

CHAPTER 3: FUSELAGE/MAIN SPAR ASSEMBLY PROCEDURE

REVISIONS

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 When such revisions are made, you should immediately replace all outdated pages with the revised pages.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

Arrows

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

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1. INTRODUCTION

The purpose of this chapter is to install the Main Spar/Belly Pan assembly onto the fuselage. The things that have to be achieved are:

1. The squareness of the wings to the fuselage
2. The angle of incidence
3. The aesthetics of the wing to fuselage junction



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3. EQUIPMENT REQUIRED

A. Parts

- Main spar/belly pan assembly
- Fuselage assembly
- Outboard wing panels



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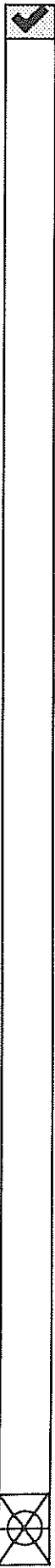
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B. Tools

- Sheet Metal Shears
- Carpenter's Square
- Carpenter's level - 4 ft. minimum
- Pencil
- Utility knife or equivalent
- Saw Horses (2)
- Adhesive measurement syringes or balance scale or Epoxy Dispensing Pump
- Small weigh scale (should be capable of measurements as fine as .1 oz.)
- #6 x 3/8 sheet metal screws or
- 1/8" dia, about 1/4" material capacity clecoes and cleco pliers
- Rubber gloves or protective hand coating
- Watch or clock
- 1/8" dia drill bit
- Drill motor
- Pop rivet gun
- Sanding block
- Water level at least 15 ft. long
- 15 ft. measuring tape
- 4 C-clamps
- Sandbags or equiv., about 30 lbs.
- String line



C. Materials & supplies

- Hysol 9339 Structural Adhesive (supplied in kit)
- Mixing sticks - tongue depressors (supplied in kit)
- Mixing dish or cup (supplied in kit)
- #40 & #80 grit abrasive paper
- Paper toweling or cloth pieces
- Wax and silicone remover (available at auto body or paint shop)
- Methylene Chloride (MC) cleaner
- Soft aluminum pop rivets, 1/8" dia., 3/8" grip
- 1" high density foam
- epoxy, flox, micro, BID glass cloth



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4. **PROCEDURE**

A. **Installing the Main Spar/Belly Pan assembly onto the fuselage.**

PRIORITIES:

It is difficult to make any two parts **exactly** the same. Because of this, you can expect to find small variances between dimensions of small parts, and the variances will increase proportionally with the size of the part. The goals you need to achieve, and their order of importance in the event of having to make a trade-off, are:

1. **THE LEFT WING SHOULD BE LIKE THE RIGHT WING** (Or, if you choose, vice versa).
2. The trailing edge should be straight from root to tip.
3. The gap between the spars and the belly pan should not be less than the thickness of the wing skin that will mount there.
4. The fuselage should be level.

Let's examine this list for a moment, and understand why and what we can do about keeping these priorities in order:

#1, the wings should be alike. The wings fly, the rest is along for the ride. The wings need to be as symmetrical to each other as possible. If they are not very close to identical, your handling will suffer. A little bit of trim adjustment will correct for most minor irregularities, but for 'wings level' flight, the wings should be levelled to earth gravity and each other, not to the fuselage joggles.

#2, the trailing edge must be straight. The hinges for the flaps and ailerons will be mounted back there, and if they aren't straight, things will bind and wear and again give you the problems associated with asymmetry.

#3, the gap at the wing root should be proper. If, to get #1 & #2 priorities right, the gap is too little or too much, a bit of cutting or bending, or micro filling will correct it. However, if the gap is too little, then adding a bit of material to all of the foam positioning blocks or, if the gap is just at one corner or end, a slight flex of the fillet joggle.

#4, Keeping the fuselage level is the lowest priority, simply because a degree one way or the other will have little or no effect on flying the plane, and will not be noticeable to the pilot or passenger. If canting the fuselage appears to be the only way to correct a gap between the wing root and the fuselage, take heart. Depending on the spot you want to correct, you may be able to adjust the fuselage fillet up or down slightly by heating it with a heat gun and applying uniform pressure (being very careful not to overdo it) to get it where you want it. Give it a try first, but if making the fuselage a little unlevel is the best solution, don't worry about it. It will not cause any problem later if you shift it slightly now.

Because of the rigidity of the fuselage structure (fslg), the rigidity of the Main Spar/Belly Pan structure (Spar assembly) and the construction method used of mating the two during their initial manufacture, these points are really quite easy to achieve.

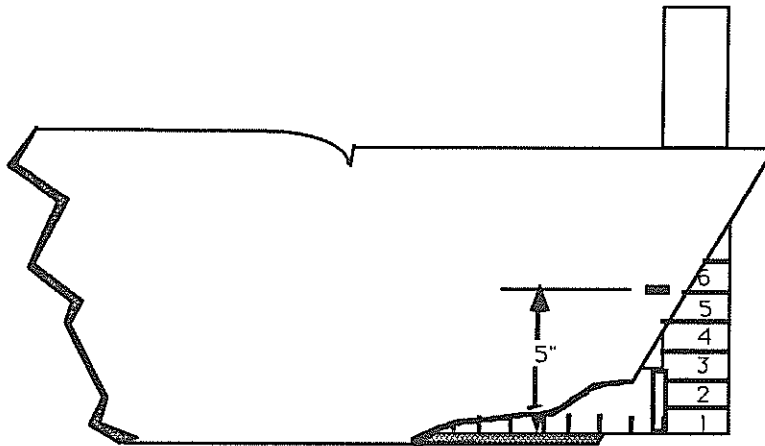
We will begin by taking several measurements, some to just double check that nothing has taken a wrong set during shipment or storage, and other measurements that we will use later when bonding the parts together. Then we will put the spar assembly into the fslg, and do some initial 'squaring'. Next we'll install the wings and take some final measurements. After all the necessary adjustments have been made, the final step will be to position the spar assembly and hold it in place for the time required for the bonding adhesive to make it a permanent part of the fslg. Most of the drawings you will need are included here, but you may need the BL-50 Rib drawing from your blueprint package if the level lines are not visible on the ribs.

NOTE: Great care is taken when constructing the parts for the fast-build kit, and as a result, it typically goes together with very little 'tweaking' necessary. If you come across a measurement or part that seems 'out-of-whack', recheck your set-up before cutting anything away that might really be correct and that you might need later.

1. The first thing we need to do is make a couple of reference marks on the tail of the plane that will be used later to level it in the upside down position. Grab your carpenter's square, and go to the tail of the plane. Referring to Figure 3-1, place the square on the inside of the plane, against the bottom, and measure up five (5") inches, marking that spot on the outside of the tail. You only need to mark one side. Also, make a mark on both longerons directly above the high density foam pads. You'll use these marks to level the fslg later, upside down, so draw a line across the longerons that you can see from both sides & underneath (a couple of pieces of 1" tape would work as well or better, see figure 3-2).

TAIL LEVEL REFERENCE

Figure 3-1



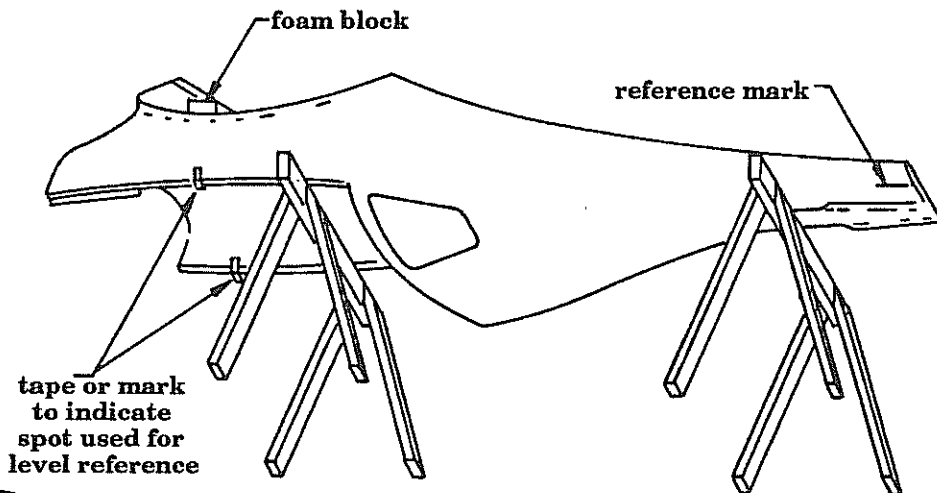
2. The next thing we need to do is get the fuselage into a position where it can be leveled, off of the floor, accessible from all sides, and upside down. The best thing is saw horses, which can be quickly constructed from some old 2x4's. You will need 2 of them for proper support. You could use a steady table, but the saw horses are a lot easier to work around, and they let you get under the fuselage for a couple of the measurements you'll need.

NOTE: *There are high density foam pads attached to the fuselage. Be careful not to damage or distort them.*

3. Turn the fslg upside down and rest it on a steady table or horses as shown in Figure 3-2. Be careful not to dent the longerons, they will be used from time to time for reference.

INVERTED FUSELAGE

Figure 3-2



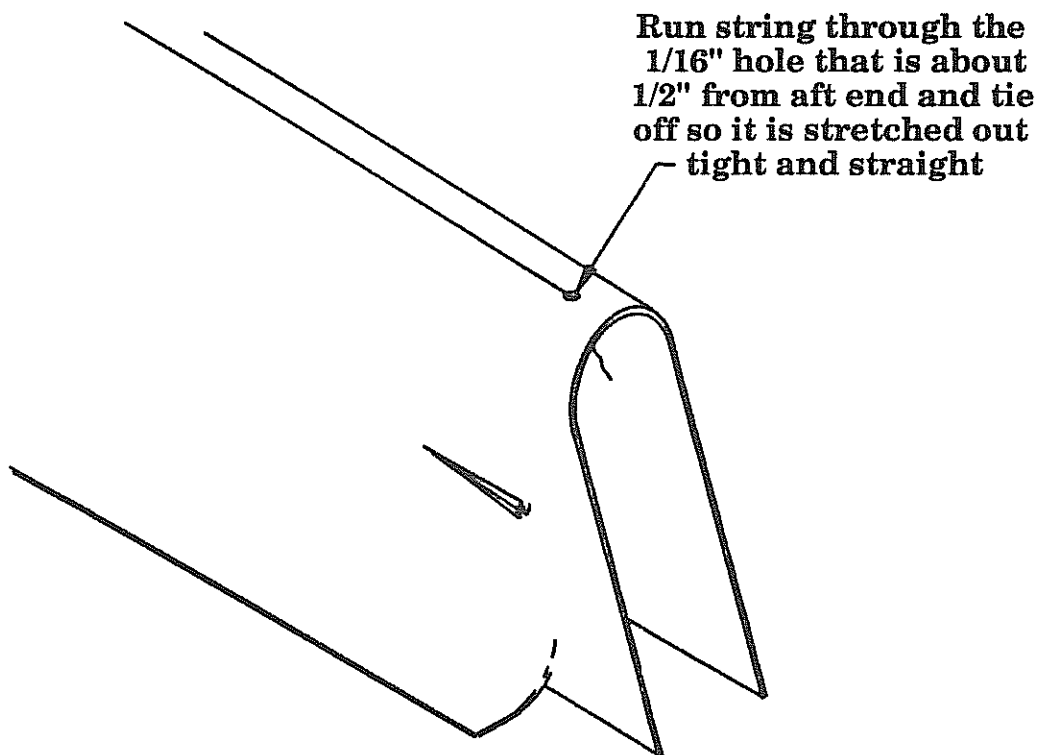
4. Laying a level across the longerons from side to side, underneath, at the spot you marked with tape, level the fslg by placing shims between the longerons and the front horse.
5. Once the plane is level side to side, you need to establish a fwd-to-aft level line. Houdini could probably do this next step with mirrors, but you may want to call a friend to help. On the front of the firewall where the two lines cross there is a small hole. Using a water level, place one end of the water line at this point. Take the other end of the water level back to the mark you made 5" up the side of the tail. Shimming between the rear horse and the tail, adjust so that the mark on the tail is level with the hole in the firewall. Recheck the side-to-side level, and re-adjust as necessary.

When you are level both ways, weight the fuselage down with something (we use shot bags, but if you don't happen to be a reloader, most anything will do) so that it will hold it's position through the next steps.

6. Examine the bottom (now on top) of the tail of the fuselage. There should be a 1/16" hole there, about 1/2" from the aft end, and at the bottom-most portion of the tail. Run a piece of string into the hole and tie it off to a pencil or something to hold it there, and run the other end of the string down the belly of the plane till it is past the firewall.

STRING LINE, AFT END

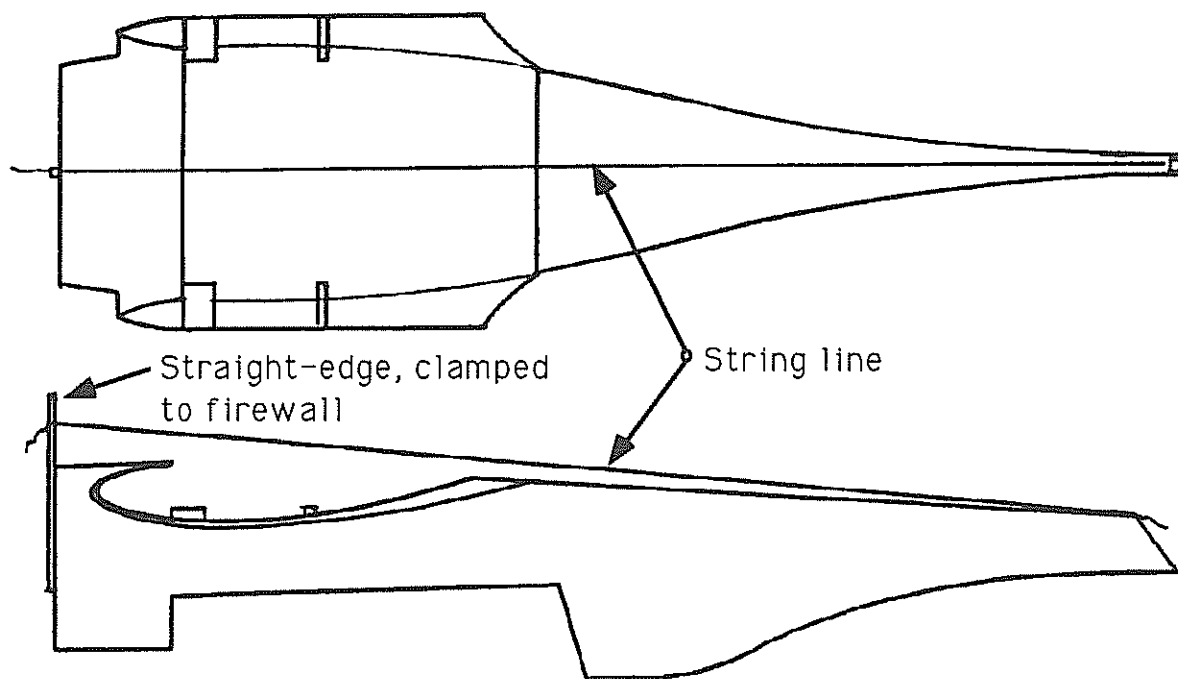
Figure 3-3



7. Lightly clamp a straight edge to the firewall, so that you have a point to tie the string to that is straight up from the hole we used earlier to level the plane. Use a level against the straight edge to establish true vertical. What we next want to achieve here is a straight line, drawn on the bottom of the plane, that runs from the firewall to the tail.

STRING LINE, FSLG BOTTOM

Figure 3-4



8. Using a plumb bob from the string line, mark several places on the fslg along the centerline. Then, using a straight edge, 'connect-the-dots' so that you have your centerline marked from end to end. Remove the string and straight edge.

This center line will be used for squaring and cutting of the wing fillets where the flaps butt up against them, and to get the Main Spar centered and in the exact proper position.

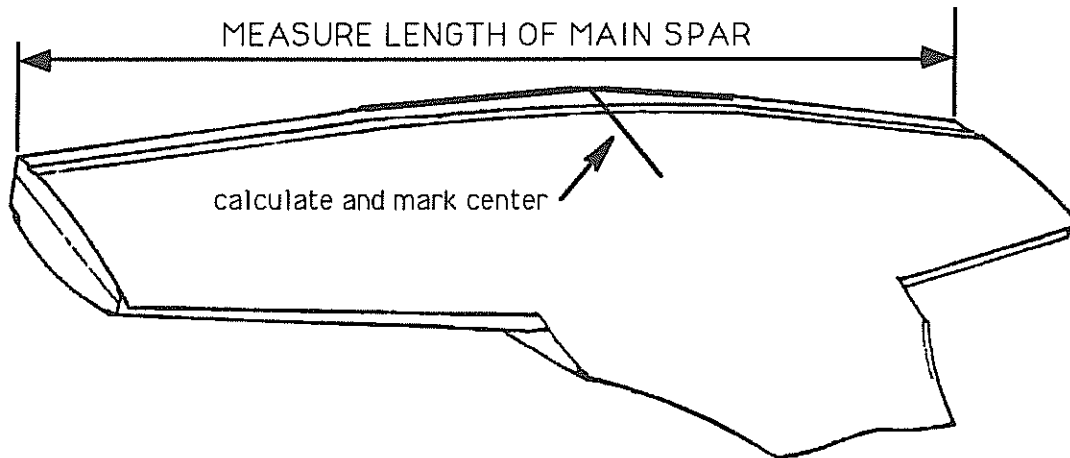
9. This is probably the best time to go ahead and measure out from the center line to the wing fillets, where the flaps will butt up against them, and determine which is the 'shorter' of the two (at the point of the foam blocks, it should be about 23" from centerline to edge of fillet, and about 23 1/4" at the flap point, refer to figure 3-4). Trim the longer side down to match. They don't have to be exact, but should be within 1/4" or so of each other after trimming.

10. Determine the center of the Main Spar:

Measure the main spar, as shown below, from forward corner to forward corner. Divide this dimension by two, and place a mark at that point, the center of the spar width. Using a square, make a line from the leading edge of the belly pan, at your center mark, back about 3 or 4 inches. We will use this line later to help center the belly pan assembly in the fuselage.

MAIN SPAR CENTER LOCATION MEASUREMENT

Figure 3-5

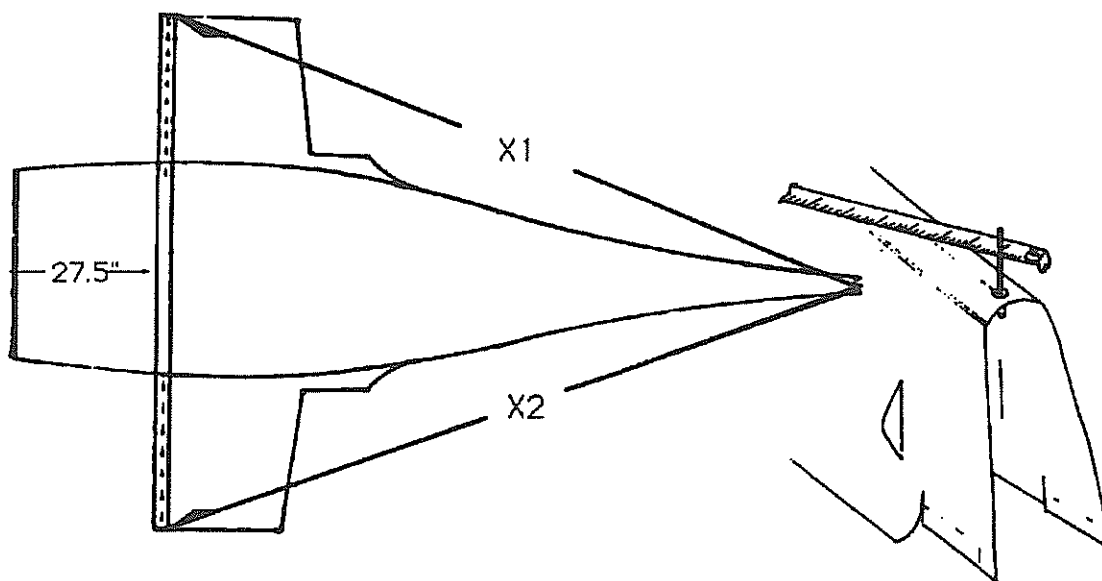


11. **Being careful not to disturb the level of the plane**, and referring to drawing 3-6 below, position the belly pan assembly so that the center mark of the belly pan is in line with the center mark of the plane bottom, and then position the belly pan assembly so that it is 27.5" from the **back** of the firewall to the **front** edge of the Main Spar. You can measure from inside the fslg, down both sides of the nose wheel tunnel, which should get you close enough for the next steps.
12. At this point, the rear spar is laying on the fslg. Mark where it is sitting on both sides of the fslg, and remove the spar assembly from the fslg.
13. Make a pair of high density foam blocks, similar to the ones on the fslg now, to support the rear spar. Make them up so that they will hold the rear spar about 5/8" off of the fslg. You will sand them down later to level the main spar assembly (the blocks usually end up to be holding the aft spar about 7/16" off of the fslg). Use micro to install them. Refer to figure 3-7.
14. After the pads have set up, carefully place the spar assembly back into position, 27.5" behind the firewall.

15. To get the spar assembly square with the fslg, refer again to the drawing below. We've found using a tape measure with a hole drilled in it is the easiest way, or you can have someone hold it carefully in place. Measure the distances marked X1 and X2 on the drawing below, and adjust the 'yaw' of the belly pan assembly until they are the same ($X1=X2$).

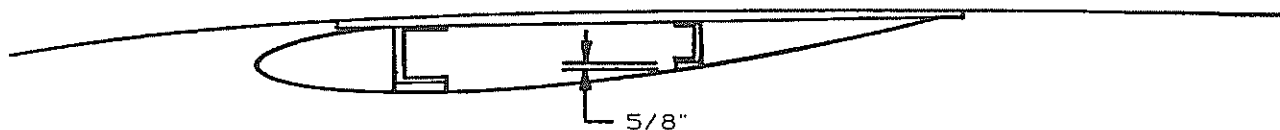
Squaring spar assembly to FSLG

Figure 3-6



ATTACHING REAR SPAR SUPPORTS TO FSLG

Figure 3-7



Note: You will find some cleco holes already drilled in the parts. They may or may not line up exactly. For now, they don't matter, and later, if they do line up great use them, but if not, just drill new holes when you need them, don't 'bend-to-fit' the old holes.

16. Now we need the level line on the BL-50 ribs. If it is no longer visible, on blueprint "E" you will find the BL-50 Rib Pattern. Cut out this pattern and carefully transfer the level line from the pattern to the ribs. With this line on and levelled, this will give your wing the proper angle of incidence.

Make sure the fuselage is still level side-to-side and fore-aft. Now, using your water level, you need to make the level line on the BL-50 ribs level with each other and the fuselage. Start with the front edge of the BL-50 rib on one side, and make the other side level with it by either building up or sanding off material from the foam blocks.

NOTE: The purpose of the forward foam blocks is to maintain about 3/8" of clearance between the main spar and the fuselage, space that you will need later when installing the wing skins. If sanding one side would make this distance less than 3/8", then correct the level by adding material to the foam on the other side. Use a 50/50 mix of micro and flox for this. Bear in mind that when you mount the spar assembly in place permanently, you can easily correct small errors at that time just by using a little more 'filler' on one side of the spar or the other, so don't spend a great deal of time to make it perfect right now, just get it within 1/8" or so of level.

To level the BL-50 line, sand or add to the filler blocks supporting the aft spar.

You may notice some small amount of twist between the two BL 50 level lines. If this has happened, don't worry about it at this point, just split the difference between the two sides and proceed. When it comes time to mount the assembly permanently, it can be 'tweaked' a bit to correct.

Also, with such a short portion of the BL-50 rib actually available for a level ref., small discrepancies are not uncommon.

17. Recheck that everything is basically level and square, and note any minor conditions that you'll want to correct during the final epoxying of the spar assembly to the fslg.

Note: If you have the space and extra help, you can be more precise by installing the wings onto the main spar/pan assembly, and checking the level lines at the BL 134 ribs (they may be wiped away - if so, you'll have to transfer them onto the ribs from the blueprints) to make sure each wing tip is level, and from one wing to the other to make sure the whole assembly is level. In order to be sure of

- (1) a smooth transition from the outer wing to the stub wing
- (2) a smooth transition from the stub wing to the fuselage
- (3) a straight hinge area for the flaps and ailerons

At this point, you need to make a few checks on each wing assembly:

WING ALIGNMENT CHECKS

Before attaching the belly pan (or center wing section) to the fslg, the outbd wing panels must be installed on order to verify alignments, primarily at the aft end of the wing panels where flaps and ailerons are going to be attached later.

19. Temporarily bolt the outbd wing panels to the belly pan section and install this complete wing assembly into the fslg. Just snug up the 1/2" attach bolts, they don't need to be torqued down for this alignment check.

You'll need a little help for this. Obviously this assembly will take up some room but the outbd wing panels do not have to be attached for very long so it should be OK if one wing sticks out of the garage door for the time being.

CHECK WING INCIDENCE

20. With the complete wing now bolted up and in position, it is a good time to make a few quick checks of incidence. This is best accomplished at the wing tip rib stations.
21. Establish the wing tip chord lines on the ribs. You may have to go back and transfer them back onto the rib sections using your full size blueprints.
22. The easiest approach to verifying that the left wing is like the right is to use a water level from tip to tip. Check the tip L.E. position left to right with a water level. If they don't match up, simply shim the wing under the fslg fillet pads until the tips do align with the water level. The required shim stock under a fillet will be real thin, if needed at all.

Now check the wing tip T.E. alignments from left to right. With the L.E. already aligned, the T.E.'s should also align. This will quickly and easily verify that the wing washout (or twist) is identical and that is of the most primary importance over all other measurements.

NOTE: The wing tips can be twisted a small amount at this time since the bottom skins have not yet been attached. Once they are bonded on, the wing will become very rigid. If any additional twisting adjustments are needed, you'll now know that it is indeed possible to achieve. This will also affect the wing T.E. skin alignments slightly.

CHECK TOP WING SKIN T.E. ALIGNMENT

23. This top wing skin trailing edge alignment is important from mostly a cosmetic viewpoint since a straight line (as measured spanwise) will mate best with the rolled leading edge of the top flap skin. The aileron will require a straight section for hinge alignment on the top T.E. wing skin but that is only a 35" long section and is quite easy to make straight. Thus, the spanwise area where the flaps locate is of most concern here.
24. At the wing tip, and measuring approximately 8-9" fwd from T.E., place one end of a string line. Run the other end inbd to the fslg fillet at a point approximately 12" fwd from wing root T.E. Your string line inbd should attach at the middle of the double joggle that's on the fslg fillet which will then represent the top surface of the stub wing skin (and that top surface is what we care about in this step). See figure 3-7.
25. The string line should remain tangent to the outbd wing skin surface and remain at least 1/4" to 5/16" off of the aft center spar cap as measured along the belly pan section. That will allow room for the stub wing skin which is about 1/4" thick.

NOTE: Since the aft spars are not yet locked together at BL-50, some alignment adjusting is available here which will affect both incidence and wing skin T.E. alignments. Also, the fslg fillet pads can be adjusted slightly to effect a good string line.

CHECK BOTTOM WING SKIN T.E. ALIGNMENT

26. In a similar manner, the bottom wing skins must align in a straight spanwise manner. The priorities are actually reversed with these since the bottom wing skin at the aileron is primarily cosmetic but the bottom wing skin line at the flap is important since the flap hinges on the bottom and needs a straight line to prevent binding. It can however tolerate a little angularity since it only rotates through 40° and not very often at that.
27. Similar to step 24 above, place a string at the bottom skin line (you'll have to simply use the tip rib since the bottom outbd wing skin is not yet fitted, nor is the outbd aft spar web so disregard those as they are likely over size at this time).
28. Run the string line inbd to the root of the flap along the hinge line which is 12" fwd from the wing T.E. at this inbd station. See figure 3-8.

The goal is to achieve a steady contact of the string line (from BL-50 and inbd) along that lower wing skin (that is already attached and integral with the belly pan).

NOTE: this inbd lower wing skin T.E. is quite flexible since it overhangs aft of the center aft spar. Therefore it can be adjusted up or down to help achieve the proper alignment. A good time to make this alignment permanent is when bonding in the additional BID tapes that will secure that T.E. skin to the inbd aft spar web.

So, at this time, all you need to know is that a good straight alignment is "possible".

29. Once you have made these check and know that all alignments are achievable, you are then ready to permanently bond the belly pan section into the fslg.

WARNING: Do not use pop rivets for any attachments to the spar caps. DRILLING HOLES INTO THE SPARS WILL TOTALLY DESTROY THEIR STRUCTURAL INTEGRITY. Use only moderate weights and/or clamping pressures for bonding purposes. Never use any amount of pressure which would result in deformation of the spar shape due to that application of weight.

30. When you are satisfied that all is in the correct position, see if any of the cleco holes line up. Put an X over any that don't to prevent any confusion, and go ahead and drill some that do, remembering the warning above.

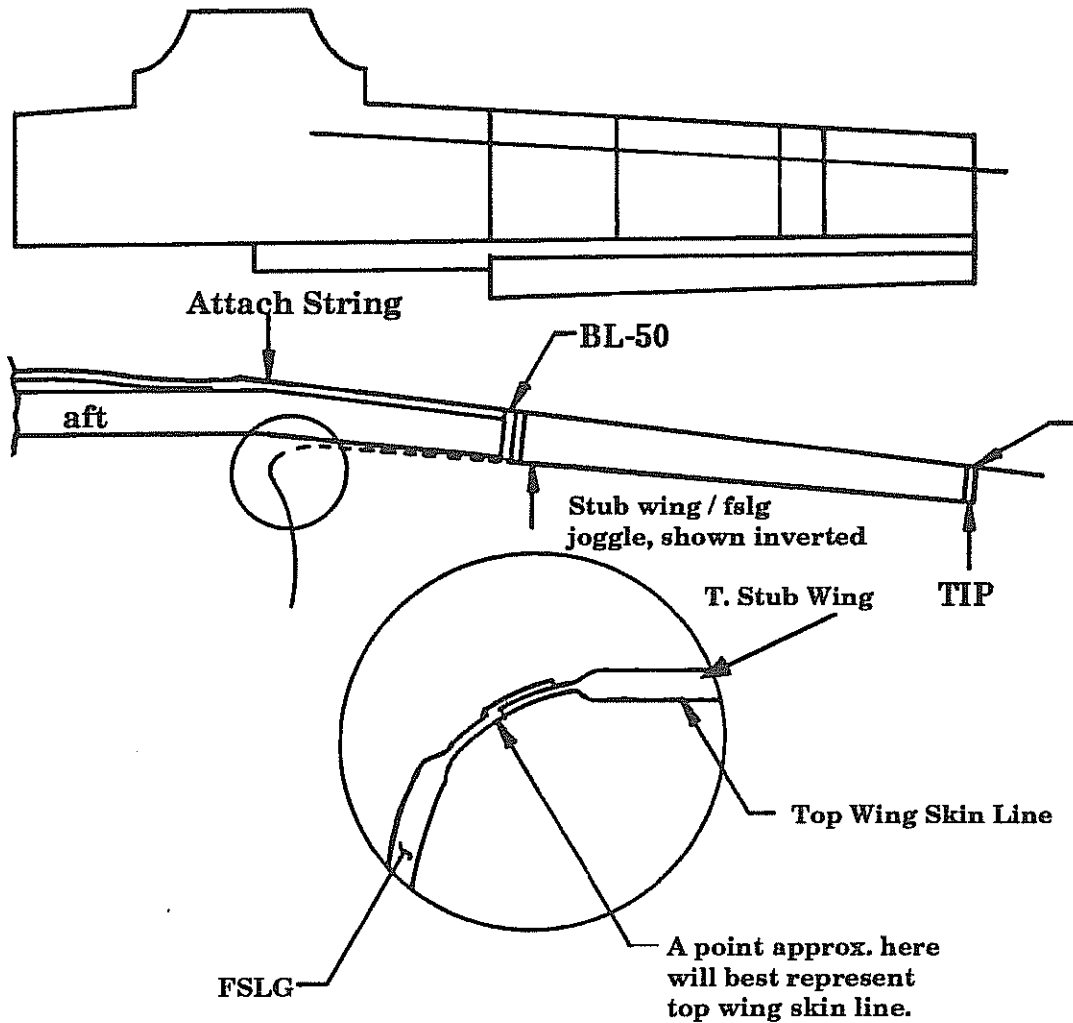
31. With everything ready, you can now permanently bond the belly pan. Use 9339 Structural Adhesive along the glass to glass bond lines and micro where the foam filler pads are located. Refer to the notes you made earlier about the little variances, and remember to add a little adhesive or micro to the spots that will need it.

You should have time to recheck your levels and block or sandbag everything so that it is in the proper position before everything sets up.

Use suitable clamps/weights to secure the belly pan during cure. Duct tape works well to hold the aft fillets together during cure. Use pop rivets along the aft joggle.

WING/BELLY PAN ALIGNMENT

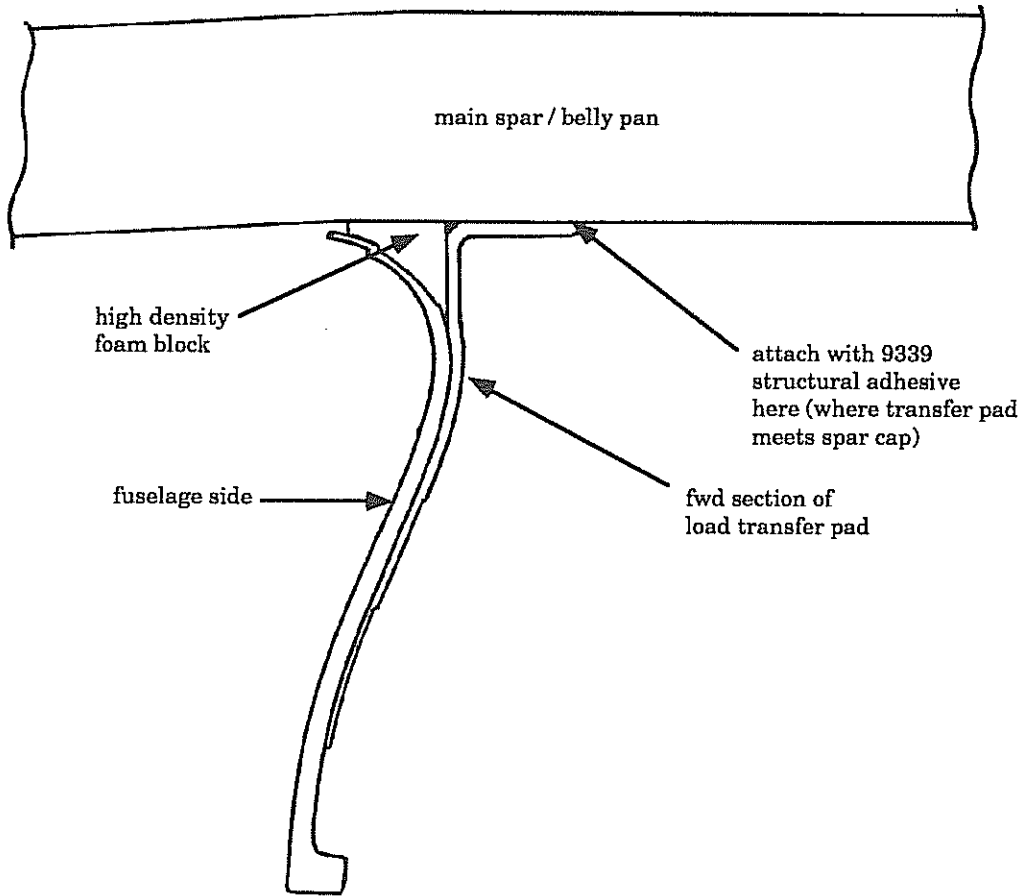
Figure 3-8



31.1 When bonding the belly pan into permanent position, note that with the Super-Fast-Build kit, the forward load transfer pad is already installed onto the fuselage side. It contains the section which also transitions horizontally onto the center main spar cap. Use the 9339 paste adhesive to secure this section onto the center main spar cap. See fig. 3-8-a

fwd load transfer pad attach

fig. 3-8-a



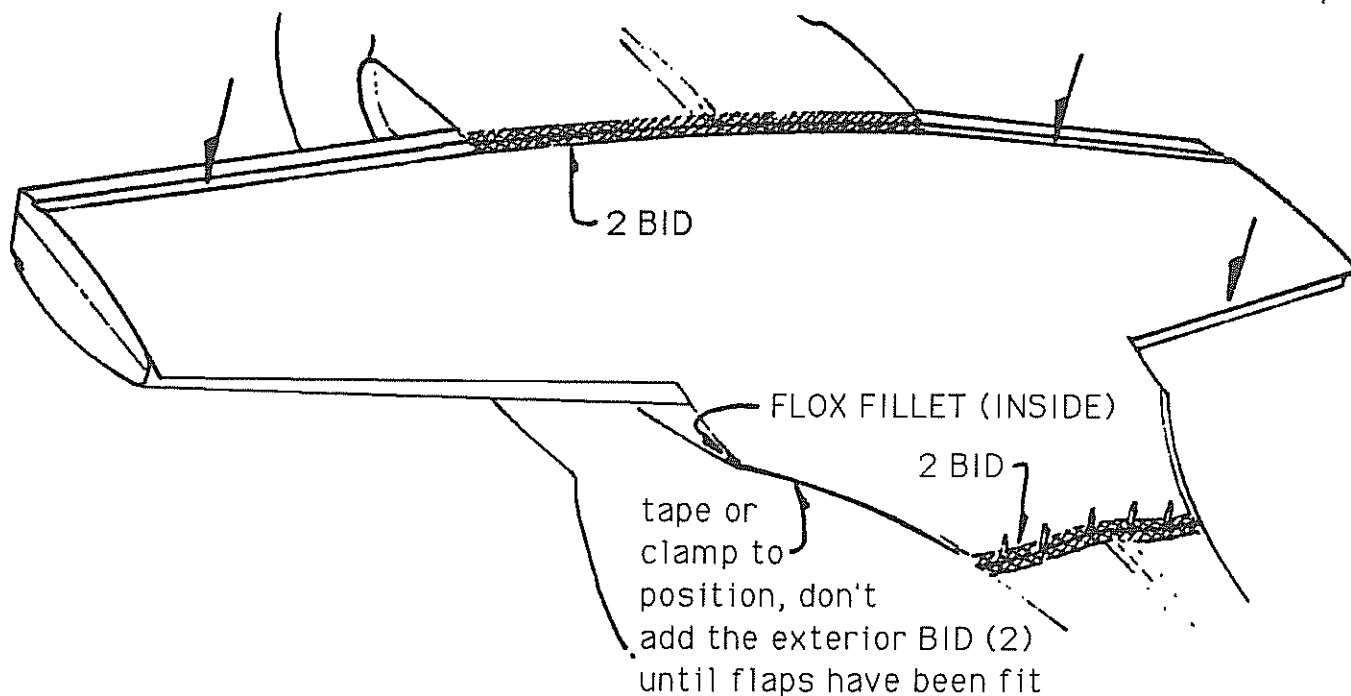
32. After cure, drill out the aft pop rivets, prepare the surfaces and add 2 BID to the aft joggle. Add 2 BID to the fwd joggle seam where it butts to the central fslg *only*, see figure 3-8.
33. 2 BID will also be applied along the aft fillets but you should wait until you have fitted the flaps, which will let you allow for slight fwd/aft fillet T.E. adjustments prior to application of those BID tapes.

Note: to prevent an interference fit later, while your wings are still in place go underneath the plane and mark the outline of the wing spar on the main spar using a pencil. You will be using 3 BID to bond the main spar to the fslg in this area, and you want to be sure to avoid putting BID tape between where the spars will mate to each other.

34. After the BID tapes have had sufficient time to cure, **TURN THE PLANE RIGHT SIDE UP**. Removing the wings first will make it much easier!

BELLY PAN INSTALLATION

Figure 3-9



35. Prior to installing the BID tapes in steps 36 & 37, use an epoxy/micro mix to fill in any gaps between parts in the area the BID tapes will go, so you will have a smooth 3/16" radius instead of a 90° angle to lay the tape into.
36. Using a 3 BID tape, bond the fwd web face of the Main Spar to the fslg center section bottom, being careful to not put BID tape in the area of the wing spars you outlined earlier.
37. Using 2 BID, bond the aft web face of the aft spar to the belly pan, from the flap line outboard.



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