

IN THE SHOP

After the empennage, the sliding canopy on the SBS airplanes probably raises more questions than any other installation. Fitting a structure of welded steel spaghetti to a hand-built fuselage is an exercise in patience and perseverance. Given the inevitable variations between individual frames, roll-bars and fuselages, it is not possible to give dimensions that will work every time. Instead, we caution builders to slow down and work carefully from "first principles." The amount of effort and time you spend on preliminary positioning and alignment, adjusting both the canopy frame and the canopy skirts, makes a big difference to the quality of the final fit of the canopy. I recently asked Scott McDaniels, the Possessor of True Knowledge at the Temple of the Sliding Canopy, for a few pearls. Here's his advice:

ADJUSTING THE FRAME

The welded steel sliding frame and rollover bar will vary dimensionally, despite the best efforts of the manufacturers and welders. The long tubing runs, combined with local heating/cooling at the welds, insure that no two will be exactly the same. The builder will have to make some adjustments to get a perfect fit.

These adjustments can be frustrating to say the least. Making a slight bend in one place often causes a change in a totally different location. You need to understand why this happens and then learn to make it work for you. If you get carried away with bending in one spot or you add or subtract bend in the wrong place you can very quickly make the fit worse that it was when you started. Move slowly and patiently.

The frame is made of tough 4130 steel tubing. Making a bend in a small localized area takes a lot of force. Making a bend over a wide area takes less force but requires more displacement because there is a lot of springback. You can make small localized bends by cutting a curve into sturdy wood block (like a length of 2x4), then clamping the block to the tube and squeezing the tube into the block with a couple large c-clamps or a big bench vice (this technique usually requires a helper). You can remove bend the same way, using blocks with less curvature than the tube being adjusted.

You can also make a bend by bridging the tube between two wood blocks (closely spaced for a localized bend, more widely spaced for a larger area bend) then put pressure (weight) on the tube. It takes more weight than you might think...use your heel while you pull with your hands just outside of the blocks.

Bend can be removed by placing the center point of the arc where you want to reduce the bend directly on the floor and stepping on the tube with your heels on each side. Depending on how weight-challenged you are it may require a little bouncing to get any results. Once again, the wider the area you need to change, the wider your feet should be, but remember that less force will be required because of the increase in leverage on the tube.

Bend just a little at a time and check the width measurements before and after attempting any bend. This is

the only way to tell when you have actually caused a change (other than putting the frame back on the fuselage). If you can detect a change while you are using your hands and feet, you probably did way too much.

The first thing to check is the profile of the lower side tubes (these may have a round or a square cross-section, depending on the era of your kit. The more recent ones are square). Viewed from above, they should very closely match the shape of the longerons. You can check by setting the frame on the fuselage and putting a 24" straightedge vertical against the side of the fuselage every 3". Add or subtract bend to make them match as closely as possible.

Once the side tubes match the fuselage shape running for and aft, and you have done the initial work of



fitting the roller tracks and rear slide, you can begin checking the front and rear bows.

Before you begin making any bend adjustments, determine what the ideal width of the frame is at the bottom of the forward bow (where the roller brackets insert) and at the base of the rear bow.

Measure the distance between the tubes on the top of the roller brackets with the rollers centered in the tracks. Subtract 1/2" to compensate for the spreading of the frame caused by attaching the plexiglas canopy. This will be the inside dimension at the base of the forward bow that you will try to maintain when making adjustments.

Measure the fuselage width at the very aft end of the frame side tubes. Subtract 3/8" to allow for the inset required for the side skirt thicknesses, and the approx. 1/4" spreading that occurs when the canopy is attached. Write the front and back dimensions on some tape and stick them on the frame so that you can refer to them when making adjustments.

With the frame in place on the fuselage, you are ready to begin checking the shape of the slider frame. Be sure that the top center of the frame at the rear is 1/16-1/8" below the turtle deck skin (to allow for the

1/16-1/8" below the turtle deck skin (to allow for the canopy thickness), and that the front top of the frame is about 1/8 - 3/16" higher than the roll bar.

Study the diagrams and note how making a bend change in one area of the bow will cause a change in position down lower on the bow. Very often a change in width can be made by causing a very small bend up higher on the bow. Conversely, if you are making a bend up high on the bow, but you do not need to change the width, you will have to make another bend at another location to return the width to the correct dimension. This is why taking measurements before and after is very important.

Begin checking the rear bows using a straight edge aligned along the extension line of the conical shape (see sketch). You should work from the top center down around the sides.

Do the same on the front canopy frame bow, but you need to check visually by standing in front of the fire-wall and looking aft. You should try to get the frame bow to be approx. 1/8-3/16" bigger than the roll bar, all the way around. The point on the roll bar that has the most curve (10 o'clock and 2 o'clock) should be a little larger (a full 3/16") than on the top or the sides.

Use a minimal number of #40 holes (such as one at each end only) when positioning the roller and slide block tracks during initial drilling. This will allow repositioning later, when you drill on the plexiglass canopy. After you are sure of the position you can drill the remaining holes and then drill all of them to final size for the mounting screws.

Use an air hose (wear eye protection) to keep the roller tracks as clean of metal drill shavings as possible. They get packed in the roller tracks and into the rollers, which prevents the canopy from sliding smoothly.

When drilling any holes in the canopy to the frame, the canopy must be clamped tightly to the frame *along the entire perimeter*. When you pull the canopy in tight to the frame the canopy changes shape and shifts its position on the frame. If the canopy is not in its final position on the frame when drilling all holes, you will have holes that misalign later when it is pulled tight during final assembly.

When you drill the holes for attaching the rear slide block to the frame, be sure the block is not tilted to one side. Also, make sure the width of the track allows the block to slide freely the full length of the track (narrow it with a file if necessary). Countersink the rivets and screws in slide track slightly below the surface so that they don't catch on the block.

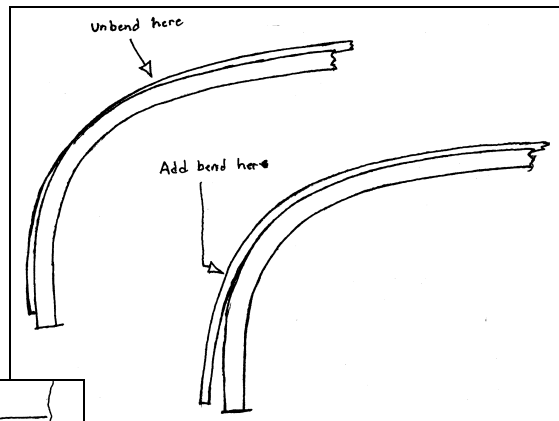
Before fitting the skirts to the frame/canopy, double

check the fit of the frame to the fuselage. With the plexi canopy clecoed onto the frame, the tubes along the sides should still be about 1/16" inside of the fuselage profile and the extended line of the turtle deck skin should be. The canopy surface should be slightly (1/16") above the profile of the turtle deck but it cannot be inside or below it. It is important, when checking the turtle deck to canopy relationship, to lay a straightedge on the skin paralleling the cone shape, not the center-line of the airplane (sketch or photo?)

FITTING AND DRILLING THE SKIRTS

All skirts should be preformed so they match the frame and fuselage. Do not use the power of clecos in holes to hold the part in shape. You want to save this positioning power for getting the last little bit of adjustment to get the part to lay tight on the fuselage.

Draw the C-759 inside canopy skirts across your thigh or a table edge to form a gentle curve that matches the curve of the fuselage side. Do the same with the C-660



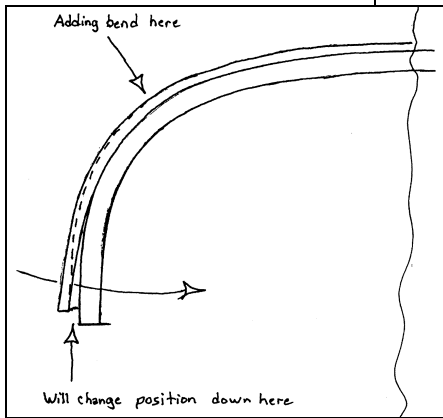
outside side skirts.

The C-666 aft skirts are a little more complicated. Don't cut them out exactly to the lines on the

aluminum sheet. These are for reference only. Cut them out as large as possible so you have the maximum to work with. Deburr the skirt edges well so you don't scratch the canopy or the fuselage while positioning them.

Because of the shape of the fuselage the aft skirts require a twist. If you hold the left skirt by the upper end (nearest the center slide block) with it hanging down vertical from your hand, as viewed from above, the lower end needs to twist towards the left side of the airplane, or counter clockwise. The right aft skirt is just the opposite -- it twists clockwise. Most of this twist happens in the bottom two thirds of the skirt (the turtle deck is almost flat on top so the twist starts as the skirt begins wrapping down around the sides)

Form a curve in the rear skirts to match the curve of the turtle deck. As with the twist, they are mostly flat on the top with the curve beginning as they wrap around on to the sides. The curve is accomplished by drawing the skin over your leg or the edge of a table. With a little practice the curve and the twist can be effected at the same time by drawing the skin at an angle.



The primary goal is to adjust the shape of the skirt so, when it is in place on the fuselage, it lays nearly flush everywhere without being held or taped down. This will greatly help in getting a good fit of the aft skirts. The better you make the relaxed fit of the skirt, the better your final fit will be.

Make slight adjustments to make these relationships as closely matched as possible. This may mean repositioning the rear slide or the side tracks to raise or lower the back, or reposition one side or the other. It may also require a slight readjustment of the frame shape even after the bubble has been drilled to the frame. The fit you get at this point is going to dictate how well the skirts finally fit.

With the C-791 side braces drilled and clecoed to the canopy frame, and the frame/canopy in the closed position on the fuselage, take measurements to verify that the fastener pattern shown on DWG 41 will work with your frame and C-791 brace positions. Modify the fastener positions slightly if/as required to match your installation. When pre-drilling the side skirts, do not drill the holes for rivets attaching them to the aft skirts. Drill these from the outside, through the aft skirt.

Leave the side skirt full width until after it has been drilled to the frame. Then cut the bottom edge of the forward portion to fit as close to the top edge of the canopy deck as it will go without rubbing. The aft edge of this cutout falls at the widest portion of the fuselage so that the skirt doesn't spread when the canopy slides.

Fit and drill the side skirts with the canopy in the fully closed position.

Drill the C-791 brace to the side skin. Drill from inside the cockpit while a helper holds the parts tightly together (with a wood block) and the skirt tight to the fuselage side while drilling. Cleco each hole as you go.

When drilling the rear skirts, open the canopy enough to tape some 1/16" spacers between the brackets and the roll bar. This will help the skirts to fit closely when the canopy is fully closed. The holes attaching the plexi to the steel frame are already drilled, and must be matched in the skirt using a hole finder. Use the thinnest hole finder you can.

Lay the preformed skirt in place and position it so it covers all of the rivet holes in the canopy frame and extends beyond the aft slide track and the side skirt at each end. Tape it in place. Use a straight edge and mark the upper end for a trim that will just clear the slide track. Remove the skirt, trim the upper end, and tape it back in place. Using your hole finder, begin drilling at the upper most hole at the inboard end of the skirt near the slide track. Continue drilling at each successive hole working your way down around the canopy frame towards the bottom. Hold the skirt down tight and flush, and cleco each hole as you go.

Remove the skirt and trim the forward edge to 1/4 - 5/16" edge distance to all of the holes. The trim line for the forward edge of the skirt area below the holes is made by extending the trim line from the bottom two holes down through the remainder of the skirt (see side view on DWG 43).

Refit the skirt and mark where the forward edge lies on the side skirt. Remove the skirt and mark aft top corner of the side skirt (hidden under the aft skirt) for removal. This important step helps keep the aft skirt from being pushed away from the fuselage.

Trim the trailing edge of the aft skirt for a pleasing shape as shown on DWG 43. Do not trim the bottom end of the skirt until later.

Reinstall the aft skirt but slip it under the side skin.

Mark the edge of the side skin on the aft skin to use as a guide in making sure that all rivet holes drilled will hit the side skin and have proper edge distance.

Mark the aft skirt to side skirt rivet locations on the side skirt (DWG 41) and drill them. Be sure that none of them will fall below the fuselage longeron.

Because the bottom aft corner of the skirt falls over a point on the fuselage where the curve of the turtle deck and the curve of the fuselage side are intersecting, it needs some massaging/shaping to make it lay tight. These curves go in different directions which makes it challenging. The skirt needs a slight curl massaged into it at the bottom aft corner to help it lay down tightly.

It helps if this corner is finished with a large radius instead of a sharp corner (viewed from the side).

When drilling the aft skirt to side skirt, pull the aft skirt forward (towards the front of the fuselage). This will pull the bottom aft corner of the skirt in tight to the fuselage. Drill a couple holes first to get the position. Then mark the bottom edge of the aft skirt and trim it so it matches the bottom of the side skirt.

Reinstall and do more massaging as required to get the skirt to lay down tight.

Drill the remaining holes, repositioning as necessary to improve the fit. The mis-match of the first two holes will not be an issue.

After completing the other aft skirt, trim them at the upper end to fit of the C-792 fairing, and drill it to the aft skirts.

When riveting the skirts, install the screws along the base of the canopy sides last. This will prevent the skirts from being pulled inward and disturbing the fit.



A thin hacksaw blade makes a thin hole-finder, particularly useful for sliding under canopy skirts and locating holes already drilled in the canopy. Find a straight, thin blade, grind the teeth off it, and cut it in half. Align and clamp the halves together and drill two #30 holes near one end, through both halves. Rivet the two halves together. Drill the other end with a single #30 hole. Countersink the inside surface of one strip slightly and insert a AN1097AD4-4 rivet. Set it just enough to make it stay, then file the shank of the rivet until it just fits a #30 hole.