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Guidance Notes

PRIVATE AND COMMERCIAL PILOT TRAINING

Stall/Spin Awareness

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STALL/SPIN AWARENESS

The removal of the requirement for the testing of Exercise 13 Spin from the Flight Test Guide-Private Pilot Licence-Aeroplane does not reduce the importance of continued training in spin recovery.

In addition, a greater emphasis should be placed on the recognition and prevention of the stalls that can lead to a spin.

This document is not a replacement for the Flight Instructor Guide (TP975), the Pilot's Operating Handbook (POH) or the Aircraft Flight Manual (AFM). It provides supplemental guidance to flight instructors and is meant to complement and expand on the procedures described in Exercises 12 and 13 of the Flight Instructor Guide.

To encourage the use of Scenario Based Training, detailed guidance is included in developing scenarios that simulate real world situations.

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STALLS

Types Of Stalls

Stalls can be practised both with and without power. Stalls should be practised to familiarize the student with the aircraft's particular stall characteristics without putting the aircraft into a potentially dangerous condition. A description of some different types of stalls follows:

- a. **Departure Stalls** (can be classified as *power-on stalls*) are practised to simulate takeoff and climb-out conditions and configuration. Many stall/spin accidents have occurred during these phases of flight, particularly during overshoots. A causal factor in such accidents has been the pilot's failure to maintain positive pitch control due to a nose-high trim setting or premature flap retraction. Failure to maintain positive control during short field takeoffs has also contributed towards accidents.
- b. **Arrival Stalls** (can be classified as *power-off stalls* or *reduced power stalls*) are practised to simulate normal approach-to-landing conditions and configuration. Simulations should also be practised at reduced power settings consistent with the approach requirements of the particular training aircraft. Many stall/spin accidents have occurred in situations, such as crossed control turns from base leg to final approach (resulting in a skidding or slipping turn); attempting to recover from a high sink rate on final approach by using only an increased pitch attitude; and improper airspeed control on final approach or in other segments of the traffic pattern.
- c. **Accelerated Stalls** can occur at higher-than-normal airspeeds due to abrupt and/or excessive control applications. These stalls may occur in steep turns, pull-ups, or other abrupt changes in flight path. For these reasons, accelerated stalls usually are more severe than unaccelerated stalls and are often unexpected.

Stall Recovery

The key factor in recovery from a stall is regaining positive control of the aircraft by reducing the angle of attack. At the first indication of a stall, the wing angle of attack must be decreased to allow the wings to regain lift. Every aircraft in upright flight may require a different amount of forward pressure to regain lift. It should be noted that too much forward pressure could hinder recovery by imposing a negative load on the wing. The next step in recovering from a stall is to smoothly apply maximum allowable power to increase the airspeed and minimize the loss of altitude. As airspeed increases and the recovery is completed, power should be adjusted to return the aeroplane to the desired flight condition. Straight and level flight should then be established with full co-ordinated use of the controls. The airspeed indicator or tachometer, if installed, should never be allowed to reach their high-speed red lines at anytime during a practice stall.

Secondary Stalls

If recovery from a stall is not made properly, a secondary stall or a spin may result. A secondary stall is caused by attempting to hasten the completion of a stall recovery before the aircraft has regained sufficient flying speed. When this stall occurs, the elevator back pressure should again be released just as in a normal stall recovery. When sufficient airspeed has been regained, the aircraft can then be returned to straight-and-level flight.

Cross-Control Stalls

Students are taught to avoid steeply banked turns at low altitude. If you overshoot the extended centreline on a turn from base to final, there is a tendency to “cheat” by applying inside rudder to increase the rate of turn – which requires opposite aileron to maintain the bank angle. The skidding turn tends to make the nose drop requiring back pressure on the control column.

In an extreme case, the result can be a full back control column with full opposite aileron and full inside rudder. The inside wing will stall first resulting in a sudden incipient spin. This is sometimes referred to as an “under the bottom stall”.

A top-rudder stall or “over the top stall” can occur when the aircraft is slipping. The aircraft should roll towards the higher wing at the point of stall.

SPINS

A spin in a small aeroplane is a controlled or uncontrolled manoeuvre in which the aeroplane descends in a helical path while flying in a stalled condition at an angle of attack greater than the angle of maximum lift. Spins result from aggravated stalls in uncoordinated flight. In an aggravated stall, one wing will drop before the other and the nose will yaw in the direction of the low wing. If a stall does not occur, a spin cannot occur.

Types Of Spins

- a. An incipient spin is that portion of a spin from the time the aeroplane stalls and rotation starts, until the spin becomes fully developed. An incipient spin that is not allowed to develop into a fully developed spin is commonly used as an introduction to spin training and spin recovery techniques.
- b. A fully developed spin occurs when the aircraft angular rotation rates, airspeed, and vertical speed are stabilized from turn-to-turn in a flight path that is close to vertical.
- c. A flat spin is characterized by a near level pitch and roll attitude with the spin axis near the C of G of the aeroplane. Recovery from a flat spin may be extremely difficult and, in some cases, impossible.

Primary Cause

The primary cause of an inadvertent spin is one wing exceeding the critical angle of attack while executing a turn with excessive or insufficient rudder, and, to a lesser extent, aileron. In an uncoordinated manoeuvre, the pitot/static instruments, especially the altimeter and airspeed indicator, are unreliable due to the uneven distribution of air pressure over the fuselage. The pilot may not be aware that the critical angle of attack is about to be exceeded until the stall warning device activates. If a stall recovery is not promptly initiated, the aeroplane is more likely to enter an inadvertent spin. The spin that occurs from cross-controlling an aircraft in a skidding turn usually results in rotation in the direction of the rudder being applied, regardless of which wing tip is raised. In a slipping turn, where opposite aileron is held against the rudder, the resultant spin will usually occur in the direction of the applied rudder and opposite the aileron that is being applied.

Spin Recovery

Before flying any aircraft, in which spins are to be conducted, it is important to determine under what conditions, and with which limitations, this exercise may be carried out. The pilot should be familiar with the weight and balance limitations, operating characteristics and standard operating procedures, including spin recovery techniques, specified in the approved AFM or POH. Pilots must also be aware that some manufacturers have updated the information regarding spins for some older aircraft models. Manufacturers use various methods of revising this information.

- The manual for the Piper PA-38 Tomahawk, issued in 1978 was revised in 1981 to include detailed information on the procedures to follow when spinning. Additional advice, outlining very specific spin characteristics in the case of a mishandled recovery, is very valuable to all pilots flying this aircraft.
- Piper Aircraft Corporation updated the PA-28-140 Cherokee Pilot Operating Handbook through a Service Bulletin (SB) in 1982. SB 753 provides “expanded spin recovery procedures to assure that proper safety practices and procedures relative to utility category flight operations are in effect”. Piper made it mandatory to retain this SB in the airplane at all times.
- Early Cessna aircraft did not include a procedure for the spin manoeuvre and Cessna has progressively updated the spin procedures included in the POHs since 1976 for C150 and since 1973 for C172 aircraft. A supplementary booklet titled ‘Spin Characteristics of Cessna Models 150, A150, 152, A152, 172, R172 and 177’ was issued in 1980 and sent to registered Cessna owners. This booklet outlines the differences in spin characteristics between models and even between some model years.

The procedures outlined below are suitable for most small aircraft and may be used in the absence of manufacturer’s data.

The first step in recovering from an upright spin is to close the throttle completely to reduce the gyroscopic effect of the propeller and minimize the loss of altitude. The next step is to neutralize the ailerons, determine the direction of the spin, and apply full opposite rudder. Just after the rudder reaches the stop, briskly move the elevator control forward sufficiently to break the stall. Some aircraft require merely a relaxation of back pressure; others require full forward elevator control pressure. Forward movement of the elevator control will decrease the angle of attack. Neutralize the rudder when the spinning stops. The aircraft will now most likely be in a spiral dive condition, so level the wings with co-ordinated controls and gradually apply enough aft elevator pressure to return to level flight. The ailerons should be neutral prior to applying significant aft pressure to prevent torsional overstress of the wing structure. Too much or abrupt aft elevator pressure and/or application of rudder and ailerons during the recovery can result in a secondary stall and possibly another spin. In some cases, the engine will stop developing power due to centrifugal force acting on the fuel in the tanks causing fuel starvation. It is, therefore, recommended to assume that power is not available when practicing spin recovery. As a rough estimate, an altitude loss of approximately 500 feet per each 3-second turn can be expected in most small aircraft in which intentional spin is approved. Greater losses can be expected at higher density altitudes.

Scenario Based Training

In order to increase the effectiveness of training it must be linked to the real world. In situations where real demonstration and practice can be too dangerous (e.g. a low altitude stall after take-off), simulations performed at a safe altitude can impart the required knowledge and skill. But these simulations must be well thought out by the instructor. Very few accidental stalls occur from an exaggerated pitch attitude. Demonstrations using less extreme attitudes provide realistic and effective training. A low level stall or spin requires a pilot to recognize the situation and implement the appropriate skill in a timely and accurate fashion. Prompt

recognition by the pilot is more likely to occur if they have been exposed to a close approximation of the situation. Describing a detailed scenario under which an exercise is to be performed sets the stage and provides that link.

Distractions

Improper airspeed management resulting in a stall or a spin is most likely to occur when the pilot is distracted. Poor weather, sickness, or intermittent equipment malfunctions can result in the pilot focusing on tasks secondary to flying the aeroplane. Emergencies such as engine failures and fires can cause strong distractions at critical times such as manoeuvring for landing.

Stall Training

Introduction

Flight instructors must provide stall training as outlined in Exercise 12 of the Flight Instructor Guide (TP975) and the Flight Training Manual. Emphasize that techniques and procedures for each aircraft may differ and that pilots should be aware of the flight characteristics of each aircraft flown. As an instructor you need to know how your training aircraft behave in order to provide an effective and safe demonstration. Strict adherence to the AFM/POH is necessary to ensure safety.

The following air exercises describe procedures that complement the Flight Instructor Guide and provide additional guidance in the training of stalls and incipient spins. To encourage the use of scenarios based on practical flight situations, some examples are provided but are not considered to be a comprehensive list. Refer to the matrix in Appendix 1 *Stall Scenario Conditions*, in this document, to help select the conditions for developing various scenarios. The intent of this matrix is to provide a variety of options. Instructors are not expected to teach every variation. Select a few that work well with the type of aircraft you fly.

Many aircraft manufacturers prohibit the use of flaps when practising intentional spins. If an inadvertent spin is entered during advanced stall practice, follow the manufacturers recommendations or, in the absence of these recommendations, retract the flaps at the first opportunity after initial recovery action has been taken.

Departure Stalls

Instructor and Student Practice

At a safe altitude,

- 1) Demonstrate coordinated and uncoordinated power-on stalls straight ahead and in turns.
- 2) Demonstrate with departure flap settings. Emphasize how these stalls could occur during takeoff. Point out the possibility of a spin developing from these types of stalls.

Stalls During Overshoots

At a safe altitude,

- 1) Trim the aircraft for a power-off descent and demonstrate a full-flap, gear extended, power-off stall, then recover with power and attempt to climb with flaps extended. If a higher than normal climb pitch attitude is held, a secondary stall will occur. (In some aeroplanes, a stall will occur if a normal climb pitch attitude is held.)
- 2) Demonstrate a full-flap, gear extended, power-off stall, then recover and retract the flaps rapidly as a higher than normal climb pitch attitude is held. A secondary stall or settling with a loss of altitude may result.
- 3) Elevator Trim Stall. Place the aeroplane in a landing approach configuration, in a trimmed descent. After the descent is established, initiate a go-around by adding full power, holding only light elevator and right rudder pressure. Allow the nose to pitch up and torque to yaw the aeroplane left. Emphasize the importance of correct attitude

control, application of control pressures, and proper trim during overshoots. Demonstrate the same exercise with the flaps retracted.

Scenarios

A reduced power setting can be used to simulate high density altitude.

During departure or overshoot

Steep climb or steep climbing turn

- avoiding obstacles
- avoiding birds or other aircraft
- showing off
- caught in a downdraft (windshear)
- wing contamination
- distraction resulting in airspeed decay

Using information from actual aviation accident reports can help lend realism to scenario development. For example,

“Location: 1,100 FT grass strip with 75 feet high pine trees at departure end of the runway. The departing C-150 was observed by witnesses to become airborne approximately 200 feet from the end of the strip and approximately 500 feet from a line of pine trees off the departure end of the strip. The a/c entered a steep climbing right turn then rolled to the left and descended in a steep nose down attitude until it collided with the ground. 2 fatal”

Using this example refer to the **Stall Scenario Conditions Appendix 1**. Starting at the left column of the matrix select

Departure stall,

1. medium power,
2. 0° flaps,
3. gear n/a,
4. coordinated medium turn,
5. climbing attitude.

This one scenario can be modified by changing any of the 5 conditions in the matrix.

Many other scenarios can be developed from the matrix by using aircraft accident reports and personal experience. Avoid using only one or two scenarios in your training. Students should be exposed to as wide a variety of situations as possible.

Arrival Stalls

Instructor and Student Practice

At a safe altitude,

- 1) Demonstrate coordinated power-off or reduced power stalls straight ahead and in turns. Demonstrate with various flap settings. Emphasize how these stalls could occur during approach. Emphasize the possibility of a spin developing from these types of stalls.
- 2) Cross-controlled Stalls in Descending Turns. Demonstrate stalls at medium and low power settings while simulating turns from base to final. Demonstrate the stalls from a properly co-ordinated turn, a slipping turn, and a skidding turn. Explain the difference between slipping and skidding turns. Explain the position of the ball on the turn coordinator (or turn and bank indicator) in each turn and the aircraft behaviour in each of the stalls.

Note: In some aircraft types a skidding descending turn stall will result in the inside wing stalling first and a sudden and aggressive incipient spin developing. Training aircraft that exhibit docile spin characteristics may not produce a convincing demonstration of this manoeuvre. Try different configurations with your aircraft to find the most effective demonstration.

Scenarios

Arriving at an airport or off-airport landing area.

- turning to correct for an overshoot of the extended runway centreline
- turning to avoid obstacles, birds, other aircraft
- attempting to stretch a glide to the runway by raising the nose and not applying power
- illusions in strong wind conditions
- distraction resulting in airspeed decay

Again, using information from actual aviation accident reports can help lend realism to scenario development. For example,

“Location: 1 mile east of the aerodrome. Weather conditions: VFR, winds NW at 15 KT, moderate turbulence. The Piper Cub J-3 overshot the extended centreline for runway 26 while turning final. Witnesses observed the a/c turning from the south to the west at a moderate bank angle. Prior to completion of the turn the a/c bank attitude increased rapidly and the nose dropped to a nearly vertical attitude. The wreckage impact was consistent with an a/c in a spin condition. 1 fatal”

This accident is consistent with an attempt to “cheat” when overshooting a turn to final by input of rudder to increase the rate of turn and opposite aileron to maintain a normal bank angle. If the aircraft is allowed to stall at this point, the inside wing will stall first and a spin will develop.

Using this example refer to the **Stall Scenario Conditions Appendix 1**. Starting at the left column of the matrix select

Arrival stall,

1. medium power,

2. 0° flaps,
3. gear n/a,
4. uncoordinated medium skidding turn,
5. descent attitude.

This one scenario can be modified by changing any of the 5 conditions in the matrix.

Engine Failure after Take-off (followed by an attempt to return to the runway)

This demonstration will show the student how much altitude the aeroplane loses when, following an engine failure after take-off, an attempt is made to return to the departure runway. In order to complete the manoeuvre, the aircraft must be turned to a reciprocal heading AND realigned with the runway. This requires much more than just 180 degrees of turn. For novice pilots, turning back is not an option. An evaluation of stall/spin accidents in Canada showed that the pilot is eight times more likely to be killed or seriously injured turning back than landing straight ahead. For expert pilots who know how much altitude is needed to complete the required manoeuvring, it can be an option but even experts should be looking for landing areas that require less manoeuvring and less risk. Perform this demonstration using either a medium or steep bank in the turn, giving emphasis to stall avoidance.

Instructor and Student Practice

At a safe altitude,

- 1) In cruise configuration, establish the best rate of climb speed (V_Y). Note your altitude.
- 2) Reduce power smoothly to idle to simulate the engine failure.
- 3) Lower the nose to maintain the best glide speed and make a 270° turn followed by a 90° turn in the opposite direction to roll out on the reciprocal of the original heading.
- 4) Point out the altitude loss and emphasize how rapidly airspeed decreases following a power failure in a climb attitude.
- 5) Demonstrate the manoeuvre again and allow the aeroplane to stall during the turn. (This is actually a variation of an approach stall.) Emphasize the possibility of a spin developing from these types of stalls.

Note: It should be stressed that the successful return to the airport after an actual engine failure on take-off depends on a variety of factors including available landing surfaces, altitude AGL when failure occurs, weather, turbulence, aircraft type and pilot skill and stress level. Point out that the altitude loss incurred during the controlled demonstration will be significantly less than in a real life situation. It is recommended to conduct the demonstration from the cruise configuration to reduce wear on the engine.

Accelerated Stalls

Instructor and Student Practice

At a safe altitude, set the aircraft up at 80% of the appropriate manoeuvring speed (V_a) for the weight of the aircraft.

- 1) Demonstrate the difference in stall speed by approaching the stall in level, unaccelerated flight and noting the airspeed at which the stall warning activates. Then demonstrate a 60° bank level turn and note the speed at which the stall warning activates. Emphasize that the stall is a function of angle of attack, not airspeed. An aircraft can stall at any speed and any attitude. Emphasize that these stalls could occur during any phase of flight, where abrupt or excessive control movements produce an increased load factor on the aircraft, such as steep turns, pulling out of a dive or sudden changes in direction of flight. Emphasize the possibility of a spin developing from these types of stalls.
- 2) Demonstrate a 45° bank turn and gradually decrease power, while trying to maintain altitude with increasing back pressure, until the stall occurs. Demonstrate a 45° bank turn at cruise or climb power and “tighten the turn” with rapid back pressure on the control column. Demonstrate an abrupt pull-up (at low speed).

Scenarios

Abrupt pull-up to avoid obstacles or after a recovery from a stall

Aggressive manoeuvring while “showing off”

Distraction resulting in airspeed decay during a turn

- While sight seeing at low level.
- Turning to look at landmarks, wildlife, people.
- Turning to avoid obstacles, aircraft.

Here is an actual aviation accident report that can help you design a realistic scenario.

“The Cessna 210 with 3 persons onboard was observed to be flying at tree top level and manoeuvring in an abrupt manner. A video camera recovered from the wreckage recorded the final minutes of the flight. The pilot was manoeuvring to allow a passenger to video tape a moose when the stall warning horn activated and the aircraft stalled in a 45° left bank turn at an altitude of 50 feet AGL. 3 fatal”

Using this example refer to the **Stall Scenario Conditions Appendix 1**. Starting at the left column of the matrix select

Accelerated stall,

1. high power,
2. approach flaps,
3. gear up,
4. coordinated steep turn,
5. level attitude.

This one scenario can be modified by changing any of the 5 conditions in the matrix.

Distractions

Improper airspeed management resulting in stalls is most likely to occur when the pilot is distracted by one or more other tasks, such as locating a checklist or attempting a restart after an engine failure; flying a traffic pattern on a windy day; reading a chart or making fuel and/or distance calculations; or attempting to retrieve items from the floor, back seat, or glove compartment.

Pilots at all skill levels should be aware of the increased risk of entering into an inadvertent stall, spin or spiral dive while performing tasks that are secondary to controlling the aircraft. Providing the student with normal tasks secondary to the control of the aircraft builds confidence and ability. A properly trimmed aeroplane is a key component of controlling the aircraft while handling distractions. The following list of deliberate distractions can challenge students and improve their skills.

1. Have the student
 - a) pick up a dropped pencil.
 - b) determine a heading to an airport using a chart.
 - c) reset the clock to Universal Co-ordinated Time.
 - d) get something from the back seat.
 - e) read the outside air temperature.
 - f) call the Flight Service Station (FSS) for weather information.
 - g) compute true airspeed with a flight computer.
 - h) identify terrain or objects on the ground.
 - i) identify a field suitable for forced landing.
2. Ask the student to decrease the cruise airspeed by 10 knots and repeat #1.
3. Have the student climb 200 feet and maintain altitude, then descend 200 feet and maintain altitude while performing a task in #1.
4. Have the student reverse course after a series of S-turns and create a distraction.

Spin Training

Introduction

Flight instructors must provide spin training as outlined in Exercise 13 of the Flight Instructor Guide (TP975) and the Flight Training Manual. Emphasize that techniques and procedures for each aircraft may differ and that pilots should be aware of the flight characteristics of each aircraft flown.

A demonstration of the full spin, performed by the student, is required during private pilot training. Students should be competent in recovery from a full spin while avoiding a secondary stall, excessive airspeed, or excessive altitude loss.

Instructor and Student Practice

- a. Spin training must be accomplished in an aircraft that is approved for spins. Before practicing intentional spins, the AFM or POH must be consulted for the proper entry and recovery techniques. Pilots should also be knowledgeable of any additional information on spinning provided by the manufacturer.
- b. Spin avoidance, incipient spins, and actual spin entry, spin, and spin recovery techniques should be practised from an altitude recommended by the aircraft manufacturer or at an altitude that will enable complete recovery by 2,000 feet AGL, whichever is greater. The entry altitude is not governed by regulation, but pilots must make this determination safely with the full knowledge of the aircraft capabilities under existing conditions of aircraft configuration, pilot skill and meteorological and human factors.
- c. Observe the airspeed indicator during the spin recovery to ensure that it does not exceed the red line (V_{ne}).
- d. Follow the recovery procedures recommended by the manufacturer in the AFM or POH. In the absence of manufacturer's recommendations, spin recovery techniques for most aircraft consist of
 1. retarding power to idle,
 2. neutralizing the ailerons,
 3. applying opposite rudder to the direction of rotation,
 4. applying positive forward-elevator movement to break the stall
 5. neutralizing the rudder as the spinning stops,
 6. and returning to level flight.

The spin characteristics of aircraft that are approved for spins will vary between aircraft types **and even between different aircraft of the same type**. One aircraft may enter and recover from a spin promptly while another aircraft of the same type may enter a spin with difficulty or require a more aggressive recovery technique. This is due to various factors such as the weight and balance of the aircraft and the rigging of the controls and wings. For this reason caution should be exercised when practising spins in a variety of aircraft.

Inadvertent Spiral

Aircraft that are difficult to spin can quickly build up speed during a failed spin entry. It is important for students to recognize this entry to a spiral dive and immediately apply the correct spiral dive recovery procedure.

Scenarios

Many of the scenarios described in the previous pages can be used in developing a scenario for a full spin. The differences are in the time to initiate recovery. Although some aircraft types are difficult to spin and require special techniques, forcing an aircraft into a spin by aggressive control inputs is not as effective for teaching as a well executed simulation.

If you are setting a scenario with the intention of entering a spin, follow the manufacturer's recommendations with regards to prohibition of intentional spins with flaps extended.

APPENDIX 1

STALL SCENARIO CONDITIONS

Refer to scenarios in Chapter 2.

Choose **one** item from each column to build the conditions for a scenario.

Describe the scenario in realistic terms prior to performing the stall

The intent of this matrix is to provide a variety of combinations. Instructors are not expected to teach every variation. Select a few that work well for the type of aircraft you fly.

STALL	POWER SETTING	A/C CONFIGURATION		A/C FLIGHT PATH		SCENARIO
		Flaps	Gear	Attitude		
DEPARTURE	High Medium (<i>simulate high density altitude</i>)	0° Approach Landing **	Up Down	Straight Coordinated turn ▪ gentle ▪ medium Uncoordinated turn	Climbing Level ^^ Descending ^^	see page 6
ARRIVAL	Medium Low	0° Approach Landing	Up Down	Straight Turn ▪ gentle ▪ medium ▪ steep Coordinated Uncoordinated turn ▪ slipping ▪ skidding	Level Descending	see page 7
ACCELERATED	High Medium Low	0° Approach Landing	Up Down	Straight Coordinated turn ▪ gentle ▪ medium ▪ steep	Level Transitioning from a dive or stall recovery	see page 9

- Stall from an engine failure and 180° turn back to the departure runway is classified as an arrival stall for this Matrix
- **Stall from an overshoot is classified as a departure stall.
- ^^With wing contamination or high density altitude aircraft may be unable to climb after take-off.
- Aircraft should be correctly trimmed for scenario e.g. Stall from an overshoot with trim still set for approach.