Rutan Aircraft Factory

RUTAN AIRCRAFT FACTORY
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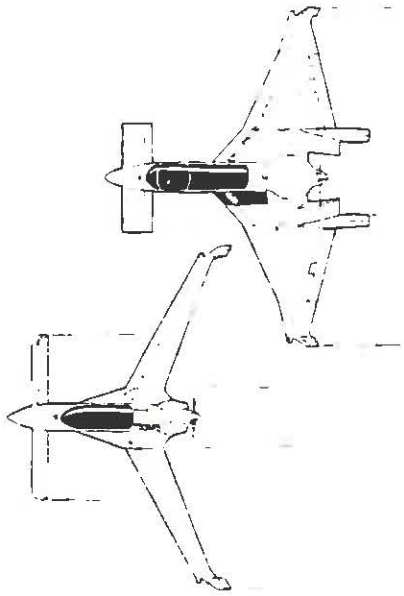


Dear Canard Builder:

The 14-page set of digital photos included in this package are black and white due to the high cost of color printing.

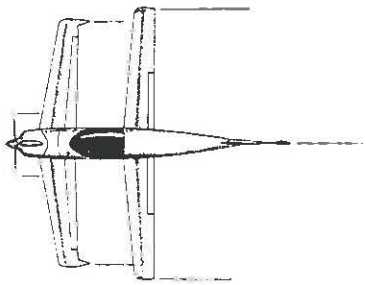
The photos are available IN COLOR for $16 upon request.

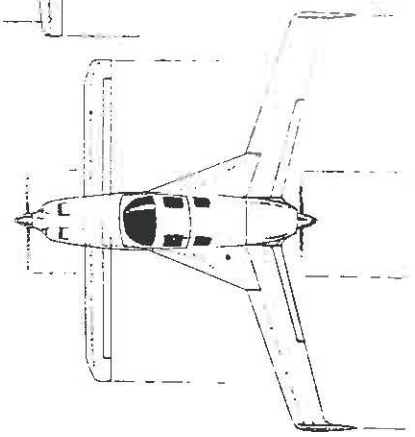
If you would like the color set of the photos please send your check or money order to:

Rutan Aircraft Factory
1654 Flight Line
Mojave, CA 93501

If you have any questions regarding the plans please send a SASE to RAF or email at raf@antelecom.net

RAF will publish the Rollover Structure Plans on its website (currently under construction) at www.rutanaircraft.com





Reminder: International Orders — Please insure your check or money order is routed through a bank with an USA address.

Terry -
Yes, Yes, Yes.
Share with Central States Assoc. members.

Per Tonya

Construction plans for a composite roll over structure for an EZ

This set of plans is produced in response to several instances of EZ's that have landed off field and flipped over. The plans-built headrest is not sufficient nor was it designed to protect the occupants in the event of a roll over. Burt has designed the structure described in this set of plans to fill that requirement.

This "Roll Bar" consists of a sandwich structure with "S" glass or carbon roving hoops at the forward and aft edges. It is laid up inside your canopy, using your own canopy as the mold, thus assuring that it will be a perfect fit on every EZ. It is, however, a fairly difficult part to fabricate and there are no less than seven cure cycles required to complete the structure. For those who do not want to take on a project of this magnitude, Bill Allen, a Long-EZ builder in England, has designed, built and has tooling to produce a steel tube weldment roll bar. He will fabricate one for you if you contact him directly. See the current CP for his address and phone.

This set of plans consists of these words; some digital photos taken during the construction phase with captions to help describe each photo; and some detail drawings of the glass structure, as well as the metal parts that will be required to lock the roll over structure into place when the canopy is closed. The premise of this design is this: the roll over structural piece itself is installed inside the canopy frame and permanently bonded to the canopy side rails. It does not contact the Plexiglas at all and is spaced away from the plexiglas approximately a tenth of an inch. Being an integral part of the canopy, it swings up and out of the way when you open your canopy, so

ingress and egress from either cockpit is completely unaffected by this roll over protective structure. When the canopy is closed and locked the roll over structure is securely located in place by its shape and by three locator pins on the right or hinged side of the canopy, and by two heavy duty latches on the left side.

The roll over structure described in these plans was fabricated in Mike and Sally's Long-EZ canopy, and in this case all of the lay-ups were vacuum bagged into place in the canopy "mold". The use of vacuum bagging made this job easier, and probably produced a lighter weight part. It may be possible to complete this part using only contact lay-ups, but since we have not actually done that, this set of plans and photos assumes the availability of a vacuum source, and knowledge of the use of vacuum bagging equipment.

You will notice that the detail photos of Mike's installation show heavy-duty latches of a different design than what is called out in this set of plans. Hindsight is always better than foresight, and once this particular latch installation was completed on Mike's airplane, Burt was able to see a few improvements that should be made in order to make this roll over protection as safe as possible. So when you see parts called out that are slightly different than what you see in these photos, realize that the latch parts in the plans have been deliberately improved.

Please read all of these words carefully, then look closely at each photo, and read the captions for each photo. Hopefully, all of the information you need to fabricate and install one of these in your EZ is in these plans somewhere!

If, after all that, you still cannot find what you need, send a self-addressed stamped envelope to RAF at 1654 Flight Line, Mojave, CA 93501.

I laid my roll over structure out on the inside of the Plexiglas canopy, using 1/4" wide masking tape and the poster board template provided in this set of plans. This gave me the position fore and aft of the roll over. The leading edge of my roll over at the top center is located half an inch aft of the forward face of the headrest. I am not even aware that it is there while I am flying. I have to turn around and look at it to even see it. Sally was expecting it to be more of a problem for visibility from the back seat, but tells me it is not nearly as bad as she had thought it would be, and is happy to have it on the EZ for the protection it provides.

You will be building the roll over inside your canopy using your own canopy as a mold. Do everything you can to protect your Plexiglas canopy from being scratched or spilling epoxy on it. I used a soft plastic film, which we normally use for vacuum bagging, but any plastic film would do the job. If I did it again, I would consider using "Spraylat" Plexiglas protector. This is available from Wicks or Spruce, and can be sprayed or brushed on, both inside and outside the Plexiglas canopy.

The first fabrication job is to build dams or forms that will allow you to do a glass layup on each canopy rail. These two small lay-ups will, in turn, become the forms or dams for the actual roll over structure and it will be a part of that structure. You must position the foam strips on the canopy frame such that they are spaced inboard from the top longerons, which will provide the correct clearance for the canopy latch system you will install later. These

PVC foam strips must be wide enough to extend down to be level with the underside of each longeron, about 1.6" wide.

You should apply enough layers of duct tape to the inside face of each top longeron to provide a thickness of duct tape of 0.1" on the right longeron, and 0.250" on the left longeron. The duct tape I used was about 0.010" per layer. Check yours with a pair of calipers. With this tape "spacer" in place, you will need to climb into the front seat and close and lock the canopy. Use an instant curing model airplane glue such as "Hotstuff" to fix the PVC foam strips to the canopy frame on both sides, with these foam pieces touching the tape spacer. Repeat for the rear seat. NOTE! You will need someone in the front seat to lock the canopy, and more important to unlock the canopy and let you out! Don't get yourself locked into the back seat!

When all of the foam strips (3 each side) are glued to the canopy frame, remove the canopy and jig it upside down at a reasonable working height. I placed mine between two plastic chairs and tied it firmly to these chairs with lots of duct tape. You do not want to drop your canopy!

You will need to apply some sort of release to these PVC foam strip dams so that they will be easy to remove after the first lay-up cures. I used a thin, blue colored plastic tape called flash tape that we have readily available in the shop. Any clear plastic tape, or even duct tape, will work fine for a release. Make sure you cover all areas of the PVC foam dams evenly and then lay-up two (2) plies of glass Bid so that it laps onto the canopy frame edges as well as up the vertical walls of the dams. Allow this to fully cure, and then very carefully remove the PVC foam dams, leaving the 2-ply lay-

up in place on the canopy rails. Carefully trim the edges of this lay-up so that the vertical component is a minimum of 1.5" tall. Sand the faces so that your next lay-up will make a good bond to these two cured parts that should still be located exactly where the foam dams positioned them.

You will need to provide a spacer between the roll over structure and the Plexiglas canopy. I used a piece of thin foam rubber for this spacer. It was laid into the canopy and trimmed to fit just to the edges of each canopy rail. In other words, it covered only the Plexiglas, and was vacuum bagged into place. The bag then became the release for the actual part. I placed the full sized template in the appropriate position and marked around its perimeter using a magic marker. Then I placed 1/4" masking tape along this magic marker line. This masking tape will create a trim line in the lay-up. I then laid up one (1) ply of BID at 45 degrees to the butt line, five (5) plies of UND with the fiber orientation 90 degrees to the butt line, and one (1) more ply of BID at 45 degrees. I then vacuum bagged this entire lay-up into the canopy. This is a tough lay-up, and care must be taken to be sure that you do not move the pre-cured glass parts already positioned on the canopy rails. Allow this to completely cure.

Next you will need to install the foam core directly on top of the lay-up you just completed. I used two (2) pieces of PVC foam, each 1/4" thick, since I found it impossible to install 1/2" thick PVC so that it would conform to the shape of the canopy. It would be easiest to bond each 1/4" thick piece into the canopy separately. In other words, two cure cycles. Each piece of PVC foam core should be perforated so that no air will be trapped between these foam cores. Use care in forcing the foam down into the canopy as it can

easily break. I managed to do this my self with one of my foam cores. I used it anyway, just microed the pieces together. Make certain these foam cores are wide enough (fore/aft) to be able to cut out the final shape. I bagged these cores into the canopy for maximum adhesion. The next lay-up is a repeat of the first one, 1 Bid, 5 Uni, and 1 Bid. Let this whole thing cure for several days. I left mine for a week.

Now you are ready to pop the whole thing out of the canopy, BUT, and this is very important, you must drill a small witness hole through the flanges of the roll over into the canopy rails, both sides, BEFORE you move the roll over structure. If you don't do this you will not know where to place it in the canopy frame when it comes time to bond it in permanently Use a jig saw, and carefully cut along the masking tape line on the outside skin of the roll over. Take care to maintain the jig saw blade at 90° to the surface all the way around. I used a Remington "grit" edged jigsaw blade, and this worked very well. Now you will need to remove the foam core around the "hoop" shaped edge, foreword and aft edges. I used a dremel with a carbide bit and removed all foam core material for a depth of 0.6". Sand the foam smooth, and also sand the inside of the glass in preparation for a one (1) ply Bid lay-up that goes down into this "trough." (See the photos).

Cut Bid strips 3" wide at 45°. You will need a spool of "S" glass roving, or Carbon roving. Pull off about 10 pieces of roving, at a time, 44" long and wet them out on a sheet of plastic on your worktable. (See photo). Slurry the foam in the bottom of the trough and wet out the glass sides of the trough. Place the 3" wide Bid strip into the trough and wet it out leaving the extra material hanging over the sides. Place the pre-wetted-out roving into the

trough on top of the 3"wide glass bid. Pack the trough somewhat more than full with the roving. Over fill each trough by at least 1/4", then work the extra glass Bid from the inside of the hoop, over the roving. Trim this glass so it covers the roving, and butts up to the extra glass on the other edge of the trough. Then wrap this extra material over the roving so as to totally enclose the roving in the trough, forming a half round edge due to the overfill. (See photos and detail drawing.) Now wet out another 3"wide Bid tape so that it wraps around the edge and onto the roll over at least 1" inside and outside. Cut squares of peel ply, roughly 5" by 5", and wet these around the edge until they are holding the entire roving edge tightly in a smooth round shape. (See photos). Note: one long piece of peel ply will not conform; short 4 to 5 inch long pieces do a great job. Allow your first edge to fully cure, then repeat all of the above for the other edge.

You are now ready to sand, fill as required, prime and paint your roll over structure. I spray painted the outside, or exterior of mine, the same color as my Long-EZ, white Imron. The inside I spray-painted with Lilith Charcoal gray Zolatone paint to match the rest of the interior of my EZ. Zolatone is wonderful for hiding minor imperfections, especially the Lilith Charcoal. This paint is available from Spruce and Wicks in one gallon cans. Be certain to mask of the areas on each end that will be bonded to your canopy rails before you do any painting!

Once the paint has thoroughly hardened you are ready to bond the finished part into the canopy. I mounted my canopy up high enough so that I could walk under it comfortably as you can see in the photos. As long as you can get under the canopy to install the roll over, that's all that counts. I found it

helped a lot to wedge a couple if pieces of wood, (1" by 1") between the canopy rails, forward and aft of where the roll over would fit, to force the canopy rails far enough apart to easily get the roll over into place. I made several practice runs at this, and located the roll over using the two small witness holes drilled prior to removing the roll over structure when it was completed. The witness holes I drilled were just the right size to accept small self-tapping screws. I installed two of these screws, then drilled two more holes at the aft edges of the roll over, and installed two more screws. I did this "dry" with no glue a couple of times, and it would certainly help alot to have someone to assist in this final installation. To remove the two sticks once you have the roll over inside the canopy, to help guide you in; because once you have the adhesive on the roll over flanges, you are only going to have one shot at this. It could be a real mess if you get adhesive all over your canopy. I did it alone and it was very difficult. I was very lucky to do as well as I did. I would never try to do it alone again.

I used Hysol 9317 structural adhesive to bond my roll over into the canopy frame. It is expensive but it is incredibly strong, (and messy!). Since there is no way to back up a flox or micro bond with fasteners, we believe that this important a structural bond needs the strength of a structural adhesive such as Hysol 9317.

Once it was in place, and the two sticks had been removed, I installed the 4 self-tapping screws, and slowly tightened each screw a little at a time until all 4 were down solid. I wiped off the excess adhesive and allowed it to cure.

I machined all of the canopy and roll over latch hardware, cleaned the parts, shot-blasted them and treated them with alodine them for corrosion protection. I strongly advise you to treat all aluminum parts on your EZ with alodine.

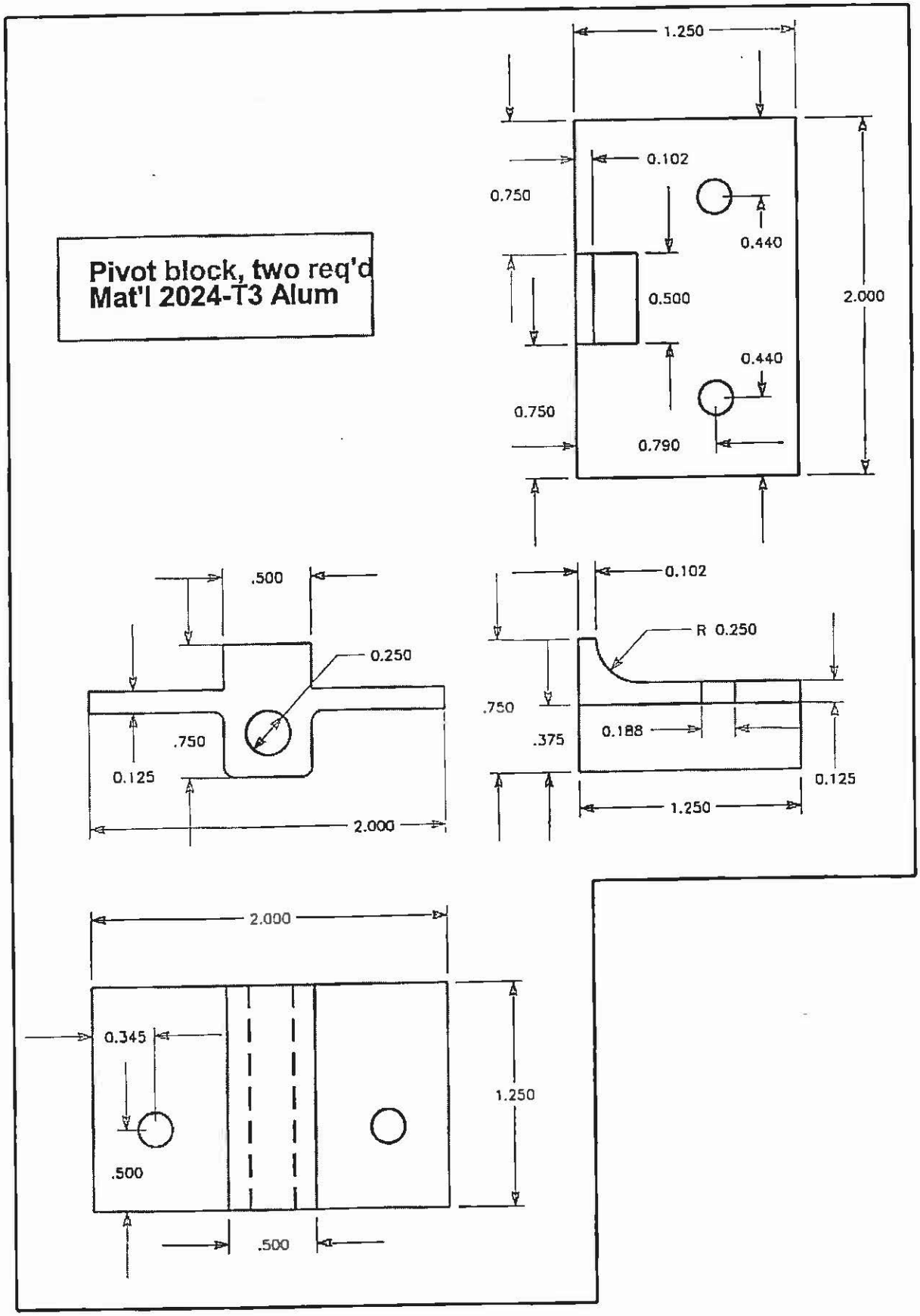
Installing the locator pins into the right top longeron, and the heavy-duty canopy latches on the left top longeron, is a somewhat difficult job, and will take some careful measuring and fitting before you drill the final holes. The heavy-duty latches that will lock the roll over (and canopy) to the fuselage, replacing the original center canopy latch, which should be discarded. There should be one locator pin forward of the pilot's seat bulkhead, and two aft of this bulkhead.

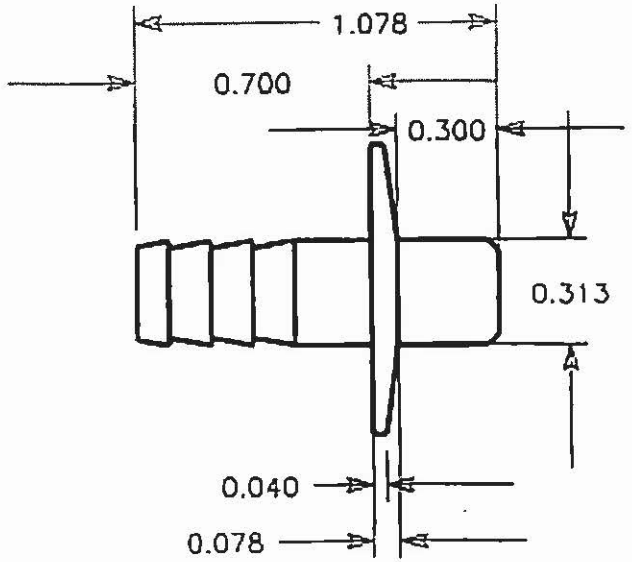
Install the canopy complete with roll over structure onto the fuselage. Use a stick cut to the appropriate length to force the canopy frame out to the correct width, then install a new cross-brace. I used a piece of carbon tubing left over from the Voyager program, but arrow shaft or aluminum tubing will also do the job. Once this repair has cured, climb into the cockpits, close the canopy, and carefully mark the spots where the locator pins will be installed. Drill a #30 or 1/8" pilot hole through the vertical flanges of the roll over and into the top longeron. Open the canopy, and carefully finish drill these holes with a 5/16 drill. Be very careful not to drill through the top longeron. I used a mechanical stop on the drill to ensure that I drilled deep enough, but not too deep. The holes in the glass flanges will need to be elongated in the vertical plane, to allow the canopy to close normally. When you are happy with the locator pins fit and function, glue them into the top longeron using the same Hysol 9317 adhesive.

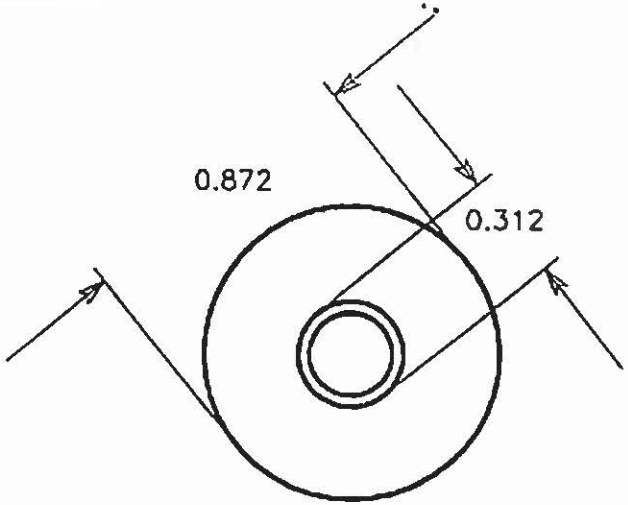
While sitting in each seat, with the canopy closed, carefully mark the location of each of the new heavy duty latches onto the roll over flange, and onto the left top longeron. Drill the flange using a 3/8" diameter drill, and install the 3 piece locking pins, one forward and one aft of the front seat bulkhead. Now locate the flanged aluminum pivot blocks on the underside of the left top longeron, and drill the 3/16" mounting holes vertically through the longeron. I used a 90° air powered drill, and drill up through the flanges. The trick is getting these pivot blocks in exactly the proper location so that the latches will perfectly align with the lock pins. It will take some fooling around, it certainly did for me, but I did eventually get it to fit. You will too if you take your time. Install the mounting bolts through the pivot blocks. You will have to open the tops of the 3/16" holes in the longerons with a dremel to allow installation of the required washers and nuts. After you have torqued these nuts, fill the holes with dry micro. Install the latches, and cut your existing canopy aluminum tube pushrods so that they will fit and operate the two new latches in conjunction with the original forward and aft canopy latches. Obtain some 1/4"-20 all-thread, cut two pieces approximately 2.5 inches long, and install this all-thread into the open ends of your aluminum pushrods. I ran a 1/4"-20 tap into these open ends then applied Loctite to the all-thread, then screwed the all thread into these pushrods. This worked very well. Assemble the remaining bits and pieces of the canopy latch hardware, and you are all done!

Fly safe, and enjoy!

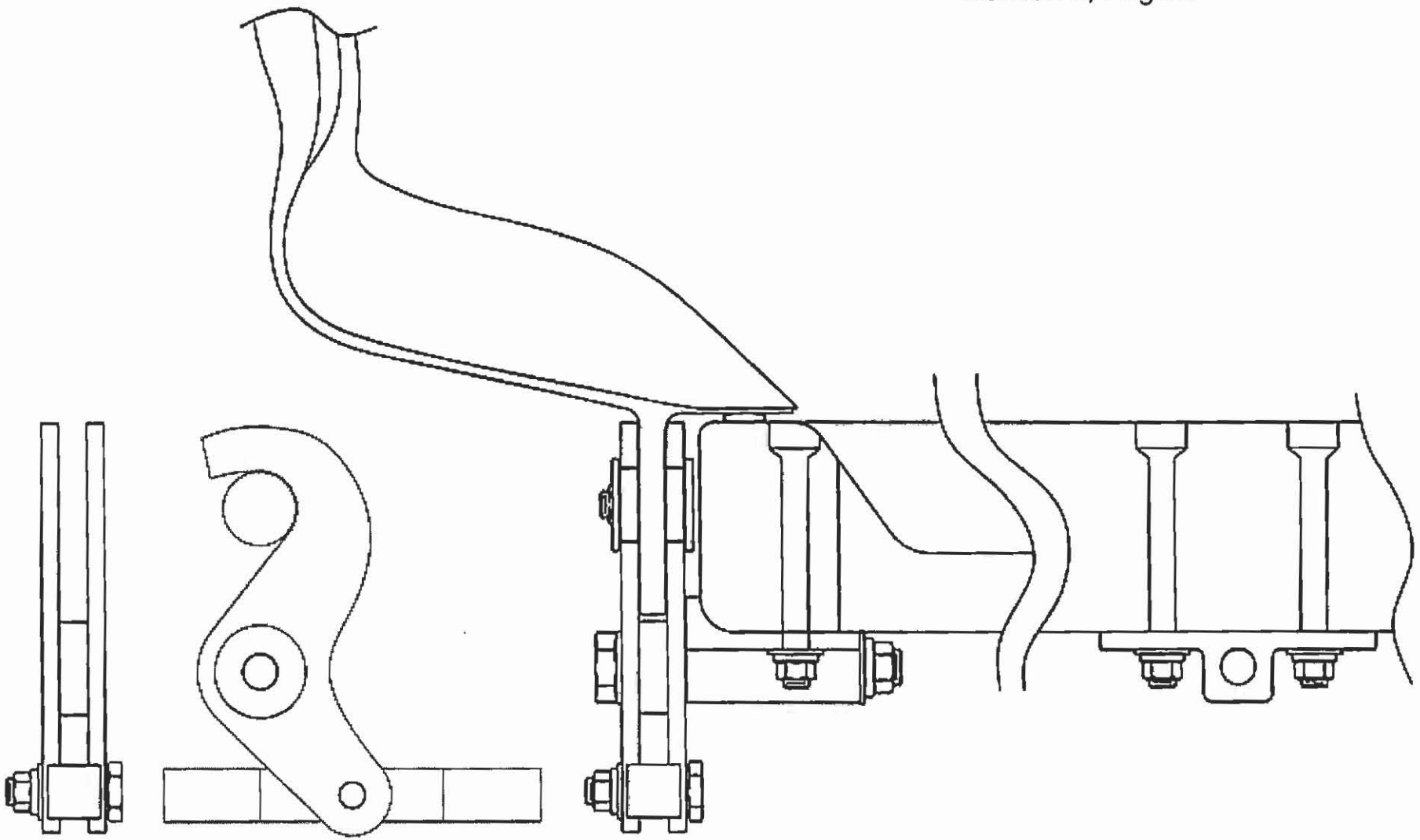
Pivot block, two req'd
Mat'l 2024-T3 Alum



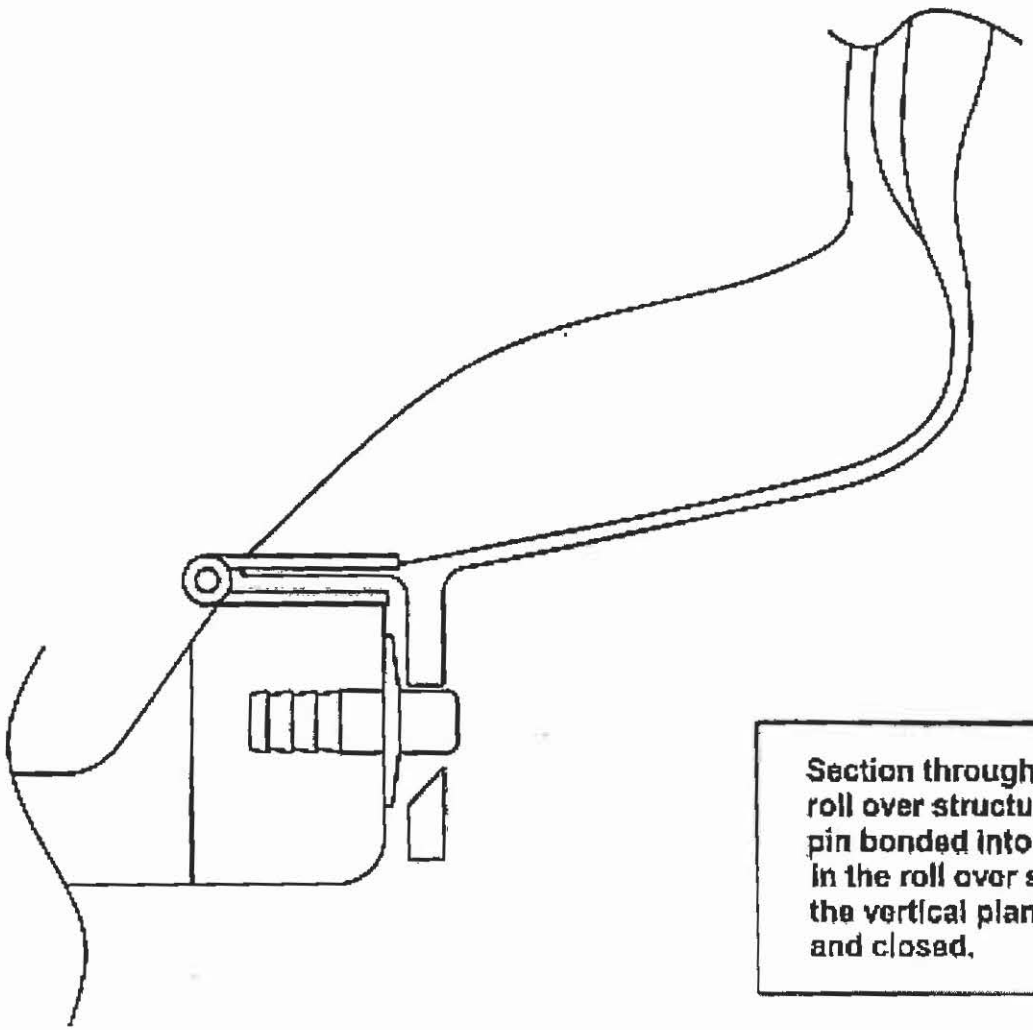




Locator pins, three req'd
Mat'l 17-4 PH stainless steel

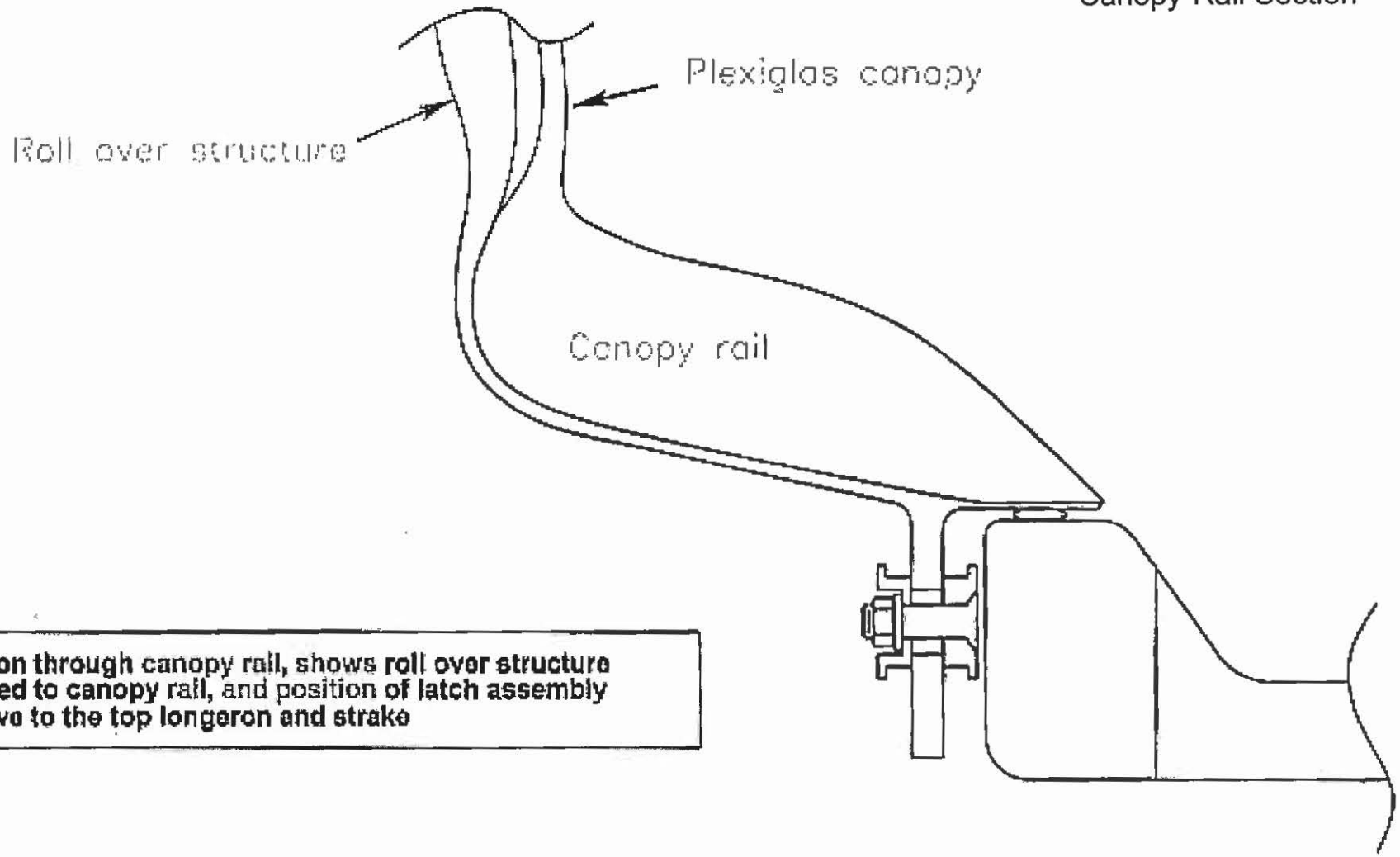


Section through canopy rail **and top longeron, shows method** of mounting pivot block **and latching mechanism including connector** block.



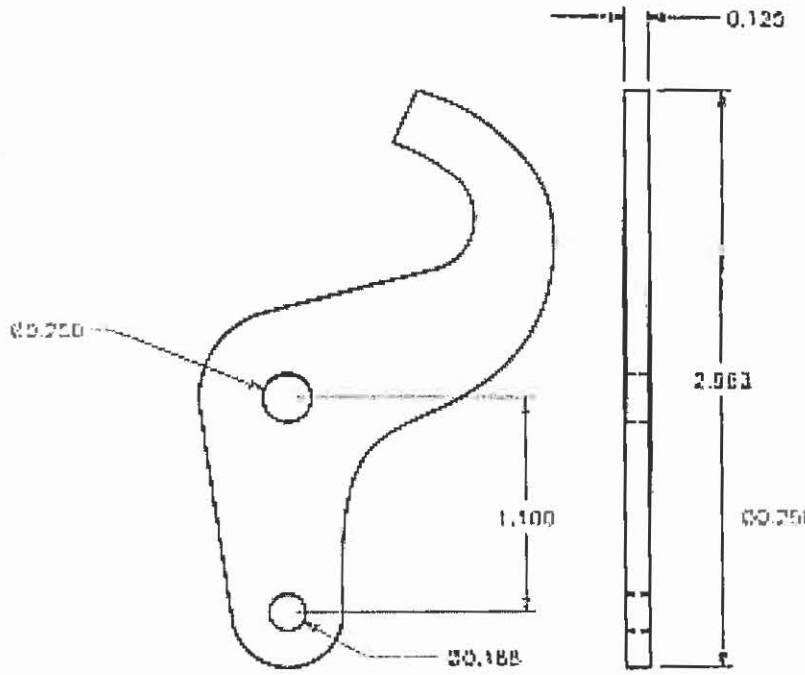
Section through canopy rail on the hinged side, shows roll over structure bonded to canopy rail, with locating pin bonded into the right top longeron. Note that the hole in the roll over structure rail is elongated and angled in the vertical plane to facilitate the canopy being opened and closed.

Canopy Rail Section

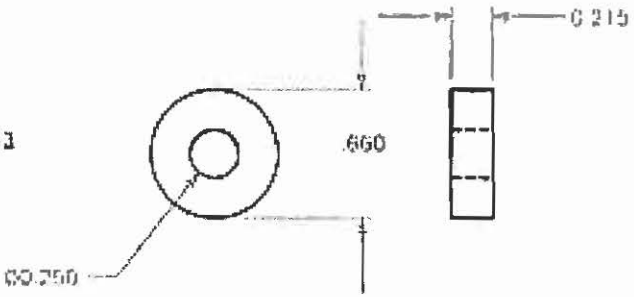


Section through canopy rail, shows roll over structure bonded to canopy rail, and position of latch assembly relative to the top longeron and strake

Latch Parts

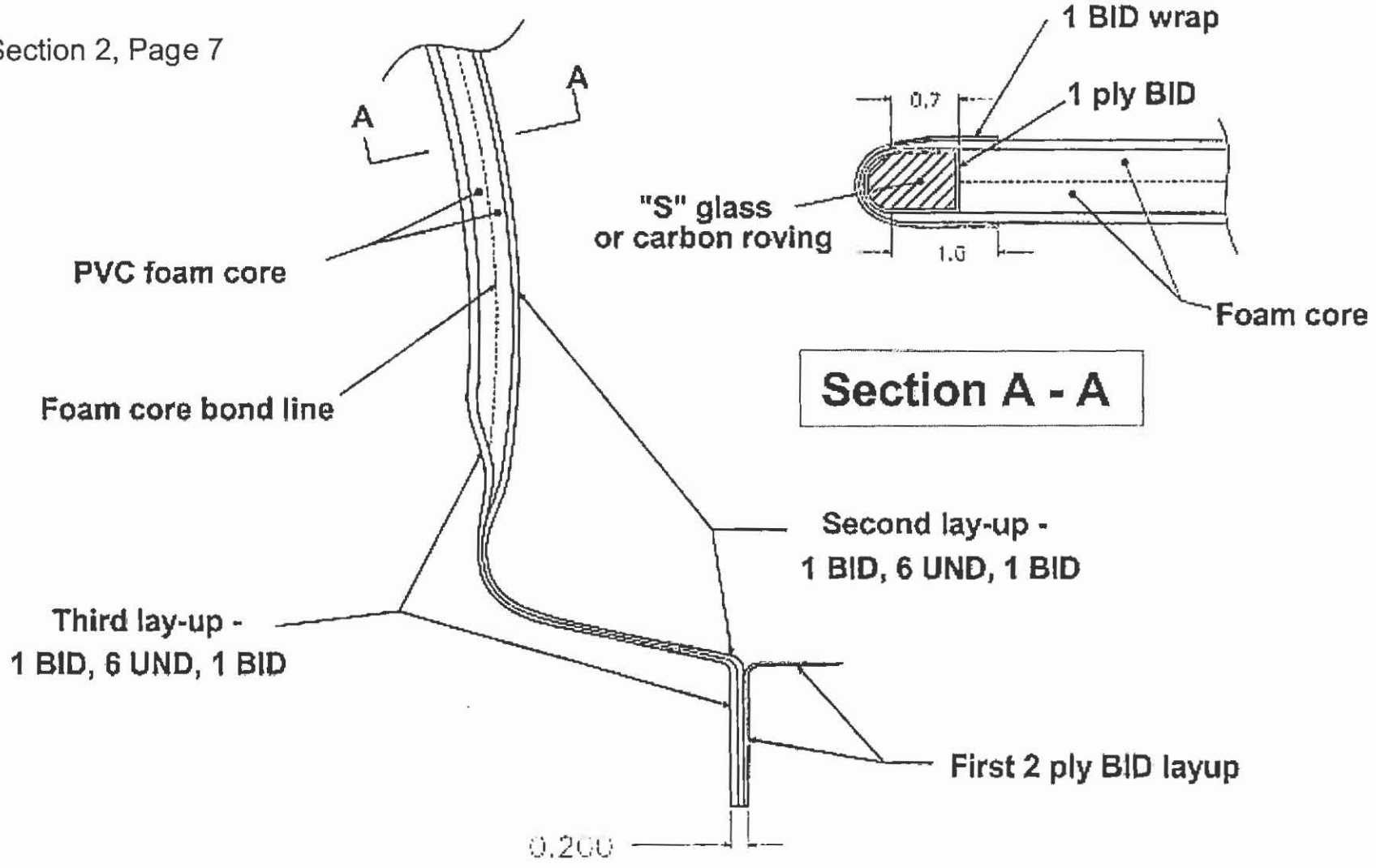


Canopy latch, four (4) req'd
Material: 2024-T3 Alum



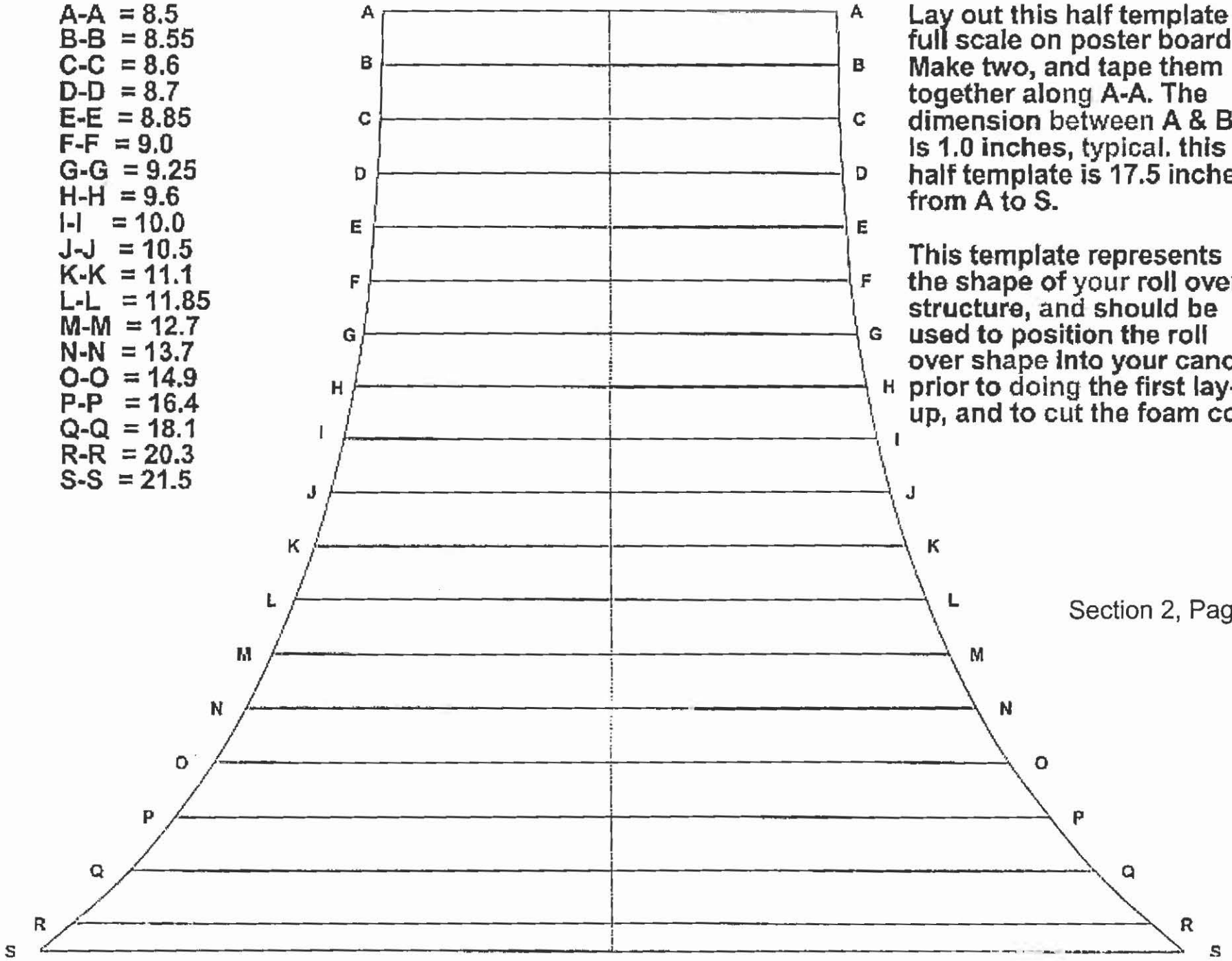
Spacer, two (2) req'd
Material: 2024-T3 Alum

Canopy latch parts, drawing is full scale. Copy this drawing on a copy machine, or trace the latch shape and transfer it to your aluminum stock.



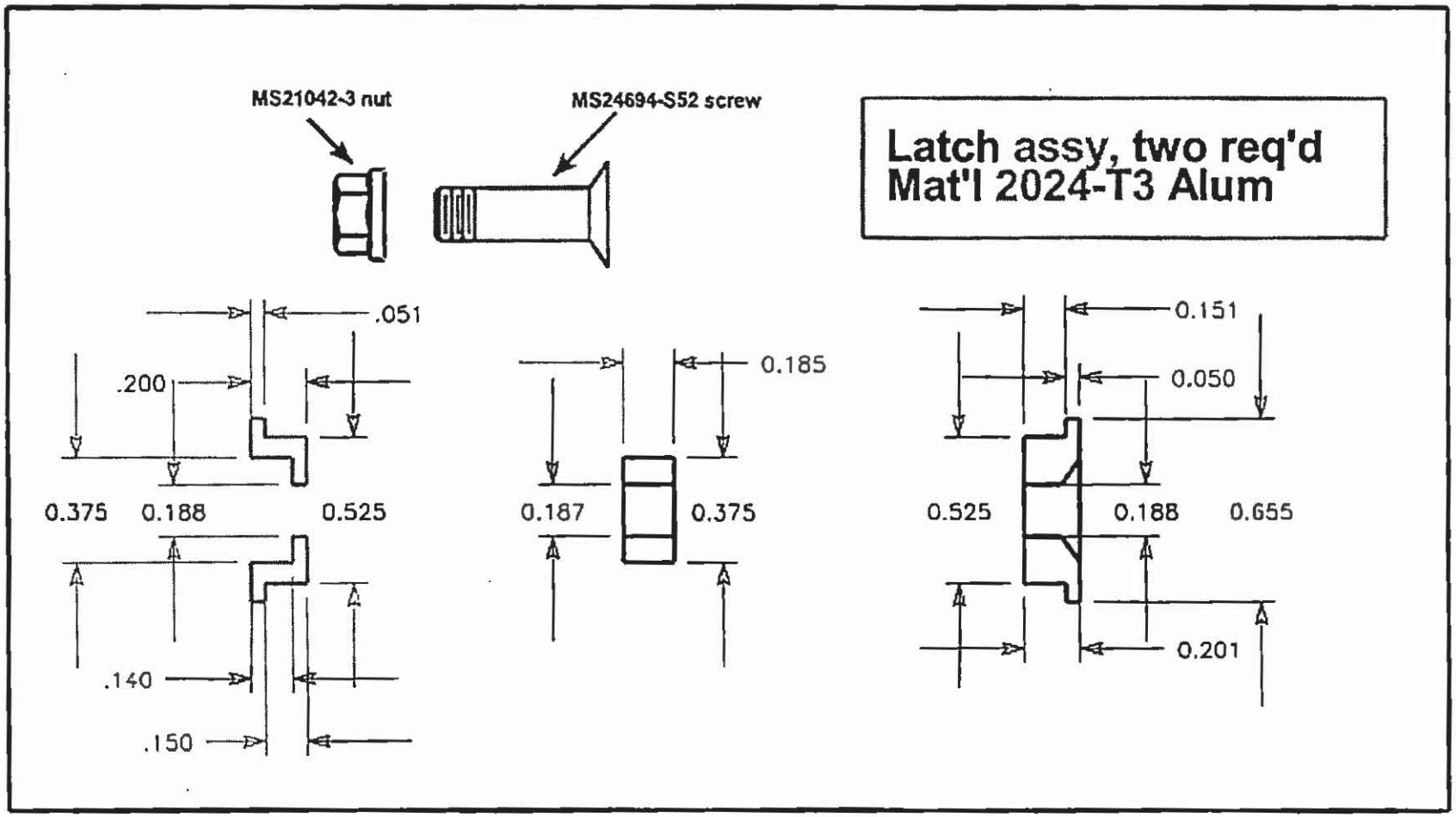
Section through the roll over structure

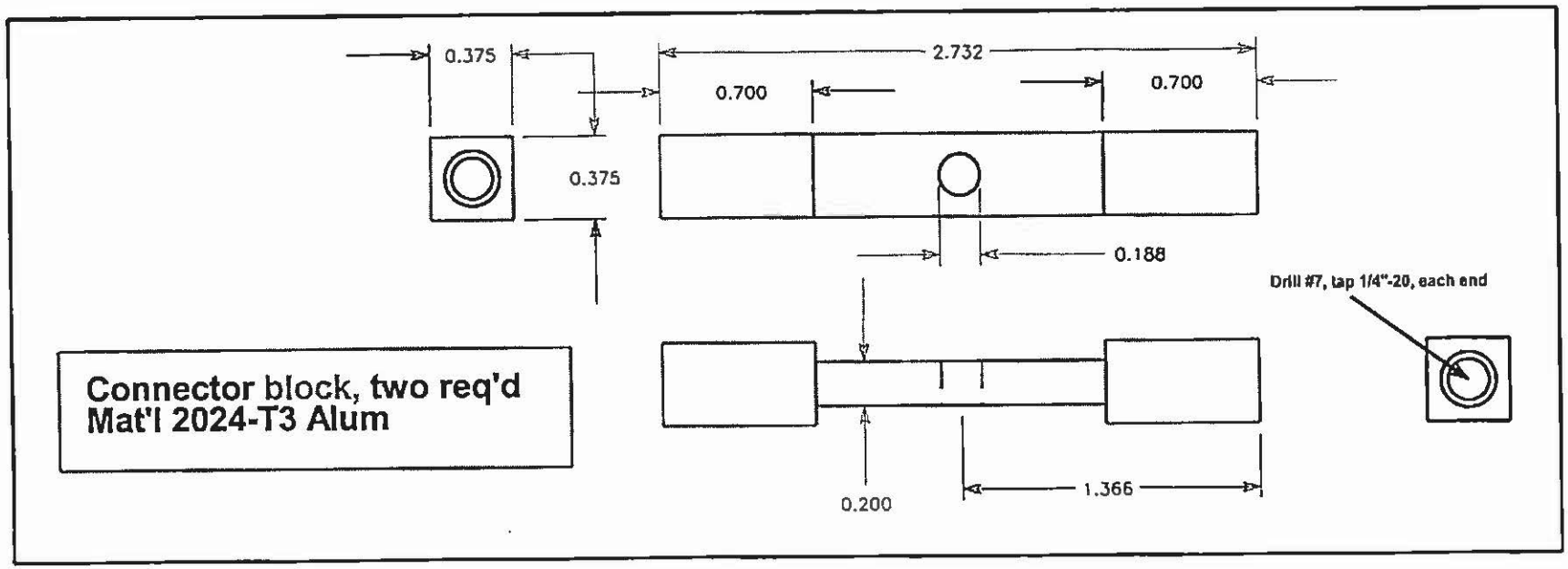
A-A = 8.5
B-B = 8.55
C-C = 8.6
D-D = 8.7
E-E = 8.85
F-F = 9.0
G-G = 9.25
H-H = 9.6
I-I = 10.0
J-J = 10.5
K-K = 11.1
L-L = 11.85
M-M = 12.7
N-N = 13.7
O-O = 14.9
P-P = 16.4
Q-Q = 18.1
R-R = 20.3
S-S = 21.5

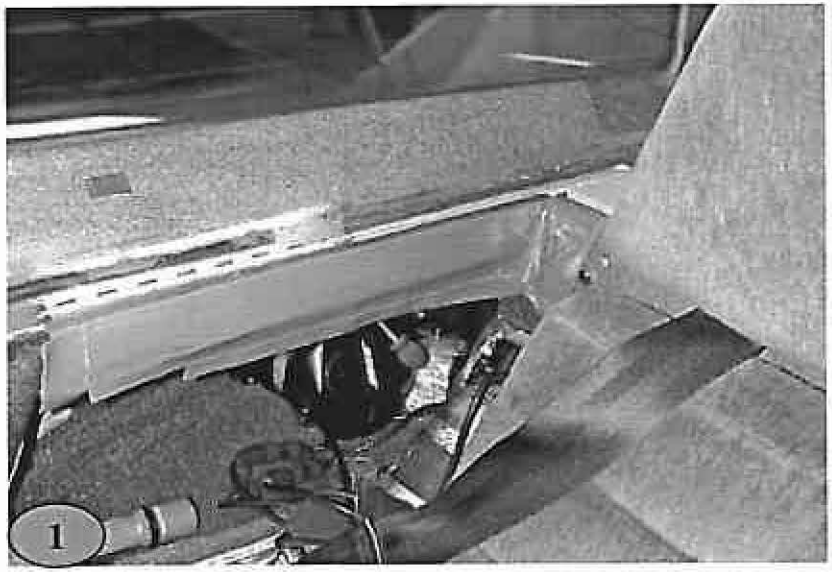


Lay out this half template full scale on poster board. Make two, and tape them together along A-A. The dimension between A & B is 1.0 inches, typical. this half template is 17.5 inches from A to S.

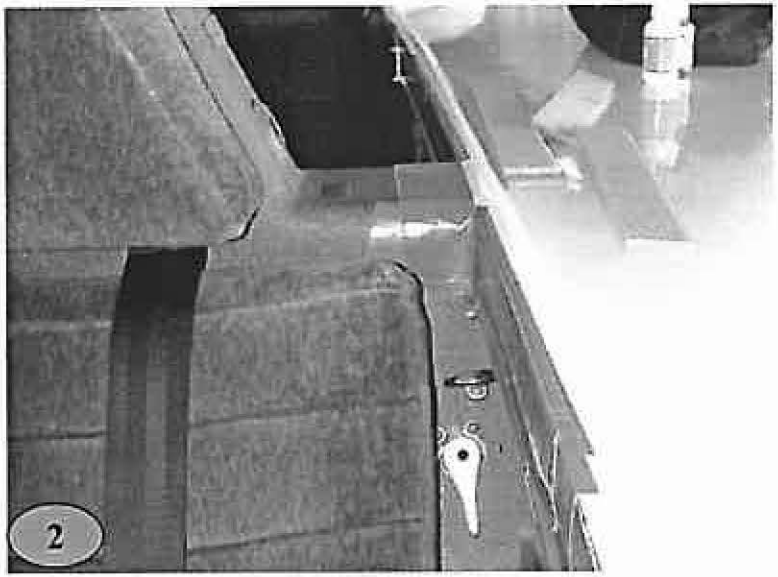
This template represents the shape of your roll over structure, and should be used to position the roll over shape into your canopy prior to doing the first lay-up, and to cut the foam cores


MS21042-3 nut
MS24694-S52 screw
Latch assy, two req'd
Mat'l 2024-T3 Alum
.051
.200
0.375
0.188
0.525
.140
.150
0.185
0.187
0.375
0.151
0.050
0.525
0.188
0.655
0.201


0.375
2.732
0.700
0.700
0.375
0.188
Drill #7, tap 1/4"-20, each end
Connector block, two req'd
Mat'l 2024-T3 Alum
0.200
1.366

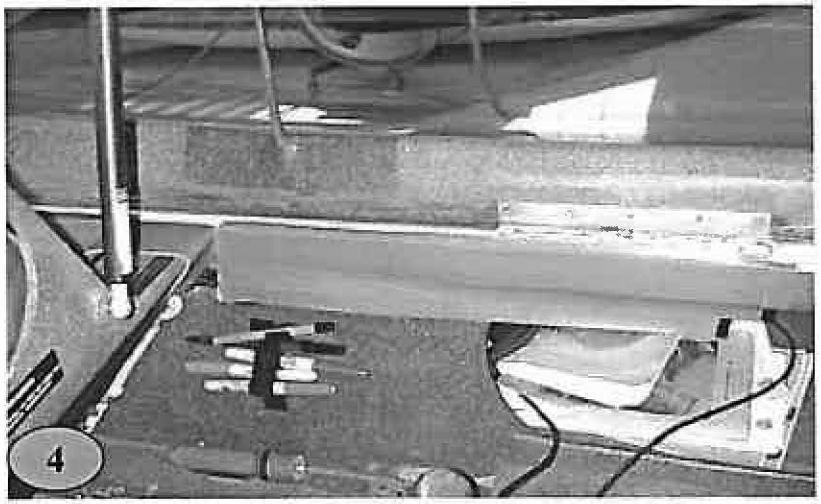


Release the top longerons as shown using duct tape. Build up approximately 0.1" thickness on the right (hinged) side.



The build up on the inside of the left (canopy latch) side must be .250 (1/4") in both the front and rear cockpits. I used strips of PVC foam and duct tape.

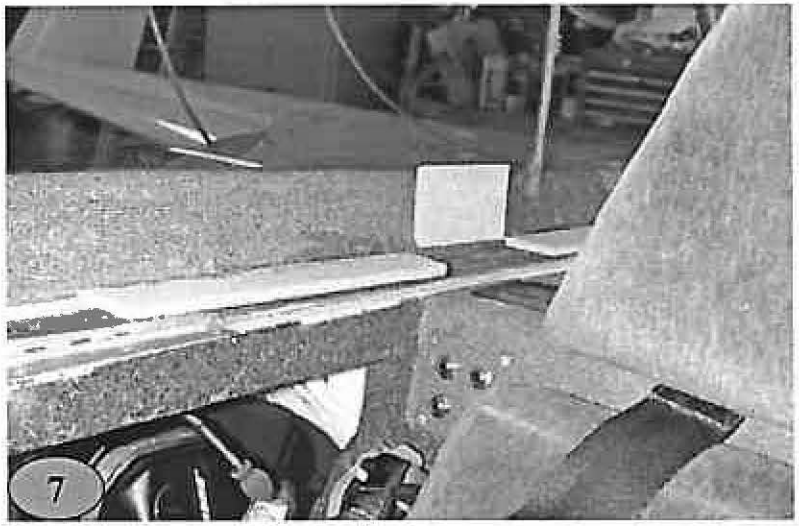
Make sure you create a duct tape build up in this area, on both sides of at least 0.15 inches.



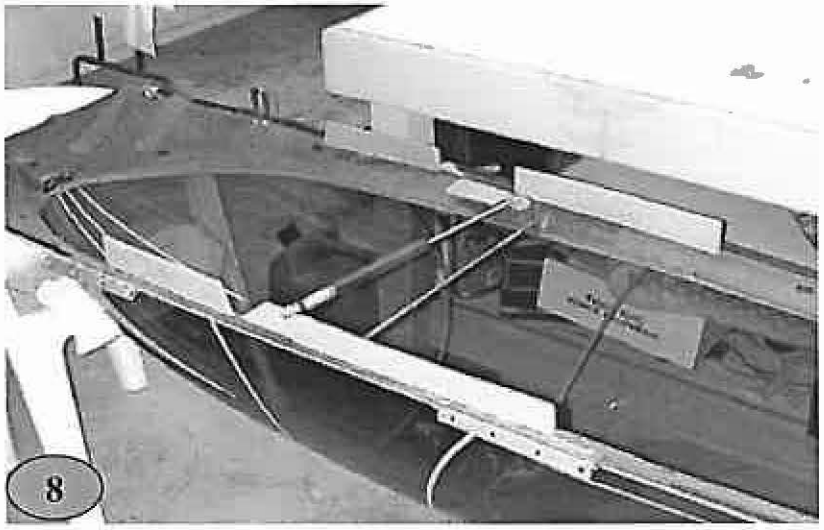
Rear cockpit, hinged side--note build up over and around front seat bulkhead structure.

I made several practice samples and checked the thickness of the duct tape build-up with a caliper.

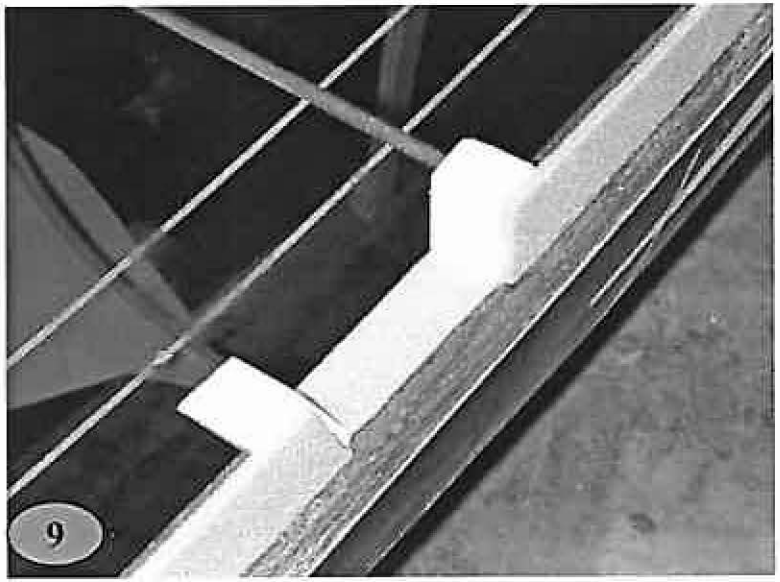
The pieces of PVC foam shown in the next three photos, are temporarily fixed into position using a quick drying cement, such as "Hot stuff"model airplane cement.



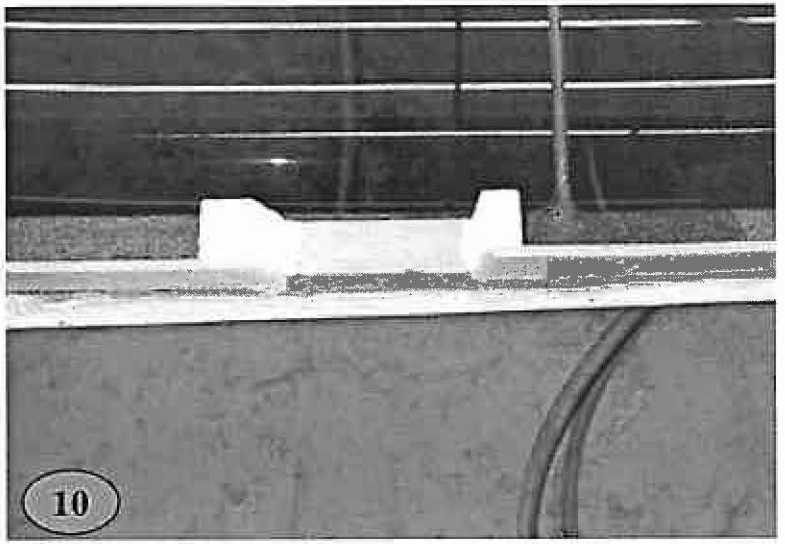
These foam strips must be cemented to the canopy rails with the canopy closed and locked. You will have to be in the cockpit(s) in order to do this. The duct tape buildups position the foam strips correctly.



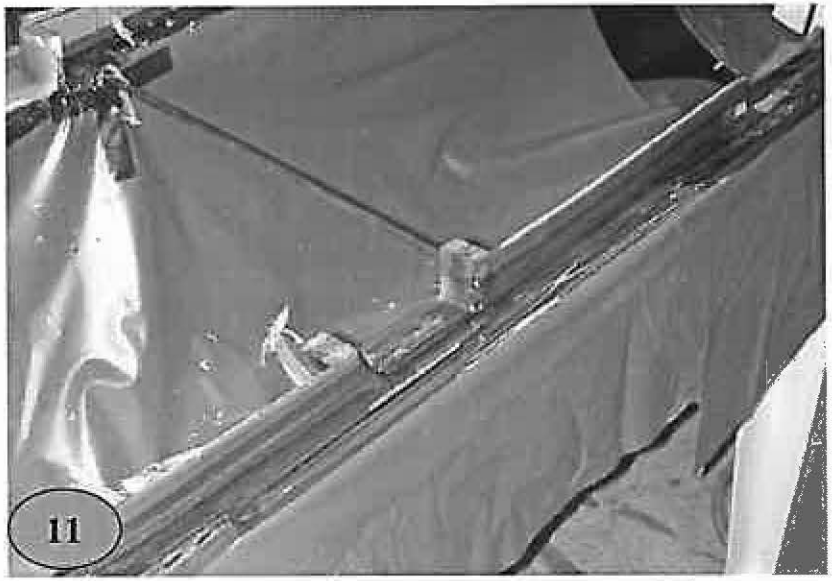
Remove the canopy, and jig it as shown preparatory to laying up the roll over structure. Do all you can to protect your Plexiglas canopy! Consider applying spraylat to protect the inside as well as the outside of the Plexiglas.



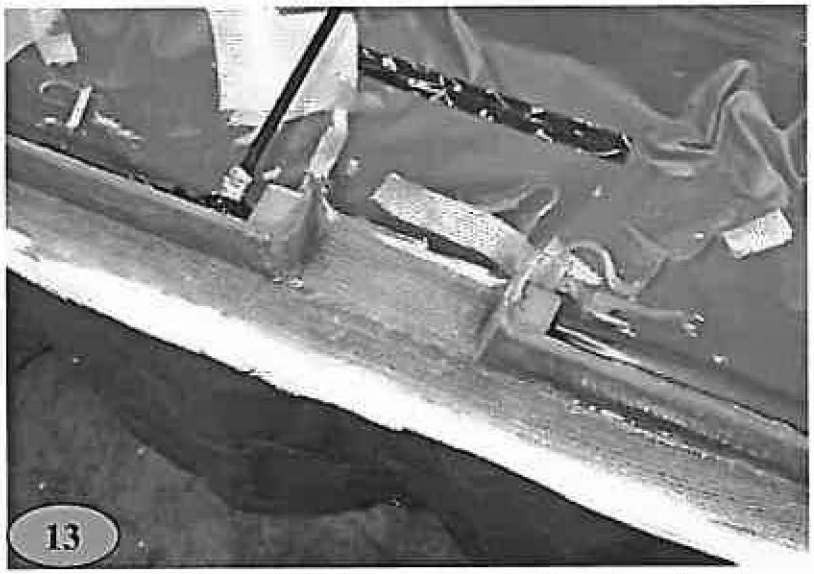
I used white "Clark" foam to build up the corners as shown. You can probably use Blue Styrofoam, the stuff you hotwire wings.



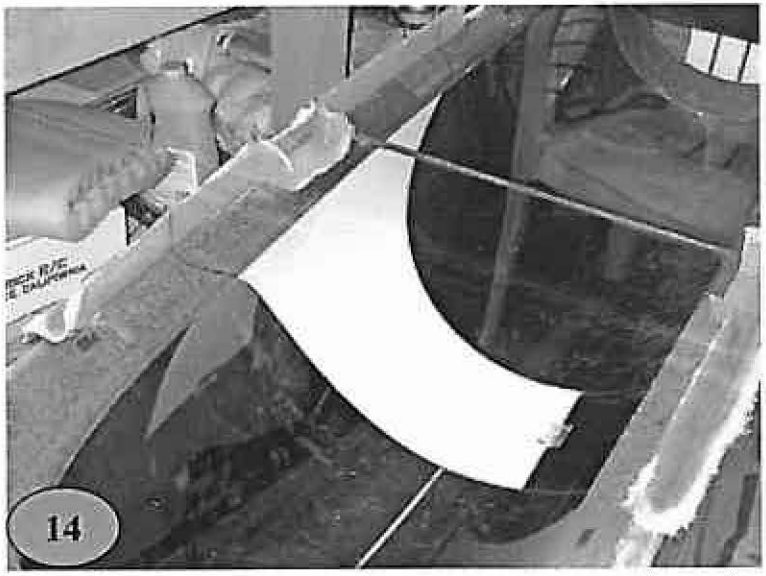
Another view, showing generously rounded corners. These foam "dams" or forms, with release tape on them, will allow you to do the appropriate lay-ups. See below, photo # 12.



I used blue flash tape as a release simply because it was available. Any plastic tape will work, including duct tape.



The first two (2) ply BID lay-up, across the edge of each canopy rail and onto the released foam dams, or forms. I added 3 extra plies where this lay-up bridges the front seat bulkhead.

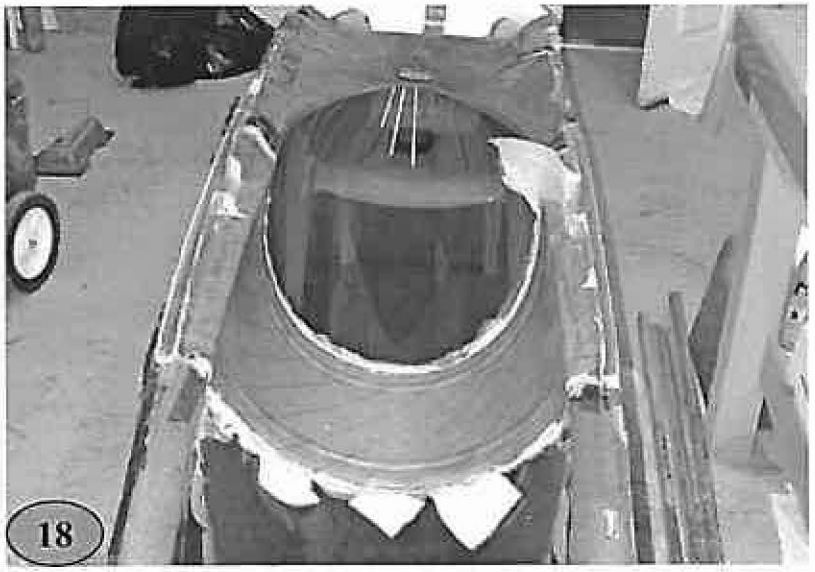


The two ply BID lay-ups are complete, and the foam dams have been removed. The poster board template is placed and trimmed so that it covers only the Plexiglas, and not the canopy rails.

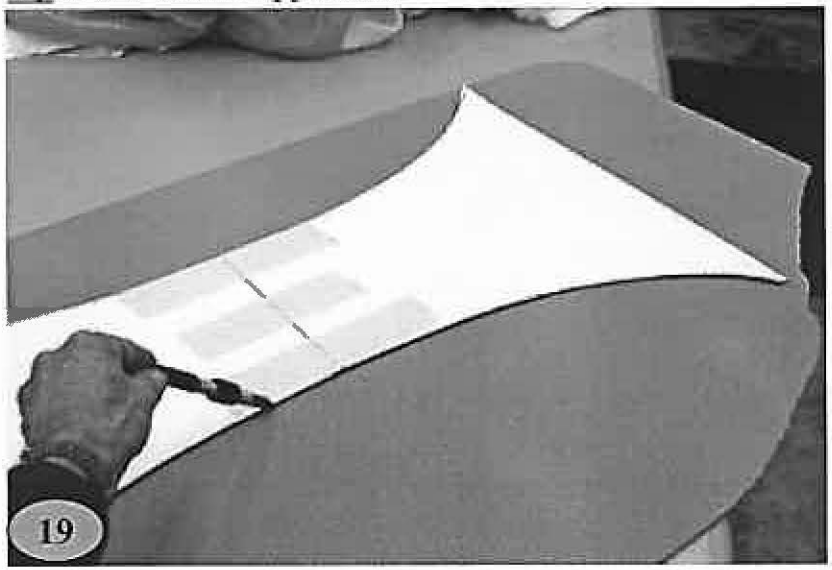
This photo does not show it clearly, but under the orange plastic vacuum bag, there is a thin spacer in the form of a sheet of .090" rubber, which I purchased from McMaster-Carr.

The first 8 ply lay-up has been completed, and is shown under an orange vacuum bag.The lay-up was done over the orange plastic bag shown in photo # 15.

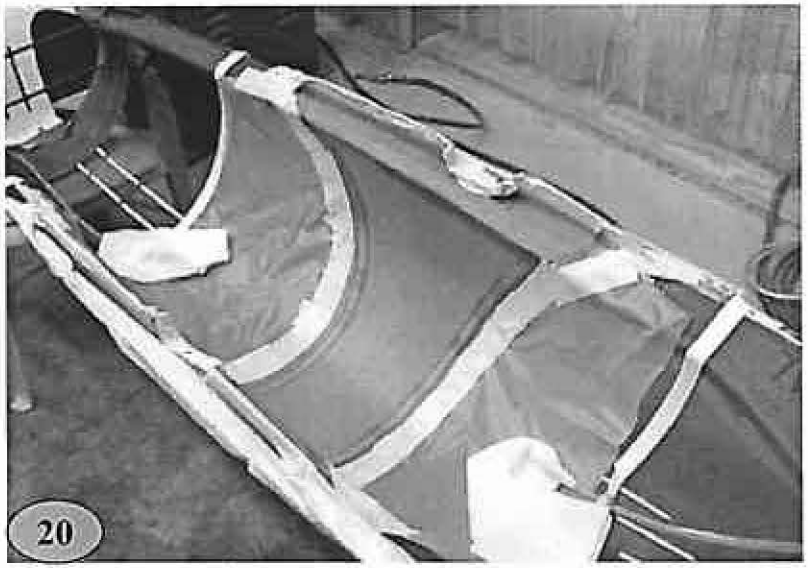
Another view of the first 8 ply lay-up under the bag. Note: the bag must encompass all of the two 2 ply BID lay-ups on each canopy rail, and is sealed to the top side of the canopy frame.



After cure the bag is removed. I also foolishly removed the under bag that was protecting my canopy and managed to spill epoxy into my canopy! Do not follow this bad example!



Using a magic marker and the poster board template to lay out the foam core, prior to cutting the 1/4" foam core shape.

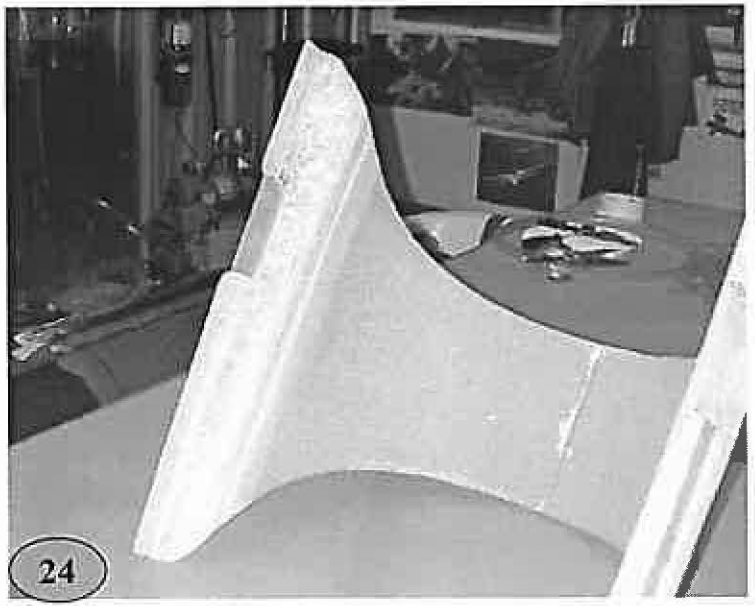


Prepping for the installation of the foam core. Note: I had to replace the protective bag, which I had foolishly removed. See photo #18.

Two pieces of 1/4 inch PVC foam core. The top piece has been slurried just prior to installing it in the canopy "mold".

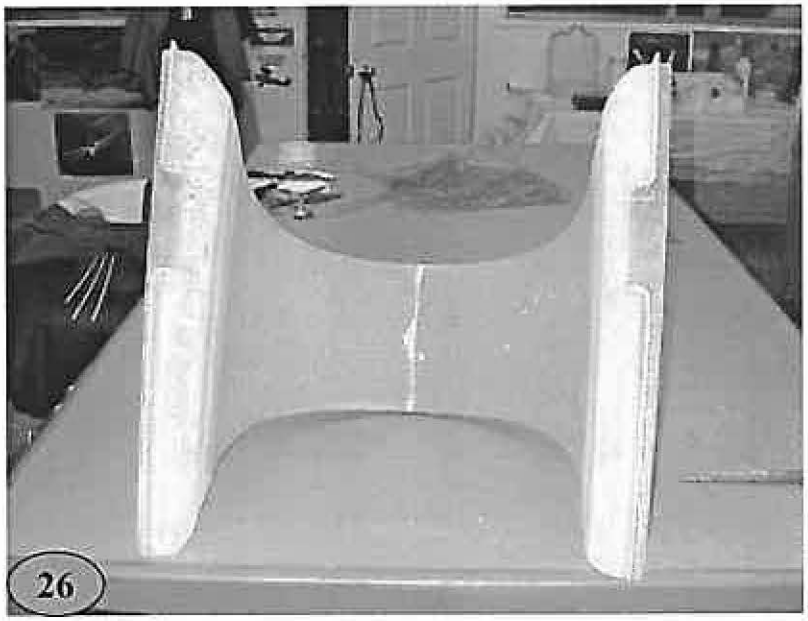
Forcing the foam core into the canopy "mold" using a 2 by 4 and a 25 pound lead shot bag!

If you look closely, you can see the foam core in position under the orange vacuum bag!

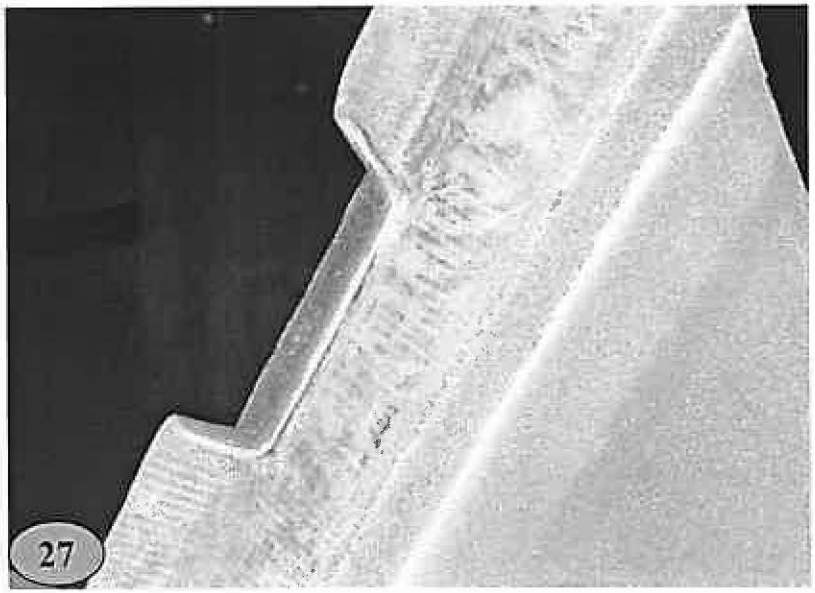


The roll over is taken out of the "mold, and trimmed close to finished size. The foam cores are sanded to the appropriate tapered shape at each side.

Roll over structure, trimmed and prepped for the final inside 8 ply lay-up.



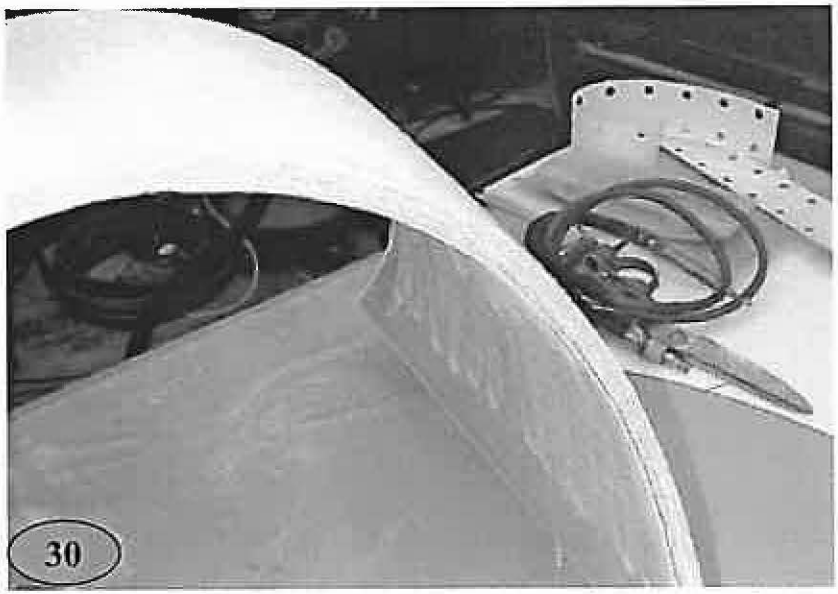
Roll over ready to go back in the "mold". Micro joint is where I accidentally broke the second piece of core during installation.



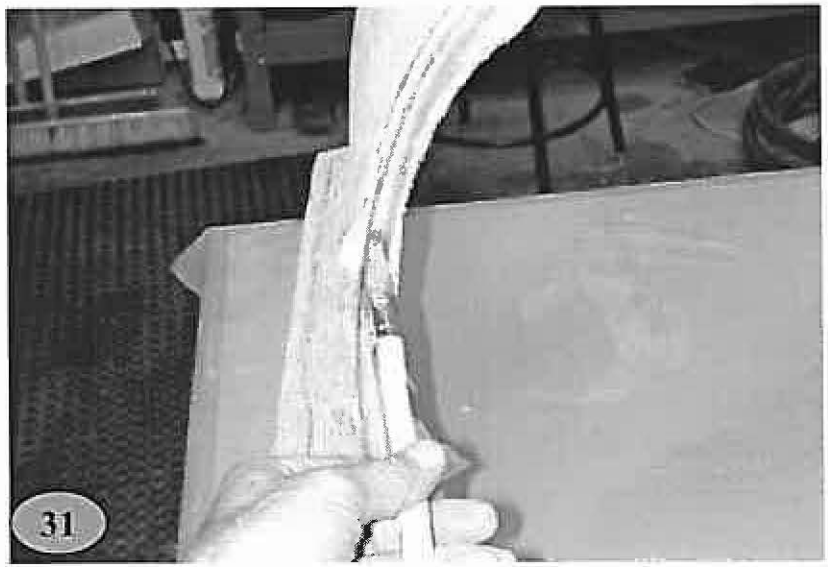
Detail shot of prepped glass surface and tapered foam cores.

The second 8 ply inside lay-up is in the bag!

Roll over with inside and outside lay-ups cured. It has been final trimmed, and is ready to groove both edges.

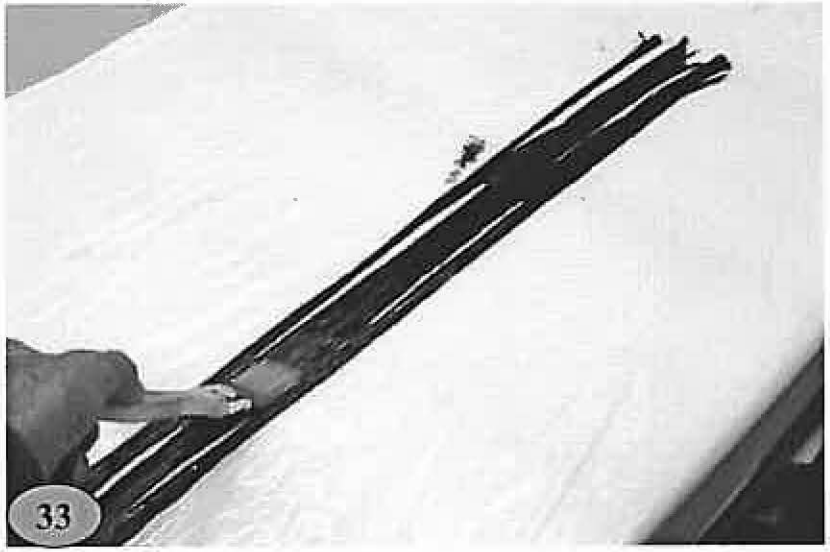


The groove or trough has been cut in this edge. All foam core was removed to a depth of 0.7 inches, and the inside of the glass has been prepped for the next lay-up.

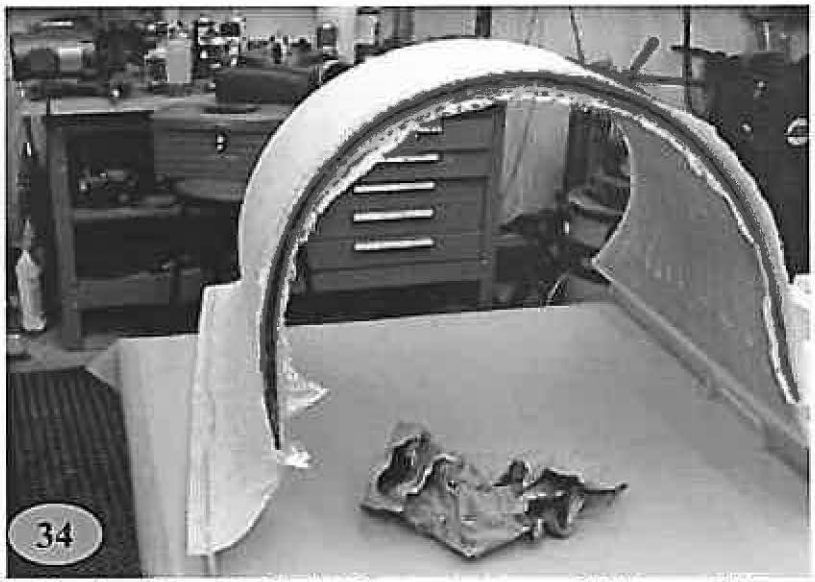


Wetting out a 1 ply BID lay-up into the trough, prior to laying in the wet the roving.

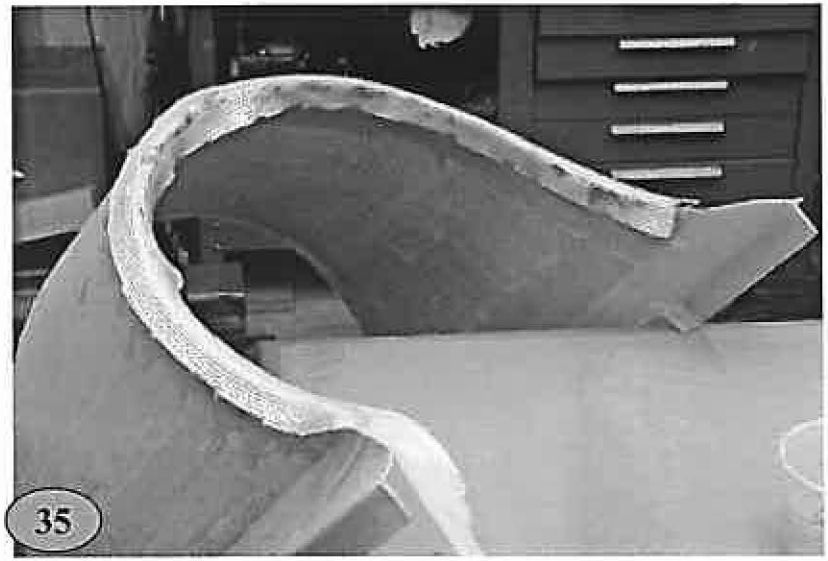
Pulling carbon roving off the spool, and cutting it to length prior to wetting it out with epoxy.



Wetting out the carbon, or "s" glass roving using a brush.



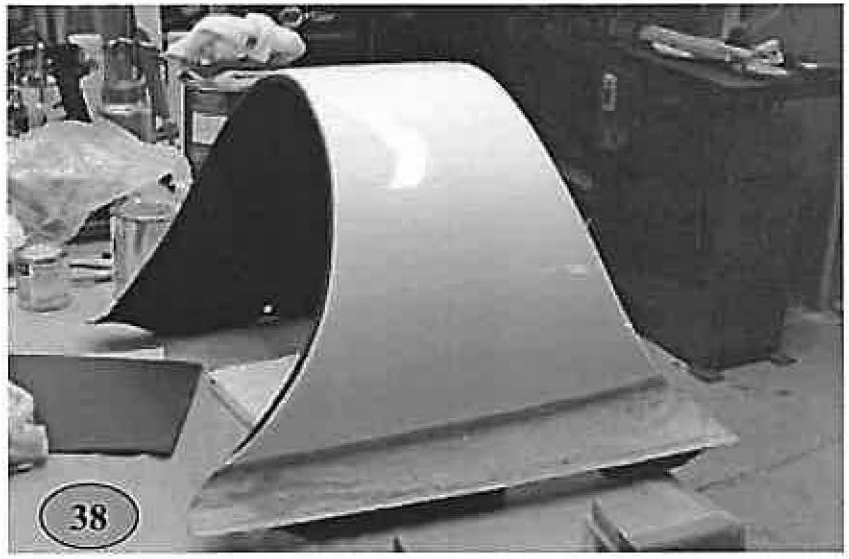
Roving is packed into the trough, to a slight over-fill, then the excess glass tape is wrapped over the roving.



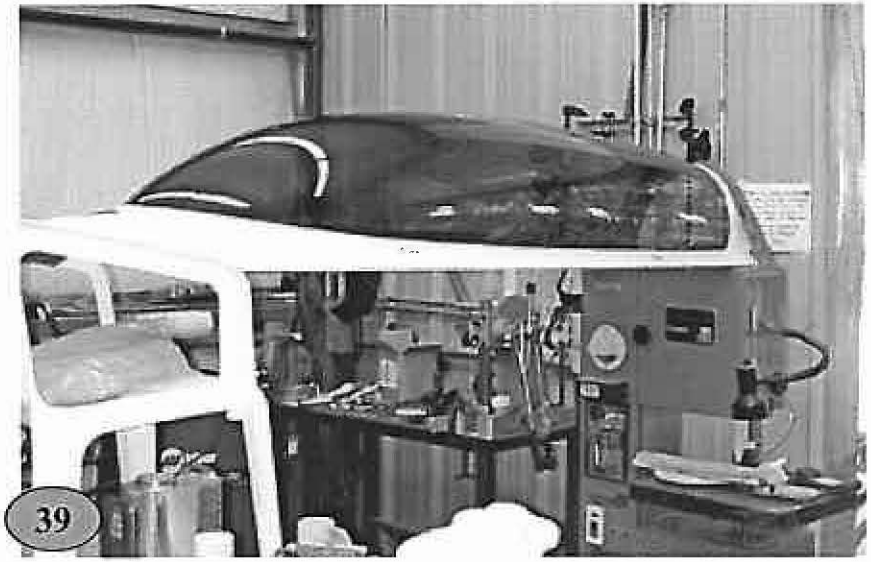
A second BID ply is layed up over the edge to wrap 1 inch onto the inside and outside skins.

Small squares of peel ply are wrapped and pulled tightly around the edge to help form the still wet roving into a nice rounded shape. Overlap these peel ply squares about 1/2".

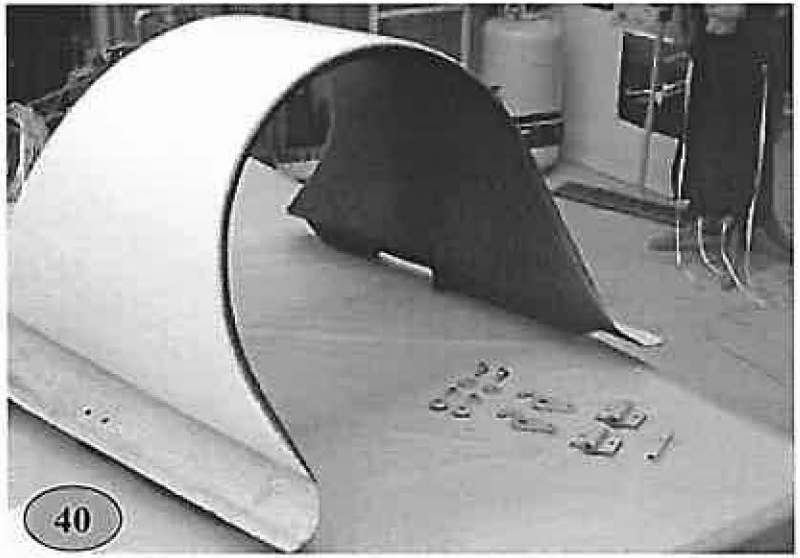
Roll over has been primed and the glass surfaces that will be bonded to the canopy rails were masked off.



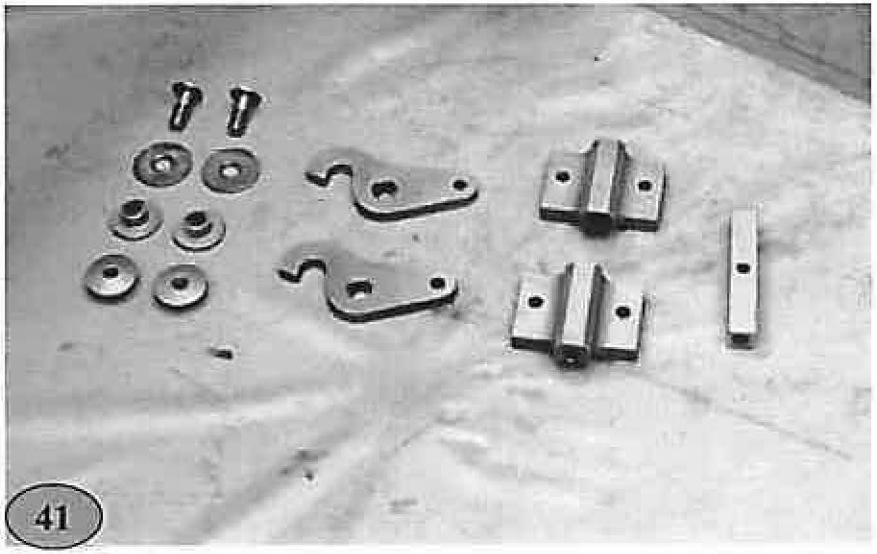
Roll over has been finish painted with white Imron out side to match my EZ, and Lilith charcoal Zolatone on the inside.



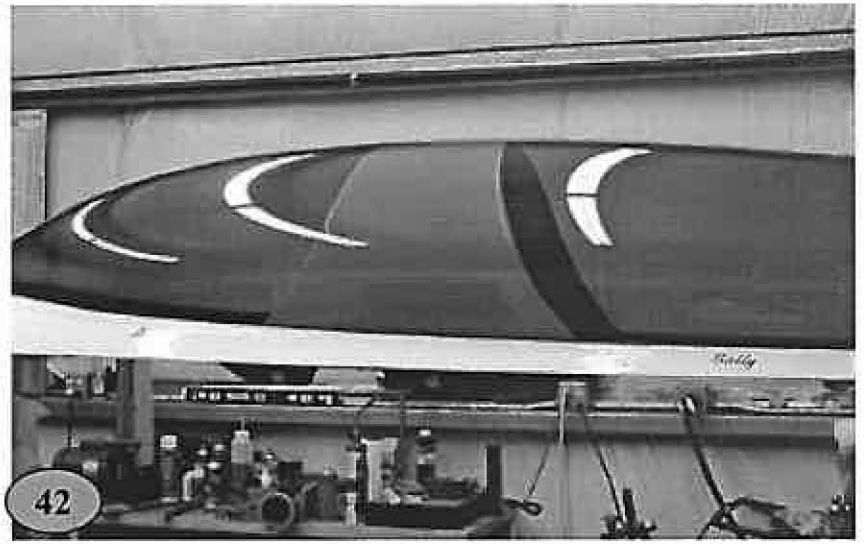
Canopy jigged up high enough to enable me to easily get under it to install the roll over structure. Be careful not to drop it!



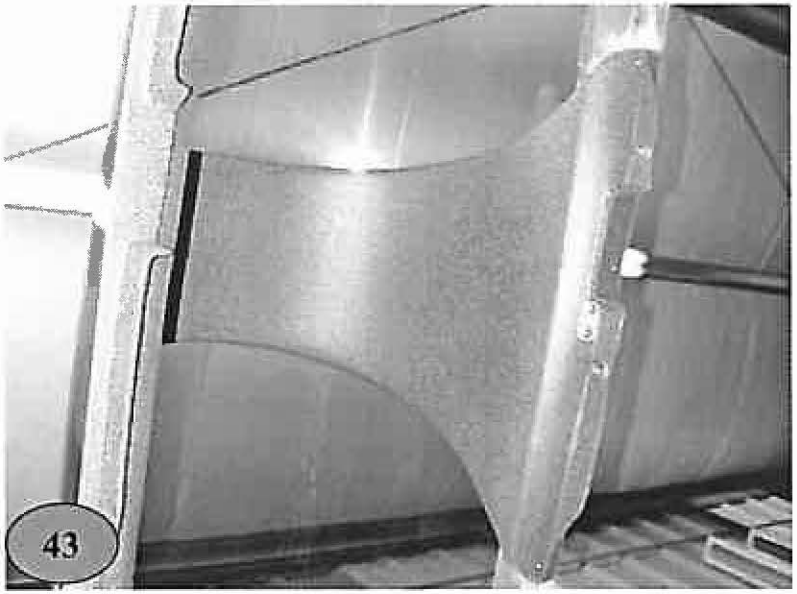
Note sanded and prepped surfaces ready to bond into canopy. The canopy latch hardware is also shown here.



Canopy latch hardware as used on N26MS only, yours will be different. See the full scale drawings.

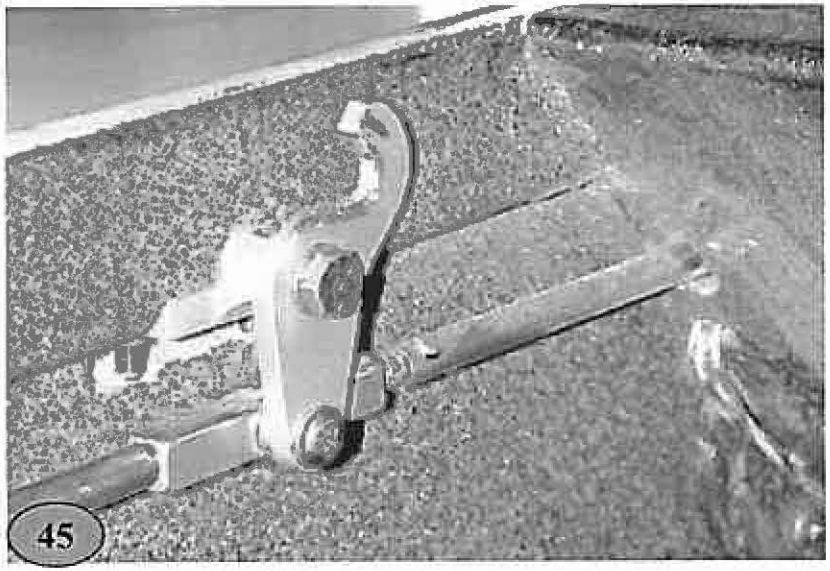


Roll over trial fitted into canopy, doesn't look half bad!

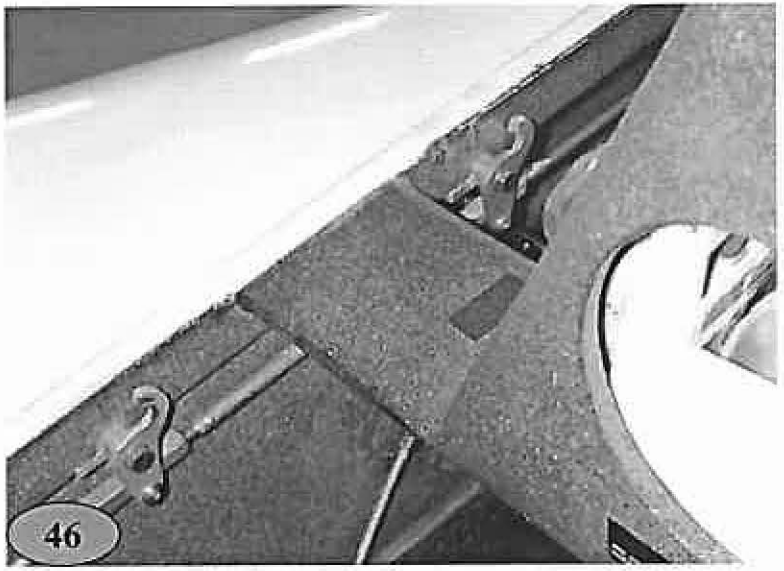


Trial fit into canopy frame using small self tapping screws to secure in position. Be sure you take the time to do this before you bond it in permanently!

Note that the roll over flanges fore and aft, were trimmed to their final configuration prior to painting.

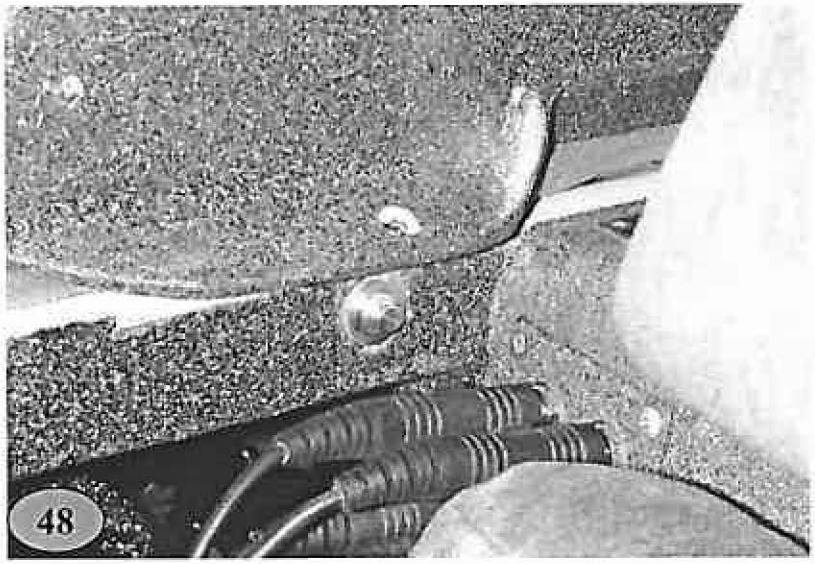


Roll over latch installed in rear cockpit of N26MS, yours will be thinner, and a doubled up design. See full scale drawings.

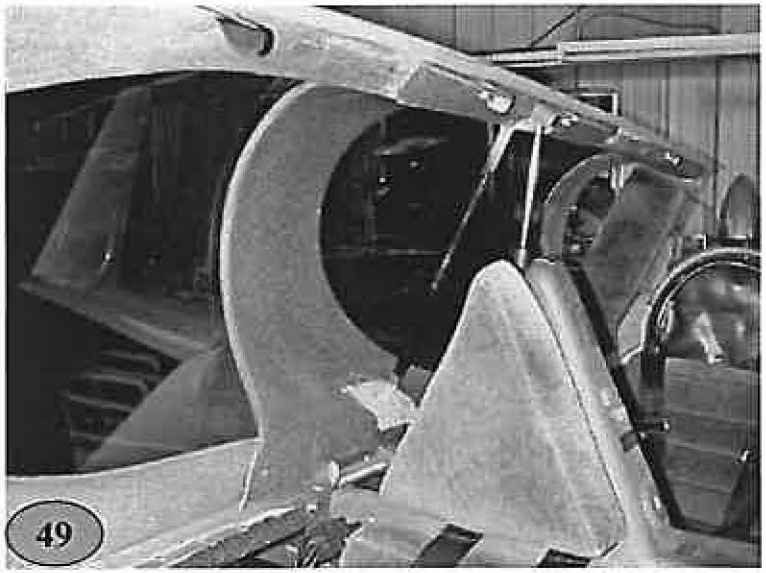


Both roll over lock down latches shown for relative position.

Two locator pins on right side in rear cockpit, showing holes in roll over flange to match locator pins.

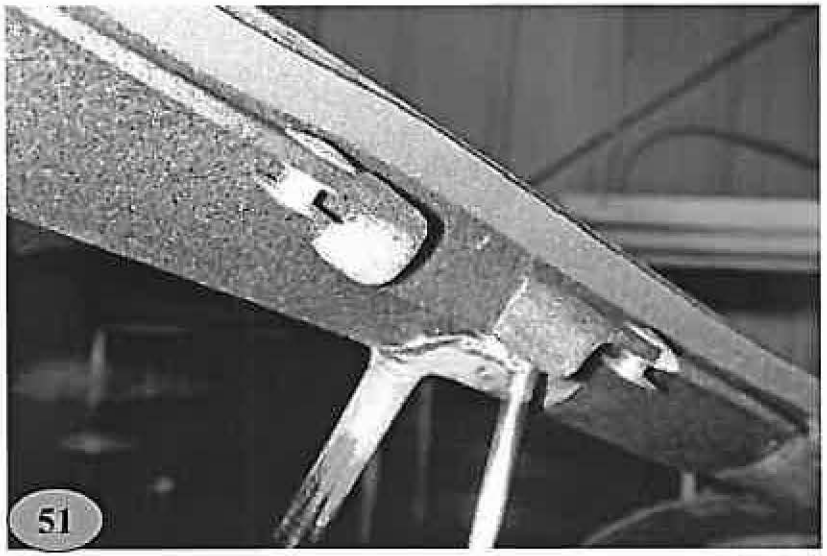


Locator pin and hole drilled in roll over flange. Note molded shape in roll over that locates over the top of the front seat bulkhead when the canopy is closed.

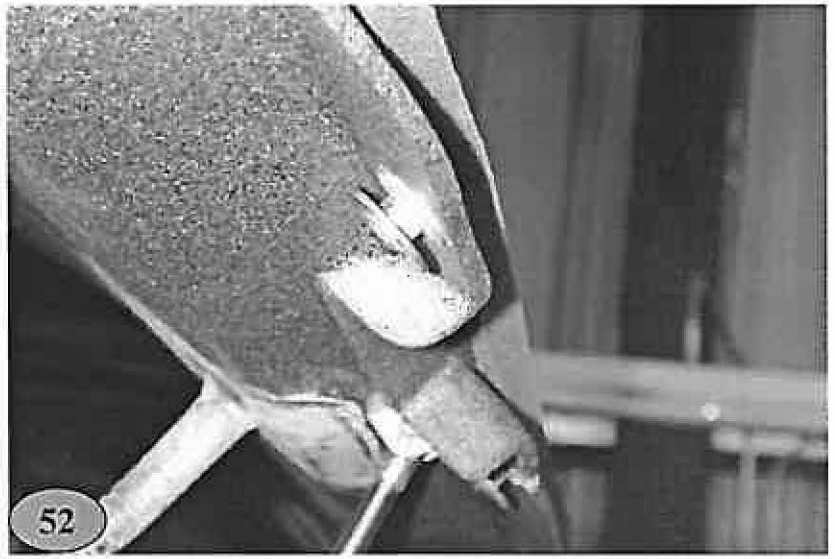


View of roll over installed, note cross tie installed, but not yet painted.

Roll over installed, shows cross tie brace, and optional gas spring canopy restraint.



My canopy lock down latch parts installed in the left flange.



The position of these latch parts is the same, but your parts are an improved design. See full scale drawings.

The completed roll over installed in the canopy of N26 MS.

While the canopy was off I just couldn't resist trying it!

It flies OK, but there is a very serious breeze in your face! I wouldn't do it again. I was very glad to get it back on the ground!

At last she is ready to fly! The roll over is not noticeable to the pilot and Sally was pleasantly surprised at how little it bothers her.