**Discussions on tank leak repairs:**

**Andrew Mara: *“****The archives appear to be down. I am tempted to put water in my strakes for leak testing. Anyone care to share their water/strake horror stories? I hear Steve Harmon has a good story.”*

**Steve Harmon:** *“I did not use water to leak test my fuel tanks.  I used a altimeter and my tanks don’t leak. I used water to post cure my tanks it actually worked pretty good the problem I had was I forgot to flush my sumps when I finished in the summer with post curing my tanks. They had water in them for all the summer and a good chunked of the winter.   I figured out I still had water in the sumps when I first tried to start my motor for the first time. Motors don’t run on water.   It took me a long time to get the water out plus it ruined my Ellison throttle body carb. Everything else is fine.  I don’t think I would repeat that particular post cure if I had to do it over.”*

**David Orr: “***I guess my comment would be that the foam is irrelevant - if you did the interior coating in wet epoxy and added the top skin properly, no leaks.  HOWEVER, to then repair any errors, I think you need to put a 5"x5" hole in the tank and locating where things don't look sealed looking inside your tank, the outside skin, as you point out, is not a specific locator.    
  
We had a guy who suggested putting in fuel, checking for leaks - actually tilting the plane with the fuel on board and seeing if you can unport the leak on the inside of the tank and cross-referencing where the leak goes away in a couple of different tilt angles- what a pain.  If you can't unport it with some pretty simple tilting, you reduce fuel 5 gallons and try again.  I've never seen that done.    
  
It is pretty easy to cut a square cork out of the top skin and with some careful sanding replace it with flox as a kind of filler between top and bottom skins, that might be quickest - the direction of the leak - where it exhibits outside the tank will likely give you some idea of where to put the hole in the tank.  If you go this way, I have some advice on reducing the junk that falls into the tank.  
  
At Santa Monica we installed the fuel drain in the tank using Bondo - which is impervious to fuel - that location is a likely one for vacuum leaks during testing, the Atkinson fuel gauge addition another, the fuel lines entry into the tank or sump another common source, and frankly the various places the fuel lines connect with valves, filters etc.    
  
I found my original leak in the leading edge joint of Task Strake top and bottom, one side only - but then I added a coat of white urethane tank seal and a coat of black urethane tank seal because I was going to use auto fuel.”*

**Greg Cross:** *“I tried a $19 refrigerant leak tester from E-Bay, and butane (from a stick grill lighter tank) - worthless.  Then I tried the same detector with spray "Duster" (definitely a halogen) - still didn't work, but it should have.  I junked the tester and borrowed a professional refrigerant leak detector - then it worked!  It really worked well and I found my pesky leak!”*

**Joel Ventura: “***Since you're talking about putting water in your strake tank, I will assume you have narrowed down the leak to that location, and ruled out any leak in the fuel line or what it connects to.*

*Fuel leaks in the strake can be very easy or surprisingly difficult to track down in our canards depending on how large they are and where they are located.  If the leak is in the area where you have direct access to the fuel containment wall, for example in the area of the fuel site gauges, the leak will be easy to find and fix by a variety of methods. But most of the tank is embedded in the strake sandwich structure consisting of the tank wall on the inside, the fiberglass skin on the outside, and foam in between. Leaks in these areas can be very difficult to find and fix, especially that area up against the rear spar.*

*A major reason for this difficulty is because part of the foam core of that sandwich is open cell foam.  The foam starts out as closed cell, but when you cut it to size you open up the top layer of cells. Then to make matters worse you sand the surfaces before you micro the layers of foam together or micro the fiberglass skin to the foam. That opens more cells, and the micro between does not form a gas or even a liquid seal. That means if you get a fuel leak in the tank wall, the fuel will be free to migrate throughout the strake sandwich structure. That in turn means the method of pressurizing the tank and looking for bubbles with a soap solution can be of little use in finding the actual location of the leak. You may find where the air or other gas is actually escaping from the strake,  but that may be many feet from the actual location of the leak in the tank inner wall. The same is true for using special gases with sensitive gas detectors.*

*There is a method, that I have heard will work in many cases, and that was described in the Central States Newsletter eight or 10 years ago.  Briefly, this method involves filling the tank to various levels in combination with tilting the airplane around its pitch and roll axes, and monitoring when the leak stops.  From these tests you can accurately locate the site of the leak, and then cut down through the outer skin and foam to the inner tank wall to repair it.  I have never tried this method because it sounds like a lot of work, can take a lot of time for the leaked fuel to work its way through the small passages in the sandwich structure so you can detect a change in flowrate, and there are some areas where it will be very difficult to repair the tank inner wall from the outside (like the area up against the rear spar).*

*So since you asked, here's my strake leak horror story. I am the third owner of my LongEz (and I assume the Cozy tank structure is basically the same).  Shortly after I purchased the airplane, I noticed the odor of fuel when enclosed in the cockpit with the canopy close. First I filled the left tank with fuel, and let it sit for a couple days before searching for the leak. I still could find no liquid fuel inside the cockpit. I then pressurized the fuel tank to the limit recommended in the Canard Pusher Newsletter. This brought liquid fuel to the surface of the pilot's left arm rest.*

*I drained the tank, and this  leak was easily fixed with a little epoxy, and I got rid of the fuel odor.  However, this armrest was a long way from the fuel tank, so I knew there was still a leak somewhere in the fuel tank wall. Besides that, I could not get the tank to hold a pressure or vacuum.  I also knew there was fuel flowing around inside the sandwich structure of the strake, and also getting into the fuselage. I spoke to a few other aircraft owners about this, and more than one admitted to having this problem. They sealed up any leaks to the outside, and just decided to live with a small amount fuel stored in the strake structure. After all, most of the foam was closed cell, so there can only be a few ounces of unusable fuel outside the tank.*

*However, this solution was not aesthetically pleasing to me. I kind of felt all the fuel should be in the fuel system as designed. I did not have a complete understanding of the situation,  so the first thing I tried was to paint the l left strake and the inner and outer left sides of the fuselage with soap solution, and pressurize the tank again with air. I could find no bubbles.  However, this close inspection revealed two small areas about 2 inches in diameter on the bottom of the strake that were possibly delaminated. This was confirmed with the coin tapping test. I cut those areas open, and both were wet with visible liquid fuel.*

*Next, I sprayed a small amount of refrigerant into the left tank, pressurize the tank, waited about 20 minutes, and carefully went over the entire strake, and inside and outside of the fuselage with a sensitive detector. Again I found nothing.  I sprayed more refrigerant into the strake, and repeated the test, with the same result. Now I was getting desperate, so I expanded my search area, and I finally got a strong signal coming out behind the top the firewall. It never occurred to me to put soap solution up there. And obviously this was a long way from the fuel tank, so it was not going to help me find the leak.  (Much later it occurred to me, that I might've been able to pull a partial vacuum in the tank, then spray refrigerant at the top of the firewall, and then search the interior of the tank with the detector. That may have worked.)*

*I resisted it for several months, but finally I was becoming convinced that the only way I was going to find and fix this leak was to cut open the tank.  It really hurt, but finally I set the base of my saber saw over at a 45° angle, and made sure the blade would not extend more than 1/2 inch below the top of the fuel tank, because the plans show the tank vent line runs one inch below the top of the tank, and I didn't want to cut that. There are three bays  in each fuel tank, separated by two baffles, so you may have to cut three holes in the top of the tank to find the leak. However, I was told that the fuel sump and all the penetrations to the fuel tank, except for the fuel filler, are in the first bay, and therefore most leaks occur in the first bay.  So I cut an oval hole in the top of the first bay about 6 inches wide and a foot long. (There are other ways to decide which bay to cut open first; see below).*

*I then sealed over the hole with a glass plate,  which was sealed to the top surface of the strake with plumbers putty, and I attempted to pull a partial vacuum on the tank through the vent line.  That did not work, because at that point I had not realized that the foam was partially open cell, and leaked badly.    So first I had to seal the edges of the oval hole with epoxy,  then  I painted the inside of that bay, and everywhere I could reach, with a soap solution. I replaced the glass plate, pulled a partial vacuum, and expected to see a foam froth around the leak.  I found nothing.*

*That was discouraging. Had I disfigured this wing for nothing?  In desperation, I filled the tank with water, replaced the glass plate, and the vacuum,  and there immediately appeared a beautiful stream of bubbles coming from that long elusive leak.  I found the leak in about 30 seconds using this method, after having tried for over 100 hours using other methods.  The reason I did not get the expected froth with the soap solution test, was because I had expected to find a very tiny leak, producing bubbles of 1/10 to 1/2 mm in diameter. Therefore, I immediately cranked the vacuum up to the maximum recommended. However the leak was much larger than I expected, producing bubbles 3 or 4 mm in diameter.  This large leak immediately blew the soap solution away from the area, so I got no bubbles. In the future I will start with a much smaller vacuum, and only then ramp it up if I see no result.*

*The leak was along the bottom back edge of the tank where the fiberglass bends up from the floor of the tank up along the vertical face of the rear spar.  These edges, and especially the corners are areas more susceptible to leaks because if the glass pulls away from the surface, the epoxy can drain out of it before it cures leaving a small epoxy starved area.  Normally when you find a small leak, you paint a little epoxy on the area, then pressurize the tank to force the epoxy into the fiberglass and any voids that exist. Since this whole small area looked starved, I did that, but in addition added a small glass patch over the area, and pressurize the tank again.  Once cured, there was no longer any sign of a leak.*

*I then tested for any additional leaks, and finally flushed the tank and the fuel lines with fuel to remove any remaining water. I at first used auto fuel, since it had 10% ethanol, I thought that would help scavenge out the water. However that made a murky mess, and I could not tell if there was any water remaining. Avgas worked much better. The water and avgas stayed in clearly delineated phases, so it was easy to pour the avgas back in the tank for the next flushing, and throw the water away. Surprisingly it took about five flushes before I no longer saw any signs of water.*

*I had left water in the fuel system for two days.  I would recommend keeping that time to a minimum, because others have reported problems with corrosion in the fuel system when water is used for testing.  I saw no signs of corrosion in my fuel system from using water for these tests.  If you have any remaining concerns about water still in your fuel system, you could put Prist in the fuel.  I do not think that Prist will damage our fiberglass tanks, because the concentration is so low, however the company never responded to my inquiry about that. (I would be very interested if any of you have any knowledge about that, because I'm very uncomfortable flying in freezing weather without Prist in my fuel.)*

*As long as this tale is, it is an abbreviated version, but I did want to mention one other thing I tried when trying to isolate the location of the leak.  When I filled the tank with water and pull a vacuum, I tried to find the leak by listening for bubbles with a stethoscope. I tried both a $100 medical stethoscope, and a $4 mechanics stethoscope I got from Harbor Freight Aircraft Tools.     The mechanics stethoscope worked far better.   It uses a metal probe to initially pick up the vibrations on the surface of the strake that originate from the bubbles.  This worked very well for the size leak I had. I don't know how well it would work for a tiny leak that only produced bubbles 1/10 of a millimeter in diameter. Note that you could also use this method with an intact tank and the avgas already in your tank, and then you would not have to worry about the negative aspects of using water. However, keep in mind, when selecting your vacuum source, that you will be pumping out an overly rich fuel air mixture, which as it is diluted, could get into the burning/explosive range. Another disadvantage of the stethoscope method I found out the hard way, is that you may be able to hear the air bubbling through the fuel that has leaked into the sandwich structure of the strake, and mistake that for the leak location.*

*And I would be very interested if someone ever tries to use the refrigerant detector method described earlier, with the detector in the tank.   That has no avgas or water drawbacks associated with it.*

*Note that Gary Hunter, who is an expert in epoxies, has strongly argued against using hot water to post cure our epoxy fuel tanks.  I don't remember the reasons offhand, but I'm sure you'll be able to find his post in the Cozy and/or the Canard Aviators archives.”*