Pitot/Static Systems

How can a system with virtually no moving parts create such a huge bill every 24 calendar months?

FAR Part 91.411 and 91.413 require that aircraft flying in con trolled airspace under IFR have their altimeter system and transponder equipment inspected and tested in accordance with the instructions contained in FAR Part 43, Appendix E and F, within the last 24 calendar months. That's fine. Avionics shops all over the country perform the necessary inspections in a little over an hour, at rates that range from $60 to $125 for the average single or light twin engine airplane. It's not a big burden and the piece of mind goes a long way. Unless there's a problem, of course, and with radio shop rates pushing $75 per hour in many places, it doesn't take much of a problem to produce a bill that creates yet another problem.

Compliance with Part 91.411 is broken out into two separate functions. The regulation states that the altimeter as a unit and any altitude reporting equipment shall be inspected each two years and must pass a series of tests outlined in Part 43, Appendix E. These inspections are to be carried out by appropriately rated individuals or instrument shops approved for such work. The second required inspection is a test and inspection of the static system which includes, among other things, a system integrity test, more commonly known as a leak check. It is this system, not the altimeter, that generally fails the altimeter/transponder check and repairs can be time-consuming and costly. Fortunately, the static leak check can be performed by your local A&P mechanic or, better yet, by you, under the supervision of your local A&P mechanic. Either way will save you a ton of money when "Sparky" comes to hook up his test equipment.

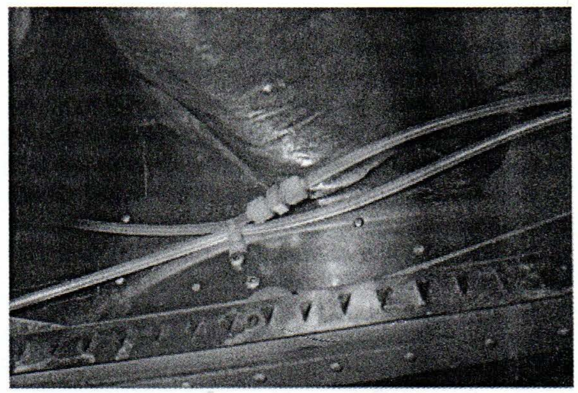
Fittings, Ferrules and Tubes

The average single engine airplane has around 30 feet of plastic, static system tubing, broken by endless fittings, tee's and adapters all designed to create an airtight loop which ties the appropriate equipment to a single ambient static source (or dual port in the case of IFR aircraft). The purpose of the system, of course, is to provide instrument sensing of a change to outside ambient pressures which translate, ultimately, into some altitude diversion. With the exception of an alternate static source, the system has no moving parts. It is simply a loop made from plastic tubes and equally plastic flareless fittings which are supposed to allow flexibility around the back of instrument panels and through fuselage formers and bulkheads. The design of the system requires a water separator to be installed in some low point in the line and the hardware must be of sufficient quality to resist kinking at bends and remain free from corrosion. It's simple, and yet, every other year or so, a new leak is found or some fitting has worked loose due to vibration or who-knows-what.

Maybe a carpet screw was driven into a side panel slightly off the mark, drilling the static line tucked behind the forward fresh air vent, or maybe the VSI line worked loose when that airport delinquent who helped you bleed your brakes managed to squirt 5606 all over the back of the panel. Anything can happen. Just ask the guy who mismanaged a static system check and blew the glass out of six different flight instruments in a cabin class twin. It happens, and when it's not mechanically induced, leaks occur when they want and where they want. It is for this reason that checking the static system yourself, prior to getting the altimeter and transponder checked, will save you money, time and aggravation.

Leak Tests and Suction Guns

To leak check the static system, it will be necessary to apply a sufficient amount of suction to the static port or some easily accessible point in the loop to simulate an altitude change of 1000 feet. FAR Part 23.1325 and 25.1325 both detail the manner in which the system should be checked and will list the minimum requirements for acceptable performance.

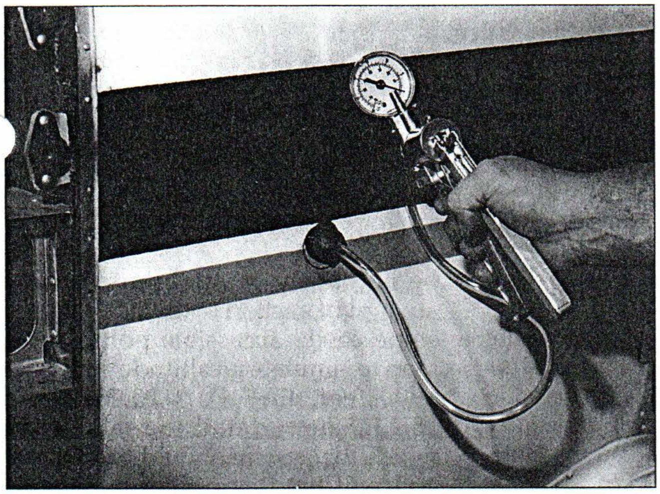


Static lines are run in the overhead cabin area or along fuselage side panels. Leaks can occur at any of the tubing connections and defects must be isolated by trial and error.

The same information is found in FAR Part 43.13-1A, Chapter 16, Section 4.

Basically, a vacuum is placed on the static system of sufficient pressure to see a climb on the altimeter of 1000 feet. After reaching this point, the vacuum source is sealed off and the system must maintain the existing altitude for a period of one minute. Maximum allowed loss in altitude (and thus a loss in vacuum) is 100 feet. If the vacuum holds, your inspection is finished. If it does not, put the cat out, cancel all your appointments and call for back-up. You'll be here a while.

FAR Part 91.411 (a)(2) states that any time a static system is opened (aside from the alternate static source) a new inspection must be accomplished to test the security of the static system. The regulation only requires that a leak check be done. It is not necessary to have the altimeter and transponder checked again unless they



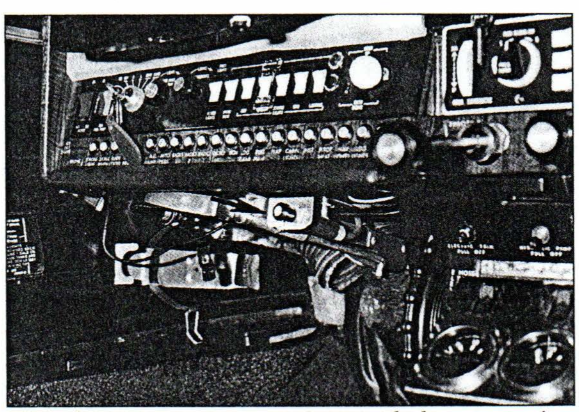
Suction is applied to the static system by using a hand-held vacuum gun. Be sure to plug the second system source for IFR-certified aircraft. Pump shown is a Matco MV4000.

have reached their two year limit. This allows the mechanic to exchange defective flight instruments, replace heated static vents and repair defects in the system without incurring the cost for a new altimeter and transponder check. The check is easily made but does require some specialized equipment.

There are several ways to tap into the static system for the leak check but no matter where you apply the suction, you'll need some device to create a vacuum. Auto shops have long used a hand-held suction gun to apply a vacuum to diaphragm-operated automatic transmissions. Some gun kits come with various adapters and cups to allow a single mechanic the ability to bleed the brakes on cars and trucks without assistance. Whether you purchase a suction gun from Snap-on Tools, Aircraft Tool Supply Co. or one of the many auto parts stores, the most important feature you'll need is the ability to seal off the vacuum applied to the system so that a realistic inspection of the system–and not the gun–can be made. A cheap vacuum pump can be unreliable and, often enough, will slowly bleed the suction off the system making the inspection impossible. For quality and design, we would recommend the Mityvac MV4000, available from your local Matco distributor, or any of the pumps which come with an all-metal casing and silicone type check valves. It's also important to purchase a pump that can be rebuilt with a manufacturers repair kit. Valves will leak over time and the pump ram seals need to be changed occasionally.

Attaching the vacuum pump to the system is easy. Attach a suitable hose to the pump and simply seal the tube to the static source using a lump of putty, sealant, or putty-type gasket material. Modeling clay and other water and dirt-based materials are not desirable because of the potential for system contamination; they're also somewhat difficult to work with. Once attached, the static system can be sucked down while watching the altimeter and VSI. Remember to plug the other static source for IFR aircraft equipped with a dual source. Work the pump slowly and allow the instruments time to react. Tapping on the altimeter will be necessary to overcome any mechanical resistance. Make sure that you don't allow any affected flight instrument the chance to "peg-out" against some maximum, and whatever happens, guard against rapid vacuum loss. If the line pulls out of the putty or your gun should fail, the altimeter will unwind in the blink of an eye and the VSI will automatically reach descent rates unheard of in your airplane.

Once the altimeter reaches 1000 feet, close off the vacuum source and start the one minute clock. If the altitude remains at or above 900 feet AGL for this check, the system is good to go. If the altitude falls or exceeds the acceptable loss rate, isolation of the leak must take place and the necessary repairs made.



The alternate static source is a good place to tap into the system and a prime place for leakage.

Looking for the Leak

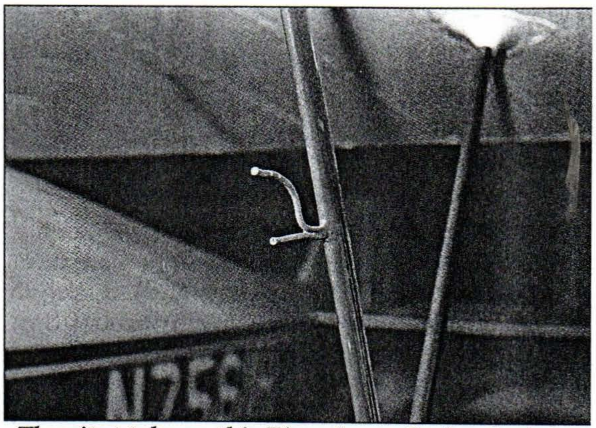
Generally speaking, most static system leaks will be found under the panel. Not always, but most of the time. For this reason, when a leak is discovered, the first thing you'll want to do is define the general vicinity of the defect. To do this, simply seal off the static port (or ports) with the putty and tap into a place in the line which will isolate the panel from the rest of the system. Usually, this is done at a place where the line from the static port meets the first component under the panel. On many Cessna aircraft, the line from the port is routed to a low point where the water drain will be located. Tap into the line which will define the panel as a unit and perform the leak check again. Regardless of the outcome of this check, work backwards to the static source and check that line as well.

Once the leak is identified in a general way, perform the leak check again and, while a vacuum is applied to the system, gently feel around lines, fittings and unions until a sudden jump in the leak is found. Manipulating the static lines at a weak point will help isolate the offending piece and will identify those areas that could cause a failure in the future. If pulling on lines and fittings doesn't isolate the culprit, a more aggressive search will be necessary. Begin by capping off lines installed at individual instruments and reducing the size of the area to be tested. Note any change in the rate of leakage with each change in the area tested. Don't forget the possibility of instrument glass leakage. A layer of putty around the glass circumference will seal a faulty instrument or eliminate the potential for leakage. Also, check the alternate static source for a seal leak in the valve. While the valve generally won't be a problem, the fittings attached to the valve tend to "work" over time and leakage at these areas is common. It's a time- consuming job and a little like a game of cat and mouse, but for those who enjoy tedious, intricate work and don't mind working in the bowels of the instrument panel, it can be quite rewarding. Especially when it's about 8:45 in the evening and everyone else has left the airport. You've missed dinner, had to cancel your card game with the boys and your wife has decided to shop for that new car on her own but, you found the leak!

Plugging the Hole

In November of 1957, the Russians launched a dog by the name of Laika into outer space aboard the earth satellite Sputnik II. It is not known whether the Russians were trying to determine if earth-bound organisms could survive a launch into space or if they just had a low opinion of the dog, but it was around this time that aircraft started using a plastic type of flexible tubing for instrument system plumbing. Commonly referred to as Tygon tubing, static systems are held together with this tough, vinyl material using clamps and flareless style fittings for attachment to instruments and "T" fittings. Older aircraft use low-pressure, Mil Spec hose and standard AN fittings for their static systems but the installations are bulky and hardware is heavy.

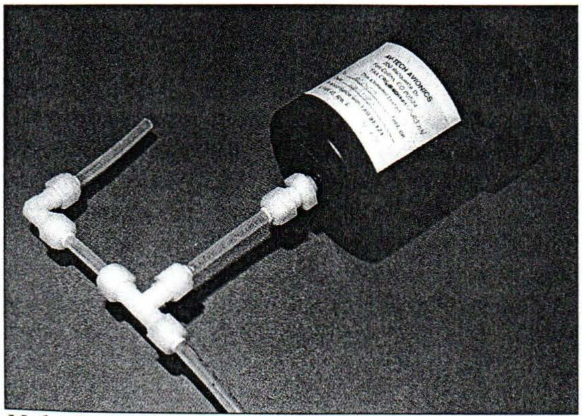
Originally introduced in 1939, there are more than eight styles of Tygon tubing, each made up of materials designed to perform in specific environments. Generally, all are flexible, heat and cold resistant, and will not corrode or otherwise deteriorate over time. Most major parts suppliers provide some pitot/static system hardware but individual pieces and parts for line repair are difficult to find, aside from ordering directly from the manufacturer. One supplier, Skybolt Aeromotive Corporation, 551 North Park Ave,. Apopka, FL 32712, phone: 1-800-223-1963 or 407-889-2613 carries a line of instrument tubing and fitting kits made from Nylo-Seal, a material made of Nylon-11 used extensively in pitot/static installations. They can supply tubing and flareless fittings as well as tees and connectors for any permanent installation or field repair.



The pitot tube on this Piper Super Cruiser is tied to the static line (on top). Note the holes drilled in the side of the static line for proper static reference.

Because repairs to leaking static lines usually involve the cutting out of a defective length and splicing in new material, the use of flareless fittings makes the job quick and easy regardless of your experience level. Simply trim the piece to be repaired, install the "B" nut and ferrule and assemble the new line to a coupling or connector. Tighten the "B" nut two to three turns only. This will force the ferrule into the female side of the connector while it grips the outside diameter of the tube. The fitting and line are now sealed. Don't over-tighten the nut and make sure the line doesn't twist during the installation.

Line terminations at instruments, water separators and alternate static sources are good candidates for replacement as time goes on. Make certain your cuts are clean and straight and position the lines so that no bend radius is less than one inch on 1/4 inch O.D. tubing. Most vinyl and nylon tubing will take tremendous pressures before bursting (compared to what you would see in the static system) but are somewhat susceptible to hardening and splitting with the application of even a little heat. Generally, plastic static lines will remain flexible at -20 F. and will work just fine to around 185 F. Any temperature higher than that will affect tube life and possibly create a hazard to system integrity. So keep the lines away from heater ducts and route with clearance around avionics stacks.



Nylo-Seal tubing and flareless fittings are standard equipment in many aircraft. Over-tightening of the fittings is a common cause of system leakage.

Pitot Lines and Airspeed

Like the static system, the pitot tub and airspeed indicator are connecte by various tubes and hoses, many o which are made from the same Tygo or Nylon-11 material used in the cabi While no mention is made of checl ing the pitot system in Part 43 Apper dix E, FAR Part 43-13-1A, Chapter 1 Section 4 does recommend cleanin and pressure testing of the systen Simply plug the pitot tube vent lo cated in the back or along the bottor of the tube and pressurize the tub with the output side of the suction gu (if yours is one that works that way Otherwise, a regulated pressur source can be used to check the pit system for leaks. Watch the airspee indicator and adjust the needle defle tion to no more than 3/4 scale or 15 knots indicated and hold for or minute. A loss of no more than te knots is considered acceptable. An further loss is reason enough to fin the source of the leak and make th necessary corrections. Again, use ca with the pressure source so as to kee the indicator glass intact and avoid rapid loss in system test pressure.

If cleaning of the pitot tube syster is required, remove the line from th back of the airspeed indicator and us clean, regulated shop air to blow bacl wards toward the pitot mast. Any dir water, bugs or other varmints will b expelled during the process. For thos who experience pitot system contam nation, it might be a good idea to wra a cloth around the tube before blov ing through the system in order t identify the offending debris. Knov ing your enemy is the key to winnir

(Continued on page 24, Pitot/Static)

(Continued from page 3, Engine Clinic)

The bickering from both sides by those instrumental in this issue is repugnant. Our efforts should be directed to the guy flying the airplane: Explain to him the importance of the inspection protocol, ease his mind about needed repairs and reassure him when repairs are not warranted. He's the one looking for answers, straight answers about the health of his engine. To leave him with nagging concerns about the inspection process or doubts about the manner and method employed in the repair is both irresponsible and self-serving. We owe him more than that.

(Continued from page 8, Annual Insp.)

12 months. The combination of correcting all mechanical deficiencies as they occur, complying with AD notes in a timely manner and keeping up with preventive maintenance during the course of the year will leave little to do during the annual but routine service and inspection. In this way, you can provide a safe aircraft, ready to serve at a moments notice, regardless of where you are in the 12 months before the next annual inspection.

(Continued from page 18, Fuel Injection)

sure that any adjustment to the wastegate plug has no deleterious effect on performance.

As always, if an adjustment makes no difference in the operation or if a component will not "dial in" to a target pressure, then the offending component is usually the one being adjusted. Before removing and replacing components, though, make certain that all other potential problems have been eliminated.

Given enough fuel supply and a nominal amount of engine RPM, the simplicity of the Continental Fuel Injection System will show itself in long, trouble-free operation.

(Continued from page 14, Bendix Switch)

you a better pilot, it will allow you more time to concentrate on a take-off roll that doesn't include doubts about whether you're *Left* or *Right* of the centerline.

CONTINUITY TEST TWIST TO START

SWITCH POSITION	CONTINUITY BETWEEN
OFF	R & GRD
	L & GRD
	L & R
	S & PR
RIGHT	L & GRD
	R & UMK
LEFT	R & GRD
	R & UMK
	GRD & UMK
BOTH	R & UMK
START	GRD & UMK
	S & BAT
	L & BO
	L & LR
	BO & LR

L-------LEFT P-----POWER
R-------RIGHT S-------SWITCH
GRD--GROUND BAT----BATTERY
UMK--UNMARKED
LR-----LEFT RETARD
BO----BOOSTER OUTPUT

(Continued from page 21, Pitot/Static)

the war.

If your altimeter and transponder are due for certification, plan to check the static system a week or so before your appointment. That will allow sufficient time to acquire the necessary parts to fix your leaking system and still give you time to buy that new car.

Postmaster: Please send address changes to Light Plane Maintenance, P.O. Box 420234, Palm Coast, FL 32142.