



FLYING LESSONS for April 1, 2021

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.**

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

Pursue **Mastery of Flight™**

This week's LESSONS:

When and Why

I saw a short discussion this week on a Facebook page aimed at student pilots. The topic was fuel tank selection, specifically the ubiquitous advisory to **select the fullest fuel tank for takeoff**.

The gist of the discussion was a warning from one instructor that, despite this advisory, pilots should not switch tanks *just before* takeoff. The warning is designed to prevent fuel starvation shortly after liftoff if the pilot does not get the fuel selector precisely aligned to the intended fuel tank.

The instructor was precisely right.

I did a test a year or so ago at the request of an Air Safety Investigator (ASI) who is a FLYING LESSONS reader and was at the time actively investigating the crash of a Beech Bonanza shortly after takeoff. His request perfectly aligned with an experiment I've planned to do for a long time but never managed to get around to doing. The ASI and I both wanted to know approximately how long it would take from an improper fuel tank selection—not getting the selector handle in the tank detent—to engine failure from fuel starvation at a takeoff power setting.

The experiment was simple: sitting out of the way in the runup area at ground-idle power, I would intentionally move the fuel selector handle to a point between the LEFT and RIGHT tank position. I would then delay about 10 seconds, simulating time spent taxiing onto the runway, and then advance power to full (hard on the brakes, still in the runup area). The intended data to be collected: **How long until engine failure?**

We did the test three times, on a premise I often state: that ***once is an anomaly, twice is a coincidence, but three times is a trend***. Consistently the engine quit from fuel starvation about **20 seconds** after going to full throttle.

Where would you be 20 seconds after the beginning of your takeoff roll? What would happen if the engine quit at that point?

It's not only important to follow checklist guidance from the *Pilot's Operating Handbook* or *Airplane Flight Manual*. It's important to understand *why* you should (or should not) do things. The "fullest tank" recommendation isn't literal, that if one tank has 15 gallons and the other has 17 that you absolutely must be on the tank with 17 gallons. What the checklist is really saying is, "select a

tank that assures you will have plenty of fuel for the operation, along with a healthy reserve.” The goal is to avoid the possibility of fuel starvation all the way through takeoff and climb to altitude.

Of course some airplanes may have maximum fuel imbalance limitations or other requirements that also affect fuel tank selection under certain conditions. Barring anything like that, however, it’s all about making sure **whichever tank you’re using, you have enough fuel.**

Back to the discussion, the counter argument is that the fullest tank *must* be selected, which presents this quandary: If both tanks are full and you’re burning from one of them, you would *have* to switch tanks shortly before takeoff to avoid using the tank with less fuel for takeoff. But this really important? **Where** does the handbook say you should select the fullest tank for takeoff? Yes, that phrase (or something similar) does appear in many POHs and AFMs. But *where* is fuel tank selection directed in the checklists leading up to takeoff?

I looked at a few sample POHs/AFMs and confirmed what I see in the airplanes I most commonly fly (Beech Bonanzas) is reflected in at least some other airplane types as well.

- In the A36 Bonanza, the Before Start checklist directs “Fuel Selector Valve...CHECK OPERATION, THEN SELECT TANK MORE NEARLY FULL.” The fuel selector is not mentioned again in the checklists until after takeoff.
- In the PA28-161 Piper Cherokee Warrior II POH, tank selection is on the Before Starting Engine checklist, where it directs the pilot to select the “desired tank.” The Before Takeoff checklist includes “Fuel selector: proper tank,” but this sounds more like a confirmation and not a directive to change tank selection at that point.
- The last mention of the fuel selector in the Cirrus SR22 manual is on the Before Takeoff checklist, where it states “Fuel Selector...Fullest Tank,” *before* the engine runup. This is the last movement of the fuel selector in the checklists before takeoff.
- The Diamond DA40 AFM calls for “Fuel Tank Selector...On Full Tank” on the Before Starting Engine checklist. Then, on the Before Taxiing checklist it directs “Fuel Tank Selector...Change Tanks, Confirm Engine Also Runs on Other Tank (At Least 1 Minute at 1500 RPM).” Then, on the Before Takeoff checklist it says “Fuel Tank Selector...Fullest Tank,” with the note that “Before takeoff, the engine must run on each tank for at least 1 minute at 1500 RPM.”

The point is, none of the checklists suggests switching fuel tanks just before taking the runway for departure, despite the oft-recommended “fullest tank for takeoff.” It’s true that, in general, we should follow this advice. But when you make the selection must be based on safety, not supposition.

If you hear or read a systems operation technique, go to the source: the Airplane Flight Manual or Pilot’s Operating Handbook. Yes, you should select a tank with sufficient fuel for takeoff. It’s critical, however, to make this selection at a time you’re certain you’ll detect an incomplete tank change before the engine quits shortly after your wheels leave the ground.

Comment: Why more airplanes do not have a “both” tank selection option that eliminates the need for switching bank and forth between tanks I don’t know. If you fly one that does not, think about the **when and why** of fuel tank selection.

Questions? Comments? Relevant experience? Send them to mastery.flight.training@cox.net.

FLYING LESSONS Weekly is sponsored by:



See <https://pilotworkshop.com>

Debrief: Readers write about recent *FLYING LESSONS*:

An anonymous reader writes about [last week's LESSONS](#) and the **Standard of Care** we exercise as a pilot:

The anecdote about a pilot flying a damaged airplane, with passengers no less, is frightening. Below is something that happened to me 18 months ago, I will try to keep it short, if you use it feel free to edit and I prefer non-attribution for this.

Regarding flying an unairworthy airplane with obvious damage: My longtime partner in my airplane retired from flying due to profound hearing loss, and we recruited another partner, who came recommended and supposedly had 110 hours of complex (retractable gear, etc.) time. The insurance company required 10 hours of dual prior to him soloing the aircraft. During his first two weeks of the instruction period he scratched the left elevator moving the airplane in or out of the hangar. Then on a subsequent day he gauged a 4 ½ inch outward opening tear in the same (left) elevator when moving the airplane in or out of the hangar. Then **he placed tape over the tear and continued flying** for additional instructional flights and one flight after the required instruction. I found out about the damage after the new partner flew his first solo post training flight during which he landed at a busy tower controlled field and taxied to the ramp after landing without contacting ground control, and got violated for that. **When I found out about the damage I immediately declared the airplane unairworthy** due to a damaged flight control and grounded the airplane until it was repaired. I told him if the FAA saw him having flown an airplane with such obvious damage he would be violated again! In addition, I involuntarily bought him out of the airplane partnership. I told him I had to buy him out because there was no way, should he have an accident, for me to be able to explain why I let a pilot with his background fly the airplane after he flew an unairworthy airplane several times, and after being violated for an improper air traffic control procedure! He was not happy about that but with the help of an attorney I bought him out and made him whole financially.

Maybe we should emphasize the notion of how a pilot will explain what they did to the investigation board after an accident when they are considering flying an airplane that is not 100% airworthy. That assumes a pilot has the judgement to recognize it when an airplane is unairworthy! Ferry permits are very easy to obtain, there is simply no excuse for flying a damaged airplane except to carefully reposition it, with a ferry permit, to where it can be repaired.

Airplanes are extremely strong when forces are applied in the direction an aerodynamicist would predict. Most structure is surprisingly fragile, however, when forces are applied in other directions. That's how a structure that can support and direct thousands of pounds of force in normal operation might be so easily damaged when impacted abnormally. Worse, when that unusual damage occurs it can significantly degrade airworthiness even in normal ways. A little duct tape might not do it. I'd like to think pilots are smart enough to realize this and refuse to fly a damaged aircraft. But if they won't do that, as you say they should consider who trying to explain their decision to fly a known-damage airplane should they be questioned by the FAA...or even a criminal court. Thank you, anonymous.

See <https://www.mastery-flight-training.com/20210325-flying-lessons.pdf>

Reader Bill Moore continues [last week's Debrief discussion](#) of a tragic attempt to return to the airport after engine failure just after takeoff:

As always you have done a wonderful job using a horrible event to help your readers possibly avoid that same fate. A couple of points to respond to;

1) My V35B [Bonanza] is based at KCOI (3601)feet long). Water to the east and west - westbound a bigger challenge. **My departure briefing** is anything below 1000 feet we will land in the water - taking off west bound it takes about 400 feet AGL to have an opportunity to reach the water. The difference from this airport and North Perry is that the water provides options to land - not as good as a field or other runways but better than a busy suburban street. I have landed at Cedar Key (KCDK), 2355 feet but water and marsh around the airport (options) and Everglades Airpark (X01), 2400 feet, also with water. **We need to plan for the worse every take off**, each airport presents different options. **Brief each take off just like the airlines**, solo or with passengers, **have a plan then execute it**. The briefing is no promise of a totally successful outcome, but it removes that time to look around if the engine fails at the worst possible time.

2) My airplane is my third in just over 35 years of flying. While some engines have a reputation of being "bullet-proof" like an IO-360, big bore Continentals may carry a higher failure rate, no data on my part just my thinking from accident reports. **If we remove fuel starvation from the engine failure discussion, true outright mechanical failure at low altitudes seems rare, not impossible but less than likely**. I now fly a factory overhauled engine with just over 200 hours. Knowing that failures can happen early on, the engine gets a through preflight inspection looking for any leaks, exhaust or cylinder issues etc. My last engine lasted 1700 hours, but towards the last 200 hours it was talking to me, oil consumption rising, cylinder blow by in evidence, and the #6 cylinder took a minute or two to wake up in cold starts. So when Curtis at Baker Aviation called me to report finding a clogged pushrod on #6, and my luck event, was that while removing an exhaust manifold on the left side a stud broke, requiring a cylinder to be pulled to repair, the tappets and cam told the story. The engine was very tired. With no hesitation, I told Curtis: order the factory reman. Then I called my wife and said do you remember what I have mentioned about our airplane engine? At first she was not sure, but then then she knew. You see Tom, for three years I have said, we will keep flying for now but we are near the end of this engine's life. Long story, but my point is **no engine will run forever**, they do talk to us, whether it is rust in the cylinder, oil usage, compression issues, **they talk to us**. **We just need to listen and make the right call**. Perhaps the goal was to move that airplane to a different shop, maybe save some dollars, I suspect if anyone knew of the possible outcome one hopes different decisions would have been made.

As always thanks for these regular lessons that may save someone from a very bad day. We need to read these and learn what from this terrible accident.

Thank you for your insights, Bill.

Frequent Debriefer John Townsley wraps it up this week:

In my experience, **flying any single engine, normally aspirated airplane over urban areas with hemmed in airports is not unlike flying into back country airstrips over heavily forested mountainous terrain. Both come with risks. Some of risks are completely mitigatable, other risks can only be partially mitigated.**

The airport I fly from is surrounded by forested hills and city. Just hangaring my aircraft near my home means I must either accept the risks inherent in urban area operations - or cease flying my own aircraft. For me the choice is clear. So **I mitigate what risks I can**. I'm confident of my ability to set my plane down where there is minimal potential for harm to anyone on the ground in urban areas, and where the risks to me and/or my passengers are also acceptably low. **A well-maintained aircraft and four-point harnesses in the front seats go a long way towards mitigating urban operational risks.**

Maintaining aircraft control through the crash is the third high card in my hand. **Intermittent gaps in the built-up areas and freeways** are my fourth high card. **But, it's a five-card game**. Some unmitigated risk remains. In my mind **maintenance errors are a biggie**. **I've experienced three engine failure (two partial, one complete) due to maintenance failures**. Other unmitigable risks include **procedural errors** I, another pilot, or ATC might make; an errant drone or a bird; a guy in a lawn chair and a bunch of balloons ... all are **stuff that just happens...** and **we must accept it will**.

When I fly over rough terrain I wear a helmet plus my BAS four-point harness. The Alaska Region released a study about six years ago that basically said **either helmets or 4-point harnesses would mitigate about 1/3 of the risk of an off airport crash**. In combination I hope to do better than that! I also **dress for the desired off airport landing, file flight plans, and invest time in thorough planning**. I consider my route and purposefully look for options to set down with high likelihood of a survivable outcome. I regard airports as pearls I can string on my magenta line (just joking).

Seriously, **I attempt to optimize my route to have high proximity to runways and unobstructed landscape (open fields), but that just ain't always possible**. In some cases, those "open fields" may be on 30-40% slopes. In others the best surrogate for an open field is a grove of short, supple trees. On some flights in the Pacific Northwest or interior Mountain regions those tilted "open fields" and groves of short

young trees are the best option given a normally aspirated engine and limited service ceiling my aircraft offer. Flying east from the Pacific Northwest takes me over high terrain, and terrain that really does reach for the sky. I just planned a flight to the Denver area and the first half of the 821 nm flight has continuous terrain of 6,000 to 9,000 feet. A direct route would take me over 10,000 to 12,000-foot terrain. Any route pushes my service ceiling. So **I look for passes, follow valleys, watch for roads, and keep those "open fields" I see near my route in the forefront of my mind.**

I've read more than one article, and even a few books by 'experts' who continually refer to "airports" when they discuss emergencies like engine failure, fire, weather, or whatever else would demand an emergency landing. To me *that's a setup for failure*. Yes, as a general rule I prefer to land at airports. But, emergency landing sites where events demand prompt return to terra firma must be thought of much more broadly. My bottom line here is that **I don't have to land on a runway to walk away** unscathed from an emergency (or even precautionary) landing. If the situation demands I'll execute my emergency landing to the best of my ability on the best site I have available to me -- airport, highway, road, field, tilted "open area", or grove of nice little trees that will readily accept my excess energy. Maintaining that breadth of options, and only that, is why I carry full hull coverage and adequate liability insurance.

Very thoughtful treatise on the very active work we must do to be ready for emergencies. Thank you, John.

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

"The great success of *FLYING LESSONS Weekly* is rooted in how often you do the right thing in encouraging all of us to fly safely and showing us ways to do so." – Bruce Dickerson

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.** to 247 Tiffany Street, Rose Hill, Kansas USA 67133.
Thank you, [generous supporters](#).

See:

www.mastery-flight-training.com/be_a_master_pilot.html
https://www.paypal.com/donate/?token=E78wOSz-a-IWNuNmXhIQRZ4awYMDr8zvX2JxHs_Cv-b7_6nFbhuIMAJTU-ikBDsW160G&country.x=US&locale.x=US

Share safer skies. [Forward *FLYING LESSONS* to a friend](#)



Pursue Mastery of Flight.

Thomas P. Turner, M.S. Aviation Safety
Flight Instructor Hall of Fame 2015 Inductee
2010 National FAA Safety Team Representative of the Year
2008 FAA Central Region CFI of the Year
Three-time Master CFI

FLYING LESSONS is ©2021 Mastery Flight Training, Inc. For more information see www.mastery-flight-training.com, or contact mastery.flight.training@cox.net.