

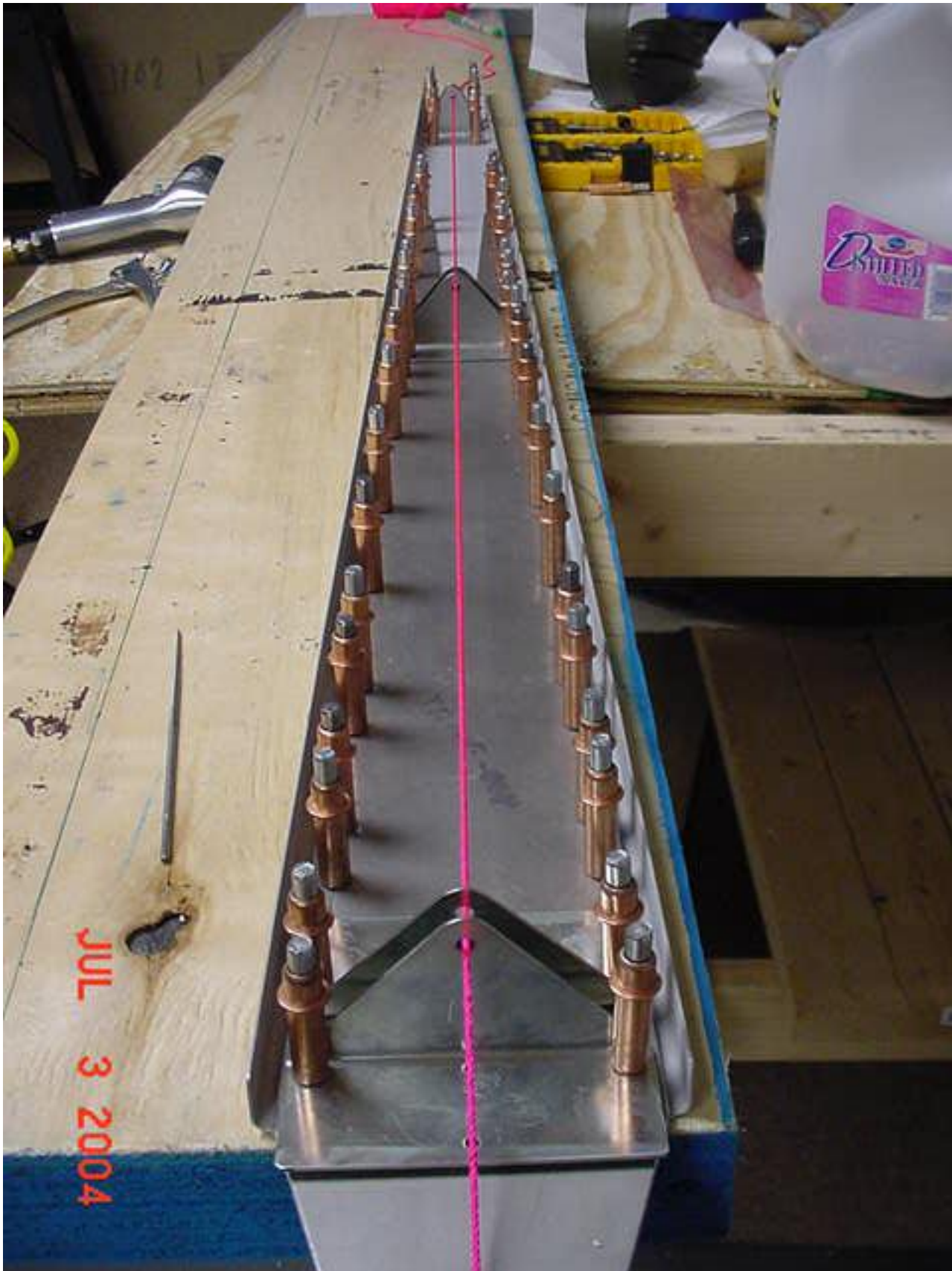
## **The Vertical Fin Spar**

I like to call the Vertical Stabilizer the "VF" (vertical fin). The processes are much the same as the HS and I'm sure many builders construct both assemblies simultaneously. The measurements in the plans for the VF are pretty straight forward. I gathered up the channel and the doubler for the rear spar and laid them out. I measured the doubler, positioned it in the spar channel and drilled it to the table/beam.



Once you have the two parts drilled @ 40 and then clekoed together, you start adding the pivot brackets that the rudder will swing on. The process is the same as with the HS, except that 2 of the 3

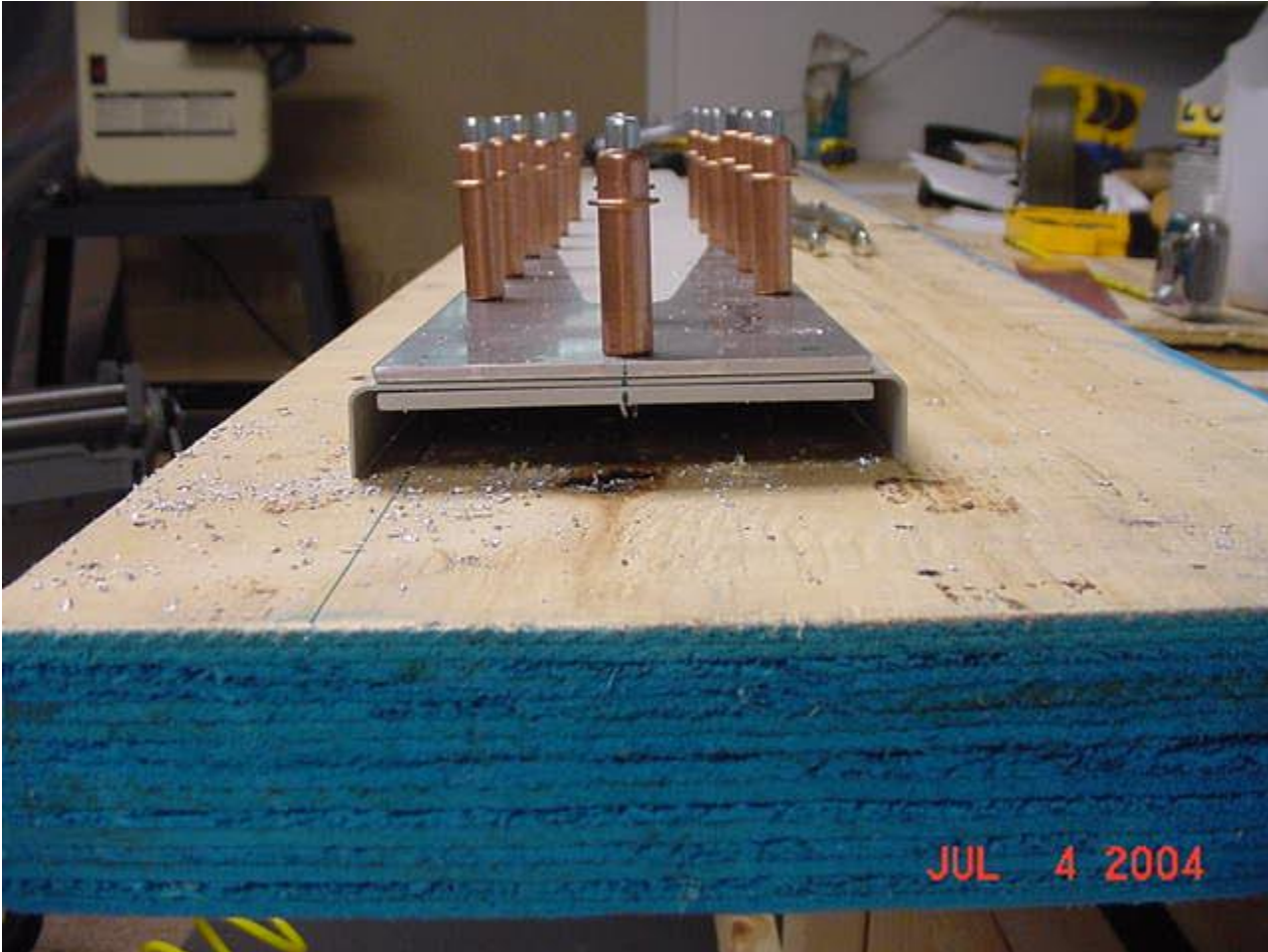
bracket's holes are pre drilled for you. That doesn't make lining up the brackets super easy, but it sure helps. Clamping them to hold them steady during drilling is not easy. Time to by more tools (clamps).



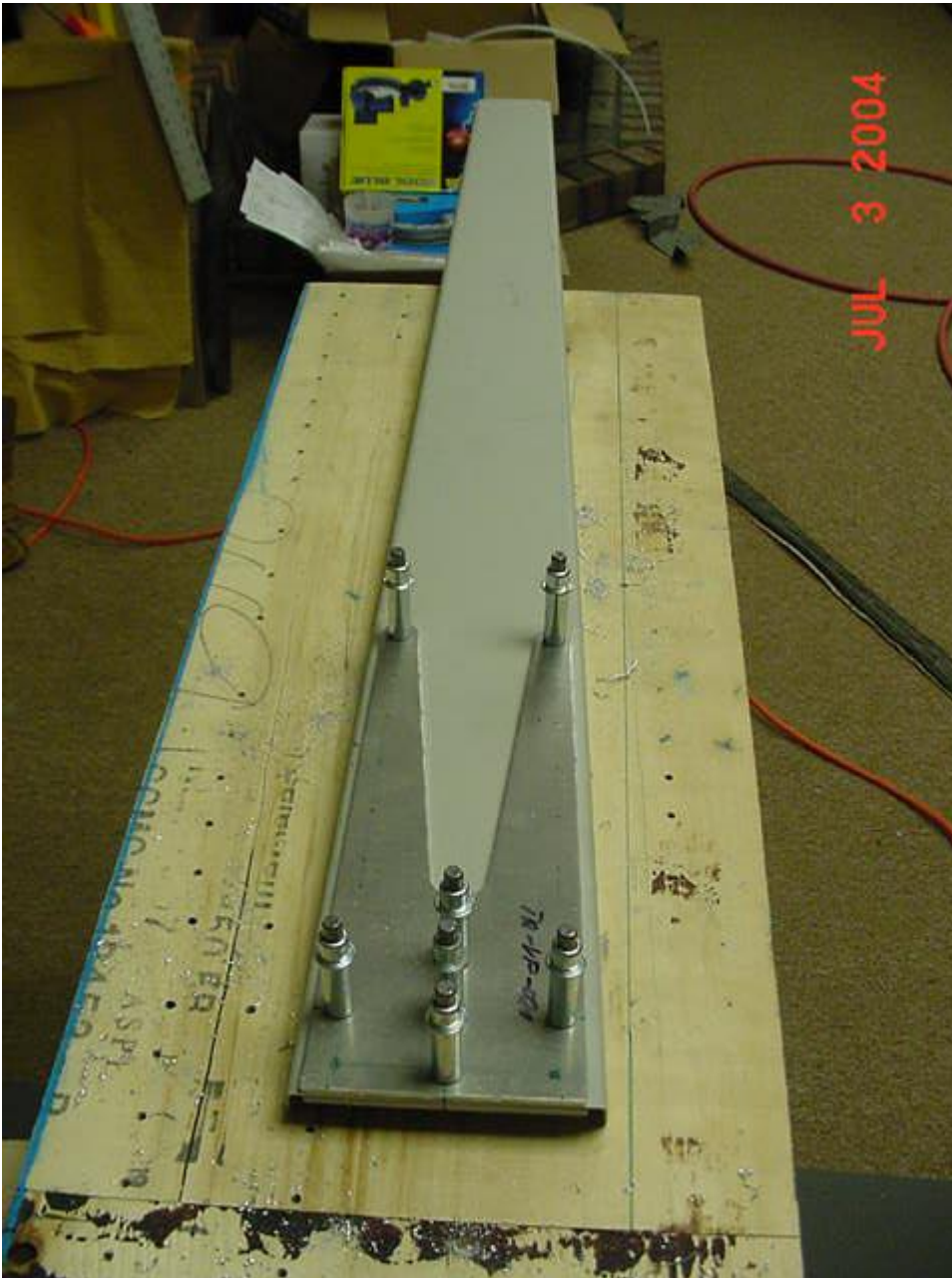


**\*\*\*NOTE:** The bottom 22 rivets of the VF-008 assy must be FLUSH rivets. The forward face of the rear spar mates flush against the #12 bulkhead, so all the rivets below the marks that are for "drilled in assy with fuselage" in the manual MUST be flush rivets.

That's about as far as I can get with the rear spar for now. Next, on to the front spar. It has a new big doubler added for the EVO edition F1. That makes the process a little more time consuming, but this part is pretty easy initially. You mark the holes for drilling on the little (old) doubler per plans. Then you sandwich the spar channel between the doublers. You mark the centers of each piece to help align them, check the position of the fingers to the edge of the spar channel, clamp it tight, and start drilling! #40 to start with, of course!

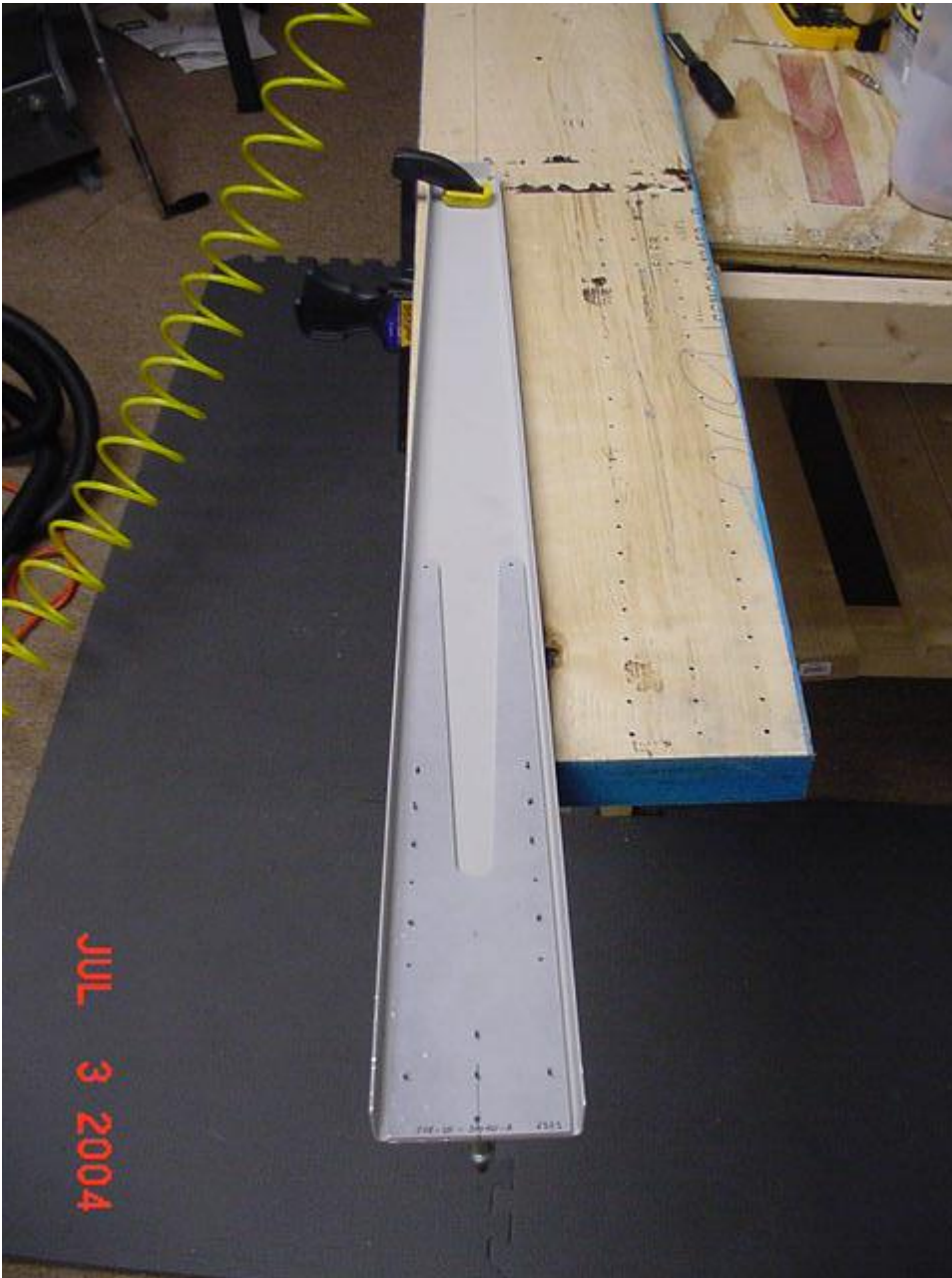


The pic above shows the doubler/channel/doubler sandwich. It's easy to work on this clamped and sitting off the edge.



Once you've drilled, clekoed, drilled, clekoed, etc., you can remove the clamp and finish drilling all the holes in the little doubler.

I had a question about the spacing on the undrilled part of the big (hidden) EVO doubler underneath, so I emailed Mark. I'll stop here for now and resume the VF when I hear back.



Above is the inside of the VF front spar channel with the EVO (big, new) spar clekoed in position. You may be able to see that up on the two big fingers there is a lot of room for drilling rivets. That's the unknown. All the other doublers have used 7/8 or 1 inch. Either will work, but I want to "get it from the main line, alright"!

I heard the good word and continued working on the VF. I went ahead and finished the front spar first. Simple countersink the new big doubler for flush rivets, and rivet the whole thing up. Kinda simple and fun.

Below is what it looks like completed.





You can see the 5 flush rivets in a cross pattern at the bottom of the rear side of the front spar in the vertical fin. Clear enough?

I was also able to complete the VF rear spar with all brackets (hopefully) in alignment. I went ahead and primed this part because it will be open to the weather.

### **Vertical Stabilizer Skeleton**

I gathered up the parts, and I was happy to lay all the parts together to see what the VF skeleton looks like. Below is a picture of the VF parts loosely together.



After a big lunch and a huge nap, I decided to, as Mark Frederick says "Carry On!". I went ahead and removed the HS from the tail jig, and repositioned the brackets to construct the Vertical Fin. I pinned the VF rear spar by the pivot brackets to the tail jig brackets (Avery). I drilled the upright for a stabilizing 1/4 threaded rod, and squared up the tip rib using a speed square, and verified everything with my digital level. All this is per plans, and the measurements are very well laid out.





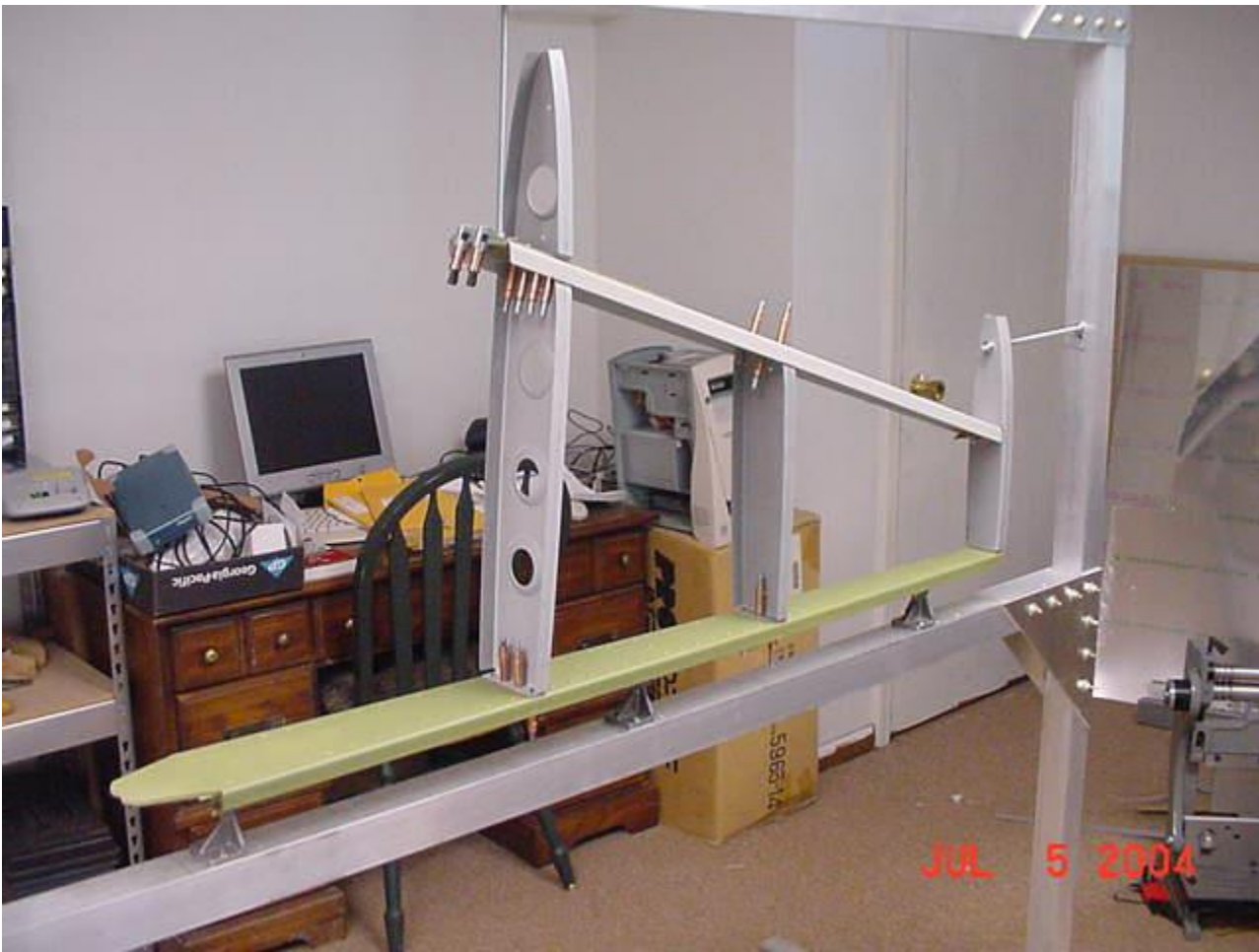
The plans say to make a bracket to position the forward spar. I decided to use some scrap aluminum plate and left over threaded rod. I drilled the 1/4 holes in the top member of the tail jig, and ran the rod down so it would sit between the bottom end of the spar and the little tip rib. After getting the bracket to sit square on the end of the fwd spar, I clamped it down. I made measurements from the plans and started aligning all of the VF parts to get ready to assemble the skeleton. That's where I stopped. 10 building hours today, and I'm pooped!

Setting up the skeleton on the aluminum H frame jig is pretty straight forward. Most of the time I spend measuring, measuring, measuring! I used cleko clamps and got all of the parts in position and marked them. Then of course, double checked all my measurements. Then I started drilling and immediately clekoing each hole as I went. I started at the spar and worked my way outward, rechecking the measurements as I went.

After everything was drilled and clekoed to the small size, I drilled it up, clekoed again, and checked my measurements as I went. So far so good.

I took everything off of the jig and deburred it. Got everything ready to rivet. BTW, I did not have to smooth the lightning holes in the ribs. They were already primed and smoothed for me! Nice bonus in the EVO!

I put everything back on the jig and riveted it. This may have been a mistake, but it turned out OK. I had to drill out several offset rivets, and the oblonged a bit. Had I reversed the rivets and put the factory head on the thick side, and the shop head on the rib side, the results would have been much easier and better. Probably would not have had to re rivet anything. That offset cup rivet set was a bitch to work with. I'll make every effort to avoid that from now on.



## VF Skin

**\*\*TIP:** If you want to get a really pretty skin on your F1 (or any riveted surface), I highly recommend that once you get the skin drilled and clekoed in place that you **GLUE** or **BOND** the skins down just prior to riveting. Pick the side you want the prettiest and glue that side to the skeleton and cleko it for about 24 hours. On a side that you may need to leave open until very last, you can still glue it prior to assembly and get a better than average looking surface. Just wax or use releasing agent on the mating surface of the skin and glue it down. The next morning, just remove the clekos and pop the skin free. When you go back to rivet it down, you will still get a better surface than if you just bang rivets in bare metal parts. I'm kind of heavy handed and it shows. I have puckers and deformations that aren't particularly pretty. I wish I would have done this trick from the start.

Once everything was riveted together, I checked the measurements again. Then I marked the centerlines on the flanges and drew extended centerlines on the H-frame jig. I grabbed the skin from the parts pile and laid it over the skeleton.

The plans are not very clear at this point, although the measurements on the diagram are fairly complete. There is no explanation on where to butt the skin, or whether or not anything needs to be trimmed prior to riveting. I guess we are just to **ASSUME**, or inherently know how to proceed. I read over the HS section and really didn't get any insight.

Finally, an email from Mark F. clarified that you are supposed to set the skin flush with the root rib flange. Then you are supposed to make the leading edge tip fit 25 3/4 inches from the spar doubler. I

had a hard time getting to this measurement. I think my front spar was a skosh to high, which made the tip rib up to high and therefore the tip of the leading edge too high.

In order to correct this, I got some PVC pipe, jammed it inside the leading edge in the bend of the VF skin, and bent it out as much as practical. I got the measurement very close. Mark sez the only problem I should have with this is that the empennage fairing may have to be tweaked a bit. Everyone tells me that is the case anyway, so I don't think I'm out that much.



**NOTE:** If you use too small a diameter pipe to close the skins, you can get a rather sharp leading edge. This can affect the way the skin sits on the ribs. You actually will want a more blunt Leading Edge so that the skins will sit back along the frame better. As it turned out, since I have such an acute angle at my LE, the skins did not sit back quite as far, and I ended up a little short at the Trailing Edge. So I ended up with more gap between the skin and my control surfaces.

I placed the skin back on the VF frame and clamped it in several places at the root and at the top (which on the jig means along both sides, since the piece is being worked on along its side). Then I ripped a couple boards down to 3/4x2x40, drilled for 1/4 threaded rod. I cut several 8 and 10 inch pieces of rod and bolted the boards over the skin and skeleton. I double checked my measurements and then transferred the extended centerline drawings onto the skin.

When I measured the centerlines of the flanges, I used 1/2 of the 3/4 inch width as a rule. So the centers are 3/8 from the outer edge of the flanges. Looking at some of the parts, I don't like how close that measurement is to rivets and doublers, so when I drill the holes, I will try to err (fudge) to the outside of the flange. Maybe get closer to 5/16 on the holes. Since I have never done this before, and



don't have near the guidance I need, a lot of this is guess work. I hope it works. If not, I can always buy new parts and do it over.



The vertical centerlines are easy to scribe. The horizontal line at angles are a bit tougher. After much consideration, not wanting to slide the skin any, I clamped the skin/frame side ends tightly and loosened the boards a bit. Just enough to slide in my 4 foot metal rule.

Now that I have the skin where I want it, I have the centerlines transferred, I have to plan some drilling. Skin rivet spacing calls for 1 1/4 optimal. Well, I measured between the primary drill/connection points of the skin and frame, and of course none of the measurement come out in easy 1 1/4 increments. This is where a "fan spacer" comes into play. I didn't think I would need one, so I didn't buy one when I got my tools. Well, was I wrong. I could have used it several times already, and for the skins, it's going to be crucial. Fortunately, my fellow builder buddy (RV6) Bruce Dallman is going to lend me his

for a while. I'll be going to OSHKOSH next week, and I'll pick up one of my own. I'd sure like to have that VF skin attached before I go up to the show.

You can get along without the fan spacer, and just make close guesstimates with a ruler. I actually found the fan spacer easy and quick to use. That's probably much due to the fact that I'm a rookie at building anything. I think the fan spacer is a nifty little gadget, and I think I'll get lots of use and considerable help using one.



Drilling on the VF skin was pretty straight forward. I clamped everything down, checked the measurements again and got out my air drill. I started at the bottom and did the vertical rivet lines along the ribs first (these are horizontal in real life). I drilled the key "corner" holes at the junctions of ribs and spars. Then I used the handy large sized fan spacer and clekoed it in these corners, making sure the spacing was about 1 1/4 inch or less. I then drilled #40 from the root rib, then the short center rib, then the top rib on one side. Then I duplicated the action on the other side of the fin.

After having all the verticals clekoed, I was able to remove the "strapping" boards and drill the horizontal line angles. Again, using the fan spacer in the key corners to lay out the nominal 1 1/4 inch measurements.

Looking through the plans, I couldn't find anywhere that describes which rivets are supposed to be used on the VF or the HS skins. I suspect they are to be flush "#3" rivets of varying length, and either through 43.13 or intuition we builders are expected to know it. Since the EVO tail is heavier duty, I'm not sure if we are supposed to use OOPS rivets like up on the fuselage, or "#4" rivets like on the cowl. Since Mark snuck off early to Airventure, I'll have to confirm other sources that might have

specific info for the EVO tail. I don't know if the skins are thicker, or if the EVO tail just has extra doublers. Therefore I am clueless as how to proceed. I guess I'll switch over to completing the HS skeleton until I can talk to Mark. Or maybe I'll just go flying instead... Drat! :-)



Before removing the clecoes and the skin, I measured the cut off marks for the rudder side of the VF. My 3in1 shear/bending/brake is only 30 inches wide, and I need 35, So I have to lean on my buddy Bruce again to use the local university's equipment. It's good to have talented friends with nice equipment and tools!

I could just take a pair of hand shears and cut this piece. I'll probably have to fine trim it anyway. But Mark F. sez that a bench type shear is what he uses and it gets the cut very nice and very close. So I think I'll give it a try. It's a little out of my way, but hopefully the results will be worth the little trip into town. Once the VF skin is trimmed for the rudder, I'll be ready to debur and cs/dimple everything and rivet the skin on the skeleton.

I took the skin to my buddies Bruce and Mark at the university and we cut the aft edges down. Now it's time to debur, dimple and countersink the frame and skin. That process went easier than I thought it would. I used my pneumatic squeezer on all of the frame, except where I could not get access or there were overlapped junctions. I used the C frame on the skin.

Unfortunately, on the third dimple, the skin jumped up, and I punched an oblong dent in the skin. It was not pretty, and I was pissed. I repaired the dent as best I could and moved on. The rest of the skin dimpled without incident and I was very pleased overall with the results.





The pic above is me with the finished Vertical Stabilizer. I'm hunched over to get a timed picture. The camera was sitting on the H frame.

Unfortunately, on the FIRST RIVET, I slipped the rivet gun and dented the skin again. It put a couple pretty deep smileys in the skin. And later on, I slid off again and wanged the skin again. Very frustrated, I stopped working, jumped on my motorcycle and went to meet a buddy of mine for a beer. Sometimes you just have to know when to quit.

After several hours and a few beers, I came back and looked at the damage. It did not look any better, as you might expect. I decided to go ahead and finish the whole VF anyway. I needed practice, and since the part was possibly ruined, I had nothing to lose but some rivets (and lots of time and money).

I could have stopped where I was and drilled out the rivets which I had already set, got a new skin, back drilled the whole thing and reskinned it. But I figured the chances of me getting it right by back drilling a new skin was not good, so it's going to be all or none. An expensive little proposition if I have to start the entire VF from scratch.

Now I have a decision to make. Do I start THE ENTIRE VF over, or do I do some bodywork on the skin. One side turned out perfectly fine. That was the "closed" side I did second. I thought it would be harder, but it was actually easier for me than the first side.

It's time to go to AirVenture at Oshkosh, so the F1 building is going on the back burner for a while. When I get back, I'll evaluate the finished VF again, and begin work on the Horizontal Stabilizer (HS)

I scuffed the surface of the dings, and then I cleaned it up nicely. After that, I spread some polyester "icing" to fill the skin wangs. I think they filled in well, I'm not going to the trouble and expense to start over (yet). But you can bet I'll be a helluva lot more careful the next time. After I finish the whole plane, I may come back and make another VF.

Later on when the rudder was nearly complete, I decided it was time to cut the notch in the VF top where the counterbalance swings through. I measured per plans and took a dremmel tool and a cut off wheel and cut the skin just short of size. I'll do the final filing when the rudder is fitted.

Now that the Vertical Stabilizer is constructed (far from finished), it goes in to storage. I'll work on it again when I install it on the airframe. That happens after the Horizontal Stabilizer is installed.

### **Vertical Fin Installation**

Now that the HS is trued as best I can to the fuselage and bolted down, it's time to tackle the Vertical Stabilizer. First thing to do is to get out that dusty old HS-015 trapezoid looking thing from last year. I brought it out, and set it behind the HS forward spar with the "tongue" facing aft. I put an .032 shim under it to prop it up. I centered it up and carefully drilled the 6 center most holes ( I had pre drilled the 6 holes per factory locations, then matched them on the spar). Turns out that I had to displace the lower outside corner holes because of rivet locations. No big deal, they only offset about .5 inches. I used some AN3 hardware and temporarily bolted that puppy in place.

Next thing to do is to set the tail spring weldment to position. I just went ahead and drilled a centered hole about 1.25 above the machine hole. I drilled it up per plans and cs'd it for a ss #8 screw. I went ahead and used a ss stop nut behind it and cranked it down tight.

Now for that big green fin. I removed the rudder and caps and brought the VF to the back on my plane. DANG IT! My ceiling was too low. I had to move the plane a little and then take out one of the drop ceiling panels to get the VF to position. WHEW! I actually never thought I'd be able to put that on with the ship still leveled! COOL!



The plans are right. You have to trim the lower flange of the aft rudder spar to get it down to position. I actually had to take off about 1 inch. I went ahead and drilled the machine hole to #30 on the VF spar. I already had a bronze cleko in the machine hole on the ship from a long time ago. Now the tricky part.

My fuse is still level. My HS is set. Now to get the vertical of the VF set up. Instead of the string method, I again used my trusty digital level. I conferred with Mark and he agreed that if the level measurements of each side of the VF spar (level set over the skin along the spar) that the VF would indeed be level. He did mention not to forget that you have to be concerned about the offset of the LE on the VF as well. That comes after getting the vertical under control.

I covered the turtle deck with extra plastic and set a sponge under the LE of the VF. Rather not have the skin divoted there. Carefully I set the VF up to position and aligned the machine holes together. Then I clekoed the parts together. I used a cheap spring camp to hold up one side of the VF against the emp. The fin wanted to lean to the left a bunch. I went back and trimmed the spar a bit more (up to an inch) and also wallered out the cleko hole a bit to scoot the bottom of the VF spar to the center of the #12 bulkhead and TS weldment. This helped get the vertical alignment closer, too.





Man, is there some twist in this thing or what? See how much the VF is offset to the right? Had to email the pic to Mark to verify that the VF can be wonky like that compared to the #12 bulkhead.

I checked the level of the fuse again, and the level of the HS (the level fits under the VF ! ) again, and tweaked the VF until it was even and ready to match drill. Now comes the hardest part. Making sure I don't move the thing when I drill it. The cheap spring clamp will help, but I'm going to have to tip toe through this process to keep this all straight.

The VF rear spar needed to go to the left a little bit more. I shimmed and clamped the side and bottom of the rear spar onto the #12 bulkhead and then removed the cleko. I drilled the hole up for an AN4-6 bolt and nutted it in. Checked the measurements again and prepared to drill the upper AN4 bolt holes. That one is a little tricky. The Tail Spring weldment now has a thick lip to it. And the upper edge is not very far above the lower edge of the hinge bracket. So positioning those two holes is difficult. And if you go by the pic in the manual, you will be too far outboard. The bolts need to go a little farther inboard, perhaps 1/8 to 1/4 inch on each side. That way you can get a wrench on the nut

and not interfere with the lip of the TS weldment.



Now you can really see how twisted the emp is. Also note the shiny new rivets in the area above the lower hinge. Yes, I didn't use flush rivets there when I made this thing over a year ago. I got to drill out and replace 12 rivets. No big deal, just didn't like wasting the time to do it. Had to, though, because the VF lower 22 rivets sit flush against the #12 bulkhead.

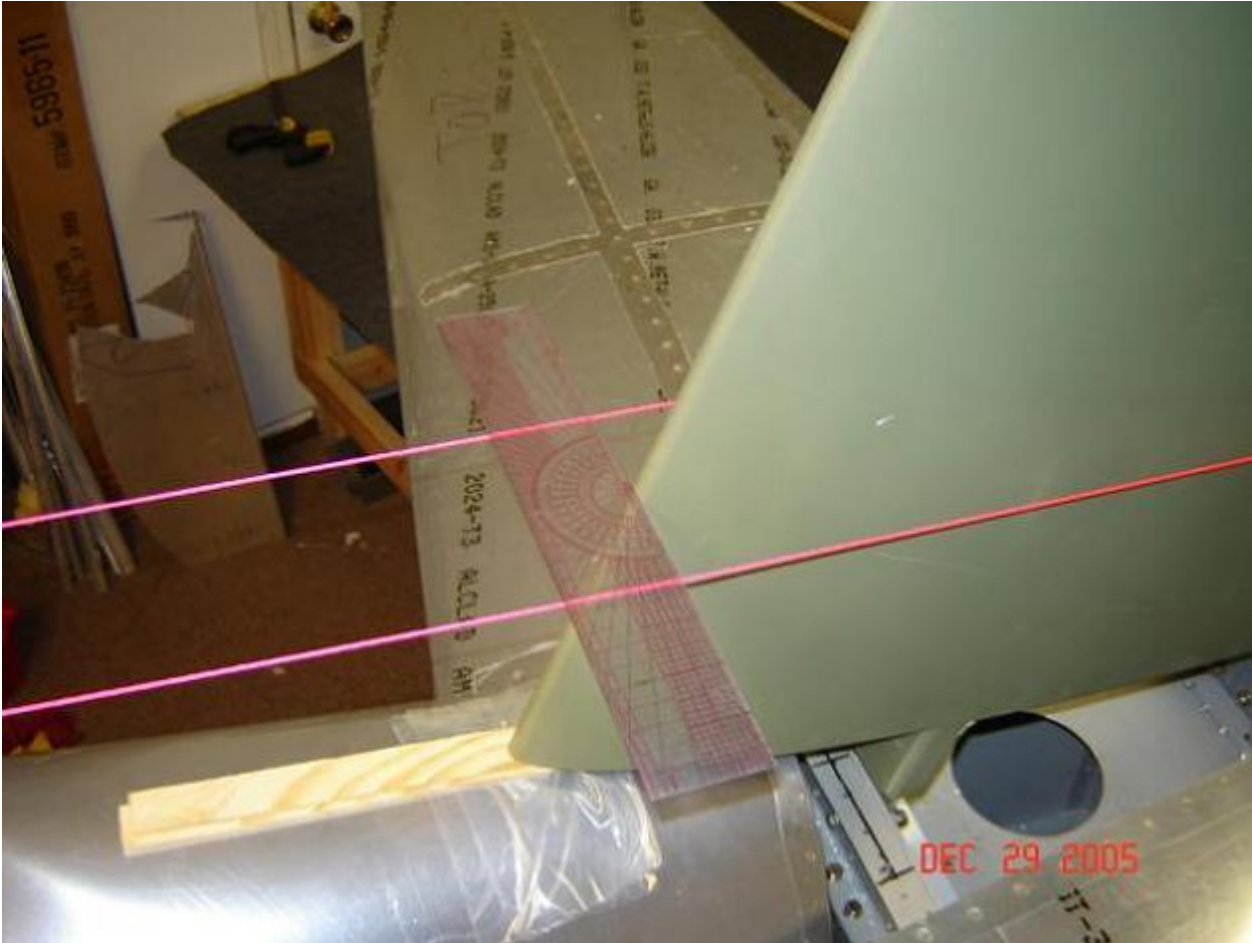
I rechecked my measurements. My VF measures at precisely 88.7 degrees on each side. That's how I know it's vertical.

Before moving on to align the LE of the VF, I have to make a 1x1x.125 angle bracket to attach the mid area at the VF spar to the empennage deck. That's relatively simple. Just have to make sure to center the bolt holes over the emp longerons and put two AN3's in there. Then drill for two AN3's through the VF spar. Easy peasy.

**\*\*\*NOTE:** At this point it is recommended that you mark the emp deck panel and cut it back to the angle bracket just fabricated and bolted to position. You have to cut the panel out in front of the angle bracket to increase the elevator horn travel in this area. You might even need to go back and cut the angle bracket back some as well.

Next step is to align the leading edge. I could attach the upper brace angle (sits on top of the emp deck), but I thought it made sense to align the rear, then front, then use the angle brace to help maintain the VF's position. Probably doesn't matter that much, but that's the way I'm proceeding.

The string method described in the manual works pretty well in this instance, and that is how I will set the VF leading edge. After that, I'll drill the forward VF spar to the HS-015 and cleko it down.



At rest, my LE was about 1/16 to 1/8 to the left. It was easy to scoot the VF's LE to the right and line it up. The tricky part will be clamping and drilling it to that position. Especially considering I need about an .040 shim between the VF and the HS at the front spar. I suppose I could take those stir sticks out and let the LE drop down a bit to let the spar parts rest closer together and avoid the shim? Maybe? DOH, better ask Mark. Think I'll quit there and come back to it again tomorrow.

### **Shim the HS-015**

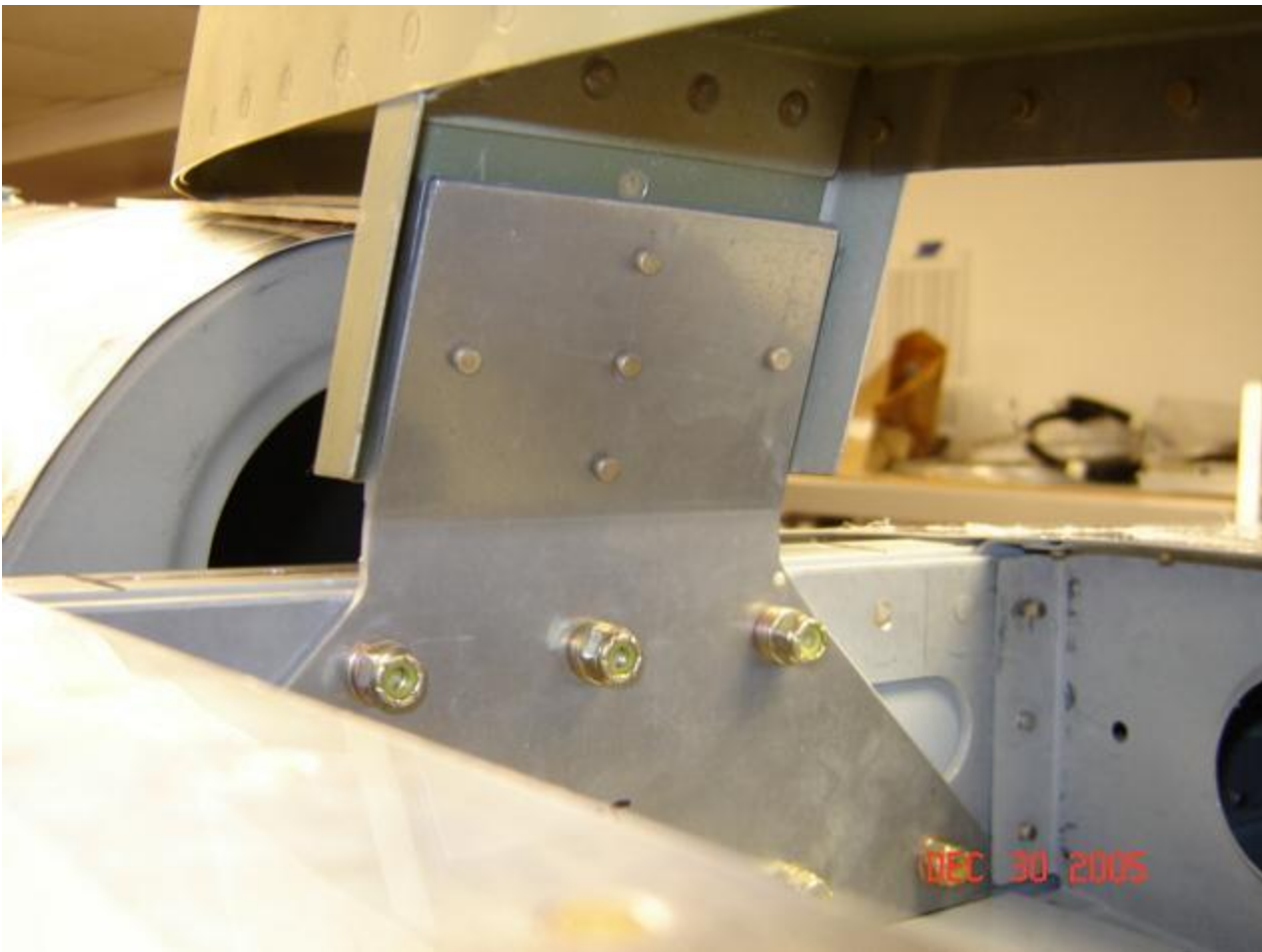
The ruler on my pink string at the LE of the VF miraculously had not moved overnight. Time to start thinking about locking this baby down. Alas, there is a HUGE gap between the VF spar and the HS-015 bracket. Mark said definitely shim it. SHIM is an understatement. I put 4 pieces of .032 under there and still had slop. Mark suggested that I use hardware store 1/8 inch aluminum. I thought I had



some, but what I had was more like 1/4". So I went with it.

Mark suggested that something was not quite right since I had such a large gap at the HS15/VF spar junction. Other than the factory bend in the HS15 being wrong or my mounting of the HS15 to the HS spar being too low, I can't imagine what I might have done to have such a large gap. Something is off somewhere. But it works.

I proposed to rivet a spacer onto the tongue of the HS-015 before drilling it to the VF forward spar. I cut a piece of aluminum 2 3/8 x 3 1/2 inches and prepared to mate it to the HS15. I used the same drilling pattern used on the lower end of the VF spar, a cross pattern that leaves 4 "corners" open for the four attach bolts. I drilled it 40, then 30, cs and deburred it and then squeezed 5 each 4-8 flush rivets on there. Remember, the forward face has to be a flush mating surface. Using 5 sized 4 rivets is overkill, but I liked the pattern, and I can always squeeze #4's much better than those dinky #3's. Ham handed, YES!

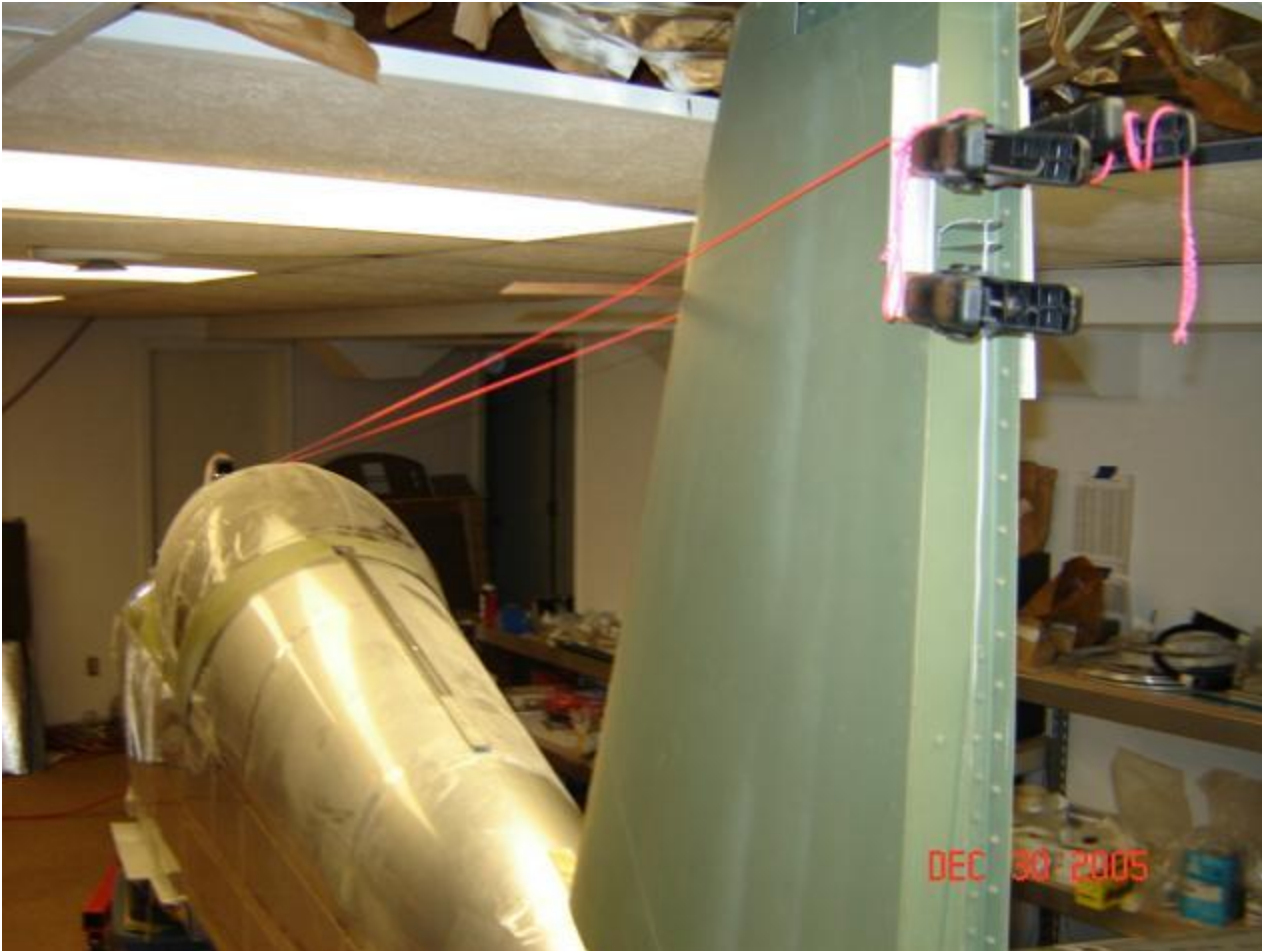


The HS15 bolted back up and I rechecked my measurements. I ran a piece of floss through the rudder brackets per Mark's suggestion to make sure I didn't twist anything. So far, so good.

### **Set the Leading Edge**

With the Rear Spar of the Vertical Fin bolted to position, the Leading Edge of the VF is still free to move. It will not only go side to side, but you can tip it up and down. You can't move it much, but just enough to get the Leading Edge centered with the long axis of the airframe.

When I was flossing my brackets, I noticed my LE measuring pink string was getting in the way, so I untied it, and moved the angle brackets, clamps and string above the upper rudder bracket. That made it easy to check the rudder bracket holes with the floss, AND gave me an opportunity to check the LE from a different perspective.



I wasn't using those centering things that go in the bracket holes. Instead, I just moved the tied down floss (Glide floss, btw, great stuff, but VERY slippery Gortex/Teflon filament) around to three locations in the holes. Essentially, I used my fingers at the top and bottom brackets and shoved the floss against different locations at the holes. IE, I shoved it to the back, the front, and at least one side. When I did this, I observed where the floss was in the middle bracket. Every time, the floss was at the same position on the bracket holes as the upper and lower brackets. Therefore, I am confident that they are still aligned.

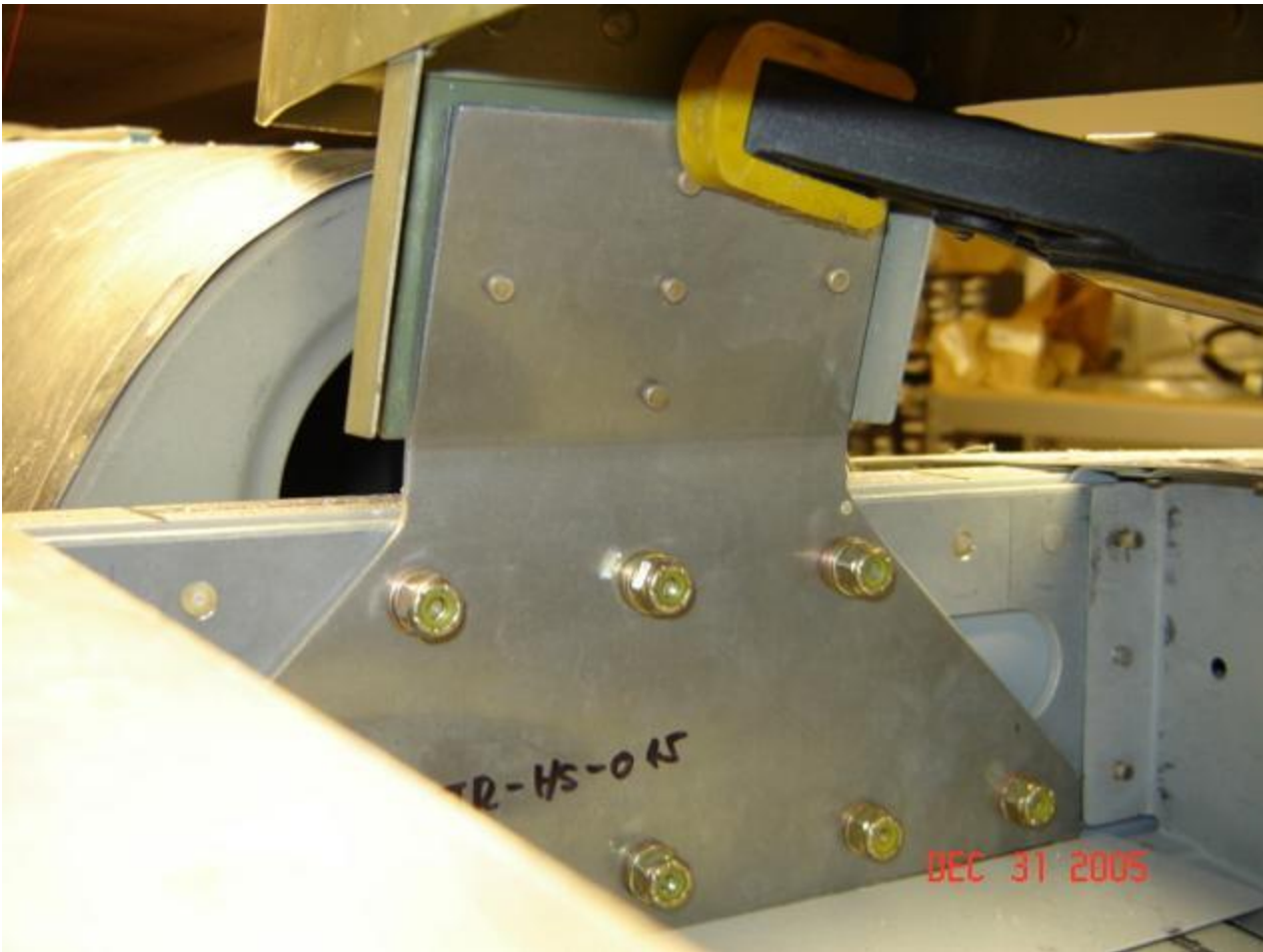
When I was doubletriplequadrouple checking the VF spar and HS15 position, I noticed that the rivet patterns did not line up. That means I am either going to have 2 bolts REAL close to a pair of rivets, or I was going to compromise the ED at the top of the HS15. The manual suggests 3/8 inch spacing from the edge. I am going to try to get 1/2 if I can. The VF rivets and the top edge of the HS-015 bracket will have to determine the location of two of the bolts. The wood spacer I had at the tip of the LE of the VF came out, and I scooted the VF downward and forward. I can only go so far. I rechecked the rudder brackets and they were still in alignment. So far so good. Now what I propose is to TRIM the tip of the LE of the VF and scoot the front of the VF down as far as I can without taking anything out of whack. That ain't gonna be much, but it feels like the tip moves fairly easily. That's a good sign.

My dremel made quick work of the tip of the nose of the VF Leading Edge. I spent some time

cleaning it up with a file, trying to follow the contour of the turtledeck. I cut a little more than 3/16 or so out of there, and then scooted the fin downward. A quick check of the rudder bracket holes and things are still OK. I went back and checked the centering of the LE and that looked good. While I was at it, I changed how I had my pink centering string set up. Since it runs over the canopy bubble, I went ahead and ran the strings and taped them down together. My center screw in the windshield bow is a skosh off center, so I compensated for this. I moved the string to what I thought was on center, then measured from the string to the rear top corner of the wing spar holes. Now I know the ship is asymmetrical when it's built (so much for factory jiggling) and even the bubble probably isn't symmetrical. But I had to pick SOME common location on the sides that I thought would be even. That's my best guess. From there, I went back and checked the LE centering again.



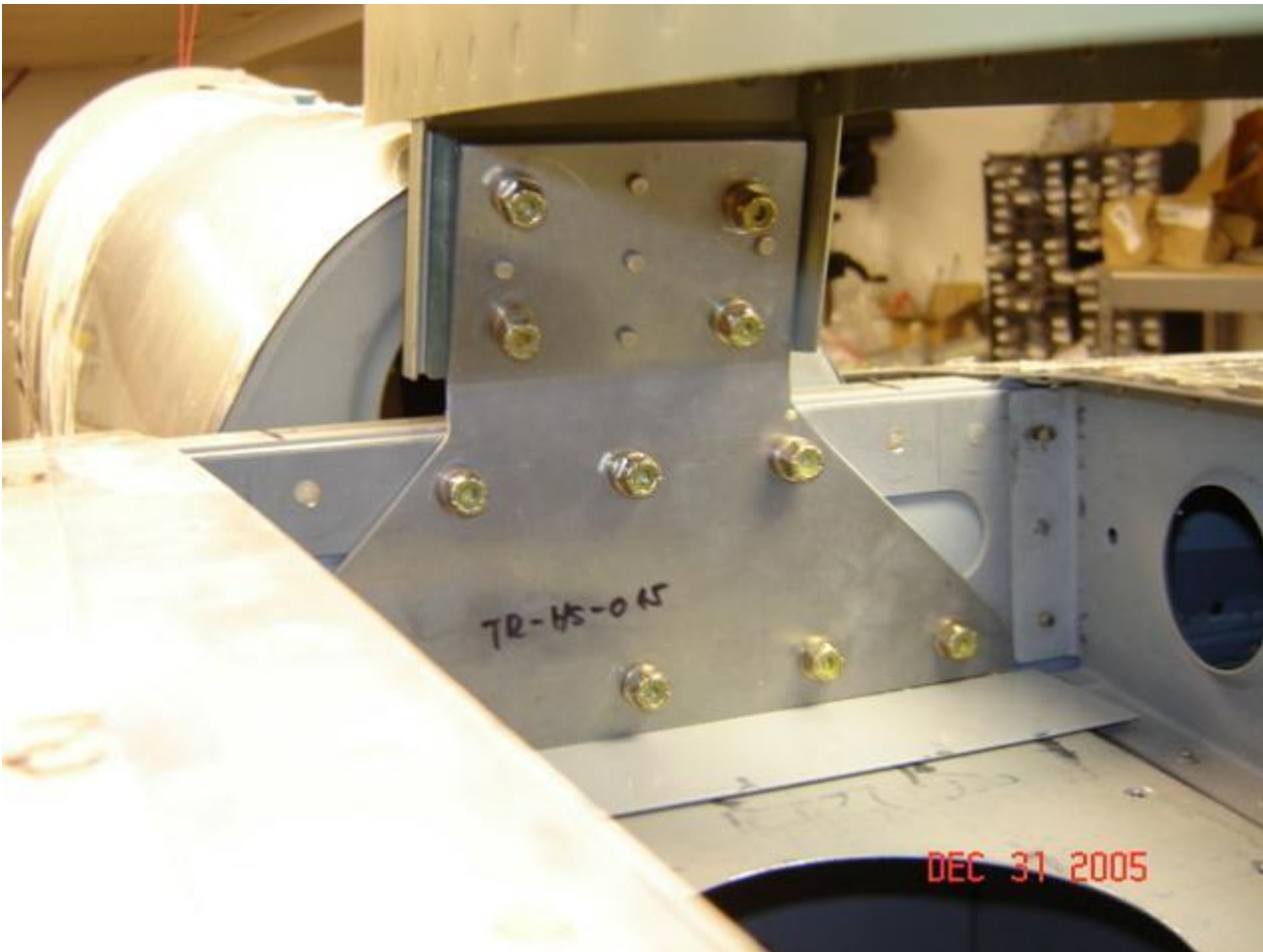
I clamped the VF spar and the HS15 together with a quick clamp and scooted the VF around a little. I double checked all the measurements again. It's good to go. By trimming the nose of the VF and moving the whole thing down, I was able to get the rivet that shows in the 2nd pic above to be hidden below the edge of the HS15 and it's spacer. NOW I have LOTS of room to put the 4 bolts in and maintain ED and clearance from rivets. Hope it all works down the road!



Notice again how the rivet that was visible above the HS-015 is now below the upper edge. The rivets still don't line up between the two parts, but now I have enough room to easily drill the parts to position. That will finally set the incidence of the Leading Edge of the Vertical Fin and complete its installation. That of course by far does NOT complete installation of the tail. After the VF front spar is bolted to the HS-015, I have to begin installation of the control surfaces, their mechanisms and alignment.

Drilling these two parts together was not much fun. Not terribly difficult, but a pain. I used an angle drill in my air drill to get the holes up to #30 of course clecoing as I went. Then each hole right up to an AN3-7 bolt and tightened down. My bolt pattern didn't turn out as pretty as I would have liked, but it's functional. I used 1/2 inch instead of the 3/8 suggested in the manual. That way, just in case I have to reposition and drill up to an AN4, I still have plenty of meat all around.





Part of the misalignment of the bolts is the wonky camera angle. But sure enough, that upper right bolt is a little down and in. Better that that up and out.

I consider this a very good way to end 2005. It looks like I have an airplane coming together. There may be light at the end of this tunnel... eventually.

HAPPY NEW YEAR!!!!!!!!!!!!!!!

Now that the Vertical and Horizontal Stabilizers are set, it's time to Hang the Rudder !