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TITLE: INNOVATIONS IN STALL/SPIN AWARENESS TRAINING

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ABSTRACT:

In 1991, the FAA phased out the old stall avoidance training standard in favor of improved stall/spin awareness training. FAR Part 61 was revised to reflect this shift in the training emphasis and AC 61-67B, "Stall and Spin Awareness Training" was published. This paper addresses the disturbing findings of a 1993 study entitled, "Re-Evaluation of Stall/Spin Prevention Training." It also highlights common misconceptions about high angle of attack flight, reviews stall/spin dynamics, and offers specialized training exercises designed to improve the student's ability to control an airplane near critical angle of attack. The PARE® spin recovery acronym--developed by Stowell during the course of teaching hands-on spin training to civilian and military pilots--is also offered as a useful tool for conveying the essential elements of the NACA/NASA standard spin recovery procedure.

DISCUSSION:

In April 1991, the FAA phased out the old stall avoidance training standard and replaced it with an improved standard known as stall/spin awareness training. The FAA revised FAR Part 61 to reflect this shift in training philosophy. The FAA also published an Advisory Circular, AC 61-67B entitled, "Stall and Spin Awareness Training." But just how successful has the FAA been in promoting and administering the transition to this new training standard?

More than a year after implementing stall/spin awareness training requirements, 97 percent of flight instructors surveyed were still unaware of the changes. The survey sample also contained 35 instructors who had been certified after the regulatory changes went into effect, yet not one of these new instructors was aware of the changes. Most of the instructors surveyed knew nothing about AC 61-67B, either. The long-term effect of this continued ignorance was demonstrated during informal surveys of pilots attending a number of stall/spin safety seminars in 1998. Collectively, on the order of 300 pilots attended the seminars, of which approximately 100 had earned Private, Commercial, or Flight Instructor certificates since April 1991. Only 10 percent of these pilots had received a copy of AC 61-67B from their instructors as part of their training, even though information contained in the circular supersedes information in the FAA’s 1980 Flight Training Handbook (AC 61-21A).

Who’s at Risk

A special study by the National Transportation Safety Board (NTSB) covering the years 1967-69 revealed, surprisingly, that 1/3 of stall/spin accidents involved pilots with more than 1,000 hours of flight time. The median pilot experience of those involved in stall/spins was 400 hours. A profile of who is most at risk of an accidental stall/spin reads like this: it’s the pilot who has logged fewer than 1,000 hours; who is on a daytime pleasure flight in good weather; who is in the traffic pattern; and who is either turning or climbing. Leading up to the inadvertent stall/spin, the pilot will be distracted into making a critical error in judgment. Fixation on the unfolding accident will effectively render one-in-three pilots deaf to the blaring stall warning horn.

It’s clear that the stall/spin problem is neither insignificant nor indiscriminate. No segment of the pilot population is immune to it. Not CFI’s, not even ATP’s. Typical pilots on typical flights fit the typical stall/spin profile. Once encountered, the prospect for survival is bleak: one out of four fatalities tied to stall/spins, an 80 percent chance of serious or fatal injury, a greater than 90 percent chance that insufficient altitude exists in which to recover. Add to this the realization that 19 percent of stall/spin accidents are associated with the flight training process. And a CFI is present in 11 percent of the stall/spin cases. In fact, students are nearly twice as likely to have a stall/spin accident with their instructors in the airplane than they are during solo training sorties.

In 1993, the Transportation Research Record published a study by Dr. Patrick Veillette entitled, "Re-Examination of Stall/Spin Prevention Training." The study assessed, among other things, the stall/spin knowledge of flight instructors. Five hundred thirteen civilian flight instructors and 28 designated flight examiners participated. This study clearly quantifies the relative lack of stall/spin expertise within our corps of FAA-certified flight instructors.

Ninety-four percent of the instructors surveyed relied primarily on popular literature (aviation magazines) for stall/spin information; ninety-six percent also relied heavily on their own instructors. The most foreboding aspect of this study, however, involves the hands-on spin experience of the instructors:

Ninety-eight percent admitted that their formal spin training consisted of no ground instruction and a mere two spins--one in each direction. Nonetheless, these instructors readily received logbook endorsements certifying that they were competent to teach spins.

Although instructors and examiners rated their understanding of stall/spin dynamics as “excellent,” survey results clearly indicate that those charged with the task of teaching and testing new pilots generally possess a marginal understanding of stall/spins themselves.

Different Airplanes, Different Behavior

A study by Brent W. Silver, published by the Society of Automotive Engineers (SAE) in 1976, looked at a database of over 41,000 accidents involving general aviation single- and twin-engine airplanes. The database included nearly 4,800 accidents classified as stalls, spins, spirals, or mushes. The study, however, considered only stalls and spins as stall/spin accidents. In addition, the study isolated single-engine designs that had at least 500 active aircraft registered during the timeframe analyzed (1965-1973). Thirty-one designs met the selection criteria. Combined, they represented a statistically large 75 percent of the total number of accidents in the database.

The 31 designs were ranked by combining their stall/spin accident rates using the formula: 10x(Fatal Rate) + (Total Rate). As for the popular student trainers in use between 1965 and 1973, the Piper PA-28 Cherokee ranked sixth; the Cessna 172, seventh; the Cessna 150, fourteenth; and the Beech 23 Musketeer, seventeenth. Statistically speaking, the stall/spin accident rates (fatal and total) for the Cherokee, the 172, and the 150 were significantly lower than that of the group means. The rates for the Musketeer, on the other hand, were higher than the group means.

Most alarming was the spread in the stall/spin accident rates among the 31 designs. The stall/spin rate of the "worst," for example, was over 25 times greater than that of the "best" airplane. Among the popular trainers, the Musketeer's fatal stall/spin accident rate was 2.8 times that of the Piper Cherokee; its total stall/spin accident rate was greater by a factor of 2.3. Had these differences been on the order of, say, 50 percent, they might be attributable to a number of variables. But the magnitude of the spreads suggests that aircraft design itself does have a strong influence on an aircraft's stall/spin susceptibility.

The FAA sponsored a follow-up study to evaluate the flying qualities of six of the 31 single-engine aircraft identified in the SAE/Silver study. The six airplanes ran the gamut from good to poor in terms of their stall/spin accident records. The study concluded that intentional stalls in these airplanes were not inherently dangerous. However, the margin between stall warning and the stall varied considerably with configuration. Stall warning frequently occurred so early as to be disregarded by the pilot. And aerodynamic buffet either was non-existent prior to the stall break, or occurred so close to it to be of no practical value as a warning. Overall, stall warning was deemed both unimpressive and inconsistent.

Another study examined the actual stall patterns of 33 aircraft. Interestingly, stalls rarely propagated along the wings in the orderly patterns depicted in flight training handbooks. Distinct stall cells often appeared instead. Moreover, aerodynamic buffet was usually absent whenever multiple cells formed throughout the wingspan. These findings not only corroborate the observations made in other studies, but also help to explain why aerodynamic buffet may be unreliable as a stall warning cue.

Spin Dynamics

Spins are extremely complex phenomena, and no single factor can be used to predict the spin characteristics or recovery potential of a given airplane. The combined influence of several interacting variables must be considered. Although tremendous advances have been made in high angle of attack research, no one yet has all of the answers to the spin problem. Enough information is available, however, to be able to separate myth from reality and to offer some practical advice on the subject.

Applying power during a spin, for example, has long been known to aggravate spin characteristics. Increasing the rpm of the propeller literally increases the rpm of the spin. Ultimately, the degree to which power influences spin dynamics depends on the size and weight of the prop compared to the rest of the airplane. It also depends on the direction and speed of the spin, the angle of attack of the spin, and the ratio of roll to yaw in the spin. In general, upright spins to the left with power “on” tend to spin both faster and flatter; upright spins to the right with power “on” tend to spin faster, but perhaps with less noticeable pitch change.

Applying right aileron during an upright spin to the left--opposite to the direction of roll--tends to level the wings and flatten the spin attitude. Applying opposite aileron tends to dampen out any roll or pitch oscillations as well. On the other hand, applying left aileron during an upright spin to the left--in the same direction of bank--tends to steepen the attitude of the spin. Roll or pitch oscillations may be amplified as well.

Misapplying the elevator during a spin can aggravate spin characteristics and delay recovery, too. The timing of this input and the amount applied are often critical elements in the recovery process. The final position of the elevator during spin recovery also depends, in part, on the perceived effectiveness of opposite rudder. For instance, if the application of opposite rudder significantly slows the rotation during an upright spin, then the elevator typically only has to move forward to its neutral position. If, on the other hand, the opposite rudder has minimal effect on the spin, then the elevator may have to move all the way to the forward control limit.

Spin recovery must take into consideration the potential aggravating effects of the various controls. If we consolidate, simplify, and prioritize rudimentary spin recovery actions, we're left with the same spin recovery actions NACA/NASA has recommended consistently for decades. For recovery from upright spins:

1. Power--Off.
2. Ailerons--Neutralize (and Flaps “up”).
3. Rudder--Apply fully opposite to the direction of yaw.
4. Elevator--Push through neutral.

Hold These Inputs Until Rotation Stops, Then:

5. Rudder--Neutralize.
6. Elevator--Easy pull to straight and level.

For maximum effect, the spin recovery actions outlined above should be applied sequentially. As soon as one item in the checklist is completed, the next item is then initiated until all four primary actions (Steps 1-4) have been implemented. The first letter in each of the four primary recovery inputs spells out the acronym, PARE® (pronounced “pair”). This acronym can be used as a mental checklist to help the pilot focus on the appropriate sequencing of recovery actions. Calling each item out loud also tends to reinforce the physical inputs.

Not only is the above spin recovery procedure consistent with NASA recommendations, but it also is the very same procedure the FAA recommends to test pilots in the Flight Test Guide for Certification of Part 23 Airplanes. Moreover, a 1996 survey of test pilots revealed that 95 percent of them use the above procedure during their spin tests. (The remaining five percent still implement the above actions, preferring instead to apply rudder and elevator actions simultaneously rather than separately.) Perhaps it's time for manufacturers, instructors, and students to listen more closely to what NACA/NASA, the FAA, and the test pilots who are spin testing light airplanes have to say about spin recovery procedure.

Stall/Spin Training Exercises

In addition to the training exercises specifically outlined in AC 61-67B, instructors can and should develop other exercises to improve the student's situational awareness, coordination, and comfort level during critical flight operations at high angles of attack. Following are a few exercises to consider:

1. Spend more time practicing the art of stall entry and recovery. Devote additional time specifically to the stall and recovery itself. During a number of power-off stalls, have the student recover from the stall and return to straight and level flight in a glide (without adding power and without entering a secondary stall).

2. Have the student perform a number of stalls while looking at the wingtip only. Perform the stall entry, the stall break, the recovery, and the return to level flight solely by reference to

one wingtip. Ailerons should remain neutral throughout the process. Rudder should be used to maintain a wings-level attitude. Have the students literally feel their way into and out of the stalls.

3. Oscillation stalls. Perform prolonged power-off stalls during which the student must maintain a heading and wings-level using quick rudder inputs only. Rudder actions are always twofold: applied opposite to the direction the airplane moves, then neutralized. Divide the cockpit duties as follows: instructor holds the stick/yoke aft, student works the rudder. As the student improves, perform the oscillation stall with partial power (up to 1300-1500 rpm, or 12-13" manifold pressure).

4. Establish a power-off glide and have the student memorize the visual glide attitude. Next, simulate engine failures during climbs at Vx and Vy. The student should react as follows: "Set it"--establish the glide attitude by pushing on the stick/yoke. "Check it"--verify that the airspeed trend is moving toward best glide speed (Vbg).

As soon as the glide attitude is established, the instructor should begin counting the number of seconds it takes for the airspeed to stabilize at the best glide speed, even though the glide attitude has been established. For example, it may take as many as 3-8 seconds for the airspeed needle to move from Vx to Vbg, depending on the airplane and the spread between these airspeeds.

A variation of this exercise is to simulate engine failures during climbs at Vy. Upon closing the throttle, have the student "set it"--best glide attitude; "check it"--airspeed is moving to Vbg; then "turn it"--execute a 180 degree turn at Vbg. Check the altitude lost from the moment power is reduced until the 180 degree turn is finished. Note, too, that this is an absolute best case scenario--an actual engine failure in the traffic pattern might require as much as twice the altitude lost during the simulation at altitude.

5. Aileron-Rudder coordination exercise. Have the student rock the wings using coordinated aileron and rudder pressures. Aileron and rudder inputs are applied together, in the same direction (left aileron, left rudder; right aileron, right rudder). Keep in mind that aileron is the primary input. Rudder is a secondary input applied in response to the aileron input.

The objective is to bank smoothly, continuously left and right while holding the nose on a heading. Roll at least 30 degrees of bank in each direction. As the student improves, increase the target bank angle. Do not look at the slip/skid ball. Have the student perform the exercise looking outside, over the nose. As a variation, have the student perform this exercise while looking at one wingtip only.

Conclusion

Contrary to the popular mantra, "no stall, no spin," spins are not caused by stalls. It's actually yaw coupling with roll at high angles of attack that drives the spin process. Therefore, yaw awareness--attention to proper coordination--should be an integral part of every stall/spin awareness training program. A key point is not only to teach students to stay coordinated during high angle of attack flight, but also to give them the confidence and encouragement to remain proficient in this area through repeated practice.

Accident prevention begins with the flight instructor. The more we as instructors become intellectually and practically knowledgeable about stalls and spins, the better our students will be able to cope safely with critical flight operations.

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ABOUT THE PRESENTER:

A noted authority on unusual attitude training, Rich Stowell has given over 3,100 hours of spin, emergency maneuver, aerobatic, and tailwheel instruction since 1987. His experience includes performing more than 13,500 spins--the equivalent of over 640 vertical miles traveled while spinning--with students from around the world. Rich has hosted several critically acclaimed aviation videos, he has written numerous articles for various aviation magazines, and he has authored two informative textbooks. He is currently working on his third book, Stall/Spin Awareness.