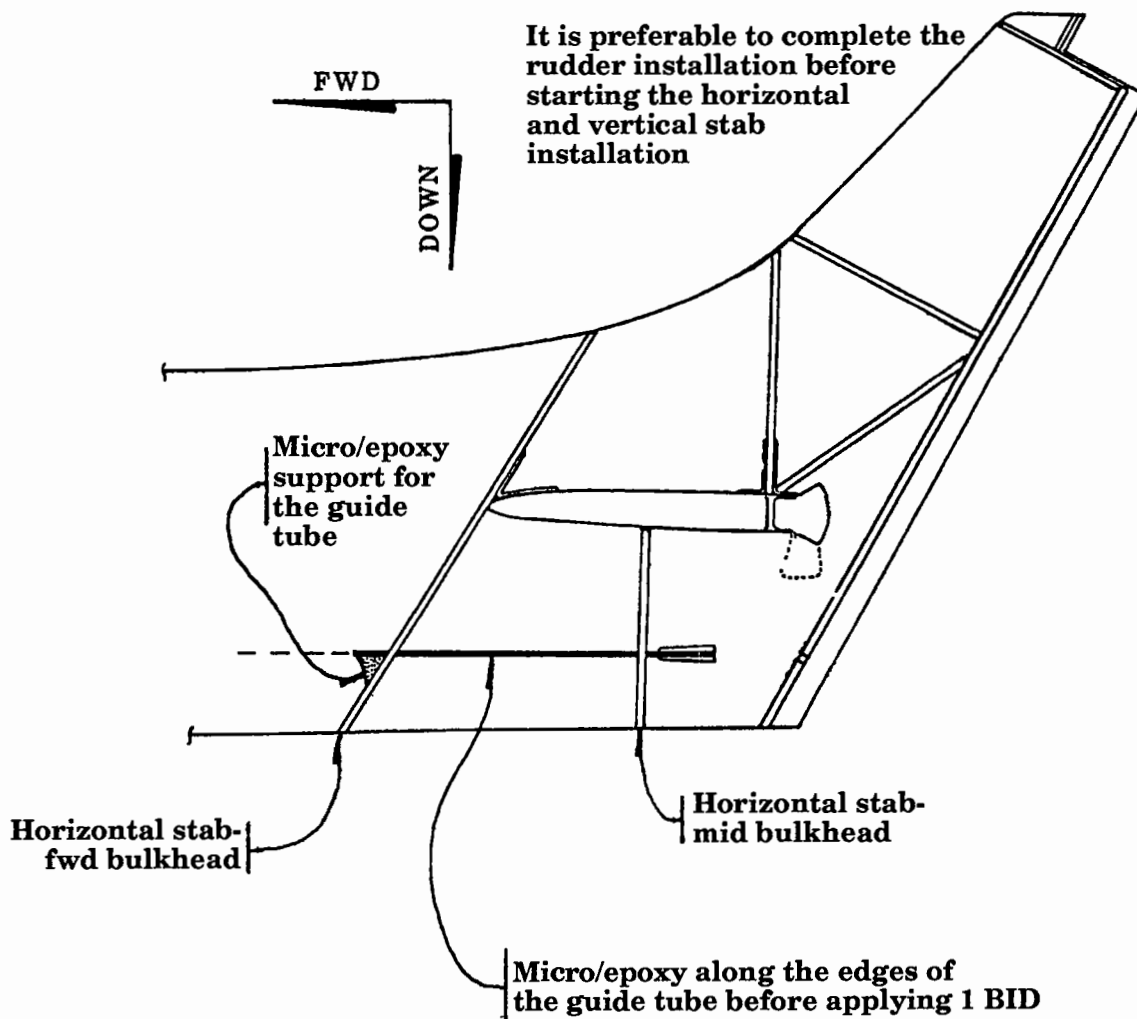
Figure 12-2



3. You can start at either the fwd or aft end, we'll start at the aft. Using a Dremel rotary tool or drill bit, open up a passage way through the end of the small fairing that sticks out from the side of the fslg, under the horizontal stab, just in front of the vertical post.
Slip the rotary file into the hole and grind away slightly into the side of the fslg, aft of this fairing such to allow the tubing to make a relatively smooth transition from the inside of the fslg to the outside and back to the rudder control horn. See figure 12-2.
4. Moving fwd from the aft fairing, the guide tube must lay along the inside of the fslg and punch through the two horizontal stab bulkheads. A long (min. 12") 3/16" dia. drill bit will work for this purpose. See figure 12-3.

Right rudder guide tube

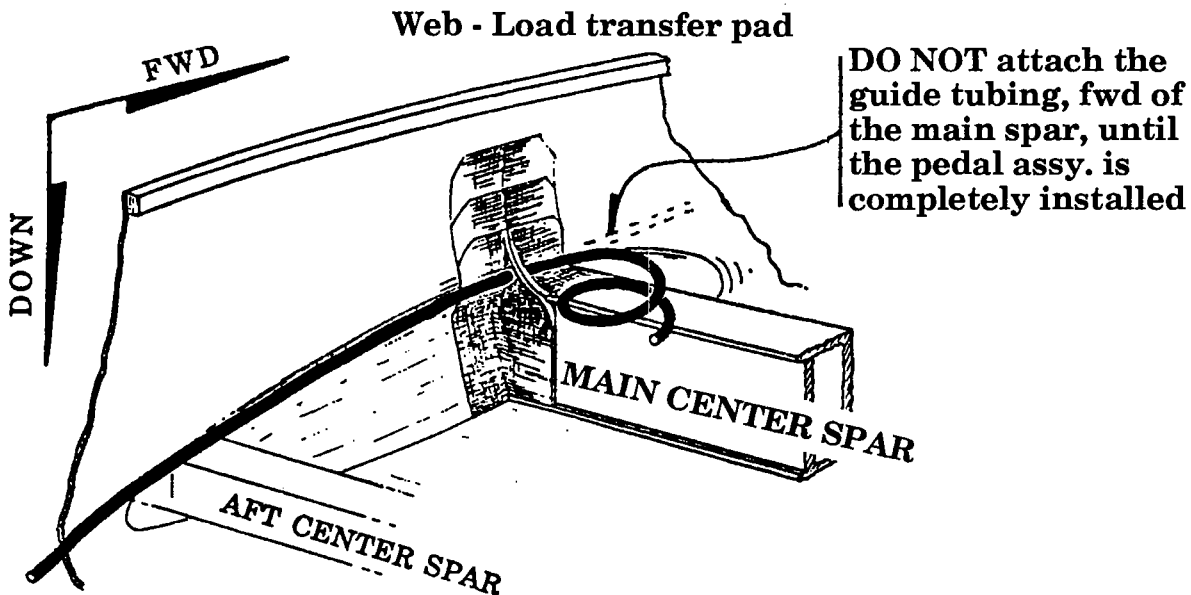
Interior view
Figure 12-3



Rudder guide - tube routing

(Aft spar - fwd)

Figure 12-4



5. Route the guide tube fwd to the baggage bulkhead. See figure 12-1. The tubing then routes fwd along the side of the fslg and follows the upper contour line where the wing intersects. The line will thus route over the aft ctr spar and along the upper edge of the cockpit close out web. Where the load transfer pads are positioned, another 3/16" dia. hole is drilled to allow the tubing to pass through. It will then route fwd above the wing fillet "roll" and terminate at a point approximately in line with the wing fillet L.E. See figure 12-4.

NOTE: Do not permanently attach or trim this guide tube (fwd of the load transfer pad) until the rudder pedal assembly is in position so that a good length and alignment check can be verified.

6. With the line "roughly" routed through the fslg and in relative position, pull it smooth and inspect the overall path to assure that it is as smooth and kink free as possible. Use a few pieces of tape to hold it in position for this inspection.
7. With the guide tubing taped in position and verified to be in the most ideal flowing path from aft to fwd, use a hot glue gun to better fix its position. A dab of hot glue about every six inches will be sufficient.

8. With the guide tubing tacked in place with hot glue, rough sand around the line (about an inch on each side of the tubing). Make a micro/epoxy fillet along both sides of the guide tubing, sand again and apply a 1 BID tape over the guide tube line. This BID tape should be about 1-1/2" wide (once again, do not apply the 1 BID from the load transfer pad area - fwd. Wait until the rudder assembly is positioned so that you can check the alignment).

9. At the aft end, trim the Nyla-Flow guide tube flush with the exterior of the exit fairing.



B. Right foot rudder cable

(Standard - pilot side only installation)

The right rudder cable will install in a similar manner with a few exceptions. See figure 12-1.

1. Locate and install the guide tube through the aft fslg fairing as performed for the left side cable guide tube. See figure 12-2.
2. Route the cable fwd through the two horizontal stab bulkheads. The line need only extend fwd of the "fwd horizontal stab bulkhead" by about 6" where it will end (This is different from the left side installation which routed the guide tube all the way fwd to the baggage bulkhead). See figure 12-1.
3. Drill a 1/4" hole in the baggage bulkhead located 1/2" above the bottom and 1-1/2" right of center line (passenger side). This is where the guide tube will begin once again. Since the rudder cable is suspended in air from the baggage bulkhead aft to the first horizontal stab bulkhead, the guide tubing is not required along that distance. The guide tubing should extend about an inch aft of the back face of the baggage bulkhead.
4. From the baggage bulkhead location, route the tubing fwd along a line that is 1-1/2" right of the center of the fslg bottom. The tubing will attach to the floor at approximately FS 63. Thus from FS 63 to the bulkhead, the tubing will angle upward (off the floor) as it moves aft to the baggage bulkhead. This section of tubing will later be attached to the floor or side of the console extension that must be installed in the baggage compartment to isolate and protect the controls. Leave this section of guide tubing loose until the console extension sides are installed. From the point where the tubing attaches to the floor (FS 63), it can start to angle inward toward the actual center line of the fslg.

NOTE: This is important since the console in the cabin area will only be 1-1/2" wide and the guide tubing must fit inside of its 1/4" walls.

5. The tubing will route under the aft ctr spar, along the floor and under the fwd main ctr spar. Through this area, it will cross to the left of fslg center line. At the fwd face of the main spar, the guide tube will angle upward to the left side of the nose gear tunnel. See figure 12-1 and 12-9.

The tubing must attach to the left side of the nose gear tunnel at a height that aligns well with the mount hole on the rudder bar. Thus, do not attach the tubing to the nose gear tunnel until the rudder pedals have been positioned and an alignment check can be verified. See figure 12-9.

6. Tape the guide tube into position and again use hot or instant glue dabs every 6" to temporarily attach it to the fslg.



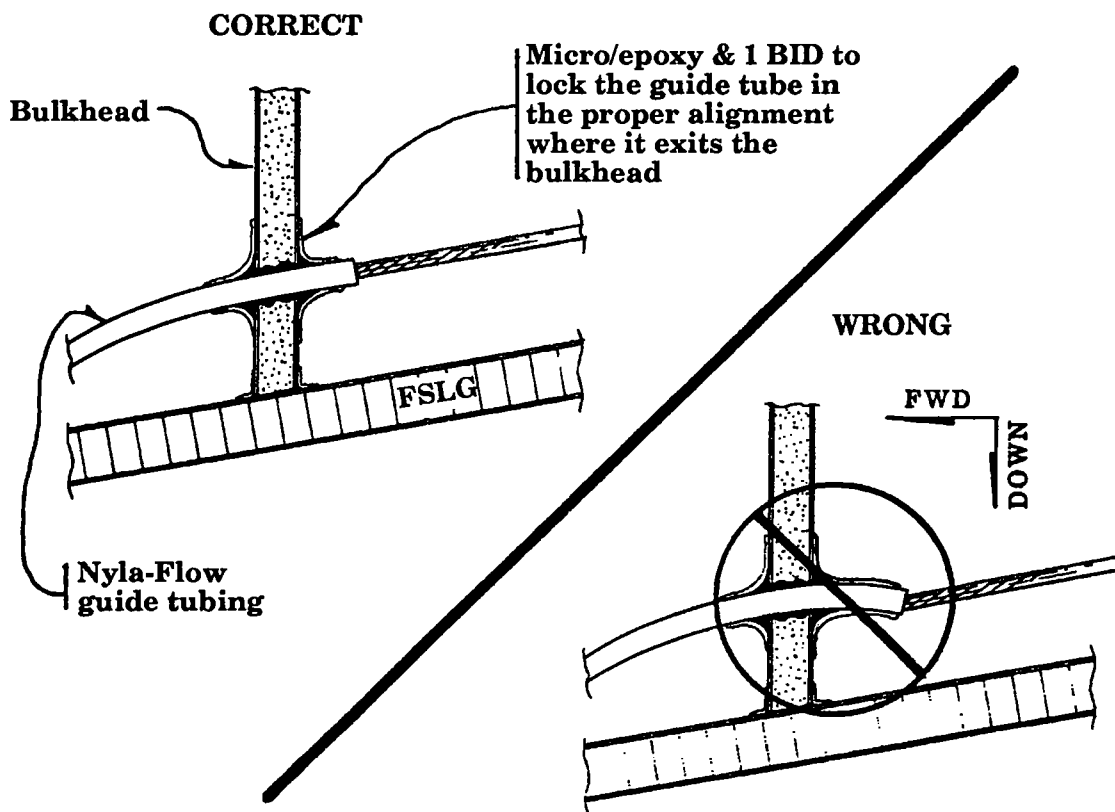
7. Next sand and clean an area extending 1" on each side of the guide tube, micro fillet along the tube, and add 1 BID ply over the tubing. Wrap a small piece of 1 BID around the piece of tubing that extends 1" aft of the aft face of the baggage bulkhead, and the similar piece of tubing on the fwd face of the horizontal stab L.E. bulkhead.

NOTE: It is advisable to route the actual cable through the guide tubing and pull it snug. This will require someone to hold it at the aft end while someone else pulls gently from the fwd end (or use clamps). With the cable pulled snug, note the relative angles at which the cable exits the guide tubing in the area between the baggage bulkhead and the fwd most horizontal stab bulkhead. The guide tubing should be anchored in a position that allows for a smooth exit and entrance of the cable. With a good entrance and exit established, use the 1 BID with micro (as a filling support) to lock in the desired guide tube termination points. See figure 12-5.

CAUTION: Failure to establish the above described smooth entrance and exit could result in excessive guide tube wear and possible malfunction of rudder control as a subsequent result.

Guide tube - bulkhead exit

Figure 12-5

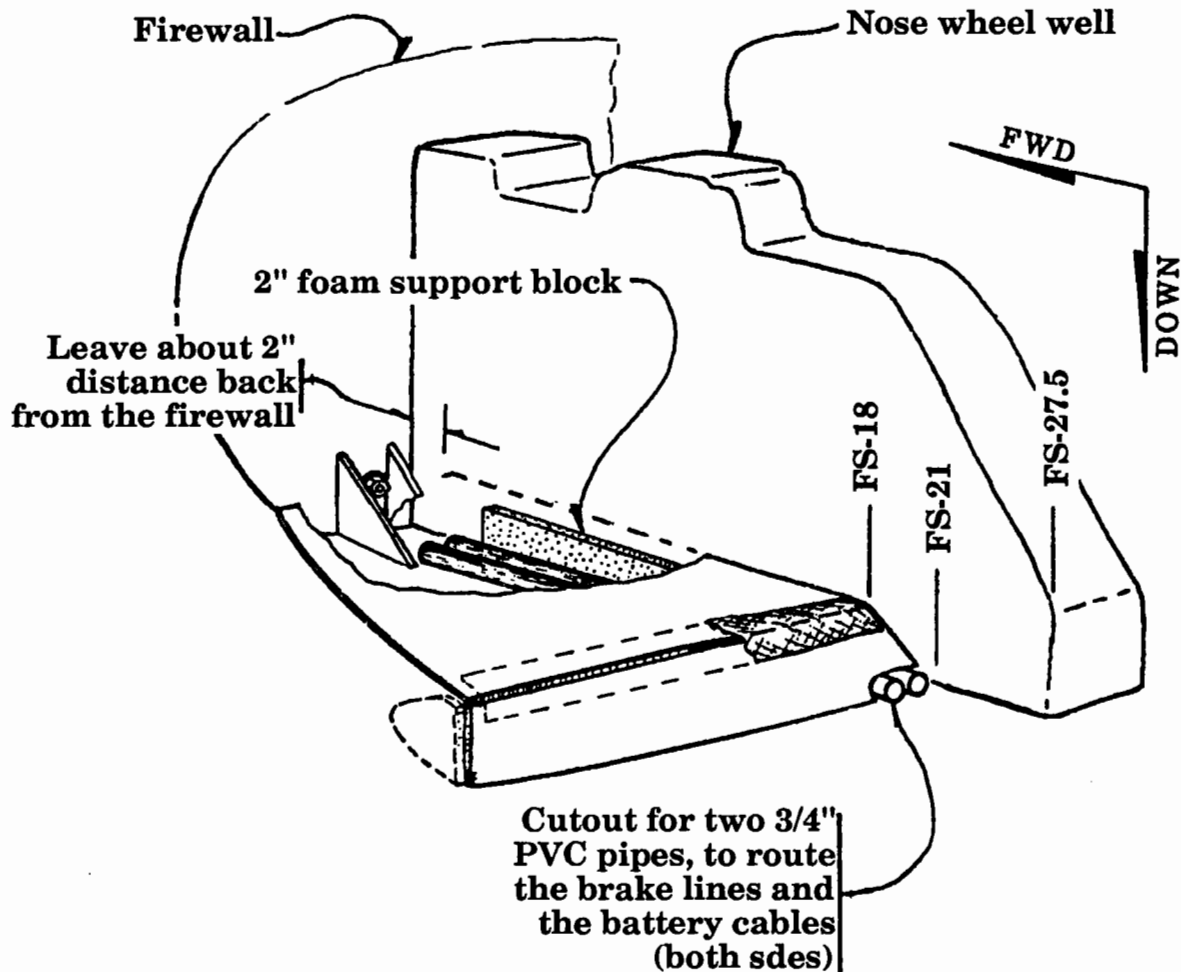


C. Cockpit sub-floor installation

The sub-floor is made of 1/4" foam core with 1 BID per side, additional BID will be applied later for stiffness. The sub-floor will extend from a point approximately 2" aft of the firewall, back to approximately FS 18 then angle down to the fslg bottom at about FS 21. These aft positions are at the builders discretion since they form an angle upon which your feet can rest during flight. These dimensions are generally acceptable and very comfortable.

Cockpit sub-floor installation

Figure 12-6



1. Select the "Cockpit Sub-Floor" template from blueprint "D". Make a cardboard pattern from this blueprint and check the fit. The floor should be flat and level relative to the longerons from left to right. The sub-floor will generally contact the tunnel sides about 2" up from the fslg bottom as measured along the vertical sides of the nose gear tunnel.

NOTE: This sub-floor can be positioned slightly higher or lower depending on your preferences. Positioning it higher will result in less "toe" room since the distance between floor and the bottom of the header tank would be reduced. Positioning it lower will increase "toe" room but also have the effect of making the floor narrower since it will contact the outboard side of the fslg at a point that is closer to center line due to the curvature of the fslg itself. Adequate room must always be maintained for access to the lower engine mount bolts and nuts. And the minimum width of the sub-floor is determined by the rudder pedal assembly since it must span across this sub-floor. See figure 12-9.

2. With the cardboard pattern fit, transfer that pattern onto the 1/4" foam core material and apply 1 BID per side. Use a grinder to sand a bevel along the outbd sides of the pattern to nest against the fslg. Place a 1/4" or 1/2" foam strip vertically against the side of the nose gear tunnel such that the inbd side of the floor can rest on it. This block can be held permanently in position with micro once it is sized properly. See figure 12-6.
3. Use a level to check that the sub-floor is in fact level, adjust the vertical foam strip as necessary to achieve a level condition.
4. Make a cut in the top skin of the sub-floor and through the core at about FS 18 so that the panel can be bent down to meet the fslg floor at about FS 21. Fit and position the panel. Place a couple of weights to hold it securely. Place a weight at the aft base to hold the angled panel down against the fslg floor as well. Add a little micro into the resultant wedge where the cut was made and apply 1 BID over it. Allow to cure in position, see figure 12-6.
5. Be sure that room is maintained at the fwd firewall end so that the engine mount attach bolts can be accessed. Also battery cables and hydraulic lines will be run through this fwd area down and under the sub-floor. See figure 12-6.

NOTE: It is not critical that the outbd, aft end of the panel wrap around and attach to the fslg and wing fillet area. This can however be done to create a neat looking installation but it is not required for strength. See figure 12-6.

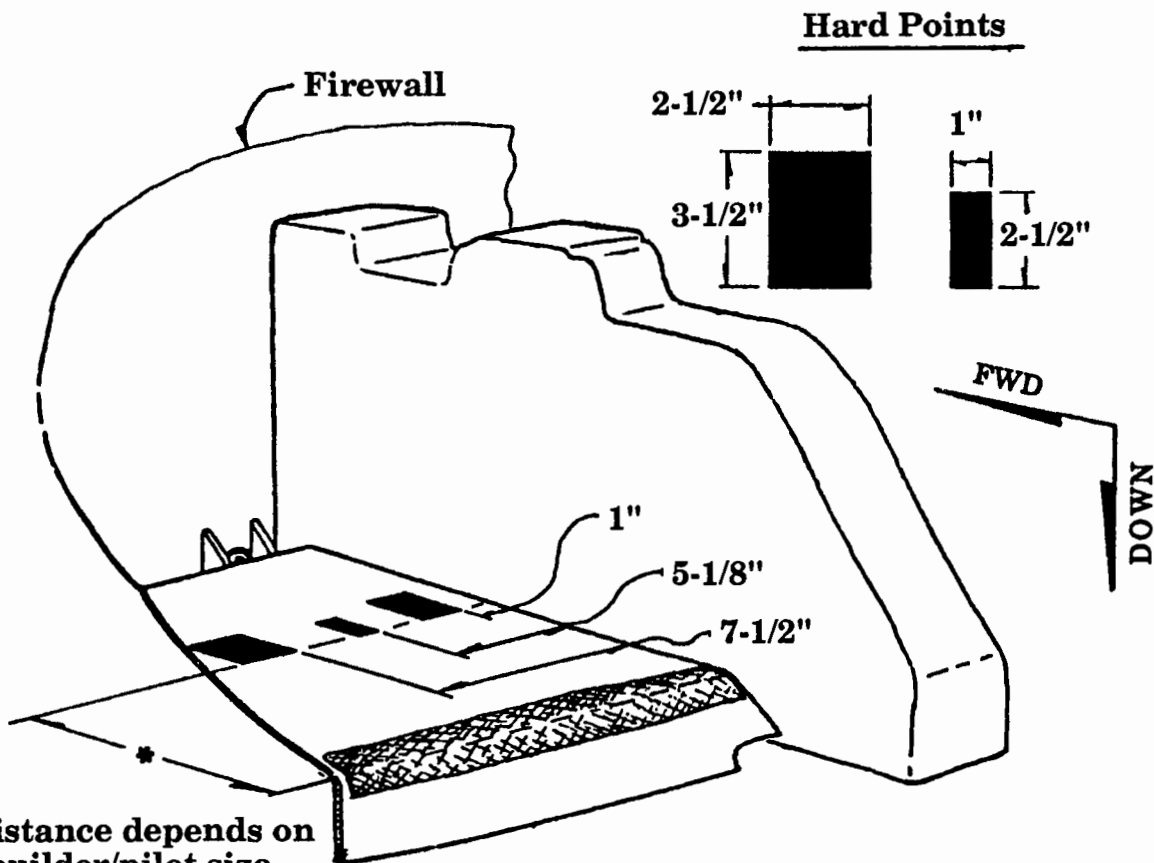


6. Per figure 12-6, insert a piece of tubing such that the brake lines can be routed under the sub-floor. Also, one battery cable (#4 wire) will be routed under the floor on each side of the tunnel. Thus two tubes (or one larger tube) are needed on the pilot side and one tube on the passenger side. Standard PVC tubing or equivalent from your hardware store works well, use two 3/4" dia. tubes. The tubing should be installed such that the lines can be inserted from the aft end and there is sufficient room remaining at the fwd (firewall) end to allow the inserted lines to turn 90° upward and exit the sub-floor area without placing any undue stress or strain on them. The tubes should be run along the side of the tunnel. See figure 12-6.

WARNING: Be careful to assure that there are no sharp edges along the ends of the inserted pieces of guide tubing that could chafe the brake lines, thus sand a smooth radius to the PVC tubing ends. A little bit of micro will be sufficient to secure the tubes in position (sound proofing and the sub-floor itself will also lock the tubes in place). Allow the tubes to stick out of the aft end by about 1/4" or so.

Sub-floor hard points

Figure 12-7



*This distance depends on the builder/pilot size

NOTE: For adjustable rudder pedals the hard points will be located / installed differently, refer to section "E", beginning on page 12-22.

7. Next, hard points will have to be installed into the sub-floor to anchor the rudder pedal assembly. For a standard, non-adjustable rudder pedal assembly, three hard points are needed, one center point and two edge points that will also anchor the brake master cylinder brackets. See figure 12-7 for locations.

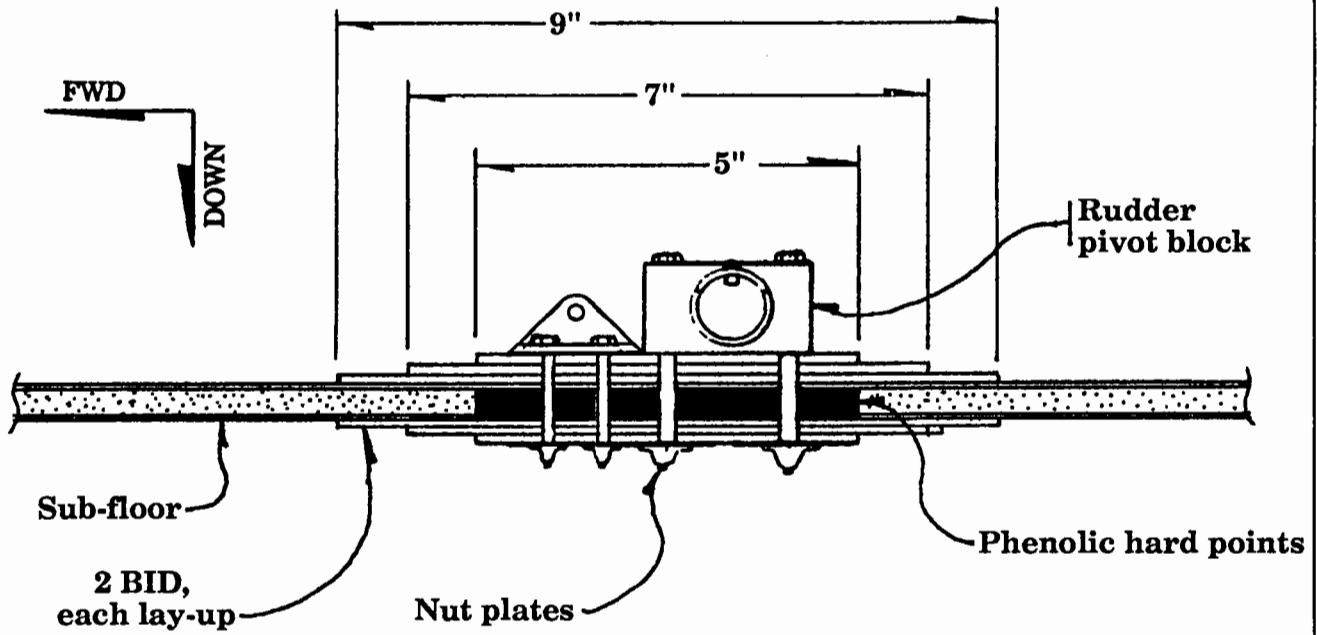
NOTE: The fwd/aft location for the rudder pedal assembly will depend on your desired location for the rudder bars. If in doubt, simply make the hard point blocks longer and wait until the cockpit installations are to a point where you can sit in the seat and establish your desired rudder pedal locations then drill and attach the rudder bar mounting nut plates to the underside of the sub-floor hard points.

8. With the rudder pedal assemblies in position, check the alignment with the cable guide tubes. Adjust vertically if necessary and add the last 1 BID to secure the left guide tube to the fslg side and the right guide tube to the nose gear tunnel side wall.
9. The sub-floor will require stiffening with additional BID plies. This is to accept the loads applied by brake pedal action. See figure 12-8.
10. The rudder pedal assembly is a simple tubular unit which rotates in three synthetic pivot blocks, see figures 12-9, 12-10 and 12-11. These blocks are normally attached directly to the fwd sub-floor. This provides for a fixed rudder pedal installation. If you require a ground **ADJUSTABLE RUDDER PEDAL SYSTEM**, then the pivot blocks will need to be installed onto a moving "base" which slides on the sub-floor, see section "E" , **ADJUSTABLE RUDDER PEDALS**.



Sub-floor reinforcement

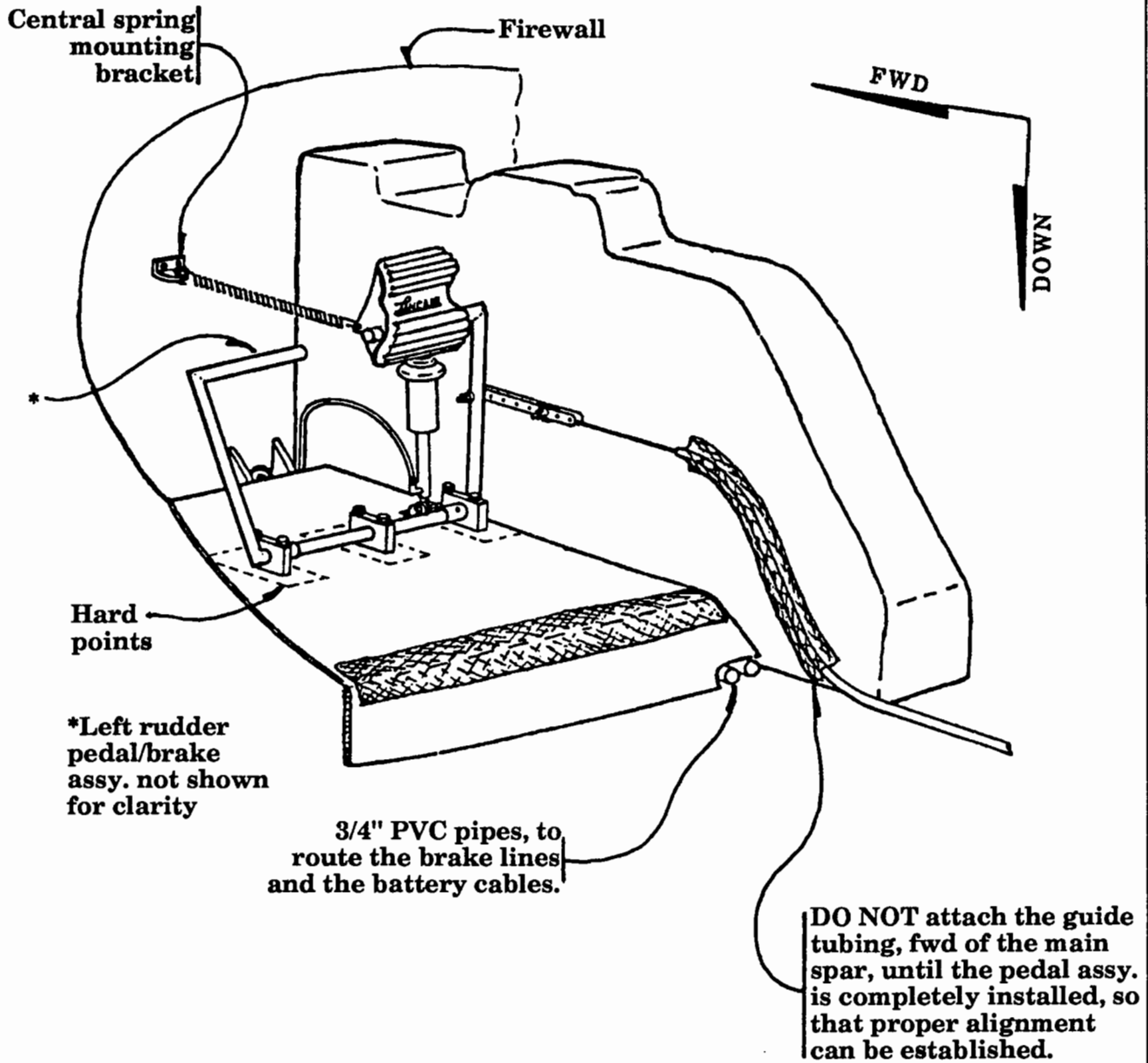
Figure 12-8



Rudder pedal assembly - installation

(Overview)

Figure 12-9



D. Brake cylinder and bottom mount bracket - installation, FIXED POSITION

Braking is accomplished via the cast rudder pedals which rotate on the rudder bars through nylon bushings, applying pressure to the master cylinders.

1. First, attach the *bottom mount bracket* to the bottom of the brake cylinder. Then attach the top of the brake cylinder to the back of the rudder pedal web. Both webs will have to be drilled (#12 bit) on each pedal, one hole is for the brake cylinder and the other is for the spring. Be sure to mount the brake cylinder to the inboard web (closest to the wheel well) on each pedal, even for the passenger side.

NOTE: At this point, the bottom mount bracket is not attached to the sub-floor. The bottom of the brake cylinder can be moved fore/aft and left/right to set the cylinder in proper vertical alignment.

2. Set the fore to aft alignment of the brake cylinder / bottom bracket just forward of the pivot bar (as close as possible, without touching the bar). Be sure that the left to right alignment of the brake cylinder is perfectly vertical. Mark the holes, move the bracket out of the way, and drill with #12 bit. The mounting holes must go through the hard points, or new hard points must be added.
3. Mount the bracket for the brake to the sub-floor per figure 12-8 and 12-9.
4. With the sub-floor hard points installed, and the additional BID plies added, the sub-floor can be permanently bonded into position. Use micro to pot it down and add 1 BID all around to attach it.

NOTE: It is highly recommended that a sound proofing material be packed solidly into the cavity between the fsfg floor and the sub-floor. This material can range from a spun fiberglass material to a foam based sound proofing material. All such materials should be fire resistant and not give off toxic fumes. One source for aircraft grade sound proofing is:

E.A.R.

Division of Cabot Corp.
7911 Zionsville Rd.
Indianapolis, IN 46268
(317) 872-1111

Use C-3002-25 & C-3002-50PSA

NOTE: If you are ordering this material, you might as well order enough to finish out the whole cockpit. E.A.R. has worked with Neico to assist in development of a set of materials for Lancair insulation. Upon contacting them, assistance can be provided. In general, the required materials are:

3 sheets	C3002-25 ALPSA
1 sheet	C3002-50 PSA
1 sheet	SD-40 ALPSA



RUDDER PEDAL PART LIST:

Qty	#	Description
2	1	Rudder pedal casting
4	2	Bushing, nylon
2	3	Position retainer (pedal) 7/8" x .058 Al. tube
1	4	Outbd rudder bar (angled)
1	5	Inbd rudder bar (squared)
3	6	Pivot block, nylon, rudder bar
2	7	Position retainer (rudder bar) 7/8" x .058 Al. tube
4	8	Adjusters - cable attach system
2	9	Brake cylinder
2	10	Attach bracket - brake cyl/base (Al. angle)

HARDWARE LIST:

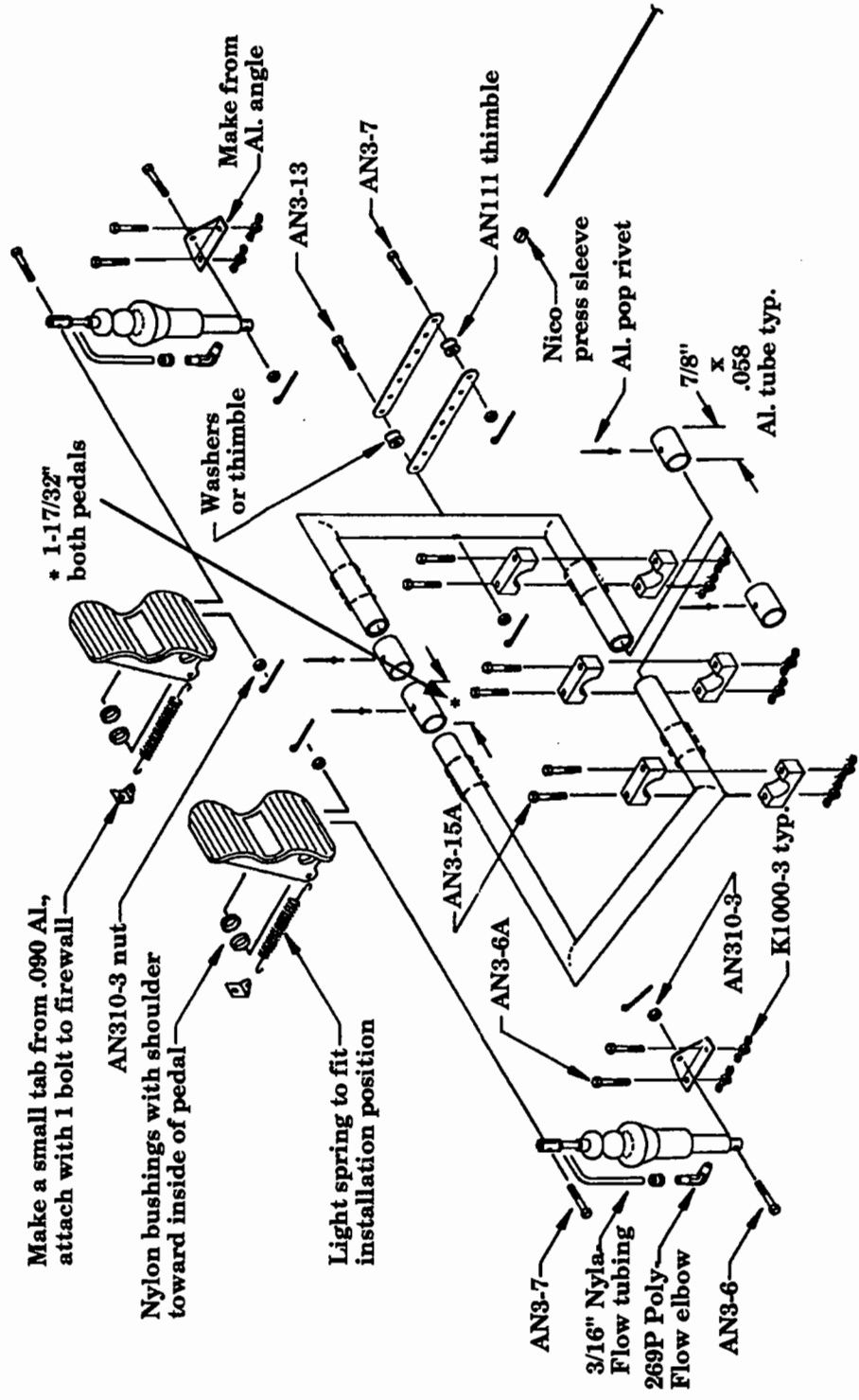
Qty	#	Description
2	1	AN3-6 bolt
6	2	AN3-6A bolt
6	3	AN3-7 bolt
2	4	AN3-13 bolt
6	5	AN3-15A bolt
4	6	AN111 thimble
8	7	AN310-3 nut
10	8	K1000-3 nut plate
6	9	AN960-10 washer
8	10	Cotter pin
4	11	Pop rivet
4	12	Poly-Flow elbow, 269P
50	13	Nyla-Flow tubing, 3/16"



Rudder pedal assembly

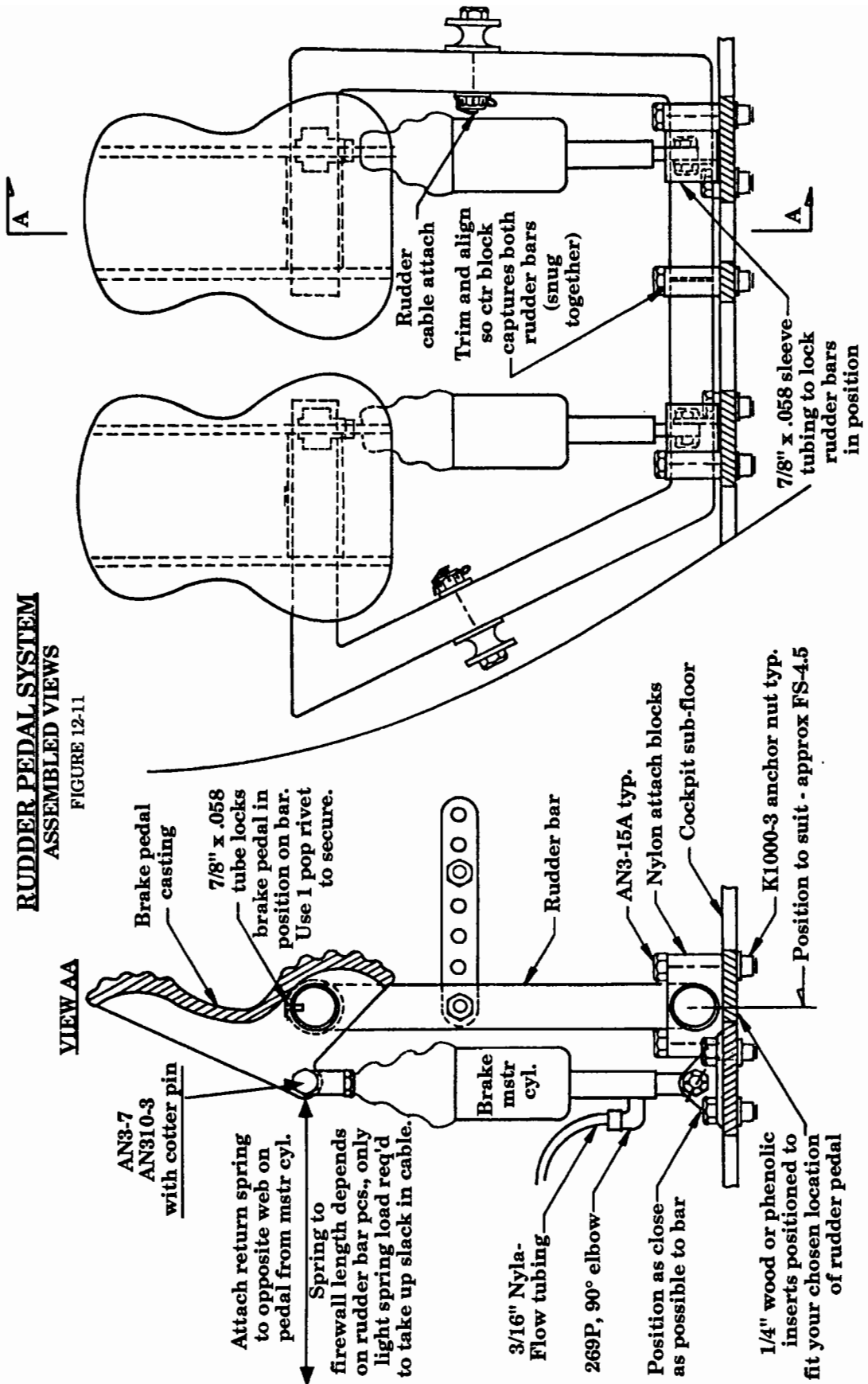
(Exploded view)

Figure 12-10



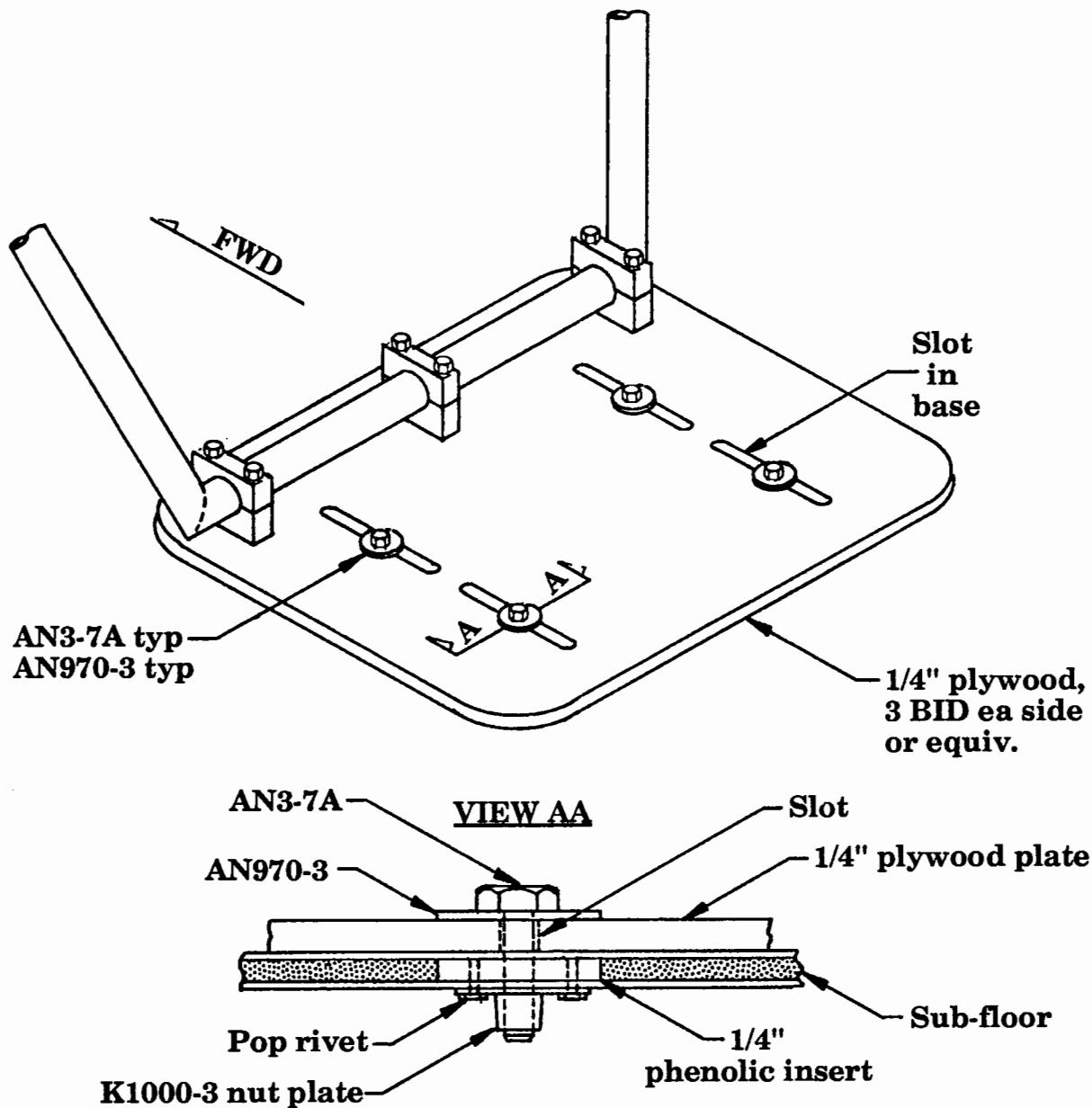
**RUDDER PEDAL SYSTEM
ASSEMBLED VIEWS**

FIGURE 12-11



- E. Adjustable rudder pedals, plywood slide plate system (optional)**
 If you are intending to install adjustable rudder pedals, their installation changes the procedure as follows: A slide plate must be made and the sub-floor hard points will be located differently to accommodate the slide plate. The sub-floor will be installed late in the procedure. The pivot blocks are mounted differently and the cable adjusters are made longer.

Plywood slide plate
 Figure 12-12



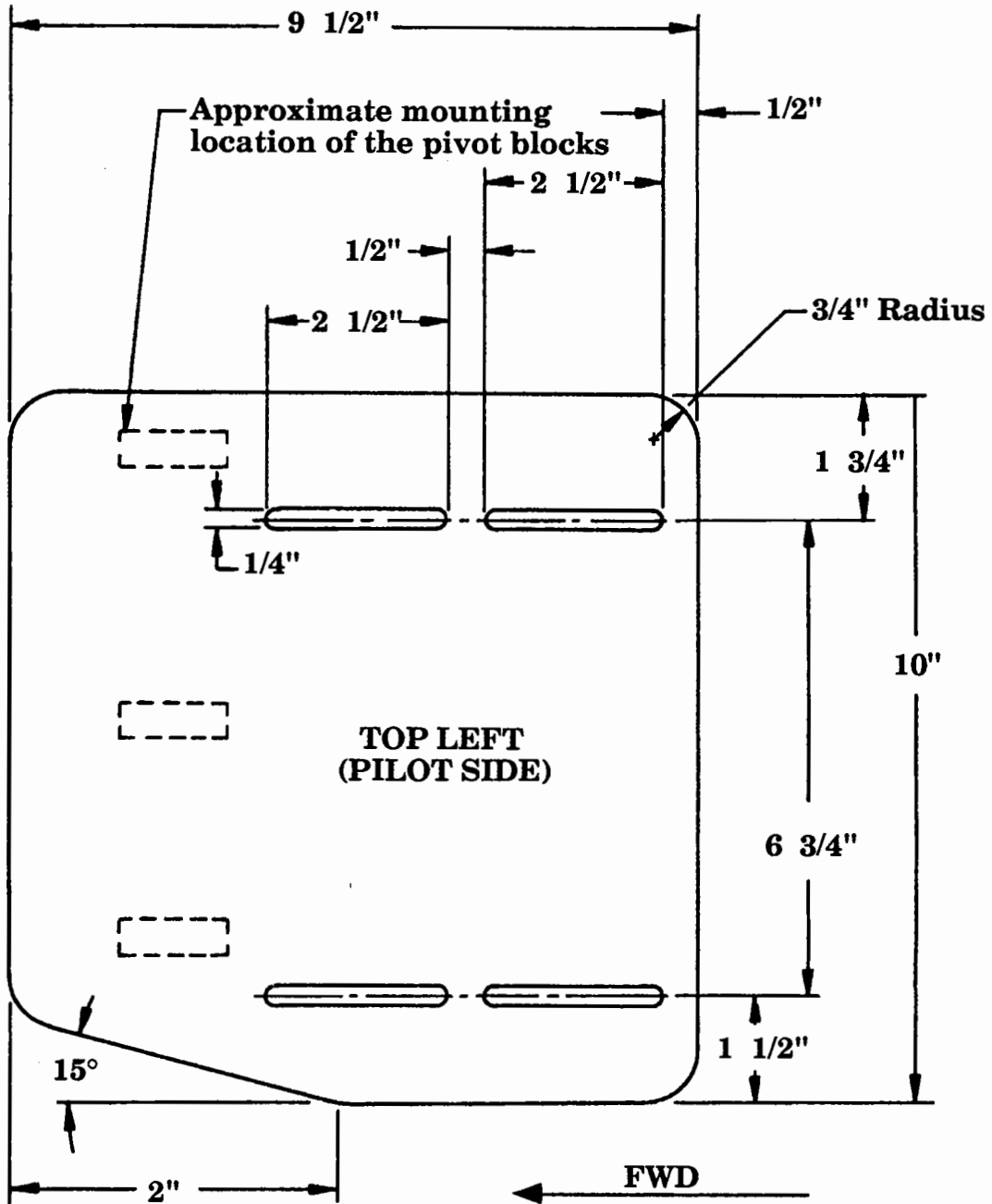
1. Make the "Adjustable Rudder Pedal Base" (base) from 1/4" plywood per figure 12-13.
2. Apply a lay up of 3 BID per side.

NOTE: The hardware on the underside of the assembled base must be flush.

3. Assemble and install the rudder pedal assembly to the base per figure 12-10 and 12-11 with the exception that the nylon Pivot Blocks must be mounted with counter sunk machine screws (MS24694-S70) from the under side of the wood base. And secure with AN356-1032 lock nuts. Also the rudder cable attachment adjusters must be made per figure 12-15, with the exception that the length must be *the length of your slots + 3"* (approximately). Braking is accomplished via the cast rudder pedals which rotate on the rudder bars through nylon bushings, applying pressure to the master cylinders.



Plywood base plate
 (Adjustable rudder pedal system)
 Figure 12-13



F. Brake cylinder and bottom mount bracket installation - adjustable

1. First, attach the *bottom mount bracket* to the bottom of the brake cylinder. Then attach the top of the brake cylinder to the back of the rudder pedal.

NOTE: At this point, the bottom mount bracket is not attached to the base. The bottom of the brake cylinder can be moved fore / aft and left / right to set the cylinder in proper vertical alignment.

2. Set the fore to aft alignment of the brake cylinder / bottom bracket just forward of the pivot bar (as close as possible, without touching the bar). Be sure that the left to right alignment of the brake cylinder is perfectly vertical. Mark the holes, move the bracket out of the way, and drill with #12 bit.
3. Mount the bracket for the brake to the sub-floor per figures 12-8 and 12-9. For adjustable pedals, use MS24694-S54 screws from underneath, and AN365-1032 lock nuts on top.



G. Sub-floor hard points - adjustable rudder pedal system

1. With the pedal/base assembly complete, sit in the seat to establish the desired adjustment range. Slide the pedal assembly to the aft most position. Remember that the length of the slots in your base will set the limit of the fore to aft travel.
2. Mark a reference line on the sub-floor at the aft edge of the pedal base assembly. Align the slots in the base, parallel to the nose gear tunnel. Carefully mark the outline of the base on the sub-floor.
3. Hold the base firmly. Use a 3/16" dia, bit. Drill into the sub-floor, through the fwd-most end, of each *aft slot*,
4. Put the AN3-7A bolts in the holes from the top, for alignment. Then push the base aft against the bolts. Drill holes in the sub-floor, at the fwd end of the *fwd slots*, in the same manner as above.
5. Remove the pedal assembly and the sub-floor from the fslg. Cut 1-1/2" squares through the bottom skin of the sub-floor, centered on the bolt holes. Remove the foam core material. Flox in 4, (1" x 1") phenolic hard points (1/4" thick) and cover with a (4" x 4") 2 BID lay-up on the sub-floor from the underside.
6. From the top side of the sub-floor, re-drill the bolt holes through the hard points. Then install the nut plates (K1000-3) from the bottom with countersunk steel pop rivets (not supplied).
7. Now the sub-floor can be installed per step 1, section D, page 12-19.
8. Install the pedal assy to the sub-floor, per figure 12-12.

**This is the end of the section dedicated to just the
ADJUSTABLE RUDDER PEDAL SYSTEM.**



H. CONTROL CABLE INSTALLATION (FIXED AND ADJUSTABLE)

1. Select the stainless steel rudder cable. One end must have a single clevis type receptacle on it and it must be bent down to approximately 25°. This can be easily accomplished by placing the "tab" end of the receptacle in a vise and carefully bending the shank downward until a 25° angle from straight is achieved.

CAUTION: Be careful when bending to not create any sharp creases from the bend. These could develop into stress concentration points and cause premature failure. A 1/8" radius should be the minimum bend radius. The purpose of this bend is to achieve a straight pull from the bare cable to the receptacle shank. This will thus not cause cable wear and the smoothly bent steel "tab" can easily take the required loads at the control horn. Insert the rudder cable itself from the aft end and push it fwd through the guide tubing.

WARNING: Do not use cable with thimble type terminations at this rudder attach position. A swaged end must be used.

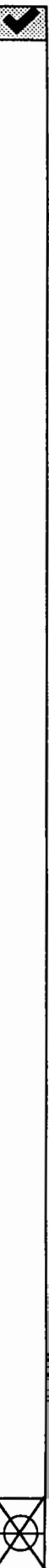
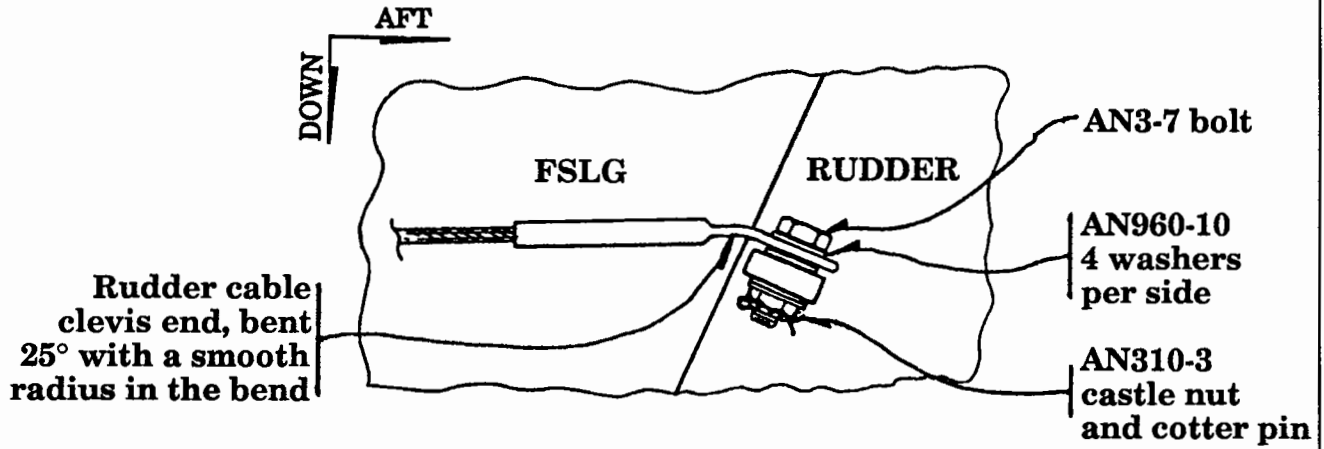
NOTE: It is extremely difficult, if not impossible, to achieve a nice cut on the stainless steel cable using a set of shears or dikes. A simple means of trimming this stainless steel cable is to use a good sized cold chisel (example: 3/4" dia. chisel about 5" long) and give the cable *only* one brisk (hard) smack with a hammer. The cable should be laid on a steel or aluminum plate for this hammer strike. This will produce a clean cut every time. Protect your eyes during this procedure since the cable end can sometimes fly up as a reaction to the impact.

2. Slip an AN3-7 bolt through the cable end clevis thus attaching at the aft end to the rudder control horn. Use an AN310-3 castle nut and cotter pin. There's no point in setting the cotter pin yet since you'll be taking the rudder off again for painting etc. See figure 12-14.



Rudder cable to control horn attachment

(aft end)
Figure 12-14



**I. Final rudder pedal to cable attachment & adjustment
(fixed & adjustable)**

1. Align the Nyla-Flow tubing (along the fslg side and the nose wheel well) for a, parallel to the floor, straight line pull with the #12 drill hole in the vertical bar on the pedal assembly.
2. Trim the guide tubing to allow 5" of exposed cable to the adjuster with the pedal in its aft-most position.
3. Secure the guide tubing in position with 1 BID, see figure 12-9.
4. Clamp the rudder in neutral, centered position.



J. Rudder bar travel & neutral position (fixed & adjustable)

1. Establish the rudder pedals travel and "neutral position" as follows:
Travel should be 1-3/8" fwd & 1-3/8" aft of "neutral position". This is measured at the #12 drill hole in the vertical member of the bars. Note where the brake cylinder begins to compress during the forward travel of the rudder bar, and be sure that the fwd extreme stops short of brake cylinder compression.

NOTE: We have found "neutral" to be approximately 15° aft of vertical for most installations. The rudder pedals should be adjusted such that with normal foot movements, no braking action is applied to the pedal assembly (i.e., the brake master cylinder is not depressed during normal rudder pedal action). It should take a concerted effort to apply brake action with the toes.

FOR THE ADJUSTABLE RUDDER PEDAL SYSTEM, set the base in the middle of it's fore/aft travel, as well.

2. At the fwd end of the rudder bars, the cable attachment will be per figure 12-15. This will require that you make four "Adjuster" pieces per figure 12-15.

NOTE: IF DUAL RUDDER PEDALS are to be used, then 8 adjusters will be required.

3. Bolt the adjusters to the outside of the vertical pedal bar, with the castle nut and cotter pin on the inside of the bar. Use washers between the two adjusters, as spacers, to get the same thickness as the AN111 thimble, or use an extra thimble as a spacer. Do not secure the bolt too tight, the adjusters must pivot with the pedal movement.
4. Slide the Nico Press Sleeve onto the exposed rudder cable.

NOTE: The following steps will be much easier with a helper, two hands are not enough.

Only one adjuster is used to position the thimble on the cable, otherwise the other adjuster would prevent finger access to the cable / thimble / press sleeve.

5. Temporarily insert a bolt through the AN111 thimble. Push one of the pair of adjusters out of the way, insert the bolt into a hole in the middle of the other adjuster.
6. Wrap the cable around the thimble and thread it back through the Nico Press Sleeve. Now, pulling on the end of the cable, work all of the slack out, until the cable is tight. Slide the Nico Press Sleeve up tight against the AN111 thimble and hold the press sleeve in position with finger pressure.



7. Remove the bolt from the thimble and adjuster. Crimp the Nico Press Sleeve **SECURELY**, in the middle and on each end of the Nico Press Sleeve so that it is evenly crimped.

NOTE: There are many brands of crimpers available in a wide price range. Even the lower priced tools work well, **BUT BE SURE TO FOLLOW THE MANUFACTURERS DIRECTIONS!!**

WARNING: Nico Press Sleeves **MUST** be crimped with proper crimpers. Pliers are **NOT** sufficient.

NOTE: When setting the cable lengths, the angle of the pedal / bar assembly will effect the cable length. It is best to sit in the seat, with padding to simulate the upholstery thickness, and have someone assist in marking positions. Allow 1-3/8", measured at the cable attach point on the rudder bars, fwd and aft of neutral for rudder bar travel, for a total, fore to aft travel of 2-3/4".

8. Trim off any excess cable.
9. Bolt the crimped thimble / cable end between the adjusters at mid point.
10. Repeat the process for the other pedal.

NOTE: Light springs should be added to the assembly from the back of the pedal to the firewall. This is merely to keep the pedals up and a slight tension on the cable lines. These springs are left to builder purchase since they are generally attached to the firewall and the needed length will vary with each builder's height. Attach the springs to the firewall with a small piece of angle aluminum. One piece can be made to accommodate both pedals by locating it mid-span on the firewall between the two points where the springs attach to the pedals. See figure 12-16. Simple tension springs from the local hardware store will work nicely. A diameter of approximately 3/8" is generally good. The length will vary depending on your location for the pedal assembly

FOR THE ADJUSTABLE RUDDER PEDAL SYSTEM, a long spring will usually tolerate most travel ranges. The springs will merely tighten up when the pedals are pulled aft.

11. Attach one end of each spring to the back of each pedal (in the web not used by the brake cylinder), and attach the other end to one common bracket on the firewall (mounted midway between the two pedals). See figure 12-9.

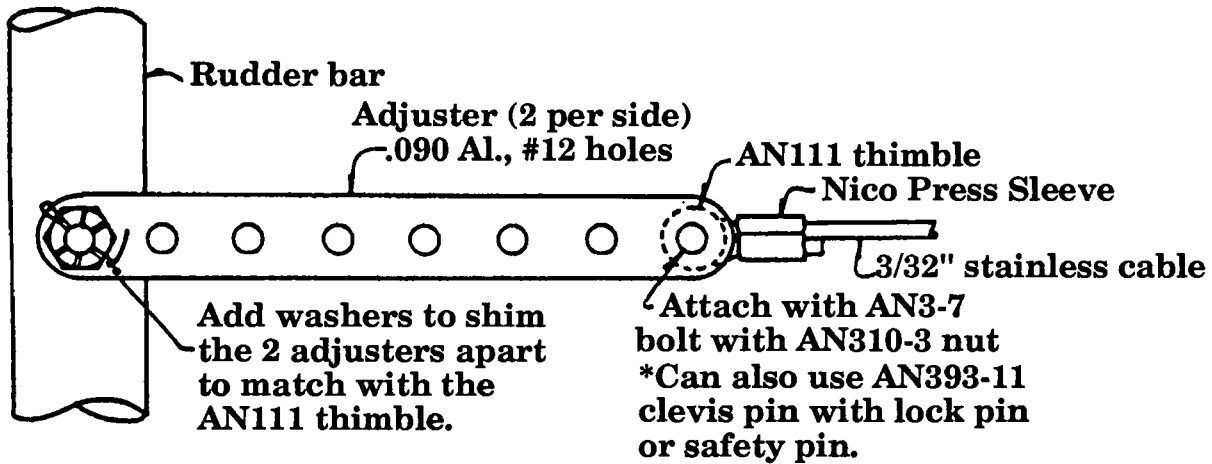


Rudder cable to pedal bar attach system

(fixed and adjustable)

FWD END

Figure 12-15



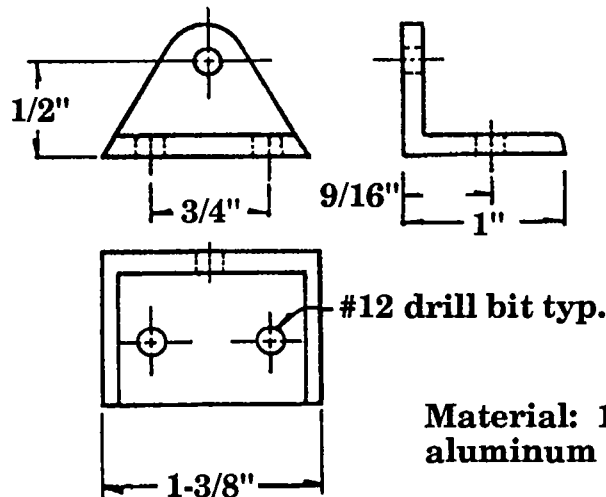
12. When the final installation for the rudder and cables is performed, snug the aft clevis end on the rudder bellcrank. Do not over-tighten since this piece must swivel slightly on the rudder control horn. Use a cotter pin to secure the castle nut in place. The bolt should insert from the top with the castle nut on the bottom, with the cotter pin inserted from the fwd side and facing aft. See figure 12-14.

Brake / spring attach bracket

Brake: 2 required

Spring: 1 required

Figure 12-16

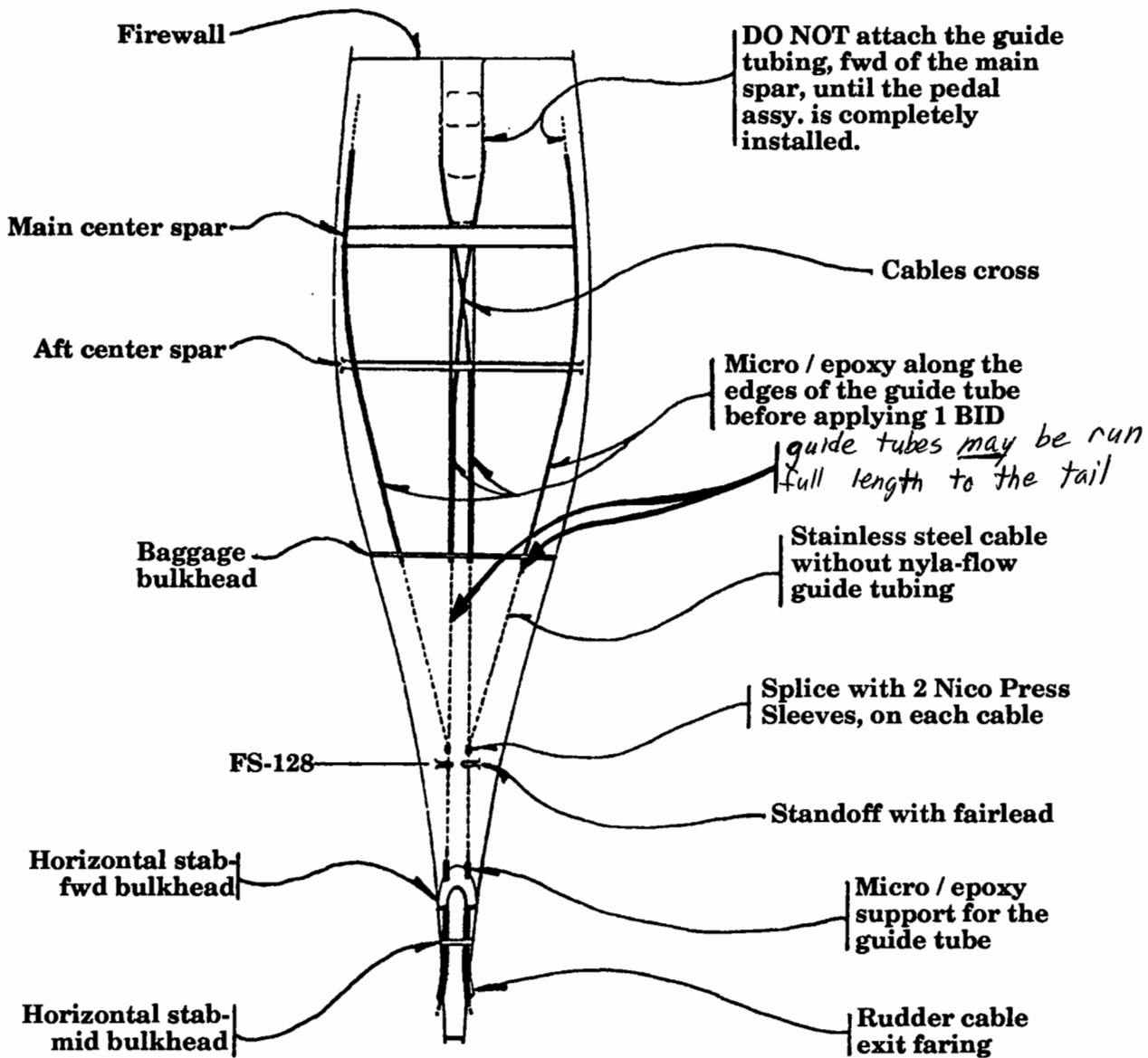


K. Dual rudder controls - optional

Controls can also be installed onto the right side for passenger rudder control. This installation will weigh about 7 lbs. It is simply unnecessary for rudder control during virtually all standard flight conditions. Rudder is of course needed for cross wind landings and brakes are needed for taxi steering. The passenger side pedal assembly is a mirror image of the pilot's (refer to step 11, page 12-17 for assembly instructions), and may also be made adjustable (see section D, page 12-18). This section will address the rudder control installation as it is effected by the addition of right side rudder controls.

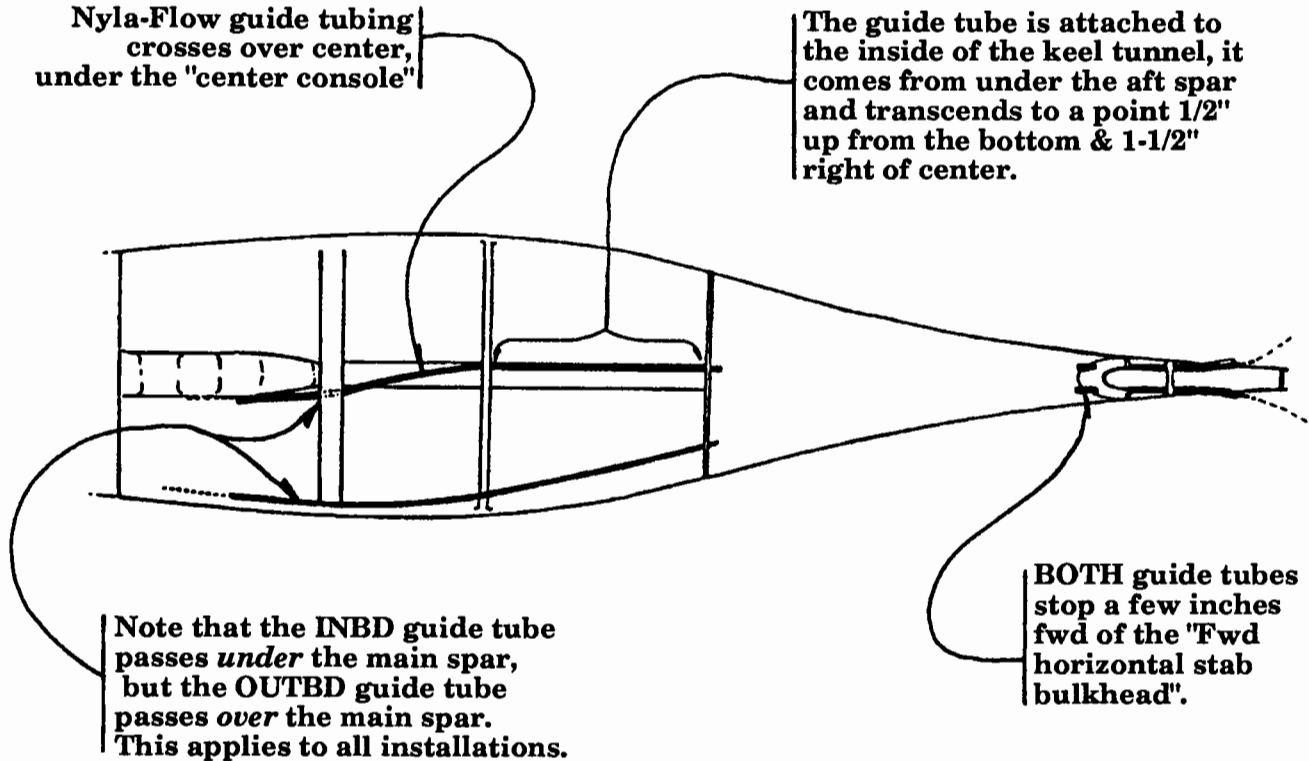
Dual rudder control system

Figure 12-17



Pilot side - dual rudder controls

Figure 12-18



1. The pilots *right* side, control cable guide tube installation, will be identical to the standard installation. The pilots *left* side control guide tube, which runs along the fslg, will be terminated at the baggage bulkhead in a manner similar to that used for the other cable guide. See figure 12-18.

2. On the right side of the fslg, fit a "mirror image" installation of the above guide tubing installation. This guide tubing on the fslg right side will thus be an identical mirror image of what was installed onto the left side of the fslg.

The guide tubes that run down the center of the fslg will cross over each other in the cockpit area (under the console). The location of the cross is not critical.

Thus, the baggage bulkhead will have two guide tubes terminating at the central area of it. The guide tube that is on the passenger side will actually be for the pilots right rudder control. The guide tube on the pilots side will be for the passenger's left rudder control. See figure 12-17.

NOTE: From aft of the baggage bulkhead, the stainless steel control cable will not be in a guide tube until it reaches the two horizontal stab bulkheads. It will run through cable guide from the horizontal stab fwd bulkhead to the exterior of the fslg. A standoff will be required on the tail cone to hold the cables off the fslg. See figures 12-17 and 12-19.

3. Use the full size "standoff" template (figure 12-20) to make a cardboard pattern for checking the fit and placement. Mark the hole center and make a 1/4" hole for aligning the standoff.
4. Thread the right and left cables fwd, in through the exit fairing and through the 1/4" hole in the cardboard pattern (be sure to thread the pattern from the back, with the left cable in the left pattern, etc.). *From here fwd the routing of the cable is temporary and for alignment only.*
5. Route the left side cable to the guide tubing that is just to the left of center on the baggage bulkhead, and the right side cable to the guide tubing to the right of center. Pull tight and clamp the ends of the cables.
6. The pattern should be suspended on the exposed cable. Slide the pattern fore or aft and trim as necessary to establish a good fit that allows the cable as straight a path as possible without contacting the fslg. The standoff should fit at approximately FS 128.

WARNING; This temporary routing is for standoff alignment only, **THIS IS NOT THE PROPER ROUTING OF THE CONTROL CABLES.**

NOTE: The elevator controls will pass down the center of the fslg floor. The rudder cables must be a minimum of 2", each side of the fslg center line, to avoid interference.

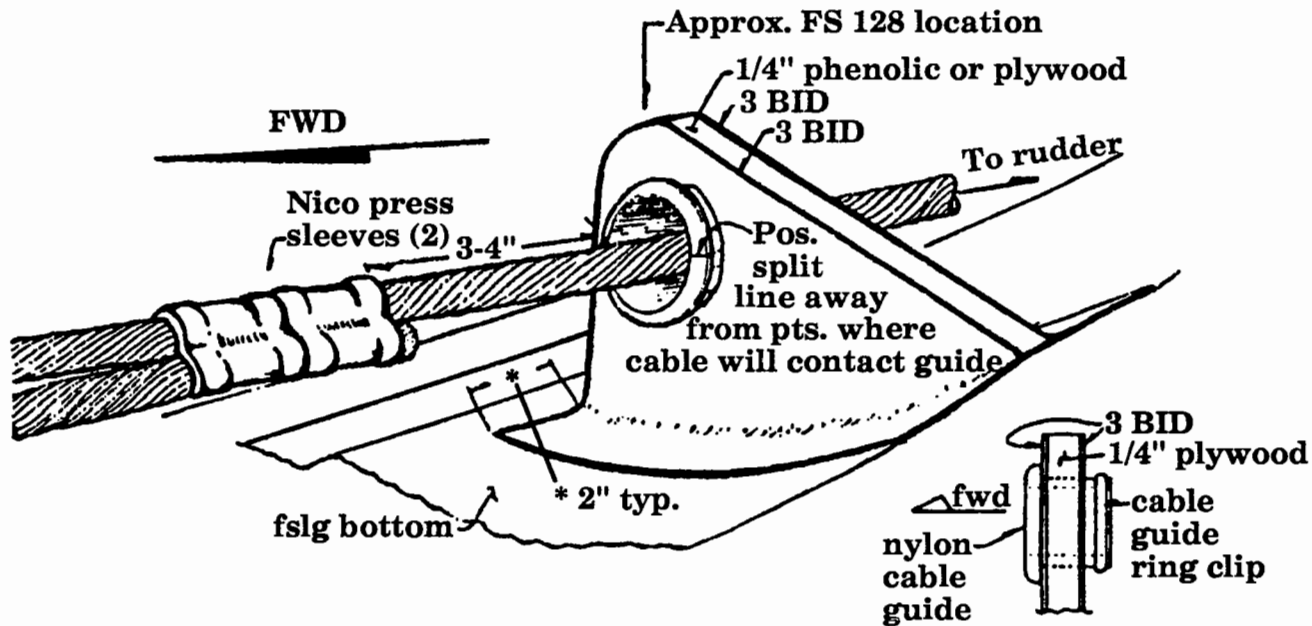
7. When you have adjusted the standoff pattern for best fit and location, carefully mark the fslg contact area for both, the right and left side.



Standoff / fairlead installation

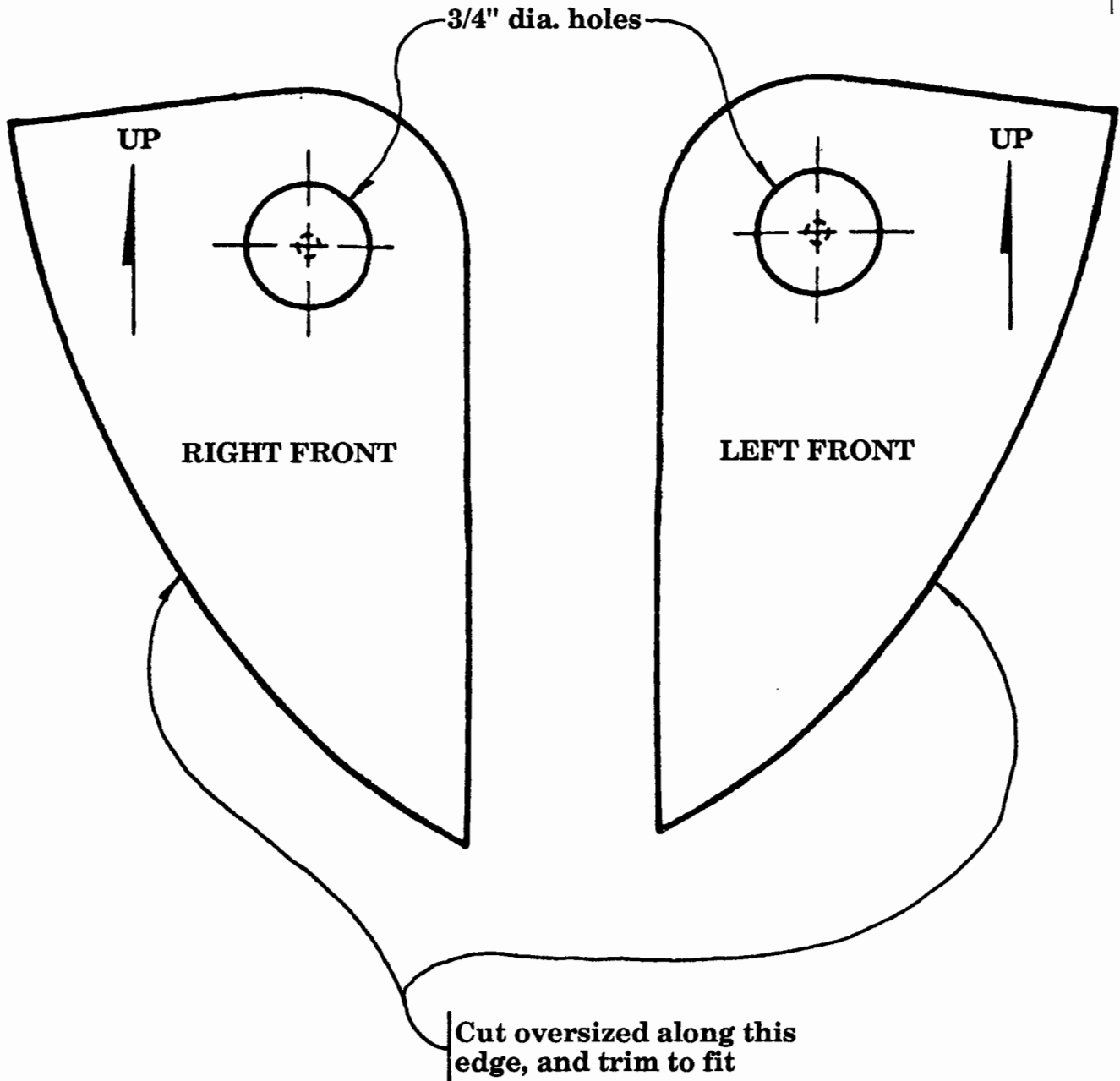
(Dual pedal system, left standoff shown)

Figure 12-19



STANDOFF PATTERN

Dual pedal system
Figure 12-20



8. Remove the cables and the pattern from the fslg. Transfer your patterns to 1/4" plywood and cut out both standoffs. Be sure to mark the hole centers.
9. Drill the 3/4" holes for the fairleads. Sand the edges smooth.
10. Install them onto the fslg inner skin using epoxy/flox and 3 BID per side. This BID should run up the full fwd and aft faces of these pieces. It is probably easiest to lay the BID over the hole. During the green stage or after full cure (use a heat gun to soften), trim the BID away with a sharp utility knife or an Xacto knife.
11. Insert the fairleads into the 3/4" hole drilled into the standoff pieces. These install from the fwd side with the retaining clip on the aft side, see figure 12-19.

NOTE: The continuous cables will be routed to the pilots rudder pedals (the right cable to the right pedal, and the left cable to the left pedal). The passenger side control cables will be spliced to the pilots cables fwd of the standoff.



L. Final installation - pilots side rudder cables

1. Use the cables with the clevis ends. Thread the left rudder cable, fwd through the left exit faring, through the left standoff, through 2 NICO PRESS SLEEVES, and fwd of the baggage bulkhead through the left-most Nyla-Flow guide tube. Pull the cable tight to the firewall.
2. Now thread the right cable fwd through the right exit faring, through the right standoff, through 2 NICO PRESS SLEEVES, and fwd of the baggage bulkhead through the Nyla-Flow tube just to the right of center. Fasten the right and left clevis to the rudder control horn, per figure 12-14. Pull the cable tight to the firewall.

NOTE: Both of the cables should be on the PILOTS SIDE. This routing is used so that in the event of a splice failure, the pilot will retain rudder control.



M. Routing passengers side rudder cables

1. Be sure the rudder is clamped straight so that the clevis ends are even.
2. Use cables without end fittings. Start at the left standoff. Slide the 2 Nico Press Sleeves along the pilots cables, to a point 3" - 4" fwd of the stand-off. Insert one end of the passengers left foot cable in through both Nico Press Sleeves, and crimp securely. See figure 12-19.

WARNING; Nico Press Sleeves ***MUST*** be crimped with proper crimpers.
Pliers are NOT sufficient.

3. Thread the other end of the cable, fwd through the guide tube that sticks out of the baggage bulkhead, just to the left of the center. Pull up slack where the cable exits the guide tube, by the passengers left foot.
4. Repeat the process for the right cable.
5. Refer to the previous sections for instructions to finish the installation.

