

How's Your Plumbing?

by Lee Kuhlke

No, I do not imply that you need to see an internist. But your glider may need a thorough examination.

Have you seen the classifieds in *Soaring*: “**Glider For Sale. Race Ready. Instruments x, y, z, etc, etc.**” What is meant by *race ready*? Is the glider ready for transport to the next contest site? Are the wings newly finished to the Akaflieg airfoil ideal? Is it over-gross with the latest gadgets and computers? To me, *race ready* means that the glider is airworthy and the instruments indicate correctly in flight.

In this article, I will limit the discussion to glider preparation of the pneumatic plumbing. Whether you fly competition, cross-country, or in the local area, it is important that the instruments are accurate. Every flight is a race against the sun. At the 2004 SSA Convention, Dave Nadler, software developer for the ILEC SN-10, listed his top 10 problems with variometers. Three of these related to the glider plumbing.

You may have assumed that since the instruments have been installed for years, that all is secure. Not so. Vinyl tubing hardens. It can crack. Loose tubing will move with disturbance or pull-ups causing errors. Connections at the instrument may become distorted. Many club gliders have never been inspected since leaving the factory.

Glider instruments are very sensitive to slight changes in air pressure. Leaks in the system will cause erroneous readings. Modern glider computers are highly dependent upon accurate inputs for their calculations. Each connection is a potential source of a leak. These leaks will have a cumulative effect and can result in a significant error at the instrument input.

RULE OF THUMB

If you disconnect tubing from a connector, cut 1/2" from the end before reconnecting it. If the length is too short, replace the tubing or insert a straight connector and connect an additional length.

The vinyl tubing has memory. It will not reseal exactly and a leak WILL result. Secure all loose tubing. As tubing flexes, the volume within the tube changes.¹ Also, connections may distort and leak due to age.

The entire time to check a system is less than two hours. Fixing the leaks is another matter!

MATERIALS

For this exercise you will need the following items (Figure 1):

1. 3 cc medical syringe
2. 60 cc medical syringe

¹Fill a tube with water and bend it. Observe the water squirt out.

3. Silicone lubricant (Vaseline will work but it causes the rubber to expand)
4. 2 - hemostats
5. Flat-beak needle-nose pliers (serrated tips will damage the tubing or connectors)
6. Wing tape or white electrical tape (black makes a mess when it is warm)
7. Small cable ties (tie wraps)
8. 6-8 feet of 5/16" OD x 3/16" ID vinyl tubing. (more if tubing will be replaced)
9. 2- T-connectors
10. 2- straight connectors
11. Stop watch or other timer



Tools needed to check and repair the glider pneumatic system.

PROCEDURES

Prepare The Syringes

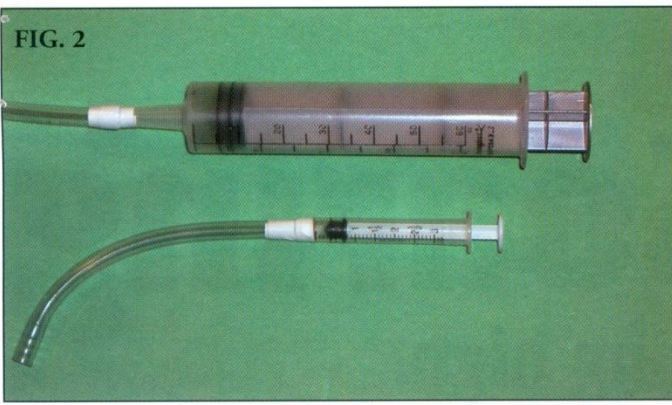
The rubber stoppers of the syringes can be sticky. You will need precise movements of the plungers for testing. Lubricate the plunger with the silicone. Insure smooth movement. Attach a 3-foot length of tubing to each syringe and seal it with tape (Figure 2). Check the seal by clamping the tube with a hemostat and withdrawing the plunger a little. It should be pulled back into the barrel.

There are two syringes. The smaller is less sensitive to technique and should be used for the direct connection to the ASI, described later. The larger syringe allows more volume for the longer tubes. When leaks are encountered it can be further withdrawn without having to disconnect and reconnect the syringe.

Airspeed Indicator (ASI)

The ASI will be the “leak detector.” The ASI consists of a

FIG. 2



Syringe tubing taped and sealed.

FIG. 4



Airspeed indicator set at 100 knots.

bellows connected to the indicator needle contained within the instrument case (Figure 3). There are two ports, pitot, and static. The bellows can be defective. If so, you need a new ASI. The most common source of a leak is the instrument face. The glass is retained by a ring on the front of the instrument and sealed with an O-ring. To adjust the face, you will need a special instrument to engage the notches. One can be made by a length of 1/2" x 1/16" aluminum the exact diameter of the ring notches. Or, one can purchase the tool from an instrument shop.

1. Begin by removing the tubing from BOTH ports of the ASI. Placing the needle nose pliers between the tube and the instrument case allows you to "push off" the tubing. Pulling the tubing acts like the "Chinese finger cuffs."
2. Set the 3cc syringe to 2cc
3. Connect the syringe tubing to the **PITOT** side of the ASI, usually the center port.
4. **CAREFULLY** push in the syringe. The needle should increase to about 40 knots. Clamp the tube with a hemostat. If the tube is not clamped, the pressure will push the plunger and give a pseudo-leak indication.

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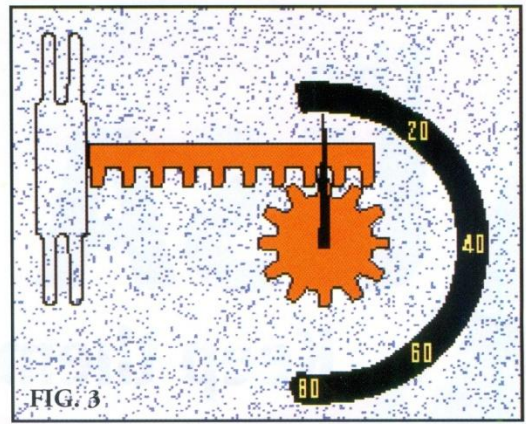


FIG. 3

Diagram of the airspeed indicator.

5. Observe the needle. It should remain steady. This checks the bellows.
6. Remove the hemostat and pull the plunger out until the indication is zero. Disconnect the tubing from the pitot port.
7. Next, set the plunger at 3cc and repeat steps 3-6. The indicator should be about 60 knots and remain steady.
8. Using the above technique and the **60cc syringe**, set the ASI to read **100 knots**. Clamp the tube and observe. The needle should be steady. Check the connections of the tubing/syringe if there is any creep. (Figure 4)

IT IS IMPORTANT THAT DURING ALL THE TESTS THE ASI NEEDLE SHOULD BE RETURNED AS NEAR TO ZERO AS POSSIBLE TO AVOID "SHOCKING" THE INSTRUMENT AND DAMAGING THE INTERNAL MECHANISM.

Now we will check the **STATIC** side. This is actually checking the integrity of the case.

9. Push the plunger of the 3cc syringe fully in and THEN connect the tube to the **STATIC** port.
10. **CAREFULLY** draw the plunger and observe the needle. The airspeed should increase to about 40 knots. Clamp the tube and check that the indication is steady. Remove the clamp and push the plunger back in to move the needle to zero.
11. Repeat Step 10 with increasing negative pressures as in Step 7 and 8 and note where 100 knots is located on the syringe.

If the ASI indication will not remain steady, there is a leak in the case. As stated before, it is usually in the face. Unscrew the retaining ring and remove the glass, clean the rubber O-ring, and lubricate it with silicone lubricant (not Vaseline). Tighten the face and check the ASI indication with the 60 cc syringe. If the indication decreases, tighten the ring and draw the plunger to indicate 100 knots again. Repeat this tightening until the

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FIG. 5



Syringe connected to external pitot tube and sealed.

indication remains steady. If the O-ring is cracked it may need to be replaced. A local instrument shop can overhaul the ASI.

IT IS IMPORTANT THAT THE AIRSPEED INDICATOR IS TIGHT OR ALL OTHER CHECKS WILL BE ERRONEOUS.

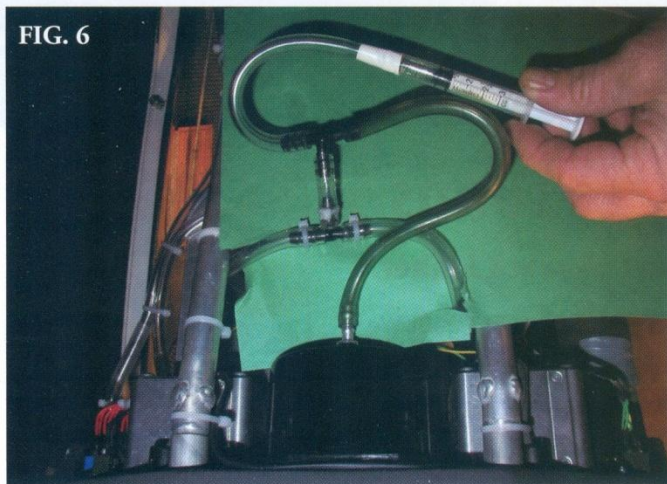
CHECKING THE SYSTEMS

Pitot System

A. If the pitot tube can be accessed directly, such as in the fin:

1. Reconnect the glider pitot tubing to the Pitot port of the ASI. Remember to cut 1/2" from the end for a fresh connection.
2. Connect the 3 cc syringe tubing to the glider pitot tube and seal the connection with tape. (Figure 5):
3. Push in the syringe, clamp the tube, and observe the ASI needle. Is it the same 40 knots and steady as when we checked the ASI alone? If not, there is a leak in the Pitot System. Now the fun begins!

FIG. 6

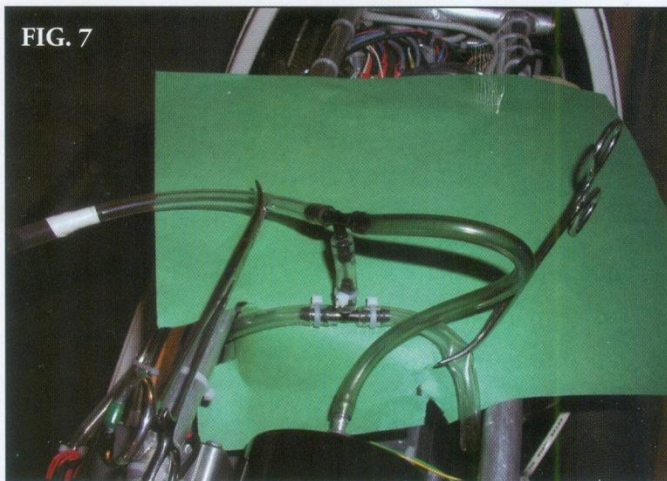


Connecting the syringe to the airspeed indicator static port and isolating the glider pitot tubing.

B. If the glider pitot tube is not easily accessible, as in the nose vent or if the above check fails, proceed as follows:

4. Place a hemostat clamp on the pitot tubing as close to the pitot tube as possible.
5. Place a T-connector on the **STATIC** port of the ASI and connect the other side of the T-connector to the glider pitot tubing. Push the plunger of the 60 cc syringe fully in and connect it to the third port of the T-connector. (Figure 6)²
6. Place a clamp on the glider pitot tubing. That is, the side of the T-connector away from the ASI.
7. Withdraw the plunger until the ASI indicates 100 knots. Clamp the syringe tubing. With both of these tubes clamped, the ASI should be as steady as in the ASI checks. This verifies the T-connector connections.

FIG. 7



Isolating the tubing connections to find the leaks.

8. Now, using the needle-nose pliers and hemostats, progressively clamp the tubing away from the T-connector toward the pitot tube until you find a leak (Figure 7). If you encounter another T-connection, use a hemostat to isolate a section. If there is a leak, cut off 1/2" of the tubing and reconnect, or replace that length of tubing. Secure each connection with a tie-wrap.
9. When all connections are secure, disconnect the glider pitot tubing from the T-connector and reconnect the pitot tubing to the **ASI PITOT** port and secure it with a tie wrap (Figure 8).
10. Remove the clamp from the pitot tube tubing in Step 4.

During all of the integrity checks, the airspeed indication is set to 100 knots and it should decrease no more than 10 knots within two minutes. (Figures 9a-9d).

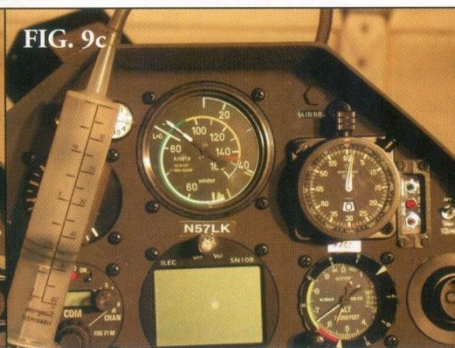
² N.B. Connecting to the static side and withdrawing the syringe has the same indication as connecting to the pitot side and pushing the syringe. It is easier to control the withdrawing than the pushing. Also, the tape used to seal the external orifices seal better with negative pressure.



Connections sealed with tie-wraps.



Figures 9a through 9d show progressive loss of airspeed indication with a leak of 19 knots in 2 minutes.



Static System

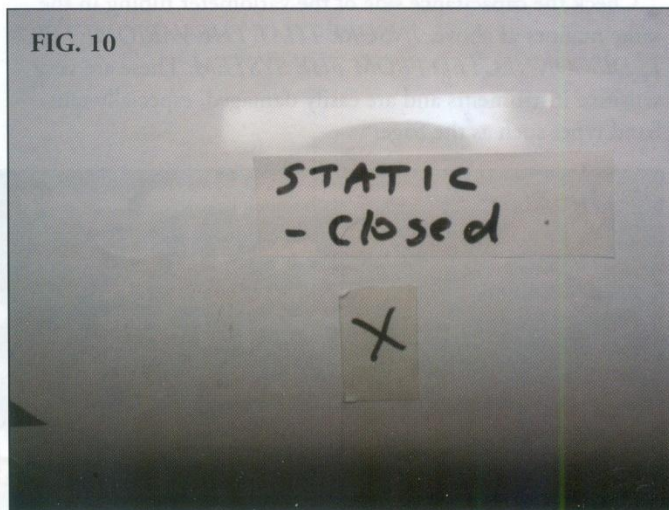
The T-connector and syringe should still be connected to the **STATIC** port of the ASI.

1. Using tape, close the glider static ports. With black marker, write CLOSED and an "X" on the tape. (Figure 10)
2. Clamp the tubing leading into the altimeter.
3. Connect the glider static tubing to the T-connector that is connected to the static port of the ASI and the syringe.
4. Withdraw the plunger to 100 knots and clamp the tube. If the airspeed decreases after setting, there is a leak in the system. First check that the tape is sealing the static ports by pressing on the tape. Then, proceed as above to isolate and repair the connections.
5. Remove the tape from the external static ports.

Total Energy System

The total energy system (TE) is checked in the same manner as the static system.

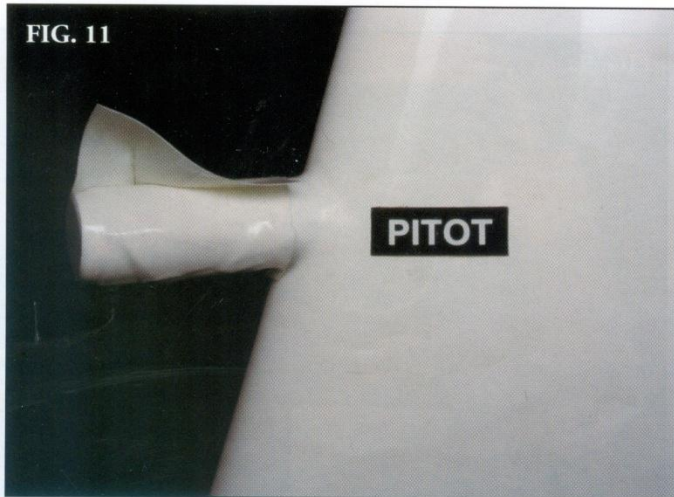
FIG. 10



Static port sealed with wing tape and marked as CLOSED.

1. Disconnect the TE tubing from the TE (or Static) side of the variometer. If there is another variometer connected, clamp the TE tube to it. There is a calibrated leak within variometers to neutralize the pressure after an altitude change.

FIG. 11



External pitot tube or total energy tube taped and sealed.

2. Seal the glider TE port with tape (**Figure 11**). Connect the TE tubing to the T-connector of the syringe which is connected to the ASI static port. Isolate and repair any leaks.

3. Now, insert the TE probe into the glider TE port. Tape the TE probe orifices. Recheck the TE system. Total energy tubes themselves can leak, especially the multi-probes. There is an O-ring in the glider fin that is supposed to seal the TE tube. It can get old and leak. They should be replaced periodically.

Multi-Probes

Each orifice of the tube will need to be checked with its respective system. In some cases, there may be leaks within the probe. The static can leak to the TE side, or to the pitot in three-way probes. These are tricky. Here, you will need to use what you have learned to isolate the leak(s).

Variometer Capacitance

Check the capacitance side of the variometer tubing in the same manner as above. **INSURE THAT THE VARIOMETER IS DISCONNECTED FROM THE SYSTEM.** These are very sensitive instruments and are easily damaged, especially taut-band types such as the Sage.



Secured and sealed pneumatic plumbing in the Ventus 2a.

Altimeter

It is unlikely that the altimeter bellows is leaking but check it anyway.

1. Disconnect the altimeter tubing from the glider static tubing and disconnect the syringe from the ASI Static. Check the altimeter directly with the syringe. This instrument is not overly sensitive but still use caution when applying pressure.
2. As with the other pressure checks, the altimeter should hold the pressure or the bellows may be leaking.
3. Disconnect the syringe and reconnect the tubing to the altimeter.

SUMMARY

The pneumatic checks should be done annually. This can be done during the off-season. Begin by insuring that the ASI is a tight instrument. Then, systematically check all the systems and connections. After you have verified a connection, tie-wrap it. This insures that it is sealed and that it was checked. Always verify the connection after the tie wrap, as this can open up a connection if the tube is loose or stiff.

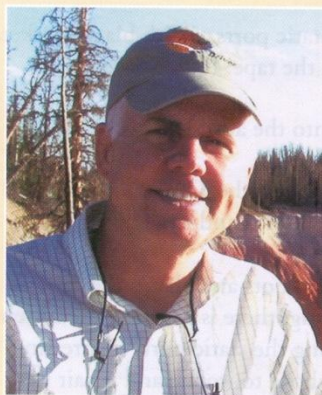
Finally, secure all tubing to minimize flexing in turbulence (**Figure 12**). Avoid connecting variometers with short lengths of tubing to reduce "cross-talk." Coiling several feet of tubing to each variometer will reduce the cross talk. Variometers should never be connected in series. In other words, there should be a T-connector between the variometers, and the TE source is connected to the T-connector. Each variometer must have its own capacitance.

BIBLIOGRAPHY

How to Fly Gliders and Pass FAA Tests, Jim D. Burch,
<http://jdburch.home.att.net2002>

Cross-Country Soaring, Helmut Reichmann, 1978

Sailplane Instruments: Present and Future, Dave Nadler,
SSA Convention, Atlanta, GA 2004



About the author: Better known lately as Mary's father, Lee earned his private airplane rating in 1968 and added a glider rating in 1979. He has logged over 2500 hours, 1300 in gliders. He holds a Diamond Badge (#514, 1982) and Lennie I (#1003, 1981). He established a National 100 km triangle Standard Class speed record

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