FLYING LESSONS for April 25, 2013

suggested by this week's aircraft mishap reports

FLYING LESSONS uses the past week's 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 make and model airplane have little direct bearing on the possible causes of aircraft accidents, so apply these *FLYING LESSONS* to any 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.

If you wish to receive the free, expanded *FLYING LESSONS* report each week, email "subscribe" to mastery.flight.training@cox.net

FLYING LESSONS is an independent product of MASTERY FLIGHT TRAINING, INC. www.mastery-flight-training.com

This week's lessons:

Last week we began development of a flight training strategy to address the 10 most common causes of fatal general aviation crashes.

The Top 10 Leading Causes of Fatal General Aviation Accidents, 2001-2011

1. Loss of Control In Flight
2. Controlled Flight Into Terrain

See www.mastery-flight-training.com/20130418flying_lessons.pdf

This issue let's look at the third most common cause:

3. System Component Failure – Powerplant

Engine failure in flight most commonly results from fuel mismanagement—in some airplane types I've studied, as much as 90% of all engine failures resulting in an NTSB-reportable accident were the result of fuel starvation (running a tank dry and impacting before getting a restart on a tank containing fuel) or fuel exhaustion (running completely out of fuel). In other words, a great many engine-related crashes result from pilot-induced engine failures. The NTSB Top 10 makes Fuel Management its own, distinct category, however, so for this issue of *FLYING LESSONS* we'll discuss engine failures that are *not* the result of fuel starvation or exhaustion.

Surviving an engine failure comes down to meeting three objectives:

1. Maintaining control of the aircraft during engine-failure flight,
2. Restarting the engine if possible, and
3. Landing under control at the slowest safe speed

There's an axiom in flying that tells us the following holds true: ATTITUDE + POWER + CONFIGURATION = PERFORMANCE

ATTITUDE is the airplane's pitch, bank and yaw...but primarily, pitch. The pitch attitude determines the airspeed the airplane will fly for a given amount of power and a given airplane CONFIGURATION (flap position; in retractable gear airplanes, gear position; in propeller aircraft with controllable pitch propellers, propeller position). If a given level of PERFORMANCE results from a POWER setting at a given ATTITUDE and CONFIGURATION, then it stands to reason that a given level of PERFORMANCE is the result of ATTITUDE and CONFIGURATION when the POWER setting is zero.

Confused? I hope not. All we're saying is that, if an engine quits, there is a specific ATTITUDE that results in best glide PERFORMANCE or, in multiengine airplanes, best single-engine PERFORMANCE for the airplane's CONFIGURATION at the time.

You can test this out with a simple experiment in flight. In clear, traffic-free skies at a safe altitude:

- Gradually reduce power to simulate an engine failure from cruise flight.

- As the airplane decelerates, ensure the flaps and landing gear (as applicable) are up.
- When the airplane reaches its published best glide (or in twins, blue line) speed, adjust the attitude to maintain that speed in a descent.
- Look at the attitude that results in best glide (or blue line) performance—both by reference to the attitude indicator or display and by visual reference outside.
- Adjust attitude up and down to vary the indicated airspeed by five knots. Compare the vertical speed that results.

Remember the "best" attitude: it is the primary reference for attaining the first objective of surviving an engine failure, maintaining control of the aircraft. Note that at speeds below maximum gross weight, the best speed (deriving "best" vertical speed) may be slower than published. But the best *attitude* will be about the same regardless of weight.

If your aircraft has controllable pitch and/or featherable propeller(s), during your descent pull the propeller control fully aft or (in the twin) your choice of actually feathering the propeller or establishing "zero thrust" (the zero thrust manifold pressure/rpm combination should be in the airplane's Pilot's Operating Handbook. If you actually feather, do so over an airport in case you can't get a restart later). Adjust the pitch attitude to remain at best glide or blue line speed.

Remember this attitude also: this is the primary reference for obtaining maximum engine-out performance in the airplane, whether it be the least rate of descent or, in a multiengine airplane, the best rate of climb/least rate of descent depending on airplane weight and environmental factors.

Best available performance comes with the wings level in rudder-coordinated flight. During your exercise (if altitude, traffic and engine temperatures permit; you may have to conduct this exercise in more than one simulated engine failure from altitude):

- Establish best glide or blue line speed and note the vertical speed.
- Then begin a standard-rate turn (about 15 degrees of bank at typical glide/blue line speeds).
- Note the change in vertical speed.
- Increase the bank angle to 30 degrees and note the even greater vertical speed.
- Try a 45-degree bank and note the result.

This exercise shows you the detrimental performance effect of turns in an engine-out scenario, even at the "best" performance airspeed. It will reinforce the need to maintain straight-ahead, wings-level and coordinated flight in order to obtain best glide or blue line performance in the event of an engine failure, with turns only as altitude permits to get to a suitable landing site.

By the way, this is a great exercise to cover in your next Flight Review or international equivalent, flown with an instructor. A Flight Review is supposed to be *instruction*, not a checkride, and doesn't this sound like an interesting, fun and important thing to learn?

Now that you have established control, the next objective is to restart the engine if possible. An engine needs three things to develop power: fuel, air, and a source of ignition. We've already deferred fuel management to a later discussion. But is there anything else you can do to affect the fuel flow to an engine?

Ensure the fuel selector is ON. There are documented cases of pilots and passengers who have inadvertently moved fuel selectors to the OFF position by bumping them or pulling a flight bag or purse strap across the selector in flight.

Turn the auxiliary fuel pump or boost pump ON (if one is installed) as directed by the Emergency Procedures checklist. The proper use of auxiliary or boost pumps (and there *is* a difference between the two) varies from one airplane type to the next. Even among different versions of the same make and model of airplane the design and use can differ—what works in a Piper doesn't necessarily work in a Cessna; what's required in a Beech Baron 58 is different from the correct use in a Baron 58TC. Read your POH, study its Limitations, the Emergency

Procedures and Normal Procedures checklists, and the Systems Description section, and review the corresponding information in the POH Supplement for any engine or fuel system modifications to that airframe. Seek out expert instruction in your airplane type and for its modifications, through the airplane owners' group that supports the model you fly or instructors or programs you'll find advertising in type club communications.

How about air flow? Replacement sources of induction air flow range from carburetor heat, to automatic induction air, to manually activated air filter bypass systems. Again, review the POH and any Supplements, and seek out the advice of experts in the type.

Ignition, too, may be confirmed or altered by the pilot—confirming the ignition switch is ON (or BOTH, in magneto-driven systems that apply to most piston airplanes), and individually selecting magneto positions as applicable to see if smooth, albeit less-than-optimal, power may result by shutting off one of the redundant systems.

The final objective to surviving an engine failure is to "land like a WUSS": **W**ings level, **U**nder control, at the **Sl**owest safe **S**peed. In multiengine airplanes, this usually means making as close-to-normal a landing as possible, at normal landing speeds and the usual landing configuration with the exception that the "dead" engine's propeller is feathered in airplane with featherable propellers.

Common engine-out crash scenarios in multiengine airplanes after the pilot has successfully controlled the airplane through transition to asymmetric thrust, are:

- Forgetting or failing to feather the propeller, resulting in increased rate of descent and inability to reach a runway or suitable landing site. This is a symptom of insufficient instruction and practice in the airplane or simulation, and insufficient study and recent practice of realistic engine failure scenarios. The pilot does not know what to do when the situation demands.
- Feathering the wrong propeller. This is also a symptom on insufficient initial and recurrent training, resulting in failing to promptly but methodically accomplish the engine-out checklist in the proper sequence with multiple verification steps before engine shutdown.
- Getting too slow on the approach, resulting in a V_{MCA} loss of directional control, a stall, or a high sink rate on final approach.
- Remaining too fast on the approach, resulting in a runway overshoot or overrun, or a loss of directional control on landing from touchdown forces.
- Failure to "trim out" when reducing power on the operating engine to land. Depending on the airspeed and power setting when the engine failed, the pilot may make significant rudder and aileron trim adjustments to compensate for asymmetric thrust. When reducing power for landing, however, the asymmetry goes away. If the pilot does not re-set trim, it may be difficult to maintain control during the flare and initial ground roll. One common technique is to trim away about half the rudder and aileron trim displacement after turning final on one engine, or when going visual on an instrument approach with a propeller feathered.
- Landing gear collapse during the landing roll, from excessive touchdown forces (speed, sink rate) or slide-loads on the landing gear system (from insufficient attention to directional control in the flare and after landing).
- Loss of control during an attempted single-engine go-around (balked landing) or missed approach, aggravated by airspeed loss brought on by delayed landing gear retraction. Remember that most multiengine airplanes have scant little single engine climb capability in a clean configuration (i.e., gear and flaps up). With gear extended, the airplane almost certainly cannot climb on one engine. This is the exception to the rule about gear retraction: do not wait to see a positive rate of climb before retracting the gear in a single-engine go-around. You will probably never get it, and if you try to force a climb the airspeed will decay dangerously, and soon.

Common engine-out crash scenarios in single-engine airplanes after the pilot has maintained control to near a landing zone include:

- A stall resulting from trying to "stretch" the glide to a landing spot, after selecting a runway or field too far from the aircraft, or by not maneuvering the airplane correctly to arrive at the selected zone.
- Otherwise getting too slow on the approach, entering a high sink rate with descent into obstacles.
- Failing to maintain wings-level flight through the touchdown and for as long as possible during the rollout or impact slide, resulting in impact forces injurious or fatal to the airplane's occupants.

Common to both single-engine and multiengine off-airport landings and runway excursions or overruns: Serious head injuries and head-trauma deaths frequently occur from otherwise survivable impacts, often with surprisingly little damage to the airframe, when the pilot and other front-seat occupants do not have or choose not to use shoulder harnesses. Shoulder harnesses are not required to be installed in most general aviation airplanes, but if they are, at least U.S. regulations require they **must** be worn by all airplane occupants at least for ground movement, takeoff and landing—not *just* the pilot, although that qualifications frequently make it into the popular aviation press (FAR 91.107). If you have a say in the airplane's installed equipment, put shoulder harnesses at the very top of your updates list.

Since it would be unlikely the pilot or passengers would have time to fasten a shoulder harness after an engine failure but before impact, and since the NTSB record clearly shows unnecessary head injury and death in otherwise survivable crashes, there really is no reason to avoid wearing shoulder harnesses in all phases of flight.

Next week we'll investigate the vexing problem of identifying, responding to and training for partial (but not total) engine power loss on takeoff and in flight…and suggest an addition to your annual training regimen to include practice to avoid death from its third most common cause in general aviation, engine failure.

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

Debrief: Readers write about recent *FLYING LESSONS:*

Frequent Debriefer Tom Allen comments on last week's introduction of an annual training syllabus to avoid the most common fatal accident causes:

> Great article. I am looking forward to reading the series. **I can practice these things on my Hundred Dollar Hamburger days**.

Excellent, Tom. That's a great way to approach the annual training suggestion. It doesn't all have to be done with a flight instructor, and none of it has to be done on a dedicated training flight. Include a little practice in every flight you make. Make a couple of turns around a point or steep turns before heading out to the fly-in or airport gathering. Try a soft-field takeoff as you depart on your next business flight, and strive to make accurate touchdowns on a preselected spot on the runway every time (I use the second runway stripe unless conditions require otherwise). Thanks, Tom.

We haven't heard from aerobatics instructor Tony Johnstone in a while, but he did chime in after last week's *LESSONS*:

> You seem to have stirred up a rousing and appropriate discussion! I, too am somewhat nonplussed by your high number of unsubscribers, I guess sometimes we just push peoples' wrong buttons, or maybe they just don't want to know that they are in the high-risk behavior group.
>
> I would like to comment on the increasing number of fuel-related accidents. I was taught (and continue to believe) that the only thing one can safely say about an aircraft fuel gauge is that there is one installed in the aircraft! In my "Stick-and-Rudder Skills" seminar, which I gave again [this year] at Sun n Fun, the observation that the only certification requirement for a fuel gauge is that it read "Empty" when it is indeed so, comes as a shock to many audience participants. There are certainly some very sophisticated and highly accurate fuel-flow monitoring systems out there, but most of us in GA still fly with some type of float gauge, (ranging from cork-and-wire in the J3, to electric gauges) which are notoriously unreliable.
>
> I think the only way you can safely manage your fuel is to know what you started with, and how much you have used. Many renter pilots pick up an aircraft with full tanks, and return it to the FBO without ever really knowing what they have burnt. I encourage everyone I fly with to dip the tanks preflight with a properly calibrated stick, and note post flight what has actually been consumed. You will soon learn what your actual consumption is, and should have confidence in your fuel state based on time rather than a potentially inaccurate gauge.
>
> In the same way that very few GA pilots in the real world actually calculate required takeoff and landing distances, or consistently do W/B calculations, this requires a commitment. I guess, at the end of the day, that is what this is all about. **If we, as instructors, can instill the concept that we should fly like professionals regardless of the mission, nobody will ever run out of fuel or runway.** I like to think that my aerobatic students come away with a pretty good understanding of angle of attack and stall-spin awareness, reducing the likelihood of a LOC [Loss of Control] accident. Now, if we can just discourage people from flying VFR into IMC, and not flying into the ground, we have taken care of most of these problems!

Thank you, Tony. As we've discussed in the past and will again when *FLYING LESSONS* gets to fuel management crashes in the Top 10 list, not every airplane's fuel tanks can be "sticked" much below a full level. But there are several ways to verify the fuel load, and we should use them all any time the fuel level is less than visually full. If any of the various methods reveals a fuel load that differs from the others, the only option is to add sufficient fuel until you know you have enough for your trip plus a reserve.

Reader Marty Vanover also writes:

> I noted your recommendation about practicing partial panel in your last *FLYING LESSONS*. I hope your readers understand the importance of this. My [Beech] Sierra is only basic IFR, dual navcomms, txpdr and the sacred six [flight instrument]. On a flight just after acquisition of the Sierra from Augusta, Maine to Nashua, NJ, in IMC conditions, we had a dual instrument failure. I am not instrument rated, but as a commercial pilot, I have had some training. My instrument-rated partner was flying the airplane. We guessed the turn coordinator failed first somewhere along the way at cruise. The failure flag on this instrument was white and didn't get [our] attention as we were still familiarizing ourselves with the airplane.
>
> En route, during a climbing turn requested by ATC, the attitude gyro (AI) stuck. My partner was unable to hold heading or altitude and for some time was fighting to control the airplane. We had an AvMap EKP IV handheld GPS on the glareshield and I could see the anticipation line (indicating where we would be in 10 minutes) moving across the terrain display. I got my partner to focus on this to stop the turning, and to ignore the AI and other instruments until we got everything sorted out. We thought we had a vacuum pump failure.
>
> ATC was asking what was happening for several minutes and if we were actually IFR certified. Once my partner was able to control the airplane we found the directional gyro was good and identified the turn coordinator and the AI as inop[erative]. We advised ATC we could not make an instrument approach into Nashua and requested a 180 [degree turn] to better weather. ATC was happy to approve the request to get us out of their airspace. Within 30 minutes we were marginal VFR and had ground reference. We broke out into VFR weather some time later Southwest of Augusta.

It helps greatly, also, to cover a failed instrument once it's been identified, to avoid the type of disorientation you describe. It sounds like your partner's performance was typical—it's fairly easy to fly partial panel, but it's very difficult to detect an instrument failure and confirm which gauges are actually inoperative. Loss of Control in partial panel situations usually occurs at the onset of the problem—during the identification stage. That's why finding an IFR simulator and an instructor who will command instrument failures and other scenarios without warning is such a valuable experience for any pilot who flies IFR or at night. Marty continues:

> Had I known more about our new hand held AvMap, I could have had a split screen with a HSI display, that would have helped my ex-military partner. But it saved our bacon that day as we didn't trust much else in the instrument panel. It allowed us to fly the airplane while methodically verifying the good instruments, and made the partial panel flight to VFR easier from there.
>
> I no longer have the partner or the [old] turn coordinator. Interestingly, the replacement turn coordinator has a red "off flag". I'm still not instrument rated, but I now practice partial panel should something similar happen during a VFR night flight (if there is such a thing).

Great advice, Marty. Thank you.

Retired corporate jet pilot and salesman, and owner of an Angle of Attack Indicator-equipped Cessna 182 I've written about in past *FLYING LESSONS*, reader Charles Lloyd writes about my general tenets for the appropriate management of risk, i.e., "safe" flying :

> This is an outstanding GA Single Pilot Operations Manual. Writing these items down and living by them will help any GA pilot make hard decisions when in a stressful situation.
>
> The only addition I make to my set of rules is to **limit myself to a 12-hour duty day**. I know that air charter and airlines use two versions of the 14-hour day but GA is single pilot with the PIC doing all the planning and dispatching. That 12-hour duty limit is from when I start working on anything until the 12 hour mark. No working all day and then jumping into an airplane late on Friday to fly all night.

Thank you, Charles. This is an excellent way to quantify "getting real about fatigue." To clarify, the 12-hour duty day limitation expires not when you take off on your after-work trip, but must remain in effect until landing, including a "time reserve" for diverting to an alternate if needed. Have you ever been booked on a commercial flight that canceled because the crew "timed out" at the end of their duty day? I have. It's inconvenient, and it's frustrating…but it's the right thing to do.

See www.mastery-flight-training.com/20130404flying_lessons.pdf

Comments? Mastery.flight.training@cox.net

"Thanks again for what you do. The information you present and the responses from your readers is a wealth of information. I hope I can remember most of it though the rest of my flying days." – Marty Vanover

It costs a great deal to host *FLYING LESSONS Weekly.* Reader donations help cover the expense of keeping *FLYING LESSONS* online. **Be a *FLYING LESSONS* supporter through the secure PayPal donations button at www.mastery-flight-training.com**.

Thank you, generous supporters

Share safer skies. Forward *FLYING LESSONS* to a friend.

Personal Aviation: Freedom. Choices. Responsibility.

Thomas P. Turner, M.S. Aviation Safety, MCFI
2010 National FAA Safety Team Representative of the Year
2008 FAA Central Region CFI of the Year