

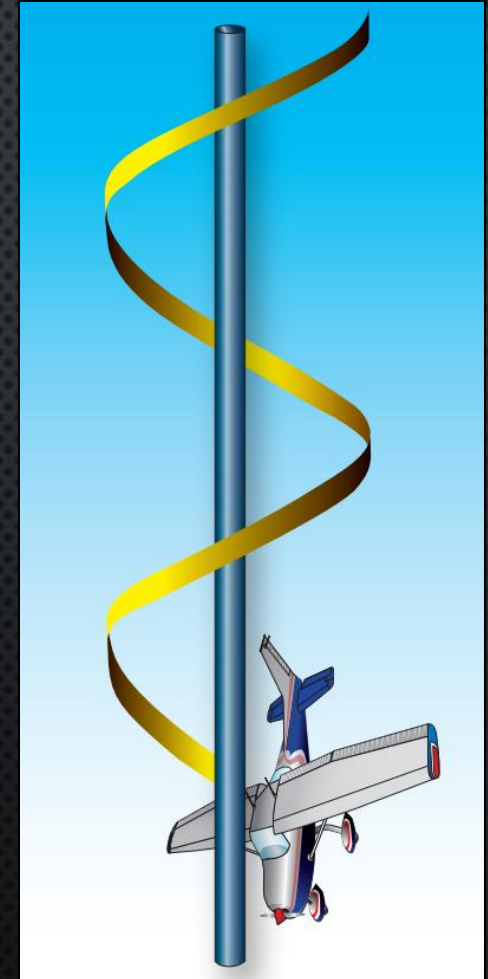
Spin Awareness Training



Dan “Taz” Christman
CHRISAIR AVIATION

Course Overview

- What is a spin?
- How does a spin occur?
- 4 Phases of a spin
- Spin entry
- Spin recovery (PARE)
- Weight and Balance Requirements
- Common Student Errors
- Regulations
- Local Area



What is a Spin (aerodynamics)?

A spin is a special category of stall resulting in autorotation about the vertical axis and a shallow, rotating, downward path. Spins can be entered intentionally or unintentionally, from any flight attitude if at the **stall** point the aircraft has sufficient **yaw**.

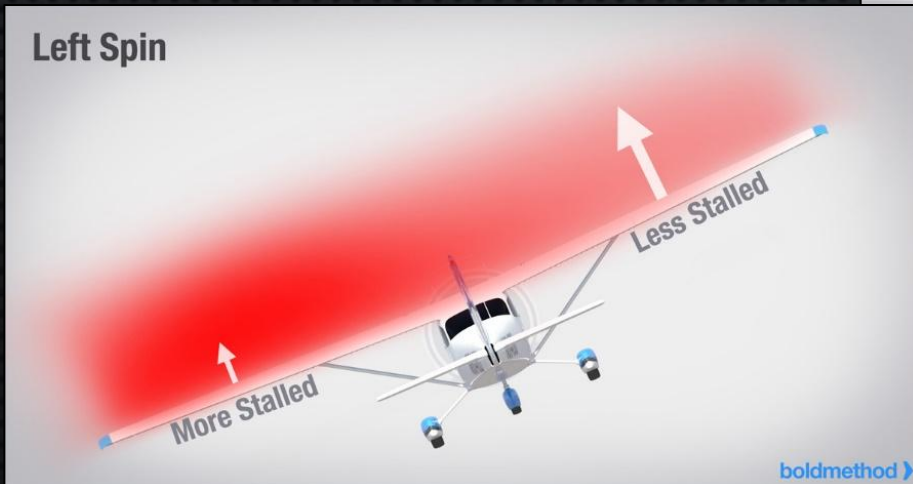


A spin is an aggravated stall that typically occurs from a full stall occurring with the airplane in a yawed state and results in the airplane following a downward corkscrew path.

What is a Spin (aerodynamics)?

In a normal spin, the wing on the inside of the turn is fully stalled while the outside wing remains partially flying. It is possible for both wings to be fully stalled but the angle of attack of each wing, and consequently its lift and drag, will be different.

Either situation causes the aircraft to autorotate (**yaw**) toward the stalled wing due to its higher drag and loss of lift. Spins are characterized by **high angle of attack**, an **airspeed below the stall on at least one wing** and a shallow descent.



Lift Differential



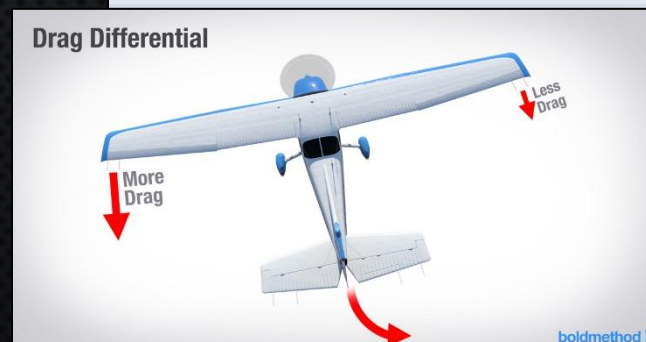
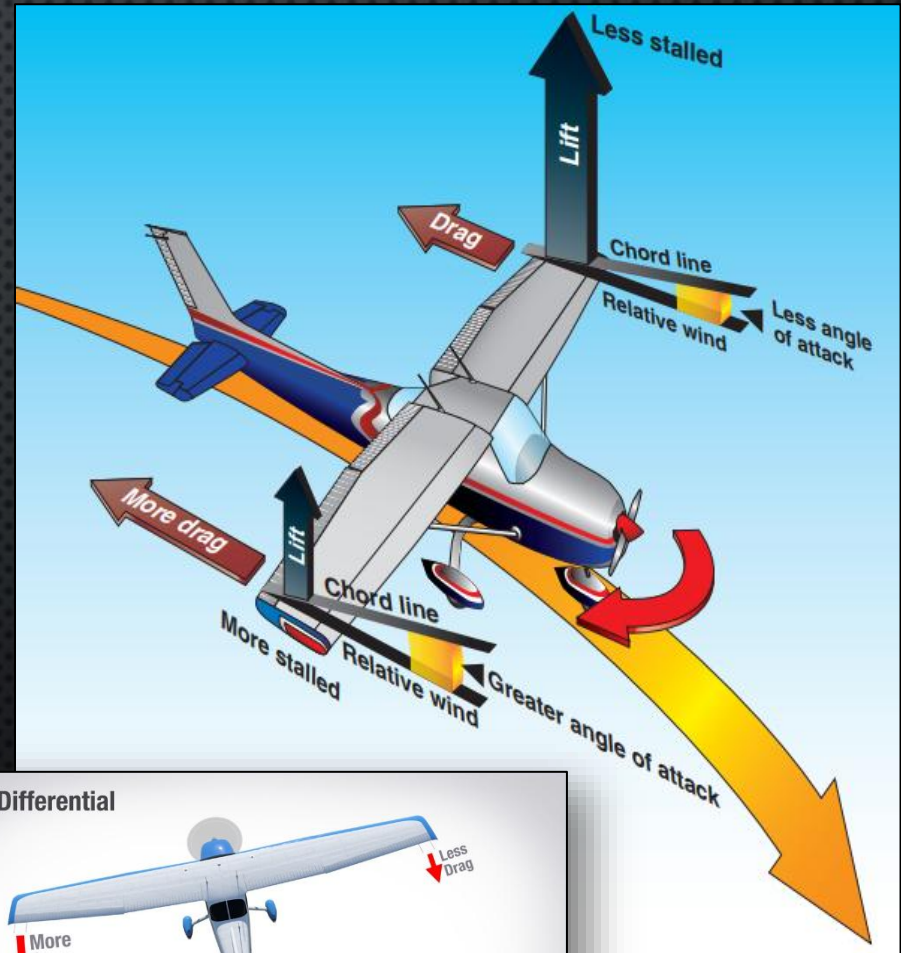
What is a Spin (aerodynamics)?

The less-stalled rising wing has a decreasing AOA, where the relative lift increases and the drag decreases.

Meanwhile, the descending wing has an increasing AOA, which results in decreasing relative lift and increasing drag.

Since your high wing generates more lift than the low wing, it rolls your aircraft into the spin.

When you combine both forces, you wind up in a fully-developed spin.



How does a spin occur?

A spin occurs when the airplane's wings exceed their critical AOA (**stall**) with a sideslip or **yaw** acting on the airplane at, or beyond, the actual stall.

An airplane will yaw not only because of incorrect rudder application but because of **adverse yaw**.

- Aileron deflection (turns / slips)
- Engine/prop effects
 - P-factor
 - Torque
 - Spiraling slipstream
 - Gyroscopic precession
- Wind shear
- Wake turbulence.



How does a spin occur?

If the **yaw** had been created by the pilot because of incorrect rudder use, the pilot may not be aware that a critical AOA has been exceeded until the airplane yaws out of control toward the lowering wing.

A **stall** that occurs while the airplane is in a slipping or skidding turn can result in a spin entry and rotation in the direction of rudder application, regardless of which wingtip is raised. If the pilot does not immediately initiate stall recovery, the airplane may enter a spin.



SLIPPING STALL



SKIDDING STALL

How does a spin occur?

Maintaining directional control and not allowing the nose to yaw before stall recovery is initiated is key to averting a spin.

The pilot must apply the correct amount of rudder to keep the nose from yawing and the wings from banking.

Modern airplanes tend to be more reluctant to spin compared to older designs, however it is not impossible for them to spin.

Mishandling the controls in turns, stalls, and flight at minimum controllable airspeeds can put even the most reluctant airplanes into an accidental spin.



How does a spin occur?

Proficiency in avoiding conditions that could lead to an accidental stall/spin situation, and in promptly taking the correct actions to recover to normal flight, is essential.

An airplane must be stalled and yawed in order to enter a spin; therefore, continued practice in stall recognition and recovery helps the pilot develop a more instinctive and prompt reaction in recognizing an approaching spin.

Upon recognition of a spin or approaching spin, the pilot should immediately execute spin recovery procedures.



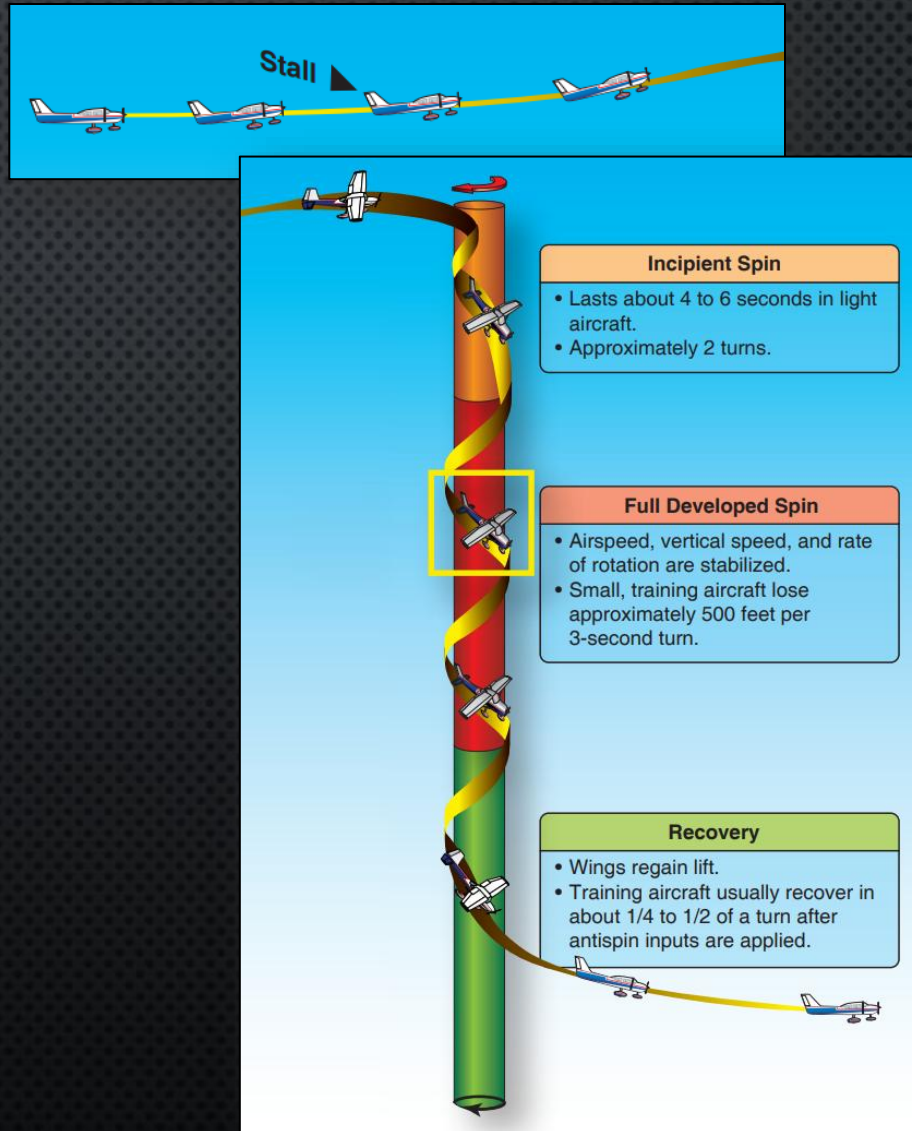
The Four Phases of a Spin

Phases of a Spin

In aircraft that are capable of recovering from a spin, the spin has four phases: **entry**, **incipient**, **developed**, and **recovery**.

Some aircraft are difficult or impossible to recover from a spin, especially a flat spin.

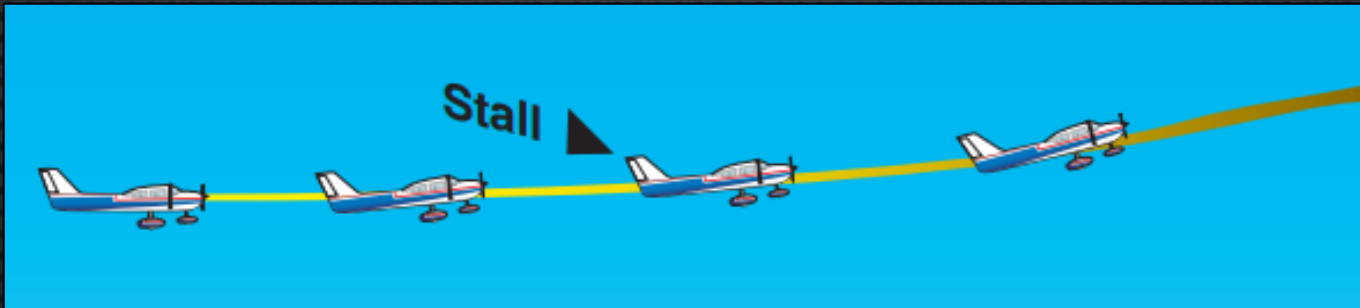
At low altitude spin recovery may also be impossible before impacting terrain, making low and slow aircraft especially vulnerable to spin related accidents.



The Four Phases of a Spin

Entry Phase

In the entry phase, the pilot intentionally or accidentally provides the necessary elements for the spin.



The entry procedure for demonstrating a spin is similar to a power-off stall. During the entry, the pilot should slowly reduce power to idle, while simultaneously raising the nose to a pitch attitude that ensures a stall.

As the airplane approaches a stall, smoothly apply full rudder in the direction of the desired spin rotation while applying full back (up) elevator to the limit of travel.

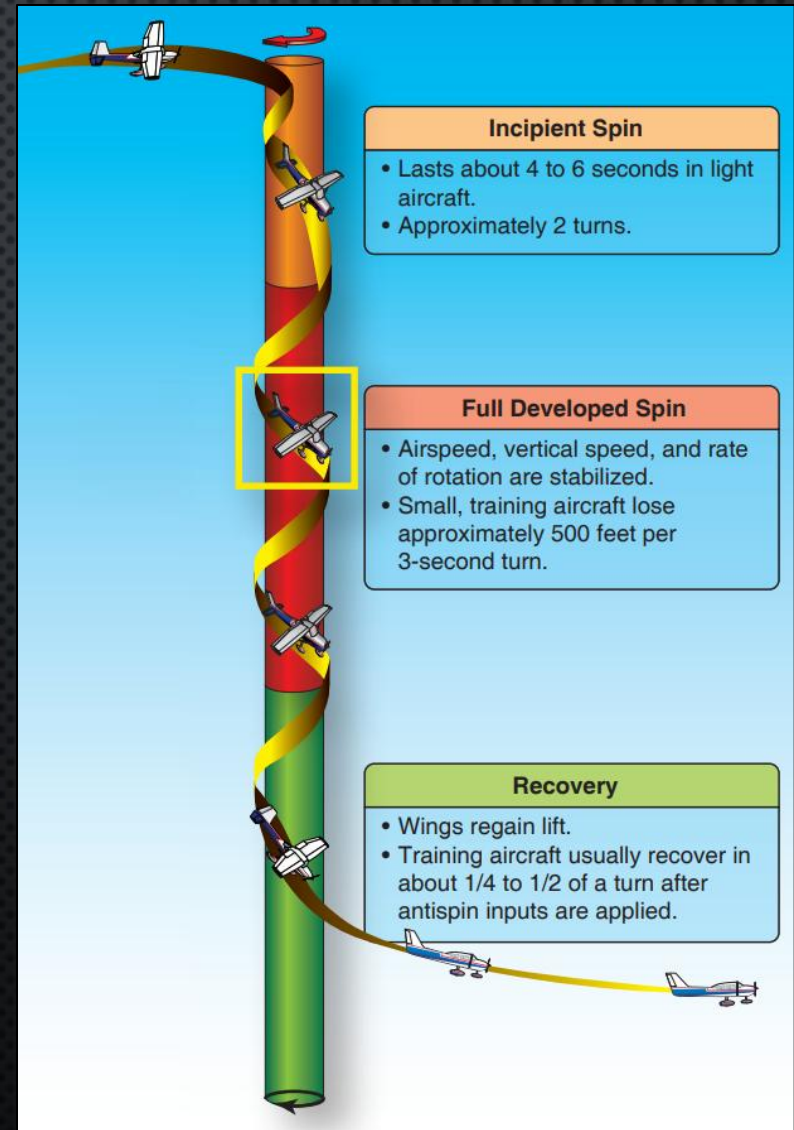
Always maintain the ailerons in the neutral position during the spin procedure unless AFM/POH specifies otherwise.

The Four Phases of a Spin

Incipient Phase

The incipient phase occurs from the time the airplane stalls and starts rotating until the spin has fully developed. *This phase may take two to four turns for most airplanes.*

In this phase, the aerodynamic and inertial forces have not achieved a balance. As the incipient phase develops, the indicated airspeed will generally stabilize at a low and constant airspeed and the symbolic airplane of the turn indicator should indicate the direction of the spin. *The slip/skid ball is unreliable when spinning.*



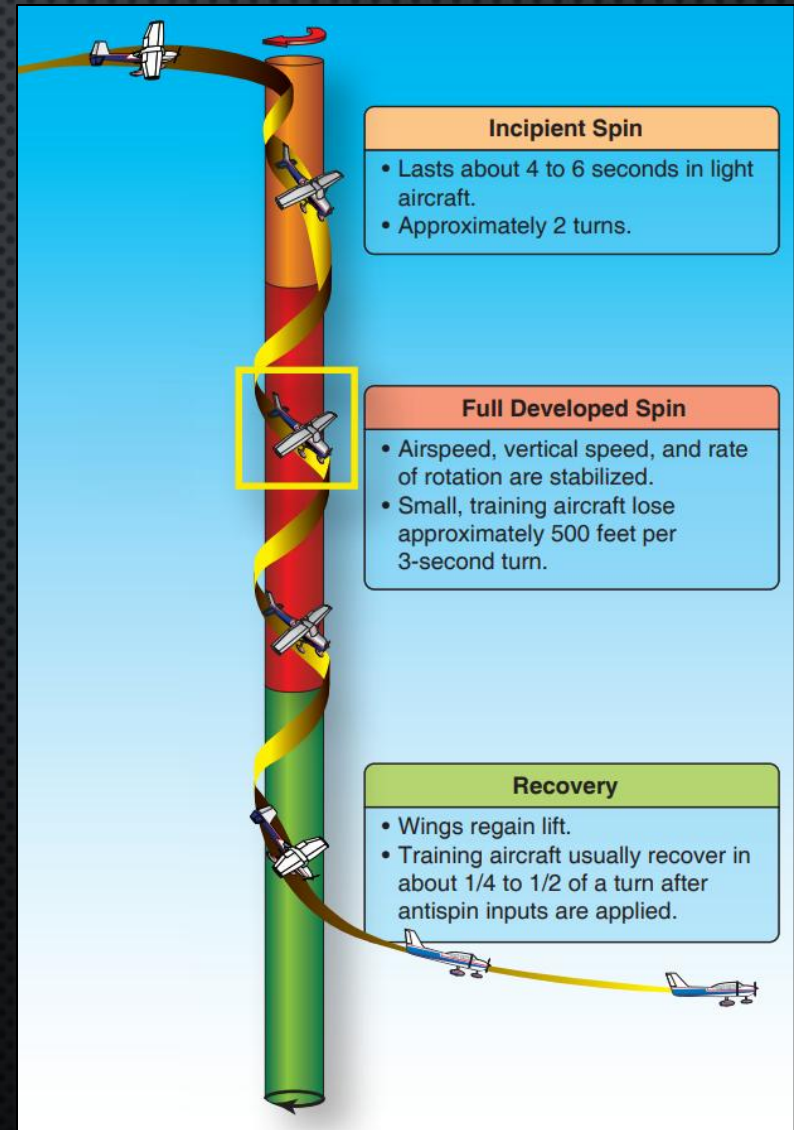
The Four Phases of a Spin

Incipient Phase

The pilot should initiate incipient spin recovery procedures prior to completing 360° of rotation.

The pilot should apply full rudder opposite the direction of rotation. The turn indicator shows a deflection in the direction of rotation if disoriented.

Incipient spins that are not allowed to develop into a steady state spin are the most commonly used maneuver in initial spin training and recovery techniques.

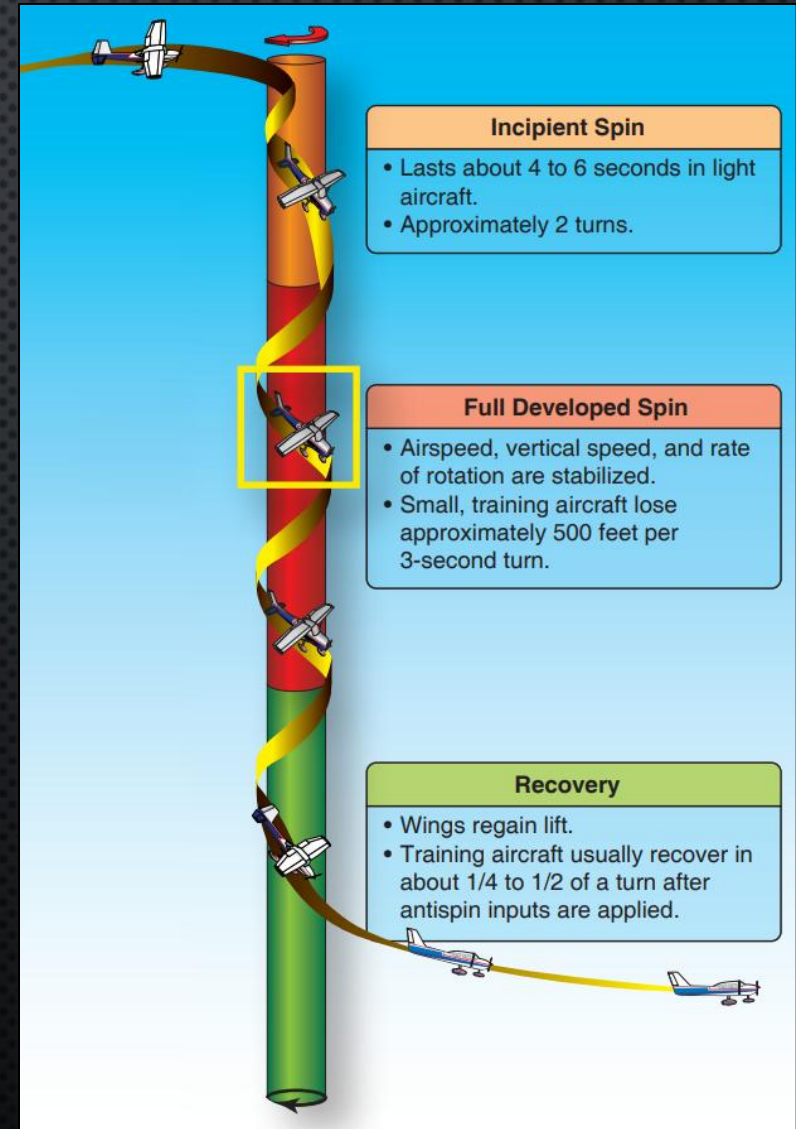


The Four Phases of a Spin

Developed Phase

The developed phase occurs when the airplane's angular rotation rate, airspeed, and vertical speed are stabilized in a flightpath that is nearly vertical.

In the developed phase, aerodynamic forces and inertial forces are in balance, and the airplane's attitude, angles, and self-sustaining motions about the vertical axis are constant or repetitive, or nearly so. The spin is in equilibrium.

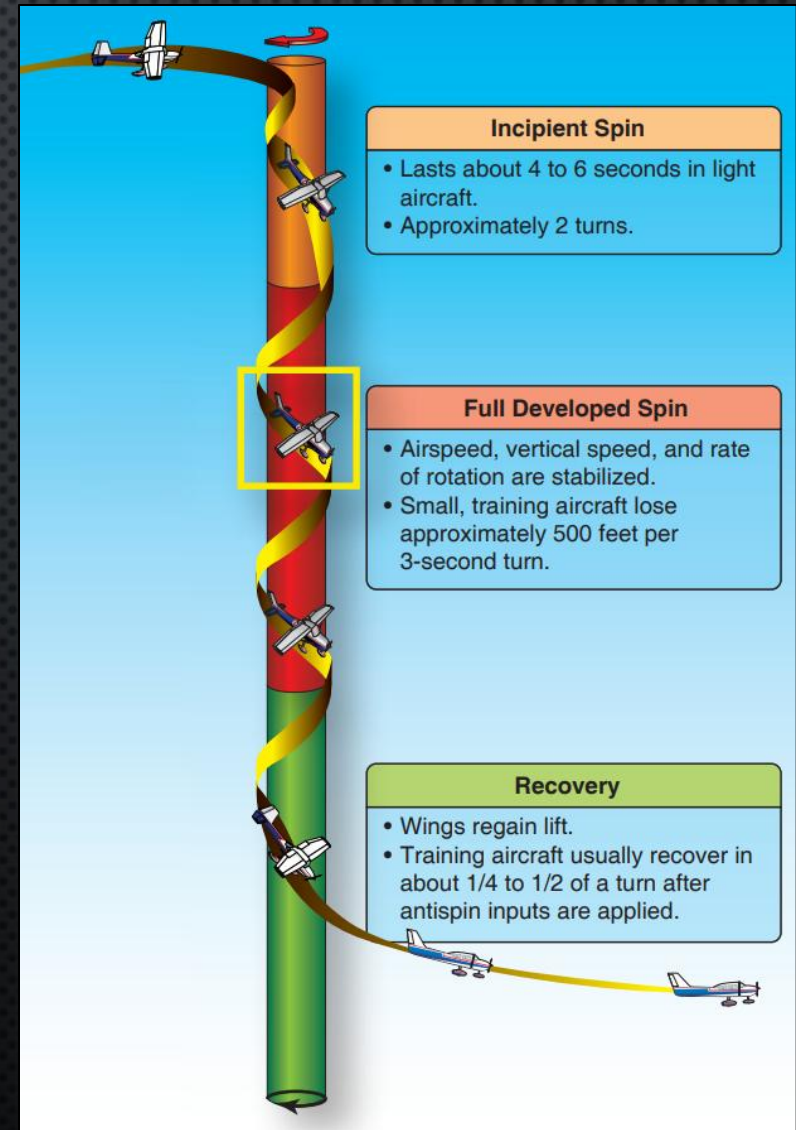


The Four Phases of a Spin

Developed Phase

It is important to note that some training airplanes will not enter into the developed phase but could transition unexpectedly from the incipient phase into a spiral dive.

In a spiral dive the airplane will not be in equilibrium but instead will be accelerating and G load can rapidly increase as a result.



The Four Phases of a Spin

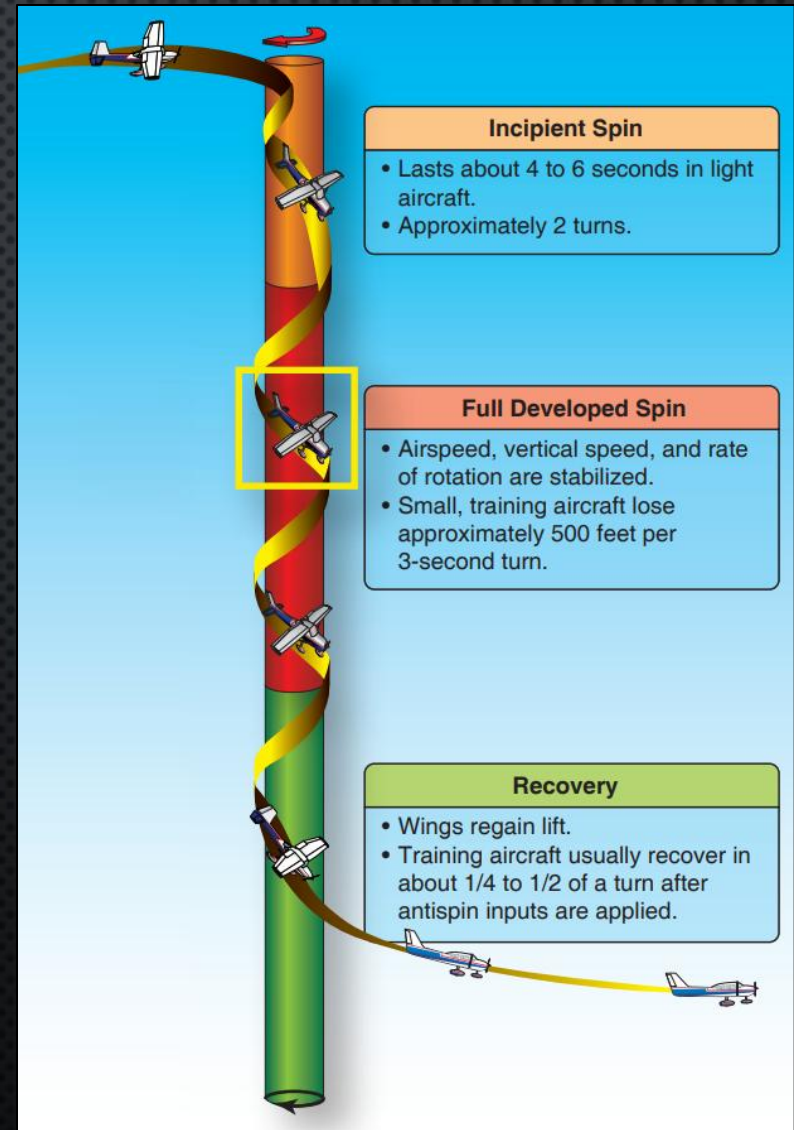
Recovery Phase

The recovery phase occurs when rotation ceases and the AOA of the wings is decreased below the critical AOA.

This phase may last for as little as a quarter turn or up to several turns depending upon the airplane and the type of spin.

To recover, the pilot applies control inputs to disrupt the spin equilibrium by stopping the rotation and unstalling the wing.

To accomplish spin recovery, always follow the manufacturer's recommended procedures. In the absence of the manufacturer's recommended spin recovery procedures and techniques, use the spin recovery procedures in the AFH.



Spin Entry (demo)



Spin Entry (demo)

Spin Procedures

The first rule for spin demonstration is to ensure that the airplane is approved for spins.

Please note that this discussion addresses generic spin procedures; it does not cover special spin procedures or techniques required for a particular airplane.

Safety dictates careful review of the AFM/POH and regulations before attempting spins in any airplane.

The review should include the following items:

- The airplane's AFM/POH limitations section, placards, or type certification data to determine if the airplane is approved for spins
- Weight and balance limitations
- Recommended entry and recovery procedures
- The current 14 CFR Part 91 parachute requirements

Spin Entry (demo)

Also essential is a thorough airplane preflight inspection, with special emphasis on excess or loose items that may affect the weight, center of gravity, and controllability of the airplane.

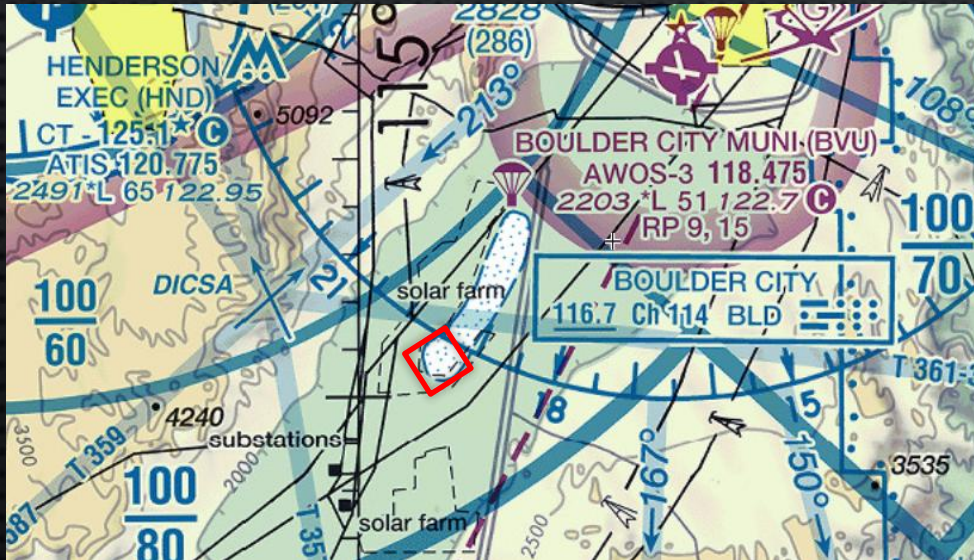
It is also important to ensure that the airplane is within any CG limitations as determined by the manufacturer. Slack or loose control cables (particularly rudder and elevator) could prevent full anti-spin control deflections and delay or preclude recovery in some airplanes.



Spin Entry (demo)

Prior to beginning spin training, clear the flight area above and below the airplane for other traffic. This task may be accomplished while slowing the airplane for the spin entry.

In addition, all spin training should be initiated at an altitude high enough to complete recovery at or above 1,500 feet AGL.



$$1716 + 1500 = 3216 \text{ MSL} \quad 3500 + 2000 = 5500 \text{ MSL}$$

Spin Entry (demo)

Decathlon Spin Entry Procedure

1. Perform HASELL check
2. Reduce the throttle to idle while maintaining altitude and begin slowing to V_S (54 MPH)
3. At approximately 3-5 MPH above V_S (59 MPH) smoothly and briskly apply full rudder in the desired spin direction.
4. As the aircraft begins to yaw, briskly pull the stick full aft to induce a stall.
5. Maintain full in-yaw rudder and full aft (up) elevator for as long as many turns as desired.

HASELL check

- Height
- Airframe
- Security
- Engine
- Location
- Lookout



Spin Recovery (PARE)

Spin Recovery Procedure

The PARE checklist provides a convenient method for teaching and recalling the steps in the NASA Standard spin recovery procedure for typical, light, single-engine, general aviation airplanes.

NASA Standard recovery actions were first introduced in 1936, and those recovery actions were verified again during an intensive spin test program conducted by NASA during the 1970s/80s using four single-engine airplanes representative of those in the broader general aviation fleet.



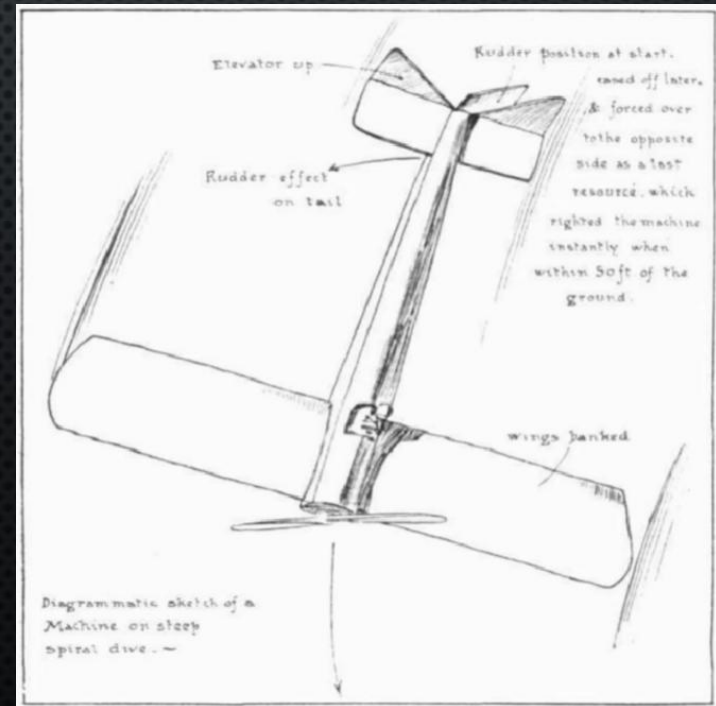
<https://youtu.be/StRTj2bsmMw>

Spin Recovery (PARE)

Spin Recovery Procedure

Lieutenant Wilfred Parke of the Royal Navy is generally recognized as the first person to recover from an accidental, fully developed aircraft spin, an event that occurred on August 25, 1912, at Larkhill, England.

His survival in an Avro Type G biplane by applying opposite rudder and reducing back pressure provided the first, critical, practical lesson in spin recovery.



Spin Recovery (PARE)

Spin Recovery Procedure

The Incident: During a 3-hour flight test, Parke's aircraft stalled and entered a steep, spinning nose-dive at approximately 700 feet.

The Recovery ("Parke's Dive"): After initial, failed attempts to recover by increasing power and holding the stick back, Parke applied full opposite rudder and pushed the stick forward, recovering at only 50 feet above the ground.

Significance: Before this event, spins were considered fatal, and this, along with subsequent scientific research by Frederick Lindemann, revolutionized early aviation safety.



Spin Recovery (PARE)

PARE Spin Recovery Procedure

1. **P**ower: idle
2. **A**ilerons: neutral (and flaps up)
3. **R**udder: full opposite to the spin and held in that position
4. **E**levator: through neutral

Hold these inputs until rotation stops, then:

1. Rudder: neutral
2. Elevator: easy pull to straight and level or a climbing attitude

Inadvertent spin recovery: If you entered the spin inadvertently, the spin recovery technique is the same as described, but because the aircraft will most likely be developing full power in the spin, the first thing to do is **retard power to idle**.



Spin Recovery (PARE)

Many pilots forget to cut the power before attempting to recover because they are used to having power off well before they deliberately enter a spin and reach the recovery stage.

Many aircraft **types will not recover with the power on**, so develop the “retard power” command into a reflex reaction to an inadvertent spin.

Power retardation should be followed by the PARE recovery.



Spin Recovery (PARE)

Airplane Flying Handbook Technique:

1. Reduce the Power (Throttle) to Idle
2. Position the Ailerons to Neutral
3. Apply Full Opposite Rudder against the Rotation
4. Apply Positive, Brisk, and Straight Forward Elevator (Forward of Neutral)
5. Neutralize the Rudder After Spin Rotation Stops
6. Apply Back Elevator Pressure to Return to Level Flight



Spin Entry (demo)

SPINS

Should an inadvertent spin occur, the following recovery procedure should be used:

1. RETARD THROTTLE TO IDLE POSITION.
2. PLACE AILERONS IN NEUTRAL POSITION.
3. APPLY AND **HOLD** FULL RUDDER OPPOSITE TO THE DIRECTION OF ROTATION.
4. JUST **AFTER** THE RUDDER REACHES THE STOP, MOVE THE CONTROL WHEEL **BRISKLY** FORWARD FAR ENOUGH TO BREAK THE STALL. Full down elevator may be required at aft center of gravity loadings to assure optimum recoveries.
5. **HOLD** THESE CONTROL INPUTS UNTIL ROTATION STOPS. Premature relaxation of the control inputs may extend the recovery.
6. AS ROTATION STOPS, NEUTRALIZE RUDDER, AND MAKE A SMOOTH RECOVERY FROM THE RESULTING DIVE.

NOTE

If disorientation precludes a visual determination of the direction of rotation, the symbolic airplane in the turn coordinator may be referred to for this information.

For additional information on spins and spin recovery, see the discussion under SPINS in Normal Procedures (Section 4).

SPINS

Normal or inverted spins are approved in this aircraft when flown in the acrobatic category. Spins are prohibited in the normal category. Use the following recovery procedure:

- (1) Throttle--CLOSED.
- (2) Ailerons--NEUTRAL POSITION.
- (3) Elevator--NEUTRAL POSITION.
- (4) Rudder--FULL DEFLECTION in the opposite direction to the rotation.

When rotation stops ($\frac{1}{2}$ to 1 turn after recovery initiated).

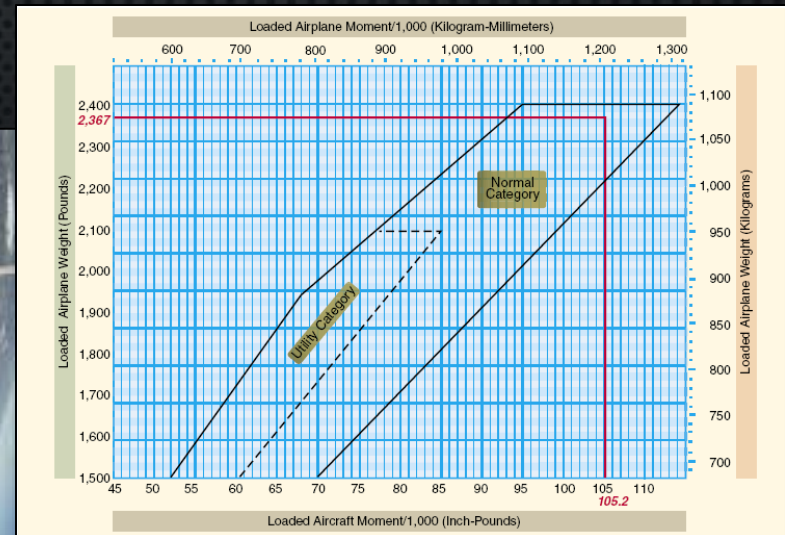
- (1) Rudder--NEUTRALIZE.
- (2) Nose attitude--RAISE smoothly to level flight attitude.

Weight and Balance

In airplanes that are approved for spins, compliance with weight and balance requirements is important for safe performance and recovery from the spin maneuver.

Pilots must be aware that even minor weight or balance changes can affect the airplane's spin recovery characteristics. **Such changes can either degrade or enhance the spin maneuver and/or recovery characteristics.**

An airplane that is approved for spins in the utility category but loaded in accordance with the normal category **may not recover** from a spin that is allowed to progress beyond one turn.



Common Student Errors

1. Failure to apply full rudder pressure (to the stops) during spin entry
2. Failure to apply and maintain full up-elevator pressure during spin entry, resulting in a spiral
3. Failure to achieve a fully-stalled condition prior to spin entry
4. Failure to apply full rudder (to the stops) briskly against the spin during recovery
5. Failure to apply sufficient forward-elevator during recovery
6. Waiting for rotation to stop before applying forward elevator
7. Failure to neutralize the rudder after rotation stops.
8. Slow and overly cautious control movements during recovery
9. Excessive back elevator pressure after rotation stops, resulting in a secondary stall
10. Insufficient back elevator pressure during recovery resulting in excessive airspeed



Regulations

Sec. 91.307 – Parachutes and parachuting.

- c) Unless each occupant of the aircraft is wearing an approved parachute, no pilot of a civil aircraft carrying any person (other than a crewmember) may execute any intentional maneuver that exceeds—
 - 1) A bank of 60 degrees relative to the horizon; or
 - 2) A nose-up or nose-down attitude of 30 degrees relative to the horizon.

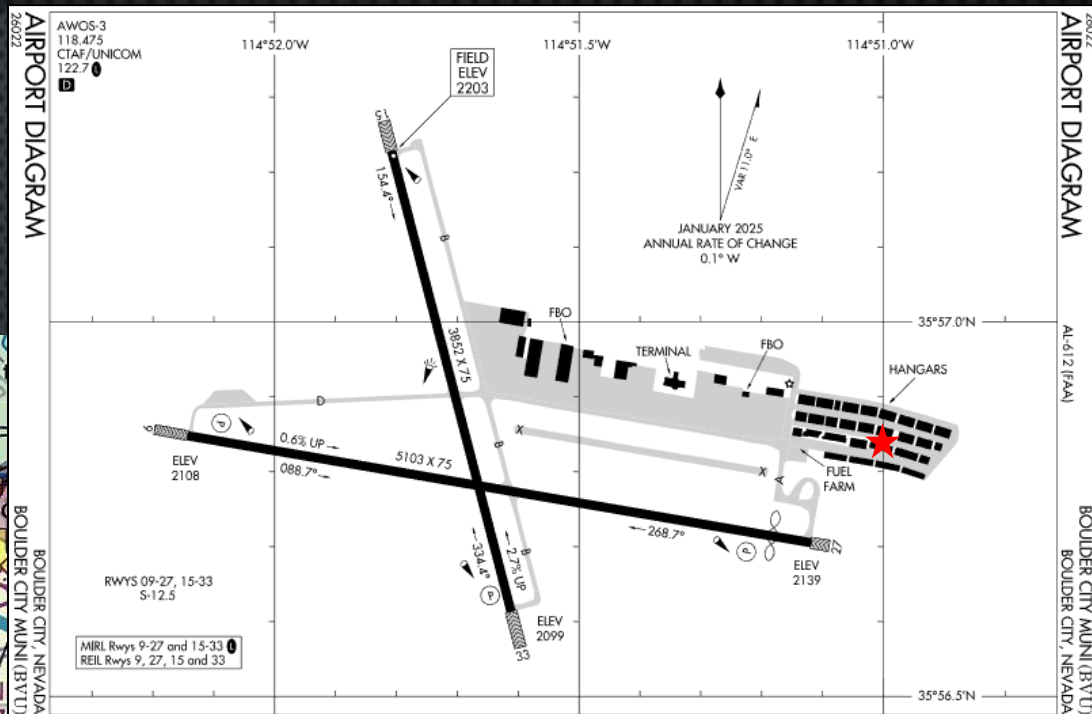
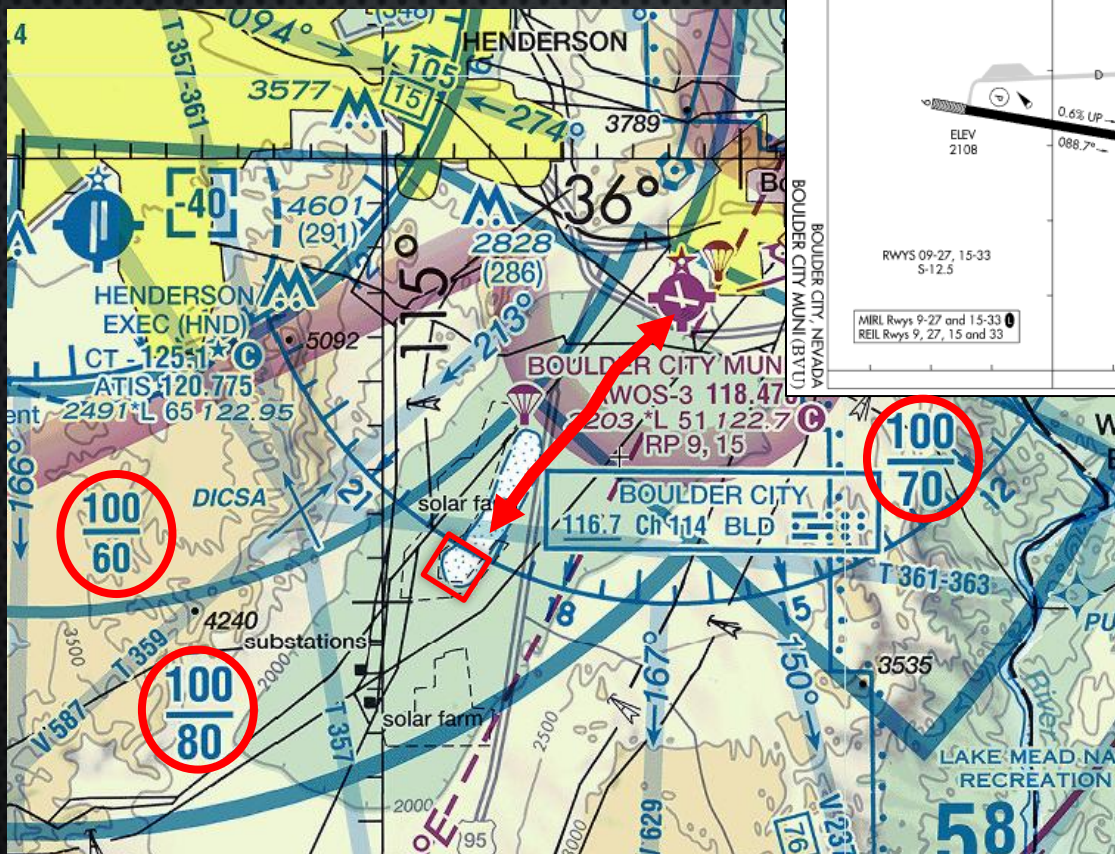
- d) Paragraph (c) of this section does not apply to--
 - 1) Flight tests for pilot certification or rating; or
 - 2) Spins and other flight maneuvers required by the regulations for any certificate or rating when given by--
 - i. A certificated flight instructor; or
 - ii. An airline transport pilot instructing in accordance with Sec. 61.67 of this chapter.



Local Area

AEROBATIC AREA

Spin Training 6000 to 3500 MSL



Course Overview

- What is a spin?
- How does a spin occur?
- 4 Phases of a spin
- Spin entry
- Spin recovery (PARE)
- Weight and Balance
- Common Student Errors
- Regulations
- Local Area



Any Questions?



Video Links

- **NASA Spin Tests**
 - <https://youtu.be/StRTj2bsmMw>
- **Parkes Dive**
 - <https://youtu.be/p6GvN4bjbnI>
- **Spinning Trials**
 - <https://youtu.be/s2vZFA5IEto>
- **General Aviation Stall/Spin Research**
 - <https://youtu.be/35yuFYq9ff4>
- **Stall/Spin Studies Relating to General Aviation**
 - <https://youtu.be/EiWxeM47jN8>
- **Stall/Spin Classic Facts and Myths**
 - <https://youtu.be/3WfNuy3f-iY>
- **Stall/Spin Parachute Recovery**
 - <https://youtu.be/rEKK-x6yjS0>
- **Gold Seal – Spins**
 - <https://youtu.be/MuMZ53iX0VU>