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Getting It Right in Maneuvering Flight

Photo by Susan Parson

Not long after I checked out in my flying club's Cessna 182 *Skylane,* I almost became a maneuvering flight statistic.

It was the classic case of having all the holes in the Swiss cheese line up in a way that could have led to an airplane-sized hole in the ground. First, the airplane was heavier than usual because, instead of flying solo, I had two passengers aboard. Second, the winds that day were westerly, which gave me a tailwind on the base leg and a much faster ground speed than I had anticipated.

You can probably see where this is going. Because I didn't account for the strong tailwind on base leg, I overshot the base-to-final turn. I should have executed an immediate go-around, but I'm ashamed to say that I reacted instead the way a lot of accident pilots do. I slightly steepened the turn but, mindful of my first instructor's command to avoid steep

Photo by James Williams

turns in the pattern, I didn't go much beyond a 30-degree bank. Since that clearly wasn't enough to correct my overshoot, I quite unconsciously applied "bottom" rudder to help slew the nose around to the runway heading.

Fortunately for my passengers, my airplane, and me, the stall horn did its job. That high-pitched beeeeeeeeeeeep that I had previously heard only in the training environment yanked my brain away from its single-minded intent to make this landing work, and cued up the well-drilled stall recovery procedure that my instructor had made me practice so much (thanks, Warren). I relaxed back pressure on the yoke, pushed the throttle forward and, once that annoying but life-saving beeeeeeeeeeping noise had been silenced, I executed the go-around that I should have made in the first place.

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Who, Me? Maneuver?

The numbers are as ugly as the accident I almost had that day. According to statistics kept by the AOPA Air Safety Foundation, nearly one-third of all fatal accidents in the last 10 years occurred from loss of control during maneuvering flight. And, although I hadn't previously thought of pattern work as "maneuvering flight," it most assuredly qualifies. Along with aerobatics, aerial work, steep turns, stall/spin activity, formation flight, and (the big no-no) "buzzing," maneuvering flight also includes normal flight operations, such as traffic-pattern flying, that take place close to the ground.

We can all understand how those "bad" pilots get in trouble with buzzing and other bad behaviors, but c'mon, how can good, conscientious, and safe pilots like you and me come to grief with the garden-variety traffic-pattern operations that we have been flying since lesson one? And, more importantly, how do we stay safe? We can avoid aerobatics and ban buzzing, but there's no practical way to avoid maneuvering in the airport-traffic pattern.

It's All about the Stall

Loss-of-control accidents in the traffic pattern—our focus in this article—usually involve an aerodynamic stall. It stands to reason, then, that the main antidote to maneuvering flight accidents in the pattern is to develop a thorough awareness and understanding of stall/spin aerodynamics. It is not possible to earn a pilot certificate without ground and flight training in these topics, so most of us think we have that angle covered already. As my near-statistical experience showed me, though, being able to accurately recite all the right words and phrases from the textbook did not mean that I had a practical understanding of how, or why, it is true that (as the books say) it is possible to stall an aircraft in any flight attitude and at any airspeed.

Having both thought about it and taught about it pretty extensively since then, I suspect that some of the confusion arises from the apparent contradiction that puzzled me the most when I sat in a private pilot ground-school course all those years ago. Specifically, if it is true that the pilot can stall an aircraft in any flight attitude and at any airspeed, why do we talk about "stall speed?" Doesn't that suggest that I can prevent an aerodynamic stall merely by ensuring that I avoid the nose-high attitude I saw so much in the training world and keep my airspeed above the published "stall speed?"

The answer is yes…and no. Let's take a closer look.

Back to Basics

First, we need a review of the basics. Maintaining control of an airplane during flight requires managing lift. Lift is produced by the dynamic effect of air acting on the airfoil, or wing. The pilot controls lift by controlling the angle of attack (AOA), which is the acute angle formed between the wing's chord line and the relative wind (that is, the direction of the air striking the wing). All other things being equal, increasing the AOA increases lift until the wing reaches the maximum, or "critical," AOA. Increasing AOA beyond this point results in a large loss of lift and an increase in drag. A wing in this condition is said to be "stalled."

We pilots tend to associate lift and loss of lift (stalls) primarily with airspeed for several reasons.

- First, there is a clear relationship between lift and velocity (speed). Lift is proportional to the square of the aircraft's velocity, so doubling the speed will quadruple the lift.
- Second, for every AOA, there is a corresponding airspeed required to maintain altitude in steady, unaccelerated flight. An aircraft flying at a higher airspeed can maintain level flight with a lower AOA, while an aircraft flying at a slower airspeed must have a higher AOA to generate enough lift for level flight.
- Third, maneuvers practiced in early flight training, such as demonstration of the effect of airspeed changes and stalls entered from a wings-level attitude, tend to emphasize the relationship between AOA and airspeed.
- Finally, the term "stall speed," which refers to the speed at which the wing reaches critical AOA in a wings level unaccelerated (1g) condition, further reinforces this association.

It is important to understand, however, that airspeed is *not* the only consideration. Because lift must equal weight, an airplane that is heavier because of physical or aerodynamic loading must generate more lift in order to maintain level flight. For any given airspeed, then, an aircraft with a greater load must be flown at a higher angle of attack in order to generate sufficient lift for level flight. Since an airfoil always stalls at the same AOA, an aircraft loaded by additional physical weight (e.g., passengers, fuel, baggage) or aerodynamic "weight" (e.g., g-force from turning flight) flies at an AOA closer to the critical AOA.


Photo by Claudio Bellotto

That was clearly the issue in my maneuvering flight mistake. Because I was operating the airplane with three passengers, and thus at a heavier physical weight, I had to fly at a higher angle of attack in order to produce the lift required to offset that weight and maintain altitude even in straight-ahead flying. That alone put my airplane's wing closer to the critical AOA.

If it is true that the pilot can stall an aircraft in any flight attitude and at any airspeed, why do we talk about "stall speed?"

But, remember that I was also making the base-to-final turn in the traffic pattern. As you learned in the private pilot ground-school textbook, the forces that cause an airplane to turn impose an aerodynamic load, or "weight," on the wings. Every pilot operating handbook (POH) includes a graph that displays the relationship between angle of bank and "g" load on the wing. In general, a 60-degree bank

in a light general aviation aircraft imposes a 2g load, which means that the effective weight of the airplane and its contents doubles. Although I wasn't close to a 60-degree bank in my *Skylane* that day, the turn I was making did impose a higher "g" load on the wings.

Connecting the Dots

Now, let's connect the dots. My airplane was heavier because of the additional physical weight (passengers) and because of aerodynamic loading (turning flight). To maintain altitude I needed to generate more lift to offset (balance) that extra weight. I didn't want to increase airspeed at a time when I was setting up to land, so I chose to increase AOA by increasing back pressure. Even though I was nowhere close to the published (1g) "stall speed" of the airplane, and even though I was nowhere near the nose-high attitude that characterized my stall entry/recovery practice in the training environment, I was dangerously close to critical (stalling) angle of attack at a time when I was also dangerously close to the ground. This was not a happy (or safe) place to be.

An airplane that is heavier must generate more lift in order to maintain level flight.

The good news, though, is that the incident prompted me to learn what I should have understood to begin with about "stall speed" and the "accelerated" stall I almost performed in garden-variety traffic pattern maneuvering flight. Once is enough—but I hope you learn from my experience, and let my "once" be enough for you as well.

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For More Information

***Maneuvering Flight – Hazardous to Your Health?* in the AOPA Air Safety Foundation Safety Safety Advisor**
www.aopa.org/asf/publications/sa20.pdf

***Airplane Flying Handbook* (FAA-H-8083-3A) can be found at:**
http://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/airplane_handbook/