CIVIL AVIATION AUTHORITY OF NEW ZEALAND
Te Mana Rererangi Tūmatanui o Aotearoa

Wing-Drop Stalling

This briefing discusses the reasons why one wing may stall before the other, resulting in the stall commonly known as a wing-drop stall, as well as the consequences and correct recovery technique.

Stalling in the turn may produce the same consequences and requires the same recovery technique. If the turn is to be maintained rather than level flight regained, only the entry and the last item in the recovery are different. Therefore, stalling in the turn may be incorporated within this briefing. However, at the PPL level, the CFI may prefer a separate briefing for stalling in the turn (refer CFI).

By wing-drop stall we mean a stall where one wing stalls before the other. The wing that reaches the critical angle first (at about 15 degrees) will stall first, losing lift and causing a roll at the stall. This often happens because of poor pilot technique where the aeroplane is out of balance at the stall, or aileron is being used.

Once the wing stalls, aileron will not stop the roll, it will worsen the situation. If the wing-drop is not promptly recovered, a spin may develop. The purpose of this exercise is to stop the natural tendency to pick the wing up with aileron and to practise the correct method of recovery.

Objectives

To revise stalling with power and flap.

To carry out a stall from straight and level flight (and the turn) recovering from a wing drop with minimum altitude loss.

Principles of Flight

Revise the cause of the stall – exceeding the critical angle of attack, regardless of the observed airspeed.

There are many reasons why aileron may be being used at the stall.

Turning

During the turn, angle of bank is maintained with aileron.

Out of Balance

If the aeroplane is permitted to yaw at or near the stall there will be a tendency for the aeroplane to roll (further effect of rudder), which will increase the angle of attack on the down-going wing. In addition, if an attempt is made to maintain wings level with aileron, the down-going aileron will increase the mean angle of attack on that wing. This usually results in that wing reaching the critical angle first.

Ice or Damage
If ice forms on the wings, or one wing is damaged, by bird strike or 'hangar rash', the smooth airflow over the wing will be disturbed, and may break away sooner than the flow over the other wing – resulting in that wing stalling earlier than the other.

Weight Imbalance
If all the passengers or fuel are on one side of the aeroplane, some aileron will be required to maintain wings level.

Turbulence
When operating near the critical angle, a gust or turbulence may result in aileron being used to maintain wings level, or the modified airflow as a result of the gust may cause one wing to exceed the critical angle.

Rigging
If the wings were fitted to the aeroplane at slightly different angles of incidence, or the flaps have been rigged incorrectly, when approaching the stall, one wing would reach the critical angle before the other.

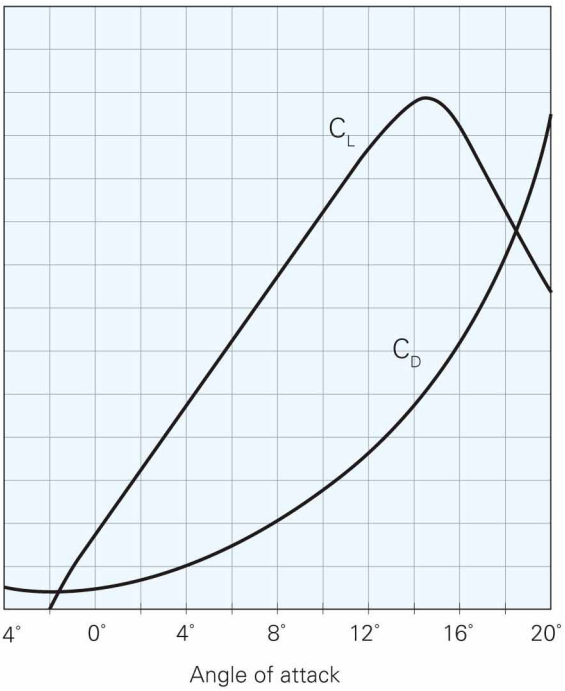
Power
Slipstream modifies the angle of attack on each wing because of its rotational nature. In clockwise rotating engines (as viewed by the pilot), the angle of attack is decreased on the starboard wing and increased on the port. Therefore, the aeroplane may drop a wing more readily when partial power is used.

Flaps
It is possible for flap to extend at slightly different angles. In addition, when flap is extended the aeroplane is less laterally stable, as the centres of pressure on each wing move in toward the wing root. This increases the tendency for the aeroplane to be easily disturbed in roll, which may cause one wing to exceed the critical angle. However, there is also a greater need to use aileron to maintain wings level in this configuration. Therefore, the aeroplane may drop a wing more readily when flap is selected.

The consequences of one wing exceeding the critical angle before the other are discussed.

The wing that stalls first has a reduction in lift, causing roll. The roll increases the angle of attack on the down-going wing and may delay the stall of the up-going wing. Increasing the angle of attack past the critical angle will result in a decrease in lift but a substantial increase in drag (use C_L and C_D against angle of attack graph).

Figure 1



The increase in drag yaws the aeroplane toward the down-going wing, which may further delay the stall of the up-going wing as a result of increased airspeed. This process, where yaw causes roll, which causes yaw, is known as *autorotation*.

By using aileron to stop the roll (a natural tendency), the mean angle of attack increases on the down-going wing. The lift continues to decrease with an increase in angle of attack (past the critical angle), while the drag continues to increase rapidly with any small increase in angle of attack. Show the effect of aileron on the C_L and C_D curves on the graph.

The use of aileron adversely affects the roll and favours autorotation. This is the reason for maintaining ailerons neutral in the initial stall recovery.

The correct method of stopping autorotation is to break the yaw-roll-yaw cycle, and since aileron cannot be used effectively to stop the roll, rudder is used to prevent further yaw. The nose is lowered simultaneously (backpressure relaxed) with the application of rudder, and this will stop the roll immediately.

Airmanship

Revise the requirement to carry out all stalling practise in a safe environment

Revise the **HASELL** and **HELL** checks.

Emphasise symptom recognition for avoidance.

The student should strive to improve situational awareness by integrating the attitude and airspeed with the aeroplane's configuration, phase of flight and symptoms of the approaching stall.

Aeroplane Management

As the objective is to carry out a stall with a wing-drop, a configuration most likely to induce a wing-drop is used, commonly 1700 rpm and full flap is used. The combination of these two factors will often lead to a wing-drop occurring at the stall.

Some aeroplane types, eg, PA38, will perform good wing-drop stalls in the basic configuration (power idle, flap up) (Refer CFI).

The use of carburettor heat may require revision.

Revise the airspeed and rpm limits.

Human Factors

Overlearning is used to improve information processing to recognise the situation and consciously ignore the roll while responding with the correct recovery technique.

Air Exercise

Start by revising stalling in various configurations. This will help make the student more comfortable before tackling the wing-drop stalls.

When satisfied that the student is ready to progress, you should begin the exercise with the demonstration and patter of a wing-drop stall (see "Airborne Sequence").

Entry

HASELL checks are completed, and a prominent outside reference point (backed by the DI) on which to keep straight is nominated.

From level flight, carburettor heat is selected HOT and the power smoothly reduced to _____ rpm. As the nose will want to yaw and pitch down, keep straight with rudder and hold the altitude with increasing backpressure.

Below _____ knots (in the white arc) select flap gradually, if applicable to aeroplane type. During the application of flap, check forward to prevent any gain in altitude due to the increase in lift, before reapplying backpressure to maintain altitude.

Through _____ knots, or when the aural stall warning is heard, select carburettor heat COLD, as full power will shortly be applied.

At the stall, altitude is lost, the nose pitches down, and one wing may drop.

If the aeroplane is reluctant to drop a wing at the stall, alter the power and flap combination (refer CFI) and relax rudder pressure to simulate the pilot's failure to maintain directional control. Alternatively, a gentle turn may be required (5 degrees angle of bank).

> There is nothing underhand about these techniques, as permitting the aeroplane to yaw or stall in the turn are possible causes of a wing-drop stall.

In addition, avoid an accelerated stall (by zooming the entry) which may produce a rapid roll. The student should see a rapid stall at some point in their training, but the first stall is not the time for it. If a pronounced wing-drop occurs, the application of full power may need to be delayed to avoid exceeding flap limiting speeds, or on the Piper Tomahawk, V_{NE}.

Recovery

The recovery may be discussed in three parts, but the ultimate objective is to coordinate all three actions.

To unstall

Keep the ailerons neutral.

At the same time

Simultaneously decrease the back pressure/check forward and apply sufficient appropriate rudder to prevent further yaw.

Excessive rudder should not be applied (to level the wings through the secondary effect of rudder) as this may cause a stall and flick manoeuvre in the opposite direction to the initial roll (wing drop).

To minimise the altitude loss

Full power is smoothly but positively applied. At the same time, level the wings with aileron (as the aeroplane is now unstalled), centralise the rudder, and raise the nose smoothly to the horizon to arrest the sink and minimise the altitude loss.

Hold the nose at the level attitude, and reduce the flap setting (as appropriate to aeroplane type) immediately.

At a safe height, safe airspeed and with a positive rate of climb – raise remaining flap (counter the pitch change). The aeroplane will continue to accelerate, and at the nominated climb speed select the climb attitude.

Straight and level flight should be regained at the starting altitude and the reference point or heading regained.

Airborne Sequence

The Exercise

The student should be capable of positioning the aeroplane within the training area at a suitable altitude, completing the necessary checks, and possibly carrying out the advanced stall and recovery. Instructor assistance is given only as required.

For the purposes of demonstration and patter, the recovery may be broken down into three separate phases (refer CFI). Alternatively the three phases may be condensed into two or even one phase, depending on your assessment of the student's ability.

> It is recommended that all stalling exercises finish with a reminder that outside of the training environment the student would recover at the onset of the stall at the latest.

At the completion of this exercise, there may be time to practise *maximum rate turns*, if previously covered.