Chapter 3 **Stalls and Spins**

Although general-aviation accidents can be attributed to numerous causes, the single most frequent and lethal consequence of these continues to be the stall/spin accident. It occurs with distressing, predictable regularity and accounts for almost half of all fatal accidents. According to the National Transportation Safety Board, the stall/spin assassin averages a kill at least once every day. One reason for this is that the very training designed to reduce the frequency of stall/spin accidents appears to be contributing to the fatality rate.

When a student is taught stall entry and recovery, he is introduced to the apparent need for an exceptionally nose-high attitude. These empirical lessons teach that an airplane stalls only when the nose is well above the horizon. Then, usually at some later date, he is informed and expected to believe that a stall can occur with the airplane in any attitude, even when the nose is below the horizon. Some basic aerodynamics and convincing logic compel him to accept this seemingly abstract notion, but it comes across only as an intellectual exercise. The facts are stored away in a cerebral memory bank, only to be recalled when needed during some FAA examination.

Although most pilots acknowledge that stalls can and do occur with the airplane in a nose-low attitude, their training reinforces, for all practical purposes, that a stall—intentional or otherwise—is definitely a nose-high maneuver. They simply are not given an opportunity to develop an awareness based on experience that the most frequent types of stall/spin accident result from a stall that occurs with the nose pointed toward or below the horizon.

Another deficiency with current training methods is the marked contrast between stalls practiced in the training environment and those that occur under critical conditions at low altitude. While receiving stall instruction, for example, the student concentrates solely on the maneuver. And with so much excess altitude usually available, there is no sense of urgency during recovery. The pilot's attitude often is characterized by nonchalance. Also, he rarely performs such an exercise with the poor control coordination and rapid airspeed decay likely to aggravate an unintentional stall.

The FAA recently conducted an in-depth stall-awareness study. One purpose was to create scenarios of flight situations that typically account for the most common stall/spin accidents. These results are extremely valuable. If properly employed by flight instructors, they can be used to teach students the conditions during which inadvertent stall/spins really occur. Pilots can develop an awareness, based on experience (not just theory), that can go a long way toward reducing the number of lives claimed by the stall/spin accident.

Topping the list of scenarios is the cross-controlled turn from base leg to final approach, an unintentional maneuver that historically claims the most victims. Although cross-controlled turns at low altitude most commonly occur while maneuvering toward an emergency landing following an engine failure, they also are induced during conventional approaches when power is available.

Assume that an airplane is slightly low on altitude when turning from base leg to a short final approach. The pilot hesitates to roll into a sufficiently steep bank because of the low altitude, a phenomenon known as ground shyness. Instead, he subconsciously yaws the airplane onto final approach by applying bottom rudder. This excessive rudder application has the added effect of increasing bank angle and forcing the nose down. Usually without realizing it (because his attention is directed outside), the pilot counteracts this by applying opposite aileron and back pressure to the control wheel. If airspeed decay and cross-controlling are sufficient, the airplane simply enters a spin toward the low wing (an under-the-bottom spin). Because of insufficient altitude, recovery usually is impossible.

This is a good example of an incipient spin, that first phase of a spin that begins at the moment of stall and ends when the spin axis becomes vertical (or nearly so) and spin rotation has increased to the fully developed spin rate. For most light airplanes, the incipient spin takes 4 to 6 seconds and approximately two rotations.

Investigators find it difficult—and sometimes impossible—to substantiate that a given accident resulted from an incipient spin. This is because spin motion prior to impact often does not develop sufficiently to either enable an eyewitness to observe the rotation or result in a conspicuous ground-wreckage pattern. Even some who survive such a harrowing experience often do not realize that they caused their aircraft to stall and spin. One reason for this is that the airplane may not attain the nose-high attitude customarily associated with a stall entry. Also, the stall may not be characterized by the familiar stall "break" and rapid, nose-down pitching moment. Instead, airplane attitude simply may approximate level flight, during which time an excessive sink rate develops. The sequence of events can be of such short duration that a pilot has little opportunity to recognize what happened.

Although this scenario deals with a skidding turn to final approach, a cross-controlled slipping turn can be more dramatic and equally lethal.

Consider again a pilot turning from base to final. This time, however, he allows the airplane to overshoot the extended runway centerline (a frequent occurrence at high density altitudes when approach ground-speed is greater than anticipated). He executes an appropriately steep turn to realign the airplane on final approach, but fails to simultaneously apply sufficient bottom rudder (a slipping turn).

The large bank angle results in a nose-down pitching moment and an increased sink rate, which is opposed by the application of up-elevator. If the maneuver is aggravated sufficiently, the airplane is forced into an accelerated (high-speed) stall. And since the airplane is slipping at the time, it may enter a spin opposite to the direction of turn. Such an "over-the-top" spin begins with a complete roll about the airplane's longitudinal axis before evolving into a conventional spin.

Does any of this imply that pilots should receive spin training? No, not at all. Knowing how to recover from a spin at the low altitudes normally associated with stall/spin accidents allows neither the time nor the altitude necessary for extrication. What is suggested, however, is that pilots become more familiar with the conditions that historically have led to stall/spin accidents and develop the knowledge and skill needed to avoid them.

One way to accomplish this is to obtain the services of a competent instructor and practice at altitude the type of stalls generally associated with stall/spin accidents. Two of these, the slipping and skidding turns from base leg to final approach, have been discussed. Other types are described later.

Another way is to recognize that inadvertent stalls most frequently occur when the pilot is distracted from his primary role of controlling the airplane. This is why stall training should require students to perform secondary chores while maneuvering at minimum-controllable airspeed.

The effects of cross-controlling should receive heavy emphasis as well. Although every pilot recognizes that a stall must precede a spin, many do not realize that a spin usually will not develop unless the airplane is either slipping or skidding when stalled. In other words, a spin generally can be avoided by coordinating aileron-rudder application and keeping the slip-skid ball centered between the lubber lines of the instrument. If a pro-spin force is present, the ball will be "out of its cage," and the airplane will tend to spin "away from the ball." In the case of a skidding left turn, for example, the ball is to the right and the spin to the left; during a slipping left turn, the ball is left and the spin is right.

When any pro-spin force is present (due to cross-controlling, or the left-turning tendency of a single-engine airplane, for instance) the likelihood of a spin can be reduced (prior to stall) simply by "stepping on the ball" and returning it to its cage. In other words, if the ball is left, apply left rudder pressure (or right aileron pressure), and vice versa. Restoring the aircraft to a coordinated flight condition usually neutralizes the pro-spin force required for spin entry.

Once a cross-controlled airplane stalls and begins to yaw into a spin, a pilot must be prepared to avert the maneuver by lowering the nose and aggressively applying rudder to prevent the yaw associated with a spin.

One way to obtain proficiency in arresting spin development is to practice a series of oscillation stalls (with a qualified instructor, please). This consists of entering a conventional, power-off, wings-level stall. But instead of recovering, keep the control wheel fully aft and the ailerons neutral. The airplane will oscillate about all three axes and might display a tendency to spin one way and then the other. By aggressively applying rudder to counter any apparent yaw, the airplane can be kept on a relatively even keel. This is best accomplished by keeping the nose pointed at some distant reference point on the horizon.

Do not attempt power-on oscillation stalls, because many airplanes do not have sufficient rudder power to tame the wild gyrations that may develop during such a maneuver. This is why a departure stall at low altitude usually is unsurvivable, especially if sufficient right rudder (to compensate for P-factor) is not being applied as the stall occurs. The left-turning tendency has the effect of skidding the airplane into a power-on, left-hand spin.

Prior to 1949, a student pilot was required to intentionally spin an airplane to qualify for a private pilot certificate. During that era, airplanes were equal to the task. To be certificated, those airplanes had to demonstrate the ability to recover from a six-turn spin by having the test pilot do no more than release the controls.

But spin requirements have changed over the years. Modern single-engine airplanes certificated in the normal category need only be shown capable of recovering from a one-turn or three-second spin (whichever takes longer) in no more than one additional spin upon the application of normal, anti-spin control deflections. Such a requirement is regarded only as an investigation of an airplane's controllability during a delayed stall recovery and not a valid test of spin characteristics. This explains why such an airplane never should be spun intentionally. Not even the manufacturer's test pilot could advise what to expect if recovery were initiated beyond the first spin. To be blunt, a pilot should assume that airplanes placarded against intentional spins may become uncontrollable in a spin.

With respect to modern airplanes, engineers and test pilots seem to agree that the trend toward increased performance has resulted in spin characteristics less favorable than those of older, slower airplanes. And, paradoxically, the newer machines that are difficult to spin intentionally seem to be the most likely to spin inadvertently if mishandled during slow flight.

Since most modern, normal-category airplanes are considered unsafe to spin, it is unlikely that future pilot-certification requirements will reinstate spin training. Instead, emphasis will be placed where it should be, on stall awareness, recognition, and prevention.

In addition to becoming aware of and possibly practicing cross-controlled turns during slow flight (with an instructor), pilots also should become familiar with the following additional situations that result in stall/spin accidents. With a little imagination, instructors can develop these into valuable training exercises.

Go around with full nose-up trim. The pilot establishes a properly trimmed, full-flap descent while approaching a runway at the recommended airspeed. If a go-around is initiated by rapidly applying full power and partially raising the flaps, insufficient forward elevator pressure can lead to an excessively nose-high attitude and a stall, especially if the center of gravity is relatively far aft.

Go around with premature flap retraction. The airplane descends toward the runway, and a landing flare is begun at the appropriate height. After airspeed decays to less than the flaps-up stall speed (the bottom of the green arc on the airspeed indicator), the pilot finds it necessary to go around, but mishandles the procedure by fully and prematurely retracting the flaps. This can result in a full-power stall and settling toward the ground in a nose-high, behind-the-power-curve attitude.

Left-turning tendency (P-factor) during a go-around following an attempted landing into a right crosswind. While on short final approach at the proper speed and trim, the pilot enters a right slip (right wing down and left rudder) to compensate for a right crosswind. He then elects to go around, adds power and raises the nose to climb attitude. If the left-rudder deflection is not neutralized quickly enough, this yawing moment combines with the left-turning tendency produced by the propeller to generate a strong pro-spin force to the left, a particularly hazardous situation if excessive nose-up elevator has been applied.

Recovery from a high sink rate on short final approach. The airplane is in the landing configuration while being flown at only 10 percent above the flaps-down stall speed. The pilot recognizes the need to go around, but is not familiar with the large amount of additional altitude loss required to arrest the high sink rate. In his zeal to begin climbing without losing additional altitude, which usually is not possible, he rotates the nose with impatient abandon, possibly before the engine has an opportunity to react to throttle application. The most likely result is a stall.

Additional scenarios that are known to have contributed to stall/spin statistics include: becoming distracted while attempting to prevent overtaking slower aircraft in the traffic pattern; encountering wind shear, mishandling short-field takeoffs, especially at high density altitudes when the airplane is heavily loaded and departure obstacles are present; mishandling airspeed and attitude immediately following an engine failure after takeoff; and attempting to return to the airport from too low an altitude following an engine failure after takeoff.

There are essentially three ways to prevent stall/spin accidents. The first is to design a stallproof airplane, a concept that does not seem to combine very well with the requirement for high-performance aircraft.

The second is to provide the pilot with sufficient and reliable warning of an impending stall. Of the various devices available, the stall-warning light is the least effective, because most stall-spin accidents occur during daylight hours in VFR conditions, when an illuminated red light commands little attention. Aural warning devices are better, but even these lose effectiveness when a pilot is preoccupied with operational contingencies. A number of pilots who survived stall/spin accidents claim never to have heard the warning.

According to simulator studies, the most effective device is a tactile stickshaker. This was effective in alerting pilots to an impending stall 99 percent of the time (compared to the 84-percent effectiveness of an intermittent horn and 64 percent effectiveness of a steady horn). Stickshakers, however, are expensive and are not yet available for small, single-engine, propeller-driven airplanes.

In the final analysis, the best available stall/spin preventative still appears to be proficiency and awareness, goals to which all pilots should constantly aspire.