Gliding Australia Training Manual

Pilot Guide

Unit 12

Slow Flying and Stalling

Unit 12 - Slow Flying and Stalling

WHAT THIS UNIT IS ABOUT

To ensure you

- can fly accurately and confidently close to the stall;
- always maintain a safe margin from the stall whenever close to the ground i.e. below 1000 feet AGL;
- can recognise the approach of a stall; and
- will initiate prompt prevention and recovery from stalls. …

WHAT ARE THE PRE-REQUISITES FOR THIS UNIT?

- GPC Unit 7 Straight flight various speeds and Trim
- GPC Unit 8 Sustained turns all controls

COMPLEMENTARY UNITS

Nil

KEY MESSAGES

- Prior to flying as pilot in command solo, the pilot must demonstrate their ability to fly constantly at their designated safe speed and confidently stall and recover.
- Sometimes pilots who do not fly frequently lose these competencies.
- If you feel that the glider is not responding correctly, move the stick forward (to unstall the wing).
- Allow the glider to establish normal flight at an appropriate airspeed prior to trying to undertaking a turn The glider takes some time to stabilise once the nose has been lowered

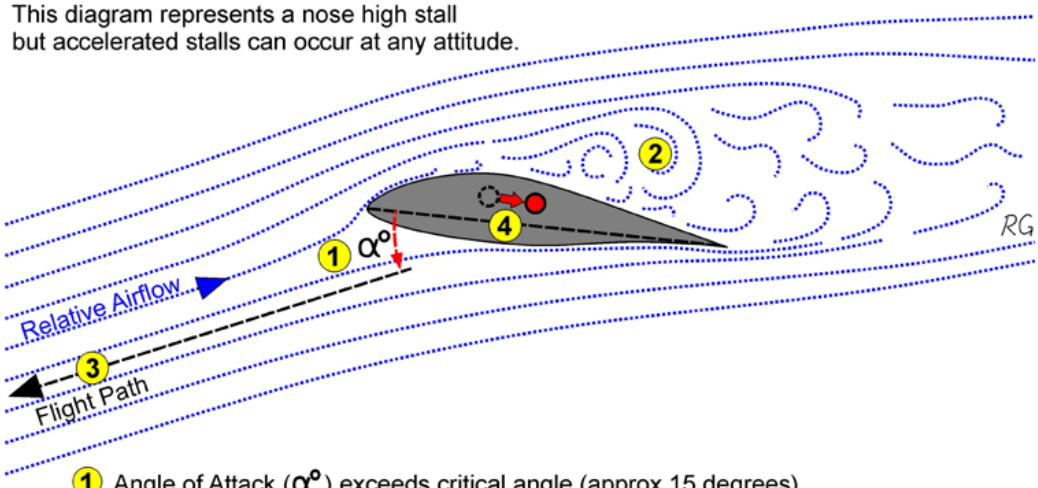
PILOT GUIDE FOR THIS UNIT

A stall in straight and level flight is quite simply a progressive loss of lift over the top section of the wing, causing the glider to lose height at an exaggerated rate. It occurs because the glider is made to fly in such a way that the angle of attack of the wing becomes too great and the smooth airflow breaks down over the top surface.

It is achieved by bringing the stick progressively further and further back, slowing the glider down and increasing the angle of attack of the wing until the stall occurs.

Airflow during a stall

This diagram represents a nose high stall
but accelerated stalls can occur at any attitude.



1. Angle of Attack (α°) exceeds critical angle (approx 15 degrees).
2. Turbulent airflow separation causes decreased Lift, increased Drag & airframe buffet.
3. Steep Flight Path = high descent rate (decreased Lift & increased Drag).
4. Rearward movement of Aerodynamic Centre causes uncommanded nose drop.

From the pilot's point of view, the symptoms of the stall occur progressively and are as follows:-

- Nose position higher than normal. Not necessarily a great deal higher, but noticeably so.
- A continuous backward movement of the stick.
- It becomes quieter in the cockpit because of the lower speed of the airflow past the canopy.
- A falling airspeed indication on the ASI
- Flying controls are less effective.
- There may be some mild buffeting of the airframe caused by the breakdown of the smooth airflow over the wing.

When the stall occurs, the airflow around the wing looks like this: -

The airflow in this picture (flowing over the wing from right to left) is shown by wool strips taped to the glider wing.

The stall is well-developed, the strips indicating that the airflow is still normal near the leading edge (strips blowing straight back), but quite disturbed further back on the wing (strips blowing in all directions, even backwards in some cases).

- When the stall actually occurs there are three possibilities in terms of glider behaviour, depending on the type of glider.

1. It may drop its nose quite markedly. If this does occur, it will occur despite the stick being fully back

2. It may not drop its nose, even though the stick is right on the back stop. In this kind of stall (e.g. Twin Astir), the rate of descent will be very high, and the glider does not respond normally to control input although the nose position gives no clue to this.

3. One wing may go down, i.e. the glider may start rolling. This phenomenon, known as wing-drop, may occur in either of the above two types of stall and it may happen at exactly the same time as the stall occurs or perhaps just before.

- Whichever of the three types of behaviour are apparent at the stall, the same action is taken by the pilot in all cases. This action is quite simply smooth and progressive forward movement of the stick to reduce the angle of attack and "unstall" the wing. Look outside at the horizon while you are doing this, to help orientation, reduce discomfort and make it more obvious when recovery action has been effective.
- There is an interesting point to consider here. Although it is quite logical that a type "2" stall above (no nose drop) can be cured by forward movement of the stick to lower the nose, it is not so readily apparent why it is necessary to move the stick forward when the nose has already dropped, or how it manages to fix a dropping wing.
- As far as the nose-drop is concerned, it is important to realise that the wing is still stalled despite the nose pitching down. If the stick is held back, the nose may pitch strongly up again and go into another stall; it will go on doing this until the stick is moved forward to unstall the wing.

Notes

- This forward movement of the stick when the nose goes down is not an instinctive reaction - all your training up to this point has tended to suggest that you should do the opposite. For this reason, stalling must be practised to the extent that forward movement of the stick when a stall is recognized becomes a CONDITIONED RESPONSE

Loss of Lateral Damping

- Wing drop occurs simply because one wing stalls before the other. When it stalls, lateral damping, the force which provides stability when the glider is rolling, is lost. There is nothing to stop the wing dropping further and further at the stall. In fact, the more the wing drops when stalled, the more it wants to keep dropping. In other words, the stability in roll provided by the lateral damping of an un-stalled wing becomes extreme instability in roll when the wing is stalled.
- The good news is that, when the stick is moved forward, the wing un-stalls, lateral damping is restored and the wing immediately stops going down.
- A characteristic of stall recovery is that, once the stick has been moved positively forward and the angle of attack restored to below the stalling angle, the smooth airflow restores itself instantly and the wing immediately starts working in its normal way. However, care should be exercised in the use of the elevator after recovery from a stall.
- If the stick is pulled back too sharply too early after stall recovery, another stall could result. The average glider needs about three seconds to accelerate from the stalled condition to a safe speed of about 1.5 times the stalling speed during a normal stall recovery.

- To summarise, always look ahead at the horizon during the first stages of stall recovery. Use the ASI as a back-up for ensuring that airspeed is building up. There is no point in diving in an exaggerated manner during stall recovery - it just wastes height. Develop a feel for when the glider has become unstalled and the nose can be safely restored to its normal position on the horizon.

Aircraft Design

- If you look along the underside of a wing from the wingtip towards the wing root, it will be noticed that the aerofoil changes from root to tip, This is called “Washout” and is how the designer ensures that the wingroot aerofoil reaches the stalling angle of attack before the wingtip. This causes wing root turbulence to hit the tailplane and produce stall warning stick shaking, while the wingtip washout delays wing drop.

FLIGHT EXERCISES FOR THIS UNIT

If possible, the in-air exercises will be introduced when thermal conditions enhance the possibility for regaining height. If not, higher than normal aerotows will be used. In winching operations, many launches may be required to cover this unit.

The instructor will ask you to fly at 45 knots and trim the glider accordingly then raise the nose slightly and continue to fly straight and level. The trim may not be sufficient and you may have to hold backward pressure on the stick.

- Try to identify the indicators of an approaching stall
    - Reduced controllability,
    - Reduced noise level,
    - Slight shuddering on the elevator.
    - Loss of lateral damping
- The instructor will demonstrate that moving the stick forward slightly removes these indicators and the glider feels like it is flying normally again.
- Then the instructor will demonstrate what happens when you fly a slightly higher nose attitude where the glider stalls and the nose drops, (in some gliders this may not be possible at a low nose attitude.) Again, the glider flies again when you move the stick slightly forward.
- Now there will be a demonstration that a higher nose attitude should more clearly identify the indicators of the approaching stall. Try to describe these indicators when you then do the same manoeuvre.
- You will be introduced into the techniques to deal with a wing drop close to stall. Forward stick and just enough rudder to stop any yaw which may have developed solves the overall problem.
    - Rudder can pick the dropped wing up but does not recover the stalled wing and is not actually necessary
    - Stick forward reduces the angle of attack immediately and hence recovers normal flight characteristics
    - The glider speed must be higher than the stall speed before the wing will carry the full weight of the glider.
- Over time you may be able to demonstrate a high nose attitude stall with the ensuing nose drop, and that even with the nose of the glider pointing down again it is not flying properly until the stick is moved forward to unstall the wing. Some gliders may let you demonstrate

that pulling the stick back in this situation does not raise the nose. You must push forward on the stick to unstall first and then recover.

- With more experience of stalling, take note to the airspeed as the glider stalls.

Advanced Training

- In later flights, the impact of airbrakes and flaps on stall speed and glider reaction is introduced, then the stall in a turn, primarily to identify the indicators and the effect of moving the stick forward.
- The instructor will avoid a spin developing through these exercises.

THINGS YOU MIGHT HAVE DIFFICULTY WITH

COMMON PROBLEMS

- don't be over anxious undertaking stalling, the aircraft will be under control at all times.
- direct attention outside the cockpit towards the horizon to counter any discomfort felt during the stall and recovery.
- ensure that the difference is noted between the nose drop at the stall and the sensations associated with negative "g".
- accidents occur when the stick is held back in the stall instead of easing it forward to recover to get the wing flying again, due to visual perception of dropping towards the ground.

HOW DO YOU DEMONSTRATE COMPETENCE?

- You can confidently fly the glider close to the stall by reference to attitude and air sounds together with the 'feel' of the stick without reference to instruments.
- You consistently demonstrate when a wing drop is experienced, moving the stick forward to lower the angle of attack with sufficient rudder away from the wing drop direction to counter any yaw.
- Demonstrate the GFA Pre-aerobatic checklist HAS(E)LL;
- Determine the use of cockpit ballast to ensure the glider is within centre of gravity limits.
- Maintain a safe speed near to the ground 1.5 Vs when flying below 1000 ft AGL.
- You fly coordinated turns in the circuit and avoid using excess rudder during the turn which may lead the glider to spin.
- Describe the aerodynamics of the stall and describe factors that impact stall speed - excessive elevator movement, G force, angle of bank, flaps and airbrakes.
- Demonstrate stall recoveries with minimal height loss appropriate to type:
    - without and with full airbrake/spoilers and
    - without and with flaps:
    - at various angles of bank
- If flying a self launching glider:
    - With and without engine power

- With and without engine pod extended

RESOURCES & REFERENCES

- Theory Lesson 4
- Australian Gliding Knowledge page 63-66
- Gliding Basics: British Gliding Association 2019
- Gliding Handbook: FAA 2013
- The Glider Pilot's Manual: Ken Stuart: 2nd Edition; Airlife 1999.
- Understanding Gliding: Derek Piggot: 3rd Issue; AC Black 1996

SELF-CHECK QUESTIONS

1. What are the symptoms of a stall in straight flight?
2. What action must the pilot take if the glider stalls?
3. Is it possible to stall in a turn without a nose-high attitude?
4. What action must the pilot take if the glider stalls in a turn?
5. Define "safe speed near the ground". Calculate the speed to fly the circuit in a glider which stalls at 33 knots in straight flight.
6. If you are turning slowly and the glider suddenly starts to noticeably increase its bank angle without any input from you, what is the problem and what would be your action?
7. What happens to the stalling speed when flaps are lowered?
8. What happens to the stalling speed when the airbrakes are opened?