FLYING LESSONS for October 26, 2017

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:

***AVWeb*'s Russ Niles** aptly summarizes a recent NTSB Probable Cause report:

A leaking oxygen hose fitting likely led to the fatal crash of a turbonormalized Mooney M20 Acclaim off the coast of Atlantic City on Sept. 10, 2015. [The pilot], a dentist from Gaylord, Michigan, was the only one aboard the aircraft, which flew on autopilot without contact with ATC for more than two hours at 25,000 feet before descending to the ocean near Atlantic City, New Jersey.

The pilot was on his way to a Mooney owners' safety conference and the NTSB speculated ***he did everything right*** to ensure a safe flight. He was still wearing his oxygen mask at the time of the crash but the technical fault made it worthless and he likely became hypoxic shortly after reaching altitude, the report says.

Investigators found that a fitting connecting an oxygen line to the regulator on the tank was loose. It may have been missed at an earlier annual and when the pilot activated the oxygen system as he climbed to altitude it likely quickly drained the tank. He read back a clearance to 25,000 about 16 minutes after he took off and was never heard from after that. Two F-16s were scrambled but the Mooney crashed before their pilots spotted it.

The NTSB final, Probable Cause report said the duration of the flight was consistent with the aircraft draining one of the aircraft's two fuel tanks on the flight.

See:
https://www.avweb.com/eletter/archives/101/3825-full.html?ET=avweb:e3825:227136a:&st=email#229816
https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20150910X75635&AKey=1&RType=Final&IType=LA

Perhaps coincidentally, this week *AIN Online* posts this podcast as well:

> Pilot George Braly recalls a flight in which his portable oxygen line becomes kinked and he ultimately loses conciousness. George is awakened by ATC and is able to increase the oxygen flow and safely descend from the high-altitude flight.
>
> In this episode **AIN** delves into the issue of hypoxia by examining both portable and built-in oxygen systems. Additionally we discuss the FAA regulations that require one pilot when flying in a pressurized aircraft above 41,000 to use an oxygen mask at all times. Studies have shown that ***82 percent of business aircraft pilots openly disregard this rule***, and this episode discusses the human factors involved in oxygen mask use on long flights and possible solutions to this problem. In this episode we will hear from:
>
> - George Braly, pilot-in-command of the Cirrus with the kinked oxygen hose
> - Dr. Brent Blue, senior Aviation Medical Examiner
> - Rob Schaeffer, product director, Environmental Systems, Cobham Mission Systems

- Chris Shaver, author of the study, "Hypoxia Training and Pilot Use of Supplemental Oxygen Above 25,000 Feet"
- Rick Miller, chairman of the High Altitude Supplemental Oxygen Working Group

Topics in this episode include:

- Supplemental oxygen regulations
- Oxygen mask use at high altitudes
- Hypoxia and symptoms of hypoxia
- Portable oxygen systems

Read Supplemental Oxygen: The Secret of Non-compliance.

See:
https://www.ainonline.com/podcast/business-aviation/2017-10-18/episode-06-perils-hypoxia?eid=325912989&bid=1903524
https://www.ainonline.com/aviation-news/business-aviation/2017-08-31/supplemental-oxygen-open-secret-non-compliance

I'll pass on the issue of intentional noncompliance with regulations until some future date. For pilots who, as the NTSB described the Mooney pilot, ***"[do] everything right,"*** I offer these thoughts about flight at ***oxygen altitudes***.

Let's define oxygen altitudes as any height at which oxygen use is required by Federal Air Regulation (or international equivalent). 14 CFR 91.211 requires use of supplemental oxygen by flight crew any time above 14,000 feet Mean Sea Level (MSL), and for any flight more than 30 minutes' duration above 12,500 feet MSL. Pilots must make supplemental oxygen available to passengers above 15,000 feet MSL, but passengers are never *required* to use supplemental oxygen. These are all ***cabin pressure altitudes***, so if the cabin is pressurized they only apply when the air pressure in the cabin is equivalent to those altitudes.

See https://www.ecfr.gov/cgi-bin/text-idx?node=14:2.0.1.3.10#se14.2.91_1211

At oxygen altitudes not only must pilots use oxygen; **we also assume responsibility to *monitor* our own oxygen state**, to ensure we are getting the supplemental oxygen we need. The **Time of Useful Consciousness (TUC)**, sometimes called the **Effective Performance Time (EPT)**, is the amount of time, on average, that a pilot can go without supplemental oxygen and still be in a condition to detect and correctly respond to hypoxia's negative effects.

Our job as oxygen monitor is to ***detect and repair any insufficient oxygen intake well before our TUC expires***.

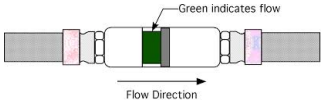
Regardless of the regulatory requirement, decades of aeromedical evaluation of young, healthy military pilots shows the TUC (EPT) to average:

Pressure/Cabin Altitude (MSL)	Time of Useful Consciousness (TUC)
15,000 ft (4550 m)	30 minutes or more
18,000 ft (5500 m)	20 to 30 minutes
22,000 ft (6700 m)	5-10 minutes
25,000 ft (7600 m)	3-6 minutes
28,000 ft (8550 m)	2-3 minutes
30,000 ft (9150 m)	1-3 minutes

We have no guidance on TUC/EPT for older or less fit pilots. But I've asked around, and there are some suggestions to help you determine when *you* need supplemental oxygen regardless of your condition and the altitude at which you fly.

First, how can you monitor your oxygen state?

- **Oxygen flow meter.** All aviation oxygen masks and cannulas have some sort of flow indicator. This may be as simple as a green-colored paper card that blows into view when sufficient oxygen is flowing through an oxygen line—and perhaps shows red when the flow is insufficient. It may be a ball that blows to an altitude reference mark when you manually open the valve to the proper flow rate, read when the flowmeter is held vertically upright.



(right) From Mountain High Equipment and Supply

- **Pulse oximeter.** A pulse oximeter is a device that clamps onto your finger. By shooting a weak light signal into your finger and measuring the reflected result, it calculates your oxygen saturation level. It also measures your pulse rate. This medical device is making headway into mainstream use by pilots who fly at **oxygen altitudes**. Frankly, they should be used by any pilot who flies above about 8000 – 10,000 feet, especially pilots with a history of smoking or breathing issues. These devices are cheap—less than $20 online. They are commonly used by athletes and are widely available.

OK, you have monitoring devices. How might you best use them? There is a lot of equipment out there, but I've never seen a precise strategy on how to use them. Here's my suggestion:

If you're flying above 10,000 feet, and certainly in the required **oxygen altitudes**:

1. **Use a pulse oximeter.** Develop a baseline for yourself by measuring your oxygen saturation while resting at your home. This compensates for pilots who live at high elevations and may be able to process more oxygen "high up." Take several readings over several days to find out what is normal for you. You'll compare this figure to the readings you'll take in flight.

   My son is a paramedic. Any non-trauma or non-stroke patient who has an oxygen saturation less than 90% gets supplemental oxygen regardless of the reason for the emergency call (trauma and stroke patients have a 95% and 94% threshold respectively). The actual protocol may differ from one agency to another, but 90% saturation might be considered the lowest "normal" oxygen reading for a pilot.

2. **Use aviation-rated oxygen delivery systems.** Cannulas are generally certificated up to 18,000 feet, but above that altitude you'll need a full mask to get the proper flow rate. Check the certification of the equipment you use. You want aviation-rated gear for flow rate indicators that indicate properly at high altitudes.

3. **Use a timer with an alarm.** You'll need something to prompt you to check the indications long before improper flow might lead to hypoxia. For this to work you need something you can set and that makes enough noise you can hear the alarm while wearing noise-attenuating headsets.

4. **Use the TUC/EPT chart.** For your altitude (or cabin altitude, in pressurized airplanes), find the TUC/EPT. Set your timer for ½ the minimum time listed for your altitude. For example:

   - At 14,000 feet, set your timer for 15 minutes
   - At 17,500 feet, set your timer for 10 minutes
   - At 21,000 feet (FL210), set your timer for 2.5 minutes
   - At 25,000 feet (FL250), set your timer for 1.5 minutes

5. **Each time the alarm sounds,** confirm the proper supplemental oxygen flow rate for your given altitude. Adjust the flow rate if needed.

6. **If:**

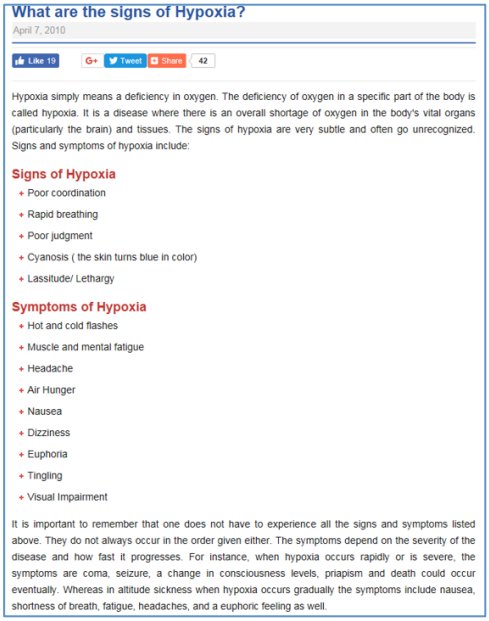
   - **the flow rate is insufficient** or there is no flow rate at all; ***and/or***
   - **your oxygen saturation level is more than 2% below your resting saturation rate at home** (suggested by Dr. Brent Blue in a presentation at Oshkosh a few years ago)**, or below 90% at any time** (suggested by paramedic protocols); ***and***
   - **you cannot immediately restore** the proper rate and saturation; ***then***
   - **make an immediate descent** to no higher than 10,000 feet.

Use the Emergency Descent technique if you are beginning this descent from above 22,000 feet (FL220). Your TUC/EPT is very short above this height.

Declare an emergency if you need to in order to make this descent. There is nothing more "emergency" than impending loss of pilot effectiveness or unconsciousness.

Personally, and having well over 1000 hours in unpressurized airplanes capable of flying in the Flight Levels (above 18,000 feet MSL in the U.S.), I recommend against flying solo above 20,000 feet. At those heights I'd like to have a second set of eyes watching me and the supplemental oxygen indicators. Of course, this means teaching that person what to look for, including the signs and syptoms of hypoxia.

See http://www.medicalhealthtests.com/askquestion/185/what-are-the-signs-of-hypoxia.html



What are the signs of Hypoxia?

April 7, 2010

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Hypoxia simply means a deficiency in oxygen. The deficiency of oxygen in a specific part of the body is called hypoxia. It is a disease where there is an overall shortage of oxygen in the body's vital organs (particularly the brain) and tissues. The signs of hypoxia are very subtle and often go unrecognized. Signs and symptoms of hypoxia include:

Signs of Hypoxia

- Poor coordination
- Rapid breathing
- Poor judgment
- Cyanosis (the skin turns blue in color)
- Lassitude/ Lethargy

Symptoms of Hypoxia

- Hot and cold flashes
- Muscle and mental fatigue
- Headache
- Air Hunger
- Nausea
- Dizziness
- Euphoria
- Tingling
- Visual Impairment

It is important to remember that one does not have to experience all the signs and symptoms listed above. They do not always occur in the order given either. The symptoms depend on the severity of the disease and how fast it progresses. For instance, when hypoxia occurs rapidly or is severe, the symptoms are coma, seizure, a change in consciousness levels, priapism and death could occur eventually. Whereas in altitude sickness when hypoxia occurs gradually the symptoms include nausea, shortness of breath, fatigue, headaches, and a euphoric feeling as well.

Comments? Questions? Let us learn from you, at mastery.flight.training@cox.net

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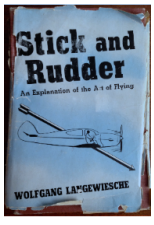
Debrief: Readers write about recent *FLYING LESSONS:*



Several readers wrote about my comments and notes on Wolfgang Langewiesche's classic *Stick and Rudder: An Explanation of the Art of Flying*. Written in 1944, Langewiesche's book is still in print. It presents a unique insight into flight control and the training of pilots.

From Wikipedia (so it has to be true!): Born in Düsseldorf, Germany, in 1907, [Langewiesche] migrated to America in 1929. He was a graduate of the London School of

Economics and earned his master's degree from Columbia University. He was in a doctoral program in the University of Chicago when he decided to learn to fly and pursue a career in aviation.

Mr. Langewiesche wrote for *Air Facts* magazine, an aviation safety-related publication edited by Leighton Collins, and his articles were the basis for most of *Stick and Rudder*. The basic facts about flying that he emphasized in 1944 have withstood much criticism since then. Over 200,000 copies of the book had been printed by 1990.

He taught "Theory of Flight" to US Army aviation cadets in the ground school at The Hawthorne School of Aeronautics in Orangeburg, South Carolina during World War II, and test flew F4U Corsairs for the Vought Corporation. He later worked for Cessna as a test pilot. In the 1950s he became *Reader's Digest*'s roving editor, retiring in 1986.

See:
https://www.amazon.com/Stick-Rudder-Explanation-Art-Flying/dp/0070362408
https://en.wikipedia.org/wiki/Wolfgang_Langewiesche

Reader Gordon Talge writes:

> I read your notes on *Stick and Rudder*. Mine is the 1944 ed., 6th printing. I'm in the process of reading it now.
>
> What impressed me most was the warning on page 135: "If an untutored person tries to fly an airplane...the flight will almost certainly end in a spiral dive and a crash." I think that is what happened to John Kennedy [Jr.]. He got in over his head.
>
> I'm not a pilot. I did take a ground school class about 20 years ago. When it came to the actual flying, it turned out to be too expensive so I dropped out without taking any lessons. *Reading Langewiesche's book has renewed my interest in flying*. What also impressed me was **how counterintuitive flying an airplane can be**. I've seen YouTube videos of stalls and spins. In one the guy was banking to the left and in a split second he flipped to the right and was in a spin. It was planned, but it sure took me by surprise.

See https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X19354&AKey=1&RType=Final&IType=MA

Hi, Gordon. Sorry it took so long for me to respond to you…I got away from the *Stick and Rudder* project for a while. You're describing a ***snap roll***, which might be described as a ***horizontal spin***. In the case of a base-to-final turn stall, the snap roll/spin occurs at something other than horizontal or vertical…but it's exactly the same thing. Langewiesche discusses the dynamics of this turn in Chapter 3, on page 51.

I hope you are indeed able to pursue flight training. It is indeed an expensive undertaking. At least treat yourself to an introductory flight lesson…it will be an unforgettable experience.

Reader Gregory John writes:

> I have been paying attention to some of the things that you've written. Thank you for the info. It has been helpful on my continued quest to be "the Safest Pilot still flying".
>
> Specifically I have also been re-reading Wolfgang Langewiesche's *Stick and Rudder: An Explanation of the Art of Flying*. And since I have NOT been able to find an electronic Copy for my Kindle I am reading the hard cover again. During my search for an electronic copy is how I came across your "highlights and margin notes" of the book.
>
> Please keep adding to your Notes and I will continue to compare them to what I discover as I read this book again. Perhaps after I complete my reading (and record my notes to an electronic file) I could share them with you to "Compare Notes."
>
> Not sure exactly where Rose Hill, Kansas is but perhaps in the near future I could travel from Minnesota (my Summer Home Base) and meet you in person. I missed Oshkosh this year but next year I will again make it happen.

Hi, Gregory. I'd very much like to see your notes on *Stick and Rudder*…just as I'd like more comments and observations from other readers. By the way, Rose Hill is just outside of Wichita, Kansas. Let me know if you're coming down this way.

Frequent Debriefer Robert Thorson asks:

> We all know this intuitively when we were kids with a stick attached to a string and a flat board and threw it in a spring creek (my PT Boat!). So which CFI led us astray? LOL

Probably me early in my career, Robert. Seriously, although I first read *Stick and Rudder* shortly after I earned my Private Pilot certificate, it took me many years and hundreds of hours of "dual given" to learn how to integrate some of Langewiesche's explanations into the instruction I give. In other words, *the system*, which for the most part relies on newly minted instructors who spend only a short while teaching before they move on to other jobs, is what's leading us astray. Modern flight training materials don't address Angle of Attack and flight maneuvers the way *Stick and Rudder* does, so flight instructors are not trained in these explanations and teaching techniques.

Readers also addressed last week's *LESSONS* on takeoff aborts. Andy Little writes:

> Firstly, thanks for your commitment to producing such a consistently thought-provoking publication which is firmly rooted in real-life situations.
>
> I'm a check and training captain with a mission aviation operator which serves communities in challenging remote bush locations around the world. In our context **being ready to abort is essential**, and operationally I have done so more times than I can remember (mostly due to external threats like animals or poor acceleration, but a number of times due to mechanical issues or pilot error in the pre take-off checks).
>
> Therefore our training has a strong focus on a few points relevant to your email today. **We do these things for every take-off:**
>
> - Nomination of an ***acceleration check point*** (which is usually possible prior to the safe abort point, and a good early indicator of whether or not you got your performance calculations right).
> - Nomination of a ***safe abort point***: the latest point the take-off can be safely aborted to stop on remaining runway *with margin remaining*.
> - **Be in "abort mode" up to the safe abort point**. We train our pilots to self-brief that if they "see, hear or feel anything unusual prior to the SAP," they should abort by <insert actions required to abort>. ***One of my favourite ways to train abort mode is to tell the pilot I will simulate an abnormal situation during the take-off, but then I do not do so. Afterwards we debrief the level of readiness to abort compared to other take-offs.***
> - **Passing the safe abort point we verbalise "continuing" and from then on if something unusual occurs we will continue if we can** (i.e., if its not a power loss situation).

See http://www.mastery-flight-training.com/20171019-flying-lessons.pdf

I'm very interested in exactly *how* your determine the acceleration check point and safe abort point for a given takeoff. Perhaps you can send me something that shows how you train these determinations to your pilots. We can all learn from that!

I'd add a "significant control difficulty" to a power loss situation to the criteria for *not* continuing beyond the safe abort point. Your thoughts? Lastly, I *love* your technique of briefing pilots you will cause them to execute a takeoff abort, and then discuss their heightened awareness of takeoff factors and performance after you do *not* call for an abort. I'll have to incorporate that idea! Thank you very much, Adam.

Reader Horacio Gutierrez adds:

> I agree that anything unusual on takeoff warrants an immediate abort, which is really no big deal. **Any possible issue is best sorted out on the ground**. I also make it a habit to reset all trims to their takeoff positions and confirm trim indicator movement as part of my after landing checklist when clear of the runway. If the pilots had done this with consideration of recent nose up trim input, they may have discovered the issue before the takeoff roll.

You're right, Horacio: resetting the trim, and confirming that action with a post-landing checklist, helps avoid a takeoff abort like that which prompted last week's *LESSON*. In that particular case, however, the failure of the elevator trim mechanism did not affect the cockpit indications and was not remedied by resetting the trim in the cockpit. In other words, they *did* reset the trim, and it *looked* like the trim was set properly when it was not. Going beyond the proper use of procedures and checklists, this event reminds us that even if we think we've done everything right, we must still be watching for unexpected situations. Thanks, Horacio.

Reader Shirley Roberts also writes:

> I was fascinated by your column concerning the need to abort a takeoff due to a nose high pitch in spite of other normal appearances. You said that a mechanic ound that the trim system's turnbuckles had failed, jamming the trim tabs. The failure must have happened during the simulated engine failure. When the crew reset and verified the trim before the next takeoff the cockpit indications were right even though the actual trim position was radically wrong.
>
> Other than that happening as indicated with the trim system's turnbuckles failing, is there any way to spot such a condition during a preflight? A few months ago I was getting flight instruction from a CFII who wanted landings to be nose high…somewhere between 12 and 15 degrees. In an A36 [Bonanza], what is your recommendation for degrees nose high upon landing? Generally, I try to do my final approach at around 85 knots.

Here we delve into the realm of airplane type-specificity. At most weights a full-flap, final approach target of 85 knots will result in the "book" roughly 80 knot obstacle clearance (50 foot) target airspeed as you begin your flare. In a well-equipped A36 (lots of heavy things forward of the firewall) and at typical training weights (two persons and half to three-quarters fuel), if you trim off elevator pressures in a landing as you describe you'll find the elevator trim in the nine to 12 units up after landing. Since the takeoff trim setting is three to six units up, this is a very nose-high setting for a go-around or if the trim is not reset before the next takeoff.

Now, this is very different in other models of Bonanza. Fly an F33A (I gave instruction in one last week) and the landing trim remains in the safe takeoff settings range. Same goes in a Cessna 172 I sometimes fly. Add a turbocharging system to that A36 and the landing trim ends up at 19 to 21 units up…*radically* nose high in the event of the next takeoff.

I suggest all pilots pay attention to the post-landing trim setting in each airplane they fly, in various loading conditions. Compare that to the takeoff setting(s) to see just how critical resetting the trim after landing is in those aircraft, and how hard you may need to push to prevent pitching up into a stall at the beginning of a balked landing (go-around).

Addressing your first question, I usually **set the cockpit trim indicator to the "zero" or neutral position before my exterior walk-around inspection**. I **then check the trim tab(s) to see if it/they are aligned with the elevator**. ***Zero in the cockpit should equate to zero in the control surface itself. If it does not, investigate*** the reason and have a mechanic make adjustments or repairs if needed before you fly. Of course, using this inspection technique requires you to re-set the trim fort takeoff and confirm that setting with the printed Before Takeoff checklist. Thank you, Shirley.

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

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