Task XI.G: Spins

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Lesson Overview

Objective

The student should develop knowledge of the elements related to spins. The student will learn how to recognize a spin and the proper recovery techniques.

Reference

- Aircraft Flight Manual / Pilot's Operating Handbook
- Airplane Flying Handbook (FAA-H-8083-3B, page(s))

Key Elements

1. Stall + Yaw = Spin
2. Brisk and Positive Recovery
3. Ensure Spins are Approved

Elements

1. Spins and Anxiety
2. Aerodynamics of a Spin
3. Relationship of Various Factors to Spins
4. Possible Spin Situations
5. Airworthiness Category and Type Certificate

6. Spin Procedures
7. Maintaining a Stabilized Spin
8. Maintaining Orientation
9. Recognizing Potential Spins

Equipment

1. White board and markers
2. References
3. iPad

Instructor Actions

1. Discuss lesson objectives
2. Present Lecture
3. Ask and Answer Questions
4. Assign homework

Student Actions

1. Participate in discussion
2. Take notes
3. Ask and respond to questions

Schedule

1. Discuss Objectives
2. Review material
3. Development
4. Conclusion

Completion Standards

The student understands the factors involved in creating and maintaining a spin and knows the process to recover from a spin.

Instructor Notes

Introduction

Attention

Seriously, what sane person WANTS to do a spin? Most people are scared of them, but understanding them will help in avoiding them and remove some of the fear.

Overview

- Review Objectives and Elements/Key ideas

What

A spin is an aggravated stall that results in what is termed “autorotation,” wherein the airplane follows a downward corkscrew path.

Why

Without an understanding of spins and the proper procedures to recover from them the pilot could be put in an impossible situation. Understanding spins also will increase confidence and help reduce the anxiety associated with spins.

Lesson Details

Spins are widely feared by the general public, as well as many pilots. There is a general aversion to them but learning the cause and proper procedure to prevent (or even recover) from them will remove some of the anxiety. Spins are avoidable and generally recoverable. This awareness can improve a pilot’s comfort level and can increase confidence.

Aerodynamics of Spins

To spin an aircraft must have both wings stalled, then one wing becomes less stalled than the other. To create this situation the aircraft must be in uncoordinated flight.

The autorotation of the spin results from an unequal angle of attack on the airplane’s wings. The lowered wing has an increasing AOA, past the critical AOA, and lift decreases while drag increases. The rising wing has a decreasing AOA, allowing lift to increase and drag to decrease, with this being the wing that is "less stalled".

This state is entered when, at the beginning of a stall, one wing drops causing the nose to yaw to the low wing. This is where the application of rudder during the stall is critical. Maintaining directional control is key to averting a spin.

If the aircraft is allowed to yaw one wing will drop in the direction of the yaw (and the other will rise). Unless the rudder is used to correct the yaw the airplane will begin to slip into the lowered wing. This can result in weathervaning into the relative wind (which would in this case be toward the lowered wing). This increases the yaw, and causes the aircraft to continue to roll toward the lowered wing. The lowered wing has an increasingly greater AOA due to the upward motion of the relative wind.

The rising wing has a smaller (and decreasing) AOA since the relative wind is striking at a smaller angle. This rising wing is less stalled and develops some lift causing the airplane to continue rolling. This contributes to the yawing and pitching motion.

Relationship of Various Factors to Spins

There are a number of factors which can contribute to, or impact, a spin. They are configuration, weight, center of gravity, and control coordination.

Configuration

If flaps are deployed they will generally increase the lifting ability of the wings and will, therefore, decrease the stall speed. This will cause the aircraft to have a larger margin of error before the stall occurs.

Weight

An increased weight increases the stall speed since it requires a higher AOA to produce the lift necessary to support the additional weight. The critical AOA will be exceeded at a higher airspeed.

Center of Gravity (CG)

- The position of the CG can impact the characteristics of the spin. The changes may allow operation within the CG, but could impact recovery characteristics.
- As the CG moves aft the airplane flies at a lower AOA (reducing back pressure and drag). This lowers the stall speed and the critical AOA will be exceeded at a lower airspeed, decreasing stability. An extremely aft CG makes spin recovery difficult as the aircraft loses it's ability to pitch down. The shorter the arm from the CG the less force the elevator is able to produce making recovery more difficult. At the extreme, an aft CG can result in a flat spin and recovery may be impossible.
- As the CG moves forward the airplane flies at a higher AOA and will stall at a higher airspeed (due to increased lift and drag). However, recovery will be easier as the aircraft wants to naturally pitch nose-down. Also, the elevator can produce more force due to the longer arm from the CG to the elevator.

Control Coordination

Fundamentally, it is uncoordinated flight which provokes spins. The aircraft must be stalled to spin and yawed to provoke a spin. Stall + Yaw == Spin

Possible Spin Situations

The primary cause of a spin is stalling while executing an uncoordinated turn. Spins can occur while practicing stalls with uncoordinated controls or aileron deflection at the critical AOA. Critical phases of flight include Takeoff/Departure, Approach/Landing, and Engine Failure.

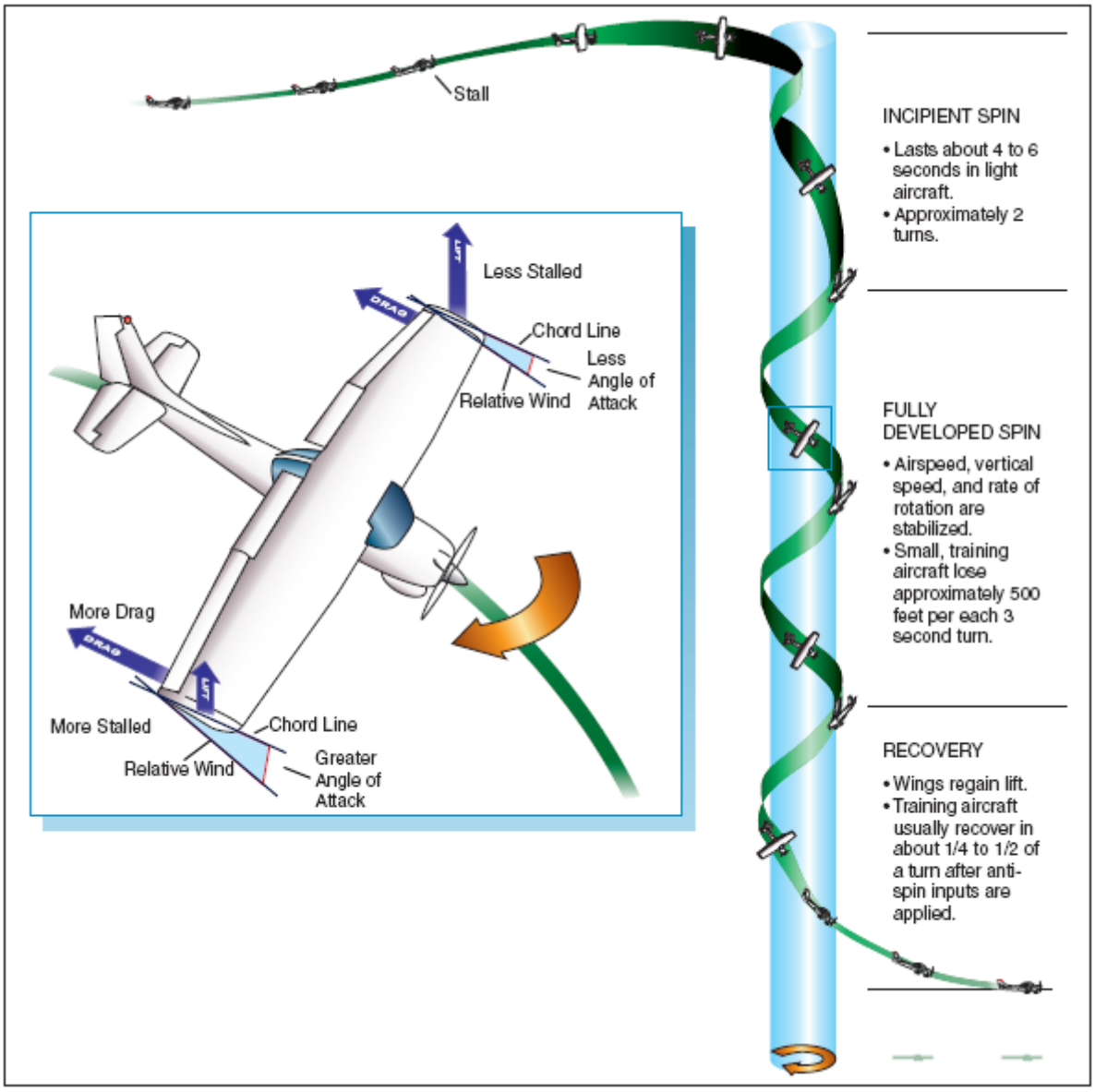
Airworthiness Category and Type Certificate

DO NOT spin an aircraft which is not authorized for spins. To determine if an aircraft is eligible for spins check the "Type Certificate and Data Sheets" for the aircraft, the AFM/POH (limitations section), or look for a placard in the aircraft which might indicate that spins are prohibited. If spins are approved, also check the W&B limitations and the manufacturer's recommended recovery procedures

Once again, if the aircraft is not authorized for spins, DO NOT spin the aircraft. Sometimes pilots will attempt to justify spinning a particular unapproved aircraft because .. technically .. the ability to recover from spins is a component of the Part 23 certification standards. Therefore the aircraft has been spin tested during the certification process.

During certification a normal category airplane must recover from a one-turn spin of not more than one additional turn, or 3 seconds, whichever takes longer. One 360° spin does not produce a stabilized spin, and therefore prolonged spins in an unapproved aircraft could be difficult or impossible to recover.

There is no requirement in 14 CFR Part 23 to investigate controllability in a true fully developed spinning condition. The one-turn margin is a check of the controllability in a delayed stall (not spin) recovery. Therefore if an aircraft is placarded against spins there is absolutely no assurance that recovery from a fully developed spin is possible.



Spin Procedures

> Spins are not taught during private pilot training. So this set of procedures is for informational/illustrative purposes only.

Before Starting

1. Perform the pre-maneuver checklist

a. Fuel Pump - ON
b. Mixture - RICH
c. Gauges - GREEN

2. Ensure that the area is clear of traffic
3. Select a starting altitude (3,500 AGL)
    a. The aircraft must be recovered above 1,500 feet AGL, and it is common for an aircraft to lose 500 feet per 3 second turn.
4. Ensure that all loose items are secured
5. Best to not eat a Chilli-Dog before the flight.

Entering the Spin

1. Perform the entry as for a power-off stall
    a. Reduce power while simultaneously raising the nose to a stalling pitch attitude.
2. As the stall approaches smoothly apply full rudder in the direction of the desired spin while applying FULL (to the limit) back elevator pressure.
    a. Keep ailerons neutral. Reduce power to idle on spin entry.

Phases

Incipient Phase

- This is the phase from the time the airplane stalls until the spin is fully developed. Incipient spins are often used as the initial introduction to spin training and recovery. The incipient phase may last up to two turns while the various aerodynamic forces come into balance.
- During this phase the airspeed should be near/below stall speed and the turn coordinator should indicate the direction of the spin. Recovery can commence prior to the first 360° turn with full rudder opposite the turn.

Developed Phase

This is the phase that occurs when the airplane's angular rotation rate, airspeed, and vertical speed are stabilized while in a flightpath that is nearly vertical. At this point the aerodynamic and inertial forces are in balance, and the spin is in equilibrium.

Recovery Phase

This is the phase where the wings decrease below the critical AOA and autorotatoin slows. Then, the nose steepens and the rotation may take 1/4 to several turns to cease.

Recovery sequence

Step 1 - Power Idle

Power aggravates the spin and can result in a flatter spin delaying recovery. Pull the engine to idle to remove these effects.

Step 2 - Ailerons Neutral

Ailerons may have an adverse effect on recovery, and if deflected in the direction of the spin can speed rotation. Ailerons opposite the spin may cause the down aileron into a deeper stall.

Step 3 - Opposite Rudder

Input FULL rudder in the direction opposite to the direction of rotation.

Step 4 - Elevator Forward

To break the stall apply a positive/brisk straight forward movement of the elevator. Do so immediately after full rudder application and hold the elevator firmly in this position. This will decrease the AOA and break the stall (spinning will stop when the stall is broken).

Step 5 - Rudder Neutral

If the rudder is not brought back to neutral after rotation ceases the increased airspeed will cause a yawing or skidding effect. Also, if the stall is not fully broken and full rudder is held in the opposite direction a spin can start again in the new direction.

Step 6 - Elevator Back

Once the stall/spin is broken raise the nose to level flight. Take care to avoid a secondary stall. Do not leave the aircraft in a nose low attitude while altitude decreases and airspeed increases.

Maintaining a Stabilized Spin

If there is a desire to maintain a stabilized spin the pilot should keep the aircraft controls in the following positions :

1. Maintain full back pressure to keep the wings stalled
2. Maintain full rudder in the direction of the turn to keep yawing
3. Maintain neutral ailerons

Failure to solidly hold the aircraft in a stall/spin condition can result in the aircraft entering a high-speed spiral dive. This can be recognized by a very nose low attitude, airspeed increasing rapidly, and a high rate of descent. This is a dangerous situation and can lead to exceeding Vne for the aircraft.

If a stall/spin is maintained the aircraft should remain with a somewhat nose low attitude, continuous rotation, possible buffeting, constant low airspeed, and a steady (not increasing) rate of descent.

Maintaining Orientation

To maintain orientation during a spin the pilot should select an outside reference and use the turn coordinator. Gyroscopic instruments may "tumble" and be misleading. This would include the heading indicator and attitude indicator.

Recognizing Potential Spins

The pilot is most at risk of spins, during normal operation, while engaged in stall (and spin)

recovery practice. It should be remembered that the spin is dependent upon the presence of yaw during the stall, so avoiding any yawing will also result in the avoidance of a spin.

Common Errors

- Failure to establish proper configuration prior to spin entry
- Failure to achieve and maintain a full stall during spin entry
- Failure to close throttle when a spin entry is achieved
- Failure to recognize the indications of an imminent, unintentional spin
- Improper use of flight controls during spin entry, rotation, or recovery
- Disorientation during a spin
- Failure to distinguish between a high-speed spiral and a spin
- Excessive speed or accelerated stall during recovery
- Failure to recover with minimum loss of altitude
- Hazards of attempting to spin an airplane not approved for spins

Conclusion

Spins can be dangerous, especially when close to the ground. Understanding the reasons a spin can happen and how to prevent one is extremely important. As long as coordination is maintained during a stall, a spin will not occur. Once in a spin, recovery is accomplished by reducing the power to idle, maintaining neutral ailerons, and applying full opposite rudder along with forward elevator pressure to break the spin. The recovery should be performed with brisk, positive pressure.

ACS Requirements

CFI PTS Standards

To determine that the applicant

1. Exhibits instructional knowledge of the elements of spins by describing:
   a. Anxiety factors associated with spin instruction.
   b. Aerodynamics of spins.
   c. Airplanes approved for the spin maneuver based on airworthiness category and type certificate.
   d. Relationship of various factors such as configuration, weight, center of gravity, and control coordination to spins.
   e. Flight situations where unintentional spins may occur.
   f. How to recognize and recover from imminent, unintentional spins.

g. Entry procedure and minimum entry altitude for intentional spins.
h. Control procedure to maintain a stabilized spin.
i. Orientation during a spin.
j. Recovery procedure and minimum recovery altitude for intentional spins.

2. Exhibits instructional knowledge of common errors related to spins by describing:
   a. Failure to establish proper configuration prior to spin entry.
   b. Failure to achieve and maintain a full stall during spin entry.
   c. Failure to close throttle when a spin entry is achieved.
   d. Failure to recognize the indications of an imminent, unintentional spin.
   e. Improper use of flight controls during spin entry, rotation, or recovery.
   f. Disorientation during a spin.
   g. Failure to distinguish between a high-speed spiral and a spin.
   h. Excessive speed or accelerated stall during recovery.
   i. Failure to recover with minimum loss of altitude.
   j. Hazards of attempting to spin an airplane not approved for spins.
3. Demonstrates and simultaneously explains a spin (one turn) from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to spins.

Private & Commercial Pilot ACS Skills Standards

None (Intentionally left blank in the ACS)