FLYING LESSONS for August 30, 2012

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.

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This week's lessons:

The NTSB this week released its Probable Cause report about the highly modified P-51 crash into the grandstand at the Reno Air Races last year. According to AVweb's report of the NTSB's press conference:

> Last year's fatal crash of a P-51 racing aircraft at Reno was caused by compromised stiffness in the elevator trim-tab system, which led to flutter and loss of elevator pitch control at race speed…. Veteran air racer Jimmy Leeward lost control of his Galloping Ghost P-51 after the home pylon turn, causing a sharp pitch up followed by a dive into a spectator area, killing him and 10 others.
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> The NTSB's investigation revealed that the aircraft was flying faster than it ever had by some 35 knots, with higher engine power settings than previously used. The board also found that there was evidence of ongoing structural failure during the race, including a cracked canopy. Further, Leeward and his crew had made major modifications to the aircraft, including the removal of the P-51's iconic belly airscoop, that compromised the structural integrity of the fuselage. The crew notified the FAA of only one of these changes, a boil-off system used to improve oil cooling.
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> The NTSB probe found that screws used to attach one of two trim tabs to the elevator were old or loose, possibly having last been replaced in 1986. This allowed the trim tab to flutter, failing the tab control rod and resulting in an instantaneous pitch-up moment that generated a calculated 17 Gs, which the board determined was beyond human endurance.

See www.avweb.com/eletter/archives/bizav/2303-full.html#207265

Ultimately it was two tiny screws that gave way, leading to trim tab flutter and separation, and an uncommanded, high G pitch up that took the pilot out of the control loop and left physics alone in command of the airplane's final path.

Most airplanes never experience the level of stress that modified Mustang underwent in the moments prior to the crash. But the more routine flying virtually all of us do still exposes our airplanes to surprisingly high flight loads. A frequent topics of discussion in airplane ownership circles is the idea of replacing aviation-spec hardware and equipment with automotive or hardware store items—aviation parts prices, the story goes, are artificially inflated by aircraft manufacturers, in part because of the high cost of liability insurance to cover aircraft parts manufacturing.

If the non-aviation parts look externally identical, even if they come from the same manufacturer, it's tempting to address some of the high cost of flying by using the cheaper parts. Trouble is, most of us (and most mechanics) are not qualified to determine the precise stresses the part must successfully bear in normal and, especially, unusual circumstances. We can't identify when a component or piece of hardware has neared or reached it stress limit, its temperature maximums, or its tensile strength.

In many cases corrosion may not be externally evident, even in an aviation-approved part. Or surface corrosion may be brushed off and the new surface painted over, without consideration of the microscopic changes in load paths that result from the missing metal.

The Reno tragedy is an extreme case. But if you are an airplane owner or mechanic, or maintain your own aircraft under Experimental-Amateur Built or Light Sport rules, remember the lesson of Reno any time you're tempted to defer routine or abnormal *maintenance* (as opposed to *repair*), or substitute unapproved or non-aviation parts.

"The pilot stated that during cruise flight he had been intermittently encountering areas of instrument meteorological conditions. After being advised of an area of precipitation ahead by air traffic control, [the pilot] requested to deviate around the weather. The pilot did not receive a reply and after a second request to deviate, ATC advised the pilot to, 'turn left.'

"Just as he initiated the left turn, the pilot encountered an area of severe turbulence, and the [aircraft's] Primary Flight Display temporarily 'went black.' When the PFD returned it displayed a message advising the pilot to 'level the wings' while the attitude and heading reference system realigned. The pilot subsequently utilized the standby instrumentation to control the airplane while he initiated an emergency descent.

"The airplane exited the turbulence and IMC at an altitude of about 4000 feet MSL, and just about that time the pilot heard a 'bang.' The airplane's windscreen then became obscured with engine oil and the engine lost power. The pilot subsequently performed a forced landing to a cornfield below and the airplane incurred substantial damage to the fuselage and both wings. The airplane's propeller was separated from the engine at the propeller flange, and was later recovered about 6 nautical miles southwest of the accident site."

Previous *FLYING LESSONS* addressed the issue of in-flight thunderstorm and turbulence avoidance, the limitations of Air Traffic Control radar (especially Center radars) in detecting precipitation, controllers' duty to assist with weather avoidance only on a time-available basis, and the inherent delays and therefore local-scale inaccuracy of NEXRAD weather uplinks. We discussed the pilot's personal responsibility to evaluate weather and deviate from a clearance in the exercise of his/her emergency authority if a clearance takes the flight into hazardous conditions, and the need to slow to the airplane's weight-adjusted Turbulent Air Penetration Speed *before* encountering the first strong bump of turbulence. We'll revisit these topics and techniques in future editions of *FLYING LESSONS*.

This week's case, however, illustrates another hazard of turbulence that makes many of us more susceptible to loss of control than perhaps we were before. Violent and rapid changes in attitude can interrupt the operation Attitude Heading Reference Systems (AHRS) that drive "glass cockpit" Primary Flight Displays.

Most general aviation airplanes with glass displays do not have a backup AHRS (pronounced "A-Hars"). And turbulence-driven excursions strong enough to knock out one AHRS might simultaneously knock out both in those few airplanes with an AHRS backup. When the AHRS goes into reset mode it can take 20 seconds to a full minute or more of straight-and-level, constant heading, unaccelerated flight for the AHRS to realign to once again drive the attitude display.

The pilot (and his/her passengers) then depends on hand-flying the airplane in turbulence strong enough to overpower the electronics, while holding attitude precisely level and on heading using a small attitude indicator that is inconveniently placed in many glass cockpit airplanes and retrofits.

If you fly (or teach) in glass-cockpit aircraft, whether original equipment or aftermarket, include a couple of minutes of precise, wings-level, constant heading flight using the backup instruments as your only guide in all required Flight Reviews (or international equivalent) and regular recurrent training in the times between.

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

Debrief: Readers write about recent *FLYING LESSONS:*

Reader Jim Herd chimes in about last week's *LESSONS* on measuring power output:

You wrote: ***If a piston engine is instrumented*** *for it, exhaust gas temperature (EGT) or, with turbocharged engines, Turbine Inlet Temperature (TIT, which is simply an EGT gauge referencing temperature just as exhaust enters the turbo), is the most direct measure of power. Manifold pressure, rpm, cylinder head temperature (CHT) and even fuel flow are merely indicators of potential power development.*

Surely this is in error, or perhaps grossly simplified? EGT or TIT can be "manipulated" in various ways that are not directed proportional to power output of the engine. For example, advanced ignition timing will make EGT/TIT decline but retarded ignition timing will make EGT/TIT increase.

Simplified, perhaps, but consistent with most engine management theorists. The absolute value of EGT (or TIT, but we'll use "EGT" for consistency) is not important, but under a given set of conditions (e.g., ignition timing, which is not adjustable in flight with non-FADEC engines) EGT will be predictable for a given leaning technique. EGT correlates to a power setting with all variables being equal. More importantly, if EGT changes without the variables being knowingly changed, it's because power development has changed.

For example, in a turbonormalized Continental Motors IO-550 engine with factory-spec ignition timing, a climb mixture setting (maximum horsepower plus additional fuel to delay ignition for cooling) occurs at about 1250F EGT. If you want climb power in this type of engine, lean until the reference EGT reads about 1250F and you'll be pretty close to the proper fuel flow. Keep it at the same temperature in climb and power output remains roughly constant. Similarly, at high-power cruise, assuming a rich of peak power setting, best power occurs at about 1575F in that same turbonormalized IO-550. Indicated EGT will be somewhat higher for a given percentage of power if cruising in a lean-of-peak condition.

Isn't the GAMI/TATI/APS "Red Box Chart" the most definitive and illustrative way to view all of this? Arguably, CHT is the most direct and proportional measure of power, based on those curves. But even then, other large variables are in play, such as detonation, which will increase CHT but surely not power.

Engine management researchers and educators at APS and GAMI teach the "target EGT" technique I described above. CHT is extremely variable based on engine baffling condition, internal fuel and air distribution, and even altitude (higher altitudes provide less airflow and, therefore, less cooling). All of APS/GAMI power discussion is based on temperatures relative to peak EGT.

You are correct that CHT control is important to valve and valve guide wear, and is postulated to correlate to increased cylinder life—it seems intuitive that cooler is better, but there's no definitive evidence that lower CHTs extend cylinder life, as stated when I took the live APS seminar. CHT also directly correlates to internal cylinder pressure (ICP), according to APS, and lower ICP is also postulated (but not *proven*) to promote cylinder life.

See:
www.advancedpilot.com
www.gami.com

As far as I can tell there is no easy rule of thumb here. Some modern engine monitors offer a readout of "%HP", but even these are questionable due to their algorithms and variables considered or ignored. And it is important to point out that power is determined very differently for LOP versus ROP. That's because the "limiting factor" (all else being equal) with LOP is fuel flow, and for ROP it is air flow (the product of rpm and MP).

Correct. Fuel flow directly correlates to percentage of power when lean of peak. The fuel-burn (in U.S. gallons per hour) multiplier for determining horsepower varies with cylinder compression ratio, and may also vary with engine size (I've never seen the computation stated for anything other than 520 to 550 cubic inch engines). Percentage of power gauges usually reference manifold pressure and propeller speed, and assume "book" mixture leaning technique. Lean differently and the percentage of power is not as depicted on the gauge.

Whether I am correct or incorrect, please clarify for all of your readers in your next *FLYING LESSONS*. This is an important point and I suspect many pilots are not informed or misinformed. But perhaps what is more important here is to understand what power levels to employ for each phase of flight, and how to set them up efficiently and without risk of serious engine damage. I realize this is beyond the scope of your comment I am quoting, but I can see how pilots could take your narrow comments and run with them.

CHT control is about the potential for cylinder longevity. But EGT is the reference for power and, once a target EGT is determined for a given engine, watching the EGT will tell you instantly whether the engine is continuing to develop your selected percentage of power. Thanks, Jim.

Reader David Heberling writes:

The account [in last week's *FLYING LESSONS*] of taking off in Dallas on a very hot and windy day made me think of another reason why they had anemic performance. I have no idea what his normal leaning procedure is, but high density altitude combined with high humidity can rob piston engines of a good portion of their rated power, especially if the engine is not leaned for the conditions. I cannot imagine that a prop can make that much of a difference, or if so, I would really question whoever is performing maintenance on that aircraft.

True, David. Density altitude is a factor even in the flatlands when the air is hot and humid. Instructors need to stress leaning for takeoff and climb power no matter where they teach. That said, I recall and issue with improper propellers installed on some Cessna 172s when I was just beginning my instructional career in the late 1980s. It may well be the airplane in last week's Debrief had the wrong propeller. How often does even a great IA check the propeller model number against the airplane's Type Certificate Data Sheet to ensure it's the correct type?

An anonymous (at his request) reader writes about glidepath control, an issue raised in last week's report and a common *FLYING LESSONS* theme:

Some years ago I flew in, on a clear VFR day, to a non-towered airport with badly faded runway markings, indicating to me general neglect. There was a displaced threshold of approximately 1100 feet for an approximately 4200 foot long runway. The runway was equipped with a PAPI. Approaching to land, it was clear to me why there was a displaced threshold, as there was a line of trees to clear. After landing, I looked back and saw orange balls marking a power line crossing final for the runway just beyond the trees (i.e., closer to the threshold), which I had not seen on the approach.

This gave me a bit of a shock. After I got home, I looked in the AF/D [Airport Facility Directory] to refresh my memory. My memory was correct--the power lines had *not* been mentioned there. This impressed upon me the importance of remaining on or above the glide slope even when landing appeared to be "assured."

More importantly, remain at or above the *visual* glide*path* to the touchdown. Most electronic glidepaths do not assure obstacle clearance below decision height or decision altitude in a glideslope-equipped approaches, or below minimum descent altitude on an approach with an advisory glidepath. Thanks for the reminder, anonymous reader.

Correction: I had a broken link in last week's report for my article "Manifold Pressure: What It Tells You, What it Doesn't." The correct link is www.ipilot.com. You'll need to registered (free) and log in to read this and many, may other articles in the Insider Series on iPilot. I apologize for not catching my error before publication.

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

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2010 National FAA Safety Team Representative of the Year
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