TECH TIME

Helpful tips for the Avionics Technician

BY AL INGLE

This month we continue our series on autopilot theory and operation by performing a real world inspection of an autopilot as installed in an aircraft. Typically the owner or operator will contact the repair station and make an appointment to have the aircraft repaired. At this time the avionics contact can probe the pilot about the symptoms and offer insight into the problem and offer possible solutions. It would be helpful if the pilot has been given a copy of the AEA's *Pilot's Avionics Troubleshooting Guide* to assist in the troubleshooting. Upon delivery of the aircraft and initiation of the proper paperwork, an avionics technician is assigned the task of troubleshooting the system. We are going to assume that after a ground functional test, the aircraft will be flown to test its aerial performance.

One never flies an aircraft without performing a ground inspection. The avionics technician should walk around the aircraft checking all control surfaces for any looseness- all bushings should be tight. Apply pressure to the horizontal and vertical stabilizers, there should be absolutely no movement. You also want to look at the trim tabs for any unusual placement or setting that may suggest aircraft trim problems. The static and pitot sources should be checked for debris and any deformation in the localized area. The pilot should be licensed and qualified and the appropriate aircraft documents available i.e. Airworthiness and Registration certificates, FCC License, Pilot's Operating Handbook (POH), appropriate placards and limitations.

For attitude based autopilots, immediately after the engine is started and vacuum is applied to the gyro horizon, monitor its movement as it spins up. For a gyro at rest, a fast erect mechanism will cause a considerable amount of background movement in the gyro as it comes up to speed. The shaking, wobbling and speed of erection is an indication of the gyro's overall serviceability and should be noted. If the gyro was spinning before the engine was started, the rotor's inertia will prevent the fast erect mechanism from operating and the erection will proceed at approximately 3º per minute. This is a common phenomenon when dropping off a passenger on a multi-leg trip. The vacuum gauge should be reading between 4.8" and 5.2" when reasonable power has been applied to the engine(s). Remember that the air density decreases with altitude and that adequate vacuum on the ground may be inadequate during cruise. Also, the vacuum gauge should be measuring the difference in potential directly across the gyro horizon, otherwise, the gyro could be receiving less air than expected with attendant decreased RPM.

For rate based autopilots the turn coordinator should indicate wings level when the aircraft is stopped and smoothly show right and left hand movement as the aircraft's heading changes. For most aircraft the defined standard rate turn is 3º, therefore the turn coordinator can be roughly checked on the ground by making large turns i.e. a 90º turn should take 30 seconds. The flag should be out of view.

For all aircraft the electrical buss should indicate a voltage found during charge i.e. 13.75 or 27.5 VDC as appropriate. The technician should be knowledgeable of the autopilot's operating procedures and the appropriate Operator's Manual for that autopilot should be available. The manual electric trim should operate smoothly and drive in both directions to the stop. The autopilot should pass its self-test (if applicable) and all disconnect modes should be checked at this time i.e. depressing the yoke mounted master disconnect, by activation of manual trim, by deactivating the autopilot circuit breaker and/or other methods described in the POH. Reengage the autopilot and ensure that all applicable axis are engaged, that is, that the yoke cannot easily be moved in roll and pitch, then manually override the yoke control both in roll and pitch to insure that the clutch(s) will slip.

Now that the fundamentals have been tested, it is time to delve into the heart of the autopilot. Holding the yoke level in its neutral pitch position, engage the autopilot. The typical default mode is HDG hold (or wings level) and attitude hold. Now apply downward pitch pressure to the yoke and after a delay of several seconds, the autotrim should begin to trim in a direction to remove the pressure that you are applying, or trim down. Reverse the pressure on the yoke by pulling it towards you and after a similar

delay, the trim should begin moving up. This is a simple and effective way to determine the basic operation of the trim system.

In the HDG mode the yoke should turn right or left as the HDG bug is displaced from the 12:00 o'clock position of the DG or the HSI indice. In the NAV mode, the autopilot will track the deviation needle, but just as a pilot must know the approximate heading to its destination or waypoint, the autopilot must also have an approximate heading. This information is derived from either the DG or HSI. Therefore, with a centered HSI course pointer (CRS), or DG HDG bug (HDG) the autopilot should follow the deviation needle. If however the CRS control or HDG bug is displaced from the 12:00 o'clock indice, the autopilot will fly an intercept heading as determined by the amount of these errors. A rule of thumb is the autopilot should intercept a full scale needle at a 45º angle. To test this, apply a NAV signal sufficient to cause a full scale deflection and then adjust the CRS/HDG error until the yoke moves to the neutral, level position. Slowly increase/decrease the CRS/HDG error such that you can make the yoke swing back and forth from level. The average of the CRS/HDG values is the intercept angle. Also note that once many autopilots are established on course with a centered needle, the course signals are "washed out" to compensate for wind drift. Select HDG mode to reset these circuits if necessary.

To test the approach mode, APR (or similar) is selected. Here the gain of the roll channel is increased and the glideslope capture circuitry enabled. The roll portion is functionally tested in a manner as described above, except the intercept angles are tighter. You may consult the operator's manual for specifics. To test the glideslope's capture and track, prior to selecting APR, an ILS signal should be radiated causing the glideslope's deviation needle to indicate a full scale "fly up". This simulates the aircraft approaching beyond the Outer Marker, or more than five (5) miles from touchdown. Select APR and ALT (altitude hold). The autopilot will maintain altitude hold and follow the Localizer deviation signals. It should not respond to the "fly up" glideslope command at this time. Now slowly (over twenty seconds or more) begin to center the glideslope deviation by adjusting the ILS ramp equipment. As the glideslope needle passes through the center or on path position, the autopilot should transition from ALT to GS capture. There may be a corresponding noticeable pitch down movement of the yoke at this time. Now the yoke should follow the action of the GS deviation needle. You are simulating the passage of the aircraft through the Outer Marker and subsequent descent to the runway. Note that some autopilots allow all angle intercept, again consult the operator's manual and test as you feel is required under the circumstances.

Additional tests that may need to be performed at this time will depend upon the autopilot, the optional equipment installed and the reported problems that are being addressed. Some autopilots have gain programmers that change the gain during an approach. These inputs typically come from the radio/radar altimeter or Outer and Middle Markers. For altitude preselect problems, the static sense line to the computer must be evacuated to simulate the Gillham (parallel) or serial altitudes required. The Flight Director can be monitored during all tests for proper operation. Don't forget to check the aural and visual disconnect devices. The autopilot disconnect's aural transducer may have been inoperative for years without the owner/operator aware of its existence.

The technician should be performing a comprehensive check during this engine runup and taxi. There is however, one more test that needs to be performed before flying the aircraft. It has been overlooked by many in the industry and caused more roll problems than possibly any other. How many times has a pilot reported the autopilot not flying a centered HDG bug, or the autopilot will not fly a centered needle? How many times has the Turn and Bank or Turn Coordinator been replaced? How many times has it been checked to confirm it is installed *level*?

Next Month: More autopilots