

# WINDOW WISDOM, PART III

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If you read the previous two articles on this subject in the October and November issues, you know how to properly remove and disassemble your old windows and clean up the airframe, window-retaining frame and related components in preparation for the new window installation. The next step is trimming and fitting.

Before we become immersed in that, however, I would like to clarify that, with respect to trimming and fitting, there are three different types of Beech window installations: (1) framed, original-thickness windows, (2) framed, enhanced-thickness windows with milled edges and (3) nonframed windows.

## 1. FRAMED WINDOWS

Standard-thickness windows are the easiest of the framed windows to fit because one only needs to get the outer edge of the window and frame assembly to fit into the structural frame. To check the fit of these windows, temporarily pop-rievet the window into the retainer frame and check it against the paper pattern you previously made of the window and frame assembly. If no major dimensional anomalies are seen, temporarily install the window and frame assembly into the structural frame.

Use enough of the structural screws to secure the window snugly in the structural frame. If a portion of the perimeter of the frame is too tight, the edge of the Plexiglas must be trimmed by removing the new window from the temporarily installed metal retaining frame and trim it using a method I'll describe later. This step may need to be repeated until the fit is perfect.

## 2. MILLED-EDGE FRAMED WINDOWS

Fitting 3/8" or 1/2" milled-edge framed windows presents a different trimming challenge. Since the retaining frames were designed to accommodate the original 3/16"

or 1/4" windows, the edges of these thicker windows have been milled down to the 1/4" thickness to fit into the original retaining frames. Simple enough so far!

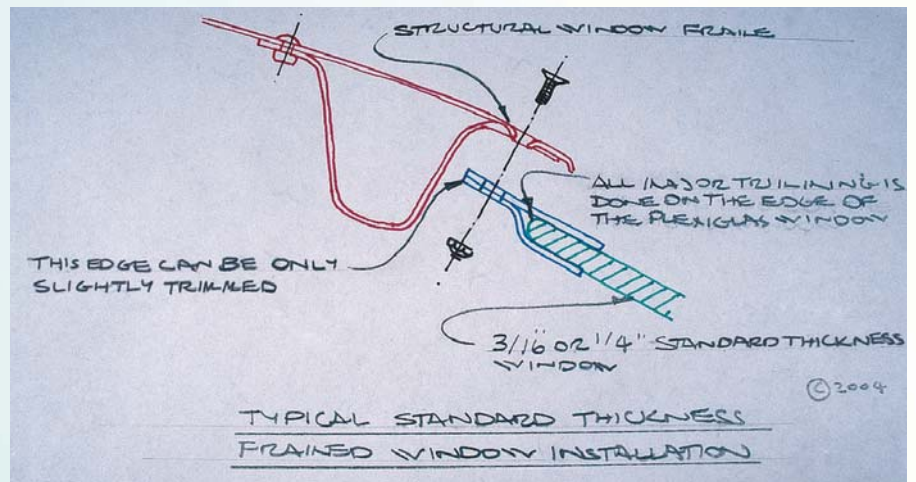
But now the fit of the inner edge of the metal frame and shape of the milled window edge must be taken into account. If you find it necessary to trim the outer edge of the Plexiglas window, you must also remove material either from the inner edge of the retaining frame or the standing ridge created by the milled edge of the window.

It is critical that you do not over-trim the supporting surface of the inner portion of the retaining frame, because this component

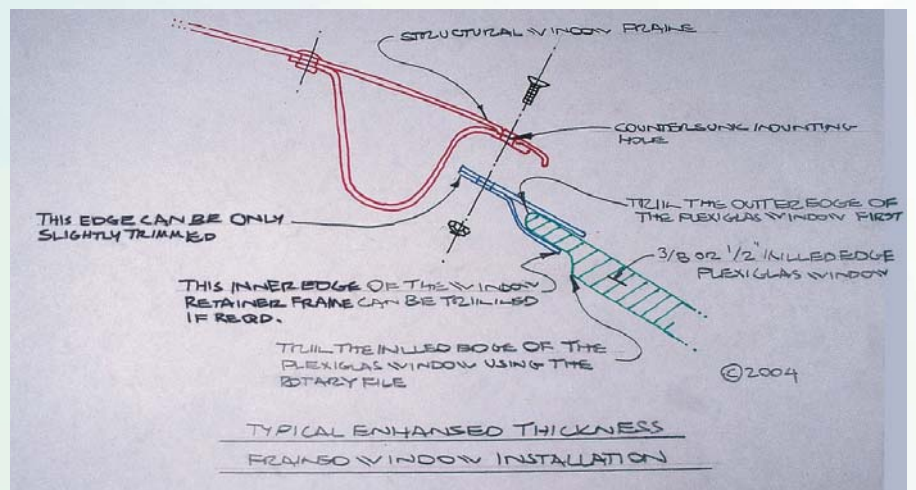
holds the window in its structural frame.

Once you see that the window/frame assembly is fitting pretty well, minor dimensional anomalies can be dealt with by removing material from the outer edge of the metal retainer frame. Keep this to a minimum, as removing too much material from this part of the frame can affect mounting hole alignment.

If it is necessary to trim the standing edge of a 3/8" or 1/2" milled-edge window, this is the best way we've found to do this in the field. Buy a 3/4" rotary file and round off the end faces of the cutting flutes on a belt sander. Using a drill motor, you can neatly trim



Sketch of a framed, standard-thickness window installation, showing places to trim.



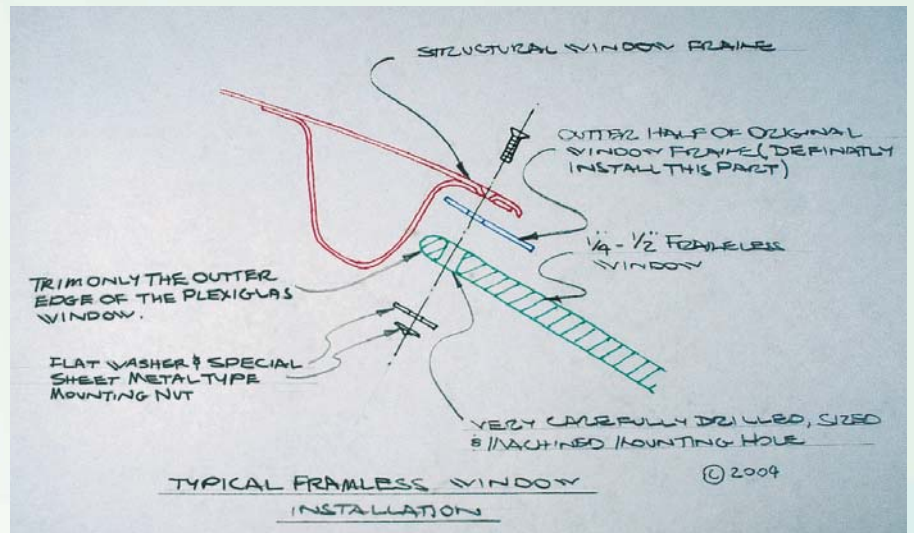
Sketch of a 3/8 or 1/2 inch milled-edge window installation, showing places to trim.

the milled edge, and the rounded cutting flutes will give a nice radiused inside corner. Practice makes perfect, so try it on the old glass first.

*TIP: Here's a great time-saver when doing all of this removal and reinstallation (applies to both framed and frameless situations). Instead of using nylock self-locking nuts, buy a bag of 6-32 plain non-structural, non-locking nuts. They spin on and off quickly and easily. Works great, and you don't even need a wrench!*

### 3. FRAMELESS WINDOWS

Frameless windows mount directly to the structural frame of the airplane. They are installed with 6-32 machine mounting screws and special sheet metal nuts installed in 1/4" holes drilled near the edge of the window. The advantage here is the absence of a retainer frame with its associated removal, fitting and clean-up. Whatever you do, still remove the flat



Sketch of frameless window installation, showing what part of the window is to be trimmed.

outer retainer frame piece and install it between the new window and the structural frame to give the window a factory-finish appearance.

For years, many installers have been saving some installation time by leaving this outer trim piece off the airplane, exposing the back side of the inner window trim plastic or metal frame. When viewed from outside the airplane, this condition is unsightly, especially when 1/2" windows are installed.

To fit the frameless window, temporarily install it into the structural frame, check for and mark any anomalies, remove and trim as indicated. As with a framed window, this step may need to be repeated. Once the frameless window is fitting perfectly in the structural frame, it's time to drill the mounting holes in the win-



Inner portion of an enhanced-thickness window retainer frame being trimmed on a bandsaw.



Using a belt sander to round off the cutting flutes of a rotary file.



Rotary file being used to mill the standing edge of a milled-edge enhanced-thickness window.



Frameless window installed without the outer trim strip, exposing the backside of the inner window frames and related hardware—very ugly!

dow. The sequence in which these holes are drilled and temporarily secured is very important in guaranteeing that the window will thoroughly seat in the structural frame, facilitating proper alignment of the new holes.

Using an original structural frame-mounting hole as a location guide, start at the center of the top of the window and carefully drill a 5/32" hole through the new window using a special Plexiglas drill bit. Be careful to guide the drill bit perpendicular to the surface of the window, ensuring a straight hole. It is also important to feed the drill bit with very light pressure, and be especially careful that the drill bit exits cleanly through the inner surface of the window. (You can practice this technique on the old window.)

Once you have your hole, install a 6-32 machine screw and a plain nut. Next, drill and secure a hole in the same way at the center of



Special tip of Plexiglas drill bit.

the bottom. Finally, drill and secure a hole halfway up each side. This seats the window at the center points of all four sides of the structural frame.

Now, starting at one of these center holes, drill three or four holes, working toward a corner, and secure every other hole with a screw and a plain nut. After you've done a few on one side, go to the opposite side and repeat the process toward the opposite corner. Continue working this way until all four sides are drilled and temporarily secured.

The idea behind this hole-drilling sequence is to move any stress, caused by screws drawing the window into the frame, toward the corners where the geometry of the window and structural frame will help relieve that stress. Be careful not to over-tighten the screws, as that can possibly start a crack. Never attempt to draw a reluctant frameless windshield into the frame using screws. If the window resists being seated in the frame with light torque on the screw, the window is likely mistrimmed. Mark the area, remove the window and retrim.

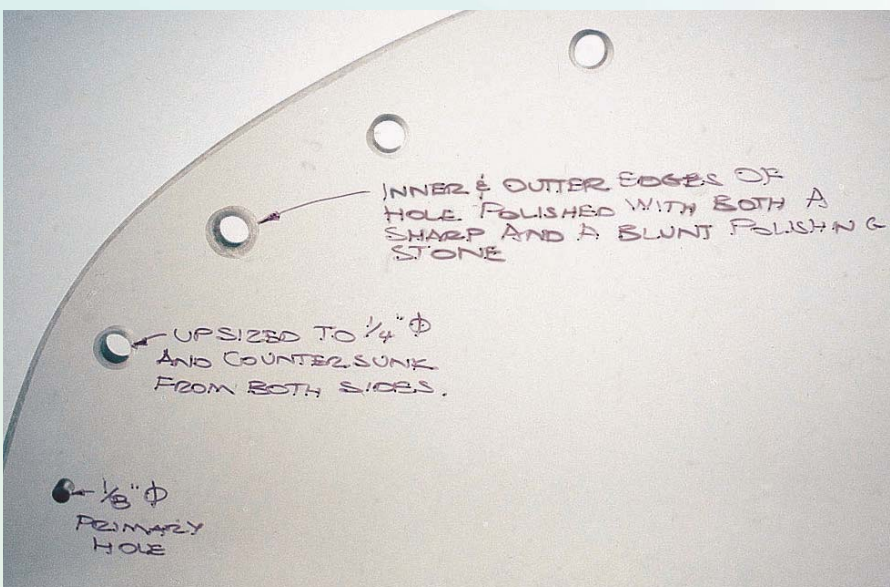
With all of the 5/32" mounting holes drilled, remove the temporary mounting screws and nuts, and then remove the window. Now it's time to upsize the pilot holes to 1/4" diameter using a special Plexiglas drill bit. Why the big hole? Remember from last month the business about how much

Plexiglas expands and contracts with temperature fluctuation. Enlarging the pilot holes to twice the size of the 1/8" mounting screws establishes enough clearance to ensure that there is no screw-to-Plexiglas contact, ultimately resulting in less stress on the window. The hole is filled with the rubber-like PRC sealer that provides a flexible cushion and also keeps out freezing water. That said, we are not finished with the holes yet.

It is very important to stress-relieve every edge and hole of the Plexiglas. Sharp corners and imperceptibly small nicks or grooves at the edge of acrylic plastic can create what engineers call a "stress riser." In layman's language, this means a weakness caused by an irregularity in the material that creates a point that is prone to being the beginning of a crack.

Here's how you properly stress-relieve a hole. First, using a 45° countersink tool, slightly countersink the edge of the hole. Now you have created two less-acute edges instead of one very sharp one. Most installers and installation instructions consider this countersinking method to be good enough. I like to go a step further. Call it an umbrella policy.

*A LITTLE TRICK: Here's a little trick that does a great job of polishing off the aforementioned double edges created by the countersink method. Buy two small tapered polishing stones, one with a sharp point and one with a fairly blunt point. With the stone mounted in a variable-speed drill, and using cold water as a flush, use the sharp-pointed stone to round off and polish the inner edge of the countersunk hole. Then repeat the process with the blunt-pointed stone to do the same for the outer edge of the hole. Works great!*



Sample shows the multiple steps in drilling and finishing the frameless window mounting holes.



Finishing stones in use to polish the countersunk holes.

Stress-relieving the holes is only part of the whole (hole) story. It is vital that a hole not be located too close to or, worse, partially into the edge of the Plexiglas window. The picture shows an absolutely disastrous installation where a majority of the holes are compromised. Buyer beware! This condition will result in a weakened mounting point, which can cause a stress riser because the mounting holes adjacent to the weakened holes must carry additional load. In reality, it's almost impossible to have a frameless window fit so well as to not have a couple of holes that are too close to or on the edge of the Plexiglas.

Beryl D'Shannon, the leading manufacturer of STC'd frameless windows, has an approved, effective, simple and clever method of solving this problem in the form of a .050" angle plate, used like a big washer to secure the edge of the window where a compromised hole exists. As can be seen in the accompanying sketch, this angle plate shares the load of the hole with both the mounting fastener and the structural frame. Using this technique, I have never had a crack develop, either at the compromised hole or at an adjacent hole.

## DOWNTIME

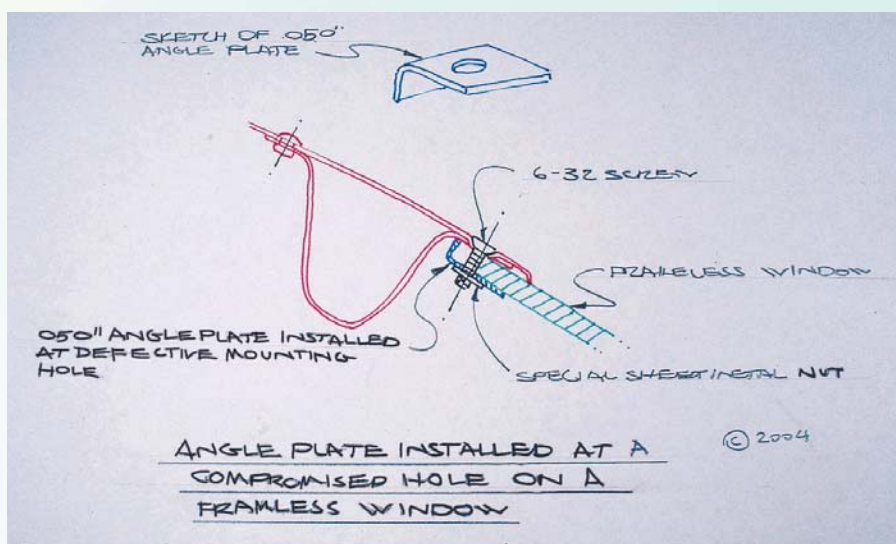
One other subject I would like to mention at this point is downtime. Installing a framed LP Aero windshield, or a Beryl D'Shannon speed-sloped windshield conversion takes about 24 man-hours. Pilot and copilot side windows average 11 to 12 hours each. I would be suspicious of the methods used by anyone who claims to do these installations in substantially less time.

Believe me, if we could cut time and not affect outcome, we would. The devil is in the details, and skipping one small detail during installation can put the entire effort at risk. One crack and it's re-do time.

A final trimming and fitting note: If you choose to install a 3/8" or 1/2" frameless windshield, check the fit between the upper right side structural window frame and the cabin door during the fitting and trimming process. It is possible to force an ill-fitting, extra-thick frameless windshield into the



A disastrous window installation with many holes on or 1/2 inch off the edge of the Plexiglas.



Sketch of reinforcement plate used to fix a compromised mounting hole in a frameless window.

structural frame with enough force to cause the contour of that structural frame to move. This can result in misalignment between the leading edge of the cabin door and the upper right side of the structural window frame. This can be avoided by closing the cabin door completely and checking for alignment as the windshield is being fitted. I like to check fit before the existing window is removed. Most of the time we can make improvements to an ill-fitting door.

I keep talking about trimming these windows, and there is definitely a foolproof method of going about it. As you might imagine, there are also some wrong ways. Probably as many different methods are employed in the attempt to trim acrylic windows as there



Misaligned cabin doors caused by improperly trimmed windshield being forced into its structural frame.



Edge of an acrylic window being trimmed with a disc sander.

are people who have attempted to do it. And yes, there are those who go about it absolutely incorrectly, and somehow get by with it.

I don't think there is any point in taking up valuable print space detailing what you should not do, with one exception. I have seen trimming with a saber saw tried far too many times, most likely because almost every handyman has a saber saw on his shelf. Trimming acrylic plastic with a saber saw is a little like trimming a 2 x 4 with a shotgun. Yes, it will be shorter, but how neatly and by how much?

Due to the reciprocating motion of a saber saw, the cut it makes in Plexiglas is very rough. Also, as the short blade cycles back and forth through the material, it creates a lot of friction and heat, causing the acrylic dust to melt on the blade and fuse to the cut edge of the acrylic. What a mess! Don't try it.

For removing major amounts of material, use a band saw with a blade that has approximately 24 teeth per inch. Plastic-cutting blades are available for this specific purpose. It's a good idea to put a nonabrasive covering on the surface of the cutting table to eliminate the possibility of scratching the window during the process. Feed the material slowly, and use a sharp blade. If you are new to the game, practice on the old window first. You'll know when you have the feed rate correct.

The best way to remove minor amounts of material is to use an 80-grit belt or disc sander. Be very careful to hold the window firmly, particularly when using a power disc sander. One slip and you get scratches on the

## SOME VERY IMPORTANT POINTS

*First, this work cannot be done in a cold T-hangar. Heat is your best friend when fitting and machining Plexiglas. When acrylic plastic is cold, it is brittle, greatly increasing crack potential during this fitting process.*

*Second, catalyst-cured PRC type sealers (Pro-seal) will not properly cure below 50 F. This sealer is a definite strength enhancement in frameless window installations, so proper cure is a must.*

*Third, and most important, this work can't be rushed. Take it from someone who grew up having to fix broken airplanes on a snowy ramp or in a freezing T-hangar. When you're cold, it's only human nature to get the job done as quickly as possible.*

*We have seen numerous failed window installations in the past 31 years, and many of those failed windows were installed in an inappropriate environment. If temperature is an issue, wait for warm weather to arrive, or send the job to someone who is experienced and properly equipped for the task at hand.*

window. On compound windows with unwieldy shapes, it's best to have an assistant hold the window while you sand the edge. And do use safety goggles. Your eyes are like magnets for the tiny flying particles of acrylic.

Once the final trimming is finished, the next step is rounding and polishing the edges of the trimmed window. Cutting or disc sanding will leave a fairly rough surface. As with hole drilling, it's very important to round off and polish all sharp edges. This can be done by hand, but a safe and faster way is to use a vibrating sander.

Start with 150-grit paper to quickly remove rough spots and round the sharp edges. Then come back with a 220- or 240-grit paper to polish every exposed edge until smooth. Again, a helper to hold the window is a good idea. The best sandpaper to use is the

black-looking wet-dry paper used by auto body shops. Household sandpaper just does not hold up.

## INSTALLATION PROCESS

Well, readers, if you have stuck with me this long, you're probably thinking this reads more like a technical manual than a how-to-do-it magazine article, but I don't know how else to thoroughly present this information. I promise to wrap it up next month with the installation process.

*ABS member Dennis Wolter started Air Mod in 1973 to bring innovative design and high-quality renovations to the general aviation market. Dennis, his wife Cynthia and 10 dedicated employees complete about 40 renovations each year at their facility on the east side of Cincinnati. Dennis has a degree in industrial design from the University of Cincinnati. He is an A&P, IA and a 3,000-hour instrument pilot.*

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July 14-17	Gig Harbor, Washington	Assoc. Aviation Enterprises (TIW)
Aug. 18-21	Sioux City, Iowa	Jetsun Aviation Centre (SUX)
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