GUIDANCE FOR THE AUTO-PILOT FLIGHT TEST

For use with Flight Test Schedule LAA/FT-AP

Because the auto-pilots are not designed for a specific aircraft type, manufacturers build in the capability for many of the system's parameters to be calibrated by the user. The purpose of the flight test is to ensure that the calibrations have been set correctly and that the auto-pilot operates safely and appropriately for the aircraft type it is fitted to.

For safety, it is best to conduct the flight test in good visual conditions, well clear of controlled airspace and descending to a height of no less than 2000 feet agl. Remember that regular and thorough look-out is vitally important, particularly as it will be necessary to refer often to instruments and the auto-pilot controller throughout this flight test. The use of an experienced observer is recommended but he/she should not be depended on for all look-out tasks.

The items below correspond to the numbered items on the flight test schedule LAA/FT-AP. Items 1 to 4 should first be checked on the ground and only if these are found to be satisfactory should flight testing proceed.

1.

- First trim the aircraft to fly straight and level with normal cruise power set and the auto-pilot off. Then engage the auto-pilot and establish that it is maintaining straight and level flight correctly. Press one of the auto-pilot disengage switches. The auto-pilot should disengage with no adverse effect on the servos.

- Re-engage the auto-pilot and, once having established that it is functioning correctly, press the other disengage switch. Again the auto-pilot should disengage from communicating with the auto-pilot servos with no adverse effect on them.

2.

- Where fitted, the aural 'auto-pilot disengaged' warning should sound when each of the auto-pilot disengage switches is operated.

3.

- Re-engage the auto-pilot and check that when operating the radio transmit button(s), using frequencies throughout the full frequency range that the servo(s) do not respond in a detrimental way.

4.

- With the auto-pilot engaged verify that it is functioning correctly once again then gently operate the aileron control to cause the aircraft to roll. You should notice the servo generated force attempting to level the wings. Check that the auto-pilot servo slips in a roll to both port and starboard. The force required to overpower the servo should be only fractionally more than that needed to manoeuvre the aircraft normally with a single finger on the stick grip.

- If an auto-pilot (pitch) system is installed, next gently pull on the elevator control to cause the aircraft to climb. As the aircraft climbs away from the established altitude, you should notice the servo generated force attempting to pitch the aircraft down. Check that the auto-pilot servo slips. Some auto-pilots may include a warning or command to descend, the function of which should be referred to in the comments box. The force required to overpower the servo should be only fractionally more than that needed to manoeuvre the aircraft normally with a single finger on the stick grip.

- Allow the aircraft to return to the established altitude and trimmed speed then repeat the above check but this time pushing gently on the elevator control to initiate a descent.

- For auto-pilots that are designed to disengage the servos after a force sufficient to cause servo clutch slip has been applied to the control column, usually with a small delay to prevent spurious disengagements, check for correct operation of the aural and visual warnings.

5.

- To establish if the connection of the auto-pilot system to the aircraft control system has any adverse effect on lateral stability, disengage the auto-pilot and carry out medium side-slips in each direction, flaps down, releasing the aileron control but maintaining the applied rudder and check that the low wing rises.

6.

- With the auto-pilot off, first establish the aircraft's maximum cruise speed (V_H) by applying full power and adjusting it to maximum continuous rpm as required and noting the maximum speed in level flight. Record this speed on the schedule.

- Return to normal cruise speed and engage the altitude hold. Increase power and adjust to maintain maximum continuous rpm while the aircraft accelerates, trimming as necessary to prevent servo slip.

- Observe the auto-pilot's behaviour in maintaining altitude throughout the acceleration and at V_H, checking that its response to altitude excursions does not induce vibration or flutter. Should flutter be observed, immediately disengage the auto-pilot, reduce power and airspeed by climbing.

7 & 10.

- In light to moderate turbulence, monitor how the auto-pilot responds to upsets in roll and pitch as appropriate. An excessively high loop gain setting will result in too aggressive a response and possibly repeated overshooting of the wings level attitude or established altitude whereas with too low a loop gain, the autopilot will respond sluggishly and allow excessive departure from established attitude or altitude; ± 10 degrees in roll and ± 30 feet in altitude is acceptable.

- With the aircraft established at an altitude and at trimmed speed observe the movement of the controls for rapid lateral or fore and aft movement known as jitter (lack of system damping). This is best done in smooth air conditions and may require a minor rapid push or pull and release on the roll and pitch controls (stick raps) to excite the system.

8.

- Where the auto-pilot is connected to navigation equipment, establish the aircraft on a track. Temporarily disengage the auto-pilot and turn the aircraft to fly the reciprocal track (off track angle of 180°). Re-engage the auto-pilot to check if it is capable to cause the aircraft to re-establish the desired track. If unsuccessful, reduce the off-track angle in increments until the auto-pilot is able to successfully re-establish the original track. Record the maximum off-track acquisition angle demonstrated.

9.

- Where the auto-pilot has the facility to accept manual turn commands, select maximum rate turn and check that the roll angle does not exceed 60° within 4 seconds of the roll command being made and that roll response is not excessive.

- Where auto-pilot manual roll control is not fitted, roll the aircraft to 60 degrees bank angle using the aircraft aileron control (auto-pilot engaged) then release it and record the time taken for the auto-pilot to return the aircraft to a wings level attitude. The time taken should be more than 4 seconds.

- For auto-pilots that are designed to disengage the servos after a force sufficient to cause servo clutch slip has been applied to the control column, usually with a small delay to

prevent spurious disengagements, first measure the minimum stick force required to cause servo clutch slip to occur then, with the auto-pilot disengaged, roll the aircraft by applying the previously established servo clutch slip force and check that the roll angle does not exceed 60° within 4 seconds of the roll commencing and that roll response is not excessive.

10. See 7.

11.
- Engage both the roll and pitch auto-pilot functions but without a specific course set. Note the altitude established then, using the turn command of the wing leveller, select a maximum rate turn. After a change of heading of at least 90 degrees, select wings level. Note the maximum deviation from the established altitude at any point in the manoeuvre. Where auto-pilot manual roll control is not fitted, cause the aircraft to turn by intercepting a pre-set track

- Repeat this check whilst turning in the opposite direction.

12.
- With the auto-pilot (pitch) system engaged and the aircraft steady in the cruise, reduce and adjust power to cause a speed reduction of 20kts within a maximum time of 1 minute. The established altitude should be maintained throughout. When the reduced speed is reached, disengage the auto-pilot (pitch) system and check that the aircraft has been re-trimmed for level flight.

- Re-engage the auto-pilot (pitch) system and accelerate back to the original cruise speed and repeat the check for re-trimmed flight.

13. Self explanatory.

14.
- Establish the flaps-up stall speed, V_{S1} by conducting stalls as necessary and record V_{S1} x 2 and V_{S1} x 1.2 on the schedule for reference.

- Set the aircraft up to fly level at the V_{S1} x 2 speed then engage the auto-pilot (pitch) system.

- Reduce power gradually until you observe the servo to slip and note the airspeed at which this first occurs. If this airspeed is less than V_{S1} x 1.2 the servo maximum torque value is too high and appropriate adjustment will be required. Record the new value on the schedule as appropriate.

- Disengage the auto-pilot (pitch) system and note the force on the control column to prevent excessive pitch down and, upon release of the controls, note the rate of pitch change (stick free pitch rate) that results. Record either a description of, or the actual values noted.

15.
- From the stable cruise condition with auto-pilot engaged, select a series of different climb rates and check that the climb rate achieved is within 20% of the value selected.

- Repeat the above when selecting a series of different descent rates.

16. Self explanatory.

17.

- Note on the schedule for reference the values for the auto-pilot's maximum vertical speed selectable, V_{S1} x 1.5 and V_{NE} x 0.9.

- From a stable normal cruise condition with the auto-pilot engaged, select maximum climb rate available without changing the power setting and check that the pitch attitude is controlled to prevent an airspeed less than V_{S1} x 1.5. Record the minimum airspeed observed.

- Repeat the above, starting from a speed no more than V_{NE} x 0.8, this time selecting maximum descent rate available and check that the pitch attitude is controlled to prevent an airspeed more than V_{NE} x 0.9. Record the maximum airspeed observed.

18.

- Note on the schedule for reference the values V_{S1} x 1.5 and V_{NE} x 0.9.

- From a stable normal cruise condition with the auto-pilot engaged, select maximum climb rate available, simultaneously applying full power and check that the airspeed does not decay below V_{S1} x 1.5 during the climb.

- From a stable normal cruise condition with the auto-pilot engaged, select maximum descent rate available, simultaneously reducing power to idle and check that the airspeed does not increase to beyond V_{NE} x 0.9 during the descent.

19.

- From the stable cruise condition with auto-pilot engaged, select the maximum climb rate available and check that the pitch up rate is not excessive, can be easily reduced by pressure on the elevator control 4 seconds after initiating the climb and that pitch attitude does not exceed 20 degrees. Carry this test out at, at least three significantly different airspeeds and power settings, e.g. normal cruise speed V_C, V_{S1} x 2 and V_H.

- Repeat the above when selecting maximum descent rate available.

20.

- With the auto-pilot (pitch) system engaged and the aircraft steady in level flight (at a slow cruise speed initially), operate the nose-up pitch trim switch continuously until 4 seconds after the first indication of aircraft pitching. CAUTION – DO NOT ALLOW THE AIRCRAFT TO DEPART FROM CONTROLLED FLIGHT AS THIS MAY CAUSE STRUCTURAL OVERLOAD OR PILOT DISORIENTATION.

- Without re-trimming, return the aircraft to level flight and its original speed and, upon manual auto-pilot disengagement, note the load on the elevator control then carefully release the elevator control to note the stick free pitch rate. Record either a description of, or the actual values noted.

- Repeat this check applying nose down trim.

- Repeat the above at increasing cruise speeds, but only if the preceding check did not result in a pitch rate or angle that was near acceptable limits.

21. Self explanatory.