Accelerated Stalls (Demonstration)

Objective

To ensure the applicant learns the purpose of and can exhibit a clear understanding of the accelerated stall maneuver and how to perform the maneuver properly.

Purpose

The accelerated stall maneuver demonstrates to pilots that an airplane can stall at any attitude or airspeed as long as the wing exceeds the critical angle of attack. Pilots will learn the proper recovery techniques and improve their awareness of the risk of entering a spin from maneuvering flight.

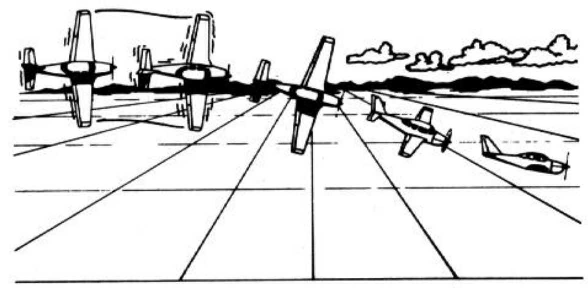


Figure 11–24 Accelerated (High Speed) Stall

Schedule

- **Ground Lesson**: 15 minutes
- Initial
    - **Flight**: 20 minutes - *Demonstration of Maneuver*
- Commercial/CFI Only
    - **Flight**: 30 minutes - *Practice Maneuver (Dual)*
    - **Flight**: 20 minutes - *Demonstrate Proficiency*
- **Debrief**: 10 minutes (*per flight*)

Equipment

- Airplane Checklist
- Whiteboard / Markers (optional)
- Model Airplane (optional)

Student Actions

- Ask any questions, receive study material for the next lesson.
- Watch linked video.
- Review listed references.

Instructor Actions

- Deliver the ground lesson (below).
- Demonstrate the maneuver in flight.
- Debrief after each flight.

Completion Standards

- **Ground**: Student can explain the purpose of the maneuver and how to execute it properly.
    - Can explain the critical angle of attack, situations leading to an accelerated stall, the dangers of uncoordinated stalls, improper stall recovery, and the factors that affect stall speed.
- **Flight**: Student can perform the maneuver to the applicable ACS standards.
    - Establishes a level, coordinated, 45° banked turn at an airspeed below Va.
    - Continually increases pitch smoothly and firmly to cause an impending stall.
    - Acknowledges first indication of the stall, and promptly recovers and climbs at Vx or Vy to return to the original altitude and heading.
    - See expanded Completion Standards below.

References

- MZeroA Flight Training - “Accelerated Stalls”
    - YouTube - https://www.youtube.com/watch?v=Upq_XADQC5E
- FAA-H-8083-3B (Airplane Flying Handbook) - Chapter 4, Page 5-6 [Stalls/Stall Recognition/Stall Recovery], Chapter 4, Page 10-11 [Accelerated Stalls]
- FAA-H-8083-25B (Pilot’s Handbook of Aeronautical Knowledge) - Chapter 5, Page 25-26 [Stalls], Chapter 5, Page 34 [Load Factors and Stalling Speeds], Chapter 5, Page 37 [Vg Diagram]
- FAA-S-ACS-7A (Commercial Pilot ACS) - Area IV Task D
- FAA-S-8081-6D (CFI PTS) - Area XI Task H

Ground Lesson Outline

- Accelerated Stalls
    - The wing can stall at any airspeed
    - Recovery from a stalled condition requires reducing AoA!
- Bank angle and load factor
- Effect on stall speed
    - Maneuvering speed
- Situations leading to an accelerated stall
    - Recovery from a normal stall, recovery from a spin
- Warning signs
    - Buffet, stall warning
- Accelerated Stall Recovery
    - Reduce AoA first! Level wings after stall is broken.
    - Risk of skidding turns, spin entry
- Safety considerations
    - Use of checklists
    - Visual traffic scanning
- Maneuver Description - step-by-step
    - Entry position, airspeed, etc.
- Expanded Completion Standards

Common Errors

- Failure to establish proper configuration prior to entry.
- **Improper or inadequate demonstration of the recognition of and recovery from an accelerated maneuver stall.**
- Failure to present simulated student instruction that adequately emphasizes the hazards of poor procedures in recovering from an accelerated stall.

Ground Lesson Content

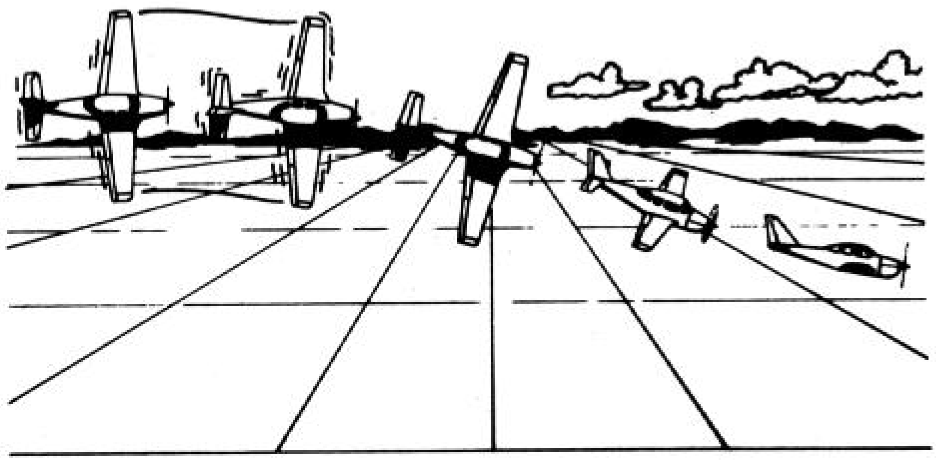
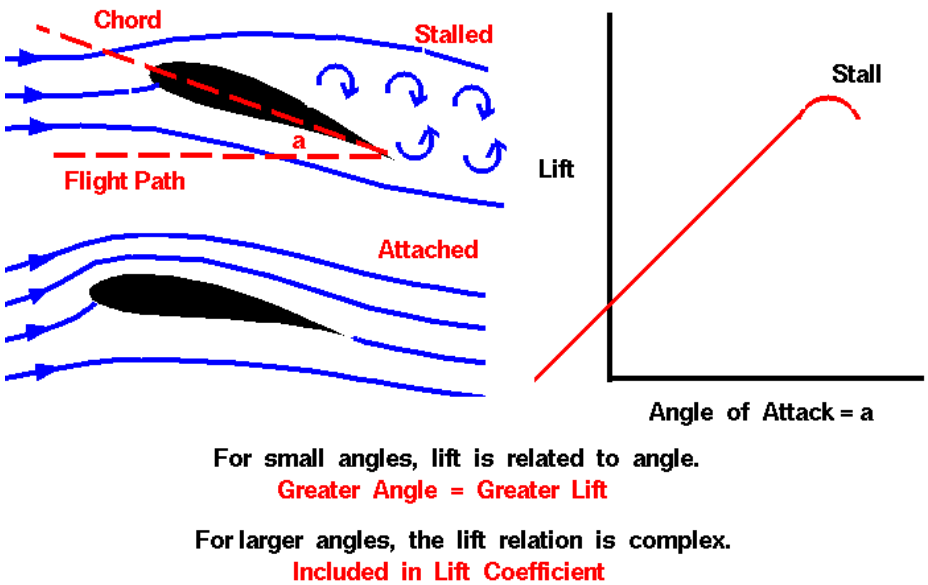
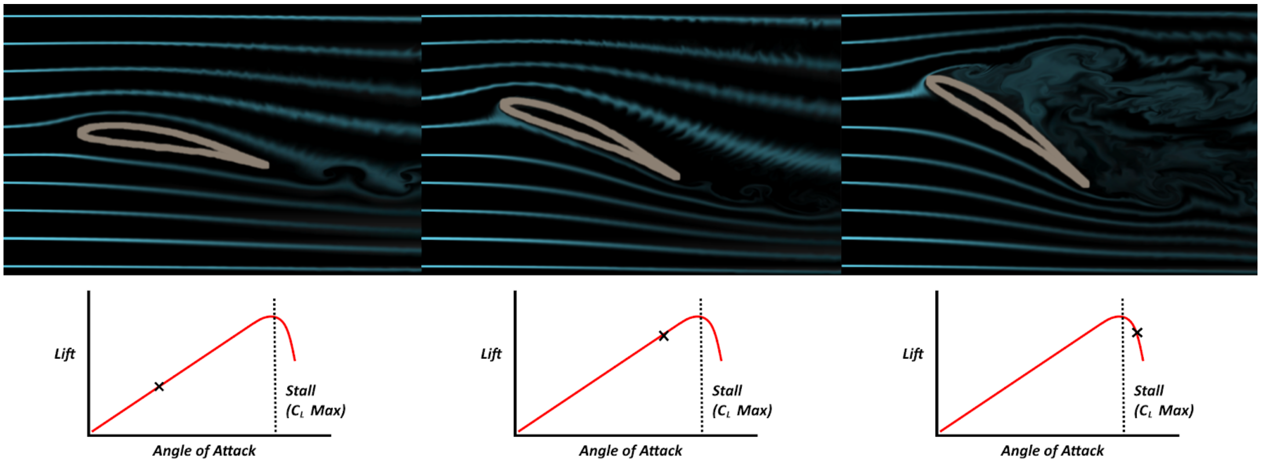


Figure 11–24 Accelerated (High Speed) Stall

- **Accelerated Stalls** - Pilots already understand that an aerodynamic *stall* is what happens when a wing 'stops flying'. *Accelerated Stalls* serve to illustrate the concepts that aggressive maneuvers and steeply banked turns increase load factor, and **a wing can stall at any airspeed**.
    - As the angle of attack increases, wings produce increasing amounts of lift. As the wing moves at a low angle of attack, the air moving over its upward surface moves as a smooth flow, which is *attached* (tends to follow the contours of the wing). Airflow at low angles of attack generates relatively little drag. As the angle of attack increases, the flow becomes more turbulent, and at some point, the air flowing over the wing's upper surface cannot remain attached, and becomes very turbulent. At this point, the lift produced by the wing drops dramatically, with a corresponding dramatic increase in drag. The angle at which the lift is at maximum, before decreasing rapidly, is called the *critical angle of attack*. Once a wing exceeds the critical angle of attack, it is said to be *stalled*. (It 'stops flying') **An important property of wings is that they always stall at the same critical angle of attack, regardless of airspeed!**

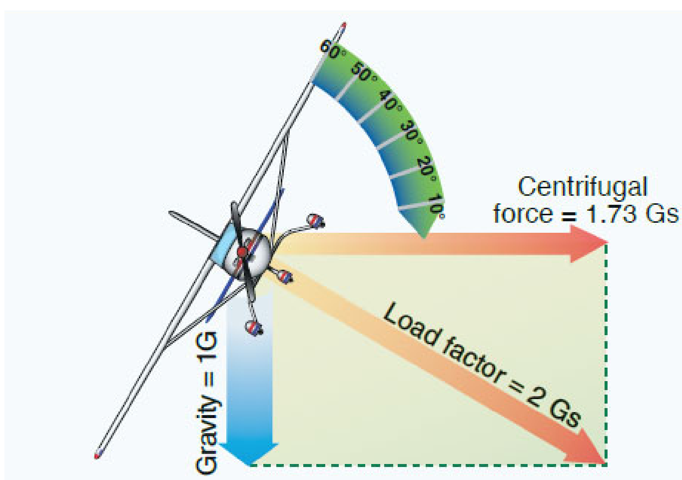


- Below is an airfoil in the normal (low angle of attack), high lift (high angle of attack), and stalled condition, along with the corresponding angle of attack vs lift graph:



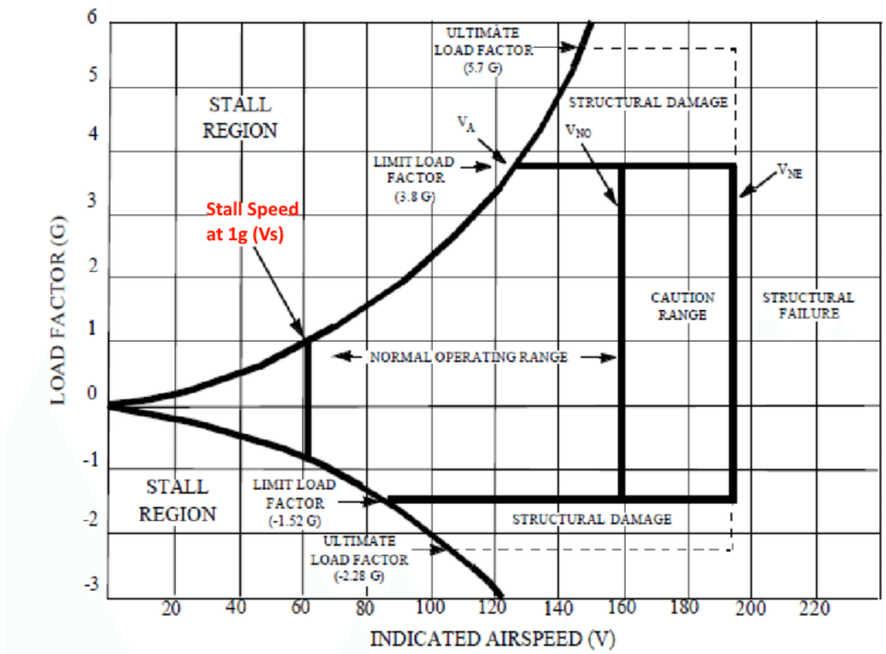
- **Recovery from a Stalled Condition -** A wing which is stalled is now producing very little lift relative to the drag it is producing. It has 'stopped flying'. **The only way to recover from the stall and to get the wing flying again is to reduce the angle of attack!**

- **Bank Angle and Load Factor -** As an airplane turns, its weight remains the same, and therefore the upward component of lift must remain equal to its weight. During a turn, some of the lift must be directed towards the center of the turn, reducing the upward component of lift. If no pilot corrections were applied, the airplane would not produce any more than the normal 1g of lift, and the airplane would begin to descend. In order to correct for the loss of vertical lift, and maintain a level altitude, the wing must produce more lift, which requires increased *back elevator pressure*. This increased back elevator pressure will cause the wing to fly at a ***higher angle of attack***, producing the increased lift that is required. This can be felt by the pilot as a higher than normal G-force.
  - In order to maintain 1g of vertical lift, while also turning, the wing must produce more than 1g of total lift. The amount of total lift is called the ***load factor***.



  - As the bank angle increases, the load factor required to maintain level flight increases slowly at first, but increases rapidly, especially at bank angles beyond 45 degrees. The load factor created by a *level, coordinated* turn **depends only on the bank angle**. Note that **airspeed does not affect the load factor of a turn.**

- **Effect on Stall Speed** - As the load factor increases in a turn, it is important to recognize that **the stall speed also increases**. We can see this relationship depicted in a so-called *Vg diagram*, shown below. The Stall Speed we normally see for our aircraft, Vs or Vs_0, applies only to 'unaccelerated' flight--that is, flight at 1g load factor. Observe from the Vg diagram that as the load factor increases, the stall speed also increases. **Note that the wing can stall at any airspeed!**
  - Eventually, the wing reaches a point called the *limit load factor*, which for a normal category airplane is +3.8G. The stall speed at this point is called **Va**, or *maneuvering speed*. Below this speed, the wing will exceed the critical AoA and stall before the aircraft suffers structural damage, however above this speed, structural damage may result. *It is critical to always perform high performance maneuvers below maneuvering speed!*



- **Situations Leading to Accelerated Stalls** - Other than intentionally performing the accelerated stall maneuver, there are a couple situations which make encountering an accelerated stall more likely:
  - **Recovery from a normal stall** - If the airplane is allowed to descend too rapidly (delayed stall recovery) during a stall, when the wing begins flying again, the airplane may be pitched steeply downwards. Attempting to raise the nose to the horizon aggressively can lead to increased load factors and a *secondary* accelerated stall. (Which is usually worse than the original stall)
  - **Recovery from a spin** - After anti-spin inputs are applied and the airplane transitions to a steep spiraling descent, the airplane will also be pitched steeply downwards at high speed. Overly aggressive dive recovery procedures (raising the nose) can also result in an accelerated stall.

- **Warning Signs** - Stalls do not occur without warning. The airplane will behave quite differently as angle of attack increases and the stall approaches:
  - **Buffet** - The stall *buffet* is the roughness or bumpiness that precedes an aerodynamic stall, caused by the increasingly turbulent airflow over the wing. This is especially true of accelerated stalls.

- **Stall Warning Horn** - Most planes have an audible stall warning horn that activates a few knots before the stall. Stall warning devices are one of the only true angle of attack sensing devices available to pilots, and **they will function when the airplane nears the critical angle of attack, regardless of airspeed!**

- **Accelerated Stall Recovery** - The primary consideration in recovery from an accelerated stall is the same as any stall-- ***reduce the angle of attack!*** (Reduce back elevator pressure)
  - *After* the angle of attack is reduced, the bank should be corrected.
  - Accelerated stalls tend to be more aggressive than a normal stall if allowed to fully develop, and there is a higher than normal risk of entering a spin. **Therefore, it is critical that if a wing drops, only rudder is used to raise the wing!** If a steep turn leads to the accelerated stall, if it is a skidding turn, it is very likely that the inside wing drops away, increasing the already-steep bank and leading to an incipient spin. This is a very dangerous situation and must be avoided!

- **Safety Considerations**
  - As with any maneuver, the **use of checklists is important**. Before beginning the maneuver, perform a pre-maneuver checklist, including performing clearing turns and identifying possible emergency landing sites.
  - It is crucial to not become so focused on performing the maneuver that an unsafe situation is created. Maintain situational awareness, make appropriate practice area radio calls, and **remember to continuously scan for traffic!**

Maneuver Description

- **Entry Altitude** - Stalls should always be performed at a safe altitude, in case of a delayed or inadequate recovery, or other problems. The maneuver should be performed such that accounting for altitude loss during the stall, the final altitude is no lower than 3,000 feet AGL. Additionally, an accelerated stall creates a large risk of an inadvertent spin. Therefore it is best to begin the maneuver **at least 3,500 feet AGL**.
- **Entry Airspeed -** The maneuver should be started at a normal cruise airspeed, at or below **Va**.
- **Checklists** - Pilots must perform a pre-maneuver checklist before beginning the maneuver.
- **Configuration** - The airplane should be configured for cruise flight.
- **Entry Power and Bank** - Bank the airplane approximately 45 degrees and set power for a coordinated, level steep turn. It is usually best to set the power *lower* than for a normal steep turn, to allow the airspeed to decay slightly and avoid excessive control forces to induce the stall.
- **Stall** - While **maintaining a coordinated turn**, smoothly but firmly increase elevator backpressure to induce an imminent stall. **Acknowledge (call out) the first indications of an approaching stall** (especially the buffet or stall warning horn).
- **Recovery** - Promptly **reduce back elevator pressure, and level the wings. If the airplane is uncoordinated and the wing stalls, one wing may drop very aggressively. Do not use aileron to raise the dropped wing, as this will deepen the stall, use opposite rudder!** Once the airplane has regained flying airspeed, establish a climb at Vx or Vy to get back to the pre-maneuver altitude.
- **Coordination** - Due to the strong left-turning tendencies present at high power settings during accelerated stalls, **proper coordination is essential**. Special attention should be given to proper

rudder input during turns. Remaining coordinated throughout the maneuver will reduce the probability of a dramatic wing drop.
- **This is a visual maneuver!** Eyes should remain outside the cockpit as much as possible to scan for traffic and to hold heading.

Expanded Completion Standards

- The pilot can explain the purpose of the accelerated stall maneuver and understands the critical angle of attack, factors that affect stall speed, the situations that lead to an accelerated stall, the risk of an uncoordinated stall, and other factors that affect the maneuver.
- The pilot can perform the maneuver to the following standards:
  - Pilot clears the area, performs a pre-maneuver/before-landing checklist, and selects an altitude which allows the maneuver to be completed **not less than 3,000ft AGL**.
  - Pilot configures the airplane and establishes level flight at an **airspeed at or below Va**.
  - Pilot enters a coordinated, level, 45 degree banked turn, and continues increasing back elevator pressure until an imminent stall is induced.
  - Pilot acknowledges (calls out) first indication of the stall.
  - Pilot recovers *promptly* from the stall by reducing pitch, and leveling wings.
  - Climb at Vx or Vy, as appropriate, and return to the original altitude and heading.