We had wanted for some time to replace the ancient Narco VOR antenna mounted on the fuselage of our S35 with the modern blade style Nav antennas mounted on the aft fuselage. In fact, we had even run the wiring for the eventual installation when the interior panels were removed to replace the rest of the antenna wiring a few years ago. After the plane sat outside in the rain for three days during a trip this spring, we decided that we really needed a canopy cover, and if we were going to get a cover, we really should remove the old VOR antenna. Getting a cover can be expensive!

My dad had installed the blade Nav antenna on his V35B several years ago. He used spars inside the fuselage between the two antenna elements to make a very stiff installation. In fact, a number of people had inquired about his installation and he wrote up a short description (see sidebar). His installation and several others incorporating the spars were approved with fairly simple descriptions on the FAA Form 337. However, the FAA has recently been requiring more documentation for installations of this nature. We prepared a Form 337 with sketches and dimensions for our proposed installation, which was reviewed by our local FAA inspector prior to installation. I talked with several Bonanza owners at Oshkosh who reported difficulty in securing approval for a blade antenna installation without more documentation than that provided by the antenna manufacturer. Thus it seemed that an article showing what we did, and the documentation that we used, might be of interest to other ABS members who are contemplating the installation of blade antennas.

Following the reasoning given by “Old Bob” in the sidebar, we attempted to locate the antenna elements as they are in the Mike Smith installations. A template placed inside the fuselage helped to make measurements and transfer them from side to side. (see Figure 1). Once a small pilot hole for the coax connector is drilled in the fuselage skin, the desired location relative to internal bulkheads and external rivet lines can be verified. Small adjustments can be made by filing the pilot hole until it is centered in the desired spot.

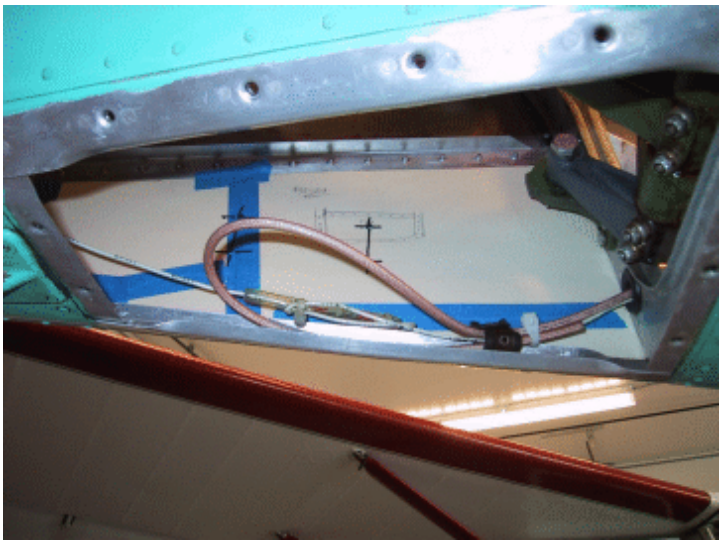

Figure 1.

After the pilot hole is enlarged for the coax connector, the antenna elements can be positioned on the fuselage and the mounting holes marked. Careful location of the mounting holes is crucial, as the fuselage skins will serve as a jig for constructing the spars. To ensure repeatable positioning of parts, the mounting holes should be just large enough to provide clearance for the mounting screws. Once the mounting holes for one blade are drilled, that blade can be temporarily mounted to the fuselage skin and used to help with the final positioning of the second blade.

Based on the location of the holes that have been drilled in the fuselage skin, the length for the spars can be measured and the parts fabricated according to the sketch in Figure 2. The spars should be made slightly longer than required, as they can be trimmed later. Figure 3 shows the doublers, the spars, and the mounting brackets cut and bent to shape. At this point, we installed nut plates on the brackets in accordance with the dimensions supplied by the antenna manufacturer, and marked each bracket to ensure that it always went in the same location.

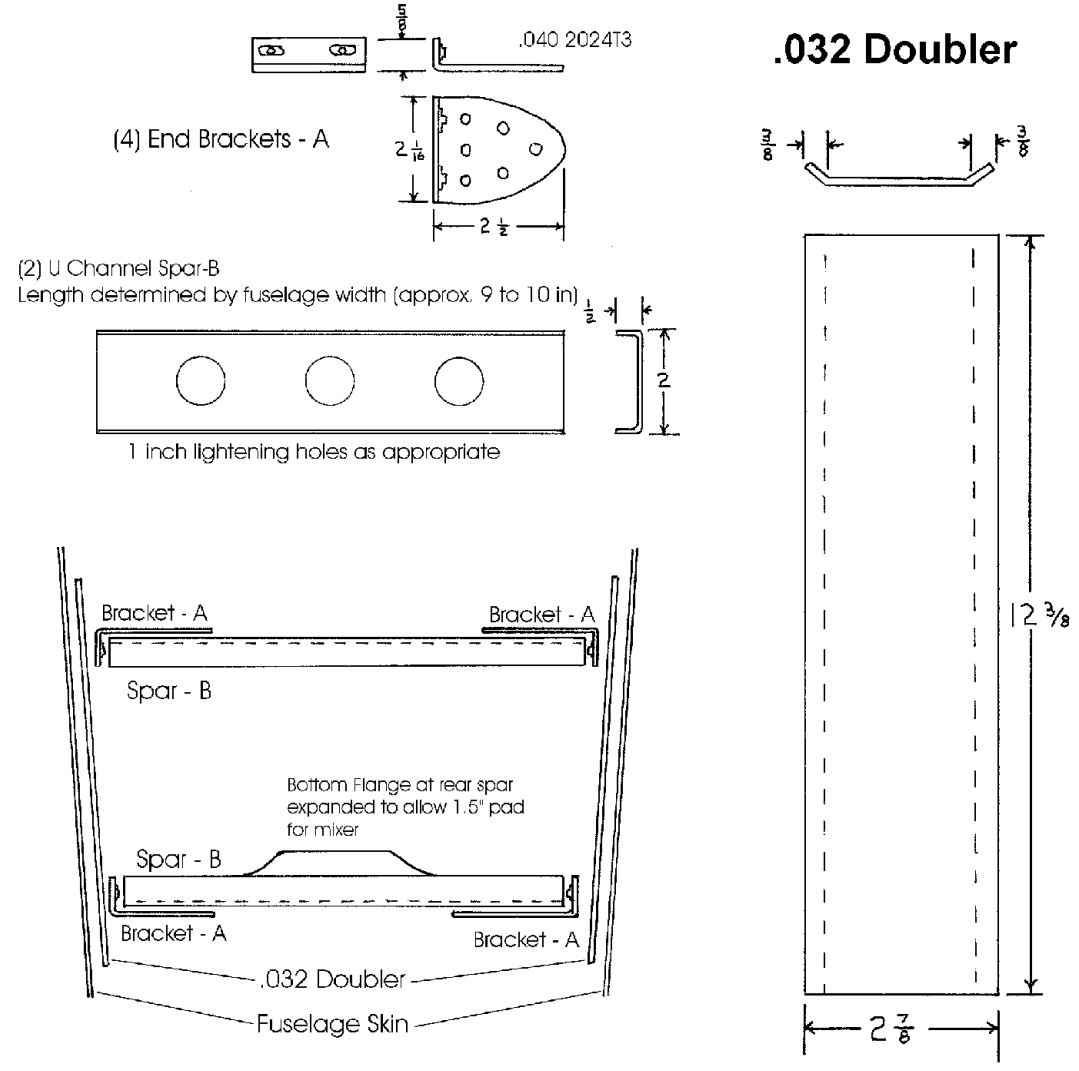

Figure 2.

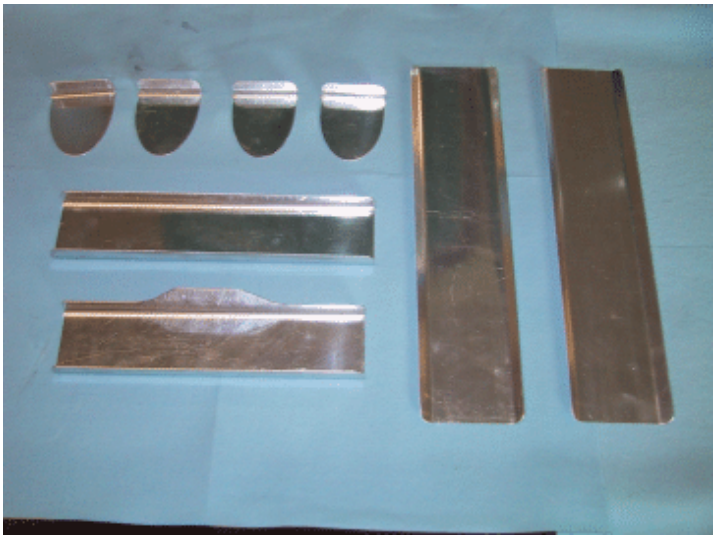
Figure 3

The holes in the doublers can be drilled at this point. The holes drilled in the fuselage skin can be used as a template, but the hole for the coax connector may need to be slightly larger than that in the fuselage skin to prevent interference with the locking collar on the antenna lead. After the mounting holes are drilled in the doubler, the antenna can be mounted with the doubler in place and the locations for the rivets securing the corners of the doubler marked. It is important to ensure that these holes are not so close to the antenna that riveting is difficult, or that the forward upper rivet hole is not so close to the ruddervator mechanism that bucking the rivet is a challenge.

Fitting the spars is the next step. We drilled two rivet holes in each of the brackets to serve as pilot holes for holes to be drilled in the spars when they were properly positioned. Access for the drill would have been easier, however, if the pilot holes for the rear spar had been located in the spar rather than the brackets, even though this would entail an extra assembly and marking step.

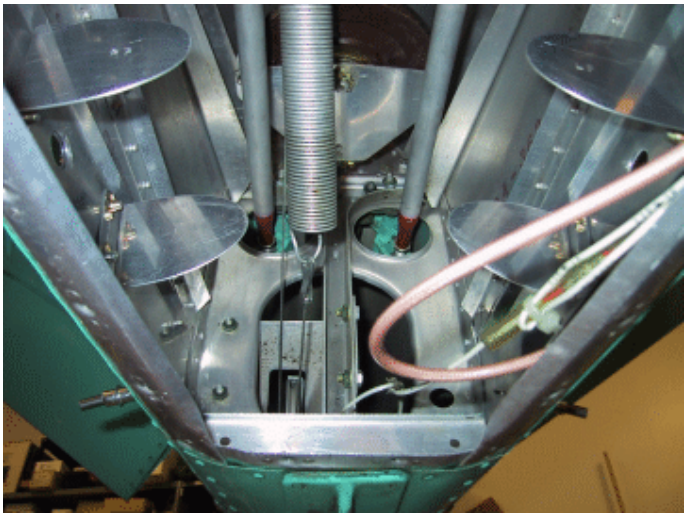
Figure 4

Figure 4 shows the brackets and doublers mounted to the inside of the fuselage skin, without the antenna elements, whose weight might slightly distort the fuselage skin. Once the brackets are bent to be perpendicular to the aircraft centerline, the spars can be trimmed to fit between the brackets. After trimming, we temporarily secured the rear spar to the brackets using clamps (Figure 5). With the spar clamped in the desired position, we drilled the rivet holes in the spar through the pilot holes on the brackets. Figure 6 shows the tight quarters for drilling that would have been avoided if we had marked the desired hole locations on the spar when it was clamped in position, and then removed the spar and drilled the pilot holes in it. As each hole was drilled, Clecos were installed to maintain the relative positioning of the brackets and spars. The rear spar with Clecos installed is shown in Figure 7. Note the shelf on the bottom of the rear spar for mounting the signal mixer supplied by the antenna manufacturer.

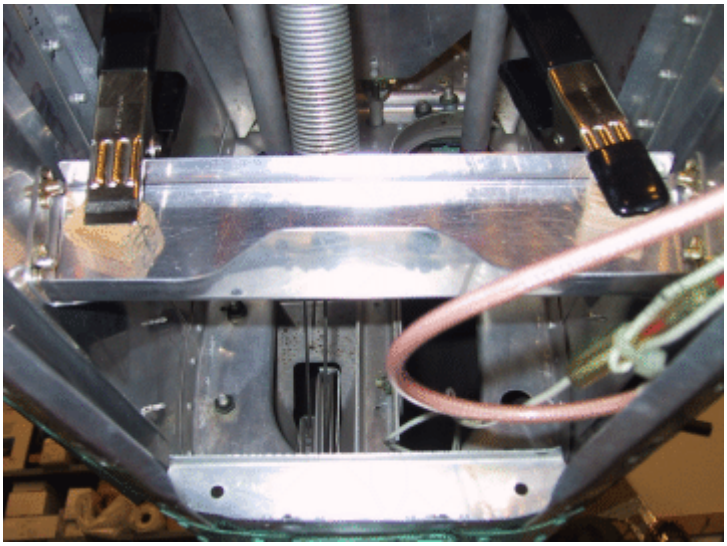

Figure 5

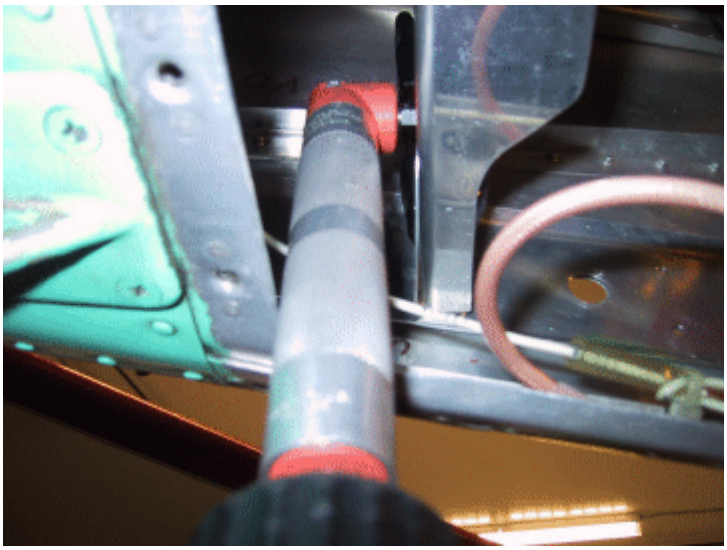

Figure 6

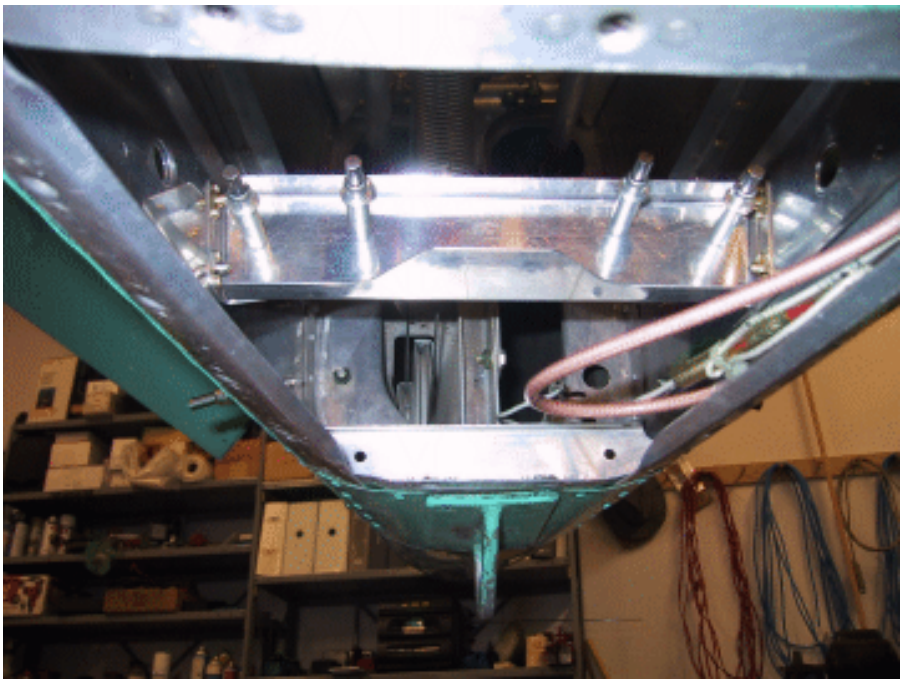
Figure 7

At this point, we removed the rear spar assembly, drilled the remaining rivet holes and secured the assembly with more Clecos. The rear spar assembly was then reinstalled before we drilled the rivet holes for the forward spar assembly. The rivet holes in the forward spar assembly were located and drilled following the same procedure used for the rear spar (Figure 8).

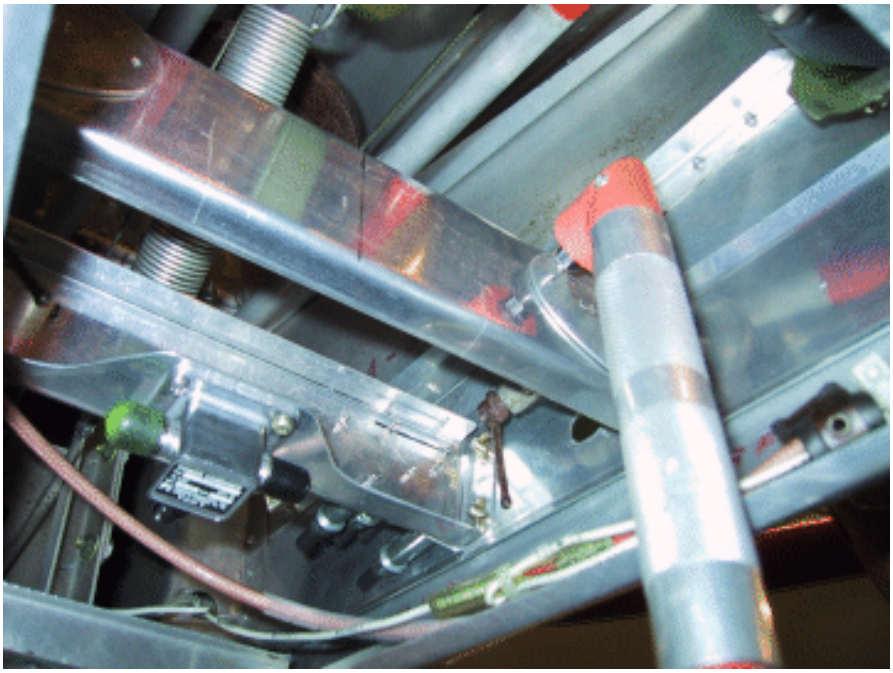
Figure 8

At this point, the lightening holes were drilled in the spars in locations that would not interfere with the brackets. The disassembled doublers, brackets and spars were then etched, treated with Alodine and given a few coats of zinc chromate primer. Since we planned to bond the doublers to the fuselage skin, the side of each doubler destined to be next to the skin was not painted. After we riveted the brackets to the spars, the spar assemblies were given a final coat of primer. Prior to the final assembly of the antenna system, the signal mixer was mounted to the rear spar and grommets were installed to allow the antenna leads to pass through the lightening holes. Figure 9 shows the parts ready for assembly.

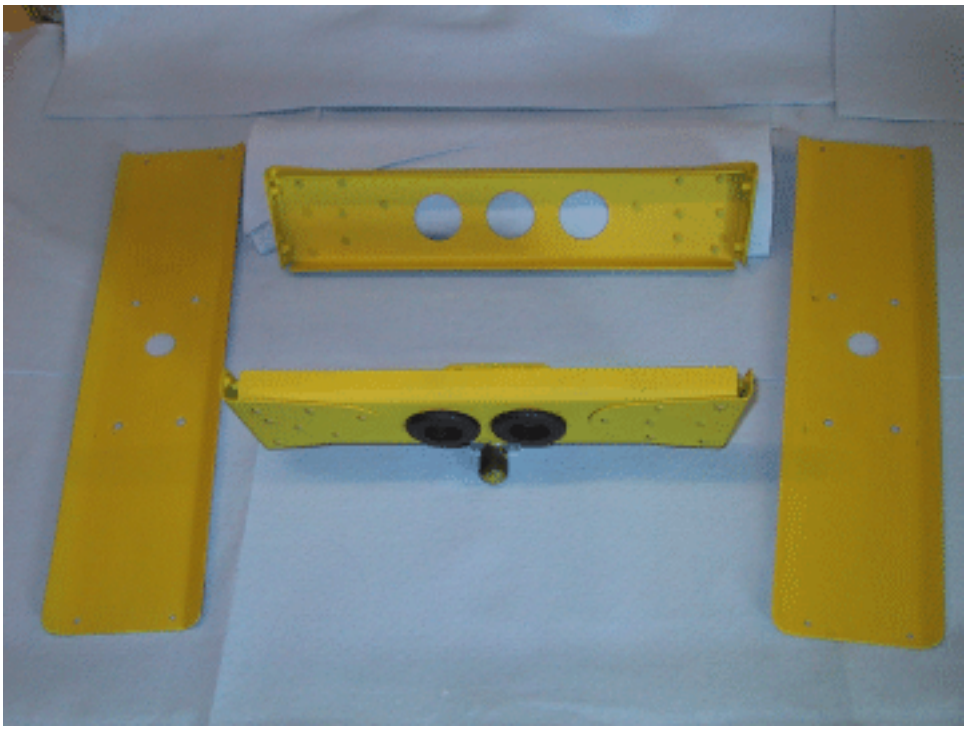

Figure 9

The manufacturer's installation instructions for the antenna specified that the antenna mounting screws have a good connection to airframe ground. To accomplish this, we removed the paint around the mounting holes on the outside fuselage skin (Figure 10) and used washers between the antenna and the skin to ensure good electrical contact in the area around the mounting holes not covered by a cork gasket. The exposed aluminum was treated with Alodine before assembly.

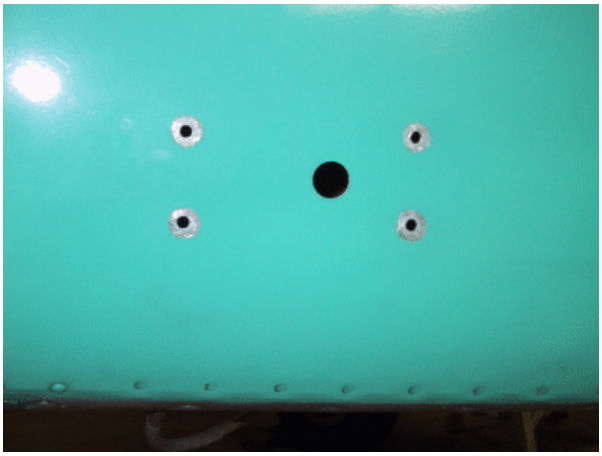

Figure 10

In order to minimize the possiblility of trapping dirt and moisture between the doublers and the fuselage skin, the doublers were secured to the fuselage skin with Hysol EA 9309NA epoxy paste adhesive. This adhesive has a working time of 40 minutes, so we gathered all parts and tools together to be fully prepared for the final installation. We assembled everything without the adhesive for a final check of fit. We then applied a thin layer of adhesive to the unpainted side of the doublers, secured the doublers to the fuselage skin with Clecos, and assembled the antenna elements and spar assemblies. After replacing each of the Clecos with a 3/32” rivet, all of the hard work was done. Figures 11 and 12 show the final installation of the antenna elements, doublers, and spars with the antenna wiring connected.

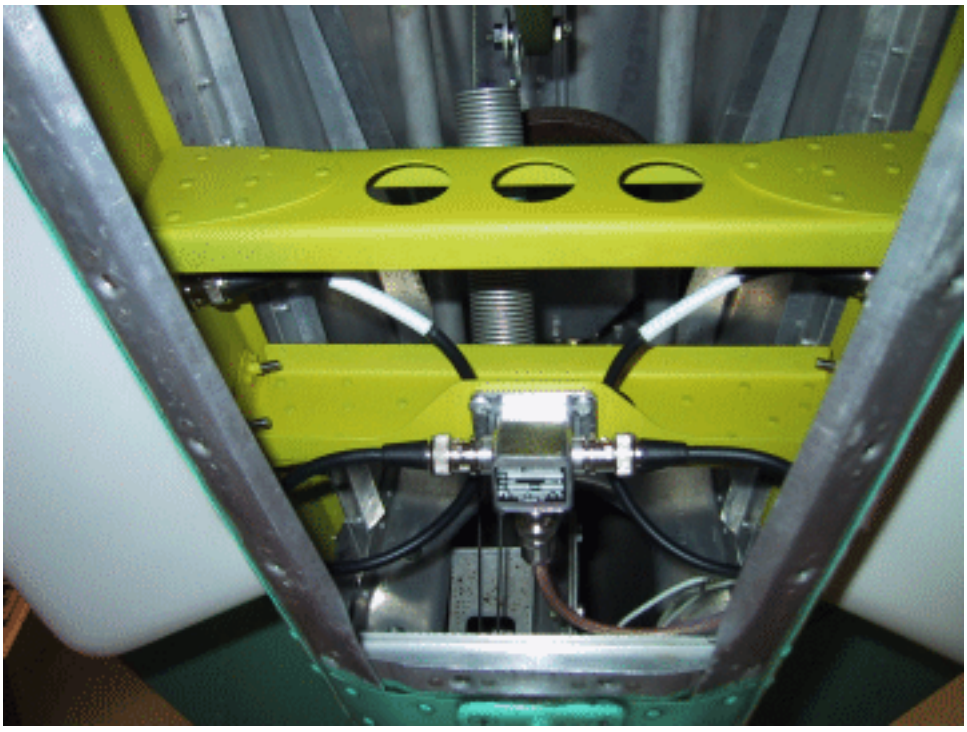

Figure 11

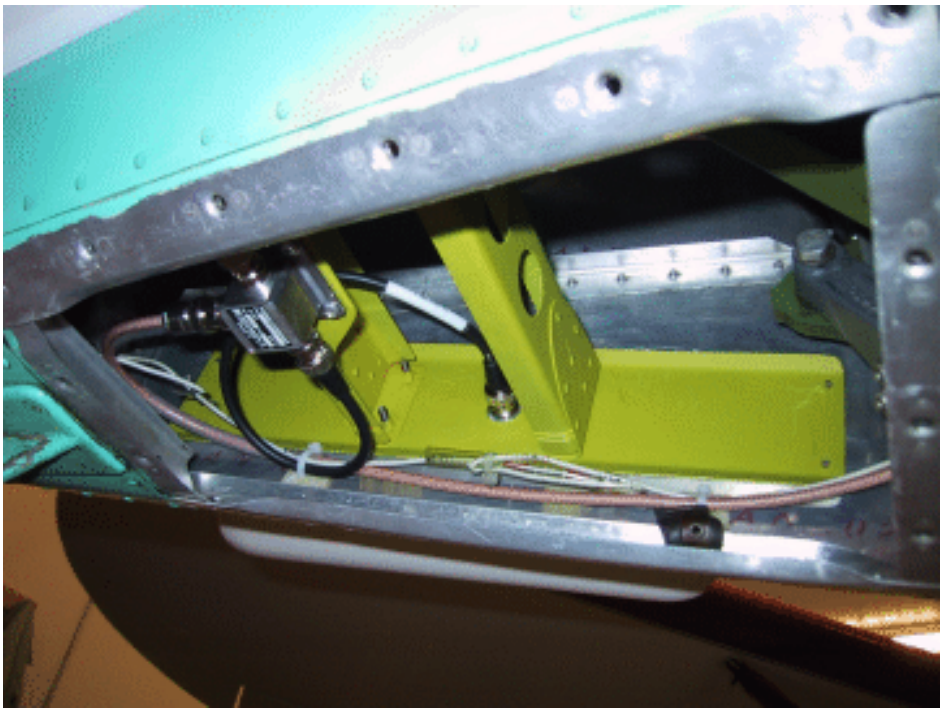

Figure 12

Figure 13

Following the antenna manufacturer's instructions regarding sealing around the base of the antenna elements with silicone sealant completed the installation. Replacing the inspection covers, completing the paperwork, and performing the testing requested by our

FAA inspector returned the airplane to IFR legal status. Figure 13 is a photo of the finished installation.

We can now use our new canopy cover, and the airplane looks much better as well. Would you believe that we picked up 10 knots at cruise? Would you believe 5?

Anyone that might be interested in a copy of the FAA Form 337 for this installation can contact Bob Siegfried, II at rsiegfri@aol.com.

Sidebar:

My Installation of Blade Style Navigation Antennas

Blade style navigation antennas are one of the speed modifications that Mike Smith used in his effort to get maximum speed from the V-tail wonder. They have the added benefit of giving a much better signal to the navigation radios and of eliminating a lot of electronic noise that can be generated when the nav antenna is on the top of the fuselage. Removal of the Flying V above the cabin provides an ideal location for the, now almost obligatory, GPS antenna!

Mike conducted many flight tests, some of which included the use of tufts, to check for airflow around antenna blades mounted on the rear of the fuselage below the tail feathers. His research showed that the blades should be mounted with the leading edges quite far down in relation to the longitudinal axis, or "waterline," of the aircraft. The position he used is one where the blades are mounted halfway between the last and the next to the last bulkheads of the fuselage. He also chose to mount them parallel to the bottom of the fuselage at that point.

I measured many of his installations and found that the average distance from the very bottom of the fuselage to the center line of the point of attachment was four inches. I started to place mine in that orientation, but found that it had the visual effect of looking as though the front end of the blades were lower than the parallel position. I ended up with a compromise position where the front end of my blades are four and one-sixteenth of an inch above the low point of the fuselage and the rear of the blades are right at four inches.

I felt that Mike had not made the attachment of the blades quite as stiff as I preferred. I also noted that many others had installed the blades in a similar position, but had made various efforts to reinforce the blade attachment by tying the attachments to stringers and bulkheads in the rear of the aircraft. I feel that attachment is undesirable. It changes the load paths in the rear of the fuselage. Mike had merely added a doubler which he glued to the skin. I found that, on at least one of the ones I inspected, the doubler had released from the skin and was serving no purpose.

It was my decision to go with no doubler and install spars between the antennas instead. When I submitted my installation to the FAA for approval, they bought it, but suggested

that I should have used a doubler as well. I recommend a doubler be installed that is glued to the skin as Mike did his, but that incorporates a single 3/32 rivet in each of the four corners as an antipeeling device. The doubler should NOT attach to anything but the skin. It should come no closer than one quarter to one half inch of the adjoining stringers and bulkheads. I really don't think it is needed, but I don't feel it is worth an argument with officialdom.

The idea is to avoid disturbing the existing structures and load paths to the greatest extent possible. The spars must be sized so as to adequately clear the tail feather's mixer mechanism.

If any more information is desired, just ask!

Happy Skies.

Old Bob
AKA
Bob Siegfried
Ancient Aviator