



FLYING LESSONS for April 22, 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.**

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This week's LESSONS:

Let's catch up and go straight to some fuel-management reader Debriefs this week...

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

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Debrief: Readers write about recent FLYING LESSONS:

Going way back to [last December](#), frequent Debriefer Robert Thorson wrote about the common—and dangerous—tendency to accept inaccurate fuel gauges or doubt low fuel indications thinking that fuel gauges cannot be accurate. Robert wrote:

I read your article on fuel gauge accuracy when it was published. It was “accurate” to the “n”th degree as a careful read of [FAA] certification will point out. I have a [coworker] who bought a very nice Beechcraft Skipper several years back and then had every instrument calibrated. He is an aero engineer so I expected that. But what surprised me was the results of **how far off the instruments were from specification**. This has some very expensive implications from engine operation to...you guessed it...running out of fuel.

This is my *LESSON*... if you won't keep your airplane up mechanically then buy a fuel stick to gauge your burn, keep a log of every flight and the resultant burn. Never fly with less than 1/3 of a tank remaining. Always make a flight plan log before takeoff even if it's “1.5 hours/19 gals required /53 on board.” Obviously a full log with time and burn for cross country flights. And use the clock in your aircraft. It wasn't put there to make sure you eat the \$100 hamburger at noon!

So my take on it would be those who left probably are ashamed to admit their sloth or other failings. ***We have become very complacent in aviation where there really is no forgiveness.***

See <https://www.mastery-flight-training.com/20201217-flying-lessons.pdf>

Flight instructor and reader Peg Ballou adds:

When I teach students the pre-takeoff/run up checklist I tell them that **saying fuel is “good” is not sufficient**. I tell them to **quantify it**: half full, 3/4, full, etc. so that **if they go around the pattern and see the**

fuel gauge drop from full to 3/4 in one circuit around the pattern they know there is something wrong. Or at least to question.

Recently I had a very bad experience with a man who was so intent on buying a plane that he didn't care about safety. **He just wanted to get that plane.** I asked the current owner how he dipped the tanks. He didn't even have a straw calibrated for the plane, and said he used a stick. I had no way to check but the gauges indicated 3/4 or so. There was also a placard that said once the gauges reached 1/4 the tank was empty. This delightful experience resulted in us flying 10 miles to the nearby airport to get a straw dipper to check the volume. It was adequate in my thinking for a trip home. When I saw the tanks bouncing off of 1/4, I suggested we stop for fuel which we did. We put 17 gallons into that plane which meant **we were using more than I anticipated, and would've run out by the time we reached our destination airport.** This is one time when caution on my part was a great decision!

Frequent Debriefers Richard Druschel asks:

In your research on fuel related crashes can you, or do you, try to determine the accuracy of the gauges? I suspect there is no way (or reason) to really do this after the fact. I wonder, beyond the complacency aspect, how much gauge error plays in the cause of the accident. Just curious.

No, Dick, all I have to go by are the published accident reports. My comments about fuel gauges are in response to the many times pilots attempt to rationalize inaccurate fuel gauges, and in the case of the [December 10 LESSONS](#) a specific comment on a [popular aviation podcast](#) that **fuel gauges are inaccurate, "cannot be trusted," and are therefore "useless."** As I wrote then (and also communicated to the podcaster): ***That's a hazardous pilot attitude that I believe directly contributes to the appalling number of fuel-related tragedies.*** But no, unless an NTSB or other investigator specifically tests and reports on the accuracy of fuel gauges in an aircraft involved in a crash, I do not have any data for specific accident aircraft.

See:

<https://www.mastery-flight-training.com/20201210-flying-lessons.pdf>

<https://aviationnewstalk.com>

Reader Ed Livermore describes fuel management *LESSONS* he's learned over time:

Fuel focus is key in my flying. A good many years ago, I had the exact experience John Collins described, including the "whoosh" upon opening a cap.

Our A36 [Bonanza] has Osborne tips (20 gallons each), which transfer fuel to the mains. So full fuel for us is either 74 usable (80 total) gallons if only the mains are full or 114 usable (120 total) if all spaces are topped. I use a combination of techniques to manage the fuel used. We often fly long legs of five hours or so; fuel certainty is important.

First one comes from pre totalizer days: let's say the tanks are filled to 120 gallons. I write on my lap clip board two columns, each 60 gallons. Once underway, we burn the initial tank down to 15 gallons or a bit more, then switch tanks and on the clipboard deduct (from the totalizer) the amount burned from the appropriate column. **I compare the total remaining to that indicated by the totalizer...and to the analog gages' needle positions. I also note the time of the initial burn.** Yep, I still check fuel by time also. This provides a good assessment of remaining fuel.

Second, we burn 22 gallons from the second main tank. We then switch back to the initial main and start the transfer pumps on both. We need a 20+ gallon "hole" in tank 2 to receive its 20 gallons, and the tip fuel being pumped into the initial tank will not catch up and over flow. 38 minutes are required to exhaust each tip tank, and more than 5 gallons will be burned from the initial before its "hole" too is greater than 20 gallons. Naturally, we also deduct the precise gallons burned from #2 from its column on the clip board. Again, we **compare the total remaining from the totalizer with our clipboard total.**

From that point, it's back and forth switching tanks and noting the exact amount burned each time and comparing with the analog gage needles. **It all has to make sense, or we land.** This method has worked perfectly for decades of flying.

Reader Clare McEwan, founder and president of [Air Safaris International](#), has a vested interest in encouraging fuel planning and management for his customers as they fly on his tours. Clare writes:

Just a quick comment/question on fuel: If people took the view that **fuel is inexpensive insurance**, would there be fewer fuel starvation incidents? On our tours, even if we have a "short hop" to the next airport, we

always encourage departure with full tanks. The cost of a fuel starvation incident will almost certainly far exceed the extra costs of flying with full fuel purchased at a higher price than the next stop offers.

See www.airsafarisint.com

Corporate pilot and safety advisor Jeff Wofford continues the theme in that same December issue of the *normalization of deviance*—the trap of gradually accepting the unacceptable as being normal. Jeff's comments:

Normalization of Deviance is a cancer in our industry. Remarks like “it’s always done that” or “this is how we have always done this” really don’t cut it. Making excuses or deviating from SOPs [Standard Operating Procedures] is not the way we should do business. We have [had] a multitude of accidents that prove this.

Stating that “well, the fuel gauges have always been inaccurate” is just an excuse. In over forty years as a professional pilot and having flown close to 100 different aircraft, I have seen airplanes with inaccurate fuel gauges, but for the most part *it was due to poor maintenance*. Other pilots accepted the statement and went ahead and operated under that assumption. Worse yet, on training aircraft many instructors passed that sentiment on to their students. So, unlike a biological cancer, this industry cancer is catching.

Whether you’re flying a C172 or a Learjet, you can make sure your fuel indicating system (and any other system for that matter) is functioning normally and is accurate. Just like your scale that you use to weigh yourself, the first thing you do is **calibrate “zero.”** Nobody wants that extra pound or two. In the same way, most fuel quantity indicating systems start the calibrating system by setting “zero.” The you go through the process of adding fuel and **verifying the operation of the system.** When you finish you have an accurate system. **If it doesn’t work right, you determine the faulty component and begin again.** Hopefully, no one would accept that low engine RPM was just an indication problem and assume that the engine was good to go (I actually think you had an article earlier this year that addressed that situation). All of us need to step up to the plate and **quit accepting NOD** and stop the complacency!

And from reader Damon Overboe:

Personally, I didn't rush out to calibrate my fuel gauges. But, I also used the article to **immediately dispel the expectation that I can't trust my fuel gauges.** I do know how much fuel each aircraft burns per hour. So now, I will begin calibrating that against the major marks on each tank, each airplane; *using the gauges to help identify that fuel's going out faster than expected, that can be a lifesaver!* It's still on me to choose when to start that calibration. The laziness or complacency in me, and probably several others says that **I've been trained not to trust those gauges,** so what's one more flight? Start calibrating on my next flight, and make a mental note to do that on each. That is probably what I'll do, and I'll probably be fine. But as I assess that, I know that's just pure laziness. I have an electric fuel pump that I can use to cut 5 gallon at a time. So why not go out and do that now, safely from the ground? I'll keep you posted on what I actually do. I know what I should do.

And finally, **we recently had our engine replaced** in one plane. We used that as **an opportunity to accurately calibrate a fuel stick.** That would have been **the perfect opportunity to calibrate the gauges too,** had I known or thought to do that. We did fly one wing to exhaustion, however, we were 4000 feet AGL, circling a non-towered field, 5000 feet of runway in a rural area, where the work was being done at. We knew that even if we couldn't get the engine restarted, we would be landing on the runway, and we were not exposing others to risk. We knew, because of expected fuel burn, about when to expect the tank to run out and were ready to go with booster and the fuel selector. As a result, we have very accurate measurements on our fuel stick. That does nothing for us in flight, but does help us analyse our fuel burn. I will be using that stick, along with pumping out 5 gal at a time, to verify available fuel and calibrate our fuel gauges.

How did your calibration work out, Damon?

Reader and frequent Debriefers Stuart Spindel writes:

I have repaired many faulty fuel senders on [Beech] Bonanzas and Barons and have found the great majority to be dirt in the senders (or transmitters). Easy to clean and return to operation. **The factory gauges are very reliable and well built, the problems center around the senders or the adjustable interface [circuit board].**

That said, I did upgrade the fuel quantity system in our Bonanza to the CiES senders and [an] Aerospace Logic digital display. **Better to know how much fuel remains than to merely know “about” how much fuel remains.** Seems that our insurers would give some credit for that.

Reader Jack Spitler continues:

As in every other area requiring threat assessment, **denial is not a strategy leading to desired outcomes**. I have been fortunate for most of my years to have certified systems indications. In early days in GA equipment I left with full tanks, switched at 3/4 to the other tank, then switched back at 1/4 tank to the 3/4 remaining and stayed there until it reached 1/4. By this time I planned to be on approach to the destination. This also worked well enough for lateral load balance. I noted on one occasion during a night flight in mountainous terrain that pausing in the off detent using this method does produce unwelcome silence.

The (old) Navy equipment on which I trained had a collector tank receiving fuel symmetrically from both wings (if the vents worked correctly) and held the inverted pickup apparatus. This reduced essentials to enable more brain cells for other mission priorities. ***This system seems simple enough to be used on GA aircraft in lieu of the selector, leaving total fuel as the only check.***

Many years ago, a friend took off in an early model Cherokee-6 with six tanks. Due to payload, all tanks were not full. In the investigation, all hardware worked and led to probable cause of fuel starvation due to tank selection. All survived the off-field landing with significant injuries due to otherwise good pilot technique. **Each flight is a new mutually exclusive event, no matter how many came before.**

...and from reader Roy Aycok:

I think you have gotten the fuel thing well covered so no need to add this comment, but I will testify **even “old oscillating wondering gauges” are still worth a lot**. I was in [a flying club] Cessna 170 a while back doing one of my multi-grass-strip boondoggles when I noticed **it appeared to be using too much fuel based on how I know the gauges usually act...they were just going down too fast** in between their usual random oscillations. Believe it or not the C170 has a JPI totalizer that was in it when we bought it and it works “pretty good.” ***[The fuel totalizer] appeared normal but my gut said something was amiss.*** When I landed there was a steady leak coming from the fuel selector out the bottom of the aircraft. **I was draining a lot of fuel overboard**. As I believe you covered well, ***[neither] the JPI nor dipping the tanks before takeoff would have saved me.*** The old floppy Scott fuel gauges were still doing their job.

Reader Stan Stewart chimes in:

I thought I would write to you about the fuel gauges in my [early 1960s Beech] 35-A33 Debonair, which are the **factory installed gauges and which have been consistent for the over 40 years that I have owned and flown this Deb**. There is one main tank gauge and one aux tank gauge and toggle switches to have the gauges indicate fuel in the left or right tanks. The gauges consistently read ¼ lower than actual, they show ¾ full when full, and the engine will run 20+ minutes on a 25-gallon main tank (22 useable) when the gauge reaches empty. I also have a JPI EDM gauge connected to a 530W GPS, which shows fuel consumed, fuel remaining, and expected remaining fuel at the destination. **I always visually inspect the fuel level in all four tanks prior to flying**. Easy with a low wing airplane!

****I have calibrated the K-Factor (actually just a constant they refer to as a “K-Factor”) in that JPI EDM to read pretty close to actual fuel burned, it consistently shows a few tenths of a gallon more burned than actual, I check it when I fill up.***

I flight plan, when VFR, to land with no less than 13 gallons (one hour at 75%) and have never, ever, landed with less than 9 gallons (45 minutes at 75%) remaining. I know this because once I put in almost 54 gallons out of 63 useable. I also know, but ignore, that the main tanks will actually feed close to 25 gallons each (the aux tanks will feed the 19 useable out of 20 in level flight, but I normally time the aux tank’s use to 45 minutes, they typically run dry around 47-50 minutes).

Once, years ago, I took off from Mackenzie, British Columbia, heading up “the trench” to Watson Lake, Yukon, with no airports between. **After 20 minutes of flight noticed that I had burned almost one half of the full left main tank, the gauge was down to ¼ tank**. I immediately returned to Mackenzie and a technician figured out ***the engine driven fuel pump had developed a bad diaphragm and was pumping fuel overboard*** out a drain tube from the fuel pump body. Would not have made it to Watson Lake! **Glad I was familiar with and was monitoring the fuel gauges!** That is **not something the JPI EDM would have indicated** as the fuel flow transducer is between the fuel pump and the spider on top of the engine. An example of ***pilots needing to know the systems*** of the aircraft they are flying intimately!

Thank you, everyone, for your insightful comments and for your patience with the time it took me to come back to your Debrief items. Readers, the record shows that we have at least one fuel management-related accident reported about every week. It’s always important to think about the hazards of fuel mismanagement, and to discuss and refine ways to better manage and monitor our fuel.

It's equally important to properly maintain fuel indicating systems, and monitor fuel on board by as many ways as possible so you can compare them against each other. If a discrepancy arises, land and resolve the discrepancy...which almost always means adding fuel.

For ideas and a great review of fuel management see AOPA Air Safety Institute's [Safety Spotlight: Fuel Management](#).

See <https://www.aopa.org/training-and-safety/online-learning/safety-spotlights/fuel-management>

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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

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