ILLUSTRATION BY **CHRIS LIVIERI**

THE MOST UNFORGIVABLE SIN

RUNNING OUT OF FUEL ONLY HAPPENS TO THE OTHER GUY, RIGHT?

BY MIKE BUSCH

I USUALLY DON'T WRITE ABOUT experimental aircraft because my 45 years of aviation experience have been almost exclusively with certificated, normal-category airplanes. However, I'm making an exception this month. This column was prompted by the June 16, 2001, crash of an experimental Lancair IV-P (NTSB reference LAX01FA212) that claimed the life of veteran pilot Tony Durizzi.

I didn't know Tony personally, but I did research his accident carefully, and I believe there are some terribly important lessons to be learned from it—lessons that might just cause you to question some of the most basic things your CFI taught you, and perhaps to change some of your most basic flying habits. At least I hope so.

TONY WHO?

Anthony J. "Tony" Durizzi's flying career started well before my time. Back in the mid-1960s, when I was just earning my private ticket, Tony was flying big radial-engine transports in Southeast Asia for Air America, the big airline operated covertly by the CIA. Colleagues who shared a cockpit with Tony agreed that he was an outstanding pilot with superb stick-and-rudder skills. You had to be to survive in Air America.

THE MOST UNFORGIVABLE SIN

In the early 1970s, Tony went to work as a pilot for Japan Airlines (JAL), where he flew for three decades and 30,000 hours (give or take) until his retirement at age 60.

Tony had a keen interest in general aviation. He was an active CFI with single, multi, and instrument instructor ratings. After retiring from JAL, Tony and airline pilot friend Mike Raney built a pressurized Lancair IV-P (serial No. 76), one of the most sophisticated, highest-performance kit planes in existence.

Tony became very active in the Lancair builder community and before long gained a reputation as a top Lancair guru. And although he did not hold an FAA mechanic certificate—just a limited repairman certificate for the aircraft that he built—Tony ultimately was appointed by the FAA as a designated airworthiness representative (DAR), empowered to inspect and sign off on the airworthiness of Lancairs and other homebuilt aircraft. Many considered Tony the most knowledgeable individual about the Lancair IV outside of the Lancair factory.

BACKGROUND OF THE CRASH

Tony's final flight was in a Lancair IV-P, but not the one he built and owned. The accident airplane, N424E, was an early Lancair IV kit (serial No. 11) originally purchased in 1990. The partially built aircraft changed hands a few times and was finally completed by professional "hired gun" A&Ps in 1998. The aircraft was acquired by two friends in the entertainment business: one a Hollywood producer and the other a member of Eric Clapton's band.

Tony had been flying the plane around the country with the Clapton band member to help him attain the necessary experience in it. After dropping off the owner at an East Coast gig, Tony flew the plane to an avionics shop in Charlottesville, Virginia (where it remained for four days), to correct problems with noise in the radios, autopilot wiring, and problems with the fuel quantity indicating system. The avionics technician troubleshot the fuel quantity indication problems and determined that the right sending unit was out of calibration and the left sending unit was totally inoperative. Replacement of the sending units would require wing removal, so Tony elected to defer the work until the aircraft was back in California.

On June 16, 2001, Tony commenced his trip from Virginia to California. He refueled the airplane in Little Rock, Arkansas, then flew on to Ada, Oklahoma, where he asked the mechanics at Tornado Alley Turbo Inc. (TATI) to take a look at the engine to find out why the airplane wasn't getting as much turbo boost at altitudes above FL200 as other Lancair IVs. The TATI techs pulled the engine cowling and found and fixed a few minor induction leaks.

While the techs were working on the airplane, Tony went to lunch with a TATI engineer. When the two returned from lunch, N424E was topped off with 24.5 gallons of 100LL—almost exactly what accident investigators calculated it should have consumed during the flight from Little Rock to Ada.

It was hot in Ada that day. Not long after the fuel truck drove off, the TATI engineer noticed fuel coming out of the Lancair's wingtip-mounted fuel vents. He was struck by the fact that there was only a slow drip coming from the left wingtip, but a steady stream coming from the right one—despite the fact that the aircraft was on a level ramp. The engineer remarked about this to Tony, who responded that it was normal for this aircraft.

Shortly thereafter, Tony took off from Ada on an IFR flight to Flagstaff, Arizona. He didn't make it.

The flight was uneventful until the engine quit during a visual approach to Flagstaff airport. Tony radioed the tower that he was not going to be able to make the field and made a forced landing in a small clearing two miles northeast of the airport. Rescue workers arrived on the scene very quickly. They found no sign of fuel in either tank, and no evidence of any post-crash fire. The Lancair's beefy composite cabin structure survived the crash remarkably intact, but Tony was killed on impact when his head struck the instrument panel.

IT JUST DOESN'T ADD UP

When Tony had lunch with the TATI engineer shortly before the accident flight, their conversation included discussion of the speed, fuel capacity, and range of the Lancair IV-P, as well as Tony's leaning habits and fuel burn. Tony told the engineer that N424E, being an early serial-number aircraft, had two 40-gallon integral wing tanks, with 78 gallons usable. Later models (including Tony's own Lancair IV-P) had more fuel capacity: 90 gallons standard, with 110 gallons optional.

Tony said that he normally leaned the big 350-hp Continental TSIO-550-E engine to 50°F lean-of-peak in cruise, resulting in a miserly 15 gph fuel burn (as shown on the aircraft's digital fuel flow and totalizer system) and a cruise speed up at the flight levels around 260 KTAS. Allowing for the higher fuel burn and lower speed during takeoff and climb, this would put the aircraft's calculated no-reserve endurance at about four and a half hours.

TONY'S FINAL FLIGHT WAS IN A LANCAIR IV-P, BUT NOT THE ONE HE BUILT AND OWNED.

It's 750 nautical miles from Ada to Flagstaff. The flight encountered 20- to 30-knot head winds (as forecast) and arrived at Flagstaff less than three and a half hours after takeoff. That means that Tony should have landed safely with more than an hour's worth of reserve fuel on board. Obviously, he didn't. But why?

That's exactly the question that the NTSB investigators wrestled with. There are really only three possibilities: the aircraft consumed a lot more than 15 gph, the tanks held a lot less than 78 gallons usable, or a substantial quantity of fuel was somehow lost in-flight. Or perhaps some combination of these.

INTEGRAL FUEL TANKS

Like most composite aircraft, the Lancair uses a "wet wing" integral tank fuel system in which a substantial portion of each wing is sealed up and used as a fuel tank. The fuel tank area of the wing includes a number of wing ribs. The Lancair carries fuel not only behind the main spar, but also in front of it in the so-called "D-section" of the wing between the spar and the leading edge.

This requires the ribs and the spar to contain a series of holes and notches to permit the free flow of fuel and air between the various structural "compartments" of the wing's wet bay. Specifically, holes and notches on the bottom of the ribs and spar allow fuel to flow from one compartment to another, while holes and notches on the top of the ribs and spar allow air to flow between the compartments. (For fuel to flow into a compartment, air must be able to flow out of it—and vice versa.)

History has shown that this has been a recurring problem area for Lancairs. In some cases, builders may not have understood the importance of these holes and neglected to drill them as called for in the plans. In other cases, wings have been assembled using excess resin that wound up plugging up some of the holes. Unfortunately, once the wings have been closed up during construction, it can be very difficult to detect such problems.

In fact, the owners of N424E had complained of precisely such a problem: The right wing tank did not seem to hold as much fuel as it should. An experienced Lancair mechanic had determined that the outboard D-section of the right wing was not taking fuel and drilled additional holes in the wing structure in an attempt to correct the problem.

After the crash, there was considerable confusion over the actual fuel capacity of N424E. NTSB investigators based their initial calculations on the 90-gallon capacity listed by Lancair, which would have put the aircraft into Flagstaff with one and a half hours of fuel remaining. Tony told the TATI engineer at lunch that the aircraft had an 80-gallon capacity, adding that the aircraft originally held only 72 gallons of fuel, but the problem was fixed and it now held 80 gallons (78 usable). That's presumably the figure he used to plan the flight.

Post-crash investigation suggests the correct number may have been 72 gallons. Examination of the right wing revealed that a critical 1/4 inch hole in the main spar that serves to vent the outboard D-section, was not present in N424E. This means that air had no way of escaping from the outboard D-section, and the entrapped air would prevent fuel from filling that section. This would account for the 8-gallon loss of fuel capacity.

THE FUEL TANK AREA OF THE WING INCLUDES A NUMBER OF WING RIBS.

Still, this alone does not provide a complete explanation of the crash. Based on the 15 gph cruise fuel burn figure that Tony quoted, I calculate that the aircraft should have burned about 62 or 63 gallons of fuel from the time he departed Ada to the time he crashed a couple of miles short of the runway at Flagstaff. Even assuming the most pessimistic fuel capacity figure for N424E (72 gallons total, 70 gallons usable), Tony should have landed at Flagstaff with at least 7 gallons remaining—a half-hour's worth—not exactly legal IFR reserves, but not a flameout either.

In the probable cause report, NTSB investigators assumed a more pessimistic fuel burn of 20.5 gph (based on the engine performance charts found in the airplane), but those assumed ROP operation, and we're pretty sure that's not how Tony operated the airplane.

The airplane was equipped with an Archangel engine fuel data system, and Archangel was able to extract stored data from the system's non-volatile memory. The final fuel totalizer value was 14.8 gallons. That's presumably how much fuel Tony thought he had left when the engine quit. Assuming he entered 78 gallons into the totalizer before takeoff at Ada, the engine most likely consumed 63.2 gallons, which agrees precisely with the 62-63 gallon calculation based on what Tony said about his powerplant management procedure.

SO WHAT REALLY HAPPENED?

So far, I've reported the facts as I know them from the NTSB factual report and other reliable sources who were involved in the investigation. In the remainder of this article, I will go way out on a limb and speculate shamelessly about what I think really happened. (Even if my speculation is wrong, the fact that it could have happened makes this a useful discussion.)

Let's theorize that when N424E was topped off in Ada, there were only 70 usable gallons of fuel on board (instead of the 78 that Tony believed), because there was 8 gallons worth of entrapped air in the right outboard D-section that couldn't get out.

As the aircraft warmed under the hot Oklahoma sun, the entrapped air would have expanded, displacing more fuel and forcing it out of the right tank vent onto the ramp. Air expands far more rapidly than fuel, which could account for why fuel was observed venting overboard from the right tank so much more rapidly than from the left tank.

Now let's theorize that Tony took off from Ada with the left tank selected (as was his habit) and climbed to his cruising altitude in the flight levels. The entrapped air in the problematic right wing would have expanded to more than twice its original volume. (Remember, air pressure drops by half going from sea level to FL180, so volume doubles.) So the entrapped air would now displace 16 gallons of fuel rather than the 8 it displaced at sea level, and an additional 8 gallons would have been expelled out the right wingtip fuel vent in-flight.

Under this scenario, the not-yet-selected right fuel tank would contain not 40 gallons (its assumed capacity) or even 32 gallons (what it probably actually held on the ground), but only 24 gallons. Total usable fuel becomes not 78 gallons or even 70 gallons, but 62 gallons—almost exactly the calculated fuel burn from Ada to 2 miles short of Flagstaff!

The accident airplane was equipped with both fuel gauges and a digital fuel totalizer. However, the fuel gauges were inoperative (Tony knew this), while the totalizer was working fine. It's reasonable to assume, therefore, that Tony knew precisely how much fuel he'd burned, but had no way of telling directly how much fuel was left in the tanks. Without working fuel gauges, he could not have detected the postulated in-flight loss of fuel.

WAS THIS CRASH SURVIVABLE?

After the engine quit, Tony apparently did exactly what you or I would have done in his situation: He turned the electric boost pump on "high" (that's where the switch was found in the wreckage) and tried switching tanks. When this failed to bring the engine back to life, Tony made a remarkable forced landing in a very small clearing, reportedly half the size of a football field. The composite cabin structure of the pressurized Lancair remained remarkably unscathed and intact.

Why didn't Tony survive the forced landing? Post-crash investigation suggests that Tony was not wearing his shoulder harness at the time of the crash, and on impact he wound up splitting his head open on the instrument panel. In a final tragic irony, there may be a very good reason that he wasn't wearing his shoulder harness: It was not equipped with an inertial reel, and it was reportedly impossible for the pilot to reach the fuel selector without first unbuckling the shoulder harness!

CAN WE LEARN FROM THIS?

It's easy to blow off these accidents as aviation's most unforgivable sin—something that only happens "to the other guy" because he (or she) just wasn't paying attention. None of us would ever do anything as dumb as running out of fuel, right?

Tony's accident provides a vivid counterexample. Here was a professional pilot, an ATP and CFI with four decades and countless hours of flying experience, who also turned out to be a renowned expert on the type of airplane he was flying, and even had lots of hours in the particular aircraft involved. He topped the tanks before takeoff. His preflight planning was unimpeachable. His only real sin was believing that his tanks actually held what the book said they should hold.

When was the last time you had your airplane defueled and then recorded precisely how much fuel it took to top off each tank?

I know, I know—you don't fly a Lancair, and your 1968 Skylane has fuel bladders, not integral tanks. But it's even easier for a bladder tank to have less-than-book capacity than for an integral tank. All it takes is a disconnected snap that allows the bladder to collapse partially in the wing bay, or an industrious mud dauber who decides your tank vent looks like prime residential real estate.

> **"THE ONLY FUEL GAUGE THAT MATTERS IS THE CLOCK." TO WHICH I SAY, "BALONEY!"**

No matter what sort of fuel system you have, it's absolutely crucial that you know the actual capacity of each tank, and that you recheck it on a regular basis to make sure something hasn't changed.

TRUST THOSE FUEL GAUGES?

How many times have you heard a CFI say something like this: "Ignore the fuel gauges. They're notoriously inaccurate, and basically worthless. The only fuel gauge that matters is the clock."

To which I say, "Baloney!" What if your fuel capacity isn't what you thought it was because you've got a collapsed bladder or a plugged vent? Or what if something has caused a bunch of fuel to siphon overboard in-flight? How accurate a fuel gauge is your Rolex then?

To my mind, fuel remaining is too important a parameter to measure solely with one instrument or one technique. The clock and fuel-flow gauge (which is essentially a poor man's totalizer) do indeed provide the primary method of keeping track of fuel used, but the fuel quantity gauges provide an essential cross-check by measuring actual fuel remaining. If there's any disagreement, I will trust whichever method (clock, totalizer, or fuel gauges) gives the most pessimistic answer, and make plans accordingly (including landing short of the planned destination if there's even the slightest doubt about fuel reserves).

Of course, if you're going to use your fuel gauges as a cross-check, then they actually have to work—and they have to be reasonably well calibrated. Actually, it's not terribly important for the fuel gauges to be anywhere close to accurate when the tanks are full, so long as they're in the ballpark when the tanks are approaching empty.

SHOULDER HARNESSES

Finally, seat and shoulder belts often make a life-and-death difference in a forced landing. While I've never known a pilot not to buckle up his or her seat belt prior to engine start, I'm amazed at how often I see pilots fail to use a shoulder belt, or even see them consciously disconnect it. Bad move!

In the event of a crash, don't count on buckling up at the last minute—believe me, that shoulder belt will be the very last thing on your mind. When your head slams into the instrument panel on impact, the fact that your hips were securely restrained won't matter much.

If you have to disconnect your shoulder belt to reach the fuel selector, cowl flap handle, or some other important control, then replace your shoulder belt with a better restraint system. Inertial reels are an absolute must-have in most airplanes. A full four-belt harness is a huge improvement over the automotive-style single shoulder belt in most spam cans.

Buckle up—and be careful up there. EAA

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