What's Your Angle?

by Paul J. Rupprecht, Education Committee Chair

Recently, the NTSB and FAA identified that "[l]oss of control is the number one root cause of fatalities in both General and Commercial Aviation." Moreover, the General Aviation Joint Steering Committee (GAJSC) stated that Angle of Attack (AOA) indictors can help pilots detect the critical angle of attack where stall occurs and avoid stalling the aircraft. Even Wolfgang Langewiesche, author of Stick and Rudder, "agreed that airplanes should have angle-of-attack indicators to help guide the unwary" as early as 1994. And this past May, FAA Administrator Michael Huerta and leaders in the general aviation community agreed to raise awareness on the importance of basic airmanship in the short term and Administrator Huerta "called on the aviation community to install life-saving equipment," such as "angle of attack indictors," in older airplanes in the long term. Why not install AoA indicators in all aircraft?

The purpose of this series of articles is to provide the general aviation pilot review of the characteristics and importance of angle of attack, the reasons to incorporate the AOA indicator in the pilot's arsenal of instruments, and then, examples of current AOA indicators on the market available to the GA market.

As a review, angle of attack (AOA) is defined as "the acute angle between the chord line of the airfoil and the direction of the relative wind—the direction of air striking the airfoil, which "flows in a direction parallel with and opposite to the direction of flight." Critical angle of attack is defined as the "angle of attack at which a wing stalls regardless of airspeed, flight attitude, or weight." Critical angle of attack occurs when the airfoil reaches an angle of attack that transitions from laminar to turbulent to separation boundary layer flow, which produces high drag and destroy lift. The result of exceeding the wing's critical angle of attack is a stall.

Historically, pilots have been trained on the subject of angle of attack in order to understand wing design and operational capabilities of an aircraft. Although most pilots have been trained to maintain certain design speeds based on the aircraft's configuration, these published stall speeds are based on unaccelerated, 1G load factor, coordinated flight, at a specific weight (typically maximum takeoff weight and maximum landing weight), and at a specific configuration (takeoff or landing). Further, pilots rely on these published speeds while referencing the airspeed indicator as the primary performance instrument to avoid stall. According to the FAA, "speed itself is not a reliable parameter to avoid a stall. Again, an airplane can stall at ANY speed," flight or pitch attitude, or weight.

As stall indicators were under research as far back as 1938, even the National

Advisory Committee for Aeronautics (NACA) identified that reliance on the airspeed indicator for stall avoidance was a dangerous proposition because that "stalling speed varies with wing loading and the air-speed meter therefore is not a reliable stall indicator." NACA explained that "[w]hen the load changes or the airplane undergoes acceleration, as, for example, in turns, the stalling speed increases in proportion to the square root of the load factor." Therefore, the NACA began research on stall warning devices to provide the pilot visual and aural warnings prior to the stall with a margin of safety, such as shown here:

Taking the NACA findings a step further, the design stall airspeeds identified on the airspeed indicator arcs, which provide stall speeds for Vso and Vsi, do not provide airspeed references the pilot may use during load changes or acceleration.

Returning to the current era, the FAA GAJSC stated that:

Angle of Attack is a better parameter to use in avoiding a stall because for any given configuration, the airplane will always stall at the same angle of attack, also known as the critical angle of attack. This stall angle of attack does not change with [airspeed], weight, temperature or density altitude. AOA indicators can help pilots detect this otherwise invisible airfoil [position] and avoid a stall.

In fact, the FAA Handbook now includes the angle of attack indicator as an "other performance instrument."

The NTSB provides the following immediate response to avoid being involved in a stall/spin accident: "At the first indication of a stall, immediately reduce the airplane's angle of attack, an immediate response is crucial to a safe recovery." Chris Shaver, NTSB Investigator, stated, "As an investigator and GA pilot, nothing pains me more than to see pilots, their friends, and their families lose their lives in accidents that are completely preventable. Low altitude stalls are just that—completely preventable."

While I was at EAA AirVenture 2013, I had the distinct pleasure of meeting with two of the leading industry manufacturers of AoA indicators: Alpha Systems and Honeywell/Bendix King. Alpha Systems have several analog and digital AoA indicators that have been on the market for over a decade, while Bendix King

entered the market with its KLR 10 Lift Reserve Indicator this past year. Both sets of systems provide visual and audible indications that are calibrated to the aircraft to provide the pilot a margin of safety before the wing stalls. In fact, the indications will provide the operator the real time dynamic level of the decay in lift as opposed to an airspeed indicator's arbitrary Vso or Vs1 arc indications based on an aircraft's wing design and configuration.

We will continue to explore the history of the angle of attack systems, including the history, benefits, and current AOA indicators on the market available to the GA market.

[Ed Note: Photos included with permission of manufacturers, Alpha Systems and Bendix King]
