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To: Autopilot repair customers

From: Penn Avionics service department

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RE: Repair procedures for older autopilot systems

We receive questions from customers regarding the technique that Penn Avionics uses to troubleshoot and repair older autopilot systems. The purpose of this memo is to describe our approach and inform the customer of the issues involved in servicing older avionics.

Older autopilot systems are defined as systems more than 15 years old. These would include but are not limited to; Century I, II, III, IV ,21, 41, King KFC 150, and 200, Cessna ARC any 200, 300, 400 series autopilot, STEC 40, 50, 60-2.

The inherent problem with repairing any autopilot systems is that for the system to function correctly, numerous sub-systems must all function correctly. This significant differentiating issue is not found in other avionics repair scenarios. There are simply many more autopilot sub assemblies that must all perform correctly as opposed to a nav-com, audio panel, or other avionics problem. Some customers believe that an autopilot repair falls into the same category as any other avionics problem; sadly this is not the case.

In general, autopilot failures that result in the autopilot system not powering up (the system is dead), are more straight forward to repair than autopilot performance problems. The most difficult (and expensive) type of autopilot problem is the “poor performance” squawk. The typical complaint would be; “the system has a slight porpoise in altitude hold”, or “it does not track the nav well”, or “it seems to run OK for 30 minutes then it won’t hold heading”. The reason this type of complaint is difficult to service is that any one (or a combination of several) autopilot sub assembles may be causing the problem.

When an autopilot system ages 15 years or more, each part of the autopilot system will not be performing to “factory new” specifications. This makes identifying the problem component more difficult. In some cases this degradation can be observed and measured, and in some cases not. In some cases an old component of the autopilot may be failed completely, but that failure is not contributing to the customer complaint. (One example might be the flap compensator pot, or an airspeed switch that has failed, or some controller mode that does not work, but the customer never uses that mode, and does not care about it). This will increase the troubleshooting time.

To clarify the last paragraph, let's look at what components of an older typical GA autopilot might cause a pitch axis problem. Let's assume the customer has complained of poor altitude hold performance. The possible areas that Penn Avionics would need to test/troubleshoot would be:

1. The autopilot computer that processes the altitude information and drives the pitch servo
2. The Pitch servo that is connected to the elevator (This is a DC motor that wears out, and has a slip clutch that will degrade over time)
3. The trim servo (if installed), that gets a drive signal from the pitch servo (if the trim servo is not driving correctly, the pitch servo and trim servo will fight each other and cause poor performance)
4. The trim amplifier (This device processes the information from the pitch servo or autopilot computer and drives the trim servo)
5. The aircraft primary control cable that is connected to the pitch servo. (Is the tension correct? We had a Piper aircraft in recently that required a 40lb tension on the primary control cable, but the measured value was less than 11lbs. This will cause sloppy control)
6. The aircraft static system that provides pressure information to the altitude hold transducer (if the static system has a leak, this will an erratic input to the transducer and cause poor performance)
7. The harness that connects the autopilot components together. (Connectors degrade; the female sockets loose the contact force against the male pins, and this will cause unpredictable problems. This is a major problem with Century systems).
8. The altitude hold module. (This device senses the outside pressure from the aircraft static system and sends the signal to the autopilot computer. If the transducer has a problem, the altitude hold will be effected)
9. The gyro horizon or the pitch accelerometer. (These devices tell the autopilot computer what is level pitch, and the autopilot uses these signal to determine how much of a drive signal to send to the pitch servo.)
10. Airframe rigging problem, or excessive friction in the control surface. (The autopilot will only work as designed if the airframe is in rig in accordance with the airframe manufacture specs. If the primary aircraft control cable is too tight or too loose, the autopilot servo will fight with it trying to control the aircraft.)
11. Autopilot component mounting. Servo's, transducers, and accelerometers have specific mounting requirements.(If these mounts get loose or degrade pitch performance will suffer)
12. Pilot error. Some pilots simply do not understand the autopilot and expect a different behavior that what they are experiencing. They believe the system has a problem, and bring it in for service.

From this list it should be obvious that there is no clear-cut easily identifiable component that would cause the pitch problem. Penn Avionics will use our past experience with each system to identify those areas that statistically cause the reported problem. In most cases we can sort out the problem in short order. If the repair solution is not obvious, Penn will work thought the autopilot system correcting what problems we find. This will allow us to eliminate specific components as we narrow down where the problem is. This process may involve several bench tests, test flights, or component substitutions.

Some customers have expressed concern having to pay for one component repair, then finding that the significant problem was a different component. Unfortunately, we know of know other way to approach these aging autopilots than this approach. If we find a component that is related to the customers reported problem and it has degraded well below spec, we simply must correct that before we can take the next troubleshooting step. Although this may not have been the specific correction that solved the customers' problem, there is no way to avoid this interim repair in the overall autopilot repair process.

Repairing any older autopilot components should help the customer experience a longer run between failures. For example, if the pitch servo is on its way out, it is only a matter of time before it fails completely and the customer has to return to the shop for a repair. The pitch servo is related to the customer's pitch problem, so Penn would normally repair the servo during the troubleshooting process. If after repairing the pitch servo, the pitch problem still existed, Penn would continue to troubleshoot the system until the problem was solved. Assume that the customers pitch problem was a degraded pressure transducer that we replaced to solve the autopilot problem. If we had left the degraded pitch servo, then no one will be very happy when the customer returns some time later with the same complaint of pitch problems. The customer now had to return twice to have a pitch problem corrected even though the two failures were un-related and involved different autopilot components.

One repair alternative the customer has is to remove the older autopilot system completely and replace it with a new autopilot. STEC has simple 2-axis systems that start in the $10,000.00 area installed. For the customer that does not wish to proceed with troubleshooting the older autopilot, or has had on-going problems with the older system, Penn would recommend replacing the system.

As all avionics systems age beyond 15 years, they become a challenge for any avionics repair shop. Many of these older avionics systems have outlived their design life yet are still in service today. This is largely due to the high cost of replacing these systems as compared to the cost of repair. Many older autopilots can be made to perform acceptably, but the process will require an understanding on the part of the aircraft owner as to what is involved.

Penn Avionics always strives to make your repair experience as simple as possible, and we thank you for your business.