SAFETY FIRST!

A column dedicated to GA safety education

by Dr. Warren V. DeHaan, Chair
Human Factors & Safety Education Committee

QUIT STALLING!

It seems that we are hearing a lot about stalls and near-stalls these days. There was the Colgan 3407 crash, the Air France 447 crash, the recent Asiana 214 crash, and even one of our own Flying Physician members' Cirrus crash a few years ago. Why are pilots (airline pilots included) stalling airplanes? At one time each one completed stall training and were judged sufficiently competent in stall recognition and recovery to pass the practical examinations for their respective pilot certificates.

Very different circumstances were present in each of these cases although they had one thing in common; in each case they exceeded or nearly exceeded the critical angle-of-attack. In the Colgan crash, the autopilot was holding altitude by increasing the angle-of-attack as drag increased due to icing. Unbelievably, the pilot pulled back on the controls instead of pushing forward when the airplane stalled. In the Air France crash, one pilot held up elevator while in a stall, all the way down to the ocean because presumably, he didn't comprehend what was happening.

In the Asiana crash the aircraft may not have stalled; the report is not completed yet. However, it certainly was close to stalling, evidenced by "stick-shaker," as the pilots tried to stretch their low approach with a power setting that was insufficient to get them all the way to the runway. In the case of our Flying Physician member, the pilot was observed to be too high on the approach, such that the pilot tried landing quite far down the runway, initiated a go-around, and stalled on the climb out.

Critical angle-of-attack doesn't care whether your airplane is large or small. If you exceed it, you are going to stall. However, even if you just approach the critical angle-of-attack (short of stalling), your induced drag is going to go way up, possibly at the very time you are trying to stretch your flight path to make it to a runway (as in the Asiana crash), or trying to clear obstacles on takeoff as you climb out of ground effect.

The Air France crash is especially interesting. If I understood him correctly, an Airbus pilot told me that before the Air France crash, they would typically expect the aircraft to recover from a stall if they lowered the nose about 10 degrees or so below the horizon. This issue has, since the air crash, been revisited because of the realization that 10 or so degrees may not be nearly enough.

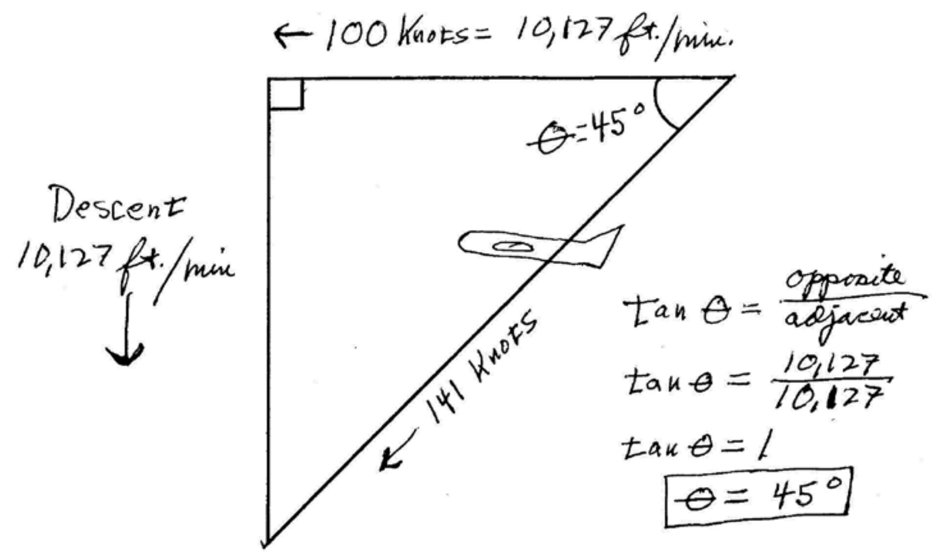
I don't know what the speeds were in the Air France crash. Apparently the pilots didn't know either. However, I can understand, under some circumstances, the recovery from a fully developed stall would require significantly more than 10 degrees nose down. As an example, assume an airliner is fully stalled and descending at 10,127 feet per minute. This is a number that I understand was close to the highest descent rate of Air France 447 when it was fully stalled. Assume that the horizontal component of an airliner's airspeed is 100 knots, which equates to 10,127 feet per minute. I purposely chose these numbers because it creates an easy example; these numbers result in two equal sides of a right triangle, thus illustrating that our example airliner's downward flight path would be 45 degrees below the horizon of a flat earth. If an airliner's wing has a critical angle-of-attack of about 20 degrees, the pilot is going to have to lower the nose to more than 25 degrees below the horizon to unstall the wing. Unfortunately, ten degrees nose down wouldn't even come close to getting out of the stall.

Apparently, the Air France pilots had no idea what their airspeed was, due to icing of sensors and the resulting lack of credible instrument readings. One blog suggested that forward airspeed fell to as low as 60 knots at one point. You would think that the decreased airflow over the cockpit could be heard and would lead to a dramatic realization that the airplane was very slow.

For another clue, I wonder why they were not able to take a look at their GPS derived groundspeed and get a ballpark idea that they were way below the clean-configuration stall speed. They were likely aware of their headwind or tailwind component long before things started to go awry. Factoring that in, they could have done a quick and dirty subtraction of the tailwind component, or addition of the headwind component, from their GPS derived groundspeed to obtain a "good enough" estimate of the horizontal component of their airspeed. With that information, they would have been aware that they were excessively slow and needed to point the nose down, way down. Instead, the co-pilot that was flying the airliner held back on the sidestick. Since the two sidesticks are not linked, the other pilot, the captain, apparently did not realize that the co-pilot was holding the airplane in a stall with back pressure on his (copilot's) sidestick. The captain had no sidestick feedback because his sidestick was motionless and therefore did not reflect the position of the copilot's sidestick. To further confound them, the angle-of-attack indicator apparently failed to provide consistent useful information.

Following is the trigonometry behind the foregoing example, which can be used to analyze a variety of combinations of descent rates and airspeed. Please note that the 100-knot figure in my example is the horizontal component of airspeed. Airspeed in the direction of the descending flight path is found by calculating the hypotenuse of the triangle (using the cosine function), since the flight path is represented by the hypotenuse. In this example, the airspeed along the flight path would be 41% faster than the horizontal (forward) component of the airspeed, therefore 141 knots. However, knowing that additional number (141) would be of no practical usefulness to the pilot for the purpose of working his way out of the stall.

A little rusty on trig functions? Here is a website that makes it fun to review:
http://www.mathsisfun.com/sine-cosine-tangent.html



So, what is the take-home message to you, fellow FPA members, from these examples and my comments? The sequence of events leading to a stall are many and varied. Besides that, an airplane can stall in any attitude and at any airspeed, including upside down and at high speed. Avoiding the circumstances that are likely to lead to a stall should always be uppermost in our minds. However, just in case we find ourselves in a stall in spite of our best piloting efforts, it always helps to have recent experience. That is a very good reason to perform recurrent stall training more often than once every two years during our biennial flight review.

Warren V. DeHaan, OD, is chair of the FPA Human Factors and Safety Education Committee. He and his wife, Vici, who is also a pilot, live in Boulder, Colorado. They fly a Cessna T-210M, N301MM, from KBDU, and he has over 4,000 hours PIC. Current ratings: ATP-Multi-engine, helicopter, glider, lighter-than-air, seaplane. CFII: Multiengine, glider, instrument