S-51 Wing Kit

Last revised 3/22/98

Inspection and set-up

First you will need to make some sort of fixture to hold the wings rigidly while you rivet them. The reason for this is that the act of riveting can change the wing geometry. Hence construction of some sort of fixture to hold the wing is essential. Do not try simply drilling out the pop rivets, reaming, deburring, countersinking and riveting without first supporting the structure.

How elaborate your tooling needs to be depends on your preferences and whether or not the washout is satisfactory as the wing comes from the factory. Washout is the angular difference between the datum lines on the tip and root ribs. The S51 has a nominal washout of 1.5°, meaning that the datum line on the tip rib angles downwards 1.5° with respect to that of the root rib. This makes the root of the wing stall before the tip.

Considerable deviation from the 1.5° figure is acceptable, provided that the washout in both wings agree within ±0.2°. At least that's the criterion the Jin Stewart used to inspect fast-build kits. Of course the factory can simply set a wing with off-spec washout aside and later custom manufacture the opposing wing with the same washout. If you are building a pop-rivet kit you face a more difficult situation, especially if you build the individual wings concurrently. To guarantee a deviation within 0.2°, you must control the washout in each wing to within 0.1°, or 6 minutes of an angle. When you think about it, that's a fairly tight spec. In fact, you will need more than a simple carpenter's level or a pendulum protractor to measure angles this accurately. Without being held in a substantial fixture firmly affixed to the floor, the wing can easily twist out of tolerance while the skins are being riveted. Further, the problem can be very expensive to fix, in extreme cases requiring disassembly and complete reskinning of the wing.

Why is Jim so particular about this? You may have observed that the S51 prototype incorporates a stall strip on one wing root, but not the other. This is because the washout is not the same in each wing, a consequence of removing the wings from the factory jigs before the skin riveting was substantially complete. As you might expect, the flight test leading to the stall strip installation was, to put it mildly, memorable. Certainly not something the average builder would want to deal with. Ask Jim for the details if you're interested.

The first thing you need to do is measure the washout in the pop-riveted wing. The fast-build kits should have been checked over, and presumably are rejected unless they are satisfactory. Do not assume that a pop-riveted wing shipped from the factory will meet spec, or even that the factory datum lines are correct (the datum lines drawn at the factory are often weakly visible). You can take the datum line location at the root rib from drawings 3100 and 3200. The only way to find the datum line at the tip rib is to obtain a full scale drawing of the rib upon which the datum is indicated. This drawing, taken directly from the lofts, can be had for the asking.

Most builders set up the wing using a moderately priced digital level which is adequate in terms of accuracy (±0.05°). A propeller protractor would also work, if you can find one.

Tooling

Figure 1.1 shows one example of good wing construction tooling. This one is both heavier and more elaborate than most. Whatever you use obviously must allow you to set and hold the correct twist in the wing while it is being riveted. Additionally, it should allow you to rotate the wing about an axis defined by the intersection of the datum surface with the main (forward) spar. This feature will make the riveting much easier and help overcome any urge you might have to remove the wings too early. Additionally, it will help greatly in leak testing the fuel tanks and allow you to install the landing gear with the wings still in the jigs, if you so desire. The size and wall thickness of the tubing used in the tooling will depend on how much (if any) you need to change the washout. The tooling should be capable of holding the wing in the desired position with the skins installed but unreamed, and with moderately heavy clecoing (say every 3th or 4th hole). If your wings require little or no retwisting, 0.125" wall 2x2 tubing should be adequate. In the above example, 0.25" wall 3x3 tubing was used. That's about what you need if you try to change the twist by a half degree. (It is rare to find a wing in which th etwist is this far off. In any case, the tooling must be accurately aligned and dogged firmly to the floor.

An elaborate set of fixtures such as pictured in Figure 1 will have some means of indexing both the root and tip rib, so that the washout is preserved upon rotation. The advantage of this is that you only need to set-up the wing in the tooling once. Most builders use less elaborate fixtures that do not preserve the washout upon rotation. This simplifies the tooling greatly, but requires the builder to re-set the washout each time the wing is rotated and the fixture ends resecured. This is not too difficult if you use a digital level, otherwise you're probably better off with the more elaborate jig.

In summary, do not attempt to construct the wings without adequate tooling. Rejigging and reskinning a wing to correct the washout is both difficult and expensive. More than one builder will vouch for this.

Figure 1.1. An example of a wing assembly fixture. This one has index plates on both ends so that the wash-out is preserved upon rotation.

Construction sequence

Generally you will need to work from the leading edge to the trailing edge. Provided that you can fabricate a few special bucking bars and have hands that are not too large, you can construct the wings without resorting to pulled rivets in any exposed area.

Begin by drilling out all of the pop-rivets and fastening the skin and internal structure evenly with #3 clecos. This will require a lot of clecos if both wings are constructed simultaneously. This is particularly important if you're retwisting the wing significantly;

you want to distribute the change in twist uniformly over the span of the wing. Actually there is no simple way to insure an even distribution once removed from the factory jigs, but you certainly stand a better chance this way than, for example, by reaming a section of skin for #4 rivets while the rest is still relatively rigidly assembled with pop-rivets. If you need to economize on clecos, consider completing the entire span forward of the main spar, then doing the entire span between the main and rear spar and/or work on one wing at a time. You obviously want to avoid concentrating the change in twist at any particular point along the span.

The nomenclature used in discussing the riveting sequence is given in Figure 1.2.

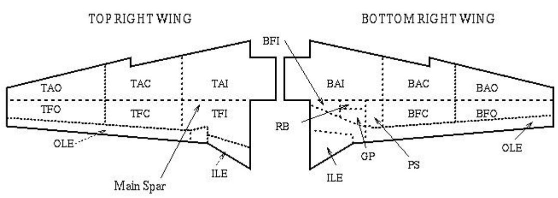


Figure 1.2. Illustration of the skin section nomenclature. A top view of the right wing is on the right and a bottom view on the left.

ILE inboard leading edge (0.040" thickness, WS 15 - 43.25)

OLE outboard leading edge (0.040, WS 53-150.5)

TFI top forward inboard skin (0.063, WS 15-62.75)

TFC top forward center skin (0.050, WS 62.75-101.25)

TFO top forward outboard skin (0.040, WS 101.25-150.5)

TAI top aft inboard skin (0.063, WS 0-62.75)

TAC top aft center skin (0.050, WS 62.75-101.25)

TAO top aft outboard skin (0.040, WS 101.25-150.5)

BFI bottom forward inboard skin (0.063, WS 15-33.5)

GP gear panel (0.063, WS 33.5-53)

PS pylon skin (0.063, WS 53-62.75)

RB rear bearing skin (0.063 WS 33.5-53)

BFC bottom forward center skin (0.050, WS 62.75-101.25)

BFO bottom forward outboard skin (0.040, WS 101.25-150.5)

BAI bottom aft inboard skin (0.063, WS 0-62.75)

BAC bottom aft center skin (0.050, WS 62.75-101.25)

BAO bottom aft outboard skin (0.040, WS 101.25-150.5)

Begin by riveting the internal structure forward of the main spar. Much of this can be done with an alligator squeezer, and the rest with a 3x gun. Larger guns will be required in other areas of the wing, but most 4x guns are too large to easily fit between the ribs. Order is not too important in the internal riveting except in a few places. We recommend not riveting in the plate (3212-14) that mounts the rear gear bearing until you have had a chance to find the approximate location of the rear bearing and can bore a hole for the bearing journal. Also, you should omit reaming or riveting some of the pilot holes securing the rib/skin angle bracket (3212-7) to the rib at WS 43.25, specifically those between the rear bearing plate and the cut-out in the rib for the actuator (see Figure 1.3). You will need to install the downlock flange (7020-5) here, and some of these rivets will be replaced by bolts. More on this later. The only other area where order might be a problem is in riveting the short spar (made form 0.125" plate)which mounts the front gear bearing, between WS 15 and 53. Here you want to build the structure up from the main spar to the leading edge.

While you are riveting the inboard ribs you should accomplish the service bulletin pertaining to the main spar, if necessary. This requires drilling out the #4 rivets holding the spar caps to the shear web between WS 15 and 33.5 and replacing them with #5 rivets, or alternatively installing #5 rivets between the existing #4 rivets. Jim has an illustration of the change that needs to be made (Figure A.1). Kits manufactured in 1998 or later should already incorporate this change.

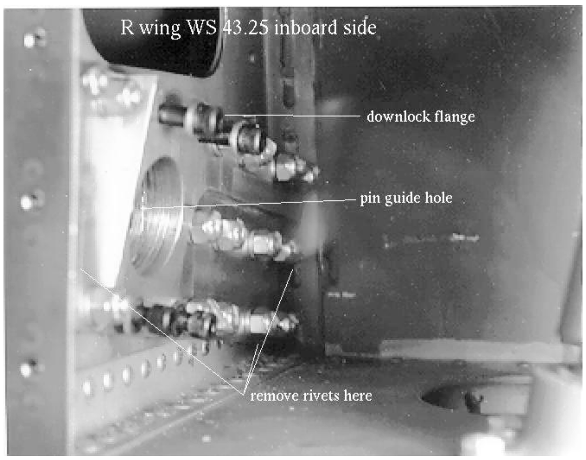


Figure 1.3. View from the bottom of the downlock plate installed in the right wing at WS 43.25. Note that the flange will overlap some of the factory pilot drilled rivet holes.

Auxiliary tanks and the leading edge

How you do the fuel system is up to you. Figure 1.4 shows a schematic which is pretty typical of an installation with auxiliary tanks. Auxiliary tanks generally occupy the volume bounded by the leading edge and the main spar, and from wing station 72.5 outboard. The tanks are most easily made if they are terminated at WS 121.25. They can be extended further outboard, but this will require replacing the main spar shear web outboard of 121.25. Inboard of 121.25 you need only fabricate some blanking plates and rivet them with Pro-seal over the access holes in the main spar shear web. Similarly, you need to blank off the lightening holes in the ribs at 72.5 and 121.25 (Figure 1.5), make some provision for a fuel gauge transmitter and install some doublers to improve the fit between the ribs, the leading edge and the stringers. A doubler is absolutely necessary at the leading edge.

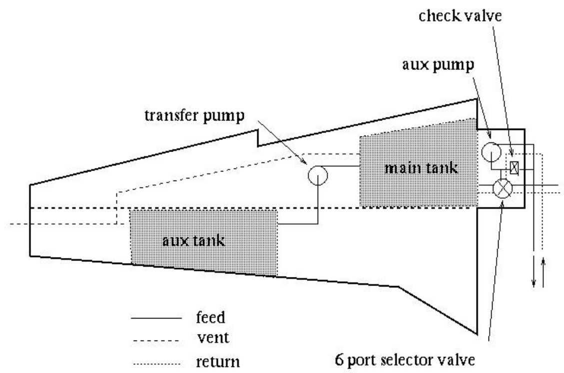


Figure 1.4. Illustration of a fuel system including auxiliary tanks in the outboard wing sections. See the final assembly section for some comments regarding installation of the auxiliary fuel pump and filter.

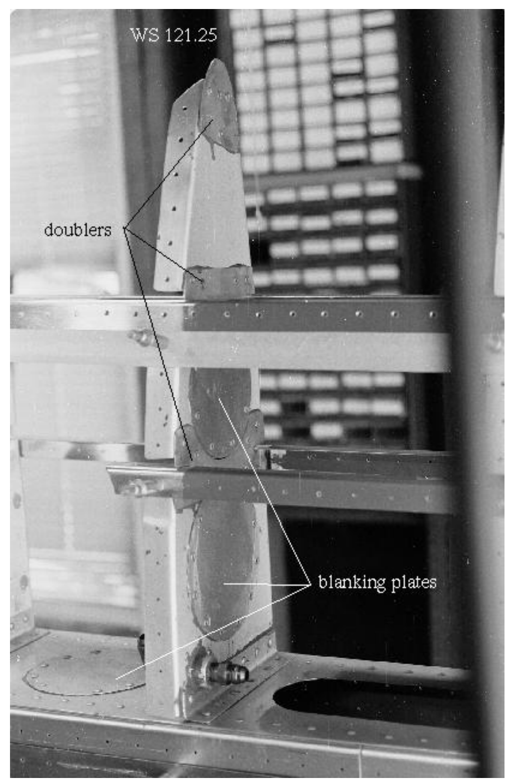


Figure 1.5. A top, inboard view of the outboard end of the auxiliary fuel tank in the left wing. In this aircraft, this is at WS 121.25.

The stringers could probably be sealed without the doubler using a mixture of class B Pro-seal and aluminum wool. You can install the blanking plates and doublers in the ribs with non-structural pulled rivets and class B-2 Pro-seal. Putting aux tanks in a pop-rivet wing requires drilling out the factory installed rivets securing the angle brackets (e.g. 3100-12) holding the ribs to the main spar and reinstalling them with Pro-seal. Now is the time to install a flange for the fuel outlet fitting and strainer in the inboard rib and a flange for the vent in the outboard rib. Make sure the fuel level transmitter can removed and replaced, either through one of the access plates in the lower skin or through the access plate in the pylon skin (PS). This may require a rather complex mounting scheme such as shown in Figure 1.6. You may want to install lines running spanwise through the forward ribs for the fuel vent, wires, gear actuator hydraulics, Pitot pressure, etc. If so, now is the time to put in the grommets and lines.

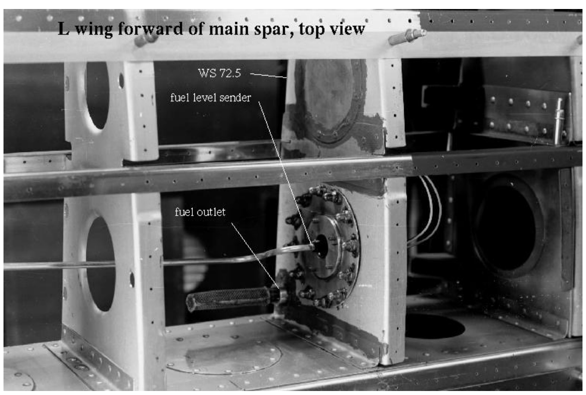


Figure 1.6. A top, outboard view of the left wing at WS 72.5. This is the inboard end of the auxiliary fuel tank.

Once the internal structure (Figure 1.7) is complete you can begin fitting and riveting the skins. Begin with the inboard and outboard leading edges. Alodine and prime the interior skin as necessary. Generally, pop-rivet skins come from the factory unprimed. The interior parts (ribs, etc) should come anodized. Anodizing provides a good deal of corrosion protection. If you want to prime in addition, probably the easiest method is to roughen the surfaces with coarse Scotchbrite, then apply zinc chromate from a spray can. Cleco the skins tightly and ream for #4 rivets. Deburr, reassemble and check the fit between the skin and ribs by looking through individual rivet holes. If a gap in excess of 0.020" or so is present, you will need to install one or more shims. If you plan to also glue the skin with structural adhesive (liquid shimming), then you need not be concerned with gaps smaller the 0.020".

Figure 1.7. View of the ribs and stringers in the left wing forward of the main spar.

Pro-seal and structural adhesive

Skins sections within the fuel tanks must be installed with Pro-seal (the generic name for tank sealant meeting MIL-S-8802E or MIL-S-8784B). These sealing compounds are manufactured under several trade names, Pro-seal, Chem-Seal, etc. There is no significant difference in any of them that meet the mil-spec; they all work equally well. Many builders install the other section using DuPont 2216 structural adhesive. This is not necessary for strength, but will improve the fit between the ribs and skins. This is generally referred to as liquid shimming. Some hints on riveting with Pro-seal and structural adhesive follow.

With Pro-seal you need to install the rivets before the sealant cures. For permanently sealed structure, use sealant meeting MIL-S-8802E. The MIL-S-8784B sealant is a low adhesion formulation for use on access plates, fuel level sensors, etc. These compounds come in different classes and curing times. Class A is for brushing, B is for filleting, and C is for faying. For installing the skins a viscous formulation with a 24 hour working time is recommended, e,g. class B-24 or C-24. Unless you can buy wholesale, SealPac (316-942-6211) seems to have about the best prices on Pro-seal. They also carry a good selection of different compounds. Call and get a catalog.

To install skins with Pro-seal, first roughen both surfaces with Scotchbrite, then clean thoroughly with acetone or MEK. Apply sealant to liberally both surfaces and also to the shims, if present. Use enough so that it will extrude when the surfaces are mated. Install shims as necessary in the areas identified previously (you did mark the location and shim thickness on the exterior of the skin, didn't you?). Mount the skin and cleco heavily, at least every third hole. Clean up the exterior and interior as much as possible with acetone or MEK, and countersink a few holes.

Probably the most common error in flush riveting is failure it countersink deep enough. The countersink cage should be adjusted so that the rivets sit *slightly below flush* to allow for expansion of the factory head. You will need to go slightly deeper with a driven rivet than a squeezed one. If in doubt, experiment on a piece of scrap. You will be surprised how deep you have to go to get the factory heads set flush.

In riveting, you should avoid beginning at one edge of the skin and working towards the other. If you do this and have a less than perfect fit, you will concentrate the error at the end of the skin. This may result in holes forced out of alignment or, in an extreme case, a wrinkle in the skin. Instead, rivet so as to distribute any fitting error over the entire skin surface. One way to do this is to start by riveting the corners. Then put a rivet in the center, halfway between this rivet and each edge, then halfway between these rivets and so on. Try to rivet as you go, e.g. countersink a few holes, then install the rivets. Whatever you do, *do not remove any of the clecos until you have rivets installed in that area*, particularly for the 0.040" skins. *You cannot hold a #4 hole in 0.040" skin in alignment with clecos after it has been countersunk.* You will get much better results if you *never put a cleco in a countersunk hole.*

Driving rivets in a Pro-sealed section is much more difficult than in a clean section. The sealant acts as a lubricant, making the set and bucking bar much more difficult to control. When you have to drill out a rivet, the turnings get mixed in with the sealant – what a mess! You can minimize the difficulty by using the minimum rivet length consistent with structural integrity, e.g. 1.5 diameters protrusion. Also, you should use acetone or MEK to clean the sealant off the rivet ends before driving. Keep the rivet set and bucking bar clean too. Excess Pro-seal can easily be wiped off before it cures. After curing it's practically impossible to remove, so clean up the areas where the skins butt before it sets!

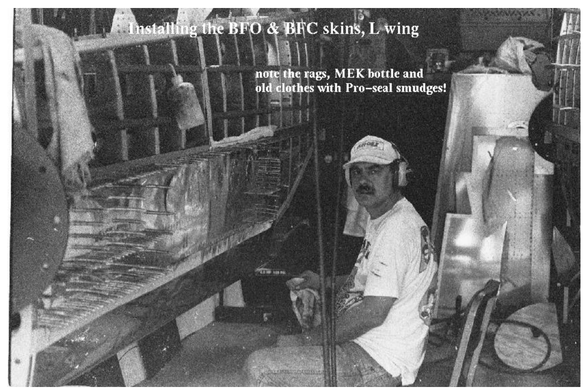


Figure 1.8. Riveting the bottom skins on the left auxiliary tank.

We recommend use of 3M 2216 structural adhesive in the non Pro-sealed sections. This both speeds up the riveting and results in a nicer finish. To do this, simply apply the adhesive to one or both surfaces before installing the skin. Install the skin with a cleco in every hole and wait a day for the epoxy to cure. With 2216, no release agent is required if you remove the clecos within 24 hours. Once the epoxy has cured, the skin is not going anywhere! Further, the adhesive will fill all small gaps between the ribs and skins, so that you will only need to install aluminum shims where large ones are required (at least 0.020"). You still need solid shims where large gaps exist because the adhesive is flexible enough to compress somewhat under the force of the rivet gun, even when it's cured completely (which appears to take about 2 weeks). Some builders glue for strength as well as fit. This is nice unless you have to reskin the surface sometime in the future. To glue for strength, treat the mating surfaces as described for Pro-seal. To glue only for fit, just prime one surface. Then you can readily remove the skin without heating if necessary. We recommend gluing for fit only, except in the landing gear area (TFI, BFI and RB skins), where Jim recommended gluing for strength. Adhesive will extrude where the skins butt up against each other. This is easy to remove after curing, especially if the extruded bead is *relatively large*. Use a piece of sharpened Plexiglass.

With a glued skin you can simply remove the clecos, countersink all the holes and then install the rivets in any order you want. The skin is not going anywhere, so the fit will be near perfect. You will probably find that you can work much faster by just going down a row of rivets, as opposed to jumping around. To get the glue to act effectively as a shim you must let it cure before riveting. A couple of days is the absolute minimum, and 2 weeks is even better.

The leading edge

Installation of the leading edge skins is straightforward. This is one of the few sections of skin that you can easily do without assistance. The aft edges of the OLE can be squeezed to the stringer. You may want to shim this edge 0.010" where it butts the 0.050" TFC and BFC skins, and 0.020" where it butts the 0.063" TFI and PS skins. You may need to make a special bucking bar to install the outboard, aft-most rivet in the top and bottom of the ILE. No special problems other than this.

If you install auxiliary fuel tanks you should seal leading edge portion of the tank and *leak test with water before you go any further.* We recommend going over the interior seams and rivet shop heads with class A-2 Pro-seal. Where the end ribs meet the leading edge you will have to use class B-2, possibly mixed with aluminum wool if the fit is not excellent. If your tooling allows you to rotate the wing about the main spar, it's easy to check most potential leak paths by rotating the leading edge down and filling it with water. Once you install more skin, it will be very difficult to fix any leaks in this section, so *do it now.*

We cannot overemphasize the need to check for leaks as the tanks are being assembled. Take our advise and save yourself a couple of months of really frustrating work later!

The bottom forward outboard skins

Install the BFO and BFC skins next. Those adding auxiliary tanks will need to cut an access hole in the bottom skin in each wet bay. See Figure 1.9 for an illustration. This is best done by removing the skin from the wing and using a circle cutter in a drill press. The access covers are secured with 6-32 or 8-32 100° screws. You need to mount blind platenuts on doubler underneath. B&B Aircraft Supplies (913-884-5930) has a stock of surplus 8-32 blind platenuts. We know of no source for 6-32 blind platenuts.

It's best not to dimple the access plates and use countersunk platenuts because it will make them more difficult to remove, once installed with sealant. Just countersink the screw holes in the plates. The 6-32 screws will work better in the 0.040" skins, if you can locate the platenuts. Many builders rivet a single blind platenut into the center of each plate. That way the plate can be removed by threading a screw into it a pulling on the screw. For inspection plates in other areas of the aircraft (e.g. that are not sealed), dimpling works better for skins 0.050" and thinner.

It will make riveting the top skins easier if you do not install the doublers for the access plates until the top skins are in place. Go ahead and drill the lower skins and doublers though. Also install the quickdrains just forward of the main spar and as far inboard as possible. The skin installation procedure is the same as for the leading edge, except that you may have to trim the skins slightly where they butt against the leading edge and/or each other. You will need a small clearance (0.010") at the butt joints to allow for thermal expansion. Also, consider installing 0.010 shims on the rib at WS 101.25, where the 0.040 skin butts against the 0.050 skin.

These sections of skin are easily installed if glued, and are only a little more difficult if Pro-sealed. You should be able to squeeze all the rivets at the main spar and, if you install the BFO skin first, those in the rib at the inboard end of the skin section. If you put in auxiliary tanks, it's best to install the bottom skin first. That way you (or your partner) can see to buck the top skin rivets through the access holes. Be sure to seal the interior joints, shop heads and check for leaks before you install the opposite skins. If you are not putting in auxiliary tanks, you can put on either the top or bottom skins first. In either case, you close out this section by reaching through the main spar, as described in the next paragraph.

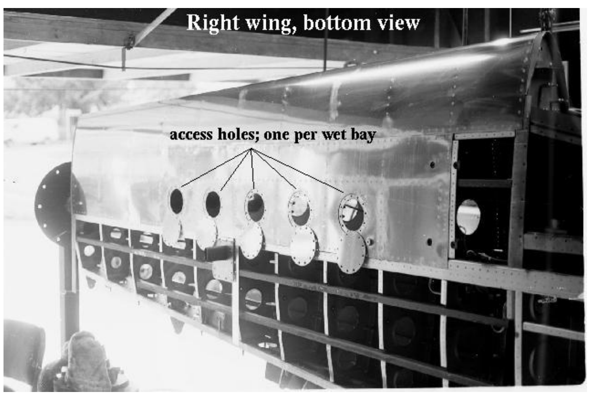


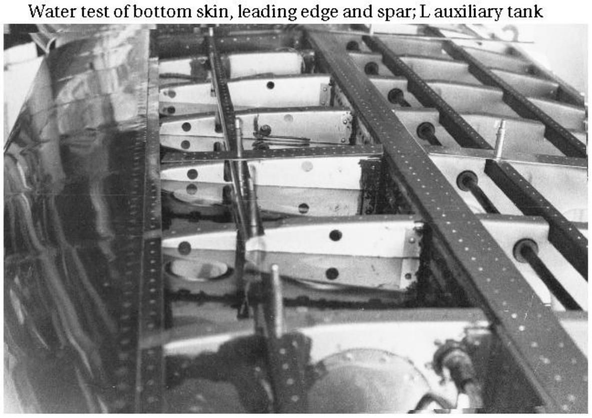
Figure 1.9. You need to put an access plate in each bay of the wet part of the wing (or else you better have very small hands attached to long, rubber arms!)

The top forward skins

Install the auxiliary tank fuel cap in the TFO skin before you rivet the top skins into place. Circle cut the fuel cap hole as far outboard and as far forward as possible to maximize tank capacity. You want the fuel cap curvature to roughly match that of the wing, so you will not be able to go as far forward as the leading edge. The optimum location will require trimming out a section of the stringer in the outboard bay. *Remember to put the lower access port doublers inside the tank before you install the top skin.* They obviously will not fit through the access ports. Assuming you installed the bottom skins first, your partner can buck the rivets through the access holes in the lower skin wet section. Some of the rivets will be difficult to see and/or reach unless you leave the access hole doublers out. Dry bays can be bucked by reaching through the main spar. The auxiliary tanks are closed out by sealing the access ports and doublers. Be sure to use low adhesion sealant for the ports, not the same stuff you used for the skins and the doublers! You want to be able to remove these plates without destroying them. Test for leaks now, while you can still easily inspect the rear of the main spar shear web and the dry side of the ribs that define the ends of the tank. First test with water (rotating the wing in the tooling to wet all surfaces), then do the usual pressure test with air (see Figure 1.10). Seal the hole in the bottom of the fuel cap before you leak test with air. You will probably be able to find all of the leaks with the water tests. The most likely places are in any seams where extensive shimming has been necessary (assuming you have already fixed any leak where the ribs meet the leading edge D-section). If the leak source in the interior is not obvious, try forcing compressed air back through the exterior surface of the leaking rivet or seam while looking for bubbles in the interior. This works every time, even when the leak path is several inches long. Leaks should be fixed inside the tank, not on the exterior surface.

Put on the TFI skin next. Jim recommends this section be glued for strength as well as fit due to the extra stress put on the fasteners by the landing gear loads. A 4x rivet gun or a heavy duty squeezer (tandem or large bore) will be required for the #5 rivets in the main spar. In installing this skin, do not glue or rivet the rear gear bearing mounting plate (3212-14) to the skin or ribs. You need to cut a hole in this plate using a circle cutter or a hole saw. You can do the job more easily if you can take the plate put and use a drill press. Also, do not countersink or install rivets in the center portion of the wheelwell span at WS15. You will end up cutting out some of the rib to provide clearance for the landing gear fork. The section of rib removed will be replaced with a doubler on the top surface of the skin (which will be hidden under the fairing).

Water test of bottom skin, leading edge and spar; L auxiliary tank



Pressure test of R auxiliary tank

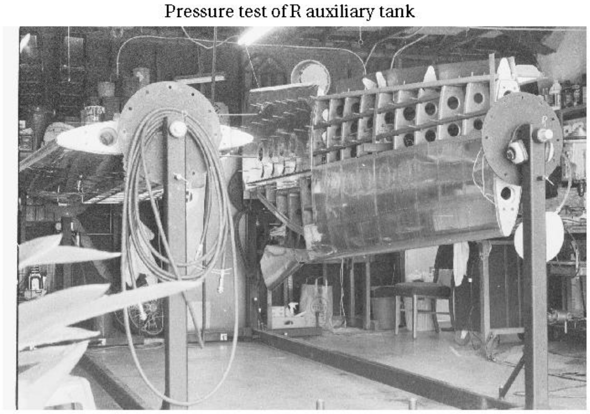


Figure 1.10. Leak testing the auxiliary tanks. Leaks are very easy to locate and fix at the stage shown in the upper plate. After the tank is complete, both are much more difficult. Cutting corners here can result in months of really frustrating work later. *Don't do it!*

Rear gear bearing location

Before you install any more skin you need to put a hole in the rear gear bearing plate (3212-14). First install the forward gear bearing (7020-22). You should be able to drop all of the gear bearings into the flanges if you heat the flange in an oven (do not exceed 350 F) and freeze the bearing. Bolt the rear bearing plate into place if you have not done so already.

You have a choice of what to use to locate the rear bearing (7020-23); the gear itself or an installation fixture which is being passed around among the builders. For the purpose of locating the rear bearing journal relief hole, the fixture is better. It's much lighter and easier to work with than the gear. Also the trunion will not protrude behind the rear bearing journal as it does in the gear.

The design of the rear bearing flange could stand some refinement. With the current design you need to relieve the front face in the upper inboard quadrant, as shown in Figure 1.11. This is because the bearing needs to sit essentially at the limit of its travel, which causes the trunion shaft to interfere with the flange. Even if you're using the fixture you might as well hog out the flange now as it will be necessary for the gear to fit properly. Make a shim just thick enough to allow the rear bearing journal (or the aft end of the trunion shaft if you are using the gear instead of the fixture) to clear the mounting plate throughout its range of motion. Place the shim between the rear bearing flange and plate, and clamp the rear bearing flange into place in the approximate location shown in Figure 1.12. If you are using the gear, you need to mate the strut (700-5,6) and trunion (7000-7,8), leaving the downlock collar (7007-1,2) off the trunion. You also need to install a tire on one of the wheels. See the section on gear assembly.

Install the landing gear or fixture in the bearings. Note that the trunion does not seat against the forward bearing due to the shim on the rear bearing. Now you need to position the rear gear bearing. The location is dictated by the following criteria:

1. In the down position, the strut (7000-4) should be vertical when viewed from the front of the aircraft. Since the wing dihedral is 5°, this requires the strut form a angle of 95° with respect to the main spar datum line outboard of the gear. The taper in the wing is about 1° top and bottom, so the angle with respect to the bottom outboard skin should be 96°.

Figure 1.11. You will have to relieve the rear bearing flange in the upper inboard quadrant in order to get the trunion to seat properly.

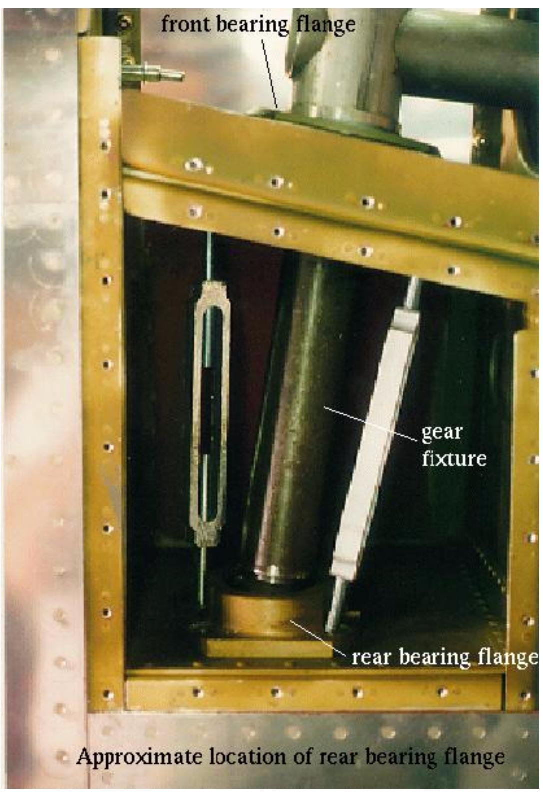


Figure 1.12. The approximate location of the rear bearing in the right wing. At this stage the fixture works better than the trunion assembly. It's much lighter and easier to clamp in position.

2. In the down position, the strut should be swept forward 10° from the vertical with the datum line at the mounting point held level. Most of the twist in the wing occurs outboard of the mounting point, so the datum line at the attach point can be adequately approximated as that at the root.
3. The wheel should be centered in the wheelwell.
4. With the toe-in set to zero, the wheel should fit into the wheelwell as flat as possible.

Unfortunately, you will probably not be able to satisfy all of these criteria simultaneously. For example, you may need to fudge a bit on (2) to adequately satisfy (4). You need to get the wheel far enough into the well so that the inner gear doors will close. You should be able to get about 3/8" clearance between the tire and the extended surface to the bottom skin. Eventually you will need to trim away a section from the rib at WS 15 so that the fork can go deeper into the wheelwell. This will give you another 3/8" to work with. You can do it now or later, when you do the final gear installation.

It's certainly safest to do the gear installation with the wings mated and supported on stands. However, if you want to do it with the wings in the fixture, the following procedure has been used satisfactorily. First rotate the wings so that the root datum line is vertical with the leading edge up. Use a combination square against the lower spar cap as a reference for the 96° angle. To satisfy (1), hang a couple of plumb bobs from the strut as shown in Figure 1.13, then use these to position the gear strut tangent to the square. With the root datum line vertical, you can easily set the 10° sweep with a combination square or pendulum protractor (Figure 1.14). *Displacement of the rear bearing towards the top and bottom skins mainly influences the sweep.* Next rotate the wheel to zero toe-in (Figure 1.15), then rotate the gear into the up position. *Moving the rear bearing inboard and outboard mainly influences the centering in the wheelwell* (Figure 1.16). Be sure to account for the gear not being completely seated in the front bearing, e.g. you want the wheel centered *when the trunion seats against the front bearing.*

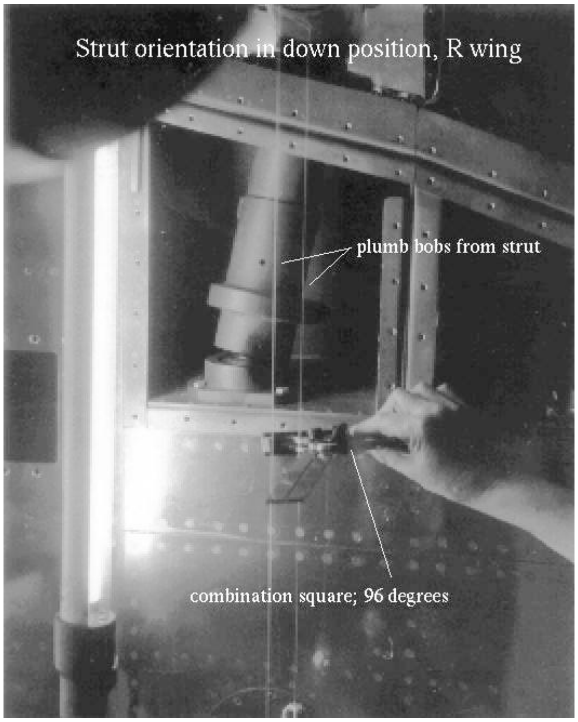


Figure 1.13. Position the main gear so that it will be vertical as viewed from the front with the wings installed on the airframe. The 96° angle accounts for the dihedral (5°) and the taper (1°) in the lower wing.

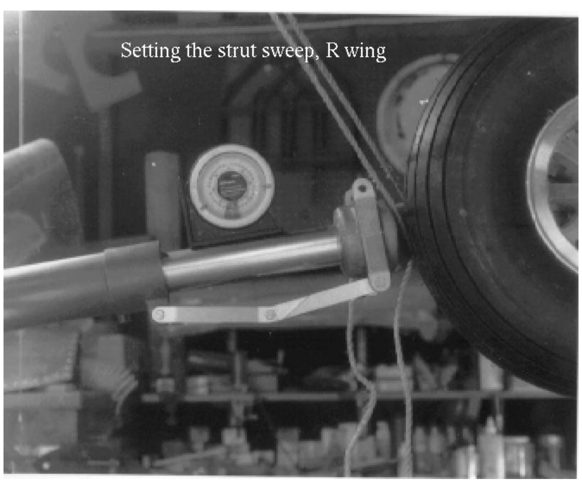


Figure 1.14. It's easy to set the sweep in the forward direction, particularly if the wing root is held vertical.

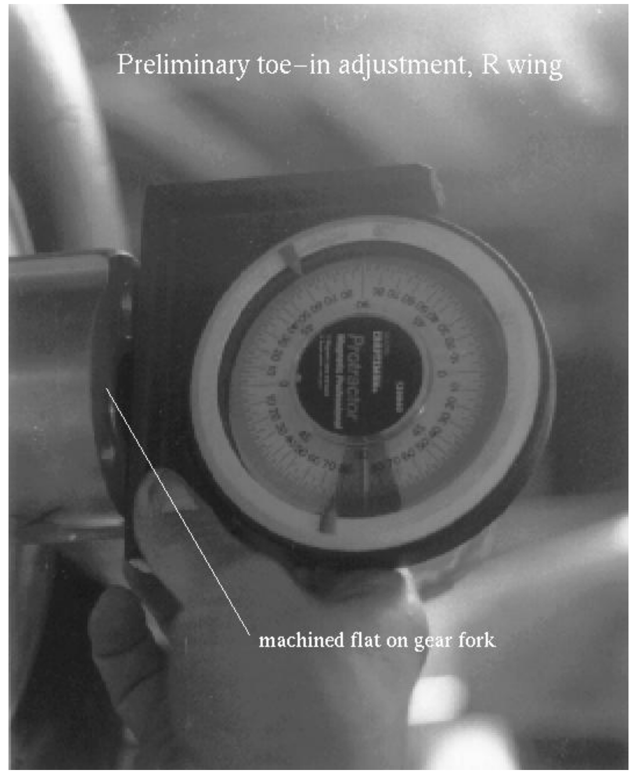


Figure 1.15. The easiest place to measure the toe-in is the flat machined on the outboard side of the fork. Adjust for zero toe-in.

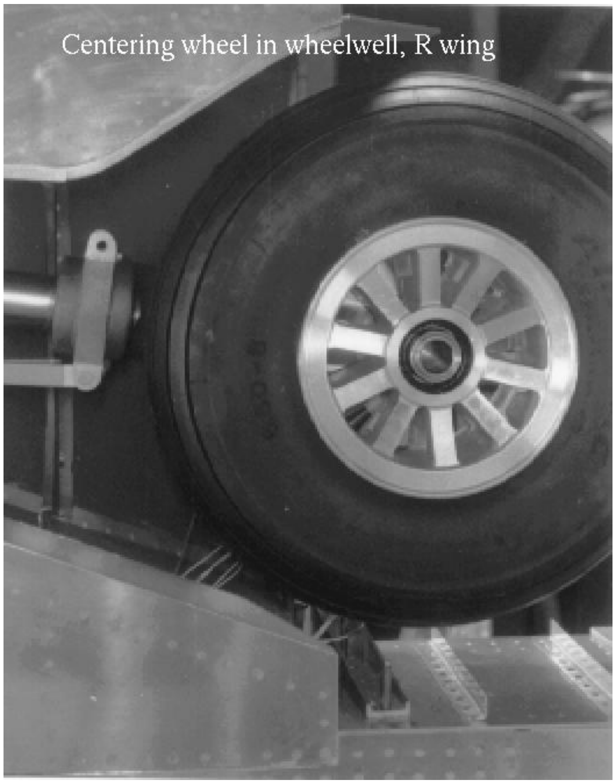


Figure 1.16. This is what the wheel should look like with the trunion completely seated in the front bearing. At this stage yours should be displaced upwards by roughly the distance between the trunion seat and the front bearing face.

Iterate on this procedure until you are satisfied, then mark the rear bearing flange position. No need to mark the bolt holes; just identify the center of the bearing flange as it sits on the plate. Note the orientation of the trunion between the gear bearings with respect to the rear bearing mounting plate. You want to locate the rear bearing so that *the trunion will have the same orientation with shim removed and the rear bearing seated on the plate*, e.g. so that the center of the bearing is at the point where the trunion axis intersects the plate surface. This will require moving the marked location of the bearing center outboard and toward the bottom skin. You will have to calculate the proper angle and distance geometrically. Apply the calculated correction to locate the center of the journal clearance hole, then remove the plate and cut the hole using a drill press and circle cutter. Make the hole somewhat smaller than the outer diameter of the bearing; 2 inches works well.

Once you have the hole cut, you can glue and rivet the rear mounting plate into the wing. When you rivet, leave out the first 4 or 5 rivets which join the plate to the rib at WS 43.25, beginning with the topmost (e.g. nearest the top skin). The gear downlock flange (7020-5 or 7006-4,5) will interfere with these rivets (see Figure 1.3). Flush rivets can be installed in some holes later, but others will have to be omitted altogether. We suggest not drilling and reaming the plate for the rear bearing mounting bolts on the basis of measurements made with the fixture. Wait until you install the landing gear for this.

Be aware the Schrader valve hole was drilled and reamed by mistake one batch of landing gear. This should have been left to the builder (see drawing 7000), because it is the easiest way to set the toe-in. Builders with gear from this batch will also have to worry about toe-in when locating the rear bearing. The toe-in will have to be close to zero; close enough so that it can be shimmed back to zero at the torque link. With the Schrader valve drilled, the toe-in and wheel position in the well are closely linked, so it may not be possible to get both correct. If you cannot, it may be necessary to move the Schrader valve hole. This can be done, but not without a milling machine. If you have this problem you need to contact PAE.

The bottom forward inboard skins

Now you can complete the skin forward of the main spar except for section PS. The PS section closes out the entire wing. Installation of the BFI skin is straightforward. Install the platenuts securing the GP skin. Floating platenuts are recommend . Use 8-32 screws and countersink the heads. Next you can install section RB. This is one of the more difficult skins to buck, and some builders resort to pulled rivets here. If you have small hands, you should be able to do the job by reaching through the access hole in the 0.125" plate (WS 33.5-43.75) and through the elongated hole in the rib at WS 53. You need to be able to get your entire hand through this hole. As mentioned previously, this hole may not exist in early kits. You will also need a special bucking bar (Figure 1.17) to get around the bolted angle brackets in some of the corners. This is all blind bucking, but by now you're probably used to it. If you or an associate cannot get your hand in, I would suggest completing the gear installation before you install section RB. In this case use structural pulled rivets (Cherrymax or Intermax) where necessary.

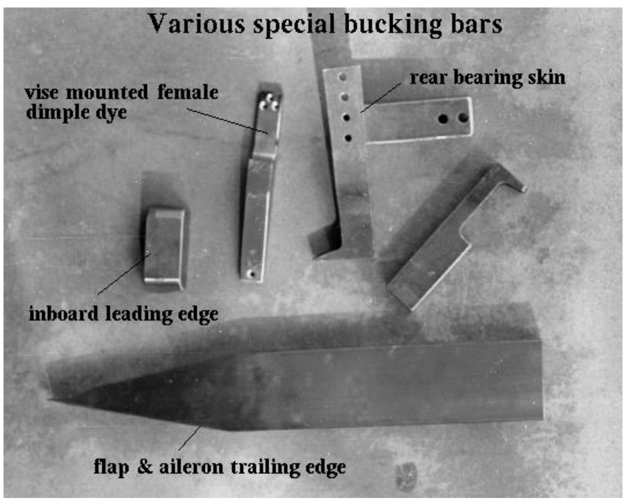


Figure 1.17. A collection of special bucking bars.

The aft outboard skins

The skins aft of the main spar are installed in much the same manner as those forward. First work on the internal structure by cutting holes for the vent and fuel feed from the auxiliary tank in the rib at WS 53 and for the fuel outlet and return lines in the rib at WS 15. Also make provision for the fuel capacity senders in the main tanks. Before you rivet ribs into place, drill out the rivets holding rib mounting angle brackets to the rear spar from WS 140.25 to but not including WS 53 (the outboard end of the main tank). These rivets are installed in the rear spar at the factory. Also drill out the rivets that secure the rear spar to the tip end rib (those in the rib, not in the spar). You likely installed these rivets when you mounted the wing in the tooling. Drill out the pop-rivets, remove the bellcrank mounting box (8045-1,2) from the rear spar and put it aside for the time being. Install any necessary wires and lines; fuel vent, fuel transfer, Pitot pressure, etc. If you install auxiliary tanks, make provision for the transfer pumps, valves, etc. You will probably end up installing and removing these from the square pylon access panel in skin PS (Figure 1.18). Make sure everything will fit through the hole.

Rivet the rear spar angle brackets to the ribs from WS 140.25 through 62.75, but do not rivet them to the rear spar. Rivet the ribs to the main spar angle brackets, then install the stringers. Use Pro-seal where necessary (WS 15 and 53), but do not Pro-seal in the bolted angle brackets at WS 43.25 (3212-6) and 53 (3212-24). You will probably need to remove these later when you buck the #5 rivets securing the skin to the main spar. Mount the Pitot tube mast (3910-1) to the rib at WS 101.25. The internal structure should now be complete except for the rear spar, which should be removable. Remove all the flap and aileron hinge brackets and cleco the rear spar into position. Cleco from the exterior except within the fuel tank.

You can install the bottom skins next. First cleco the BAO and BAC skins into place an install the Pitot mast coverplate. Use platenuts to secure the plate to the doublers. As for the skins forward of the main spar, working from outboard to inboard will maximize the number of rivets that can be squeezed. *Do not apply any glue or Pro-seal where the skins mate to the rear spar, countersink the holes for or rivet any of the skins to the rear spar; you will need to remove the rear spar to buck the rivets for the top skins.* As for the aux tanks, it will work best if you do not rivet the doublers (3000-9) for the main tank access plates to the bottom skin. Go ahead and install blind platenuts on the doublers though. You will need a 4x or larger gun to drive the #5 rivets mating the BAI skin to the main spar. Install the quickdrains in the main tanks and seal the interior of the main tanks at the spar caps, sear web and bottom skin (except for the rear spar). In sealing the main spar, work Pro-seal into the gap between the spar cap and shear web. Class A Pro-seal will run down and fill it nicely if you rotate the wing in the tooling properly. Also be sure to seal the aft edge of the spar cap where it is laminated by brushing on class A Pro-seal. You will probably have to use class B Pro-seal mixed with aluminum wool to seal the gaps where the spar caps pass through the end ribs.

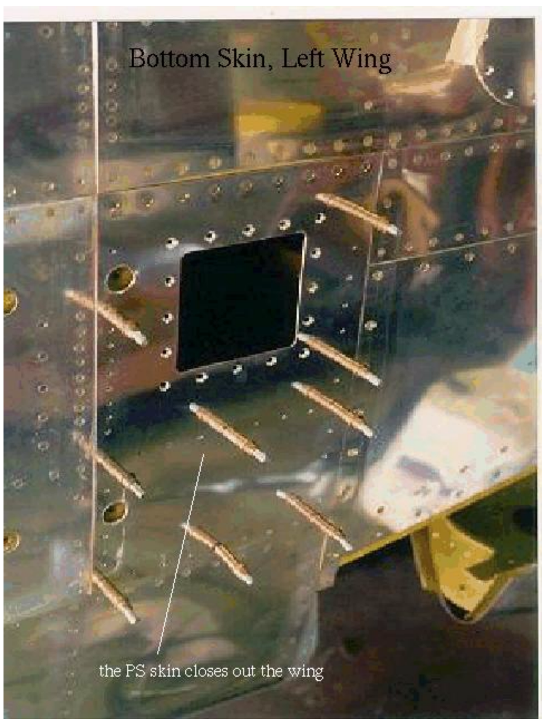


Figure 1.18. To get adequate access through the pylon access panel it's essential to rivet the doubler to the cover plate, not the skin. You will close out the wing through this opening.

After you have the skin riveted to the lower spar cap, permanently install and seal the bottom angle bracket and bolts at WS 43.25. Make sure that the AN5 thrubolts do not bottom out. This should complete the bottom aft skins. You can install the Pitot tube now, while you can still get access from the top.

Now install the top skins aft of the main spar. Working from outboard to inboard is again best. Glue in the TAO skin, but do not rivet. Again, *do not glue in the rear spar.* You can squeeze the rivets into the rib at WS 101.25. Install the TAC skin similarly, squeezing the rivets at the inboard rib. Do not install the top of the main fuel tank (TAI) yet. To rivet the top skins, remove the rear spar by removing the clecos and sliding the spar towards the root. When it frees up in the tapered wing, lift it up so that the angle brackets and blind platenuts within the main tank clear the ribs, then slide it all the way out. Now you can reach through the aft end to buck all the remaining rivets in the top skin.

Before you install the rear spar you need to determine if you can get your hand through the aileron bellcrank box (8045-1,2). If you can you can use AN365 nuts on the corners as indicated in the plans. If not, put platenuts on the box. *Remember to put the aileron bellcrank box inside the appropriate bay before you reinstall the rear spar.*

Use Pro-seal on the machined angle brackets at WS 43.25 and 53 and along the joint between the rear spar and the BAI skin. Also, make sure that the AN5 bolts that secure these brackets to the spar are not too long. This was a problem with some of the early fast-build wings. You can use conventional rivets for most of the rear spar installation. You will have to reach through the lightening holes in the rear spar shear web to buck them. You will need to use pulled rivets to attach the outboard few ribs where you cannot get your hand through the holes. Use pulled rivets to attach the rear spar to the end rib (WS 150.5). If you can reach through the aileron bellcrank box you can attach it with conventional rivets. Otherwise use pulled rivets.

Rivet the rear spar to the ribs, then countersink the skins and rivet them to the rear spar. Plan to complete the trailing edge of the BAI skin before the Pro-seal cures. This line of rivets can be squeezed with an alligator squeezer. Seal the interior of seam between the tank bottom and rear spar and leak check with water before you go further.

Mating the wings is simplified if you leave the TAI skin off until this is accomplished. The problem is that the step fitting (3020-16) mating the lower main spar caps must be installed from the interior. You could do the work through the access hole in the inboard bay, but you would need a large, right angle drillmotor, and even then it will much more difficult. Better to wait on that last major skin section.

If you want, you can trim the skin at the aft edge and build and install the ailerons and flaps before you mate the wings. This will maximize the work you can do in a garage, so that's the way it's laid out here. Or, if you want you can mate the wings and finish riveting the skins now. If so, jump ahead to the section on mating the wings.

Preliminary trimming of the wing skins

The skin trim lines should coincide roughly with the hinge lines for the ailerons and flaps. Just to make it easier to fit the ailerons and flaps, it's best to take a little skin off the trailing edge now. Mark the projection of the hinge lines on the upper and lower skins. The flap line will lie forward of the aileron line, so the cut must jog at some point. The jog cut should be *perpendicular to the hinge line*, not parallel to the ribs. Remount the hinge brackets to the rear spar if you have not done so already, and use the aileron and flap to determine the position of the jog. There is also a jog cut at the inboard edge of the flap, inboard of which the skin is trimmed nearly to the rear spar. When you get all the lines marked, trim away a bit of skin. *Don't try to trim too close*, because these lines are not very accurate. Three-quarters of an inch behind the lines is probably safe at this point. A router with a quarter inch carbide cutter will cut a nice straight trim line if you a have a length of straight, rigid material to use as a fence.

Tape the edges when you're finished trimming. That will prevent the flaps and ailerons from being scratched when you mount and dismount them, which you will be doing a lot.

Remove the inboard and outboard hinge brackets for both the ailerons and flaps and install the spherical bearings. Ream out the pilot hole using a milling machine or drill press. If you use a hand drill you're almost certain to move the hole. Finish with a 0.750" reamer, then heat the hinge and freeze the bearing. The bearing should drop in and be held firmly upon reaching ambient temperature. If the bearing is loose, don't peen the hinge; use some Locktite RC-609 on it instead. Remount the hinges and use a string to check the alignment of the center hinges. You may need to ream out the pilot hole a bit to see how far the hole will have to be moved (e.g. to get the string to pass through without touching). If the pilot hole is in the correct place, ream it and insert the bearing. If it is not correct, use a milling machine and a 2-flute end mill to move the hole before reaming.

Preliminary mounting of the ailerons

Drill out the pop-rivets holding the aileron leading edge D-section (3500-29,30) to the spar. Remove the D-section and set it aside for now. Drill out the pop-rivets holding either the top or bottom skins (but not both). Remove the skin. Remove the hinges and drill and ream the pivot pilot holes to 5/16". All of the aileron hinges will eventually be attached with 10-32 platenuts, but that's not necessary for now. Reassemble using clecos to hold the hinges in place from the interior. Replace the skin. Use clecos except at the spar, where you will have to use 3/32 aluminum pop-rivets. Leave the D-section out for now; it will just get in the way. You can now mate the aileron to the wing. Set it in the neutral position by eyeball (compare with the top and bottom wing skins). Make sure the twist in the aileron conforms to that in the wing. With the aileron held in the neutral position mark the position of the leading edge of the aileron spar on the top and bottom skins. These are your final trim lines for the ailerons.

Preliminary mounting of the flaps

Follow a procedure similar to the ailerons. Remove and ream the mini-ribs (3400-24→40) forward of the spar that act as hinges for the AN5 hinge bolts. Reinstall the hinges, but leave the rest of the forward ribs out for now. Mark the datum line on the inboard rib (consult the drawing 3400-1 and be sure any tooling holes you use as a reference are in the right place –

some are not). Leave the stainless steel skins (3400-48→51) off the top leading edge and the aluminum skins off the bottom leading edge. This will enable you to get to the hinge bolts easily. Install the flap on the wing. Check the twist visually. Set the flap in the neutral position by rotating it so the datum line on the inboard rib is parallel to the wing datum at the root. *Do not try to eyeball this one; measure it and be sure it's right.* With the flap held in the neutral (up) position, the top wing skin should be trimmed so as to butt up against the top skin of the flap. Mark this line carefully on the upper skin. The lower trim line will be 3/8 of an inch to the rear of the step in the forward mini-ribs. Jim has a sketch which illustrates all of this (see Figure A.2). Mark this line on the lower skin.

The final wing skin trim

The aileron trim lines and the lower flap trim line should be accurate enough to use for the final trim. Go ahead and trim to the lines. Use a Vixen file for the last 1/8 inch or so. We suggest trimming the top inboard skins about 1/8 inch short of line, and making the final trim after the flaps are riveted. This is the most critical trim on the wings, since the butt joint constitutes the upstop for the flaps. If you blow it by a lot, you will have to replace the TAI and TAC skins. The TAI skin is easy since it's not reamed or riveted yet. The TAC skin would be a disaster since you would have to remove the rear spar. If you end up trimming a bit short, say less than 0.050", consider reskinning the top of the flap instead of replacing wing skins.

Wing mating

To mate the wings it's best to hold them with the leading edge down, as shown in Figure 1.19. Support the root ends on sawhorses, and shim as necessary to match the spar shear webs at the root. Stretch some monofilament fishing line between the wing tips at the main spar. Using the seam between the skins along the main spar as a guide, adjust the tip stands so that the main spar shear webs lie in a plane. Set the dihedral so that the distance between the top spar cap and the stretched line is 9.94" where the wings join. This gives 5° dihedral. Trim as necessary so that the wings join the keel plate properly at the root. You will probably have to trim about 0.150" from each top main sparcap and a lessor amount from the shear web. If in doubt, cleco the wing/fuselage mating brackets (3020,24,25) to the spars and compare the distance between centers with that specified in the plans. You want 25.0" between centers for the forward attach fittings and 24.5" between centers for the rear.

Figure 1.19. Preparing to mate the wings.

Once you have everything trimmed and aligned, clamp the top step fitting (3020-15) to the exterior of the top main sparcap. This will help hold the alignment. Insert the keelplate (3020-2) between the wings and locate the bottom step fitting (3020-16) on the interior of the bottom main sparcap. Leave the stiffeners (3020-20→23) off the keel plate for now. Drill out a couple of the pilot holes in the lower step fitting for each wing from the inside. You will not be able to clamp this piece, so we suggest drilling the next to the furthest outboard pairs of holes (the ones that will eventually be reamed for AN4 bolts) to 3/16". Install AN3 blots in these holes as you go, then and recheck the wing alignment. Assuming it's OK, go ahead and drill out and ream the remaining holes *except for the most inboard, where the pilot holes in the step fitting are missing*, installing the bolts as you go. The most inboard pairs of holes (the ones that will eventually be reamed for AN6 bolts) must not be drilled until the bottom skin mating flange is installed. Finally, remove the temporary AN3 bolts and ream these holes for AN4s. You can use the same procedure for the top step fitting, but wait until the top skin has been riveted into place.

Next install the fittings (3020-11,12) joining the forward and rear spar shear webs. You can clamp/cleco these in position, so this is not very difficult. These fittings locate the keel plate, so make sure the top and bottom are positioned correctly before you drill, ream and bolt.

Install the lower skin mating flanges (3020-5,6) next, as shown in Figure 1.20. The end with the smallest radius of curvature (e.g. the most curved part) goes towards the trailing edge. The set of flanges with the thickest web goes on the wing bottom. With the doubler (3020-9) inserted between the lower skin and the flange, locate one of the flanges so that the two pilot holes nearest the leading edge are aligned with the two rows of bolts holding the step fitting to the lower spar cap. The hole spacings on 3020-9 and 3020-16 are slightly different, so some compromise is necessary. This will cause the forward edge of the flange (3020-9) to extend a bit beyond the keel plate. Trimming the end of the flange off will result in the loss of one of the lower thrubolts joining the wings. Jim says this is OK. Once you have the flange located, drill and ream the pilot holes beginning in the middle and working towards each end. Install bolts in every few holes as you go. Before working on the opposing flange you need to drill and ream the keel plate for the AN4 thrubolts. Do this with the opposing flange removed. The flange thrubolt holes are already reamed to 0.250", so you want to avoid enlarging these.

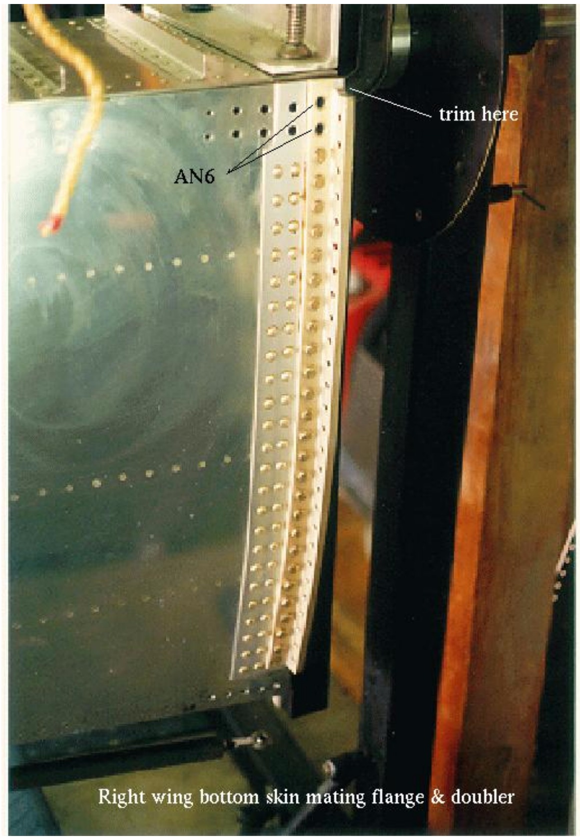


Figure 1.20. View of the bottom mating flange installed on the right wing.

When you have the holes in the keel plate, bolt the flanges together and drill and ream the skin for the other flange. The opposite doubler should be installed before you drill, of course. Finally you can drill the doublers and skin for #6 rivets. You should deburr the bolt and rivet holes in the skin and doubler, so don't install the rivets yet.

Fit, Pro-seal and rivet the TAI skins on both wings now. You will likely have to trim the root ends a fair amount. Be sure to put the lower skin access plate doublers (3000-9) in the correct bays before you mount the skins. If you have not riveted in these doublers, you can reach to buck the top skin rivets fairly easily. If you have already installed the doublers, you will need small arms (small enough to get your elbow through the access ports). Even then, many of the rivets in the aft portion must be bucked blind.

Now you can install the remaining mating flanges. The procedure is pretty much the same as for the bottom surface. You will not be able to drill and ream the keelplate for the top thrubolts due to the dihedral in the wings. Install one of the top skin mating flanges (3020-3,4) and bolt to the top skin following the previously outlined procedure. Then clamp the flange firmly to the keelplate. Take the wings apart and remove the clamped keelplate/flange assembly. Now you can drill and ream the keelplate for the thrubolts on the bench. Then mate the keelplate to the opposite wing. The thrubolt holes in the lower skin and shear web fittings will insure that the keelplate is oriented properly. Bolt the other half of the top wing mate fitting to the keelplate, and drill and ream the top skin. Finally, take everything apart and deburr all of the holes. Then install the #6 rivets in the skin doublers at the root. You need a tandem squeezer or a 5x gun for this. Hopefully you can borrow one from your local airline mechanic. If you can't you can use Hyloks instead of rivets.

Aileron construction

It's not particularly easy to do a first class riveting job on the ailerons or flaps, so this is a poor place to learn how to rivet. We suggest you develop proficiency somewhere else on the aircraft where the skin is thicker and less susceptible to damage. We suggest you work on the right aileron first because the servo tab makes the left slightly more difficult. You should mount the ailerons and make sure the twist is reasonably correct before you do any reaming or riveting. The ailerons and flaps are best built starting at the trailing edge and working forwards. Both are closed out by installation of the main spar.

First attach all the hinges with 10-32 platenuts. This includes the control pushrod hinge (3500-15,16). Most of the platenuts can be mounted on the interior of the spar, but a few must mount on the interior of a rib. Rivet these to the rib only, not through the spar. It's best to make a fixture to hold the hinges in a straight line while you're locating the platenuts and reaming the holes.

Most of the flush rivet holes will have to be dimpled. The only exception might be where the skins and leading edge D-section (3500-29) are riveted to the spar. The D-section is 0.040", so if you put it on the exterior (the newer kits come that way from the factory) you can countersink these holes. Countersinking here makes the closeout easier. Holes that are to be dimpled should be reamed with a 1/8" inch drill (not a #30) because dimpling will enlarge the hole somewhat.

Begin riveting the structure at the trailing edge. Remove the trailing edge and doubler, dimple and rivet them together. You should pull the dimples in the trailing edge. You can buy a set of dies used with a pop-rivet gun to do this. These dies are cheap, but do a remarkably good job. In the doubler you can pull the dimples or put them in with a rivet gun. The gun is much faster, and no one is going to see an occasional smile here anyway. If you want to use the gun, the fastest way is to cut the female half of the dimple dye into a piece of steel thin enough to get up inside the doubler. See Figure 1.17 for an example. You will use this on the flaps too, so it's worth the effort. Make a bucking bar you can hold in a vise to buck the rivets. 4-4 rivets work better than 4-5s here.

Most of the rest of the skins, ribs, etc can be dimpled with a squeezer. Where you cannot use a squeezer we recommend pulling the dimples, at least on the exterior surfaces. Dimple where necessary and rivet the top skin to the trailing edge doubler. Put the assembly back together, remove the bottom skin, and rivet the top skin to the ribs. *Do not rivet the skin to the spar.* Rivet the bottom skin to the trailing edge doubler, then the ribs. Reassemble (leave out the D-section) and use pulled rivets to attach the ribs to the spar.

All that's left to rivet is the D-section. The following procedure, which assumes the D-section is the exterior skin, works well. Glue and celco the spar, skin and D-section together as described for the wing skins. After the adhesive has cured, remove the celcos and the hinges. Make a long bucking bar (Figure 1.21) that extends completely through the aileron D-section. Clamp one end in a vise and support the other (with a block of wood or whatever) on a solid bench. Countersink the holes and rivet beginning at the ends and working towards the middle. The trick to doing this is to first hold the aileron off the bucking bar just enough so the rivet sets flush. Hit it just enough to set the rivet. Then just push the aileron against the bucking bar and set the rivet the rest of the way. Set them well, because the next one inboard can't be set much deeper than the previous one. Save this bucking bar, because with minor modification it can be used to put the leading edge D-sections on the elevators.

The left aileron goes together in a similar manner. Remember to use #3 dimpled rivets on the servo tab. The plans are not very specific about attaching the servo tab to its pushrod. The attachment is via a clevis pin on the prototype.

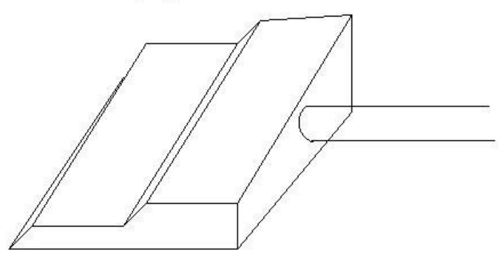


Figure 1.21. Sketch of the stepped wedge bucking bar used to close out the trailing edge of the flaps and ailerons. Retain this for use with the elevators.

Flap construction

There is no reasonable procedure to assemble the flaps without without resorting to at least a few pulled rivets in exposed places. You should confirm that the flap twist is in reasonable accord with that of the wing. Assuming that it is, go ahead and ream the skins. These will all be dimpled, so use a 1/8" drill. Remove the skins and hinges, ream the hinges for the AN5 hinge bolts if you have not already done so, and install a 5/16-24 platenut for each bolt. You will have to install and remove these bolts through the holes provided for this purpose in the stainless steel top leading edge, so *be sure you put the platenut on the opposite side of the hinge.* The ends of the hinges are attached to the spar with AN3 bolts, so drill and ream accordingly. For purposes of construction, there is no need to install platenuts for these; just use AN365 nuts. Dimple the ribs and spars where necessary and complete the internal structure by riveting the main spar, short inboard spar and the ribs together. Install 10-32 platenuts in the root end rib for the fitting that accepts the control pushrod end. Check to make sure the hinge line is straight, and if necessary shim the hinge brackets.

Begin riveting the skin to the trailing edge, as for the ailerons. Dimple and rivet the trailing edge to the doubler. Dimple and rivet the top skin to the trailing edge, then rivet this assembly to the internal structure, all except the main spar. Install the bottom skin beginning at the outboard end and working towards the root. By peeling back the skin you can buck most of the rivets in each bay. Do not rivet this skin to the main spar. Use pulled Intermax rivets (provided with the hardware kit) where necessary on the ribs and short spar. To rivet the bottom skin to the trailing edge doubler using conventional rivets, you will need to make a short bucking bar fastened to the end of a long shaft which can be pushed/pulled through the trailing edge. Machine a wedge-shaped bucking bar (Figure 1.21) so that it fits inside the trailing edge doubler while resting against the rivet line securing the top skin to the doubler. The top and bottom surfaces should be parallel to the surfaces of the skin. The surface upon which the shop head rests must be stepped so that the rivets (4-4's) will not quite seat in the dimple. This surface is used to seat the rivet. The next (higher) step should be high enough to set the rivet completely. To finish the trailing edge, place the flap top down on a solid bench. Find a long metal bar with a good finish and place it between the bench and flap along the rivet line joining the top skin and trailing edge doubler. This surface is going to take a lot of the bucking force, so make sure it's solid. Push/pull the bucking bar in from the end of the flap and position the first (lowest) step under the rivet. Drive the rivet just enough to seat. Then, using the shaft, push/pull the bar in until the rivet sits on the next (highest) step and finish driving the rivet.

When the skins are installed, dimple and insert the stainless steel upper leading edge halves between the skin and the spar, then rivet them in. Rivet the mini-ribs (3400-25→40) and hinges forward of the main spar to the upper leading edge. Quite a few of these rivets can be squeezed. Finally, dimple and rivet in the lower leading edge halves. You will have to use pulled rivets where the lower leading edge fastens to the mini-ribs and hinges, but most of the rivets in the main spar can be driven.

Mounting the flaps and ailerons

Mounting the flaps will be easier (easier, not easy) if you drill a hole in each end of the flaps along the axis of the hinge bolts. You can stick a piece of 1/4" tubing through this hole and through the platenut to act as a temporary hinge pin. Begin by mounting the flaps. With the ailerons removed, position the flap and pin each end with 1/4 tubing. You need a tool to insert the bolts. A half inch socket on the end of a bent piece of 1/4" square rod will serve. Push the bolt through the spherical bearing until it seats against the platenut, displacing the 1/4 tubing. Install the bolts using a quarter inch drive ratchet with a long extension and a universal joint on the end. A Snap-On wobble extension might work better if you have one. For purposes of fitting, you only need bolts in the end hinges. Leave out the center one. Now you can finish trimming the top wing skins, as described previously. To remove the flaps, unscrew the hinge bolts and, if necessary, drive them out using the 1/4 tubing.

With the flaps removed, the ailerons are easy to mount and dismount if you leave out the middle hinge bolt. Make sure they fit satisfactorily and move without binding, particularly with the doubler that mates with the wing tip to the wing.

For complete installation, mount the aileron first. Insert the outboard hinge bolt, then the center bolt (keep trying until you get it). Does the inboard hinge lines up perfectly? Since you held the aileron hinges in a line during construction and have moved the center wing hinge hole as necessary to insure alignment, they should be close. You should be able to insert the inboard bolt using just a bit of force on the aileron.

To mount the flaps, position them and pin the center and inboard hinges. Use a bent piece of 1/4" tube for the center pin. Put a bolt in the outboard hinge (this should not be too difficult due to the considerable play in the other hinges). Put a bolt in the center hinge next. Hopefully the inboard hinge will be aligned perfectly. If not, try making a special bolt with about a half inch, unthreaded lead of 1/4" diameter. If you have a lathe, start with a long AN5 bolt, turn down the end and cut additional thread back to the correct grip length. If this does not work, better reposition the center hinge by replacing the 1/4" plate holding the spherical bearing.

Aileron control system assembly

You need to balance all the control surfaces. This can be done by inserting lengths of 5/8" drill rod in the inboard and outboard hinge holes and suspending the assembly between 2 flat, level knife edges. Stack lead weights on the counterweight channel (or box) until static balance is achieved. For the ailerons, you can actually cast the lead into the channels, provided that you first clamp them so the will not warp. For the other control surfaces (elevator and rudder) you will have to make a wooden mold.

On the aileron pushrod idler arm (8047-6), use a pivot bolt that is just long enough to mount the idler arm with the bushings installed, as shown in Figure 1.22. Use no washers and an AN320 castle nut. Cut the bolt off as short as possible. You will also have to machine away most of the web on the idler arm. If you do all this, the idler arm will just clear the leading edge of the flap.

The pushrod (8045-9) connecting the bellcrank and the aileron is not furnished with the kit. Sections of hardware store stainless steel 5/16-24 threaded rod will work fine. They need to be about 4.5" long. You will need to cut a section out of the trailing edge of the BAO skin to provide access to the pushrod rod end where it connects to the aileron. Make an access plate (Figure 1.23) to cover it and secure it with a few 6-32 screws and platenuts. You may want to make a similar cut to provide easier access to the center aileron hinge bolt.

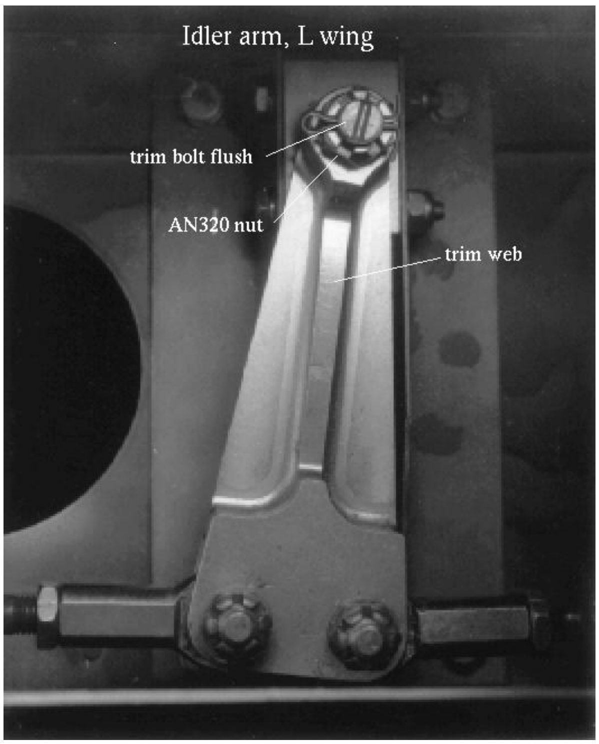


Figure 1.22. Aileron idler installed on the rear wing spar. Trim the pivot bolt back as far as possible and use a shear castle nut to secure the arm.

You will have to construct the pushrod which connects the aileron servo tab to the bracket mounted on the hinge. Brazing or silver soldering is fine if you don't have access to welding equipment. The linkage will not work if constructed exactly as shown in drawing 3510. You will probably find it necessary to put a slight bend in the rod.

Main gear installation

The following paragraphs describe the installation of the main landing gear, except for the actuators and uplock assemblies. These are covered in the section of final assembly.

There has been a design change made to the first couple of runs of landing gear. Measure the wall thickness of the strut (7000-7,8) and trunion (7007-1,2) to determine if you have parts from these runs. If you have 0.125" wall thickness, you need to contact PAE about having your landing gear retrofitted to 0.250" wall. Those builders with the original struts and trunions (there are apparently still a few out there) also have downlock levers that are not heat treated. *Do not install any part of a landing gear assembly with 0.125" wall struts and trunions. Call PAE and get the retrofit.*

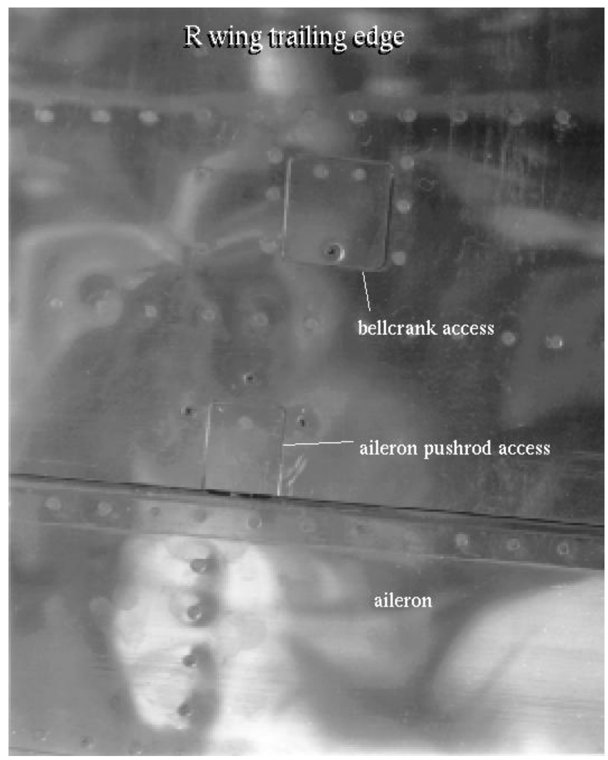


Figure 1.23. Access plate for the aileron pushrod end. This is not shown in the plans, but practically essential in the assembly. You can cut a similar palte for the center hinge bolt.

Assuming you have assemblies of current design, first assemble the struts. Break the edges on all snap and o-ring groves so as to not cut the o-rings. You will need to install a seal where the strut valvestem (7000-9) mates to the lower endcap (7000-24). You can machine either the valvestem or endcap for a o-ring, use a washer with a rubber seal cast into it, or just use Pro-seal. Washers with cast-in elastomer seals are available from Earl's or Aircraft Spruce.

Assemble the chromed strut (7000-4) and axle (7300-6) to the fork. Applying a little bit of heat to the fork will make the assembly easier. A propane torch works well. The chrome struts are already drilled and reamed for the thrubolt securing the strut to the fork. This makes it necessary to pick up these holes from the inside of the fork. This is most easily done on a vertical mill, but a drill press should also work if you're careful. Index the strut so that the hole is aligned with the mill head, then dog the strut to the table using v-blocks. Sweat the fork on the strut and position the axle axis perpendicular to the hole, then drill and ream the fork.

You will use an AN4 bolt to secure the axle to the fork, but *do not drill the hole and install it until you have the brake caliper and disk positioned.* Jim recommends not removing any more material than necessary from the caliper side of the fork. You can drill and tap the fork for a Helicoil and install the AN4 crossbolt without a nut. If you go this way, be user to use a vibration resistant (red) Helicoil.

You will need to install bushings in the fork where the torque link (7000-14,25) mounts. This is not shown in the plans. Use the same bushings as those furnished for the torque links. Use one or two AN960 washers in between the torque links. This will give you a bit of adjustment for toe-out.

In mating the strut and fork, the tube welded to the strut to which the gear door linkage attaches should go on the *inboard side.* Also, make sure the cut out on the fork for the brake caliper is *oriented to the rear.*

Installing the tires

Put the tires on the wheels. On some of the early set of wheels you will need to drill a hole in each wheel for the valvestem. The valvestem goes in the rim opposite the fork (the wheel half without the brake disk mounting standoffs). A 5/8" diameter hole centered 1-5/16" from the inner edge of the rim and centered between the webs works well. The hole should be bored at an angle corresponding to that of the valvestem in the tube; about 13° outward from perpendicular to the wheel axis. Use a die grinder to radius the hole edge, particularly where the tube and valvestem seat. Hardware store grade 3 bolts are OK for securing the wheel halves.

Tires tend to fit very tightly on some of the rims, far tighter than usual on aircraft. If you have rims from one of these batchs, you will probably have to use a press to mount and dismount the tires. Some brands of tires are reportedly worse than others in this respect. Condor tires are supposed to be especially difficult.

Installing the brakes

Mount the wheels and brakes to the strut assembly. You will have to reduce the length of the spacer (7300-18) holding the inner wheel bearing off the inner surface of the fork so that the brake disks will fit in the calipers. This will require reducing the axle length by a corresponding amount (by trimming the inboard end of the axle).

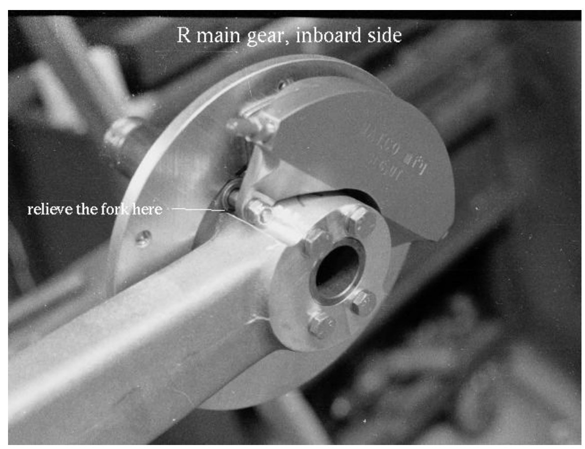


Figure 1.24. Disk and caliper on the right fork. You will have to relieve the outboard edge of the fork slightly to get the caliper to fit.

Begin by mounting the calipers to the fork. To get the torque plate (7300-14) flush against the fork it will be necessary to relieve the fork a bit to clear the welds securing the selves to the plate, as shown in Figure 1.24. The torque plate attaches with AN5-25A and AN6-26A bolts. The AN5s also secure part of the uplock assembly to fork, so these may seem a bit long. Mount the brake caliper to the torque plate and install the disk (7300-13) in between the pads. Orient the disk so that the side with the large counterbore faces the wheel. Install the spacer between the bearing and fork. It fits very tightly in the ID of the torque plate, so *make sure that it bottoms against the fork*. Install the bearings and the wheel. You will not be able to get the wheel close enough to the fork to bolt on the brake disk because the spacer is too long. The amount by which the spacer should be trimmed is a matter of compromise. Obviously the length must be reduced at least enough so that the brake disk seats on the wheel. Further shortening has the desirable effects of increasing the clearance between the tire and gear door in the up position and helping to align the centerplane of the tire with the axis of the strut. The latter helps reduce torsional loads on the torque link when landing. This should reduce the frequent need for replacement of the torque link bushings. Shortening the spacer will also increase the interference between the wheel and the inside caliper. On some early sets of wheels, this may result in having to take more metal off either the caliper or wheel, as shown in Figure 1.25. This is addressed in detail later. At this stage you should be able to determine about how much you want to trim the spacer by measuring the partially mated wheel and brake. Some suggested dimensions based on my experience are given a bit later.

The final problem in the brake installation is the lack of adequate clearance between some of the earlier wheels and the side of the brake caliper. If you have wheels from one of these batches, this will be obvious when you try mating the disk to the wheel. To fix this, you need to either grind down the outer edge of the caliper and/or turn a radius on the wheel just inside the sleeves that mount the disk. The latter option is preferable, but it obviously requires access to a lathe with a moderately large swing. Use 1.5" 1/4-20 carbon steel cap screws to secure brake disk to wheel. At least one well known race car builder (Caroll Smith) recommends against using stainless steel in this application, probably because the much lower thermal conductivity of the stainless will make the brakes run hotter.

BTW, although the Caroll Smith books are directed towards race cars, they contain far more information useful to the metal airplane builder than anything we have seen from "Tony B". Smith has 2 books out; *Prepare to Win* and *Engineer to Win*. Both are recommended reading.

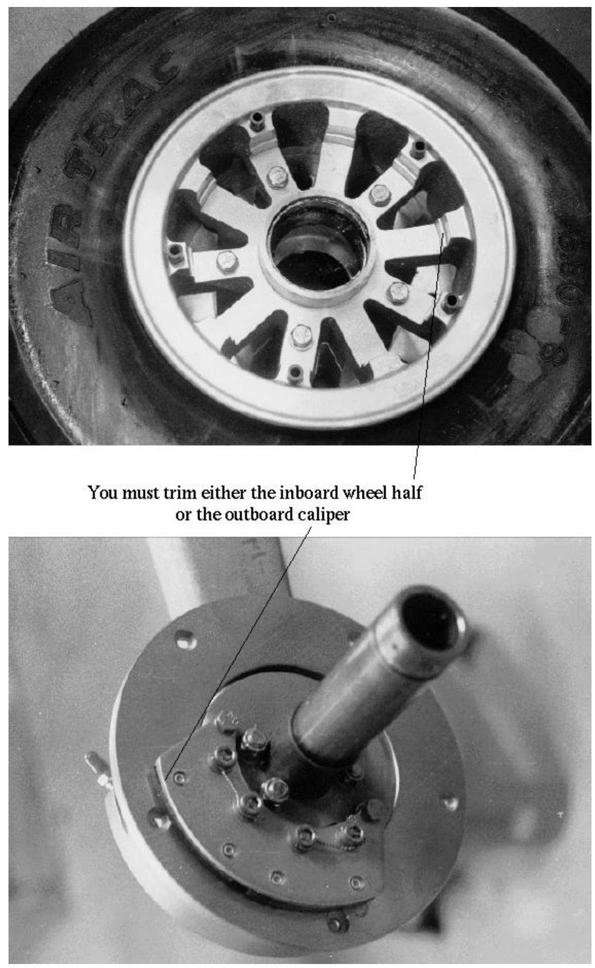


Figure 1.25. To get the calipers to fit on some of the earlier batches of wheels you will have to machine the rims or grind away some of the brake pad plate (or both).

You can expect to trim the spacer (7300-18) to a maximum length of 1.660" just to get the brakes mounted to the wheel. Of course the exact amount will depend on the thickness of the brake pads, and your's may not be exactly the same as ours. If you trim the spacer to 1.660" and do not grind anything off the inner caliper, you may need to relieve the inner diameter of the wheel as illustrated in Figure 1.26. If you do this you can expect a tire to fork clearance of about 0.2" with McCreary or Goodyear tires. The clearance is reported to be somewhat greater with Condors.

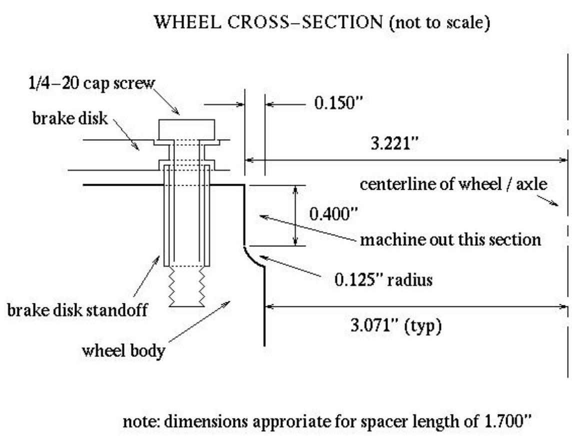


Figure 1.26. Sketch showing dimensions for machining the wheel rims from early production runs.

Installing the axle and wheel

Trim the axle as necessary and reinstall it in the fork. Be sure to account for the washer (7300-8) that retains the outboard wheel bearing when you determine the axle length. This washer (and the seal on the inboard side) is not furnished with the kit. The inboard side seal is a standard automotive part (NAPA#47593). You will have to fabricate the washer. The axle length will depend on how thick you make your washer. The axle is secured with an AN4 crossbolt. You may not be able to install the bolt conventionally without interfering with the brake caliper. The best solution is to use a Helicoil, as described previously. Otherwise you will have to counterbore the fork on the caliper side.

Mounting the trunion in the wing

It easier to install the trunion in the wing before mating it with the strut. First assemble the strut and trunion and downlock lever (7007-5,6) on the bench just to check the fit. Since the downlock levers are now heat treated after the machining and welding is complete, in some cases the ID will need to be honed before it will fit on the trunion. When the everything fits OK, remove the strut and proceed as follows. If you have not already done so, trim away the upper inboard quadrant of the rear bearing flange as illustrated in Figure 1.11 to clear bottom of trunion. Mount the front and rear bearings on the trunion and then bolt the assembly into the wing at the front bearing. Leave the downlock lever off for now. You should have already cut a hole in the rear bearing plate to provide clearance for the rear bearing journal and the aft end of the trunion. You may have to trim a bit from the front bearing flange to get the trunion to seat against the bearing. Assemble the strut to the trunion, but do not drill the hole for the Schrader valve pin. If you have a set of gear with the hole already reamed, don't install the pin yet.

Now you need to find the final location of the rear gear bearing and bolt it into place. If you have already riveted the RB skin in place, you will need to make a couple of clamps to hold the rear bearing. Turnbuckles with adaptors brazed to the ends (as in Figure 1.27) work fine. The procedure for locating the rear bearing is as described previously, but now you will have a much better idea of the fit of the tire in the wheelwell. If you have trimmed the wheel standoff spacer as described in the brake installation, you should be able to get about 3/8" clearance between the tire and the (extended) contour of the bottom skin with the gear in the up position. You can get an additional 3/8" clearance by trimming away a section of the rib at WS 15 where it hits the fork.

Once you have the rear bearing positioned, drill and ream the rear bearing plate and bolt the rear bearing into place. Cut out the rib at WS 15 for the fork and install a doubler on the top skin as shown in Figure 1.28. The doubler will sit under the fairing, so it need not be a work of art.

Installing the downlock

This is one procedure that's described in some detail in the notes on the plans. To these we add the following.

First remove the trunion and remount with the downlock lever installed. Make sure the trunion seats against the front bearing face, then use a wooden wedge between the lever and the rear bearing plate to seat the lever firmly against the rear surface of the front bearing.

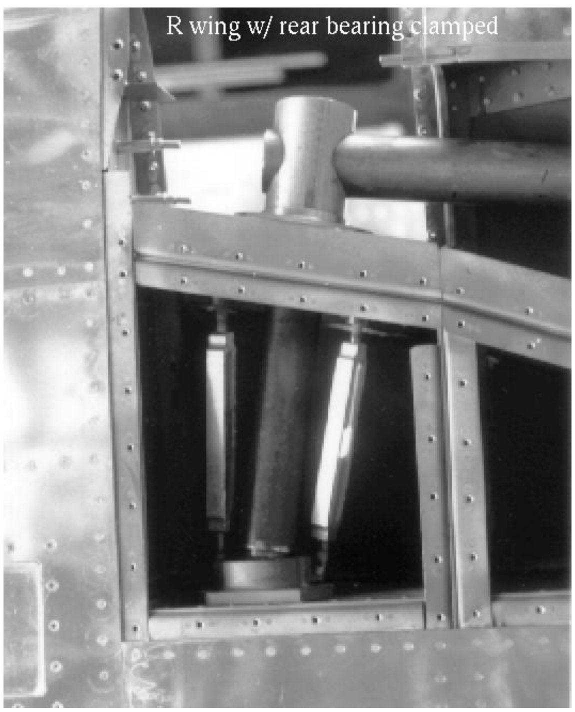


Figure 1.27. Clamps made from turnbuckles can be used to hold the rear bearing in place during alignment.

You need to cut a hole in the rib at WS 43.25 to accept the downlock pin guide (7020-6). This must eventually be bored at an angle with respect to the rib so that the axis of the pin guide is aligned with the downlock lever mated to the trunion. Jim wants the pin guide to fit tightly in the hole so that the loads are transferred directly from the pin to the rib, not through the bolts securing the downlock flange (7020-5). The major diameter of this hole should be a few thousandths over 1.500". A boring fixture such shown in Figure 1.29 is ideal for this purpose.

In preparation for this operation, locate and cut an undersized hole in the rib using a hole saw. A 1-7/16 diameter saw will work OK. The hole location is denoted as point A in drawing 7020). *Be very sure you have it in the right place before you cut metal.* If you have any doubt, put the downlock lever on the trunion and install it in the wing. When the lever is rotated so that the lug is closest to the rib, the lung should be directly abeam point A.

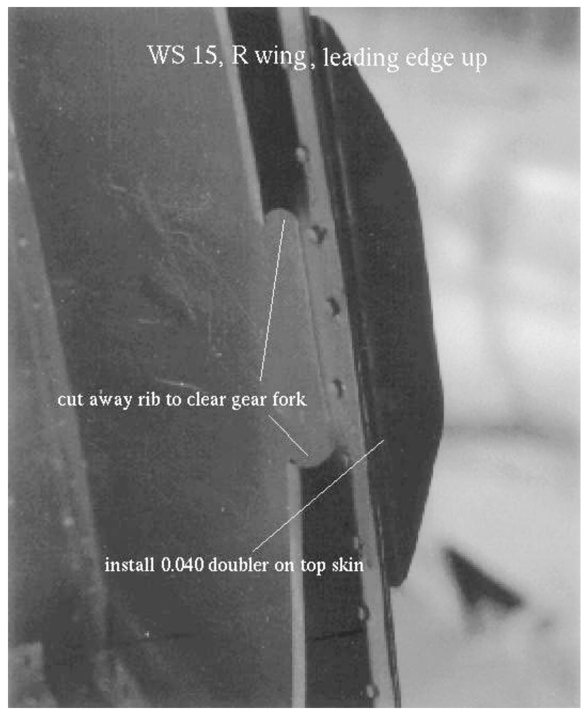


Figure 1.28. Here you are looking at the right wing from the bottom inboard side. The wheel fork goes in the cutout in the rib, and a doubler is installed on the top skin.

The downlock flange should be oriented so that its major axis (the long side) is perpendicular to the trunion. This requires tilting the flange off the vertical $8-9°$, with the top of the flange displaced towards the trailing edge of the wing (see Figure 1.30). As mentioned previously, this makes the flange overlap a number of pilot holes for rivets. Hopefully you have not installed these. If you have, drill them out. The flange will also overlap the angle bracket joining the rear plate to the rib in the upper inboard side of WS 43.25. You need to install a 0.040" shim between the flange and rib except in these areas Similarly, the steel downlock stop (7020-10) on the outboard side of the rib will partially overlap the angle bracket holding the bottom skin to the rib. Shim this out 0.040" also. Locate and clamp the flange in position with the proper orientation and with the pin guide holes aligned. Use the boring tool (Figure 1.30) or, with care a die grinder or half-round file, to ream the pin guide hole for a close fit.

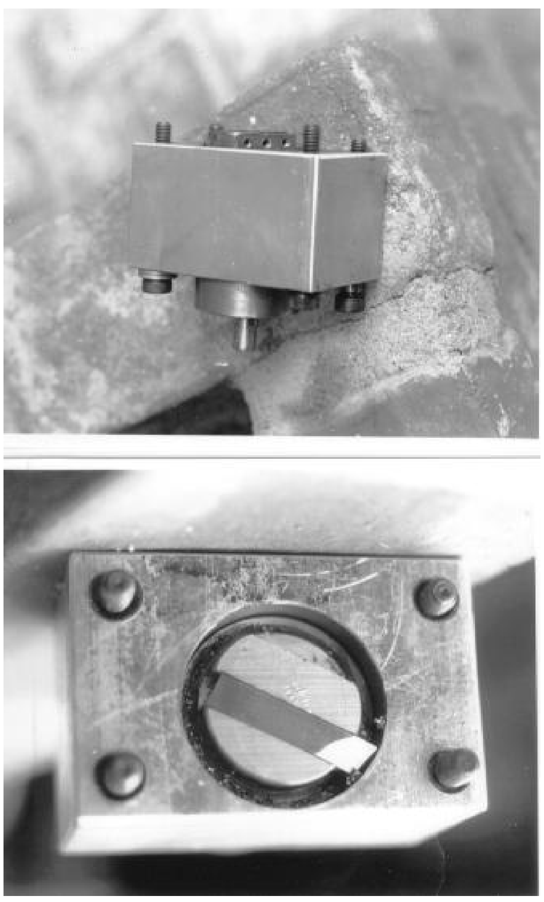


Figure 1.29. This fixture attaches to the downlock plate pin guide holes with 4 bolts. The cutter reams the downlock pin hole in the rib to the correct size and angle.

Install the pin guide, then drill and ream the bolt holes securing the flange to the rib. Once you have the bolt holes drilled, you can install rivets in those holes in the anglebrackets which do not interfere with the downlock flange and its attach hardware. In particular, you can likely install flush rivets in some of the holes in the angle bracket mating the rear bearing plate to the rib.

Assemble and install the downlock pin (7020-15), rotate the lever on the trunion to the down position and check the fit of the downlock lug between the pin and stop. It's possible that you may have to take a small amount off the face of the stop and/or the lug itself to get the lug to engage. The lug should show at least 0.375" engagement with the downlock pin. If you get less than this, your only choice is to machine a bit off the flange of the downlock pin guide so it will protrude a bit further out of the rib. *Building the lug up with weld is not recommended* because it can effect the heat treat of the material.

The last step in the downlock installation is location and assembly of the torque tube (7020-4, see Figure 1.31). There is a service bulletin calling for some minor changes to this part (see Figure A.3). Now would be a good time to make the changes, if necessary.

Orient the wing with the leading edge up. Rotate the downlock lever so that the lug is engaged in the down and locked position. Assemble the torque tube, bearing and flanges (7020-14) and position the rear bearing approximately as shown in Figure 1.31. Position the front bearing so that the torque tube is approximately parallel to the trunion. Assemble the actuator so that the distance between the rod ends is 9.25" when fully compressed. Install the actuator between the torque tube and downlock lever as shown in Figure 1.32.

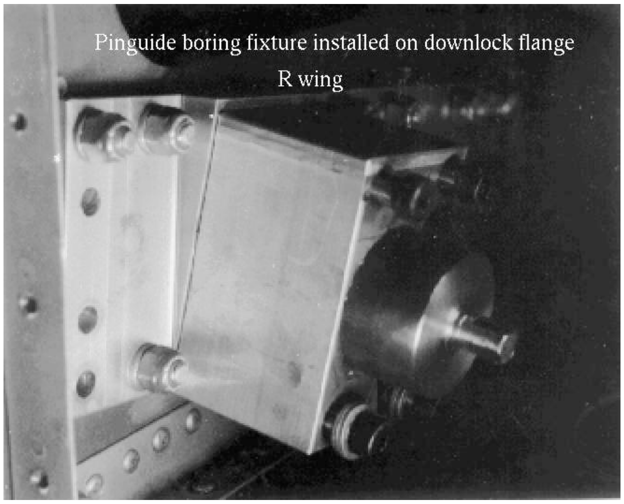


Figure 1.30. Boring tool installed on the downlock plate.

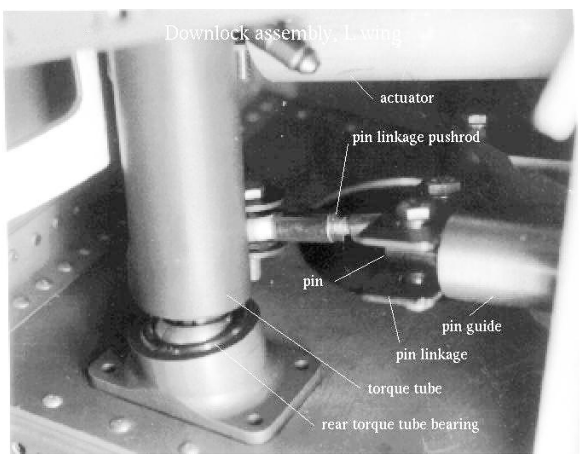


Figure 1.31. Positioning the torque tube. You are looking at the left wing from the bottom.

Assemble the pushrod (7020-18) between the pin linkage and torque tube, then refine the torque tube bearing locations as follows:

1. Measure the angle of the trunion with respect to vertical in both axes, as shown in Figure 1.33. By far the easiest place to do this is at the extreme leading edge of the trunion. For example, here the left trunion is about 10° off vertical in the plane of the wing and about 9° in the out of plane direction.

2. Orient the pushrod (7020-18) parallel to the downlock pin (7020-13) as shown in Figure 1.34. If the pin is fully engaged, this can be done by positioning the rear torque tube bearing in the out-of-plane direction (e.g towards the top or bottom skin) so that the pin linkage (7020-8) is perpendicular to the pushrod. Mark the position of the bottom of the rear bearing flange on the mounting plate.

3. As shown in Figure 1.35, use a combination square and straight edge to measure the angle of the pin linkage with respect to the bottom skin. Set the axis defined by the center of the torque tube and the pushrod end to this same angle. This is most easily measured at the rear of the torque tube lever (Figure 1.36).

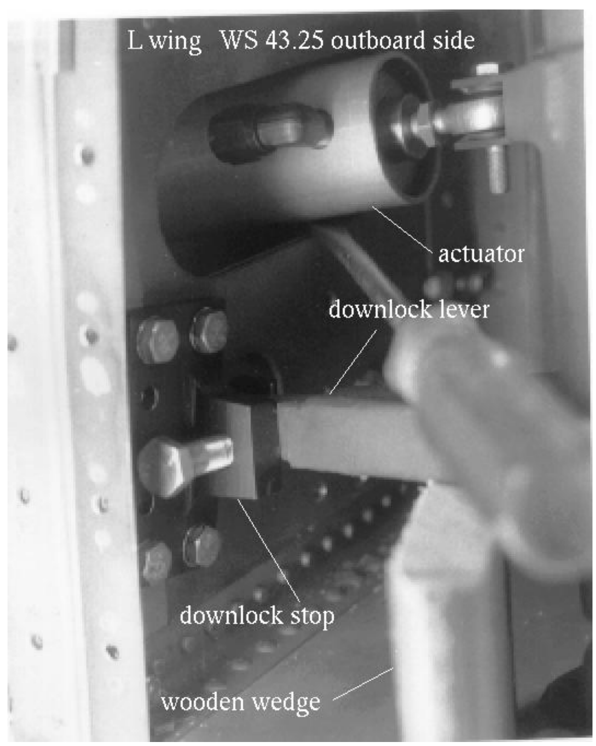


Figure 1.32. The left main gear actuator and downlock lever. The screwdriver is not part of the assembly!

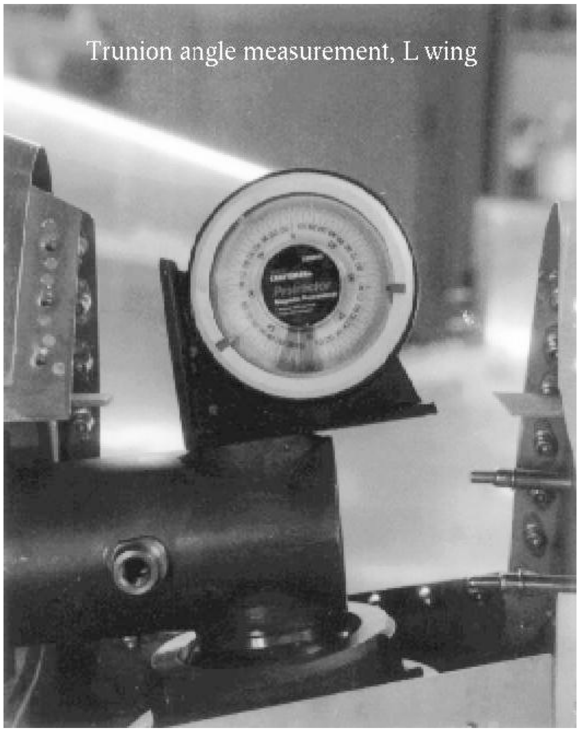


Figure 1.33. The easiest place to measure the trunion angle is at the forward end.

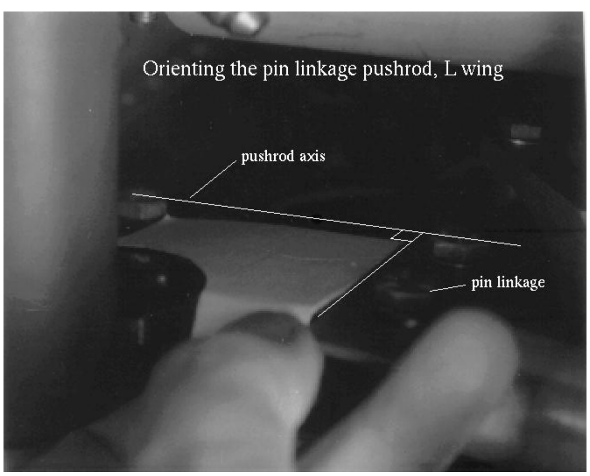


Figure 1.34. The pin linkage should be perpendicular to the pushrod when the pin is fully engaged.

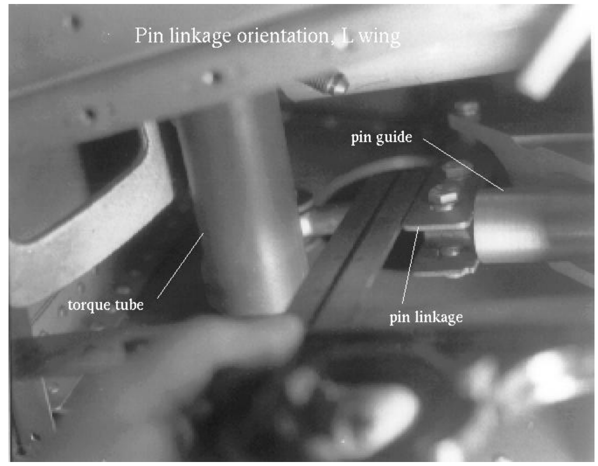


Figure 1.35. In order to locate the torque tube, you first need to measure the pin linkage angle with respect to some reference plane. Here we use the bottom skin.

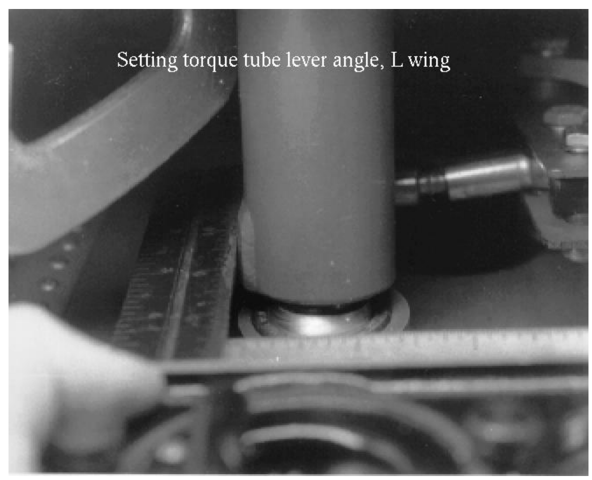


Figure 1.36. If you measure off the back of the torque tube arm as shown, be sure to account for the fact that this is at a slightly different angle than a line between the tube axis and the pushrod attach point.

Note that the back of the torque tube arm is not quite parallel to the axis between the torque tube (7020-4) and the actuator attach point. If you measure off the back of the torque tube arm, be sure to accout for this. Rotate the torque tube to get the proper angle. In rotating the torque tube, maintain the actuator length at 9.25" (Figure 1.37). It will be necessary to move the front torque tube bearing in the spanwise direction when you do this.

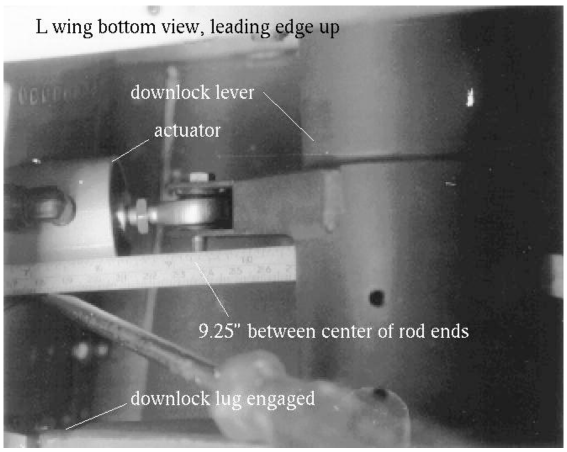


Figure 1.37. Make sure you keep the actuator length at 9.25" when locating the torque tube.

4. As illustrated in Figure 1.38, move the rear bearing in the spanwise direction so that the torque tube orientation matches that of the trunion in the plane of the wing.

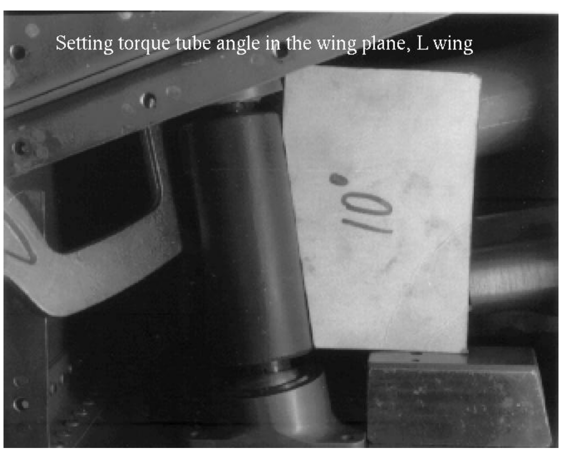


Figure 1.38. View of the torque tube in the left wing from the bottom. The leading edge is up, so the rear bearing is at the bottom.

5. Move the front bearing in the cordwise direction so that the out of plane angle matches that of the trunion (Figure 1.39).

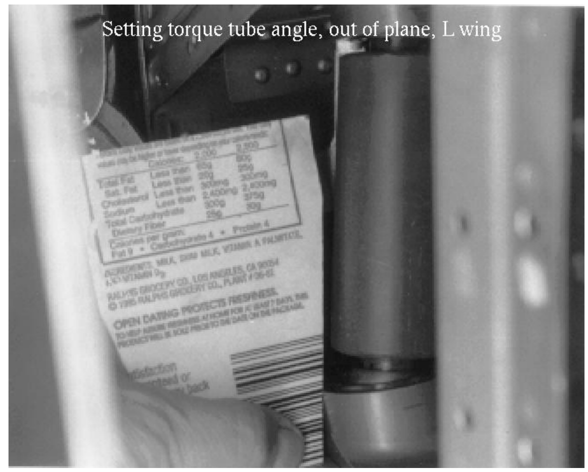


Figure 1.39. View of the torque tube in the left wing from outboard and below. The leading edge is up, so the rear bearing is at the bottom.

Iterate on this procedure as necessary until

- the actuator length is about 9.25" in the down and locked position
- the torque tube (7020-4) is parallel to the trunion (7007-1,2)
- the pin pushrod (7020-18) is parallel to the pin guide (7020-6) axis
- the axis defined by the torque tube and pushrod end bearing centers is parallel to the pin linkage (7020-8) in the down and locked position.

When you have the bearing correctly positioned, drill and ream the bolt holes. After this is done, you may find considerable play in the engagement of the torque tube in the spherical bearings. In this case you can use spacers (Figure 1.40) to insure adequate engagement in both the front and rear bearings. Or you can put shims under the bearing flanges, which accomplishes the same purpose.

Installing the trunion crossbolts

The holes for the trunion crossbolts must be reamed so that the struts will be vertical with the gear down and locked and the wings assembled to the fuselage. The safest way to do this is to wait until the wings are mated to the fuselage. However, in the interest of maximizing the amount of work that can be done at home, the following procedure will also work.

Rotate the wing to horizontal with the top skin up. Carefully measure the angle with respect to vertical of the plane defined by the upper (3020-3,4) and lower (3020-5,6) skin mating flanges. If the wing datum is level in the spanwise direction, this should be the dihedral angle; 5°. With the downlock lever in the down and locked position and seated firmly against the rear of the front gear bearing, position the strut so that it is parallel to the plane defined by the upper and lower skin mating flanges, e.g. so that is it off vertical by the dihedral angle. Assuming you have the toe-in adjusted to zero, it's easiest to measure this angle off the machined flat where the fork mates to the axle. It's difficult to make a reliable measurement off the strut itself due to the 10° forward sweep. Once you have everything set, secure the strut in position, drill one end of one of the thrubolt holes to 0.25" with a hand drill and install a 0.25" spring pin. Recheck your measurements to make sure nothing has moved. If everything looks OK you can remove the trunion and downlock lever from the wing, reassemble and replace the spring pin, then drill and ream the thrubolt holes to 0.375", installing the bolts as you go. The drilling and reaming should be done on a milling machine. With great care, perhaps a drill press could be used. If you use a milling machine and the hand drilled hole is not perfect (it probably will not be), you can straighten it up using an undersized 2 flute endmill first.

Adjusting the toe-in

The toe-in adjustment is best be left until the wings are mated to the fuselage. But if you can't wait, try the following.

If your trunion is not drilled and reamed for the Schrader valve pin you just need to rotate the gear to the down and locked position with the wing oriented with the leading edge up. If your tooling is adjusted correctly the main spar datum should be level. If it's not, measure the angle of the main spar with respect to the vertical. Put a washer in between the torque links at the elbow to provide a little field adjustment for toe-in. Rotate the strut in the trunion until the toe-in is zero (perpendicular to the spar), then carefully remove the trunion and ptrut from the wing and drill and ream the hole for the Schrader valve pin.

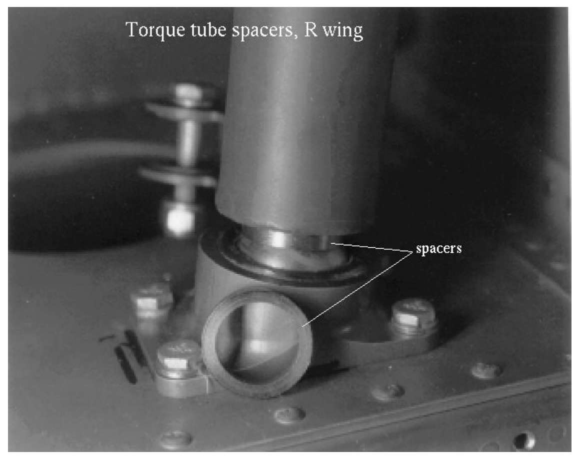


Figure 1.40. You will probably have to install spacers or shims to insure adequate engagement in both bearings.

One batch of gear was made with the Schrader valve pin holes already drilled and reamed. This batch also had the thin wall. If yours are from this batch all you can do is install them and see if the toe-in is OK. There must be no toe-in. If you have toe-in, you will need to move the hole in either the strut or trunion. PAE can do the at the same time the fix the wall thickness; just let them know how far and in which direction to move the hole. Generally, a little toe-out is acceptable. This will increase tire wear, but will not result in dangerous ground handling characteristics. You can increase the toe-in slightly by adding washers between the torque links at the elbow.

The S51 landing gear design was modified as a result of cracks being found in the first kit built aircraft. The upper strut and the trunion were originally constructed from non heat treated 0.125" wall tubing. This was changed to 0.250 wall tubing, and the downlock lever assembly was heat treated after welding. *Make sure your landing gear upper strut and trunion have 0.25" wall. Old assemblies made from thin tubing must be returned to PAE for retrofit.*

The OD of the modified trunions is too large to use with the Schrader valve pins presently being suppled. These pins were sized for the original trunions made from thin wall tubing, and are too short to engage both sides of the modified trunions. The best fix for this is to remove 0.0625" from each side of the trunions with a spot facing counterbore, then used a lathe to remove 0.150" from the shoulder of the pins. This results in very nearly full engagement. The next batch of Schrader valve pins will be longer, so future builders will not have to do this.

The rest

If you want, you can perform the following tasks which are covered in detail elsewhere.

- You can install the strut (outer) gear doors (drawing 7305). The procedure is covered in the Final Assembly section. You can also fit the leading edge covers (3600-11) for the trunions. You want to trim these and install them with 8-32 100° screws. The covers should be dimpled for the screws, not countersunk, and countersunk platenuts used.

- You can install the wing tips, which are currently made of fiberglass. If you want, they can be extended enough to house a Archer nav antenna. See the Final Assembly section.

- You can complete the fuel system plumbing in the center bays of the wings. See the Final Assembly section.

- The inner gear doors are also not generally available at this time. However, complete drawings (7306-1 through 7306-4) and some of the parts do exist. If you want to tackle this part of the project now, contact PAE.

- You can mount the aileron push-pull tube pedestal (8047-2) to the rear spar mate fitting and install the tubes.