Flight Instructor Open Forum

Teaching Spins, Spin Awareness, and Spin Recovery

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Topic: TEACHING SPINS, SPIN AWARENESS, AND SPIN RECOVERY

The Problem:

The phrase *Aerodynamic Stall/Spin* appears in two of the top eleven causes of GA accidents:

- Number 3, "Maneuvering – Low Altitude Flying"
- Number 7, "Initial Climb"

Other key stats:

- Greater than 90% of stall/spin accidents in certificated aircraft occur at or below pattern altitude
- Stall/spins have historically ranked among the top causes of fatal accidents
- Stall/spins similar to the representative accident included herein continue to occur

The Flight Instructor Practical Test Standards for Airplane (FAA-S-8081-6C) require testing on spins. The following is an excerpt from that document.

G. TASK: SPINS (ASEL)
NOTE: At the discretion of the examiner, a logbook record attesting applicant instructional competency in spin entries, spins, and spin recoveries may be accepted in lieu of this TASK. The flight instructor who conducted the spin instruction must certify the logbook record.
REFERENCES: 14 CFR part 23; Type Certificate Data Sheet; AC 61-67, FAA-H-8083-3; POH/AFM.
Objective. 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.

Required Equipment for the Seminar:

Access to the Internet for Anatomy of a Stall/Spin Accident YouTube video by AvWeb (Note: although this case happens to involve a Cirrus, the scenario and resulting spin are not specific to that aircraft)

Copies of NTSB report

Copy of Current Version of AC 61-67, Stall and Spin Awareness Training

Copy of AOPA ASF Safety Advisor, "Maneuvering Flight – Hazardous to Your Health?"

Copies of Quiz for attendees who want WINGS credit

Background/Attention Step:

1. View the video: http://www.youtube.com/watch?v=7nm_hoHhbFo&feature=player_embedded

2. Review the NTSB accident report: http://www.ntsb.gov/ntsb/brief2.asp?ev_id=20080206X00142&ntsbno=DFW08FA060&akey=1 (Note: although this case happens to involve a Cirrus, the scenario and resulting spin are not specific to this aircraft)

Training Delivery Method:

This is a Guided Discussion centering on a "typical" stall/spin accident that occurred during a flight review, with questions posed by the presenter and a quiz at the end.

Opening Discussion Questions:

Question 1: What are your thoughts on this accident?

Question 2: Where does the first major link occur in the accident chain?

Question 3: How many warning signs can you identify in the accident sequence?

Question 4: Relative to the traffic pattern, what elements of stall/spin awareness do you emphasize?

Spin Quiz:

The following quiz will be completed by those desiring WINGS credit.

1. What two ingredients are necessary in order to spin?
    a. Yaw and roll
    b. Stall and slow airspeed
    c. Stall and yaw
    d. Pitch and power
2. What are the four phases of a spin?
    a. Entry, incipient, developed, recovery
    b. Entry, incipient, autorotation, recovery
    c. Initiation, incipient, developed, recovery
    d. Entry, incipient, developed, exit
3. Which of the following is/are true regarding the left and right wings during a spin?
    a. Neither wing is producing any lift
    b. The angles of attack are unequal
    c. The drag is high and equal
    d. All of the above
4. Unless recommended otherwise, when applying spin recovery inputs, you should:
    a. Apply all inputs simultaneously
    b. Apply inputs sequentially, carefully evaluating the effect in between
    c. Apply all inputs smoothly, just like normal flying
    d. Apply inputs sequentially and positively
5. Which of the following tend to aggravate spin characteristics?
    a. Power on, ailerons opposite, aft center of gravity
    b. Equal amounts of fuel in the tanks, carb heat on, rudder neutral
    c. Power off, ailerons neutral, forward center of gravity
    d. Gear down, flaps up, rudder full opposite
6. The most common spin accident scenario occurs while:
    a. Executing a go-around
    b. Operating near the one-g stall speed
    c. Maneuvering at low altitude
    d. Practicing power on stalls
7. During a disorienting upright spin, direction of rotation can be determined by looking at:
    a. The slip/skid ball
    b. The directional gyro
    c. The attitude indicator
    d. The symbolic airplane of the turn coordinator
8. After applying full opposite rudder, how long should you wait before applying forward elevator?
    a. Until rotation has stopped
    b. Once opposite rudder has been fully applied
    c. Until a safe flying speed has been attained
    d. Approximately three seconds

9. The only official source for determining whether or not an airplane is approved for intentional spins is/are:
    a. Type Certification Data Sheets or Aircraft Specifications
    b. The limitations section of the FAA-approved AFM/POH
    c. On cockpit placards
    d. All of the above

10. Which of the following is a true statement?
    a. It is sometimes permissible to perform intentional spins in the Normal category
    b. Intentional spins are always approved when in the Utility category
    c. An airplane approved for spins in the Utility Category, but loaded in the Normal Category, may not recover from a spin that is allowed to progress beyond the incipient phase
    d. All of the above

11. A common error in the performance of *intentional* spins is:
    a. Failure to make the appropriate Mayday call while spinning
    b. Failure to apply full opposite rudder during recovery
    c. Failure to let go of the controls
    d. Failure to bring an airsick bag on the flight

12. The spin that occurs from cross controlling an aircraft usually results in rotation:
    a. In the direction of the applied rudder, regardless of which wingtip is raised
    b. That is impossible to stop
    c. In the direction of the turn
    d. That becomes flat

Quiz Answer Key:

1. C. Stall and yaw
2. A. Entry, incipient, developed, recovery
3. B. The angles of attack are unequal
4. D. Apply inputs sequentially and positively
5. A. Power on, ailerons opposite, aft center of gravity
6. C. Maneuvering at low altitude
7. D. The symbolic airplane of the turn coordinator
8. B. Once opposite rudder has been fully applied
9. D. All of the above
10. C. An airplane approved for spins in the Utility Category, but loaded in the Normal Category, may not recover from a spin that is allowed to progress beyond the incipient phase
11. B. Failure to apply full opposite rudder during recovery
12. A. In the direction of the applied rudder, regardless of which wingtip is raised

ANATOMY OF A STALL/SPIN ACCIDENT

NTSB Accident Report: DFW08FA060

(see next five pages for text of report)

Available: http://www.ntsb.gov/ntsb/brief2.asp?ev_id=20080206X00142&ntsbno=DFW08FA060&akey=1

Video Reconstruction: http://www.youtube.com/watch?v=7nm_hoHhbFo&feature=player_embedded

Although this particular accident involves a Cirrus, it is representative of a common stall/spin accident scenario encountered by pilots flying all types of airplanes and thus, is being used here merely for illustrative and educational purposes

DFW08FA060

HISTORY OF FLIGHT

On February 2, 2008, approximately 1713 central standard time, a Cirrus SR22, N824BJ, single-engine airplane, was destroyed when it collided with terrain while maneuvering near the Lindsay Municipal Airport (1K2), Lindsay, Oklahoma. The certified flight instructor and the private pilot were fatally injured. The airplane was registered to and operated by the private pilot. No flight plan was filed and visual meteorological conditions prevailed for the instructional flight conducted under 14 Code of Federal Regulations Part 91.

The flight instructor, who was also a Federal Aviation Administration (FAA) certified airframe and power plant mechanic (A&P), operated a maintenance facility from a private airstrip about 5 miles southeast of the Lindsay Airport. According to one of his customers, the instructor had called him on the day of the accident, and told him that he had completed the annual inspection on his airplane. The instructor planned to reposition it to Lindsay Airport, because he was already scheduled to be there to give the private pilot, whom the customer knew as well, a "biennial flight review." Later that day, the customer saw the accident airplane in the traffic pattern and drove to the airport. When he arrived, he saw the airplane departing to the north. The customer then drove over to a friend's hangar, picked him up, and drove to the departure end of Runway 10 so they could watch the airplane land. About 20 minutes later, he "heard an engine accelerate then a boom." The customer said that he had not seen or heard the airplane prior to the sound of the engine accelerating.

Another witness was in his backyard when he heard the airplane's engine "wind up hard." He said, "I turned to look at the plane, and it looked like it fell to the ground in a 45 degree angle - The plane disappeared behind a row of trees - then I saw a ball of smoke - then I heard it hit the ground." The witness also stated that he heard an airplane making "circles" around the airport before the crash but he was not sure it was the accident airplane. Several other people heard the airplane flying in the vicinity of the airport and reported hearing the airplane's engine "missing" or "cutting out."

Lindsay Municipal Airport is an uncontrolled airport and pilots communicate via a common traffic advisory frequency (CTAF). There were no reports that the pilots made any distress calls prior to the accident.

A review of radar data revealed a VFR target at an altitude of 1,700 feet mean sea level (msl) north of Lindsay Municipal Airport, at 1659. The target continued to track to the north before it made a left turn to the northwest and flew for approximately 15 miles. During this time, the target climbed to an altitude of 3,000 feet msl.

Approximately 1704, when the target was at an altitude of 2,800 feet msl it entered a left turn to the south. The target then descended to 2,700 feet msl, and then climbed to 2,800 feet msl, as it continued on a southerly heading.

At 1705, the target made a right, 360-degree turn at an altitude of 2,800 feet msl before it returned to a southerly heading.

At 1708, the target entered a left turn to the east-southeast at an altitude of 2,700 feet msl. The target was northwest of the airport and began to track toward the southeast. During this portion of the flight, the target climbed to an altitude of 2,900 feet and then began a steady descent as it approached the airport from the northwest before the data ended at 1712. At that time, the airplane was located approximately three-quarters of a mile northeast of the approach end of Runway 19, and was at an altitude of approximately 1,500 feet msl.

PILOT INFORMATION

The flight instructor held a commercial certificate for airplane single-engine land, and instrument airplane. He also held a certified flight instructor rating for airplane single-engine land, and instrument airplane. In addition, he was a certified airframe and power plant mechanic, with inspector authorization (IA). His last FAA second-class medical was issued on January 30, 2007. A review of his logbook's revealed that his last entry was made on October 30, 2007. At that time, he had accrued a total of 1,438.8 hours. There was no entry that he had any previous experience in the same make and model as the accident airplane.

The pilot held a private pilot certificate for airplane single-engine land, and instrument airplane. His last FAA third class medical was issued on January 17, 2008. A review of his logbook revealed that he had accumulated approximately 1,327 hours, of which 230 hours were in a Cirrus SR22 airplane.

AIRCRAFT INFORMATION

The airplane was a 2006 Cirrus SR22, serial number 2119, and was powered by a Teledyne Continental Motors (TCM), IO-550-N (42), serial number 689918 engine. A Hartzell PHC-J3YF-1RF/ FP4809B propeller was attached to the engine.

A review of the airframe logbooks revealed that the last annual inspection was completed on October 2, 2007, at an airplane total time of 155.7 hours. At the time of the accident, the airplane and engine had accrued a total of 198.3 hours.

METEORLOGICAL INFORMATION

Weather at Paul's Valley Municipal Airport (PVJ), approximately 20 nautical miles southeast of the accident site, at 1750, was reported as wind from 080 degrees at 5 knots, visibility 10 miles, clear skies, temperature 57 degrees Fahrenheit, dewpoint 37 degrees Fahrenheit, and a barometric pressure setting of 29.99 inches of Mercury.

WRECKAGE INFORMATION

The airplane came to rest in a pasture approximately .25-miles northwest of Lindsay Municipal Airport on a magnetic heading of approximately 240 degrees at a field elevation of 965 feet msl. A post-impact fire consumed the main wreckage of the airplane, which consisted of the cockpit, fuselage, tail section, left and right wings, main landing gear, and the engine.

The initial impact mark was about 45 feet from where the main wreckage came to rest. The initial impact mark included two horizontal impact marks (consistent with the leading edge of the wings) that expanded to the left and right of a 3- foot by 4- foot- wide crater. A piece of red navigational lens was found at the far most end of the right impact mark.

The three-bladed propeller and numerous pieces of Plexiglas were found imbedded in the initial impact crater. One blade exhibited an "S" bend. The second propeller blade exhibited leading edge damage and the third propeller blade was fractured at the blade root. This blade exhibited an "S" bend, and was bent toward the non-cambered side of the blade, beginning at the blade root.

The nose wheel, Cirrus Airframe Parachute System (CAPS), parachute rocket motor, engine cowling, and sections of airframe were found scattered along the wreckage path between the initial impact point and the main wreckage.

Examination of the airplane's safety equipment revealed that the CAPS activation handle was intact and in its holder, the rocket motor was expended, and the deployment pack consisted of a partially packed parachute (risers extended out of the bag). A portion of the front right seat's shoulder harness, including a deployed airbag, was found in the wreckage.

Flight control continuity was established for all flight controls from the respective surface to the cockpit. Examination of the flap actuator revealed the flaps were fully retracted.

The engine was examined at Teledyne Continental Motors on June 17, 2008, under the supervision of the Safety Board. Examination of the engine revealed that it had sustained impact and thermal damage, but all six cylinders remained attached to the engine. The left and right magneto exhibited impact and thermal damage; however, the left magneto was only partially attached to the engine. The spark plugs were removed. The number three top plug was damaged, but each of the plugs exhibited normal operating wear signatures in accordance with the Champion aviation check-a-plug comparison chart. The fuel pump remained attached to the engine and exhibited thermal and impact damage. The fuel mixture control was in the "full rich" position. The pump was removed from the engine and the drive coupling was intact. The cylinders were inspected using a lighted borescope. The cylinder bores were free of scoring within the bore ring travel area. A complete teardown examination of the engine revealed there were no mechanical deficiencies that would have precluded the engine from operating normally at the time of the accident.

MEDICAL AND PATHOLOGICAL INFORMATION

The Oklahoma Office of the Chief Medical Examiner, Oklahoma City, Oklahoma conducted autopsies on both pilots on February 3, 2008. The cause of death was determined to be multiple blunt force injuries.

The FAA Toxicology Accident Research Library, Oklahoma City, Oklahoma, conducted toxicological Testing. Both pilots tested negative for carbon monoxide, cyanide, ethanol, and drugs.

TESTS AND RESEARCH

The airplane was equipped with an Avidyne EXP5000 primary flight display (PFD) and an Avidyne EX5000 multi-function flight display (MFD). The Avidyne displays are the main two elements of the airplane’s Electronic Integrated Flight Deck. The displays present navigation and flight data to the pilot on liquid-crystal computer screens, replacing the individual gauges and flight instruments found in earlier generation general aviation airplane cockpits. The PFD, which records performance parameters, samples and stores several data streams in a sequential fashion; when the recording limit of the PFD is reached, the oldest record is dropped and a new record is added. The MFD, which records engine RPM and manifold pressure, generates new data files for each power on cycle. New MFD data are sampled every 6 seconds, and recorded to memory once every minute. If an interruption of electrical power occurs during the minute between MFD memory-write cycles, data sampled during that portion of a minute are not recorded.

In this case, the MFD data ended at 17:12:29.7, but the PFD data recorded until 17:13:13.8. Consequently, the last 44 seconds of MFD data were lost, most likely due to the 1-minute data-writing interval.

A Safety Board National Resource Specialist for Aircraft Performance performed an Aircraft Performance study. This study described the results of using weight and balance information, PFD and MFD data, POH information, and flight-test data to define the position of the airplane relative to the runway 19 threshold, and to compare the performance of the airplane during the last 44 seconds of the flight with the nominal performance of the SR22.

The results of the performance study showed that the airplane was within the allowable weight and balance envelope at the time of the accident. The lift and drag coefficients were consistent with the expected flaps-up performance of the SR22 at idle power, and a gross weight of 3,150 pounds. The data revealed:

At 17:12:30, as the airplane descended through 1,700 feet msl (735 feet agl) at a reduced power setting (16.4 inches of Mercury, manifold pressure 2,000 RPM), on a track consistent with a right downwind for runway 01 at Lindsay Airport.

While there was no engine data available after 17:12:30, the computed coefficient of drag after this time matched the data obtained from flight tests of the SR22 with the flaps retracted and the engine at idle power. Consequently, it was likely that the power remained at idle speed for the remainder of the flight.

At 17:12:47, while descending through 1,520 feet (555 feet agl), the airplane entered a right bank, and reached a 47-degree bank angle at 17:12:56. This right turn was consistent with making a turn onto left base for runway 19. During this time, the airplane's angle of attack increased from about 6.5 degrees at 17:12:47 to 10 degrees at 17:12:56.

At 17:13:05, when the airplane was at an altitude of 1,200 feet (235 feet agl), the airplane rolled through a wings-level attitude at a roll rate of 25 degrees per second into a steep left bank, in a turn towards runway 19. During this maneuver, the airplane's descent ceased but the angle of attack increased from 10 degrees to 15 degrees.

At 17:13:08, at a left bank angle of 53°, the airplane over flew the extended centerline of runway 19 at an altitude of 1,188 feet msl (223 feet agl). A second later, the left bank angle reached 60 degrees and the angle of attack exceeded 17 degrees. This angle of attack was consistent with flight test data for a flaps-retracted, wings level stall.

According to the Aircraft Performance Study, "Analysis of the angle of attack distribution along the wing during the final seconds of the flight indicated that at about 17:13:09, the angle of attack at every point along the left wing, from the centerline to the wingtip, exceeded the wings-level stall angle of attack of 17 degrees, while the angle of attack along the right wing was below 17° everywhere. This angle of attack distribution may have caused the left wing to stall before the right wing, decreasing the lift and increasing the drag on the left wing. This in turn would have generated additional yawing and rolling moments to the left, which may have produced the increase in left rolling and yawing rates observed at 17:13:09, and the increase in bank angle from -60° to -80°.

Between 17:13:09 and 17:13:11, the roll and yaw accelerations and rates reversed suddenly, and the airplane rolled and yawed violently to the right. The rapid roll rate to the right also reversed the distribution along the span, so that the right wing became deeply stalled, while the outboard portions of the left wing dropped below 17° angle of attack. This new angle of attack distribution generated an additional right rolling moment, accelerating the roll to the right. The reversal in yaw acceleration at 17:13:10 preceded the reversal in roll acceleration slightly. Hence, the initiating event of the roll and yaw reversals seems to have been the sudden yaw acceleration to the right. Such acceleration might have been provided by an abrupt and large right rudder input. In fact, the sudden application of a large rudder input during an accelerated stall is a well-known method of entering a snap roll. The circumstances of the sudden roll and yaw reversal to the right during the final moments of the accident flight appear similar to those of a snap-roll maneuver. It is possible that the pilots, faced with the increased roll rate to the left due to the stall of the left wing, input right rudder along with right aileron in an attempt to recover to wings-level, resulting in the snap-roll to the right. Once inverted, there was insufficient altitude to recover before impact with the ground."

ADDITIONAL INFORMATION

The airplane wreckage was released to a representative of the owner's insurance company.

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Chapter 4
Slow Flight, Stalls, and Spins

INTRODUCTION

The maintenance of lift and control of an airplane in flight requires a certain minimum airspeed. This critical airspeed depends on certain factors, such as gross weight, load factors, and existing density altitude. The minimum speed below which further controlled flight is impossible is called the stalling speed. An important feature of pilot training is the development of the ability to estimate the margin of safety above the stalling speed. Also, the ability to determine the characteristic responses of any airplane at different airspeeds is of great importance to the pilot. The student pilot, therefore, must develop this awareness in order to safely avoid stalls and to operate an airplane correctly and safely at slow airspeeds.

SLOW FLIGHT

Slow flight could be thought of, by some, as a speed that is less than cruise. In pilot training and testing, however, slow flight is broken down into two distinct elements: (1) the establishment, maintenance of, and maneuvering of the airplane at airspeeds and in configurations appropriate to takeoffs, climbs, descents, landing approaches and go-arounds, and, (2) maneuvering at the slowest airspeed at which the airplane is capable of maintaining controlled flight without indications of a stall—usually 3 to 5 knots above stalling speed.

FLIGHT AT LESS THAN CRUISE AIRSPEEDS

Maneuvering during slow flight demonstrates the flight characteristics and degree of controllability of an airplane at less than cruise speeds. The ability to determine the characteristic control responses at the lower airspeeds appropriate to takeoffs, departures, and landing approaches is a critical factor in stall awareness.

As airspeed decreases, control effectiveness decreases disproportionately. For instance, there may be a certain loss of effectiveness when the airspeed is reduced from 30 to 20 m.p.h. above the stalling speed, but there will normally be a much greater loss as the airspeed is further reduced to 10 m.p.h. above stalling. The objective of maneuvering during slow flight is to develop the pilot's sense of feel and ability to use the controls correctly, and to improve proficiency in performing maneuvers that require slow airspeeds. Maneuvering during slow flight should be performed using both instrument indications and outside visual reference. Slow flight should be practiced from straight glides, straight-and-level flight, and from medium banked gliding and level flight turns. Slow flight at approach speeds should include slowing the airplane smoothly and promptly from cruising to approach speeds without changes in altitude or heading, and determining and using appropriate power and trim settings. Slow flight at approach speed should also include configuration changes, such as landing gear and flaps, while maintaining heading and altitude.

FLIGHT AT MINIMUM CONTROLLABLE AIRSPEED

This maneuver demonstrates the flight characteristics and degree of controllability of the airplane at its *minimum* flying speed. By definition, the term "flight at minimum controllable airspeed" means a speed at which any further increase in angle of attack or load factor, or reduction in power will cause an immediate stall. Instruction in flight at minimum controllable airspeed should be introduced at reduced power settings, with the airspeed sufficiently above the stall to permit maneuvering, but close enough to the stall to sense the characteristics of flight at very low airspeed—which are sloppy controls, ragged response to control inputs, and difficulty maintaining altitude. Maneuvering at minimum controllable airspeed should be performed using both instrument indications and outside visual reference. It is important that pilots form the habit of frequent reference to the flight instruments, especially the airspeed indicator, while flying at very low airspeeds. However, a "feel" for the airplane at very low airspeeds must be developed to avoid inadvertent stalls and to operate the airplane with precision.

To begin the maneuver, the throttle is gradually reduced from cruising position. While the airspeed is decreasing, the position of the nose in relation to the horizon should be noted and should be raised as necessary to maintain altitude.

When the airspeed reaches the maximum allowable for landing gear operation, the landing gear (if equipped with retractable gear) should be extended and all gear down checks performed. As the airspeed reaches the maximum allowable for flap operation, full flaps

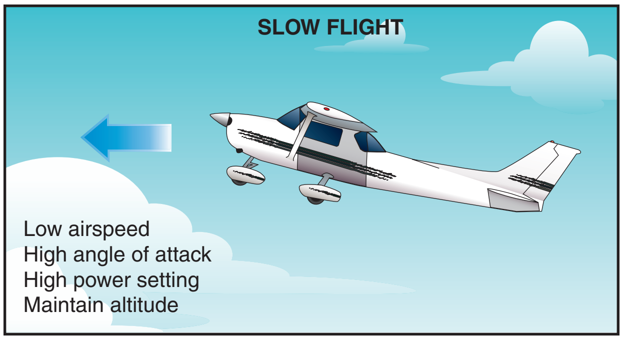

Figure 4-1. Slow flight—Low airspeed, high angle of attack, high power, and constant altitude.

should be lowered and the pitch attitude adjusted to maintain altitude. [Figure 4-1] Additional power will be required as the speed further decreases to maintain the airspeed just above a stall. As the speed decreases further, the pilot should note the feel of the flight controls, especially the elevator. The pilot should also note the sound of the airflow as it falls off in tone level.

As airspeed is reduced, the flight controls become less effective and the normal nosedown tendency is reduced. The elevators become less responsive and coarse control movements become necessary to retain control of the airplane. The slipstream effect produces a strong yaw so the application of rudder is required to maintain coordinated flight. The secondary effect of applied rudder is to induce a roll, so aileron is required to keep the wings level. This can result in flying with crossed controls.

During these changing flight conditions, it is important to retrim the airplane as often as necessary to compensate for changes in control pressures. If the airplane has been trimmed for cruising speed, heavy aft control pressure will be needed on the elevators, making precise control impossible. If too much speed is lost, or too little power is used, further back pressure on the elevator control may result in a loss of altitude or a stall. When the desired pitch attitude and minimum control airspeed have been established, it is important to continually cross-check the attitude indicator, altimeter, and airspeed indicator, as well as outside references to ensure that accurate control is being maintained.

The pilot should understand that when flying more slowly than **minimum drag speed ($LD/_{MAX}$)** the airplane will exhibit a characteristic known as "**speed instability**." If the airplane is disturbed by even the slightest turbulence, the airspeed will decrease. As airspeed decreases, the total drag also increases resulting in a further loss in airspeed. The total drag continues to rise and the speed continues to fall. Unless more power is applied and/or the nose is lowered, the speed will continue to decay right down to the stall. This is an extremely important factor in the performance of slow flight. The pilot must understand that, at speed less than minimum drag speed, the airspeed is unstable and will continue to decay if allowed to do so.

When the attitude, airspeed, and power have been stabilized in straight flight, turns should be practiced to determine the airplane's controllability characteristics at this minimum speed. During the turns, power and pitch attitude may need to be increased to maintain the airspeed and altitude. The objective is to acquaint the pilot with the lack of maneuverability at minimum speeds, the danger of incipient stalls, and the tendency of the airplane to stall as the bank is increased. A stall may also occur as a result of abrupt or rough control movements when flying at this critical airspeed.

Abruptly raising the flaps while at minimum controllable airspeed will result in lift suddenly being lost, causing the airplane to lose altitude or perhaps stall.

Once flight at minimum controllable airspeed is set up properly for level flight, a descent or climb at minimum controllable airspeed can be established by adjusting the power as necessary to establish the desired rate of descent or climb. The beginning pilot should note the increased yawing tendency at minimum control airspeed at high power settings with flaps fully extended. In some airplanes, an attempt to climb at such a slow airspeed may result in a *loss* of altitude, even with maximum power applied.

Common errors in the performance of slow flight are:

- Failure to adequately clear the area.
- Inadequate back-elevator pressure as power is reduced, resulting in altitude loss.
- Excessive back-elevator pressure as power is reduced, resulting in a climb, followed by a rapid reduction in airspeed and "mushing."
- Inadequate compensation for adverse yaw during turns.
- Fixation on the airspeed indicator.
- Failure to anticipate changes in lift as flaps are extended or retracted.
- Inadequate power management.
- Inability to adequately divide attention between airplane control and orientation.

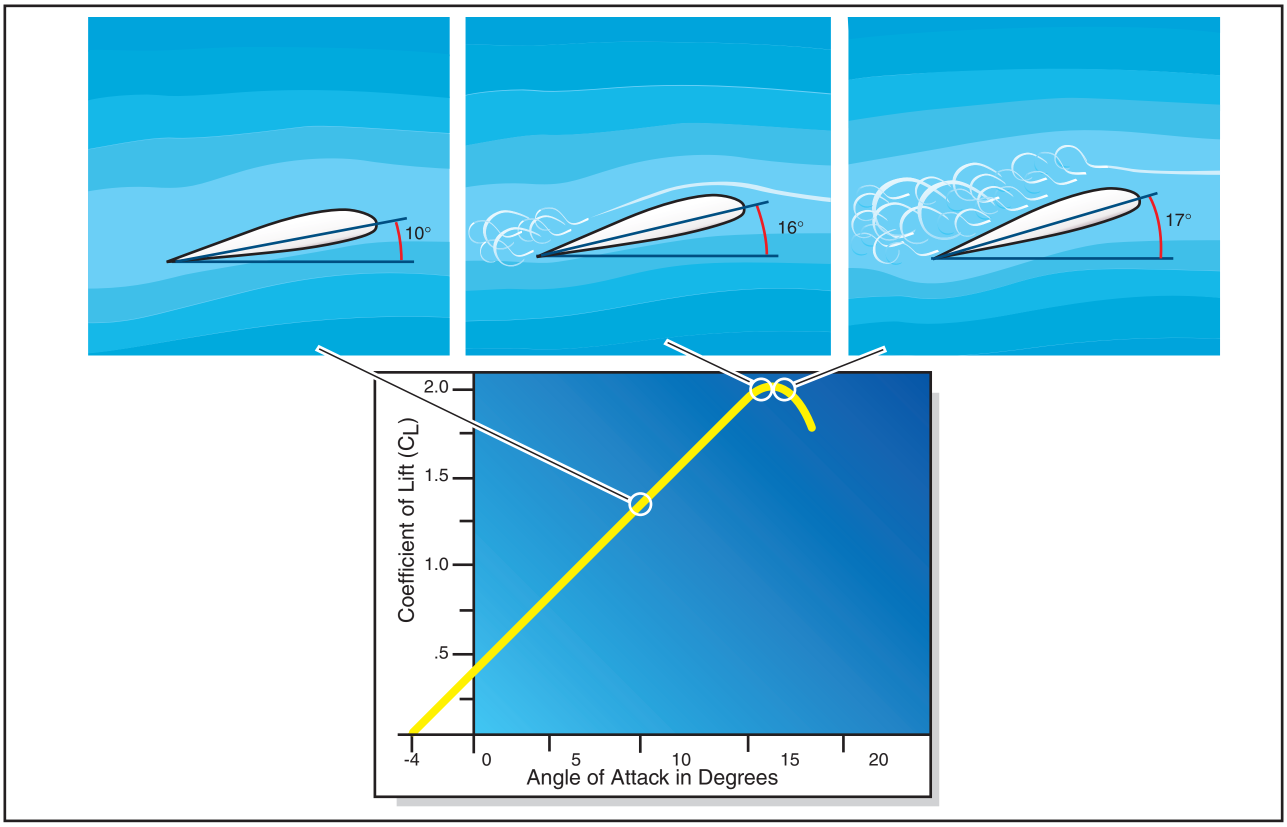

Figure 4-2. Critical angle of attack and stall.

STALLS

A stall occurs when the smooth airflow over the airplane's wing is disrupted, and the lift degenerates rapidly. This is caused when the wing exceeds its critical angle of attack. This can occur at any airspeed, in any attitude, with any power setting. [Figure 4-2]

The practice of stall recovery and the development of awareness of stalls are of primary importance in pilot training. The objectives in performing intentional stalls are to familiarize the pilot with the conditions that produce stalls, to assist in recognizing an approaching stall, and to develop the habit of taking prompt preventive or corrective action.

Intentional stalls should be performed at an altitude that will provide adequate height above the ground for recovery and return to normal level flight. Though it depends on the degree to which a stall has progressed, most stalls require some loss of altitude during recovery. The longer it takes to recognize the approaching stall, the more complete the stall is likely to become, and the greater the loss of altitude to be expected.

RECOGNITION OF STALLS

Pilots must recognize the flight conditions that are conducive to stalls and know how to apply the necessary corrective action. They should learn to recognize an approaching stall by sight, sound, and feel. The following cues may be useful in recognizing the approaching stall.

- Vision is useful in detecting a stall condition by noting the attitude of the airplane. This sense can only be relied on when the stall is the result of an unusual attitude of the airplane. Since the airplane can also be stalled from a normal attitude, vision in this instance would be of little help in detecting the approaching stall.

- Hearing is also helpful in sensing a stall condition. In the case of fixed-pitch propeller airplanes in a power-on condition, a change in sound due to loss of revolutions per minute (r.p.m.) is particularly noticeable. The lessening of the noise made by the air flowing along the airplane structure as airspeed decreases is also quite noticeable, and when the stall is almost complete, vibration and incident noises often increase greatly.

- Kinesthesia, or the sensing of changes in direction or speed of motion, is probably the most important and the best indicator to the trained and experienced pilot. If this sensitivity is properly developed, it will warn of a decrease in speed or the beginning of a settling or mushing of the airplane.

- Feel is an important sense in recognizing the onset of a stall. The feeling of control pressures is very important. As speed is reduced, the resistance to pressures on the controls becomes progressively less. Pressures exerted on the controls tend to become movements of the control surfaces. The lag between these movements and the response of the airplane becomes greater, until in a complete stall all controls can be moved with almost no resistance, and with little immediate effect on the airplane. Just before the stall occurs, buffeting, uncontrollable pitching, or vibrations may begin.

Several types of stall warning indicators have been developed to warn pilots of an approaching stall. The use of such indicators is valuable and desirable, but the reason for practicing stalls is to learn to recognize stalls without the benefit of warning devices.

FUNDAMENTALS OF STALL RECOVERY

During the practice of intentional stalls, the real objective is not to learn how to stall an airplane, but to learn how to recognize an approaching stall and take prompt corrective action. [Figure 4-3] Though the recovery actions must be taken in a coordinated manner, they are broken down into three actions here for explanation purposes.

First, at the indication of a stall, the pitch attitude and angle of attack must be decreased positively and immediately. Since the basic cause of a stall is always an excessive angle of attack, the cause must first be eliminated by releasing the back-elevator pressure that was necessary to attain that angle of attack or by moving the elevator control forward. This lowers the nose and returns the wing to an effective angle of attack. The amount of elevator control pressure or movement used depends on the design of the airplane, the severity of the stall, and the proximity of the ground. In some airplanes, a moderate movement of the elevator control—perhaps slightly forward of neutral—is enough, while in others a forcible push to the full forward position may be required. An excessive negative load on the wings caused by excessive forward movement of the elevator may impede, rather than hasten, the stall recovery. The object is to reduce the angle of attack but only enough to allow the wing to regain lift.

Second, the maximum allowable power should be applied to increase the airplane's airspeed and assist in reducing the wing's angle of attack. The throttle should be promptly, but smoothly, advanced to the maximum allowable power. The flight instructor

Figure 4-3. Stall recognition and recovery.

should emphasize, however, that power is not essential for a safe stall recovery if sufficient altitude is available. Reducing the angle of attack is the only way of recovering from a stall regardless of the amount of power used.

Although stall recoveries should be practiced without, as well as with the use of power, in most actual stalls the application of more power, if available, is an integral part of the stall recovery. Usually, the greater the power applied, the less the loss of altitude.

Maximum allowable power applied at the instant of a stall will usually not cause overspeeding of an engine equipped with a fixed-pitch propeller, due to the heavy air load imposed on the propeller at slow airspeeds. However, it will be necessary to reduce the power as airspeed is gained after the stall recovery so the airspeed will not become excessive. When performing intentional stalls, the tachometer indication should never be allowed to exceed the red line (maximum allowable r.p.m.) marked on the instrument.

Third, straight-and-level flight should be regained with coordinated use of all controls.

Practice in both power-on and power-off stalls is important because it simulates stall conditions that could occur during normal flight maneuvers. For example, the power-on stalls are practiced to show what could happen if the airplane were climbing at an excessively nose-high attitude immediately after takeoff or during a climbing turn. The power-off turning stalls are practiced to show what could happen if the controls are improperly used during a turn from the base leg to the final approach. The power-off straight-ahead stall simulates the attitude and flight characteristics of a particular airplane during the final approach and landing.

Usually, the first few practices should include only approaches to stalls, with recovery initiated as soon as the first buffeting or partial loss of control is noted. In this way, the pilot can become familiar with the indications of an approaching stall without actually stalling the airplane. Once the pilot becomes comfortable with this procedure, the airplane should be slowed in such a manner that it stalls in as near a level pitch attitude as is possible. The student pilot must not be allowed to form the impression that in all circumstances, a high pitch attitude is necessary to exceed the critical angle of attack, or that in all circumstances, a level or near level pitch attitude is indicative of a low angle of attack. Recovery should be practiced first *without* the addition of power, by merely relieving enough back-elevator pressure that the stall is broken and the airplane assumes a normal glide attitude. The instructor should also introduce the student to a secondary stall at this point. Stall recoveries should then be practiced with the addition of power to determine how effective power will be in executing a safe recovery and minimizing altitude loss.

Stall accidents usually result from an inadvertent stall at a low altitude in which a recovery was not accomplished prior to contact with the surface. As a preventive measure, stalls should be practiced at an altitude which will allow recovery no lower than 1,500 feet AGL. To recover with a minimum loss of altitude requires a reduction in the angle of attack (lowering the airplane's pitch attitude), application of power, and termination of the descent without entering another (secondary) stall.

USE OF AILERONS/RUDDER IN STALL RECOVERY

Different types of airplanes have different stall characteristics. Most airplanes are designed so that the wings will stall progressively outward from the wing roots (where the wing attaches to the fuselage) to the wingtips. This is the result of designing the wings in a manner that the wingtips have less angle of incidence than the wing roots. [Figure 4-4] Such a design feature causes the wingtips to have a smaller angle of attack than the wing roots during flight.

Figure 4-4. Wingtip washout.

Exceeding the critical angle of attack causes a stall; the wing roots of an airplane will exceed the critical angle before the wingtips, and the wing roots will stall first. The wings are designed in this manner so that aileron control will be available at high angles of attack (slow airspeed) and give the airplane more stable stalling characteristics.

When the airplane is in a stalled condition, the wingtips continue to provide some degree of lift, and the ailerons still have some control effect. During recovery from a stall, the return of lift begins at the tips and progresses toward the roots. Thus, the ailerons can be used to level the wings.

Using the ailerons requires finesse to avoid an aggravated stall condition. For example, if the right wing dropped during the stall and excessive aileron control were applied to the left to raise the wing, the aileron deflected downward (right wing) would produce a greater angle of attack (and drag), and possibly a more complete stall at the tip as the critical angle of attack is exceeded. The increase in drag created by the high angle of attack on that wing might cause the airplane to yaw in that direction. This adverse yaw could result in a spin unless directional control was maintained by rudder, and/or the aileron control sufficiently reduced.

Even though excessive aileron pressure may have been applied, a spin will not occur if directional (yaw) control is maintained by timely application of coordinated rudder pressure. Therefore, it is important that the rudder be used properly during both the entry and the recovery from a stall. The primary use of the rudder in stall recoveries is to counteract any tendency of the airplane to yaw or slip. The correct recovery technique would be to decrease the pitch attitude by applying forward-elevator pressure to break the stall, advancing the throttle to increase airspeed, and simultaneously maintaining directional control with coordinated use of the aileron and rudder.

STALL CHARACTERISTICS

Because of engineering design variations, the stall characteristics for all airplanes cannot be specifically described; however, the similarities found in small general aviation training-type airplanes are noteworthy enough to be considered. It will be noted that the power-on and power-off stall warning indications will be different. The power-off stall will have less noticeable clues (buffeting, shaking) than the power-on stall. In the power-off stall, the predominant clue can be the elevator control position (full up-elevator against the stops) and a high descent rate. When performing the power-on stall, the buffeting will likely be the predominant clue that provides a positive indication of the stall. For the purpose of airplane certification, the stall warning may be furnished either through the inherent aerodynamic qualities of the airplane, or by a stall warning device that will give a clear distinguishable indication of the stall. Most airplanes are equipped with a stall warning device.

The factors that affect the stalling characteristics of the airplane are balance, bank, pitch attitude, coordination, drag, and power. The pilot should learn the effect of the stall characteristics of the airplane being flown and the proper correction. It should be reemphasized that a stall can occur at any airspeed, in any attitude, or at any power setting, depending on the total number of factors affecting the particular airplane.

A number of factors may be induced as the result of other factors. For example, when the airplane is in a nose-high turning attitude, the angle of bank has a tendency to increase. This occurs because with the airspeed decreasing, the airplane begins flying in a smaller and smaller arc. Since the outer wing is moving in a larger radius and traveling faster than the inner wing, it has more lift and causes an overbanking tendency. At the same time, because of the decreasing airspeed and lift on both wings, the pitch attitude tends to lower. In addition, since the airspeed is decreasing while the power setting remains constant, the effect of torque becomes more prominent, causing the airplane to yaw.

During the practice of power-on turning stalls, to compensate for these factors and to maintain a constant flight attitude until the stall occurs, aileron pressure must be continually adjusted to keep the bank attitude constant. At the same time, back-elevator pressure must be continually increased to maintain the pitch attitude, as well as right rudder pressure increased to keep the ball centered and to prevent adverse yaw from changing the turn rate. If the bank is allowed to become too steep, the vertical component of lift decreases and makes it even more difficult to maintain a constant pitch attitude.

Whenever practicing turning stalls, a constant pitch and bank attitude should be maintained until the stall occurs. Whatever control pressures are necessary should be applied even though the controls appear to be crossed (aileron pressure in one direction, rudder pressure in the opposite direction). During the entry to a power-on turning stall to the right, in particular, the controls will be crossed to some extent. This is due to right rudder pressure being used to overcome torque and left aileron pressure being used to prevent the bank from increasing.

APPROACHES TO STALLS (IMMINENT STALLS)—POWER-ON OR POWER-OFF

An imminent stall is one in which the airplane is approaching a stall but is not allowed to completely stall. This stall maneuver is primarily for practice in retaining (or regaining) full control of the airplane immediately upon recognizing that it is almost in a stall or that a stall is likely to occur if timely preventive action is not taken.

The practice of these stalls is of particular value in developing the pilot's sense of feel for executing maneuvers in which maximum airplane performance is required. These maneuvers require flight with the airplane approaching a stall, and recovery initiated before a stall occurs. As in all maneuvers that involve significant changes in altitude or direction, the pilot must ensure that the area is clear of other air traffic before executing the maneuver.

These stalls may be entered and performed in the attitudes and with the same configuration of the basic full stalls or other maneuvers described in this chapter. However, instead of allowing a complete stall, when the first buffeting or decay of control effectiveness is noted, the angle of attack must be reduced immediately by releasing the back-elevator pressure and applying whatever additional power is necessary. Since the airplane will not be completely stalled, the pitch attitude needs to be decreased only to a point where minimum controllable airspeed is attained or until adequate control effectiveness is regained.

The pilot must promptly recognize the indication of a stall and take timely, positive control action to prevent a full stall. Performance is unsatisfactory if a full stall occurs, if an excessively low pitch attitude is attained, or if the pilot fails to take timely action to avoid excessive airspeed, excessive loss of altitude, or a spin.

FULL STALLS POWER-OFF

The practice of power-off stalls is usually performed with normal landing approach conditions in simulation of an accidental stall occurring during landing approaches. Airplanes equipped with flaps and/or retractable landing gear should be in the landing configuration. Airspeed in excess of the normal approach speed should not be carried into a stall entry since it could result in an abnormally nose-high attitude. Before executing these practice stalls, the pilot must be sure the area is clear of other air traffic.

After extending the landing gear, applying carburetor heat (if applicable), and retarding the throttle to idle (or normal approach power), the airplane should be held at a constant altitude in level flight until the airspeed decelerates to that of a normal approach. The airplane should then be smoothly nosed down into the normal approach attitude to maintain that airspeed. Wing flaps should be extended and pitch attitude adjusted to maintain the airspeed.

When the approach attitude and airspeed have stabilized, the airplane's nose should be smoothly raised to an attitude that will induce a stall. Directional control should be maintained with the rudder, the wings held level by use of the ailerons, and a constant-pitch attitude maintained with the elevator until the stall occurs. The stall will be recognized by clues, such as full up-elevator, high descent rate, uncontrollable nosedown pitching, and possible buffeting.

Recovering from the stall should be accomplished by reducing the angle of attack, releasing back-elevator pressure, and advancing the throttle to maximum allowable power. Right rudder pressure is necessary to overcome the engine torque effects as power is advanced and the nose is being lowered. [Figure 4-5]

The nose should be lowered as necessary to regain flying speed and returned to straight-and-level flight

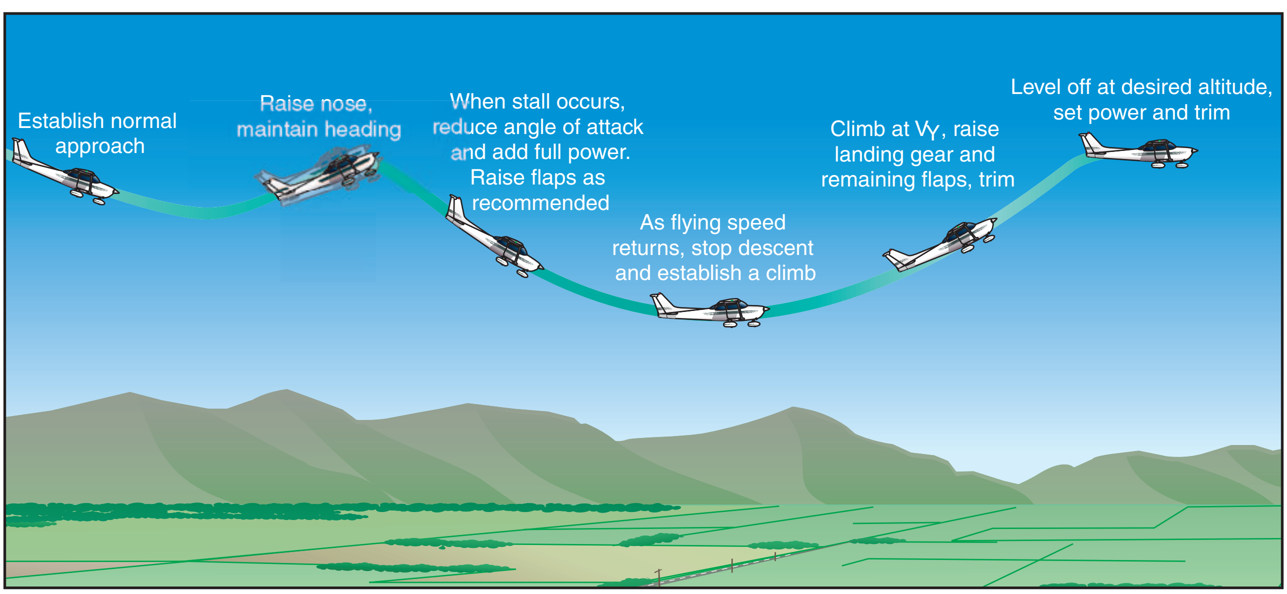

Figure 4-5. Power-off stall and recovery.

attitude. After establishing a positive rate of climb, the flaps and landing gear are retracted, as necessary, and when in level flight, the throttle should be returned to cruise power setting. After recovery is complete, a climb or go-around procedure should be initiated, as the situation dictates, to assure a minimum loss of altitude.

Recovery from power-off stalls should also be practiced from shallow banked turns to simulate an inadvertent stall during a turn from base leg to final approach. During the practice of these stalls, care should be taken that the turn continues at a uniform rate until the complete stall occurs. If the power-off turn is not properly coordinated while approaching the stall, wallowing may result when the stall occurs. If the airplane is in a slip, the outer wing may stall first and whip downward abruptly. This does not affect the recovery procedure in any way; the angle of attack must be reduced, the heading maintained, and the wings leveled by coordinated use of the controls. In the practice of turning stalls, no attempt should be made to stall the airplane on a predetermined heading. However, to simulate a turn from base to final approach, the stall normally should be made to occur within a heading change of approximately 90°.

After the stall occurs, the recovery should be made straight ahead with minimum loss of altitude, and accomplished in accordance with the recovery procedure discussed earlier.

Recoveries from power-off stalls should be accomplished both with, and without, the addition of power, and may be initiated either just after the stall occurs, or after the nose has pitched down through the level flight attitude.

FULL STALLS POWER-ON

Power-on stall recoveries are practiced from straight climbs, and climbing turns with 15 to 20° banks, to simulate an accidental stall occurring during takeoffs and climbs. Airplanes equipped with flaps and/or retractable landing gear should normally be in the takeoff configuration; however, power-on stalls should also be practiced with the airplane in a clean configuration (flaps and/or gear retracted) as in departure and normal climbs.

After establishing the takeoff or climb configuration, the airplane should be slowed to the normal lift-off speed while clearing the area for other air traffic. When the desired speed is attained, the power should be set at takeoff power for the takeoff stall or the recommended climb power for the departure stall while establishing a climb attitude. The purpose of reducing the airspeed to lift-off airspeed before the throttle is advanced to the recommended setting is to avoid an excessively steep nose-up attitude for a long period before the airplane stalls.

After the climb attitude is established, the nose is then brought smoothly upward to an attitude obviously impossible for the airplane to maintain and is held at that attitude until the full stall occurs. In most airplanes, after attaining the stalling attitude, the elevator control must be moved progressively further back as the airspeed decreases until, at the full stall, it will have reached its limit and cannot be moved back any farther.

Recovery from the stall should be accomplished by immediately reducing the angle of attack by positively

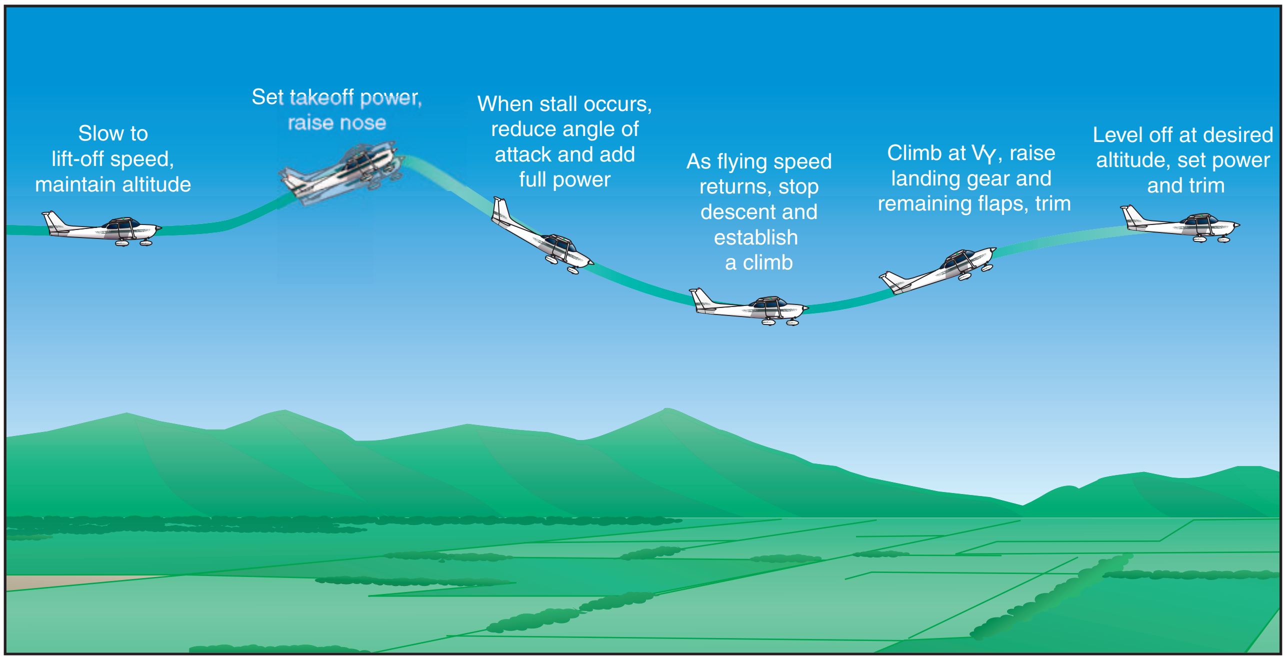

Figure 4-6. Power-on stall.

releasing back-elevator pressure and, in the case of a departure stall, smoothly advancing the throttle to maximum allowable power. In this case, since the throttle is already at the climb power setting, the addition of power will be relatively slight. [Figure 4-6]

The nose should be lowered as necessary to regain flying speed with the minimum loss of altitude and then raised to climb attitude. Then, the airplane should be returned to the normal straight-and-level flight attitude, and when in normal level flight, the throttle should be returned to cruise power setting. The pilot must recognize instantly when the stall has occurred and take prompt action to prevent a prolonged stalled condition.

SECONDARY STALL

This stall is called a secondary stall since it may occur after a recovery from a preceding stall. It is caused by attempting to hasten the completion of a stall recovery before the airplane has regained sufficient flying speed. [Figure 4-7] When this stall occurs, the back-elevator pressure should again be released just as in a normal stall recovery. When sufficient airspeed has been regained, the airplane can then be returned to straight-and-level flight.

This stall usually occurs when the pilot uses abrupt control input to return to straight-and-level flight after a stall or spin recovery. It also occurs when the pilot fails to reduce the angle of attack sufficiently during stall recovery by not lowering pitch attitude sufficiently, or by attempting to break the stall by using power only.

ACCELERATED STALLS

Though the stalls just discussed normally occur at a specific airspeed, the pilot must thoroughly understand that all stalls result solely from attempts to fly at excessively high angles of attack. During flight, the angle of attack of an airplane wing is determined by a number of factors, the most important of which are the airspeed, the gross weight of the airplane, and the load factors imposed by maneuvering.

At the same gross weight, airplane configuration, and power setting, a given airplane will consistently stall at the same indicated airspeed if no acceleration is involved. The airplane will, however, stall at a higher indicated airspeed when excessive maneuvering loads are imposed by steep turns, pull-ups, or other abrupt changes in its flightpath. Stalls entered from such flight situations are called "accelerated maneuver stalls," a term, which has no reference to the airspeeds involved.

Stalls which result from abrupt maneuvers tend to be more rapid, or severe, than the unaccelerated stalls, and because they occur at higher-than-normal airspeeds, and/or may occur at lower than anticipated pitch attitudes, they may be unexpected by an inexperienced pilot. Failure to take immediate steps toward recovery when an accelerated stall occurs may result in a complete loss of flight control, notably, power-on spins.

This stall should never be practiced with wing flaps in the extended position due to the lower "G" load limitations in that configuration.

Accelerated maneuver stalls should not be performed in any airplane, which is prohibited from such maneuvers by its type certification restrictions or Airplane Flight Manual (AFM) and/or Pilot's Operating Handbook (POH). If they are permitted, they should be performed with a bank of approximately 45°, and in no case at a speed greater

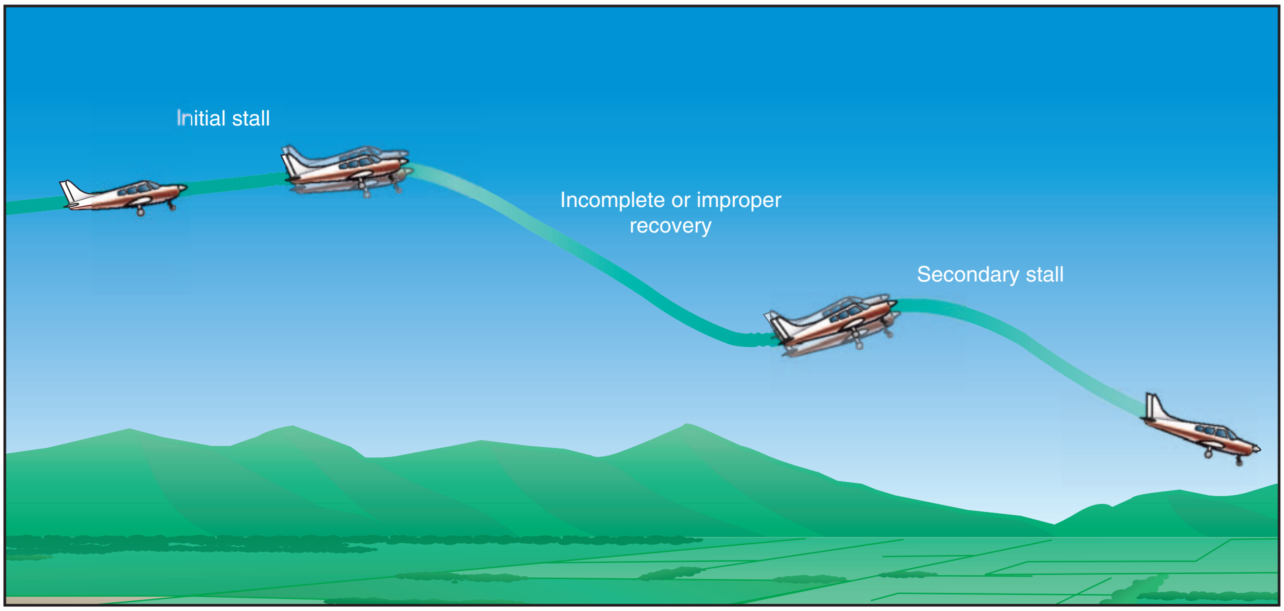

Figure 4-7. Secondary stall.

than the airplane manufacturer's recommended airspeeds or the design maneuvering speed specified for the airplane. The design maneuvering speed is the maximum speed at which the airplane can be stalled or full available aerodynamic control will not exceed the airplane's limit load factor. At or below this speed, the airplane will usually stall before the limit load factor can be exceeded. Those speeds must not be exceeded because of the extremely high structural loads that are imposed on the airplane, especially if there is turbulence. In most cases, these stalls should be performed at no more than 1.2 times the normal stall speed.

The objective of demonstrating accelerated stalls is not to develop competency in setting up the stall, but rather to learn how they may occur and to develop the ability to recognize such stalls immediately, and to take prompt, effective recovery action. It is important that recoveries are made at the first indication of a stall, or immediately after the stall has fully developed; a prolonged stall condition should never be allowed.

An airplane will stall during a coordinated steep turn exactly as it does from straight flight, except that the pitching and rolling actions tend to be more sudden. If the airplane is slipping toward the inside of the turn at the time the stall occurs, it tends to roll rapidly toward the outside of the turn as the nose pitches down because the outside wing stalls before the inside wing. If the airplane is skidding toward the outside of the turn, it will have a tendency to roll to the inside of the turn because the inside wing stalls first. If the coordination of the turn at the time of the stall is accurate, the airplane's nose will pitch away from the pilot just as it does in a straight flight stall, since both wings stall simultaneously.

An accelerated stall demonstration is entered by establishing the desired flight attitude, then smoothly, firmly, and progressively increasing the angle of attack until a stall occurs. Because of the rapidly changing flight attitude, sudden stall entry, and possible loss of altitude, it is extremely vital that the area be clear of other aircraft and the entry altitude be adequate for safe recovery.

This demonstration stall, as in all stalls, is accomplished by exerting excessive back-elevator pressure. Most frequently it would occur during improperly executed steep turns, stall and spin recoveries, and pullouts from steep dives. The objectives are to determine the stall characteristics of the airplane and develop the ability to instinctively recover at the onset of a stall at other-than-normal stall speed or flight attitudes. An accelerated stall, although usually demonstrated in steep turns, may actually be encountered any time excessive back-elevator pressure is applied and/or the angle of attack is increased too rapidly.

From straight-and-level flight at maneuvering speed or less, the airplane should be rolled into a steep level flight turn and back-elevator pressure gradually applied. After the turn and bank are established, back-elevator pressure should be smoothly and steadily increased. The resulting apparent centrifugal force will push the pilot's body down in the seat, increase the wing loading, and decrease the airspeed. After the airspeed reaches the design maneuvering speed or within 20 knots above the unaccelerated stall speed, back-elevator pressure should be firmly increased until a definite stall occurs. These speed restrictions must be observed to prevent exceeding the load limit of the airplane.

When the airplane stalls, recovery should be made promptly, by releasing sufficient back-elevator pressure and increasing power to reduce the angle of attack. If an uncoordinated turn is made, one wing may tend to drop suddenly, causing the airplane to roll in that direction. If this occurs, the excessive back-elevator pressure must be released, power added, and the airplane returned to straight-and-level flight with coordinated control pressure.

The pilot should recognize when the stall is imminent and take prompt action to prevent a completely stalled condition. It is imperative that a prolonged stall, excessive airspeed, excessive loss of altitude, or spin be avoided.

CROSS-CONTROL STALL

The objective of a cross-control stall demonstration maneuver is to show the effect of improper control technique and to emphasize the importance of using coordinated control pressures whenever making turns. This type of stall occurs with the controls crossed—aileron pressure applied in one direction and rudder pressure in the opposite direction.

In addition, when excessive back-elevator pressure is applied, a cross-control stall may result. This is a stall that is most apt to occur during a poorly planned and executed base-to-final approach turn, and often is the result of overshooting the centerline of the runway during that turn. Normally, the proper action to correct for overshooting the runway is to increase the rate of turn by using coordinated aileron and rudder. At the relatively low altitude of a base-to-final approach turn, improperly trained pilots may be apprehensive of steepening the bank to increase the rate of turn, and rather than steepening the bank, they hold the bank constant and attempt to increase the rate of turn by adding more rudder pressure in an effort to align it with the runway.

The addition of inside rudder pressure will cause the speed of the outer wing to increase, therefore, creating greater lift on that wing. To keep that wing from rising and to maintain a constant angle of bank, opposite aileron pressure needs to be applied. The added inside rudder pressure will also cause the nose to lower in relation to the horizon. Consequently, additional back-elevator pressure would be required to maintain a constant-pitch attitude. The resulting condition is a turn with rudder applied in one direction, aileron in the opposite direction, and excessive back-elevator pressure—a pronounced cross-control condition.

Since the airplane is in a skidding turn during the cross-control condition, the wing on the outside of the turn speeds up and produces more lift than the inside wing; thus, the airplane starts to increase its bank. The down aileron on the inside of the turn helps drag that wing back, slowing it up and decreasing its lift, which requires more aileron application. This further causes the airplane to roll. The roll may be so fast that it is possible the bank will be vertical or past vertical before it can be stopped.

For the demonstration of the maneuver, it is important that it be entered at a safe altitude because of the possible extreme nosedown attitude and loss of altitude that may result.

Before demonstrating this stall, the pilot should clear the area for other air traffic while slowly retarding the throttle. Then the landing gear (if retractable gear) should be lowered, the throttle closed, and the altitude maintained until the airspeed approaches the normal glide speed. Because of the possibility of exceeding the airplane's limitations, flaps should not be extended. While the gliding attitude and airspeed are being established, the airplane should be retrimmed. When the glide is stabilized, the airplane should be rolled into a medium-banked turn to simulate a final approach turn that would overshoot the centerline of the runway. During the turn, excessive rudder pressure should be applied in the direction of the turn but the bank held constant by applying opposite aileron pressure. At the same time, increased back-elevator pressure is required to keep the nose from lowering.

All of these control pressures should be increased until the airplane stalls. When the stall occurs, recovery is made by releasing the control pressures and increasing power as necessary to recover.

In a cross-control stall, the airplane often stalls with little warning. The nose may pitch down, the inside wing may suddenly drop, and the airplane may continue to roll to an inverted position. This is usually the beginning of a spin. It is obvious that close to the ground is no place to allow this to happen.

Recovery must be made before the airplane enters an abnormal attitude (vertical spiral or spin); it is a simple matter to return to straight-and-level flight by coordinated use of the controls. The pilot must be able to recognize when this stall is imminent and must take immediate action to prevent a completely stalled condition. It is imperative that this type of stall not occur during an actual approach to a landing, since recovery may be impossible prior to ground contact due to the low altitude.

The flight instructor should be aware that during traffic pattern operations, any conditions that result in overshooting the turn from base leg to final approach, dramatically increases the possibility of an unintentional accelerated stall while the airplane is in a cross-control condition.

ELEVATOR TRIM STALL

The elevator trim stall maneuver shows what can happen when full power is applied for a go-around and positive control of the airplane is not maintained. [Figure 4-8] Such a situation may occur during a go-around procedure from a normal landing approach

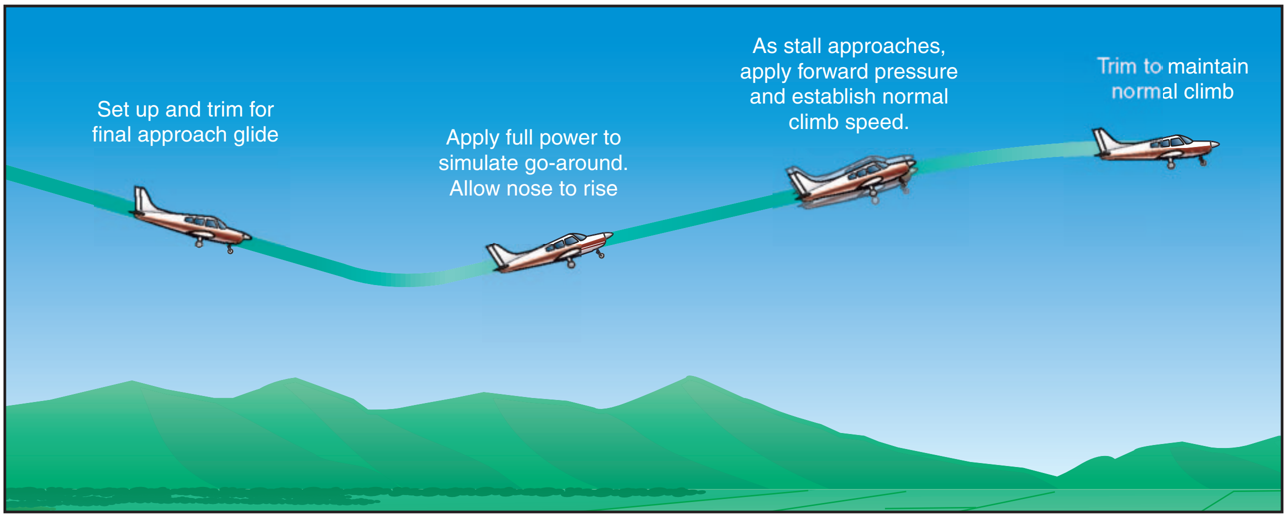

Figure 4-8. Elevator trim stall.

or a simulated forced landing approach, or immediately after a takeoff. The objective of the demonstration is to show the importance of making smooth power applications, overcoming strong trim forces and maintaining positive control of the airplane to hold safe flight attitudes, and using proper and timely trim techniques.

At a safe altitude and after ensuring that the area is clear of other air traffic, the pilot should slowly retard the throttle and extend the landing gear (if retractable gear). One-half to full flaps should be lowered, the throttle closed, and altitude maintained until the airspeed approaches the normal glide speed. When the normal glide is established, the airplane should be trimmed for the glide just as would be done during a landing approach (nose-up trim).

During this simulated final approach glide, the throttle is then advanced smoothly to maximum allowable power as would be done in a go-around procedure. The combined forces of thrust, torque, and back-elevator trim will tend to make the nose rise sharply and turn to the left.

When the throttle is fully advanced and the pitch attitude increases above the normal climbing attitude and it is apparent that a stall is approaching, adequate forward pressure must be applied to return the airplane to the normal climbing attitude. While holding the airplane in this attitude, the trim should then be adjusted to relieve the heavy control pressures and the normal go-around and level-off procedures completed.

The pilot should recognize when a stall is approaching, and take prompt action to prevent a completely stalled condition. It is imperative that a stall not occur during an actual go-around from a landing approach.

Common errors in the performance of intentional stalls are:

- Failure to adequately clear the area.
- Inability to recognize an approaching stall condition through feel for the airplane.
- Premature recovery.
- Over-reliance on the airspeed indicator while excluding other cues.
- Inadequate scanning resulting in an unintentional wing-low condition during entry.
- Excessive back-elevator pressure resulting in an exaggerated nose-up attitude during entry.
- Inadequate rudder control.
- Inadvertent secondary stall during recovery.
- Failure to maintain a constant bank angle during turning stalls.
- Excessive forward-elevator pressure during recovery resulting in negative load on the wings.
- Excessive airspeed buildup during recovery.
- Failure to take timely action to prevent a full stall during the conduct of imminent stalls.

SPINS

A spin may be defined as an aggravated stall that results in what is termed "autorotation" wherein the airplane follows a downward corkscrew path. As the airplane rotates around a vertical axis, the rising wing is less stalled than the descending wing creating a rolling, yawing, and pitching motion. The airplane is basically being forced downward by gravity, rolling, yawing, and pitching in a spiral path. [Figure 4-9]

The autorotation results from an unequal angle of attack on the airplane's wings. The rising wing has a decreasing angle of attack, where the relative lift increases and the drag decreases. In effect, this wing is less stalled. Meanwhile, the descending wing has an

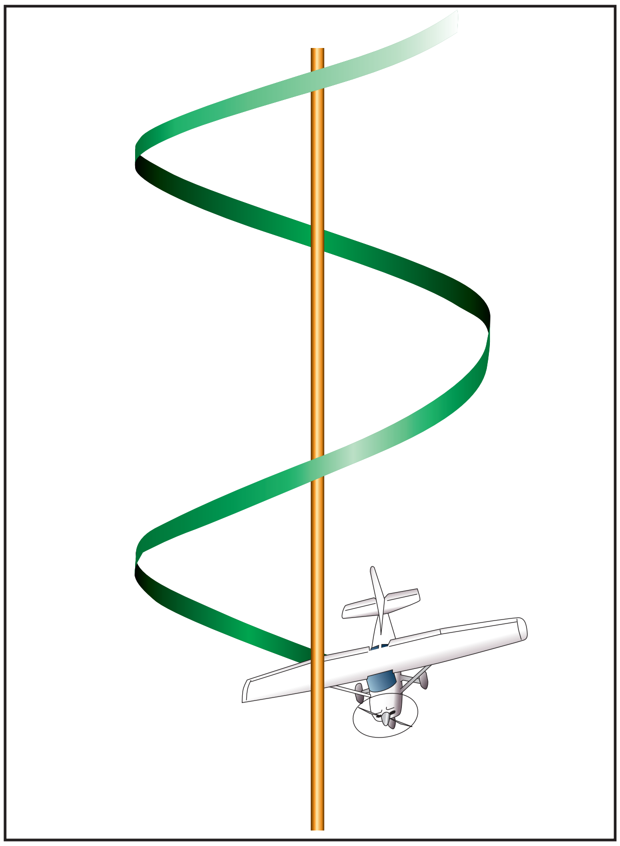

Figure 4-9. Spin—an aggravated stall and autorotation.

increasing angle of attack, past the wing's critical angle of attack (stall) where the relative lift decreases and drag increases.

A spin is caused when the airplane's wing exceeds its critical angle of attack (stall) with a sideslip or yaw acting on the airplane at, or beyond, the actual stall. During this uncoordinated maneuver, a pilot may not be aware that a critical angle of attack has been exceeded until the airplane yaws out of control toward the lowering wing. If stall recovery is not initiated immediately, the airplane may enter a spin.

If this stall occurs while the airplane is in a slipping or skidding turn, this can result in a spin entry and rotation in the direction that the rudder is being applied, regardless of which wingtip is raised.

Many airplanes have to be forced to spin and require considerable judgment and technique to get the spin started. These same airplanes that have to be forced to spin, may be accidentally put into a spin by mishandling the controls in turns, stalls, and flight at minimum controllable airspeeds. This fact is additional evidence of the necessity for the practice of stalls until the ability to recognize and recover from them is developed.

Often a wing will drop at the beginning of a stall. When this happens, the nose will attempt to move (yaw) in the direction of the low wing. This is where use of the rudder is important during a stall. The correct amount of opposite rudder must be applied to keep the nose from yawing toward the low wing. By maintaining directional control and not allowing the nose to yaw toward the low wing, before stall recovery is initiated, a spin will be averted. If the nose is allowed to yaw during the stall, the airplane will begin to slip in the direction of the lowered wing, and will enter a spin. An airplane must be stalled in order to enter a spin; therefore, continued practice in stalls will help the pilot develop a more instinctive and prompt reaction in recognizing an approaching spin. It is essential to learn to apply immediate corrective action any time it is apparent that the airplane is nearing spin conditions. If it is impossible to avoid a spin, the pilot should immediately execute spin recovery procedures.

SPIN PROCEDURES

The flight instructor should demonstrate spins in those airplanes that are approved for spins. Special spin procedures or techniques required for a particular airplane are not presented here. Before beginning any spin operations, the following items should be reviewed.

- 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 requirements for parachutes. It would be appropriate to review a current Title 14 of the Code of Federal Regulations (14 CFR) part 91 for the latest parachute requirements.

A thorough airplane preflight should be accomplished with special emphasis on excess or loose items that may affect the weight, center of gravity, and controllability of the airplane. Slack or loose control cables (particularly rudder and elevator) could prevent full anti-spin control deflections and delay or preclude recovery in some airplanes.

Prior to beginning spin training, the flight area, above and below the airplane, must be clear of other air traffic. This may be accomplished while slowing the airplane for the spin entry. All spin training should be initiated at an altitude high enough for a completed recovery at or above 1,500 feet AGL.

It may be appropriate to introduce spin training by first practicing both power-on and power-off stalls, in a clean configuration. This practice would be used to familiarize the student with the airplane's specific stall and recovery characteristics. Care should be taken with the handling of the power (throttle) in entries and during spins. Carburetor heat should be applied according to the manufacturer's recommendations.

There are four phases of a spin: **entry**, **incipient**, **developed**, and **recovery**. [Figure 4-10 on next page]

ENTRY PHASE

The entry phase is where the pilot provides the necessary elements for the spin, either accidentally or intentionally. The entry procedure for demonstrating a spin is similar to a power-off stall. During the entry, the power should be reduced slowly to idle, while simultaneously raising the nose to a pitch attitude that will ensure 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.

INCIPIENT PHASE

The incipient phase is from the time the airplane stalls and rotation starts until the spin has fully developed. This change may take up to two turns for most airplanes. Incipient spins that are not allowed to develop into a steady-state spin are the most commonly used in the introduction to spin training and recovery techniques. In

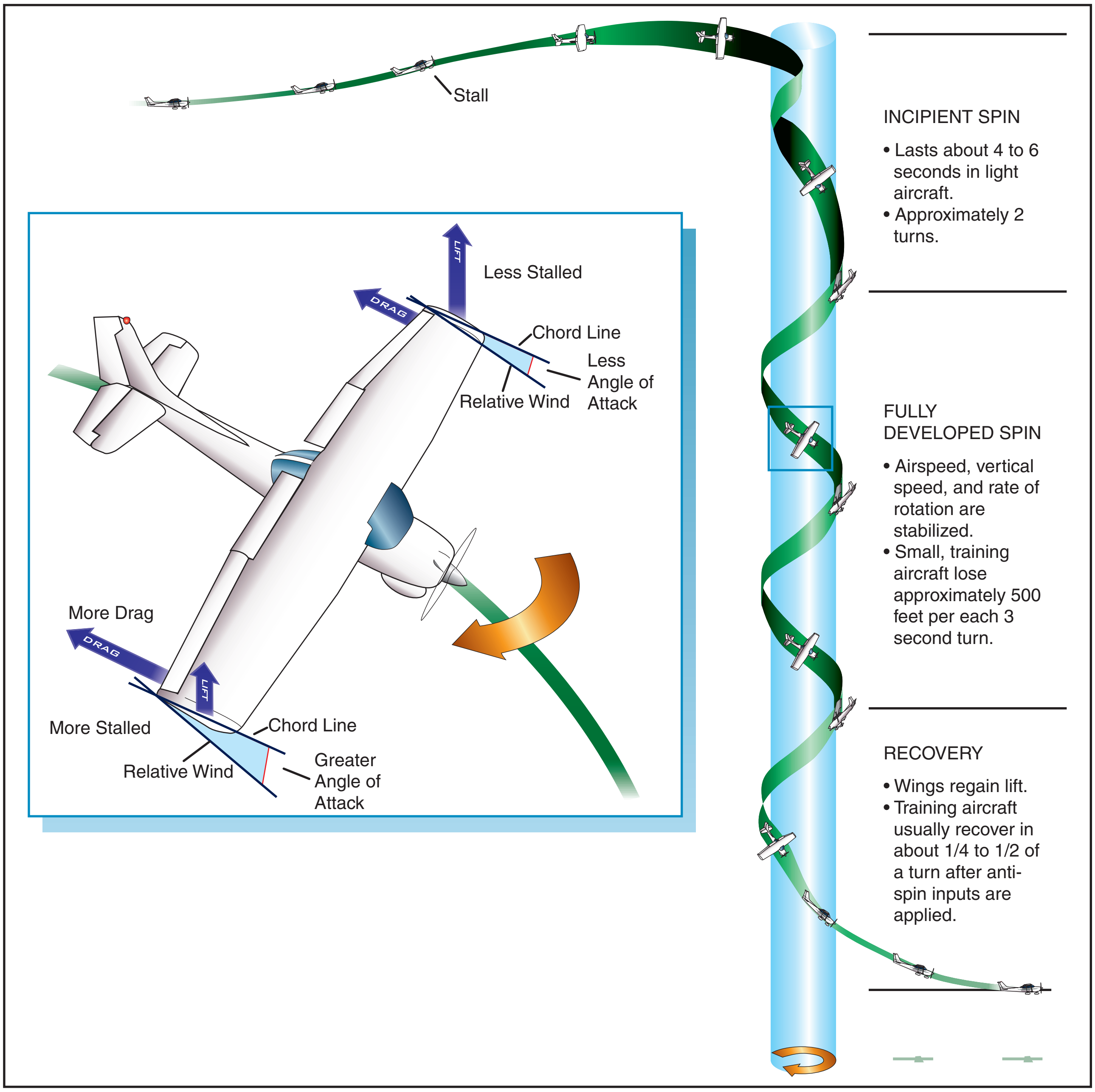

Figure 4-10. Spin entry and recovery.

this phase, the aerodynamic and inertial forces have not achieved a balance. As the incipient spin develops, the indicated airspeed should be near or below stall airspeed, and the turn-and-slip indicator should indicate the direction of the spin.

The incipient spin recovery procedure should be commenced prior to the completion of 360° of rotation. The pilot should apply full rudder opposite the direction of rotation. If the pilot is not sure of the direction of the spin, check the turn-and-slip indicator; it will show a deflection in the direction of rotation.

DEVELOPED PHASE

The developed phase occurs when the airplane's angular rotation rate, airspeed, and vertical speed are stabilized while in a flightpath that is nearly vertical. This is where airplane aerodynamic forces and inertial forces are in balance, and the attitude, angles, and self-sustaining motions about the vertical axis are constant or repetitive. The spin is in equilibrium.

RECOVERY PHASE

The recovery phase occurs when the angle of attack of the wings decreases below the critical angle of attack and autorotation slows. Then the nose steepens and rotation stops. This phase may last for a quarter turn to several turns.

To recover, control inputs are initiated to disrupt the spin equilibrium by stopping the rotation and stall. To accomplish spin recovery, the manufacturer's recommended procedures should be followed. In the absence of the manufacturer's recommended spin recovery procedures and techniques, the following spin recovery procedures are recommended.

Step 1—REDUCE THE POWER (THROTTLE) TO IDLE. Power aggravates the spin characteristics. It usually results in a flatter spin attitude and increased rotation rates.

Step 2—POSITION THE AILERONS TO NEUTRAL. Ailerons may have an adverse effect on spin recovery. Aileron control in the direction of the spin may speed up the rate of rotation and delay the recovery. Aileron control opposite the direction of the spin may cause the down aileron to move the wing deeper into the stall and aggravate the situation. The best procedure is to ensure that the ailerons are neutral.

Step 3—APPLY FULL OPPOSITE RUDDER AGAINST THE ROTATION. Make sure that full (against the stop) opposite rudder has been applied.

Step 4—APPLY A POSITIVE AND BRISK, STRAIGHT FORWARD MOVEMENT OF THE ELEVATOR CONTROL FORWARD OF THE NEUTRAL TO BREAK THE STALL. This should be done immediately after full rudder application. The forceful movement of the elevator will decrease the excessive angle of attack and break the stall. The controls should be held firmly in this position. When the stall is "broken," the spinning will stop.

Step 5—AFTER SPIN ROTATION STOPS, NEUTRALIZE THE RUDDER. If the rudder is not neutralized at this time, the ensuing increased airspeed acting upon a deflected rudder will cause a yawing or skidding effect.

Slow and overly cautious control movements during spin recovery must be avoided. In certain cases it has been found that such movements result in the airplane continuing to spin indefinitely, even with anti-spin inputs. A brisk and positive technique, on the other hand, results in a more positive spin recovery.

Step 6—BEGIN APPLYING BACK-ELEVATOR PRESSURE TO RAISE THE NOSE TO LEVEL FLIGHT. Caution must be used not to apply excessive back-elevator pressure after the rotation stops. Excessive back-elevator pressure can cause a secondary stall and result in another spin. Care should be taken not to exceed the "G" load limits and airspeed limitations during recovery. If the flaps and/or retractable landing gear are extended prior to the spin, they should be retracted as soon as possible after spin entry.

It is important to remember that the above spin recovery procedures and techniques are recommended for use only in the absence of the manufacturer's procedures. Before any pilot attempts to begin spin training, that pilot must be familiar with the procedures provided by the manufacturer for spin recovery.

The most common problems in spin recovery include pilot confusion as to the direction of spin rotation and whether the maneuver is a spin versus spiral. If the airspeed is increasing, the airplane is no longer in a spin but in a spiral. In a spin, the airplane is stalled. The indicated airspeed, therefore, should reflect stall speed.

INTENTIONAL SPINS

The *intentional spinning* of an airplane, for which the spin maneuver is not specifically approved, is NOT authorized by this handbook or by the Code of Federal Regulations. The official sources for determining if the spin maneuver IS APPROVED or NOT APPROVED for a specific airplane are:

- Type Certificate Data Sheets or the Aircraft Specifications.
- The limitation section of the FAA-approved AFM/POH. The limitation sections may provide additional specific requirements for spin authorization, such as limiting gross weight, CG range, and amount of fuel.
- On a placard located in clear view of the pilot in the airplane, NO ACROBATIC MANEUVERS INCLUDING SPINS APPROVED. In airplanes placarded against spins, there is no assurance that recovery from a fully developed spin is possible.

There are occurrences involving airplanes wherein spin restrictions are *intentionally* ignored by some pilots. Despite the installation of placards prohibiting intentional spins in these airplanes, a number of pilots, and some flight instructors, attempt to justify the maneuver, rationalizing that the spin restriction results merely because of a "technicality" in the airworthiness standards.

Some pilots reason that the airplane was spin tested during its certification process and, therefore, no problem should result from demonstrating or practicing spins. However, those pilots overlook the fact that a normal category airplane certification only requires the airplane recover from a one-turn spin in not more than one additional turn or 3 seconds, whichever takes longer. This same test of controllability can also be used in certificating an airplane in the Utility category (14 CFR section 23.221 (b)).

The point is that 360° of rotation (one-turn spin) does not provide a stabilized spin. If the airplane's controllability has not been explored by the engineering test pilot beyond the certification requirements, prolonged spins (inadvertent or intentional) in that airplane place an operating pilot in an unexplored flight situation. Recovery may be difficult or impossible.

In 14 CFR part 23, "Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes," there are no requirements for investigation of *controllability* in a true spinning condition for the Normal category airplanes. The one-turn "margin of safety" is essentially a check of the airplane's controllability in a delayed recovery from a *stall*. Therefore*, in airplanes placarded against spins there is absolutely no assurance whatever that recovery from a fully developed spin is possible under any circumstances.* The pilot of an airplane placarded against intentional spins should assume that the airplane may well become uncontrollable in a spin.

WEIGHT AND BALANCE REQUIREMENTS

With each airplane that is approved for spinning, the weight and balance requirements are important for safe performance and recovery from the spin maneuver. Pilots must be aware that just minor weight or balance changes can affect the airplane's spin recovery characteristics. Such changes can either alter or enhance the spin maneuver and/or recovery characteristics. For example, the addition of weight in the aft baggage compartment, or additional fuel, may still permit the airplane to be operated within CG, but could seriously affect the spin and recovery characteristics.

An airplane that may be difficult to spin intentionally in the Utility Category (restricted aft CG and reduced weight) could have less resistance to spin entry in the Normal Category (less restricted aft CG and increased weight). This situation is due to the airplane being able to generate a higher angle of attack and load factor. Furthermore, an airplane that is approved for spins in the Utility Category, but loaded in the Normal Category, may not recover from a spin that is allowed to progress beyond the incipient phase.

Common errors in the performance of *intentional* spins are:

- Failure to apply full rudder pressure in the desired spin direction during spin entry.
- Failure to apply and maintain full up-elevator pressure during spin entry, resulting in a spiral.
- Failure to achieve a fully stalled condition prior to spin entry.
- Failure to apply full rudder against the spin during recovery.
- Failure to apply sufficient forward-elevator pressure during recovery.
- Failure to neutralize the rudder during recovery after rotation stops, resulting in a possible secondary spin.
- Slow and overly cautious control movements during recovery.
- Excessive back-elevator pressure after rotation stops, resulting in possible secondary stall.
- Insufficient back-elevator pressure during recovery resulting in excessive airspeed.

U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Stall and Spin Awareness Training | **Date:** 9/20/07 | **AC No:** 61-67C
Initiated by: AFS-810 | **Change:** 1

1. PURPOSE. This advisory circular (AC) has been updated to reflect new resources for sport pilots and warnings about design maneuvering speed.

2. PRINCIPLE CHANGES. This change updates resources for sport pilots and warnings about design maneuvering speed.

a. Paragraph 2b(12) adds Sports Pilot Practical Test Standards.

b. Paragraph 5 contains the proper Internet address for this AC.

c. Paragraph 100f adds information regarding design maneuvering speed.

d. Paragraph 100g adds information regarding load factor.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
ii	9/25/00	ii	9/20/07
2	9/25/00	2	9/20/07

ORIGINAL SIGNED BY
Carol Giles for

James J. Ballough
Director, Flight Standards Service

U.S. Department
of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Stall and Spin Awareness Training **Date:** 9/20/07 **AC No:** 61-67C
Initiated by: AFS-810 **Change:** 1

1. PURPOSE. This advisory circular (AC) explains the stall and spin awareness training required under Title 14 of the Code of Federal Regulations (14 CFR) part 61 and offers guidance to flight instructors who provide it. This AC also informs pilots of the airworthiness standards for the type certification of normal, utility, and acrobatic category airplanes prescribed in 14 CFR part 23, § 23.221, concerning spin maneuvers, and it emphasizes the importance of observing restrictions that prohibit the intentional spins of certain airplanes.

2. RELATED READING MATERIAL (current editions).

a. Report No. FAA-RD-77-26, General Aviation Pilot Stall Awareness Training Study. This document may be purchased from the National Technical Information Service (NTIS), U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161. To order by telephone call: (800) 553-6847. The NTIS identification number is ADA041310.

b. The following documents are available on the Internet at http: www.faa.gov/.

(1) AC 61-65, Certification: Pilots and Flight and Ground Instructors.

(2) FAA-H-8083-1, Aircraft Weight and Balance Handbook.

(3) FAA-H-8083-3, Airplane Flying Handbook.

(4) FAA-H-8083-9, Aviation Instructor’s Handbook.

(5) FAA-S-8081-3, Recreational Pilot - Practical Test Standards for Airplane and Rotorcraft.

(6) FAA-S-8081-6, Flight Instructor - Practical Test Standards for Airplane (Single-Engine/ Multiengine).

(7) FAA-S-8081-8, Flight Instructor - Practical Test Standards for Glider.

(8) FAA-S-8081-12, Commercial Pilot - Practical Test Standards for Airplane.

(9) FAA-S-8081-14, Private Pilot - Practical Test Standards for Airplane.

(10) FAA-S-8081-22, Private Pilot - Practical Test Standards for Glider.

(11) FAA-S-8081-23, Commercial Pilot - Practical Test Standards for Glider.

(12) FAA-S-8081-29, Sport Pilot - Practical Test Standards for Airplane, Gyroplane, Glider, Flight Instructor.

(13) FAA-S-8081-31, Sport Pilot - Practical Standards for Weight Shift Control, Powered Parachute, Flight Instructor.

3. BACKGROUND. In January 1980, the Federal Aviation Administration (FAA) announced its policy of incorporating the use of certain distractions during the performance of flight test maneuvers. This policy came about as a result of Report No. FAA-RD-77-26, General Aviation Pilot Stall Awareness Study, which revealed that stall/spin related accidents accounted for approximately one-quarter of all fatal general aviation accidents. National Transportation Safety Board (NTSB) statistics indicate that most stall/spin accidents result when a pilot is distracted momentarily from the primary task of flying the aircraft. Changes to part 61, completed in 1991, included increased stall and spin awareness training for recreational, private, and commercial pilot certificate applicants. The training is intended to emphasize recognition of situations that could lead to an inadvertent stall and/or spin by using realistic distractions such as those suggested in Report No. FAA-RD-77-26 and incorporated into the performance of flight test maneuvers. Although the training is intended to emphasize stall and spin awareness and recovery techniques for all pilots, only flight instructor-airplane and flight instructor-glider candidates are required to demonstrate instructional proficiency in spin entry, spins, and spin recovery techniques as a requirement for certification. Part 61 was extensively updated in 1997. Sections of part 23 (Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes) that apply to spin requirements and placards have changed. This AC incorporates those changes.

4. COMMENTS INVITED. Comments regarding this publication should be directed to:

Federal Aviation Administration
General Aviation and Commercial Division, AFS-800
800 Independence Ave., S.W.
Washington, DC 20591

Every comment will not necessarily generate a direct acknowledgment to the commenter. Comments received will be considered in the development of upcoming AC revisions or other related technical material.

5. INTERNET. AC 61-67C, Stall and Spin Awareness Training, can be accessed on the Internet at http://rgl.faa.gov/.

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CHAPTER 1. GROUND TRAINING: STALL AND SPIN AWARENESS

100. STALL/SPIN EFFECTS AND DEFINITIONS. A stall occurs when the smooth airflow over the airplane's wing is disrupted, and the lift degenerates rapidly. This is caused when the wing exceeds its critical angle of attack. This can occur at any airspeed, in any attitude, with any power setting. If recovery from a stall is not achieved in a timely and appropriate manner by reducing the Angle of Attack (AOA), a secondary stall and/or a spin may result. All spins are preceded by a stall on at least part of the wing. The angle of the relative wind is determined primarily by the aircraft's airspeed and attitude. Factors such as aircraft weight, center of gravity, configuration, and the amount of acceleration used in a turn are also considered. The speed at which the critical angle of the relative wind is exceeded is the stall speed. Stall speeds are listed in the Airplane Flight Manual (AFM) or the Pilot Operating Handbook (POH) and pertain to certain conditions or aircraft configurations, e.g., landing configuration. Other specific operational speeds are calculated based upon the aircraft's stall speed in the landing configuration. Airspeed values specified in the AFM or POH may vary under different circumstances. Factors such as weight, center of gravity, altitude, temperature, turbulence, and the presence of snow, ice, or frost on the wings will affect an aircraft's stall speed. To thoroughly understand the stall/spin phenomenon, some basic factors affecting aircraft aerodynamics and flight should be reviewed with particular emphasis on their relation to stall speeds. Much of the information in this AC is also applicable to gliders. The following terms are defined as they relate to stalls/spins.

a. Angle of Attack. AOA is the angle at which the chord line of the wing meets the relative wind. The chord line is a straight line drawn through the profile of the wing connecting the extremities of the leading edge and trailing edge. The AOA must be small enough to allow attached airflow over and under the airfoil to produce lift. AOA is an element of lift. Change in AOA will affect the amount of lift that is produced. An excessive AOA will disrupt the flow of air over the airfoil. If the AOA is not reduced, a section of the airfoil will reach its critical AOA, lose lift, and stall. Exceeding the critical AOA for a particular airfoil section will always result in a stall of that section.

b. Airspeed. Airspeed is controlled primarily by the elevator or longitudinal control position for a given configuration and power. Conversely, airspeed is controlled by power at a given configuration and AOA. If an airplane's speed is too slow, the AOA required for level flight will be so large that the air can no longer follow the upper curvature of the wing. The result is a separation of airflow from the wing, loss of lift, a large increase in drag, and eventually a stall if the AOA is not reduced. The stall is the result of excessive AOA - not insufficient airspeed. For example, at a 60° banked turn in level coordinated flight, the load factor is 2 G's and the stall speed increases 40 percent over the straight and level stall speed. A stall can occur at any airspeed, in any attitude, at any power setting.

c. Configuration. Flaps, landing gear, and other configuring devices can affect an airplane's stall speed. Extension of flaps and/or landing gear in flight will increase drag. Flap extension will generally increase the lifting ability of the wings, thus reducing the airplane's stall speed. The effect of flaps on an airplane's stall speed can be seen by markings on the airplane's airspeed indicator, where the lower airspeed limit of the white arc (power-off stall speed with gear and flaps in the landing configuration) is less than the lower airspeed limit of the green arc (power-off stall speed in the clean configuration).

d. V_{SO}. V_{SO} is the stall speed or the minimum steady flight speed in the landing configuration.

e. V_{S1}. V_{S1} is the stall speed or the minimum steady flight speed obtained in a specified configuration.

f. V_A. V_A is the design maneuvering speed. Do not use full or abrupt control movements at or above this speed. It is possible to exceed the airplane structural limits at or above V_A. Rapid and large alternating control inputs, especially in combination with large changes in pitch, roll, or yaw (e.g., large side slip angles) may result in structural failures at any speed, even below V_A.

g. Load Factor. Load factor is the ratio of the lifting force produced by the wings to the actual weight of the airplane and its contents. Load factors are usually expressed in terms of "G." The aircraft's stall speed increases in proportion to the square root of the load factor. For example, an airplane that has a normal unaccelerated stall speed of 45 knots can be stalled at 90 knots when subjected to a load factor of 4 G's. The possibility of inadvertently stalling the airplane by increasing the load factor (i.e., by putting the airplane in a steep turn or spiral) is much greater than in normal cruise flight. When an airplane stalls at a higher indicated air speed due to excessive maneuvering loads, it is called an accelerated maneuver stall. A stall entered from straight and level flight or from an unaccelerated straight climb will not produce additional load factors. In a constant rate turn, increased load factors will cause an airplane's stall speed to increase as the angle of bank increases. Excessively steep banks should be avoided because the airplane will stall at a much higher speed. If the aircraft exceeds maneuvering speed, structural damage to the aircraft may result before it stalls. If the nose falls during a steep turn, the pilot might attempt to raise it to the level flight attitude without shallowing the bank. This situation tightens the turn and can lead to a diving spiral. A feeling of weightlessness will result if a stall recovery is performed by abruptly pushing the elevator control forward, which will reduce the up load on the wings. Recoveries from stalls and spins involve a tradeoff between loss of altitude (and an increase in airspeed) and an increase in load factor in the pullup. However, recovery from the dive following spin recovery generally causes higher airspeeds and consequently higher load factors than stall recoveries due to the much lower position of the nose. Significant load factor increases are sometimes induced during pullup after recovery from a stall or spin. It should be noted that structural damage can result from the high load factors that could be imposed on the aircraft by intentional stalls practiced above the airplane's design maneuvering speed. Large, aggressive control reversals can also lead to loads that can exceed the structural design limits, even at speeds below the airplane's design maneuvering speed.

h. Center of Gravity (CG). The CG location has a direct effect on the effective lift and AOA of the wing, the amount and direction of force on the tail, and the degree of stabilizer deflection needed to supply the proper tail force for equilibrium. The CG position, therefore, has a significant effect on stability and stall/spin recovery. As the CG is moved aft, the amount of elevator deflection needed to stall the airplane at a given load factor will be reduced. An increased AOA will be achieved with less elevator control force. This could make the entry into inadvertent stalls easier, and during the subsequent recovery, it would be easier to generate higher load factors due to the reduced elevator control forces. In an airplane with an extremely aft CG, very light back elevator control forces may lead to inadvertent stall entries and if a spin is entered, the balance of forces on the airplane may result in a flat spin. Recovery from a flat spin is often impossible. A forward CG location will often cause the stalling AOA to be reached at a higher airspeed. Increased back elevator control force is generally required with a forward CG location.

i. Weight. Although the distribution of weight has the most direct effect on stability, increased gross weight can also have an effect on an aircraft's flight characteristics, regardless of the

CG position. As the weight of the airplane is increased, the stall speed increases. The increased weight requires a higher AOA to produce additional lift to support the weight.

j. Altitude and Temperature. Altitude has little or no effect on an airplane's indicated stall speed. Thinner air at higher altitudes will result in decreased aircraft performance and a higher true airspeed for a given indicated airspeed. Higher than standard temperatures will also contribute to increased true airspeed for a given indicated airspeed. However, the higher true airspeed has no effect on indicated approach or stall speeds. The manufacturer's recommended indicated airspeeds should therefore be maintained during the landing approach, regardless of the elevation or the density altitude at the airport of landing.

k. Snow, Ice, or Frost on the Wings. Even a small accumulation of snow, ice, or frost on an aircraft's surface can cause an increase in that aircraft's stall speed. Such accumulation changes the shape of the wing, disrupting the smooth flow of air over the surface and, consequently, increasing drag and decreasing lift. Flight should not be attempted when snow, ice, or frost have accumulated on the aircraft surfaces.

l. Turbulence. Turbulence can cause an aircraft to stall at a significantly higher airspeed than in stable conditions. A vertical gust or windshear can cause a sudden change in the relative wind, and result in an abrupt increase in AOA. Although a gust may not be maintained long enough for a stall to develop, the aircraft may stall while the pilot is attempting to control the flightpath, particularly during an approach in gusty conditions. When flying in moderate to severe turbulence or strong crosswinds, a higher than normal approach speed should be maintained. In cruise flight in moderate or severe turbulence, an airspeed well above the indicated stall speed and below maneuvering speed should be used. Maneuvering speed is lower at a lower weight.

101. DISTRACTIONS. Stalls resulting from improper airspeed management are 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 or spin while performing tasks that are secondary to controlling the aircraft.

102. WING CONTAMINATION EFFECTS ON STALL WARNING, STALL SPEED, AND POSTSTALL RECOVERY. Stall speeds and stall characteristics are usually determined with uncontaminated airfoils. For airplanes that are certified for flight in icing conditions, ice shapes may have also been considered for their effects on aircraft. However, not all possible icing conditions and configurations can be tested. Icing is the primary concern, but any contamination or alteration of the leading edge caused by factors such as mud, insect residue, or ice can significantly alter the aerodynamic characteristics of the wing, but it is icing that is of primary concern.

a. In some icing conditions there are adverse changes to the stall speed, stall characteristics, performance, and handling characteristics of the airplane. These adverse changes are potentially hazardous for several reasons. First, aerodynamic stall may occur with little or none of the usual cues in advance. These cues include airframe or control surface buffet, reduced control effectiveness, and activation of the stall warning horn, stick shaker, and stick pusher. Next, because insufficient power or thrust to increase speed while holding constant altitude to reduce the AOA. Finally, postal recovery of a contaminated airplane may be complicated by gross changes in control effectiveness, airplane response characteristics, and abnormal control forces. As a result of these factors, large losses in altitude can occur during recovery.

b. Accordingly, in these conditions, a prompt control input to decrease pitch attitude to recover lateral control, with aggressive power application ensures the most rapid recovery with minimum altitude loss. The AOA must be reduced immediately as the wing, or part of the wing is already stalled and no margin remains to allow holding altitude/ attitude as power is applied. The pilot should note the AOA (or airspeed) at upset and not approach that AOA (airspeed) during the recovery or another upset may occur. This AOA may be well below the normal stall AOA (below shaker AOA) and the airspeed may be well above normal stall airspeed. Stall speed increases as high as 50 knots have been observed in post upset data review.

c. Further complications involve use of the autopilot. The autopilot may apply control inputs that will mask detection of some of these tactile cues by the pilot or attempt to control the airplane in the stall. Sudden autopilot self-disconnect with control surfaces trimmed into extreme positions or with controls trimmed into uncoordinated flight will complicate poststall recovery and may lead to a spin or spiral.

103. STALL RECOGNITION. There are several ways to recognize that a stall is impending before it actually occurs. When one or more of these indicators is noted, initiation of a recovery should be instinctive (unless a full stall is being practiced intentionally from an altitude that allows recovery at least 1,500 feet above ground level (AGL) for single-engine airplanes and 3,000 feet AGL for multiengine airplanes). One indication of a stall is a mushy feeling in the flight controls and less control effect as the aircraft's speed is reduced. This reduction in control effectiveness is attributed in part to reduced airflow over the flight control surfaces. In fixed pitch propeller airplanes, a loss of revolutions per minute (rpm) may be evident when approaching a stall in power-on conditions. For both airplanes and gliders, a reduction in the sound of air flowing along the fuselage is usually evident. Just before the stall occurs, buffeting, uncontrollable pitching, or vibrations may begin. Many aircraft are equipped with stall warning devices that will alert the pilot 4 to 8 knots prior to the onset of a stall. Finally, kinesthesia (the sensing of changes in direction or speed of motion), when properly learned and developed, will warn the pilot of a decrease in speed or the beginning of a mushing of the aircraft. These preliminary indications serve as a warning to the pilot to increase airspeed by adding power, lowering the nose, and/or decreasing the angle of bank.

104. TYPES OF STALLS. Stalls can be practiced both with and without power. Stalls should be practiced to familiarize the student with the aircraft's particular stall characteristics without putting the aircraft into a potentially dangerous condition. In multiengine airplanes, single-engine stalls must be avoided. Descriptions of some different types of stalls follows:

a. Power-off stalls (also known as approach-to-landing stalls) are practiced to simulate normal approach-to-landing conditions and configuration. Many stall/spin accidents have occurred in these power-off 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.

b. Power-on stalls (also known as departure stalls) are practiced to simulate takeoff and climbout conditions and configuration. Many stall/spin accidents have occurred during these phases of flight, particularly during go-arounds. A causal factor in such accidents has been the pilot's failure to maintain positive control due to a nose-high trim setting or premature flap retraction, and during short field takeoffs has also been a causal accident factor.

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, pullups, or other abrupt changes in flightpath. Accelerated stalls usually are more severe than unaccelerated stalls and are often unexpected because they occur at higher-than-normal airspeeds.

105. STALL RECOVERY. The key factor in recovering from a stall is regaining positive control of the aircraft by reducing the AOA. At the first indication of a stall, the aircraft AOA must be decreased to allow the wings to regain lift. Every aircraft in upright flight may require a different amount of forward pressure or relaxation of elevator back pressure to regain lift. It should be noted that too much forward pressure can 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 (if applicable) to increase the airspeed and to minimize the loss of altitude. Certain high performance airplanes may require only an increase in thrust and relaxation of the back pressure on the yoke to effect recovery. As airspeed increases and the recovery is completed, power should be adjusted to return the airplane to the desired flight condition. Straight and level flight should be established with full coordinated 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.

106. 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, appropriate forward pressure or the relaxation of back elevator pressure should again be performed just as in a normal stall recovery. When sufficient airspeed has been regained, the aircraft can then be returned to straight and level flight.

107. SPINS. A spin may be defined as an aggravated stall that results in what is termed “autorotation” wherein the airplane follows a downward corkscrew path. As the airplane rotates around a vertical axis, the rising wing is less stalled than the descending wing creating a rolling, yawing, and pitching motion. The airplane is basically being forced downward by gravity, rolling, yawing, and pitching in a spiral path.

108. WEIGHT AND BALANCE. Minor weight or balance changes can affect an aircraft's spin characteristics. For example, the addition of a suitcase in the aft baggage compartment will affect the weight and balance of the aircraft. An aircraft that may be difficult to spin intentionally in the utility category (restricted aft CG and reduced weight) could have less resistance to spin entry in the normal category (less restricted aft CG and increased weight) due to its ability to generate a higher AOA and increased load factor. Furthermore, an aircraft that is approved for spins in the utility category, but loaded in the normal category, may not be recoverable from a spin that is allowed to progress beyond one turn or 3-second spin, whichever is longer (refer to § 23.221(a)).

109. PRIMARY CAUSE. The primary cause of an inadvertent spin is exceeding the critical AOA while applying excessive or insufficient rudder and, to a lesser extent, aileron. Insufficient or excessive control inputs to correct for Power Factor (PF), or asymmetric propeller loading, could aggravate the precipitation of a spin. At a high AOA the downward moving blade, which is normally on the right side of the propeller arc, has a higher AOA and therefore higher thrust than the upward moving blade on the left. This results in a tendency for the airplane to yaw around the vertical axis to the left. If insufficient or excessive rudder correction is applied to counteract PF, uncoordinated flight may result. A classic situation where PF could play an important role in a stall/spin accident is during a go-around or short field takeoff where the airplane is at a high pitch attitude, high power setting, and low airspeed. In an uncoordinated maneuver, 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 a critical AOA is approaching until the stall warning device activates. If a stall recovery is not promptly initiated, the airplane is more likely to enter an inadvertent spin. For example, stall/spin accidents have occurred during a turn from base to final because the pilot attempted to rudder the airplane around (skid) so as not to overshoot the runway nor use excessive bank angle in the traffic pattern. The spin that occurs from cross controlling an aircraft usually results in rotation in the direction of the rudder being applied, regardless of which wingtip is raised. In a skidding turn, where both aileron and rudder are applied in the same direction, rotation will be in the direction the controls are applied. However, in a slipping turn, where opposite aileron is held against the rudder, the resultant spin will usually occur in the direction opposite the aileron that is being applied.

110. TYPES OF SPINS.

a. An incipient spin is that portion of a spin from the time the airplane stalls and rotation starts, until the spin becomes fully developed. Incipient spins that are not allowed to develop into a steady state spin are commonly used as an introduction to spin training and recovery techniques.

b. A fully developed, steady state spin occurs when the aircraft angular rotation rate, airspeed, and vertical speed are stabilized from turn-to-turn in a flightpath 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 CG of the airplane. Recovery from a flat spin may be extremely difficult and, in some cases, impossible.

111. SPIN RECOVERY. Before flying any aircraft, in which spins are to be conducted, the pilot should be familiar with the operating characteristics and standard operating procedures, including spin recovery techniques, specified in the approved AFM or POH. The first step in recovering from an upright spin is to close the throttle completely to eliminate power and minimize the loss of altitude. If the particular aircraft spin recovery techniques are not known, the next step is to neutralize the ailerons, determine the direction of the turn, and apply full opposite rudder. When the rotation slows, briskly move the elevator control forward to approximately the neutral position. 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 AOA. Once the stall is broken, the spinning will stop. Neutralize the rudder when the spinning stops to avoid entering a spin in the opposite direction. When the rudder is neutralized, gradually apply enough aft elevator pressure to return to level flight. 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. If the spin is being performed in an airplane, the engine will sometimes stop developing power due to centrifugal force acting on the fuel in the airplane's tanks causing fuel interruption. 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 spins are authorized. Greater losses can be expected at higher density altitudes.

112. SPIRAL MODE RECOVERY. The spiral mode is an autorotation mode similar to a spin. The center of rotation is close to the centerline of the airplane but the airplane is not stalled. Many airplanes and gliders will not spin at forward CG locations but will spiral. Many airplanes will enter a spin but the spin will become more vertical and degenerate into a spiral. It is important to note that when the spin transitions into the spiral the airspeed will increase as the nose goes down to near vertical. The side forces on the airplane build very rapidly and recovery must be effected immediately before exceeding the structural limits of the airplane. Release the back pressure on the stick (yoke), neutralize the rudder and recover from the steep dive. As in stall and spin recovery, avoid abrupt or excessive elevator inputs that could lead to a secondary stall.

113. THRU 199. RESERVED.

CHAPTER 2. FLIGHT TRAINING: STALLS

200. STALL TRAINING. Flight instructor-airplane and flight instructor-glider applicants must be able to give stall training. The flight instructor should emphasize that techniques and procedures for each aircraft may differ and that pilots should be aware of the flight characteristics of each aircraft flown. The most effective training method contained in Report No. FAA-RD-77-26, General Aviation Pilot Stall Awareness Study, is the simulation of scenarios that can lead to inadvertent stalls by creating distractions while the student is practicing certain maneuvers. Stall demonstrations and practice, including maneuvering during slow flight and other maneuvers with distractions that can lead to inadvertent stalls, should be conducted at a sufficient altitude to enable recovery above 1,500 feet AGL in single-engine airplanes and 3,000 feet AGL in multiengine airplanes. Because of the possible catastrophic consequences, single-engine stalls should not be demonstrated or practiced in multiengine airplanes. Airplanes with normally aspirated engines will lose power as altitude increases because of the reduced density of the air entering the induction system of the engines. This loss of power will result in a V_{MC} lower than the stall speed at higher altitudes. (V_{MC} is the minimum control speed with the critical engine inoperative). Also, some airplanes have such an effective rudder that even at sea level V_{MC} is lower than stall speed. For these airplanes, demonstrating loss of directional control may be safely conducted by limiting rudder travel to simulate maximum rudder available. Limiting rudder travel should be accomplished well above the power-off stall speed (approximately 20 knots). This will avoid the hazards of stalling one wing with the maximum allowable power applied to the engine on the other wing. The flight training required by part 61 does not entail the actual practicing of spins for other than flight instructor-airplane and flight instructor-glider applicants, but emphasizes stall and spin avoidance. The following training elements are based on Report No. FAA-RD-77-26:

a. Stall Avoidance Practice at Slow Airspeeds.

(1) Assign a heading and an altitude. Have the student reduce power and slow to an airspeed just above the stall speed, using trim as necessary.

(2) Have the student maintain heading and altitude with the stall warning device activated.

(3) Demonstrate the effect of elevator trim (use neutral and full noseup settings) and rudder trim, if available.

(4) Note the left turning tendency and rudder effectiveness for lateral/directional control.

(5) Emphasize how right rudder pressure is necessary to center the ball indicator and maintain heading.

(6) Release the rudder and advise the student to observe the left yaw.

(7) Adverse yaw demonstration. While at a low airspeed, have the student enter left and right turns without using rudder pedals.

(8) Have the student practice turns, climbs, and descents at low airspeeds.

(9) Demonstrate the proper flap extension and retraction procedures while in level flight to avoid a stall at low airspeeds. Note the change in stall speeds with flaps extended and retracted.

(10) Utilize realistic distractions at low airspeeds. Give the student a task to perform while flying at a low airspeed. Instruct the student to divide his/her attention between the task and flying the aircraft to maintain control and avoid a stall. The following distractions can be used:

(a) Drop a pencil. Ask the student to pick it up.

(b) Ask the student to determine a heading to an airport using a chart.

(c) Ask the student to reset the clock to Universal Coordinated Time.

(d) Ask the student to get something from the back seat.

(e) Ask the student to read the outside air temperature.

(f) Ask the student to call the Flight Service Station (FSS) for weather information.

(g) Ask the student to compute true airspeed with a flight computer.

(h) Ask the student to identify terrain or objects on the ground.

(i) Ask the student to identify a field suitable for a forced landing.

(j) Have the student climb 200 feet and maintain altitude, then descend 200 feet and maintain altitude.

(k) Have the student reverse course after a series of S-turns.

(11) Fly at low airspeeds with the airspeed indicator covered. Use various flap settings and distractions.

b. Power-on (Departure) Stall.

(1) At a safe altitude, have the student attempt coordinated power-on (departure) stalls straight ahead and in turns. Emphasize how these stalls could occur during takeoff.

(2) Ask the student to demonstrate a power-on (departure) stall and distract him/her just before the stall occurs. Explain any effects the distraction may have had on the stall or recovery.

c. Engine Failure in a Climb Followed by a Gliding Turn. This demonstration will show the student how much altitude the airplane loses following a power failure after takeoff and during a turn back to the runway and why returning to the airport after losing an engine is not a recommended procedure. This can be performed using either a medium or a steep bank in the turn, but emphasis should be given to stall avoidance.

(1) Set up best rate of climb (V_Y). Directly below you there should be a straight line landmark (i.e., road or power line) parallel to your flightpath.

(2) Reduce power smoothly to idle as the airplane passes through a cardinal altitude.

(3) Lower the nose to maintain the best glide speed and make a 260° turn at the best glide speed. Emphasize that this turn should be into the wind (if there is a crosswind).

(4) Re-intercept your final outbound course over the landmark you chose, inbound with an 80° turn in the opposite direction.

(5) Point out the altitude loss and emphasize how rapidly airspeed decreases following a power failure in a climb attitude.

NOTE: Depending on winds, length of runway, and altitude the 260/80° turns may need to be modified (250/70° or 270/90°) to meet the existing situation.

d. Cross Controlled Stalls in Gliding Turns. Perform stalls in gliding turns to simulate turns from base to final. Perform the stalls from a properly coordinated turn, a slipping turn, and a skidding turn. Explain the difference between slipping and skidding turns. Explain the ball indicator position in each turn and the aircraft behavior in each of the stalls.

e. Power-off (Approach-To-Landing) Stalls.

(1) Have the student perform a full-flap, gear extended, power-off stall with the correct recovery and cleanup procedures. Note the loss of altitude.

(2) Have the student repeat this procedure and distract the student during the stall and recovery and note the effect of the distraction. Show how errors in flap retraction procedure can cause a secondary stall.

f. Stalls During Go-arounds.

(1) Have the student perform a full-flap, gear extended, power-off stall, then recover and attempt to climb with flaps extended. If a higher than normal climb pitch attitude is held, a secondary stall will occur. (In some airplanes, a stall will occur if a normal climb pitch attitude is held).

(2) Have the student perform 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.

g. Elevator Trim Stall.

(1) Have the student place the airplane in a landing approach configuration, in a trimmed descent.

(2) After the descent is established, initiate a go-around by adding full power, holding only light elevator and right rudder pressure.

(3) Allow the nose to pitch up and torque to swerve the airplane left. At the first indication of a stall, recover to a normal climbing pitch attitude.

(4) Emphasize the importance of correct attitude control, application of control pressures, and proper trim during go-arounds.

201. THRU 299. RESERVED.

CHAPTER 3. FLIGHT TRAINING: SPINS

300. SPIN TRAINING. Spin training is required for flight instructor-airplane and flight instructor-glider applicants only. Upon completion of the training, the applicant's log book or training record should be endorsed by the flight instructor who provided the training. A sample endorsement of spin training for flight instructor applicants is available in the current edition of AC 61-65, Certification: Pilots and Flight and Ground Instructors.

a. Spin training must be accomplished in an aircraft that is approved for spins. Before practicing intentional spins, the AFM or POH should be consulted for the proper entry and recovery techniques.

b. The training should begin by practicing both power-on and power-off stalls to familiarize the applicant with the aircraft's stall characteristics. Spin avoidance, incipient spins, actual spin entry, spin, and spin recovery techniques should be practiced from an altitude above 3,500 feet AGL.

c. Spin avoidance training should consist of stalls and maneuvering during slow flight using realistic distractions such as those listed in chapter 2. Performance is considered unsatisfactory if it becomes necessary for the instructor to take control of the aircraft to avoid a fully developed spin.

d. Incipient spins should be practiced to train the instructor applicant to recover from a student's poorly performed stall or unusual attitude that could lead to a spin. Configure the aircraft for a power-on or power-off stall, and continue to apply back elevator pressure. As the stall occurs, apply right or left rudder and allow the nose to yaw toward the stalled wing. Release the spin inducing controls and recover as the spin begins by applying opposite rudder and forward elevator pressure. The instructor should discuss control application in the recovery.

e. Spin entry, spin, and spin recovery should be demonstrated by the instructor and repeated in both directions by the applicant.

(1) Apply the entry procedure for a power-off stall. As the airplane approaches a stall, smoothly apply full rudder in the direction of desired spin rotation and continue to apply back elevator to the limit of travel. The ailerons should be neutral.

(2) Allow the spin to develop, and be fully recovered no later than one full turn. Observe the airspeed indicator during the spin and subsequent recovery to ensure that it does not reach the red line (V_{NE}).

(3) Follow the recovery procedures recommended by the manufacturer in the AFM or POH. In most aircraft, spin recovery techniques consist of retarding power (if in a powered aircraft), applying opposite rudder to slow the rotation, neutralizing the ailerons, applying positive forward elevator movement to break the stall, neutralizing the rudder as the spinning stops, and returning to level flight.

f. During spin training if a spin is not fully developed, the aircraft may instead go into a spiral. A spiral may be recognized by a rapidly increasing airspeed after the attempted spin entry.

(In an actual spin, the airspeed normally stabilizes below stall speed). The pilot must recognize a spiral and initiate immediate recovery to prevent exceeding structural limits of the airplane.

301. SPIN TRAINING AND PARACHUTES. Part 91, § 91.307(c), prohibits the pilot of a civil aircraft from executing any intentional maneuver that exceeds 60° of bank relative to the horizon, or exceeds 30° noseup or nosedown attitude relative to the horizon, unless an approved parachute is worn by each occupant (other than a crewmember). Section 91.307(d) states, in part, that § 91.307(c) does not apply to flight tests for a pilot certificate or rating; or spins and other flight maneuvers required by the regulations for any certificate or rating when given by a certified flight instructor (CFI) or an airline transport pilot (ATP) instructing in accordance with § 61.167.

a. Section 61.183(i) requires an applicant for a flight instructor certificate or rating to receive flight training in stall awareness, spin entry, spins, and spin recovery procedures. The applicant must also possess and demonstrate instructional proficiency in these areas to receive the certificate or rating.

b. Because spin entry, spins, and spin recovery are required for a flight instructor certificate or rating, a person receiving instruction from a CFI (or an ATP instructing in accordance with § 61.167) need not wear an approved parachute while instruction is being provided in these maneuvers. This provision applies regardless of the certificate or rating for which the person is receiving training and also if the person is receiving instruction that is not being provided for the purpose of obtaining any additional certificate or rating. The instructor providing the training is also not required to wear an approved parachute while providing this flight training.

c. Any pilot or required crewmember may perform a maneuver that exceeds the limits prescribed in § 91.307(c) without wearing an approved parachute, provided there are no other occupants in the aircraft or the other occupants are wearing approved parachutes.

302. THRU 399. RESERVED.

CHAPTER 4. AIRWORTHINESS STANDARDS

400. OPERATING LIMITATIONS. Operating limitations are imposed for the safety of pilots and their passengers. Operations contrary to these restrictions are a serious compromise of safety. It is important that all pilots and flight and ground instructors, and pilot examiners apply the following information on spins to pilot training and flight operations.

a. Normal Category. These airplanes are not approved for performing acrobatic maneuvers, including spins, and are placarded against intentional spins. However, to provide a margin of safety when recovery from a stall is delayed, normal category airplanes are tested during certification and must be able to recover from a one turn spin or a 3-second spin, whichever takes longer, in no longer than one additional turn with the controls used in the normally used for recovery or demonstrating the airplane's resistance to spins. In addition for airplanes demonstrating compliance with one turn or 3-second requirements:

(1) For both the flaps retracted and flaps extended conditions, the applicable airspeed limit and positive limit maneuvering load factor must not be exceeded;

(2) No control forces or characteristic encountered during the spin of the recovery may adversely affect prompt recovery;

(3) It must be impossible to obtain uncontrollable spins with any use of the flight or engine power controls either at the entry or during the spin; and

(4) In extended condition, the flaps may be retracted during recovery but not before the rotation has ceased.

NOTE: Since airplanes certificated in the normal category have not been tested for more than a one turn or 3-second spin, their performance characteristics beyond these limits are unknown. This is the reason they are placarded against intentional spins.

b. Acrobatic Category. An acrobatic category airplane must meet the spin requirements for normal category aircraft and the following additional requirements:

(1) The airplane must recover from any point in a spin, up to and including six turns, or any greater number of turns for which certification is requested, in no more than one and a half additional turns after initiation of the first control action for recovery. However, beyond three turns, the spin may be discontinued if spiral characteristics appear.

(2) The applicable airspeed limits and limit maneuvering load factor must not be exceeded. For the flaps extended configuration for which approval is requested, the flaps must not be retracted during recovery.

(3) It must be impossible to obtain uncontrollable spins with any use of the flight or engine power controls either at the entry or during the spin.

(4) There must be no characteristics during the spin (such as excessive rates of rotation or extreme oscillatory motion) that might prevent a successful recovery due to disorientation or incapacitation of the pilot.

NOTE: Unless a greater number of turns are requested for certification acrobatic category airplanes have not been tested for more than six turns. The recovery characteristics for additional turns are unknown.

c. Utility Category. A utility category airplane must meet the spin requirements for both normal and acrobatic category airplanes and the applicable emergency exit requirements of § 23.807 if the aircraft is approved for spins.

401. PLACARDS. Under § 23.1567, all airplanes type-certificated under part 23 must have a flight maneuver placard containing the following information:

a. For normal category airplanes, there must be a placard in front of and in clear view of the pilot stating, "No acrobatic maneuvers, including spins, approved."

b. For utility category airplanes that meet the spin requirements, there must be a placard in front of and in clear view of the pilot stating, "Acrobatic maneuvers are limited to the following (list approved maneuvers and the recommended entry speed for each)."

c. For utility category airplanes that do not meet the spin requirements for acrobatic category airplanes, there must be an additional placard in clear view of the pilot stating: "Spins Prohibited."

d. For acrobatic category airplanes, there must be a placard in clear view of the pilot listing the approved acrobatic maneuvers and the recommended entry airspeed for each. If inverted flight maneuvers are not approved, the placard must include a notation to this effect.

e. For acrobatic category airplanes and utility category airplanes approved for spin, there must be a placard in clear view of the pilot listing the control actions for the recovery from spinning maneuvers; and stating that recovery must be initiated when spiral characteristics appear, or after not more than six turns or not more than any greater number of turns for which the airplane has been certificated.

402. PILOT AWARENESS. The pilot of an airplane placarded against intentional spins should assume that the airplane may become uncontrollable in a spin. In addition, stall warning devices should not be deactivated for pilot certification flight tests in airplanes for which they are required equipment.

403. THRU 499. RESERVED.

MANEUVERING FLIGHT – Hazardous to Your Health?

Many pilots think maneuvering flight only includes hazardous operations such as buzzing, but when you fly in a traffic pattern you perform maneuvering flight.

More than one-quarter (26.6 percent) of all fatal accidents in the last 10 years occurred during maneuvering flight, which includes buzzing, formation flying, aerial work, stalls/spins, canyon flying, aerobatics, and normal flight operation. Basically, any type of flying performed close to the ground – the traffic pattern, for example – or involving steep turns and aerobatics is considered maneuvering.

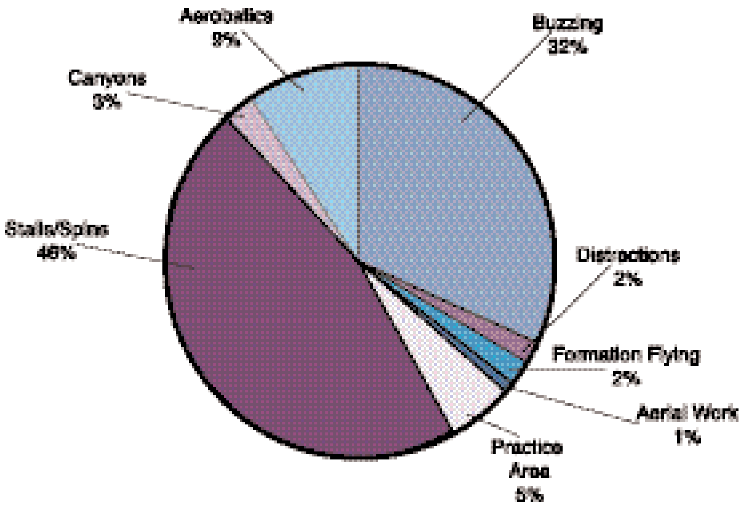
Disclaimer: The purpose of this publication is to inform pilots of the hazards of maneuvering flight. As pilots, we understand that many times maneuvering flight encompasses so called 'fun flying' maneuvers. Our objective is simple: educate pilots about the associated risks and reduce the number of maneuvering flight accidents.

Any discussion of maneuvering involves *airmanship*. This may be defined as the physical handling of the aircraft and the ability to put the machine just where you want it. Pilots lacking in airmanship, either because they are rusty or never learned, cause many accidents that can be avoided with appropriate training.

Maneuvering can be further broken down into two segments: legitimate flying activities and recklessness. Pilots in the first group must take additional precautions while performing in a potentially hazardous environment. Staying inside the flight envelope while not hitting the ground is all part of avoiding a maneuvering mishap. **Routinely operating in the traffic pattern is maneuvering flight, so you can't just write this off as something that only happens to buzzing "bozos."**

The second group of pilots fails to understand or deliberately takes significant risks. Some can be led to the path of safety and the others may very well become an accident statistic. *No amount of training can compensate for really bad judgment.*

Causes of Maneuvering Flight Accidents



During a recent four-year period, maneuvering flight accidents resulted in 570 fatalities and an estimated *$1.7 billion* in lost wages, insurance claims, lawsuits, etc. That does not take into account accidents where only the aircraft was damaged. Who pays? You do! Higher insurance for pilots, FBOs, and manufacturers, and more regulation add up to higher flying expenses for all of us.

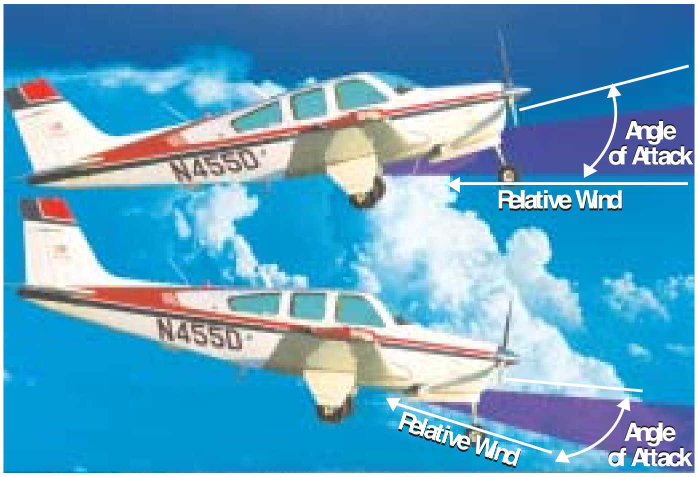
There's also the toll it takes on the public's opinion of general aviation. Recently, AOPA randomly surveyed pilots about their experience with maneuvering flight. The vast majority (87 percent) said buzzing is extremely or moderately damaging to public opinion of general aviation. More than one-third (38 percent) reported being acquainted with or hearing locally of a pilot who gave in to the urge to buzz. Seventeen percent of those surveyed knew three or more pilots who buzz at least sometimes. Nearly half of those surveyed (46 percent) said a temporary license suspension or a small fine would be acceptable punishment for buzzing.

Relative Wind and Angle of Attack

As students, pilots learn that relative wind occurs opposite the direction of flight. That is not to be confused with the direction the nose is pointing. The relative wind is often not directly off the nose.

Any discussion of aerodynamics includes angle of attack (AOA). This is the angle between the chord line of the wing and the relative wind. When the aircraft reaches its critical angle of attack, it will stall. For many GA aircraft, that occurs between 16 and 18 degrees.

AOA accidents happen during "stalling flight." This includes both nose-up and nose-down flight attitudes, in turns and during pull-ups (vertical turns). A too-high AOA and subsequent stall can easily happen with the nose down and plenty of airspeed. *It's the AOA, not the speed* that causes the stall. The chance of an angle-of-attack accident is higher during buzzing, although that type of maneuver can hardly be considered normal flight. GA pilots do not usually receive training on this type of flying.



When a pilot attempts to buzz an object on the ground, he or she is descending nose-down, and then – hopefully – pulls out of the dive in time to recover. If the angle of attack is too steep during that pull-out, the wing will stall – violently. It won't be the garden-variety stall with minor altitude loss that you experienced in training. At low altitudes, chalk one up for the Grim Reaper.

While we're on the subject of buzzing, here's one more reason why it's a bad idea: target fixation. The pilot becomes so focused on the target that he/she waits too long to pull out of the maneuver and crashes into terrain. The military learned this long ago and spends considerable time training their pilots on the fine art of survivable strafing.

Fool's Game

If you feel compelled to try this, go to a high altitude, say 6,000 feet agl, put the aircraft into a dive such as one might in a buzz job, and at 5,200 feet pull back firmly on the yoke to break the dive and level out. Let's simulate the ground level at 5,000 feet so that the buzz job is a "reasonable" 200 feet agl. One of several things may happen:

- Most likely the aircraft will hit the "ground" **(game over).**
- The aircraft will go into a violent accelerated stall like nothing you've ever experienced in training and hit the "ground" **(game over).**
- Because the maneuver was entered at higher than maneuvering speed – minor detail that most buzzers ignore – something breaks on the airframe when the pilot pulls hard to break the dive; the airplane begins to disassemble itself and hits the "ground" **(game over).**
- Because the airplane has been abused by other buzzers, it starts coming apart even before you reach maximum load – see above **(game over).**
- You are exceptionally skilled, lucky, or both. You manage to break the dive at a mere 20 feet agl, one tick mark on the altimeter. The crowd goes WILD, except for the one that got the aircraft tail number and reports it to the FAA. **YOU WIN** – sort of.

Of all the possible outcomes, this seems like a losing proposition but hey, you could be the next winner.

Fine print: There are some warnings the lawyers asked us to include – this is for illustration purposes only and isn't intended as an actual training exercise: Your practice buzz job should take place in uncongested airspace, off airways, and preferably with flight following. The aircraft should be in top shape and should have quick release doors such that you can exit quickly, and you should wear a recently packed parachute.

Distractions

Distractions can play a large role in maneuvering accidents. The infamous base-to-final turn is but one example. Flying in the traffic pattern is stressful enough on a busy day, but take into account looking for traffic, running the checklist, configuring the aircraft, and the ingredients are there for distraction. If you overshoot the runway when turning final, steepening the turn to compensate will only make things worse. When banking too steeply, while adding back pressure to maintain altitude, the angle of attack increases. This is the start of a hazardous stall scenario, which would be nearly impossible to recover from at such a low altitude. Instead, keep a normal turn going and once you roll out, if the approach is not salvageable, go around. There's no shame in flying safely – only in showing off or trying to save a bad landing.

In the traffic pattern, small distractions can lead to emergencies if not handled properly. An open door in flight is just that – a distraction. Don't allow it to overwhelm you and cause a fatal accident. There's a reason that distractions are used by examiners.

During the preflight inspection, the pilot added a quart of engine oil. Shortly after liftoff, the oil access door on the cowling came open. The pilot elected to continue the takeoff on the 3,100-foot runway due to a concern that he did not have enough runway remaining to stop. Witnesses observed the airplane turn to the left, enter a steep descent, and impact the ground. The pilot stated that he "must have become fixated on the flopping door." Examination of the engine did not reveal evidence of any pre-impact mechanical discrepancies that would have resulted in a power loss.

Airmanship in the Traffic Pattern

As mentioned earlier, flying in the traffic pattern consists of maneuvering flight that includes low altitudes, slow airspeeds, and high angles of attack. Understand the aircraft's limitations, and follow the basic rules you first learned as a student pilot:

- "Cheating" on a turn is not good airmanship and is hazardous. Trying to maintain a shallow bank but increase the turn rate with rudder results in crossed controls, a skid, and the potential for a low altitude spin. Base-to-final is a dangerous place.
- The famous stabilized approach. The airlines insist that the crew essentially stop maneuvering 1,000 feet above the ground when landing. For lighter aircraft, we might accept 500 feet as the maneuvering "hard deck." This means the flight is on airspeed, at the right altitude, with an appropriate descent rate and aligned with the runway. Not stable on final approach? Go around!
- Distractions are a major source of maneuvering mishaps. Complete the before landing checklist, with the possible exceptions of landing flaps and prop full forward (on aircraft with a controllable pitch propeller), before turning base. Statistics

show that 39 percent of fatal stall/spin accidents begin below 250 feet agl. If interrupted, run the entire list again. It's better to take extra time than miss a critical item. Don't have time before turning final? Go around – you're not ready for landing. Start the checklist earlier next time.

The airplane impacted terrain after losing control while on approach, killing one of the two pilots on board. A witness stated, "On several of these approaches, I noticed that the nose would rise to above level flight slightly during or after the turn, and it appeared that the application of right rudder was used to force the nose to align with the runway, causing a skid during a portion of the turn. It was apparent that the same techniques were being used on this approach, and suddenly the right wing started down, rotation began, and the aircraft contacted the ground nearly straight down, maybe a block from the end of the runway facing west/northwest. The close-in base leg with relatively flat turn (bank angle) and skid from right rudder application were visible before the roll started. The engine was audible, sounding as though normal full throttle had been applied, in an attempt to recover from the obvious spin that had begun. The aircraft spun to the right and hit the ground." The pilot-rated rear seat occupant stated that the aircraft did not have a nose-up attitude before it nosed over. He stated that he and the front seat pilot were alternating flying the takeoffs and landings. The front pilot was flying the accident approach to land. The pilot stated there was no binding in the aircraft controls and the engine was performing normally. The airplane's operator had endorsed both pilots' applications for their instructor ratings.

Impossible Turn

Everyone knows about the dangers of attempting the impossible turn – or do they?

If you experience a complete engine failure after takeoff in a single-engine aircraft, what would you do? Would you attempt to turn back to the airport or land straight ahead? That should be decided prior to takeoff so it is an automatic process if the worst happens.

It's better not to turn unless there is plenty of maneuvering room. A good rule of thumb is to select a landing area no more than 30 degrees to either side of the nose of the aircraft. A greater turn may easily use more altitude than you have available.

Buzzing

Flying low over a friend's house to show off your outstanding piloting skills is never a good idea. Momentary lapses in judgment have proven fatal for many pilots. Buzzing accidents account for one-third of all maneuvering accidents, and are entirely preventable. During the last ten years, buzzing accidents accounted for 914 of 2,865, or 32 percent, of maneuvering accidents. At altitudes below 1,000 agl, no amount of skill will allow recovery from a spin, so prevention means not engaging in such stunts in the first place.

The pilot of a Beech 23 flew over his friend's house and the friend watched from the ground and waved. The pilot rocked the airplane's wings and buzzed the house. During the second circuit, the airplane quickly banked left and rolled out on a southerly heading. It began to descend and the engine revved to full power. The airplane kept losing altitude, then pitched up 10 degrees. It cleared the house by 25-30 feet and struck a tree at 50-60 mph. There was a 5-15 knot tailwind at the time.

Aerial Work

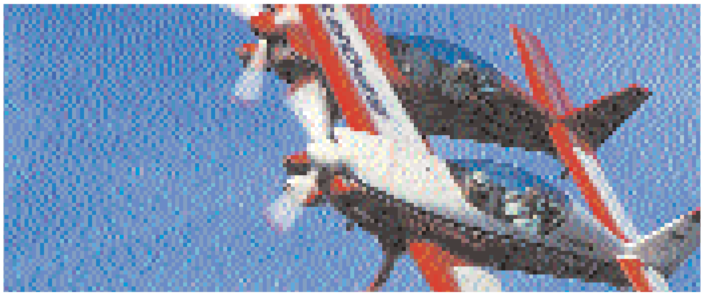
Accidents that occur during legitimate task-oriented flight are the exception to the typical maneuvering accident, accounting for only one percent of all maneuvering flight accidents. Aerial work includes photography, pipeline patrol, banner towing, and crop dusting. (For this publication, ASF categorized crop dusting accidents by their primary cause, i.e. stall/spin or distractions.) These activities require a significant division-of-attention at low altitudes. Pilots performing aerial work are generally highly qualified and use excellent judgment. But, if something goes wrong, there is little time to recover. Equipment malfunction and failure to follow established procedures are the most common causal accident factors.

The pilot had made two successful banner tows before the accident occurred. On the third banner tow, the hook missed the banner rope and grabbed one of the pick-up poles instead. The pilot tried to keep the aircraft and attached pole over the airport to minimize the possibility of property damage or injury to people on the ground if the pole broke free. The pilot tried to stay within the airport boundary and he entered a climbing left turn. He added too much left rudder and entered a spin. Altitude at this point was approximately 300' agl. He attempted to do a spin recovery but the airplane impacted the runway in a 30 degrees nose low attitude. The airplane bounced twice before impacting a jet blast wall.

The National Transportation Safety Board determined the probable cause of this accident was the pilot's failure to maintain control of the airplane which resulted in the inadvertent spin.

Formation Flight

Formation flying accounts for two percent of maneuvering accidents. Since formation flying is routinely performed during aerial photography missions, it's critical to know the pilot you're flying alongside. Discuss the flight beforehand and ensure that he/she is qualified in flying formation. A miscommunication or lack of skill can be deadly. It is not something to be undertaken without training – period. Just because somebody says they're a formation pilot doesn't make it so. Are you willing to bet your aircraft and possibly your life on someone's inflated opinion of their skills?



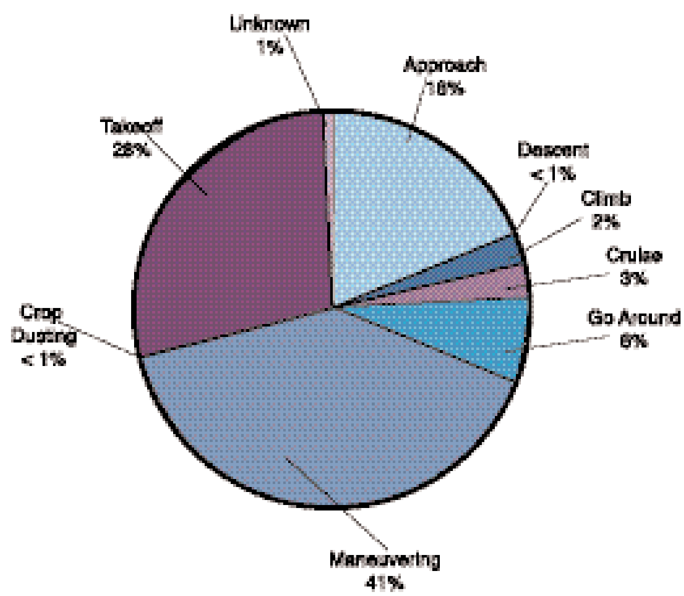
The pilots of a Mitsubishi MU-2 and a Cessna 310 flew in formation at night although neither pilot had formal training in formation flying nor experience in night formation flying. They joined up in flight and the MU-2 pilot was flying on the wing of the C310. The MU-2 pilot communicated that he was going to change positions from the right side to the left side of the C310. The C310 pilot and his passenger lost sight of the MU-2 when it dropped back to a position at the rear of the C310. Soon after, the two aircraft collided and the MU-2 pilot lost control of the aircraft and crashed. The right horizontal stabilizer was torn from the C310 and the empennage, right wing, and propellers were damaged. It landed without injury to its occupants. An investigation revealed the tail light of the C310 was inoperative.

Untrained night formation flight, in greatly different aircraft, and a nav light inoperative makes a mishap almost inevitable.

Stalls/Spins

Stall/spin accidents are responsible for nearly half of all maneuvering flight accidents. Most of these occur at low altitudes, and over one-quarter of them occur on takeoff.

Fatal Stall/Spin Accidents - Phase of Flight



The FAA eliminated spin demonstrations by most pilot applicants in 1949, leaving only the CFI certificate with that requirement. The rationale for eliminating the spins was that emphasis on stall recognition and recovery would provide more benefit than skill in spin recovery. Following the U.S. lead, Canada and the United Kingdom dropped spin demonstrations for non-CFI checkrides for the same reasons.

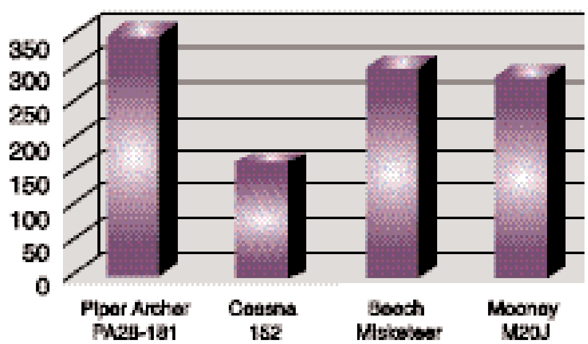
Although the total number of stall/spin accidents has dropped dramatically since 1949, those that do occur usually start at low altitudes. In fact, a recent ASF study of 465 fatal stall/spin accidents that occurred from 1991 through 2000 showed that at least 80 percent of the accidents started from an altitude of less than 1,000 feet agl, the usual traffic pattern altitude.

The study found that only 7.1 percent of the aircraft involved in the stall/spin accidents definitely started the stall/spin from an altitude of greater than 1,000 feet agl. Just over 13 percent of the aircraft were reported at an "unknown" altitude at the beginning of the accident, and so were given the benefit of the doubt.

Another study done earlier by the FAA Small Aircraft Directorate, which included some 1,700 stall/spin accidents dating from 1973, concluded that 93 percent of such accidents started at or below pattern altitude.

Pilot operating handbooks for various typical GA aircraft estimate average altitude loss during stalls, assuming proper recovery technique, between 100 and 350 feet.

Maximum Altitude Lost During a Stall



Altitude Loss In Spins Is Another Animal

But recovery from a spin is a far different matter, and takes much more altitude, even with skilled pilots. A NASA study done in the 1970s proved that the average altitude loss in spins done with a Grumman American AA-1 (Yankee) and a Piper PA-28R (Arrow), two popular single-engine aircraft, was nearly 1,200 feet. (It should be noted that neither aircraft is approved for spins, but NASA was testing them for possible improvements in spin handling characteristics.)

In the Yankee, it took an average of 210 feet for spin entry, 340 feet for stopping the turn, and another 550 feet for recovery, for a total of 1100 feet. In the Arrow, the figures were 140 feet for entry, 400 feet for stopping the rotation, and 620 for recovery, for a total of 1160 feet.

In short, the average vertical recovery distance was just short of 1,200 feet. Pilots allowing a spin to develop at or below traffic pattern altitude are nearly certain to crash, no matter how quick their reflexes or skillful their recovery.

To learn more, go to www.asf.org, click Accident Database, Special Reports, and select the topic specific study of stalls and spins. The URL is as follows: www.aopa.org/asf/publications/topics/stall_spin.pdf

By the book–The Federal Aviation Regulations (FARs) state that 1,500 feet agl is the minimum altitude for recovery from aerobatic flight, including spins. One thousand feet can easily be lost in just the entry and one turn. *Allow several thousand feet of buffer on recovery.* Many POHs recommend the minimum safe altitudes to start the maneuver – If you know something the factory test pilots don't, then ignore those recommendations but understand the risks have just increased – significantly

Want to learn how to maneuver? Take an upset or aerobatics course. There are schools that will teach you how to really handle maneuvering flight. There are several positive outcomes. First, most pilots are impressed with the safety precautions taken to prevent an accident. This includes excellent maintenance to ensure aircraft are not overstressed, superb instructors who specialize in this type of instruction, and usually a flight operations manual that clearly outlines minimum altitudes, practice areas, and collision avoidance procedures. Secondly, the programs demonstrate how an aircraft handles in extreme flight situations. Finally, and perhaps most importantly, pilots learn what is not possible and that they must avoid those situations completely. It's a sensible strategy and far superior to the do-it-yourself approach that most accident pilots follow.

Density altitude can be deceiving and many canyons are not like the Grand Canyon. If the terrain climbs only slightly faster than the aircraft, a sudden stop may be inevitable.

Canyon Flying

Experienced mountain pilots are trained to fly in those unique conditions, and are also familiar with the terrain in which they fly. Sightseeing and following a river at low altitude, with terrain on each side, is a dangerous situation. Rivers turn, and surprises can always be found around the next bend. Wires, hills, rising terrain, another aircraft – the possibilities are endless. Experienced canyon flyers know the terrain, and always have an out. Is your airplane capable of making a 180-degree turn within the confines of the canyon walls to avoid rising terrain? Probably not, and if you're not sure, don't do it. Trying to out climb rising terrain usually proves futile. Avoid the situation in the first place by not flying below canyon rims.

Two Beech Bonanzas collided with terrain while maneuvering near Ojai, California. All aboard both aircraft, six people, died.

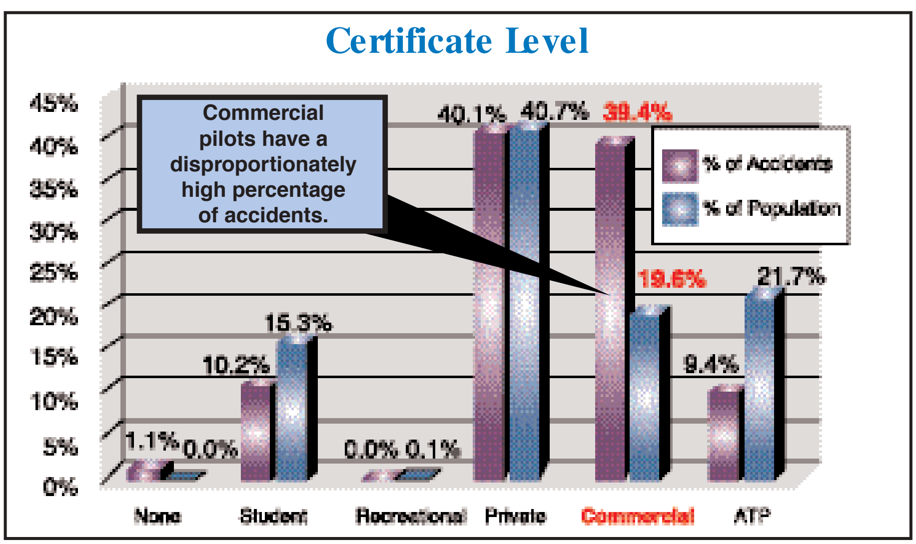
The aircraft were part of a group that routinely flew together on weekends. The accident flight consisted of a group of eight airplanes in formation with the accident pilot as the lead pilot. The group formed up at 4,500 feet. The witness reported that after flying around the area for about 25 minutes, the lead instructed everyone to separate and follow in trail. The lead and the number two airplane stayed in formation, with the second airplane on the right wing. The rest of the airplanes followed in loose trail as the leader maneuvered in a serpentine manner.

The two lead airplanes separated from the group, descended to an estimated 500 to 1,000 feet agl, and flew up a canyon. Moments later, smoke and fire were observed.

The airplanes came to rest within 75 feet of each other at the bottom of the head of the canyon at an estimated elevation of 4,925 feet. The slope of the terrain at the accident site was approximately 45 degrees. The terrain at the head of the canyon was estimated of 5,400 feet, less than 1/2 mile from the accident site.

Who

It's a common myth within the pilot community that student pilots have the most accidents. Students have a proportionately lower percentage of maneuvering accidents compared to the number of students in the pilot population. In fact, only commercial pilots had more than their share of accidents, with 19.6% of the pilot population and 39.4% of all maneuvering accidents.



This may be due to more experienced pilots becoming complacent, or erroneously believing they are in control of an out-of-control situation.

Before starting a buzz job, canyon run, formation flight, etc., consider this checklist:

- ✔ Inform your passenger of the real risks and whether they'd like to participate.
- ✔ Become thoroughly informed of the

area, wires, terrain, etc.

✔ Practice in the aircraft you are going to use and have it inspected for structural integrity if there will be any high G maneuvers.

✔ Contact your insurance agent to be sure there is appropriate coverage for the damage that may result from a miscalculation. Real damages may exceed low liability limits.

Some Suggestions

DO

- **Do** remember that the majority of fatal stall/spin accidents occur at low altitudes, from which recovery is unlikely. Prevention is essential.
- **Do** practice stalls or approaches to stalls at a safe altitude and only when you are competent. If it's been a while, take an experienced CFI with you.
- **Do** practice spins only with an instructor who is proficient in spins in the specific aircraft make and model.
- **Do** use a properly maintained and approved aircraft. In some cases a parachute may be required.
- **Do** fly at a safe altitude above the ground so that you won't be surprised by terrain, wires, or towers that might require a quick pull-up and a probable stall.
- **Do** remember that turns, vertical (pull-ups) or horizontal, load the wings and will increase the stall speed, sometimes dramatically.
- **Do** fly formation or individual photo missions only after you have received appropriate training, have briefed the operation, and are confident of the other pilot's abilities.

DON'T

- **Don't** explore the corners of the flight envelope close to the ground.
- **Don't** exceed 30 degrees of bank in the traffic pattern. Use coordinated controls.
- **Don't** follow another aircraft in the pattern too closely. If you cannot maintain a safe distance – go around.
- **Don't** buzz or otherwise show off with any aircraft. You don't need to – as a pilot you belong to a special group – less than one third of one percent of the U.S. adult population is certificated to fly.
- **Don't** attempt maneuvers for which you have not been trained.

Safe Pilots. Safe Skies.

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SA20/02-05