FLYING LESSONS for September 13, 2018

by **Thomas P. Turner**, Mastery Flight Training, Inc.
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FLYING LESSONS uses recent mishap reports to consider what *might* have contributed to accidents, so you can make better decisions if you face similar circumstances. In almost all cases design characteristics of a specific airplane have little direct bearing on the possible causes of aircraft accidents—but knowing how your airplane's systems respond can make the difference as a scenario unfolds. So apply these *FLYING LESSONS* to the specific airplane you fly. Verify all technical information before applying it to your aircraft or operation, with manufacturers' data and recommendations taking precedence. **You are pilot in command and are ultimately responsible for the decisions you make.**

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This week's LESSONS:

With a lot of reader comments and some flashbacks to past *FLYING LESSONS*, let's launch right into the Debrief this week.

Questions? Ideas? Opinions? Send them to mastery.flight.training@cox.net

Tom, I've been a long-time reader. Just wanted to acknowledge how much work it takes to do what you do and do it for free no less. I appreciate your effort, time and contribution of your knowledge for the betterment of safe flight!

– Fred Bedard

Thank you, Fred. Readers, please help cover the costs of providing *FLYING LESSONS* through the secure PayPal donations button at www.mastery-flight-training.com. Or send a check to **Mastery Flight Training, Inc.** 247 Tiffany Street, Rose Hill, Kansas USA 67133. Thank you, generous supporters.

Debrief: Readers write about recent *FLYING LESSONS:*

Reader Joe Pullium writes:

> I enjoyed your article on steep turns recently [*FLYING LESSONS Weekly*, May 10, 2018]. While getting recurrent [training] in my [Beech] Baron and preparing for my biennial [Flight Review] and IPC [Instrument Proficiency Check] I almost let it get away from me. I got distracted while holding in IMC and let my turn get too steep (my bad for not using a standard rate turn to start). I let the nose drop and you know what happened then. I had an instructor on board and we caught the error at about the same time. It really got my attention and scared the crap out of me and was a good reminder how quickly things can go bad in these type airplanes. Went on to pass my IPC and [Flight Review].

See https://www.mastery-flight-training.com/20180510-flying-lessons.pdf

As I wrote that week in **Stability, Steep Turns and Spirals**, any pitch-stable airplane will tend to enter a spiral if banked beyond about 35-40° and the pilot does not resist the airplane's tendency to descend. In a steep bank much less lift is in the vertical and the airplane can no longer hold altitude without additional pilot input—increasing up elevator and/or adding power. Absent those inputs the airplane's nose drops below the horizon and airspeed increases. The stable airplane will attempt to return to the slower airspeed for which it is trimmed, so it will pitch up…but relative to the airplane, not perpendicular to the horizon. This condition continues to build into the so-called graveyard spiral. It's recoverable, but the pilot needs to know how to recover:

- level the wings,
- reduce power,
- add drag if necessary to avoid exceeding V_{NE} (assuming retractable landing gear),
- allow the nose to pitch up to the climb attitude, and
- apply forward pressure on the elevator control as needed to avoid pitching up into a stall or even overstressing the airplane.

The avoidance tactic, as you note, is to maintain shallow bank angles in Instrument Meteorological Conditions (IMC)—a standard rate turn. And, to manage distractions, keep your instrument scan active, and detect and correct any trend toward a spiral. Thanks, Joe. I'm glad you learned that *LESSON* under controlled circumstances.

Reader Chris Ceplecha writes about one of the Reading File items in last week's report, "Flying Tired" from the National Business Aviation Association:

> Interesting video, and I agree with most of the premises but,,,,,,,,
>
> The example citing less sleep as a factor in expanding one's personal envelope is well,,, less than intelligent. 26 years flying in the USAF and having attended formal aircraft accident and safety investigation board training hammered home one very definite rule; that **trying to fly in a sleep deprived state is foolhardy**. There are numerous studies that indicate individuals who are deprived of sleep preform worse than those that are intoxicated. Let me state that again. Simulator studies accomplished by the military indicated **that individuals who had been upon for 18 hours prior to the simulator event preformed WORSE than individuals that were well rested but had consumed three drinks.** Let that sink it for a bit.
>
> So, I am all for individuals expanding their comfort zone, but **DO NOT SHORT CHANGE YOURSELF ON SLEEP. YOU MIGHT AS WELL BE FLYING DRUNK!** The video should NEVER have cited that as an example, for citing it gave rational to do it. Pure unnecessary risk.
>
> Please put out a rebuttal so some less than experienced pilots deem it is okay to fly in a sleep deprived state.

I agree, Chris. Let's go way back to my January 22, 2009 *FLYING LESSONS* for a refresher on being refreshed:

The issue of **pilot fatigue** is only beginning to be scientifically addressed for commercial flight operations, and is largely untouched for private vehicle operation (including general aviation airplanes). Little about fatigue exists in typical civilian pilot training texts beyond this simple self-evaluation guidance, part of the "IMSAFE" model, in Chapter 17 of the *Pilot's Handbook of Aeronautical Knowledge*:

Fatigue—Am I tired and not adequately rested? Fatigue continues to be one of the most insidious hazards to flight safety, as it may not be apparent to a pilot until serious errors are made.

We do have some guidance, however. Dr. Samuel Strauss of NASA's Johnson Space Center Office of Aerospace Medicine writes:

> Fatigue is a threat to aviation safety because of the impairments in alertness and performance it creates. "Fatigue" is defined as "a non-pathologic state resulting in a decreased ability to maintain function or workload due to mental or physical stress." The term used to describe a range of experiences from sleepy, or tired, to exhausted. There

> are two major physiological phenomena that have been demonstrated to create fatigue: sleep loss and circadian rhythm disruption. Fatigue is a normal response to many conditions common to flight operations because of sleep loss, shift work, and long duty cycles. It has significant physiological and performance consequences because it is essential that all flight crewmembers remain alert and contribute to flight safety by their actions, observations and communications. **The only effective treatment for fatigue is adequate sleep** [emphasis added].
>
> A National Transportation Safety Board (NTSB) safety study of US major carrier accidents involving flight crew from 1978 to 1990, one finding directly addressed the concern about fatigue. It stated: "Half the captains for whom data were available had been awake for more than 12 hours prior to their accidents. Half the first officers had been awake for more than 11 hours. Crews comprising captains and first officers whose time since awake was above the median for their crew position made more errors overall, and significantly more procedural and tactical decision errors."

GA pilots have no dispatch support structure to assess levels of fatigue, and sleep needs vary between individuals, changing as those individuals age. Dr. Strauss continues:

> There is considerable variability in individual sleep needs. Some individuals do well with 6 hours sleep per night, yet others need 9 or 10 hours sleep. However, **most adults require 8 hours of restful sleep to stay out of sleep debt**. With aging there is usually a significant decline in habitual daily sleep due to increased nighttime awakenings. Therefore, **in older individuals decreased quality of nighttime sleep can result in increased daytime fatigue**, sleepiness, dozing and napping.
>
> Napping seems to compensate for the loss of quality sleep during nighttime hours, but the need for a mid-day nap may not be compatible with flight duty demands on short haul flights. Research has demonstrated that pre-planned cockpit rest has improved in-flight sustained attention and psychomotor response speed....
>
> **Complete recovery from significant sleep debt may not occur after a single sleep period. Usually two nights of recovery are required.** Eight to 10 hours of recovery sleep per sleep period may be required for most people to achieve effective levels of alertness and performance.... Off duty time must be adequate to allow for at least eight hours of restful sleep per night in order to recover from sleep debt, and therefore the potentially hazardous effects of flying while fatigued.

So how can you tell when you're too fatigued? Here are some warning signs:

- Eyes going in and out of focus
- Head bobs involuntarily
- Persistent yawning
- Wandering or poorly organized thoughts
- Spotty near-term memory
- Missed or erroneous performance of routine procedures
- Degradation of control accuracy

If you have these symptoms in flight it's already too late to avoid the hazards of fatigue. The trick is to assess not only your fatigue condition before taking off, but to make an educated guess at how fatigued you'll be ***at the end*** of your flight...in the highest workload phase of flight, approach and landing (and, if needed, missed approach and diversion to an alternate).

Your best defense is to establish personal duty time limits. Air carrier rules (FAR 121.471) generally require, with some exceptions:

Rest for scheduled flight during the 24 hours preceding the completion of any flight segment:

- Nine consecutive of hours rest for less than eight hours scheduled flight time
- 10 hours rest for eight hours or more, but less than nine hours scheduled flight time
- 11 hours rest for nine hours or more scheduled flight time

Often for GA pilots the flight comes at the end of a work or vacation day. **Substitute the word "awake" for "flight" time** and you'll get a good start at establishing personal duty limits:

- Nine consecutive of hours rest for less than eight hours scheduled awake time
- 10 hours rest for eight hours or more, but less than nine hours scheduled awake time
- 11 hours rest for nine hours or more scheduled awake time

As Chris noted, the effects of fatigue mimic those of drinking alcohol. Numerous studies, including this one from Australia, arrive at a similar conclusion:

> Being awake for 17 to 19 hours roughly equates to a blood alcohol content of .05, according to a study by Dr. Ann Williamson of the University of New South Wales. The Australian study looked at fatigue's effects on cognitive and motor speed, accuracy, coordination and attention. Reaction time on some tests was up to 50 percent worse in the sleep deprivation condition than the alcohol condition.

Since I wrote that 2009 report, the National Business Aviation Association (NBAA) has published its own guidelines for crew duty time. They recommend no more than 14 hours' duty time in a 24-hour period. I've adopted this 14-hour "rule" as a personal standard.

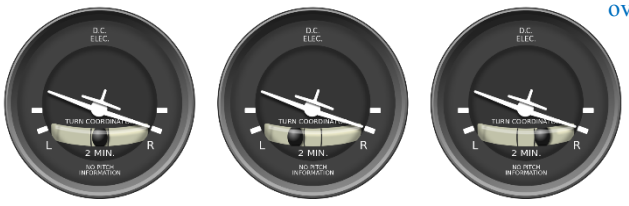
Your "duty" time ends at your estimated arrival time at the end of your flight, including flight to an alternate—think of it as "**alarm clock to engine shutdown**" time. It you don't have adequate rest for the work day plus the flight time, take time for a real nap before departure, or stay over and begin your trip the next morning. You can't accept the risk of suffering the symptoms of fatigue while at the controls of an airplane.

See http://aeromedical.org/Articles/Pilot_Fatigue.html for the full article including citations.

See:
https://www.mastery-flight-training.com/20180906-flying-lessons.pdf
http://m.aviationweek.com/business-aviation/flying-tired-recovery-sleep-loss-not-so-simple?eid=forward
https://www.faasafety.gov/files/gslac/library/documents/2009/Jan/31382/FLYING%20LESSONS%20090122.pdf
www.faa.gov/library/manuals/aviation/pilot_handbook/media/PHAK%20-%20Chapter%2017.pdf
http://aeromedical.org/Articles/Pilot_Fatigue.html
https://www.ishn.com/articles/84638-fatigue-vs-alcohol-effects-can-be-similar

Frequent Debriefer and aerobatics instructor Tony Johnstone writes:

> Not a specific response, but something in my humble opinion to think about regarding loss of control accidents. If you look at the spectrum of **LOC accidents** they **are usually stall-spin events** (***emphasis on the spin***). Stalls will certainly occur if the AOA [angle of attack] exceeds critical alpha, but **the airplane will not spin if there is no yawing component**.
>
> Stalls are actually recoverable at pretty low altitudes. Spins, not so much. I have been teaching this stuff for over 15 years, and **I think we are moving in the wrong direction regarding stall-spin avoidance**. I don't believe AOA indicators are going to solve this, in fact I think (as you probably know intuitively but haven't yet had that "AHA" moment") but **the biggest problem is actually misuse of the RUDDER**!



Coordinated turn Skid Slip

> In a skidding turn, the rudder (bottom) drives the nose down, so the pilot tends to pull back to maintain the pitch attitude, which increases AOA and may result in a stall-spin without any visual cues to the pilot. Reviewing the Cessna 414 accident at SNA last month I am pretty sure that is what happened, but the NTSB will have the final say. You have seen my short video demonstrating this in my Decathlon. [The] spin occurred with no appreciable change in bank angle or pitch attitude due to relatively mild misuse of rudder.

> Just thinking out loud. You have a good audience and maybe can propagate this somehow if you think it worthwhile!

See https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20180805X00700&AKey=1&RType=Prelim&IType=FA

Like many others, Tony, I jumped on the Angle of Attack Indicator bandwagon. Like you already knew, however, I came to realize that the primary hazard of stall/spin loss of control is uncoordinated flight, that is, one wing stalling while the other wing is still generating lift, and the immediate rotation that results. If the Angle of Attack indicator is calibrated to read correctly when the relative wind is coming from something other than straight ahead, *and* the AoA sensor happens to be on the same wing that is at the higher angle of attack and will stall first, then an AoA display may help the pilot detect and avoid the stall and subsequent spin. If the other wing stalls first, and/or the AoA sensor is not in calibration in slipping or skidding slight, then the AoA device might be indicating something other than a critical condition even as the stall occurs. I can't find it in my *FLYING LESSONS* saved files in time for this week's report, but I recall postulating that a more effective AoA indicator would include sensors on *both* wings, with the cockpit display depicting the angle of attack of whichever wing was at the higher AoA.

Another option is to mount the AoA sensor on the airplane's right wing, given that most airplanes' conventional stall warning vane is on the left wing. In any event, mount the AoA sensor on the opposite wing from the stall warning vane. That way you have impending stall indications regardless of which wing is at the higher angle of attack—the AoA display if the high AoA wing is the one with the sensor, or the stall warning horn or light is that wing is nearing its critical angle of attack first. Respond to the first indication of impending stall.

I have seen your video, Tony, but could not find the link to include in this report. I did find a similar video by fellow *FLYING LESSONS* reader Bruce Williams that demonstrates the same thing.

An Angle of Attack indicator, backed up by a conventional stall warning system, can improve the chances a pilot will detect and correct for a stall before it even occurs. **Whatever stall warning occurs first, the pilot's response should be to lower the angle of attack and coordinate the rudder.** Regardless of the type(s) of stall advisory equipment on board an airplane, as you note, teaching and employing ***this conditioned response*** to the first indication of a stall **is the missing element** in our ongoing efforts to reduce the rate and number of Loss of Control – Inflight (LOC) crashes.

See https://www.youtube.com/watch?v=rYHNO2kvuZI

Questions? Comments? Suggestions? Let us know, at mastery.flight.training@cox.net

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