THE PERMIT RENEWAL TEST FLIGHT FIXED WING AIRCRAFT

Every LAA Permit to Fly aircraft must be flight tested at each annual renewal of the Permit to Fly. The results of the flight test are forwarded by the owner to the LAA Engineering Office together with the maintenance details and fee, and the results are examined by the LAA Engineering staff as part of the checking process for the renewal of the Permit. The flight test is carried out in accordance with the schedule provided in the blue Permit renewal form LAA/FWR-1 which is provided by the inspector responsible for the renewal inspection.

1. Who Does The Flight Test?

The flight test must be carried out by a pilot who has studied the test requirements and is fully capable of carrying them out. Many owners prefer to do the flight tests themselves, and would not risk letting anyone else fly their prized machines. The minimum previous flying experience for the pilot carrying out the test is 100 hours total time including 10 hours either on type or on a similar or related type. Having said this, many pilot/owners with many more hours but out of practise at stalling, sideslipping etc do no feel confident about carrying out the tests, and prefer to ask someone else to do this on their behalf. If you should be in this position, avoid the local 'ace of the base' whose experience in propping up the bar exceeds his actual competence with stick and rudder. Some busy owners are only too happy to leave the flight testing to the maintenance organisation carrying out the renewal, while some individual LAA inspectors regard it as part of their responsibilities to carry out the flight test themselves. It is up to the owner to talk this through with the inspector when the renewal is being organised, to come to a mutually satisfactory arrangement and fix up the insurance accordingly.

2. Must the Flight Test be done solo?

The renewal flight test should be carried out at no less than 90% of the maximum permitted gross weight, in order that the performance can be checked at close to the worst case conditions. For two seat aircraft it is usually easiest to achieve this by carrying two crew rather than seat ballast, since there is usually no readily available method for securing ballast without any possibility of the ballast moving around and jamming the controls or causing some other hazard. The second crew member can ease the pilot's workload by looking after the recording of the test results and keeping an eye open for other aircraft whilst the pilot is concentrating on the tests. The second crew member must be briefed by the pilot before the flight about the contents of the test schedule and the fact that there may be marginally more risk during a test flight than at other times. The flight must take place in the spirit of genuine technical investigation and not a joy-ride. Both crew must be aware that the flight test results are being obtained as part of a mandatory procedure and that there may well be circumstances in the future where the pilot will have to be prepared to attest to the results in court.

3. Before the Flight

If the flight test is being carried out after the annual renewal inspection, then, after any work required by the inspector has been completed to his or her satisfaction, the inspector will need to ‘certify’ the work by signing a PMR (Permit Maintenance Release) plus, if the Permit to Fly has expired, but less than twelve months ago, a PFRC (Permit Flight Release Certificate). If the Permit expiry date was more than twelve months ago, the renewal form has to be sent to LAA Engineering and the Engineering staff will then review the application and, if satisfactory, will issue the Permit Flight Release Certificate and send it on to the owner.

Note: The PFRC cannot be used to authorise flight outside the UK. If the permit expires while the aircraft is abroad, a special procedure is used to authorise the test flight. Contact Ken Cragie at LAA HQ for details.

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Once this paperwork is in place and the insurance has been organised, the pilot needs to prepare for the test flight by giving the aeroplane an extended pre-flight check. Have all tools, inspection mirrors, rags etc been removed from the dim and distant corners of the airframe? Are all the inspection panels back in place? Are all the cowlings properly buttoned up? Is the correct oil in the engine and gearbox and are the drain plugs wire locked? If the fuel system has been drained, has it been checked for air-locks in the pipes after re-fuelling, and proper flow from each tank established?

Now the pilot needs to think in particular about aspects of the aeroplane that may relate to the flight test results. Stand back and take a good look at the aeroplane from about ten yards or so directly behind it. Do the flying surfaces look properly rigged with even incidence and wash-out either side? Are the trailing edges getting unduly distorted under fabric tension, which may upset the trim? With the control stick central, are the ailerons in line with the fixed wing trailing edges or, in older aircraft, correctly and evenly 'drooped' so as to balloon up to the in-line position when in flight? Are the leading edges of the wings battered out of shape by decades of accumulated 'hangar rash' which may upset the stall characteristics? Is there any evidence of a build-up of mud, water or ice in the trailing edges of the control surfaces which may upset their balance and cause them to flutter at less than Vne? If a control surface has a large fixed trim tab on it, this may point towards an effort to correct some fundamental rigging error which may show up through unexpected stall handling or excessive stick pressure being required to stay level at different airspeeds. Is the pitot tube straight, healthy looking and clear of insects or other debris which might make the ASI under-read and tempt the pilot to dive the aircraft to a speed faster than it is designed to withstand? Similarly, are the pitot and static lines free of water, which can have the same effect?

4. Weight and Balance

The pilot must get hold of the up-to-date weight and balance schedule for the machine and work out how to load the aeroplane to between 90 and 100% of the maximum take-off weight allowable as indicated on the Permit to Fly, and to keep within the permitted centre of gravity range as the fuel is burned up during the flight. The aim should be to simulate the typical actual loading during a fully loaded flight. The actual take-off weight and cg position must be recorded on the flight test form. It is not sufficient to state 'within limits'.

5. Equipment

You will need the test schedule, something to write with, a spare something to write with, a stopwatch (preferably) or watch with seconds indication. You will need some means of measuring the ambient air temperature - preferably an OAT gauge fitted to the aeroplane; alternatively you can ask the local Met. office for an 'aftercast' temperature estimate.

6. Weather

The test flight will need to be carried out in reasonably calm weather in order to give meaningful results and to allow the dive to Vne to be carried out without a risk of overstress. An adequate ceiling will be required to allow stall tests to be carried out at a safe height.

7. Engine Run and Ground Checks

Particular attention needs to be paid to the engine ground run checks if the aircraft has been worked on for its permit renewal prior to the flight. All that is required is to allow the engine to warm up to its normal operating temperatures and then record the maximum static engine rpm, having been sure to position the aeroplane over a piece of ground free of grit etc which might damage the propeller. Check all other instrument indications and that the engine controls operate normally. Causes for rejection would be any unusual instrument indication or control malfunction, or a maximum static engine rpm which was outside the permitted range. For many homebuilt aircraft the acceptable range is undefined, but most certificated vintage aircraft have specified limits in their Flight Manuals which should be complied with.

After the engine tests are completed, the flying controls, trimmers etc should be checked along with the flight and navigation instruments, as for a normal pre take-off check, and any unsatisfactory features noted. If in doubt, shut down and get it sorted before committing yourself to flight.

8. Taxiing and Take-off

All that the test schedule asks is for the aeroplane to be taxied out in the normal way, and to check for any abnormal features or inadequacies of the brakes, steering, controllability etc. Any unusual tendency to swing on take-off should be noted. Common causes of rejection here would be stretched and ineffective tailwheel steering springs, unserviceable or wrongly adjusted 'break-out' tailwheel steering mechanisms, and snagging or uneven brakes.

9. Climb

Although this test comes first on the schedule, it is not necessary to carry out the climb test immediately after take-off. You may want to feel the aeroplane out first, or position to a piece of unrestricted airspace. The climb should, however be done fairly early on in the test so as to ensure that the total weight is close to that calculated, ie not too much fuel has been burnt off. The aim of the climb test is to measure the rate of climb under steady state conditions at full throttle and check the engine operation under these conditions.

Before starting this test, you should record the QNH and the outside air temperature. This information is required so that should the need arise we can correct the measured climb rate results back to 'standard atmosphere' conditions, ie adjust the figures to account for the effect of the actual air density on the day. We would only normally have to do this if you have a marginal climber and do the test on a very hot day, and your recorded climb rate works out to be sub-standard.

Assuming that local terrain height allows, the timed climb should be carried out between 1000 and 2000 ft QNH. If you are flying from, say Dunkeswell which is something like 800 ft ASL, you will probably need to make the climb between 1500 and 2500 ft QNH, or even 2000 ft and 3000 ft. In this case, simply mark the schedule up accordingly. It is also important to carry out the climb in a piece of airspace free of turbulence, thermic or orographic activity which will upset the results - this means a day when there is not too much wind, clear of cumulus type cloud and hilly areas.

How is the climb carried out? It is not acceptable to fly along level at full throttle at 1000 ft, pull the stick back to climb and simultaneously trip the stopwatch. The extra airspeed at the start would result in a 'zoom climb' in which the initial climb rate would be much higher than the sustainable rate. Assuming you are not making the test directly after take-off, you should start the climb by first setting the aeroplane up in level flight at, say, 200 feet below the targeted 'start altitude'. Bring the airspeed slowly back to the best climb airspeed, at the same time reducing the throttle setting to maintain roughly level flight. Trim. Once the correct airspeed is established, open the throttle fully and nose up into the climb, make whatever further trim adjustment is needed to stabilise at the best climb airspeed, at the same time making sure that the skid ball is accurately centred by proper use of the feet. Now watch the altimeter and start the stopwatch as you pass through the selected altitude. Now concentrate on flying accurately straight ahead and in balance at within 2 or 3 mph of the trimmed airspeed, if necessary weaving slightly for visibility ahead. If your aircraft is a Pitts or Glasair then the test may only take 30 seconds or so. If you have a more pedestrian machine then you may have a leisurely two or three minutes whilst the altimeter grinds its way up to the finish altitude. As you pass through the finish altitude, record the elapsed time, also note down the airspeed in the climb and the engine rpm before going on to the next test.

Any significant degradation in the rate from that obtained in previous years needs to be investigated - it may be that the engine is no longer producing peak power for some reason, or a wooden propeller may be warping out of true pitch with age, or the aeroplane may be out of rig. We will also expect to see an appropriate engine rpm in the climb, showing that the propeller is suitably matched. The engine rpm at full throttle in the climb must not exceed the engine's maximum permitted RPM stated on the Permit to Fly limitations sheet.

10. Stalls

The test schedule states that the stalls should be carried out at a safe altitude. What constitutes a safe altitude will depend on the type of aeroplane concerned - 2000 ft AGL might be appropriate for a microlight whereas one might want twice this for a 'hot ship'. Depending on the aircraft type, you may not expect any dramatic stall characteristics to be revealed in straightforward stalls with the engine throttled back, but aeroplanes seem to be particularly good at springing a surprise on you when there is not much height to play with. For example, the engine might stop. Therefore you should have a field within gliding distance, a restart procedure and a 'decision height' in mind.

The aim is to approach the stall in approximately level flight with the throttle closed and the speed bleeding off very slowly, the airspeed dropping by roughly 1 mph per second. It may take a few attempts to get the knack of bringing the stick back at the correct rate to achieve this, and to use the feet to keep the aeroplane in balance as the speed falls away. If the stick is brought back too quickly, the aeroplane's nose will end up way too high, with the result that when the stall comes it is much more violent than is required, and the nose will plunge through the horizon on its way down. This will indicate how well the cockpit floor has been cleared of dirt prior to the flight, but very little else.

All that is required is a gentle stall, in which there should be plenty of time to notice the airspeed at which stall warning starts (natural or artificial) and the minimum airspeed achieved before the nose or wing starts to drop. As soon as this occurs, normal recovery action should be taken. Notice whether there has been any unusual tendency for a wing to drop or any other unusual characteristic such as a 'lightening off' of the back stick force just before the stall or tendency of the rudder to snatch at the stall. Note the results on the schedule and repeat the procedure with the flaps down. This time, particular care will be needed to avoid exceeding the flap limiting speed on the recovery from the stall.

Any significant change in the recorded stalls speeds or characteristics from those obtained in previous years indicates the need for further investigation. It might indicate that the airspeed indicator needs to be re-calibrated, or the pitot re-aligned, or it might be that the airframe or controls have been mis-rigged. It may be that the wings have been re-covered and that small but vital stall trip strips have not been re-fitted again afterwards.

Be aware, though, of the fact that the loaded centre of gravity position and the piloting technique will probably have a significant effect on the stall results and if you did not carry out last years tests yourself, you might not be comparing like with like.

11. Lateral and Directional Stability

The aim of the lateral and directional stability test is to check the aeroplane's natural tendency to recover from a sideslip type manoeuvre when either the ailerons or the rudder controls are released. It is not expected that the machine will magically return to level flight when the aileron or rudder control is released, but merely that there is a tendency to roll or yaw in the correct direction. Even though you may not usually sideslip the aircraft, nevertheless inadvertent sideslips will be induced in turbulent conditions and it is important to ensure that the aeroplane has a tendency to recover rather than 'wind up' into a screaming spiral dive or depart into an uncontrolled yaw. To a large extent these characteristics are 'designed in' on the drawing board depending on the amount of wing dihedral, fin area, fuselage keel area etc but nevertheless minor changes in powerplant, propeller and control systems can have an adverse effect. The aeroplane will not be able to recover if the rudder and ailerons do not neutralise themselves when the controls are released - a common cause of this is excessive friction in the control circuits. Control cables which are too highly tensioned, worn out bellcrank bearings, binding gap-covers and coupled steerable nosewheels are common sources of extra friction.

12. Maximum Speed Test

This test must be made in a smooth piece of air, since turbulence encountered at the high-speed end of the aeroplane's flight envelope might result in the airframe being overstressed. If yours is an open cockpit machine, make sure your maps and test schedules are well secured before starting the test - they will not be much use to you if they end up wrapped around the fin or making their own way down. The angle of dive which is needed will vary depending on the aeroplane type and you should not use any steeper angle of dive than is required. Forget all those old Hollywood test flying movies - for most LAA types you should not need more than 15-20 degrees of dive at the most. Keep an eye on the tachometer and throttle back to prevent the rpm exceeding the red line. If yours is a two-stroke powered aircraft, be very careful to avoid excessively high EGTs which may occur due to high rpm coupled with lean mixture at reduced throttle setting, and could very quickly cause a seizure or melt the piston crowns. If the EGTs near the limit, throttle back further or stop the test.

Bear in mind that if any kind of major high speed problem is experienced, such as flutter or (as happened on a recent CAA flight test of a Glasair 3) a burst-open engine cowling, you will be much better off if the nose is above the horizon and the airspeed is decreasing at the time, rather than screaming down with the speed still building. Therefore after attaining the required Vne as called up on the Permit to Fly Limitations Sheet, you should gently ease the nose up above the horizontal before experimenting gingerly with the other controls.

Causes of rejection on this test include any kind of control vibration, buffet or flutter, controls which become excessively stiff or ineffective at high airspeed, an excessive trim change making it hard to keep the wings level, prevent yaw or control the aeroplane in pitch, or an inability to prevent the engine rpm exceeding the red line figure.

13. Simulated Balked landing

The aim of this test is to show that the aeroplane handles satisfactorily and the engine responds properly when the throttle is opened up rapidly during a go-around. This test is particularly relevant to the older types of engine which are prone to plug fouling after a long period of idling, and having simple carburettors prone to 'lean cut' when the throttle is opened quickly. This might prevent the engine from responding promptly to opening the throttle, or may even cause it to stop altogether.

The method used is to set the aeroplane up in a normal throttled back approach, albeit at a safe altitude, then, when ready, open up the throttle rapidly and re-establish the aeroplane in a maximum rate climb. The aim is not to slam the throttle open, but merely to open it fully and positively in one movement, as would occur in an actual go-around.

The aeroplane handling aspects of a go-around very rarely present a problem, the only time that this may cause concern is with a design with a high engine thrustline (such as, for example, the Quad City Challenger microlight) in which there is a marked nose-down pitch when the throttle is opened. In an extreme case there might be a risk of the pilot, when carrying out an actual baulked landing, nosing the aeroplane into the ground before getting the pitch under control.

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14. Functioning

The function check simply involves running through all the aircraft systems and testing each system in turn for correct operation. This is broken down into the categories of controls, instruments, engine and radio. It should be checked that each flying control operates freely without undue friction or backlash, that the trimmer and their indicators work properly throughout the range and hold a set position rather than 'creeping back' under airloads and vibration. Each flap position should be selected at the maximum appropriate and permissible flap lowering speed and it must be checked that operation is normal and that there is no undue change in lateral trim (ie rolling tendency) when flaps are lowered, indicating that the flaps are not deflecting evenly port and starboard. Engine checks include selecting each fuel tank for not less than 3 minutes (longer, if a large header tank is fitted such as the Kitfox and Avid Flyer use) to check that the fuel flows from each tank and that the quantity gauges read sensibly.

15. Landing

A normal approach and landing should be made and any unusual characteristics or unsatisfactory tendencies noted. Reasons for rejection would include inability to control the aeroplane directionally after touchdown (assuming the conditions did not exceed the crosswind limits and normal techniques are used), jammed undercarriage shock-absorbers, poor braking, undue tendency to nose-over when brakes are applied and engine stopping on touchdown due to too slow an idle.

16. Finally

After the flight, any adjustments or other corrective work needed should be arranged between the owner and the aircraft's inspector at the earliest opportunity, so that the appropriate parts of the test can be repeated whilst still fresh in the pilot's mind. The idea is not to carry a whole list of 'deferred defects' through into the next period of validity of the Permit to Fly, but to sort them out at Permit renewal so that the flying year starts with a clean bill of health.

A surprising number of Permit renewals are delayed because the pilot carrying out the test has not entered the information up properly on the schedule, written his or her name and signed the appropriate declaration. Please check it over before putting it in the post.

17 Further Reading

CAP 520 'Light Aircraft Maintenance', Westward Documedia Ltd, 37 Windsor Street, Cheltenham, Glos. GL52 2DG. Telephone: 01242 235151 or The Stationary Office 0870 6005522.

'Flight Testing Homebuilt Aircraft', Askue V, available for sale from LAA Office.