

**Window Replacement on Sojourn, a Forty Foot Island Trader Pilot House Motor Sailer**  
Gene & Kay Jurrens (#1093)

Our boat, manufactured by Marine Trading International, is now over twenty years old, and has teak-framed fixed and sliding windows on both sides of her pilothouse. The safety glass in these rather large windows started cracking and delaminating last year. This is a common problem with old safety glass that is subjected to the rigors of boat movement and exposure. I will describe the complete replacement of these windows with a total of four fixed panes and four sliding panes. My primary objective was to do so without perturbing the lovely interior teak frames and paneling. I have not yet replaced our three windshield windows as they are still in good shape. These photographs give you a peek at the finished product.



This article describes, in no-nonsense detail, the lessons learned during this rather aggressive do-it-yourself project, and the step-by-step process from start to finish. I am convinced that if you have never done this before, and are contemplating doing so, this article will be of value to you. When I do my windshield windows, I am now confident this will be very manageable with my new found experience.

When you tackle such a project, acknowledge that you're going to be creating big holes in the



bulkheads of your boat when you remove your windows. It is critical that you thoroughly plan ahead to minimize the time your boat is open to the weather.

I would also strongly suggest tackling only one window at a time for at least three reasons. First, you will use each window as a learning experience for the next, so starting with the least visible and simplest window is recommended. In my case, I started with the simplest shape (rectangle) on the side of the boat away from the dock in her home port. Second, if you run into repair problems on a window (like repairing likely de-lamination around the window's rough opening in an older boat, requiring over night adhesive curing and clamping time), the boat's interior could be open to the weather for more than a day. And third, if you didn't plan sufficiently for materials on hand (e.g., not enough caulk), you'll be able to order some more after sealing up the boat one window at a time.

You'll need to figure out what materials you'll need. Spend some quality think time on this. Please. Measure and make drawings, but recognize precise measurements will not be possible up front in all cases. For example, you won't know exact total dimensions for the window glass until you disassemble the frame, so rough dimensions are OK for ordering purposes until the disassembly of each window is achieved. Also, do not assume all windows have identical dimensions. They do NOT, although they are close.

My overall strategy was to take rough but generous measurements for materials ordering purposes, and then take more precise measurements during the destruction (disassembly) process. I ordered everything I envisioned needing for the entire set of windows being replaced in advance of starting the whole process, but subsequently treated each window as a discrete project, and made any in-process adjustments for materials as I went. This proved to be a very good plan, and the only thing I ran short of once I started were easily and locally obtainable materials like stainless screws and additional caulk. These were the two items for which I significantly under-estimated.

This warrants saying again. Please, get all your materials ordered and on hand before starting. This is critical. Lead time on some materials can take weeks, depending on your location. Use a

local glass shop to cut and polish your glass to size if possible and affordable, window by window. They will also store your raw window material for you until you need it. Make sure you have ordered and received locally your glass (or plastic), frame material, any caulks and adhesives you will need, fasteners (screws, etc), several feet of 9/16 inch brass tubing and stainless marine sliding window channel. Quantities of each will depend on the size of your windows, but I'll describe how much of each I used to the best of my memory and records for my project.

Also, obviously, you will need a number of tools and devices for the "destruction" as well as for the "construction". The rather non-trivial list of tools needed includes:

- claw hammer & small crow bar
- several dozen wooden builder's shims to coax the window frames away from the bulkheads after the initial adhesive bond is weakened (not a small feat)
- various scrapers to clean up old residual adhesive once the frames and glass are removed
- a stiff three inch putty knife
- bench grinder
- 10 inch (long!) 9/16" drill bit
- cross-cut file (flat and round)
- damaged-screw remover
- table saw, circular saw & saber saw with fine tooth blade
- any router with round-over bit with bearing guide
- tin snips
- hacksaw for cutting small brass tubing
- windshield remover tool (explained later)
- caulk removal tool
- an electric drill/screwdriver (cordless if possible) with various bits to match at least two different sizes of flathead screws (#6 and #10) to assemble and install the frames
- LOTS of caulk to bed the new glass and frames (I used 3 tubes per window)
- at least two pipe clamps

The list of materials I used (totaling approximately \$1700) included:

- King Starboard plastic window frame material (I used a 54x48 inch sheet, 1/2 inch thick) \$300
- Lexan 1/4 inch polycarbonate sheet (I had a local glass shop order dimensions I needed) \$500
- Boat Life polysulfide caulk (I used at least 15 tubes for four windows) \$225
- Stainless marine channel for window sliders (I used two 8 foot sections per window, and ordered one extra from my local auto glass shop) \$400
- Several dozen each of #10 1 1/4 inch & #6 3/4 inch stainless flat head screws \$100
- 3M 8209 adhesive to weld King Starboard (2 tubes - optional) \$100
- West System epoxy, mixing cups, several application syringes, stir sticks \$75
- Mineral spirits to ease removal of old residual bedding \$15

See figure 1 for an overview of the window's construction on my boat, and the method you'll probably be duplicating for your new windows to the extent your boat is similar to mine.

### Removing the Existing Teak Frames

OK, let's get to work.

First, you'll likely have to drill out the bungs covering screws that attach the frame to the bulkhead. Use a Forstner bit (that drills a flat-bottomed hole) to drill out the bungs. Mine were 3/8 inch, so I used a 3/8 inch bit. This will expose the screws, but may slightly damage the screw heads. If you're lucky, your screws will be stainless and not brass. If the former, and the slot isn't too badly damaged by your bit, you should be able to use your cordless drill with a screwdriver bit to remove. If they are damaged, use a damaged screw remover (mine are Craftsman, \$20 from Sears). If they are brass, you may not be so lucky. They are too soft to use the damaged screw remover. I had two windows that had brass screws (and two that had stainless!) for which I had to use my Dremel tool (with a flexible shaft and small diamond bit) to re-cut slots into the brass screw heads. Tedious, but it works. Be patient and get it right, and the screws will come out. Use lots of pressure on the screwdriver.

Next, after all bungs and screws have been removed, strip all possible caulk away from the first frame with a plastic caulk removal tool. Second, use a rather stiff good quality three-inch putty knife with a handle strong enough to pound on. The kind with a plastic handle with a metal end worked well for me. While not good for it, this will become a throw away tool after this project, if it doesn't fly overboard first! I slightly rounded the sharp corners of this putty knife on the bench grinder at home so as not to accidentally scratch the external bulkhead. A metal file would have worked too. Use this knife to gently pry and pound it in between the frame and bulkhead an inch or so deep all the way around the frame.

Once the initial bond between the exterior wall and the frame is opened a bit, start to drive several wooden builder's shims into the gap. Use one each at several inch intervals – yes, all concurrently. This is necessary to break the very tenacious continuous bond of what I began to refer to “Chinese black 5200” – after twenty-plus years, its still as sticky as the day it cured.

Pound the shims in being careful not to strike the bulkhead with the hammer. Put one shim behind the one you're pounding to get the business end of it away from the bulkhead to give you room to pound safely. The key is not to mark up the outside bulkhead in a highly visible area.

Now you probably have a dozen or more shims sticking out from behind your frame all the way around. So it looks silly. So what? When you pound one in, the one next to it will loosen up – tap it in further. Before you know it, the frame will start separating more from the bulkhead.

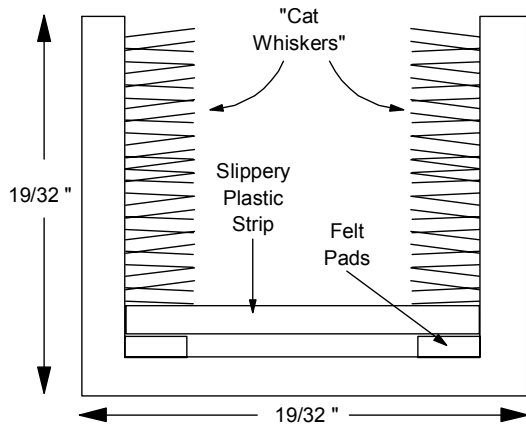
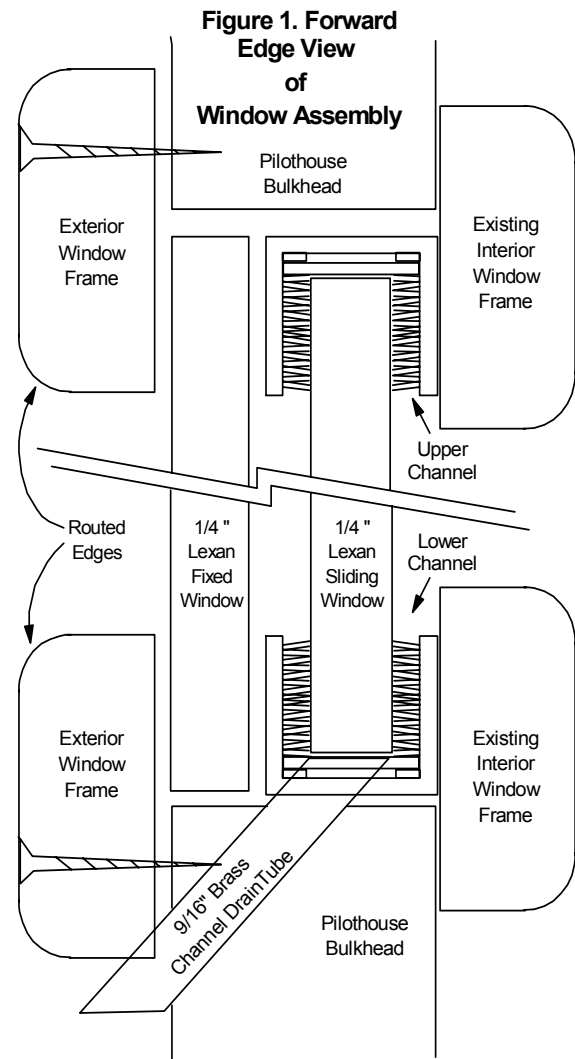


Figure 2. Stainless Marine Slider Channel



As it does, it's likely to put uneven stress on the window glass, which will begin to crack. Don't worry, although you might want to criss-cross some duct tape to the glass to keep it held together. It will anyway if its Safety glass like mine, which is actually two sheets of glass laminated on either side of a pliable thin sheet of transparent mylar film in the middle. This is what keeps it in one piece even if the outer laminations of glass crack. You want to keep it in one piece so you can have your glass shop precisely duplicate its dimensions in your replacement glass (or Plexiglas, or Lexan).

Here comes the hard part. Resign yourself that you will be destroying those beautiful varnished teak frames you've lovingly cared for over the years in order to get them off. Get over it. If yours are glued to the ship like mine, there's no

other way. Do it. I found this emotionally very draining. Shattering teak is very counter-intuitive to the conscientious boater. Once I got past this emotional hurdle, it was largely a downhill slide. Once the adhesive bond is broken on a portion of the window frame, haul away on it until it literally breaks loose, probably shattering the old teak as it does. You can do it!

After the frame begins to come off, you will see the rough opening now exposed around the window. At your earliest opportunity, measure the fixed pane of glass with more precision than your planning and ordering dimensions. That way, if your window shatters while prying it out, you'll have a back-up plan. The frame around the fixed panes will come off more easily than around the sliders. You should take notice how the manufacturer used thicker wood around the slider than the fixed pane. I will describe a way to easily duplicate this later. Don't worry about this for now.

### **Removing the Glass**

Let's assume you now have an entire frame removed, and the glass panes are exposed, peacefully lying there in all that "black Chinese 5200 adhesive". You should see the fixed pane simply butting up flush inside the rough opening. Actually, you'll learn that if your windows are like mine, it is actually bedded to the out-board edge of a stainless U-shaped channel that allows the sliding pane to slide (see figure 2). The sliding pane will be resting inside that channel that allows it to slide just in-board of the fixed .

Now is the time when a specialized tool that your local glass shop uses to remove windshields from cars will come in very handy. Do not be too proud to beg your glass shop to use this tool. It will save you HOURS of frustration and probably injuries. It looks like a very long handled utility knife—the kind with the triangular blade that we've all used. The other feature that makes this tool different and useful for this application is that where the knife blade is secured, the knife body itself is very slender, allowing it to fit in places where your standard utility knife would not fit. It also has a long handle. Wrap this tool where it will contact your bulkhead with duct tape. This will prevent this aluminum tool from marking your bulkhead. Use the knife to slice the adhesive (like cutting heavy rubber bands) to free the glass from its bedding.

You should now begin to see the glass starting to free up from its adhesive. Work your way around the fixed pane and get that out. It may require gentle pressure on the glass from inside the boat. Set it aside. All that remains is to remove the sliding pane. Do this by prying out the outer edge of the old top and bottom slider channel. I had good success using Channel Lock pliers.

You should place the sliding window in the center of the rough opening (i.e., "half open"), and pull it right out of the channel from the top edge. Set aside or take immediately (and carefully) to your local glass shop to duplicate with whatever window material you have chosen, have ordered and they now have on hand for you (you do have it on hand, right?).

I used ¼ inch Lexan with a custom ordered blue charcoal tint and mar-resistant finish on both sides. This is key because while Lexan is extremely strong, it is prone to scratch. I retrieved the finished window panes for this first window from my glass shop, and had them on hand for subsequent steps.

### **Removing the Old Slider Channels**

Next, you will have to remove the old channel from the rough opening. Again, this windshield removal tool helps a great deal to actually slice the bond of the black sticky stuff between the channel and the inside frame (be careful not to damage that) as well as the channel and the rough opening in the bulkhead. Once you have gone around these surfaces with this cutting tool once or twice, then use your large Channel Lock pliers to rip the old channel out. Be brutal. It will come out twisted and bent. Get it out of there, being careful not to cut yourself or scratch the boat in the process.

Now you should have your entire rough opening clear of all except excess bedding material in the rough opening and where the old frame was removed. There may or may not be some wood shims that would have been wedged horizontally between the channel and the rough opening. Sometimes the builder would do this if they had glass already cut, but the opening was a bit large.

You'll want to measure these and try to duplicate them OR get rid of them and have your glass cut slightly larger. I chose the former method on only one of four windows that had any shims at all. I just didn't remove them since there

appeared to be no de-lamination below these shims that needed repair (sounded solid when I knocked on the bulkhead, and there was no bounce when pounding (lightly) on the top of the horizontal shims.

Another test for repairs that might be needed is to squeeze between thumb and fingers the outer and inner walls of the bulkhead through the rough opening. If there is movement (you are able to compress the wall) you definitely want to fill the void. But first, clean out any excess bedding compound.

### **Repairing the De-Lamination Voids**

If after doing this, you can see, feel or hear any voids using the techniques above, mix up some epoxy (resin and hardener) in the appropriate proportions. I then used a West System syringe to inject liquid epoxy into the voids. A WORD OF CAUTION... if you have voids, that is, the core has rotted leaving “holes” inside your wall, you want to fill them, but be careful that this liquid adhesive doesn’t unintentionally leak through into your interior, or spaces below these bulkheads.

Check frequently during the injection process. I had some bleed through to my interior wall’s wainscoting through the seams. I anticipated this and used blue masking tape beneath and up around the lower corners of the entire interior window frame. I also pressed this tape into the seams of the wainscoting for about a foot below the entire frame.

Since the head is below and forward of our pilothouse, we also had some glue run down into our shower stall, so be prepared to have this stuff find its way down and in. Check every few minutes. It might take awhile (as it did in our shower).

### **New Slider Channels – Try For Fit**

Your rough opening should now be mostly clear of excess bedding material (at least any “chunks”). The interior edge of the opening will be defined by the (hopefully untouched) existing interior frame. Clean any excess bedding material from these surfaces as well. A claw-type scraper with the blade at right angles to the surface worked well. You are now ready to install your new channel. You will be completely lining this opening with channel. This stuff

comes in 8 foot lengths, so cut to length with a good set of tin snips. Miter the corners so the pieces friction-fit into the opening snugly. Place them in the opening for a dry fit. They should be pretty snug up against the interior frame.

### **New Glass – Try For Fit**

Now is the time to see how your new window panes fit in the opening. The first to go in is the sliding pane. Leave the protective paper on both sides of the window. Insert the bottom of the pane into the bottom slider in the center of the opening. Pull the upper channel (still un-bedded at this point) out just enough to fit the top of the sliding pane into the upper channel, and shove the whole works back into the opening. You should be able to slide the window in the channel now, although it will be a bit stiff due to the thickness of the protective paper on both sides. That’s OK. If it won’t slide at all, it’s time to go back to the glass shop or get the file out.

Once you’re satisfied that the sliding window slides, its time to try your fixed pane for a good fit. Again, without using any bedding material yet, and leaving the protective paper on both sides, put the fixed pane in place. If it fits OK, tape it into place with some blue masking tape. If not, trim for a good fit. Now it’s time to start working on your first frame.

### **Creating a New Rectangular Window Frame**

I used a UV-stabilized high density polyethylene building material that sells under the brand name of King Starboard for my new frames. I ordered, and had on hand, a ½ inch thick 48 x 54 inch sheet from West Marine. I made good use of my table saw (on the docks) to cut my 2 ¼ inch wide “lumber” to approximate my old frame dimensions. Your frame width dimension may vary. The key is to adequately cover the perimeter the old frame covered, and to give you a good bedding surface for the fixed pane, and to ensure you can align with the inner edge of the slider’s channel (see **Tip** box below).

**Tip:** When measuring, placing and fastening all subsequent pieces, here’s a tip I didn’t learn until half finished with my first window. You’ll want to not only cover up the surface that the old frame covered (the “ugly stuff”), you’ll also want to align the edge closest to the center of the frame with the edge of the channel. Refer back to Figure 1 for an example. Look at the top edge of

the lower frame. Note how its top edge is at the same level as the top edge of the channel. This is important--get this right.

This material is neat stuff that cuts and routes like wood. You can't paint it, so choose a color you'll want to live with forever (I used white, but it also comes in an off white called sea foam and grey). If you want to glue it, you will need a very specialized adhesive to do so, but gluing is optional. I'll describe this process later if you choose to go this route. This board comes with a protective film to prevent damage to its surfaces. Leave this film in place until just before you're going to start cutting it. Then take the film off. If you don't, it just gums up your saw, and can cause feed problems through the saw. If the boards get marked up a bit, you can usually sand off any smudges or incidental scratches when finishing.

Once I had a number of 54 inch strips cut, I measured lengths that I would need by basically duplicating the pattern of the old frame (obvious by presence of residual bedding, discoloration, etc). Cut the strips to length without worrying about rounded corners at this point. See Figure 3 for my frames' butt joint pattern.

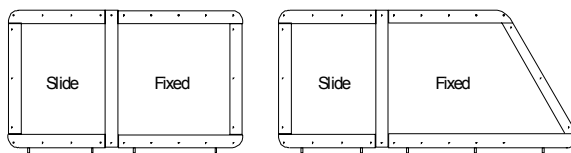


Figure 3. New Window Frame Layout

By using this sort of pattern, you will not need a frame piece longer than the 54 inch dimension of the King Starboard sheet. You can buy a larger sheet of this material, but it will cost you significantly more. Additionally, far more elegant joints are possible, and feel free to adopt your thoughts to this design, but I chose this method. Though less elegant, this design, along with solidly bedded joints, have proven to keep the windows bone dry inside and greatly simplify an already difficult project.

Also, I plan to construct mesh window covers over these windows at all times (i.e., Phifertex mesh fabric from Sailrite.com). Not only do they hide frames arguably less cosmetically appealing than the teak frames, they act as bug screens and filter out 75 percent of UV radiation.

So now you should have your mitered channel lining the rough opening. Inside the channel you should have your sliding window, still covered with protective paper. Outboard of the slider and channel, you should have your fixed window taped in place.

Now you are cutting your dimensioned "lumber", one strip at a time, to length. I suggest cutting one strip to length for the vertical middle piece first. Match the top and bottom markings of the old frame to cover up the "ugly stuff", and position it with the trailing edge of the fixed window. Now slide it horizontally back (assuming your fixed pane is forward) one inch or so. The key here is that whatever you do, duplicate it on all other windows. Don't worry about the space between this frame piece and the sliding window at this point. We're going to take care of that. Make sure the piece is vertical (parallel to the fixed pane).

Fasten this piece to the bulkhead, top and bottom, with two 1 ¼ #10 stainless flat head screws, which you must countersink flush to the surface of the frame. On my boat, I placed these screws approximately 7/8 inch from the ends to get a solid bite into the pilothouse wall. Whatever dimension you use, remember to be consistent for appearances sake. All subsequent pieces will be attached using this same type of screw. You're first piece is now in place. We'll shape it and make it look pretty later. This is just the initial custom fitting exercise.

Now you're ready for your next piece, using this center vertical piece as your "anchor". I suggest doing the bottom aft strips (below the fixed pane) so you can set subsequent vertical pieces on them. Again, don't worry yet about rounded corners and edges. That comes later. The key now is that your horizontal bottom pieces line up with the bottom of your vertical center piece and with the top of the channel you have temporarily installed in the opening.

Be sure your channel is pressed down close to its final position as you align the frame piece with it. You might even go 1/16 inch higher than the channel with your frame piece to allow for bedding below the channel. Be sure this and subsequent frame pieces are long enough to eventually round the corner, but not yet. You should plan, however, for about a two inch radius (I used an 11.5 ounce coffee can for my pattern). This radius can really be anything you

want it to be, but you must keep this in mind as you proceed on this and the rest of the windows you're going to replace.

Now you're ready to cut the aft vertical (aft of the sliding pane). You'll do this one first as the frame pieces around the sliding pane are a little trickier than the fixed pane (aligning with the channel edge) so get these done first. As you place your verticals, you'll want to ensure they appear vertical on the boat, match to the old frame's outer perimeter, and are reasonably parallel to the center vertical you've already attached. As you measure the length of these verticals, also keep in mind that you'll probably need to adjust their length slightly when you do your top horizontal pieces, which will need to be square with the verticals and match up to the upper end of the middle vertical. Making slight adjustments to make this happen are likely and OK, as long as you don't cut your verticals too short.

And again, make sure you're aligning all perimeter frame pieces around the sliding window with the edge of the slider channel. Screw in place with (only) two screws each. We'll use additional screws later. Do this because you'll want to plan our final screw pattern once you see the entire frame assembled and on the boat.

At this point you should have your aft (slider) pane encompassed with four frame pieces. If your boat is at the dock, try to view it from a distance of twenty paces or so (use your dinghy or your neighbor's boat otherwise). It is important to get a good overall perspective before you go any farther. Does it look OK? If not, fix it now. Do the angles appear as they should, or did you get one or more frame pieces "crooked". It's not too late to adjust, but it will be too late very soon. If you're satisfied, let's move on. And don't worry about the space between the sliding window and your new frame. That comes later.

It's time to frame your fixed pane. Use the same method as before, only now you don't have to worry about aligning with the channel because the fixed pane hides that. Here it's important to ensure you cover up the "ugly stuff" around the perimeter and to ensure you've got a solid bedding surface around the edge of the window between window and frame. I had almost an inch to work with, which I believe is adequate. Again, use only two screws to fasten each piece. Do not

drill additional holes in the frame pieces yet for additional screws. This will come later.

You should now have the 7 major frame pieces in place for your first window. We have some additional pieces to cut, but its time to take another big picture view from 20 paces away (or a short dinghy ride away). Does it look OK? Are there any adjustments that you'd make before proceeding? If so, do it now. If not, we're ready to move on to shaping the edges of these major frame pieces for this first window.

Since shaping 7 individual frame pieces to look like one frame, shaping is best done with the frame assembled. Before removing the frame pieces from the pilothouse bulkhead, I placed a piece of blue masking tape across each joint between pieces, made a calibrating mark, and numbered the joint so that I could quite precisely re-create the assembly off the boat.

Since I used a router with a round-over bit with a bearing guide, I needed clearance behind the frame. I solved this problem by building a frame of 2x4s stood on edge that matched the dimensions of the window frame. I laid this frame on a smooth and level horizontal surface, both while I built it, and when I placed the window frame pieces on it. The concept is that these 2 ¼ inch wide frame pieces will be screwed down to a 1 ½ inch wide surface (the edge of each 2x4). I could then run my router around the complete assembly without interference from behind (now below) the frame. But first, I used my coffee can to mark the rounded corners and cut them with a saber saw.

This next step is extremely important before routing the edges. You must take a rather aggressive cross-cut file and ensure a very round set of corners. If there are any saber saw "jitters" in the edge, your router bit's bearing guide will faithfully reproduce those undesirable jitters. Additionally, as you screw your frame pieces to this 2x4 frame, make sure the joints are at the same elevation. If, for example, one horizontal piece mates to a vertical piece, but because of the way you constructed your 2x4 frame, one is a little higher than the other, your router will also create an undesirable "jump" from one to the other. Use scraps of wood to shim the lower one up a bit so there is a smooth transition for the router to transit.

If you have any obstructions to the router's path, deal with them now. This will likely happen either at the corners, or for more complex window shapes. For example, I didn't plan my rather hasty construction of this frame to account for rounded corners (I built the 2x4 frame before rounding the window frame corners). So I took the window frame pieces off and used my circular saw to cut clearance at the corners of the 2x4 frame for the router bit's bearing. This frame will be used and modified for the subsequent windows, so take a little time to get it right. It will pay off in the finished appearance of your window frames.

Once you are satisfied that there will be a continuous smooth path for the router to follow, take one more look. You've got too much time invested in this frame to screw it up now. Please, also be sure to perform a trial cut on a scrap piece of frame material with the router to get the right radius for both outside edges and inside edges of the window frame to suit you. Remember, it's better to start with too small a radius than too large as you can simply retrace the frame with a deeper cut next time. Take the numbered tape pieces off now that your frame is assembled on the 2x4 frame. If you're satisfied, then let her rip. Move in the direction counter to the router's revolution. Go around the inside and outside of the frame as many times as necessary to get the desired look. This takes a little skill, but less than I feared. Go for it! Does it look OK? Then proceed. If not, set the router bit a little deeper and do it again. It will never be perfect.

The more experienced woodworker you are, the more likely you're going to be closer to perfect. Stop when it looks good. Knowing when to stop is key. Don't keep going until you screw it up! Now re-number your frame pieces with blue masking tape.

We now need to deal with the gap between the frame around the sliding pane and the channel. Re-assemble your frame on the boat's bulkhead (yes, do it again—trust me). Use your taped numbers to be sure you get it right. This next part of the process is a little tricky, but with care, and adjustments as you go, you will create a nice finished appearance in the frame around the sliding window. And this is where you can definitely benefit from my trials and errors. This alone should save you 20 hours of frustrating effort.

Measure the gap between channel and frame. In my case it was 3/8 inch. I had 1/2 inch material to work with to make these "shims", so I used my table saw to rip a 2 1/4 inch strip (one that was 54 inches in length was sufficient per window for my installation). I did this by setting my table saw fence 3/8 inch from the blade, and then stood my strip on edge to rip it. To do this, my blade had to be capable of ripping something 2 1/4 inches high. This is best done with two people – one feeding with a push stick, and one gently guiding from the back side of the saw blade.

Two challenges presented themselves in accomplishing this. First, this 1/2 inch material is not completely rigid, so it's key to keep it pressed firmly against the saw's fence on both sides of the blade. Second, since the strip is 54 inches long, it's awkward to get a smooth rip along its entire length. This was a bit tricky, but the cut does not have to be perfect, since it will be largely hidden between two caulked or glued surfaces. Be careful! If you have any misgivings about performing this cut, get a professional or a skilled woodworking friend to do it for you.

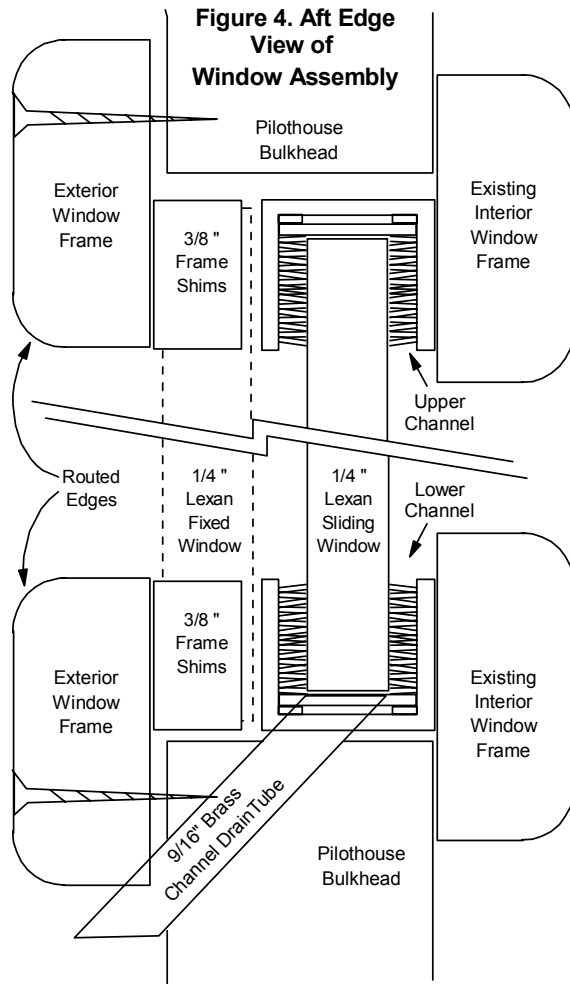
Once this cut is complete, you now have your raw material for your sliding window "frame shims". These must now be dimensioned to fit snugly between the frame and the channel so they are flush with the interior edge of the frame pieces surrounding the sliding window. I suggest again starting at the bottom.

The bottom horizontal piece should fill the gap between the channel and the inboard edge of the bottom exterior frame piece. It should also extend fore and aft snugly with the aft edge butting up against the rough opening behind the aft vertical frame piece, and the forward edge butting up against the fixed window pane behind the center vertical frame piece. I learned through trial and error that the next best piece to create is the top horizontal shim. Like the bottom shim, it should extend fore and aft behind the vertical frame members. Just snug fit these two pieces into the frame (no glue or screws yet).

Now your dimensions for the vertical shims should be self evident. Cut and place into position. You should now have a pretty finished look to your entire frame except for rounding the corners, routing the edges, and additional countersunk holes for more screws. You guessed it--that all comes later. Your temporary exterior



frame & frame shim assembly should appear as in Figure 4.



Using your taped numbering process, fasten your new frame shims to the frame pieces. The next step is to precisely disassemble the frame around the sliding pane. Before you do so, use a continuous piece of blue masking tape to tape each frame shim to its respective frame piece. The trick is to retain the calibrated relationship between them as you take them off the pilothouse wall for gluing and/or screwing them together. I found it helpful that once I had all pieces taped, I loosened all the screws holding all four frame pieces to the bulkhead, and then carefully removed the verticals first, then the top horizontal, and finally the bottom horizontal.

Once I got them off and carefully laid them aside, I picked them up one piece at a time and marked across the surface of both the shim and the frame so I could line them up appropriately after removing the tape. I used #6  $\frac{3}{4}$  inch

stainless flat head screws countersunk every six inches to secure each shim to each frame piece. It is essential to get these flush or slightly below flush for the best appearance.

Also, in my installation, the backside of the center vertical shim is visible from inside the boat, so I took a little extra care on the spacing of the screws, the consistency between windows, and the general dressy appearance of this shim.

Now you have a decision to make. Just prior to the final assembly of your first frame, you can either glue each frame shim to each frame piece, in addition to the screws now holding them together, or you can simply disassemble, caulk and reassemble the mated surfaces. Gluing actually welds the two pieces together permanently, whereas caulking them waterproofs the joint but does not permanently weld them. Gluing is more expensive but also more permanent. Your call. I glued two windows, tired of the time this took (overnight drying), and caulked the final two windows. Time will tell whether the additional time and expense of gluing was worth it or not.

If you glue, you must use a specialized adhesive for King Starboard produced by 3M called 8209. If you go this route, you should definitely plan on using their specialized applicator and purchase at least two tubes (for 4 windows in my case). Total was \$90 for glue and gun. Not cheap, and it must be kept refrigerated.

After allowing the glue to cure overnight (do NOT try to wipe excess wet glue squeezed out of joint!) you are actually dealing with fused plastic, and will need to peel, file and sand the joint smooth. This is literally now one piece of plastic forever.

If you choose to just caulk the joint, I did this just prior to assembling the window back onto the bulkhead. Care is required not to get caulk everywhere, but doable. This saved one day per window on my last two windows. The nice thing about King Starboard is that excess caulk squeezed out of bedded joints peels off very easily, so caulk away and just leave the excess all over the place until you're doing your finish work clean up.

Now that your frame shims are glued and sanded, or caulked and you have caulk oozing all over the place, it is time to assemble the window

temporarily one more time (believe me, its worth it). If you caulked your shims, just be careful at this point to not get it all over your bulkhead. The purpose of this assembly is one final try for fit and to tape the perimeter for final caulking to be done later. How does it look? OK? Then proceed. Using blue masking tape, tape around the final perimeter of your window. I left about ¼ inch of the bulkhead visible around the frame. The blue perimeter also enhances your final outline of the window. Step back (or row back) twenty paces. Still look OK? Good.

Let's take the whole thing apart, for the last time, including the frame pieces, the fixed window pane, and the sliding window. Leave the channel in place for now. Set the frame and window pieces aside but close by in their appropriate orientation, preferably still with their taped numbers on them.

It's time to start the final assembly and bedding process. You should be looking at your rough opening still lined by the four friction fit pieces of channel. Lay the bottom piece with the "U" up on the deck just below the rough opening. Lay the top piece with the "U" down so as to be able to distinguish the two during the sticky caulking process. Lean the aft and forward vertical pieces vertically against the bulkhead aft and forward of the rough opening respectively. Have at least three tubes of caulk, one in the gun, ready to go per window. Lay a heavy bead of caulk around the entire perimeter of the rough opening, so that two sides of the "U" channel, one horizontal and one vertical, will be solidly bedded. You'll get some caulk oozing out of there, but don't worry. It's better to have ooze to clean up later than a possible incursion point for moisture.

Now re-insert first the bottom channel piece, then the verticals, then the top. For this last piece, you may have to pull the top of the verticals out slightly to re-mate the mitered friction fit joints to the top piece. That works well.

Next you will begin to install the window panes. Take the adhesive protective paper off both sides of the sliding pane, carefully insert the bottom edge into the center of the bottom channel, and carefully pull the top channel back out just enough to get the top edge of the window into the top channel piece. Push the whole assembly firmly back into place.

It's time to run a rather heavy bead of caulk around the entire perimeter of the outboard edge of the channel. Again, err on the side of being too generous. The only thing to really watch for is that you don't get caulk into the channel. If you get some ooze, do not move the sliding window pane until the caulk sets up or you'll smear it into a huge mess.

Once you've got a bead around the perimeter of the outboard edge of the channel, its time to press the fixed pane into place. Remove the protective paper and press into place. The caulk should hold this pane in place.

Now it's time to caulk in preparation for assembling the frame onto the bulkhead for the final time. Generously apply caulk to the perimeter of the rough opening (where the back of the frame will contact the wall). Dab all old and new screw holes in the bulkhead with caulk. Run an extra bead around the edge of the fixed pane as well for good measure. Be a bit cautious you don't get too carried away as you don't want a lot of caulk oozing onto the finished surface of the window.

Next, you'll be preparing one piece of the frame at a time. I started with the pieces surrounding the fixed pane first. Get the two screws for each piece started and slightly protruding from the back of each piece. Use these to calibrate the exact location of each piece to the two holes you had previously drilled for each piece in the bulkhead.

Start with the center vertical frame piece. With the screws started as described above, run a bead of caulk along each butt joint where this piece will contact the four horizontal pieces.

Also run a bead where this piece will come in contact with the fixed pane. On my boat, this was the forward half of the rear edge. Now carefully hold the piece in place, exercising caution not to smear caulk on a visible window surface. Get the screws started and slightly snug them down, but not too much. You want the caulk to set up a bit before you really snug them down. This will also make it easier to get your overlapping frame shims attached to the slider frame pieces inserted behind the center vertical piece.

Next comes the bottom horizontal piece forward of the center vertical. Get the screws started and

slightly protruding from the rear surface. Run a bead of caulk along the entire rear surface of this piece. Again, your only caution is to not get too much oozing out onto the window's surface. Slightly snug these two screws down, and move onto the forward vertical. Use the same routine. Lastly, place the top forward horizontal piece into place. You should now have your fixed pane encompassed with frame pieces. Next you'll move on to constructing frame shims surrounding the sliding window pane.

Start with the bottom piece, using the same methods as above. Use caution to not get much caulk on the ends of the frame shim as this will squeeze into the channel and sliding window.

Use the same methods for remaining frame pieces.

Finally, measure, drill, countersink and install the remaining screws. You should have a screw every 6 to 8 inches around the entire frame (except the center vertical piece, of course). I put a dab of caulk into each screw hole just prior to installing each screw. Leave any caulk ooze until it sets up. It will clean up easily when dry.

### **Brass Drain Tubes**

As you can imagine, if rain were to beat on the sliding window, or if you were to take sea spray over the gunwales, water would find its way into the sliding window's channel. Unless we provide a path of lesser resistance, some of this water could easily find its way into the interior of the boat.

To prevent this, we will provide drains to the exterior of the boat. These will take the form of drain tubes. To create these without enabling a path for moisture into the core of your bulkheads, drill a 9/16 inch hole from the bottom of the sliding window's channel to the exterior bulkhead just below the edge of the bottom window frame piece. In this hole, you will insert a four inch section of 9/16 inch brass tubing available at most hobby stores or a good hardware store. See the photograph. Also see Figure 4.



As you insert this tube into your hole, you'll want to first coat the surface with a generous amount of bathroom silicon caulk. To prevent the silicon from getting into the tube, first insert a 1/4 inch wooden dowel into the tube, and then push dowel, inside the tube, through the hole as a single assembly from the outside until firmly seated against the bottom of your channel inside. Test this by carefully sliding the window over the top of the hole. Then withdraw the dowel, go inside the boat, and push the dowel from inside out to ensure no residual caulk remains inside your drain tube.

Since silicon does not withstand UV rays well, after it dries thoroughly, you'll want to ensure it and the surrounding hole around the outside of your drain tube are liberally coated with good old polysulfide caulk (i.e., Boat Life or similar). I installed two drain tubes on my rectangular windows, approximately 6 inches from the inside edge of each lower corner, and three on my larger forward windows (see Figure 3). Space these drains to suit your taste.

Keep your 1/4 inch wooden dowel to periodically check to ensure your drains are clear over the coming months and years. I check mine once or twice a month.

All that remains is cleaning any dried caulk from around the window and between joints. This will be relatively easy if you used the same materials I did. Once the dried "oozes" have been removed, run a final bead of caulk around the perimeter of the frame and the fixed window pane. Dab a bit of caulk around each drain tube. And you're done.

Congratulations! You have just finished one window! The next one will go easier.

## Subsequent Windows

Follow the same methodology as the first window. Don't forget that if you did as I did, you'll do the similarly shaped window on the opposite side next, and it will be a mirror image of the first. Get this into your head up front, and things will go easier. It also allows you to use your 2x4 routing frame as-is before you need to modify it for different-shaped windows, assuming yours are like mine.

The next two windows, if similar to mine, will have a bit more complex shape (refer again back to Figure 3). The bad news is there is a difference. The good news is that the difference is in the fixed pane. All the necessary frame shims will be much the same. The only other complexity is that you'll need to adapt your 2x4 routing frame to the pointed forward end of the forward windows. Just remember, no two windows are exactly the same, so plan each step as if they were different, and this will minimize or eliminate redo.

You're going to do a terrific job. The hardest part is getting started and resigning yourself to the fact that the tenacious adhesives used in these boats' manufacture will drive you to destroy your original teak frames in getting them off. Think "lower maintenance". It helps—until the wife says she liked the looks of the old frames better! Life goes on.



## Summary

My total investment in materials was approximately \$1700. My time investment was approximately 40 hours for each of the first two

windows, and about 25 hours each for the last two, over the course of two months of weekends and weather windows. For these four windows, at a rather stingy shop rate of \$50 per hour for "custom work", I figure I saved myself at least \$6,500 in labor and maybe another \$600 in tax (7% in Minnesota).

Additionally, I'm absolutely convinced that I achieved a higher quality and more comprehensive result than a window specialist would have done, although probably not as precise, but certainly more solid. And the feeling of accomplishment (not to mention the seven grand I can spend on other refit items) was worth the time and effort alone! If you are contemplating tackling such a project, be prepared to spend the think time, and be ready for frustration, boat down time and a terrific feeling of accomplishment!

Good luck!

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