Stalls and the Glider Pilot

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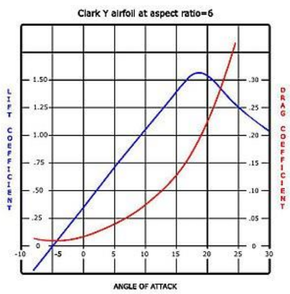
In a recent article from SSF, you learned the intricacies of what seemed like a simple task-turning flight. In this article, I would like to proceed to the topic of Stalls, and why its understanding is so important to the Glider Pilot.

Back in my F-16 days, we had an often-used saying: "horn time is quality time." Let me explain. The F-16 was the first operational fighter that was a Controlled Configured Vehicle, (CCV) that is to say, controlled by a fly-by-wire Flight Control System. (FLCS) (how the military loves acronyms!) It needed multiple redundant FLCS computers that could sample all flight properties and make corresponding control inputs in all 3 axes many times per second to fly the aircraft. Yes, you are right-the pilot did not really fly the aircraft, the computer did; the pilot merely input flight direction desires into the joystick, and the FLCS made it happen. Since computers can essentially be programmed to command anything, the limits on aircraft performance, especially where maximum G was concerned, lay in the physiological limits of humans.

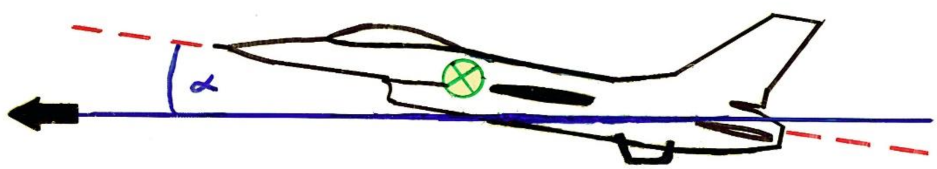
This brings us to our discussion of stalls. The FLCS of the F-16 was Angle of Attack (AOA) limited to produce a max of 9 G, the limit of human endurance for most of us. For maximum performance maneuvering, the FLCS allowed joystick inputs to dictate G up to the point where stall AOA occurred. Just prior to reaching that point, an aural tone sounded in the headset to warn the pilot that stall AOA was near, and hence my comment above: to max perform, (e.g.-win the swirling dogfight) you wanted to be near the stall, but when the horn sounded, standard Rules of Engagement (ROE) dictated that the pilot back off the G. But, during those few moments that the horn sounded, max performance was achieved! (quality time indeed)

Let's apply this discussion to glider flying. Obviously, we are in a much slower realm, flying aircraft with sticks and rudders that connect directly to flight controls. The FLCS wiring is replaced by cables and pushrods, and the FLCS computer is us! So, how do we achieve max performance without stalling? This knowledge will aid us greatly as Glider Pilots in 2 areas: achieving maximum thermal climb performance, and avoiding stalls flying near the ground, such as during traffic patterns.

We need to define a few terms. It will be easier by referring to the graphic below:



Our primary interest is in the blue line depicting the relationship between AOA and Lift Coefficient. Our first definition is "the stall." In FAA-speak, a stall occurs when exceeding the critical AOA, but what is that? The answer lies in seeing what AOA corresponds to the blue line above reaching its peak. Please note that lift creation does not abruptly stop just beyond the peak, but rather tapers off. As is typical of most General Aviation aircraft, the angle corresponding to the peak is around 18 degrees. But what exactly is AOA?



AOA is symbolized by the Greek letter alpha, and is defined as the angular difference between the free stream velocity (the relative wind) and the Mean Aerodynamic Chord of the wing.

In simple terms, the glider is stalled when the AOA is above the critical angle and it is not stalled when operating below it. Two primary factors can drive the AOA above the critical angle: 1) internal (i.e., the pilot pulls back on the stick) and 2) external (i.e., entering a strong thermal).

In some cases, especially if the stall is pilot induced, the glider will provide some warning that a stall is imminent. Those include low/decreasing airspeed, as depicted on the ASI, decreasing wind noise, nose-high attitude, stick well-back, mushy flight controls, and buffeting. Not all aircraft exhibit all the preceding, but all of them display some. An uncommanded pitch down motion is a good indication that a stall has occurred.

Once a stall has occurred, the pilot must take positive steps to return to normal flight. If the stick is held full aft, the glider may never return to an unstalled condition. Relaxing the back pressure or moving the stick forward off of the back stop is required to begin the stall recovery process.

Then you need time and vertical space. The glider needs to accelerate in descent to an airspeed where the AOA is below the critical angle. Then the pilot usually needs to pull out of a dive and return to an appropriate airspeed and flight condition.

We want maximum performance from our gliders, not in "turn and burn" dogfighting fashion, but rather, to get the best climb in thermals possible, and that requires maneuvering fairly close to the stall AOA. Best thermal climb generally results from flying at the glider's minimum sink speed for the established bank angle. Although it might seem intuitive to merely fly the glider as slowly as possible above the stall to minimize sink, let me refer you back to the graphic depicting AOA and Lift, and now refer to the red Drag Coefficient line. Drag increases exponentially as AOA is increased, so that the net result of flying too close in proximity to stall AOA is a greater sink rate.

While you and your instructor have practiced deliberate stalls and stall recovery, in many cases an inadvertent stall can also occur, catching the pilot by surprise. A sudden gust, an attempt to quickly tighten the turn to stay in the thermal core, or being distracted by watching another glider in your gaggle are all reasons that an inadvertent stall might occur. Knowing how to recover quickly and efficiently can mean the difference between a serious accident and a non-event.

Now, on to avoiding stalls when close to the ground. Why is this important? I stated above that the glider will not "fall out of the sky" when stall AOA is reached, but I did mention that it would sink fast. This is because any glider correctly loaded will have its Center of Gravity (CG) forward of the Center of Lift, (CL) in order to maintain positive static and dynamic pitch stability. (again-no FLCS) Consequently, one of the first things that happens when stall occurs is that the nose pitches down, since the total Lift created no longer supports the weight of the aircraft.

This pitch down is unavoidable, and if there is insufficient altitude to allow the glider to accelerate back to a speed that lowers the AOA below the critical angle, ground impact will occur. This is why every glider POH dictates a pattern airspeed that provides a good buffer above the stall, which we dissipate during round out and touch down. What variables impact the best IAS to use in the pattern? The SSA/SSF recommend using 1.5 Vso plus ½ the wind plus a gust factor. This extra airspeed is usually warranted when there is vertical or horizontal gusting taking place, just to make sure that we can always glide to the runway, and never get too close to stall AOA near the ground while doing it.

The Flight Review is a great time to discuss stalls with your CFI, and practice entries and recoveries. It's also a great time to get some practice recovering from inadvertent stalls. Some questions that you might bring to the table to generate good discussion are:

1. Is it true that an aircraft can stall at any airspeed or attitude?
2. What is an "accelerated" stall?
3. How does stalling an aircraft lead to a possible spin entry?

4. Is it true that I pass through the stall regime on every flight?

Armed with good knowledge of the stall, some Dual Instruction in the same will go a long way toward making all of your flights much safer. Here's hoping that all your thermal climbs are filled with "quality time," and your patterns stay as far away from stall AOA as practical until those final moments just before touchdown.