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The Aviation Consumer®

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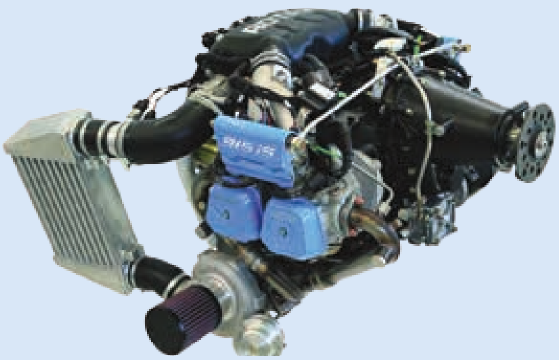

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The Aviation Consumer

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2018 MARKET PREDICTION: MORE AVIONICS GROWTH

With all the new avionics we reported on over the past year, readers have asked for my market predictions for the new year. Before looking into the crystal ball for 2018, it's worth a look at last year's performance of the avionics sector for clues. I'm cautiously optimistic looking ahead because buyers bought lots of avionics in 2017—$1.73 billion worth during the first nine months. This is according to the Aircraft Electronics Association (AEA), which has tracked sales numbers for the business and general aviation avionics market since 2013 through an independent third-party research firm.

The numbers prove that shops really are as busy as many of them report because 57.7 percent of the sales came from the retrofit market, while forward-fit sales (equipment installed by aircraft manufacturers) was 42.3 percent. This is a 4.1-percent increase compared to the first nine months of 2016. These numbers aren't based on the list price of equipment, but instead on net sales, and represent certified and non-certified panel-mounted avionics, portable avionics, billable equipment upgrades and also batteries, which seems an odd accessory to include in the tally. To me, batteries are gotta-have items, want them or not. And, the numbers don't include what consumers spent on repairs/overhauls, navigation data subscriptions and extended warranty plans. If you pay for nav data, you know it's real money. It's so substantial that I think data subscriptions alone would boost the overall $1.73 billion figure considerably. According to the companies that separated total sales figures between North America and other international markets, 73.5 percent of sales during the first nine months of 2017 were U.S. and Canada.

The uptick in sales isn't surprising to me because the majority of avionics shops I've spoken to over the past year enthusiastically report a scheduling backlog for major work. But many attest to struggling through some lean years, and some shops that were mismanaged didn't survive. Still, with all the talk of a shrinking overall market, why the boom in avionics? For one, there is a lot to buy, including low-cost glass (that's Dynon's STC'd Skyview for Skyhawks in the main photo), well-equipped autopilots for under ten grand and way too many choices of ADS-B gear. The 2020 ADS-B mandate is at the two-year mark, but I know plenty of owners who still haven't upgraded.

I asked Jessica Koss at Garmin for her take and she believes ADS-B upgrades are driving the sales boom because buyers are adding on other equipment during the install for convenience. The low-cost G5 EFIS is one popular add-on, Koss said. Over at Avidyne, CEO Dan Schwinn had similar thoughts, crediting ADS-B compliance for sparking other upgrades while the aircraft is down. Avidyne reports strong demand for its new IFD550 navigator. We'll have a report coming up. Jessica Power at Power Aviation Strategies, a new marketing firm specializing in avionics shop branding, predicts a strengthening of the shop network.

But forget about products and more good places to have the work done. This latest boom is a trend I've witnessed before and I think it reflects a strong stock market. Disposable money, perhaps. As I write this, the Dow Jones sits at 23,557. On this day in November 2012, it ended at 13,104. From experience, I know a strong market drives avionics and other upgrades. In the past, when stock portfolios were healthy, buyers wrote big checks for avionics and other improvements. What comes to mind is the era when Garmin's GNS530/430 radios were flying off the shelves faster than shops could reorder. At the time, I marveled that owners of aging entry-level piston singles were writing $50,000 checks for the latest and greatest avionics gear simply because they could, even if it meant the airplane would be upside down in value. That bubble eventually burst and a lot of those owners lost big when used aircraft demand tanked. That might happen again, but with luck, lower-priced avionics will lessen the sting. —*Larry Anglisano*

REAL ANNUALS

I read with interest, as I tend to do with all things aviation, the article in the December 2017 *Aviation Consumer* about Premier Aircraft refurbishing Piper Dakotas. I was enjoying it until I read the part about Dakotas not getting "real annuals."

I have no vested interest in this area, but I do feel that the statement is insulting to field mechanics everywhere. I have owned a number of planes from different manufacturers and they have been serviced by both service centers and field mechanics. Personally, I have experienced some of the worst service from authorized service centers. I have found under my cowling rags and plastic cups. How about watching a mechanic come at your windshield with brown paper towels from the men's room to clean it for you? I've also dealt with repairs not done correctly, which had to be redone by my local mechanic. I ultimately got a full refund from the service center, but my plane was down for additional time. Spending extra money for the privilege of a service center is no guarantee of better work.

Right now my Piper Matrix is at a service center getting an annual for the first time since I have owned it. We shall see if it is a "real" one.

Dr. Stephen M. Saracino
via email

While Premier's view may have a whiff of sales hyperbole, it's unrealistic to think the overall maintenance state of the GA fleet is good, especially for older airframes of lower value. Whether maintained by a service center or not, we think older airplanes are often poster children for deferred maintenance, missed or poorly complied-with ADs and undocumented repairs.

AN EXPERT ON THE PITTS

One of my students showed up with the November 2017 *Aviation Consumer*, which included your review of the used Pitts Special. I was prepared to be nitpicky because writers have a terrible habit of mixing facts with opinion when it comes to my biplane baby, so I had my electronic red pencil out ready to fire away some corrections. I was amazed that I didn't want to use it once. You guys did a super accurate job and represented the airplane fairly, and I applaud your writing and research mightily.

The only minor point is that you bought into the it's-small-so-it's-twitchy syndrome. In actuality (this is the aero engineer in me, not the Pitts instructor, speaking) aerodynamically, the airplane falls right into the rule-of-thumb ranges in terms of length and gear width design. What makes it quicker on the ground is that it touches down so fast. In the best of calm days, we're touching down around 70 to 73 MPH, so the "velocity squared" thing comes into play. Put 15 MPH of wind on the nose so we're closer to Citabria speeds and the airplane is a pussycat.

I probably shouldn't make the next statement because it's bad luck: I'm coming up on 7000 hours in type and over 6000 in the pattern at roughly six landings per hour and so far haven't put a mark on a Pitts (if you don't count hitting six Canada geese on takeoff). But, as I'm fastening the belts, 100 percent of the time I hear myself saying "Is this the flight that's going to bite me in the butt?" The airplane keeps you focused and completely honest and the challenge never goes away. That's what most of us love about it.

The reason people have problems with the airplane on the runway isn't that it's supposedly "squirrely," but because the average pilot's basic skills have eroded over time. Put the airplane on square, with no drift, and it'll roll straight.

But, if the pilot isn't keeping the ball in the center and makes a nearly perfect approach, it'll chase his butt all over the airport. Ground handling problems are the result of approach problems.

Budd Davisson, Plus 5 Aviation LLC
Phoenix, Arizona

GARMIN G5 EFIS INTERFACES

In your budget EFIS shootout article in the January 2017 *Aviation Consumer*, you said the Garmin G5 display would accept input from the company's WAAS panel navigators in lieu of installing a dedicated GPS antenna for the built-in GPS. The G5 STC installation manual says the input format for the remote GPS data stream needs to be set for MapMX format 1.

The Appareo ESG transponder has a GPS that transmits over a RS-232 serial bus, but there's no mention if this is a pass-through of the encoder's altitude, the ESG antenna signal or something else that just might interface with the G5 and save installing a dedicated antenna for it. I'd like to know. Appareo hasn't a clue and Garmin won't talk anything but Garmin.

John Siebold
Boise, Idaho

That's a popular question. Garmin tells us the G5 is only approved for connecting to an external GPS that outputs the proprietary MapMX data label.

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Rotax 915 iS: Incremental Power Boost

At 135 HP, the 915 iS expands the basic 900-series platform. Searey will offer it as an upgrade for kit aircraft and possibly S-LSAs.

by Paul Bertorelli

Aft of the firewall, a new Cirrus SR22 is the epitome of the technologically advanced aircraft. But the front end of the thing is pretty much frozen in the mid-20th century: old-school mechanical fuel injection, World War II magnetos, manual mixture control. This is so because buyers have wanted it this way; a Star Trek flight deck propelled by a '59 Buick engine room.

Pushing against this reality is Rotax, a company whose main menu is populated by sophisticated recreational engines with a sideline in airplane motors. From this unique mix comes the latest Rotax foray into bleeding-edge engine technology: the Rotax 915 iS. As we go to press this month, the engine is in the final stages of being wrung out in several airframes, including a Searey amphibian we flew in Florida.

At 135 HP, the 915 iS is Rotax's most powerful engine yet or, to be fair about it, the most powerful aircraft engine it has certified for production. Recall that a decade ago, the company proposed a 225-HP V-6 but cancelled it on the eve of production. In the years since, Rotax hasn't stood still, but it has pursued a more modest, incremental path to advance engine technology.

MORE POWER

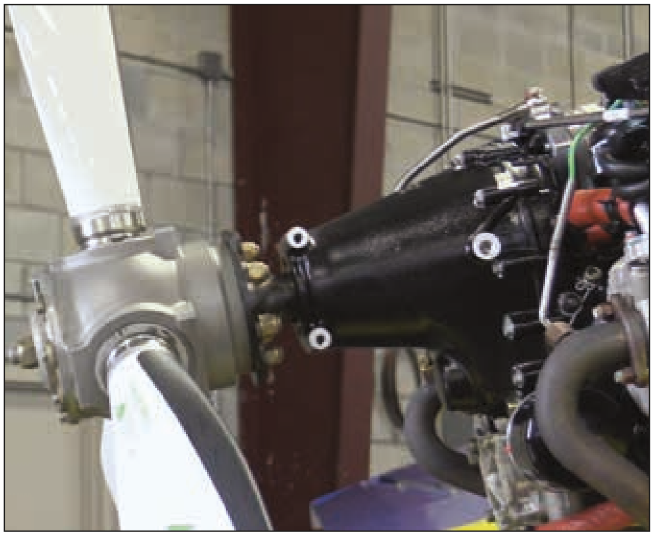
Rotax surprised everyone by introducing the 912 iS in 2012, then followed that with a Sport model that has improved induction for higher takeoff torque. The 912 iS has the same 100 HP as the 912 ULS, but it offers fuel injection and improved electronic engine management that make it substantially more efficient than the ULS. While the 912 iS hasn't become the de facto standard for light sport aircraft, it has achieved significant market penetration.

The 915 iS builds on that very same platform, but it does deliver more power, up to 135 HP according to the published specs. Rotax's Marc Becker told us initial demand for the engine comes from the robust European gyrocopter market and from companies envisioning light four-place aircraft.

One of these is the French company Issoire, whose APM 40 Simba is a test bed for the 915 iS. (Don't feel diminished if you've never heard of it; we hadn't either.) More familiar is the Progressive Aerodyne Searey, which is also a test-bed aircraft in a joint effort between Rotax, MT Propeller and RS Aerotech, which is developing an engine monitoring unit specifically for the 915 iS. The engine had flown more than 100 test hours when we trialed it off the water at Searey headquarters in Tavares, Florida, in November 2017.

It's fair to say the 915 iS is a stretched version of the 912. It uses

In the Searey installation, the 915 iS requires a radiator with a scoop, right. The intercooler is immediately behind it angled into the slipstream. The 912 iS has a new design gearbox and a constant-speed prop, middle photo. RS Aerotech provides a sophisticated data recording engine monitoring system, lower photo.



the same basic mechanical platform, with four cylinders cooled by a combination of water jackets and airflow. The heads have been tweaked to improve cooling around the valves, a change that makes sense given that the additional horsepower is coming from turbocharging, not additional displacement or stroking.

The 915 iS crankshaft follows the standard Rotax motorcycle-style design of multiple components pressed together, with single-piece rods inserted onto the crank journals rather than rods with big-end caps. The 915 iS has slightly larger crank journals to accommodate the higher power. It also has forged rather than cast pistons whose bottom surfaces get additional cooling through oil spray.

Like the 912 iS, the engine has electronically controlled dual-port injection, but not the direct injection found in many automobile engines. Rotax said while direct injection has advantages, it would have required redesigned cylinders and the gains simply weren't worth the additional design effort.

TWEAKING THE 912

Ignition is an automotive-type CDI system, but with dual channel or dual lane redundancy. This is transparent to the pilot in the form of a pair of annunciator lamps in the cockpit that confirm the health of each lane. No specific runup is required, just a switch check to confirm that both channels are working.

The 915 iS gets a further performance kick from the addition of an intercooled turbocharger and a constant-speed, three-blade prop from MT. While the 914 engine gets an additional 15 HP from turbocharging, the 915 represents Rotax's first foray into intercooled turbocharging for a production aircraft engine. The 915 uses a similar engine control unit as the 912, but it was obviously tweaked to include a turbocharger wastegate controller and an automatic prop control.

While all of that is built into the software, there's also a manual backup for the prop or, more specifically, an electronically controlled manual backup. The engine monitoring system will give the pilot the option of controlling the prop manually, although the final details of how that will work hadn't been worked out when we flew the airplane.

Like all of Rotax's four-cylinder aircraft engines, the 915 iS relies on small displacement (82 cubic inches) and high RPM—4800 RPM in cruise. That means it's geared, but here Rotax made a major change. The 915 has a redesigned gearbox that retains a crankshaft-protecting clutch, but it also has a torsion bar arrangement to damp prop and shaft harmonics. The gearbox is noticeably longer.

The extra power comes at the expense of weight, of course. The 912 iS dry weight uninstalled is 140 pounds, while the 915 iS weighs 185 pounds dry.

Installed weight will vary somewhat by installation. In the Searey, for example, the engine is installed as a pusher and has a substantial water radiator with a scoop and a fan. The intercooler is mounted aft of that, poked up into the airstream on the front of the engine. Other installa-

The higher power of the 915 iS, left, gets the Searey off the water in about 11 seconds, two seconds faster than the 914-powered version.

tions may or may not require similar hardware.

There's a yin and yang to the numbers here, which is to say pluses and minuses. The 915 iS's power-to-weight ratio is 0.72 HP/lb. while the 912 iS is 0.58 HP/lb. Looking at other engines in the Rotax line, the stalwart 912 ULS has a power-to-weight ratio of 0.80 HP/lb., using the Rotax dry weight data. The turbocharged 914, with its old-school carburetion, tops the line at 0.82 HP/lb. Actual installation numbers will change those calcs, but the dry weights show there's no free lunch when you add intercooling and turbocharging to what's basically a light engine.

Are these numbers better than the typical Lycoming or Continental engine? Generally yes, although engines from the legacy companies have a profusion of models and weights that complicate the comparison. At 125 HP, Continental's IO-240 is a fair apples to apples. It has a dry power-to-weight ratio of 0.49 HP/lb. Lycoming's 115-HP O-235 is a little worse, at 0.46 HP/lb.

It's not so simple as this, however. When radiators and all the associated plumbing are installed for the Rotax powerplants, the weight and complexity go up and so does cooling drag, variable with the type of airframe. Still, LSA manufacturers who have used all of the engine choices tell us that the Rotax engines are still the lightest and the Continental O-200 and Lycoming O-235 aren't always easy options. As for efficiency, we don't have reliable data on this yet. However, we would expect it to be similar to the 912 iS, which considerably bettered fuel economy over the 912 ULS.

The carbureted 912 ULS has a typical brake specific fuel consumption (BSFC) of 0.44, which is similar to typical Lycoming engines. According to Rotax's side-by-side data flown in a Tecnam P92, the 912 iS achieved 0.36 to 0.38 BSFC, which is among the best efficiency for gasoline engines and rivals diesel performance. We don't yet know if the 915 iS will turn similar performance.

But it has the technology to do so. The engine management system has a feature called Eco. Like motorcycles, the 915 iS uses throttle position sensing as a closed-loop input. Above 97.6 percent throttle position, the engine runs full rich or nearly. Below that, it runs in what Rotax calls Eco mode, in which case it leans to what European engineers refer to as a Lambda value, specifically Lambda 1.05. In rich mode, it runs at Lambda 0.88. For reference, Lambda 1 is a stoichiometric air-to-fuel ratio of 14 to 1; 1.05 is slightly lean of stoichiometric. The

SEAREY VS. ICON: AN ACCIDENT PREDICTOR?

In early November, the much-promoted Icon A5 suffered a setback when famed baseball star Roy Halladay was killed flying his A5 in Florida. The accident ignited criticism aimed at Icon for promoting low-altitude flight to neophyte pilots.

Icon has now suffered two fatal accidents in a fleet numbering about two dozen aircraft. While this is too few to make a meaningful judgment on accident patterns, a look at the Searey history might be illuminating as a predictor.

Progressive Aerodyne has fielded about 700 Seareys, most experimentals but some LSAs, too. We found 46 accidents, five of which were fatal. That's a fatality percentage of 11 percent or about half the GA average of 21 percent. Of the total Searey fleet, about 7 percent have been in accidents. Amphibians are routinely operated low over the water and sometimes over adjacent land, so you'd expect low flying to be a frequent accident cause. But we found only five accidents related to low flying and two of those involved wire or tree strikes. We didn't see a pattern of steep turns followed by a stall into the water or catching a wingtip and cartwheeling.

More common is the amphibious aircraft pilot's classic screwup: landing on the water with land wheels down. In seaplanes, this is frequently fatal, but far less so in flying boats. While Seareys have flipped in this circumstance, it's not common. More likely is that drag loads on the lowered wheels will damage the hull and the aircraft will sink. Other accident causes are a smattering of hitting obstacles in the water, smacking into docks, engine failures and the occasional stall/mush.

Once it has several hundred airplanes in the field, will the Icon accident history look similar? No one knows, but Progressive Aerodyne points out that its buyers tend to be experienced pilots. Icon, on the other hand, hopes to grow new pilots with a unique, easy-to-fly aircraft.

test aircraft we flew wasn't equipped with a percent power indicator so we couldn't estimate BSFC. We'll follow up on this data later when the engine is fielded.

POWER PUNCH

It's not often that you hear anyone say an airplane is overpowered, but that was initially the case with the 915 iS Searey. Test pilot Daniel Nickens told us during the initial flight trials, the airplane accelerated so abruptly with the 915 iS that the nose was forced down into the water, killing the acceleration.

Like any high-mounted pusher engine, the Searey has a slight nose-down moment when power is added, but it can be overcome with elevator control or, in the case of flying hulls, the buoyancy of the hull. Nickens said the power onset had to be dialed back to keep this from occurring.

We flew both the 914-powered Searey Elite and the test-bed 915 iS aircraft for comparison. The performance difference is noticeable, but not night and day, at least on takeoff. We timed the 914-powered aircraft at about 13 seconds, while it was 11 seconds for the 915 iS airplane. We noticed no unmanageable pitch-down moments during any phase of flight. With the constant-speed prop, the 915 aircraft is faster—much faster.

With full throttle at about 1500 feet, the airplane was indicating over 110 MPH and still had something left. The 914 aircraft indicated about 101 MPH at full throttle. Typical cruise speed would be closer to 90 MPH and with 23 gallons aboard, that's 4.5 hours with reserves. The 915 aircraft should have comparable, if a little shorter, legs.

With its electronic prop control and automatic leaning, the 915 iS is single lever and like the 912 iS, there's no runup function. You simply start it, warm it up and check that there aren't any faults in the dual-lane ignition system. The test aircraft we flew was equipped with a device called an EMU915iS, a sophisticated engine monitoring system developed by Stock Flight systems.

In addition to recording all of the engine's critical parameters, Peter Stock told us in its final production form, the EMU will automatically download recorded engine data for forwarding to Rotax whenever it's within range of an appropriate data network. Rotax may eventually offer ongoing engine analysis and likely predictive fault and maintenance tracking for its engine customers.

For pilots who say they want cutting-edge engine technology, the 915 iS qualifies, in our view, even if it's a derivative design. Continental's diesels have comparable electronic controls, but they're hardly making much of a dent in the market and they employ previous-generation automotive technology. Lycoming's IE^2 engine goes to the same place, but isn't fielded yet.

OFF TO MARKET

As for the 915 iS, the market may not be readily visible. Searey, for example, faces a dual challenge in an engine that pushes the airplane above the 1430-pound LSA limit and of also gaining approval for a constant-speed prop. It plans to petition the FAA for a waiver on both of these items. Meanwhile, once the engine is approved and in production—which it is expected to be within two or three months—the company can offer it in the kit version of the Searey.

No prices have been announced yet so we don't know what the upsell price of a 915 iS-equipped airplane will be. In the LSA market, buyers have typically opted for high-priced, fully loaded airplanes. When we asked Progressive Aerodyne's Kevin Oaks if he expects the same with the 915-powered Searey, he replied that the company isn't sure what the response will be. His best guess was that one in five customers might pay extra for the larger engine.

Complicating the decision may be that the company's least expensive airplane, the Searey Adventure (formerly the Sport) is also the lightest and a strong performer, even with the 100-HP 912 engine. It has a steam-gauge panel.

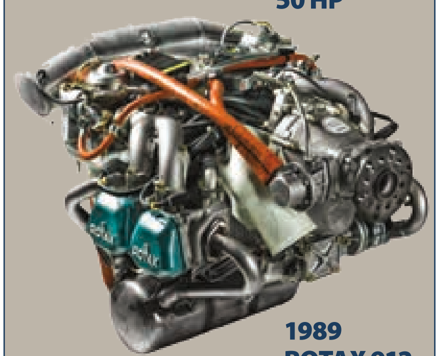
But Kerry Richter, a Progressive Aerodyne co-founder, says the company sensed an interest in the market for higher performance and that the 915 iS made it possible to achieve that while retaining the airplane's characteristic simplicity. A year or two from now, they'll know if the bet paid off.

YouTube See a video review of the Rotax 915 iS at http://tinyurl.com/j95ht2a

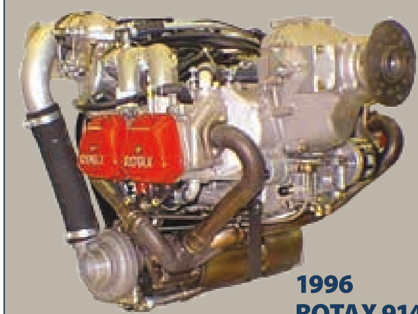
ROTAX: A SHORT HISTORY

LATE 1970s
ROTAX 447
42 HP

EARLY 1980s
ROTAX 503
50 HP



1989
ROTAX 912
80/100 HP



1996
ROTAX 914
115 HP

2012
ROTAX 912 iS
100 HP

Window Replacement: Options Abound

When it's time to replace your acrylic windows options include thicker material, numerous tints and infrared-blocking materials.

by Rick Durden

Despite pilots' most intense desires, airplane components wear out. Fortunately for their wallets, the major stuff on general aviation airplanes that are hangared and flown a few hundred hours a year—the airframe parts and pieces—should last the better part of a century. Along those lines, the things used by pilots to see through portions of the airframe, the windows, generally have a useful life measured in decades.

I'll note here that the windows on your airplane probably aren't glass, they're acrylic, though I'll sometimes use "glass" as a shorthand term. The enemies of acrylic windows are sunlight, dust, chemicals and scratches.

John Zofko Jr., founder of Great Lakes Aero Products, one of the big three aircraft window manufacturers, told me that a reasonable expectation for the life of the windows of an airplane that is hangared is 30 years. If the airplane is tied down, plan on 10-15 years. Scott Utz, proprietor of Arapahoe Aero on Denver's Centennial Airport, advised me that, in his experience, aircraft tied down at high-altitude airports, with their more intense sunlight exposure, need window replacement near the bottom end of his estimated life span. In addition, the longevity of acrylic depends on how it's treated.

WHEN TO REPLACE?

Your glass should tell you when it needs to be replaced. Crazing, which is just a lot of little cracks in the acrylic, and milkiness, the whitening that comes from exposure to sunlight, affect your ability to see out of the airplane. Aging glass will manifest itself to you when flying into a low sun or at night. That becomes a hazard—you can't see obstructions and may be unable to safely make a landing or takeoff into a setting or rising sun.

In addition, don't think that crazing is a cosmetic matter that you can ignore by flying only when the sun is high—those cracks that create the effect also are weakening the acrylic.

Delaying replacement can have serious financial repercussions—the sealant around the glass deteriorates and/or windows simply loosen up in their frames with the passage of time. That means rainwater will seep inside the airframe—creating a high probability of corrosion. This is of particular concern on older Mooneys, but certainly isn't limited to that marque.

There is almost no guidance on what is acceptable wear and tear on the windows for unpressurized airplanes built before the late 1990s. The manufacturers provide no criteria as to service limits, so one has to look to FAR Part 43.13's inspection criteria—and it's nearly silent on the subject.

Later airplanes have published tolerances regarding crack lengths and locations on windows, but deal with crazing and milkiness by providing guidance on clarity and line of sight and deferring to the judgment of maintenance technicians.

WHAT'S AVAILABLE

There are a surprising number of

CHECKLIST

- (+) UV- and IR-blocking tints can increase the lives of cabin interior materials.
- (~) While glass on hangared airplanes can last 30 years, plan on 10-15 if tied down.
- (−) Improper care and cleaning can shorten acrylic life dramatically.

New windshield halves being installed on a Piper Cherokee.

CLEAR (UNTINTED) WINDSHIELD SELECT PRICE COMPARISONS BY THICKNESS (INCHES)			
AIRCRAFT	LP AERO PLASTICS	GREAT LAKES AERO PRODUCTS	CEE BAILEY
BEECH V35A BONANZA	$1357 (0.250) $1989 (0.312) $2166 (0.375) $2592 (0.500)	$1081.84 (0.250) $1587.70 (0.375 outside milled) $1729.04 (0.375 inside milled)	$849 (0.250)
1969 CESSNA 172	$630 (0.125) $683 (0.187)	$502.77 (0.125) $504.13 (0.150) $505.50 (0.187)	$528 (0.250)
1970 CESSNA 310Q	$1645 (0.250)	$791.63 (0.250)	$682 (0.250)
1973 PIPER ARCHER (two-piece windshield)	$252 each (0.125) $274 each (0.187)	$193.48 each (0.125) $220.73 each (0.187) $249.34 each (0.250)	$168 each (0.125) $205.85 each (0.250)
1975 PIPER SENECA II (two-piece windshield)	$228 each (0.125) $262 each (0.187)	$218.00 (0.125) $249.34 (0.187) $316.10 (0.250)	$225 each (0.125) $271 each (0.250)

options available for replacement glass. In many cases you'll be faced with a choice of tint colors (or no tint) and, in many cases, a range of thicknesses.

Depending on the vendor, color choices may include clear, green, gray, bronze and blue. Figure on a 20 percent and up price bump for tinted glass. During my search of options, I saw tints that allowed transmission of as little as 10 percent of ambient sunlight—but only for the side windows behind the pilot. For the windshield and front windows, there is a safety issue. FAR 23.775 specifies a maximum degree of tint—the acrylic must allow a 70 percent or greater light transmission. Manufacturers measure that with a light meter.

UV AND IR BLOCKING

One of the more exciting developments of the last 20 years is tint that blocks ultraviolet and infrared radiation. These are touted—accurately, from firsthand observation—to reduce the very real risk pilots face of skin cancer and eye damage that comes with flying. The IR and UV blocking tints should also reduce damage to interior plastics and fabrics, as well as keep solar heating of the cabin down. Ordinary tinting does not block UV and IR radiation.

During a visit I made to Great Lakes Aero Products, a UV light was shined through windshield material onto a piece of paper. As shown in the photo on the next page, the paper fluoresced. As also shown in the photo, the SG (solar gray) tinted acrylic dramatically reduced UV transmission.

The UV and IR blocking tints are 25-75 percent more expensive than untinted glass.

THICKNESS

Increasing window thickness reduces cabin noise. In testing *Aviation Consumer* did in a Mooney in 2007, measurements showed that cabin noise level was reduced from 1-3.5 dB, depending on the location within the cabin.

A side benefit to a thicker windshield is strength. While I could find no test data, I did read accounts of airplanes with relatively new, thicker replacement windshields withstanding bird strikes that may have broken through original-thickness windshields.

Depending on the airplane, thicker glass may need to be milled around the edges to fit in the opening designed for thinner glass. In some cases a thicker window can be ordered from the manufacturer; however, the manufacturer may expressly indicate it does not recommend that particular installation.

Increased thickness adds about three pounds to the weight of a full set of replacement glass.

THE REPLACEMENT PROCESS

The process of replacing glass means doing what is necessary on the airframe to get at the existing glass—that may mean anything from simply folding back or removing interior fabric or plastic to a major excavation chore on some composite airplanes. The glass is removed, the area cleaned up so there will be a good seal with the new installation and the new glass installed.

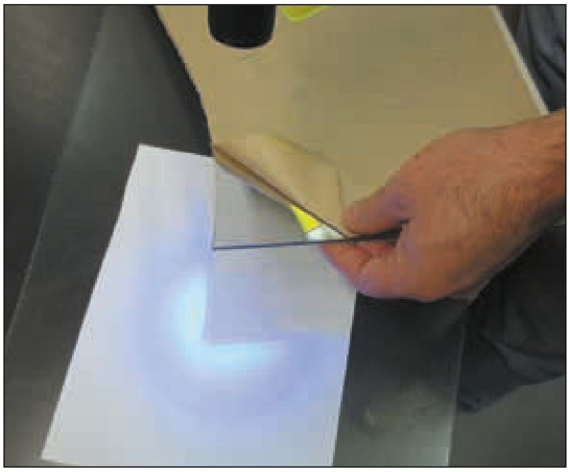
As I was doing the research for this article I was impressed by the amount of information made available by the window manufacturers for those who are doing the installations. I also noted that in many cases, it's necessary to provide the manufacturer with the aircraft serial number to ensure it gets the correct glass and fit as the aircraft manufacturers often made small changes over the course of production of a particular model.

The method of sealing the windows varies with the manufacturer. Cessna uses a felt seal that must be replaced with the window—the seal itself can wear out. According to Scott Utz, it's not unusual to see windows that are loose within their mountings because the seal is gone. Piper's felt seal is similar to Cessna's. Beech uses a permagum seal that is akin to strips of caulk. Cirrus has a sealant that is similar to fuel tank sealant and easy to work with.

HOW LONG DOES IT TAKE?

Shops I spoke with gave ranges for glass replacement. For a Cessna 172, figure on a windshield install to run 24-30 hours; all glass 50-60 hours. The 172 windshield is tricky—both to make and to install—because of all the compound curves.

A Piper Arrow windshield runs six to eight hours total; it can be



A replacement windshield ready for installation on a Piper Apache, above. Paper struck by UV light fluoresces, below. The portion of the UV light passing through UV-tinted, solar gray acrylic windshield material was largely blocked; the paper did not fluoresce.

done in a day. All glass usually takes about 20 hours. Piper is the easiest to replace because just a little bit of the interior needs to come out.

In general, older Mooneys are easier than newer—the newer, cleaner airplanes have more bodywork to deal with.

I was told repeatedly that the most difficult glass work is on composite aircraft—particularly on the Cessna 350 and 400. An owner should figure on 100 hours for the windshield and 40 for each side window. The glass is put in place from the outside, the special glue used has to be heated and then kept at temperature for several hours, and cosmetic work including body filler has to be done and the area painted.

At the other end of the composite spectrum, the Cirrus series has glass that is fairly easy to replace—for a composite airplane. The work is all done from the inside.

I heard some horror stories of inexperienced shops that either spent an inordinate amount of time on installations, did them poorly or couldn't do them at all. My suggestion is to make sure your shop has installed glass on your type of airplane.

CARE

Whether you are dealing with new replacement glass or your existing acrylic, the care is the same. Do not use any harsh chemicals or ammonia-based cleaners when cleaning the acrylic—I was told of people who used lacquer thinner, wood alcohol and abrasives to clean their windows and then were puzzled as to why their windows became nearly opaque.

The manufacturers recommended mild dish soap mixed with water and rubbing the window with one's bare hand (no jewelry) as the best method. If a cloth is used, it should be soft and non-abrasive. The manufacturers' websites have good information on cleaning and protection.

The May 2015 issue of *Aviation Consumer* had a review of windshield cleaning products that offered both cleaning and rain protection—Plexi Klear, All Klear and 210 were the top picks.

COVERS AND SHIELDS

For protecting the windows and windshield, some shops I spoke with liked external covers; others didn't like them at all. Everyone agreed that if used, they have to be tight and keep dust out. A cover flapping in the wind will damage acrylic quickly, especially if there is any dust under it. The chemicals used to bond the interior material to the outside cover of some will migrate through the cloth to the acrylic and damage it. Sewn rather than bonded covers were recommended.

I received conflicting recommendations on sunshields. Some told me that they hasten acrylic deterioration because the UV rays go through the glass and then are reflected back out, doubling the effect. Shades should not have any metal surfaces that come into contact with the acrylic.

CONCLUSION

Window and windshield replacement is a fact of life for aircraft owners who cannot hangar their airplanes. The price of the replacement glass is almost always less than the cost of the labor for the replacement—so the savings gained in selecting a shop that has experience doing the work on your type of airplane may allow you to buy UV- and IR-radiation-blocking acrylic and could pay off in a longer life for the interior and you.

We think the benefits of an exterior cover or interior window shields exceed the risk—just make sure your cover doesn't flap or have dust under it and that your window shields don't have anything metallic touching the acrylic.

CONTACTS

Cee Bailey
800-788-0618
www.ceebaileys.com

Great Lakes Aero Products
888-826-2043
www.glapinc.com

LP Aero
800-957-2376
www.lpaero.com

Icom's New A25N: More Watts, Big Battery

Icom's latest-gen A25N portable transceiver has built-in GPS, an impressive high-power transmitter and a Bluetooth app interface.

by Larry Anglisano

In previous *Aviation Consumer* evaluations, Icom's A22 portable comm transceiver got high marks for durability, reliability and ease of use. After nearly a decade of use and abuse, a vintage A22 soldiers on in our own flight bag.

We like the Icom portables in part because a radio used for emergency backup should be easy to use in a pinch. Plus, it must have a simple feature set when used as a primary radio in lesser equipped aircraft.

So when we saw the list of gee-whiz features packed into the new A25N (a model that replaces the utilitarian A22)—we wondered if Icom ruined a good thing. To find out, we ordered the flagship A25N for a close look. Worth noting is Icom also offers the A25C, a stripped-down comm-only model. Here's a field report.

SIZE AND POWER MATTERS

Portable transceivers need to be easy to manage with one hand, small enough to stash in a map pocket and the keys and controls need to be friendly for fat fingers. In our view, Icom nailed the ergos with the A25.

Weighing 13.6 ounces with the rechargeable lithium ion battery and whip antenna attached, the waterproof radio's chassis measures 5.8 inches high, 2.3 inches wide and 1.3 inches deep. You'll have to remove the long antenna to fit the A25 into a dedicated radio pocket of a flight tote, but we think the A25 is just the right size. The keys and knobs are signature Icom, which is to say they have a high-quality, rugged feel.

The A25 comes standard with an AC charging/power adapter (it doesn't use a USB cable) and charging time is roughly three hours. There's a convenient drop-in charging base as standard and also an optional cigar lighter plug. With lots of users switching to USB panel power (either hard mounted or with an adapter), we wish the A25 had a USB charging option. Battery endurance is listed at roughly 10 hours, but expect less when transmitting. Current draw during transmit is less than 1.8 amps. Still, we think that's impressive endurance. There's an optional battery case that accommodates six AA alkaline batteries.

Icom increased the transmit power output in the new A25 to 6 watts, compared to 5 watts in the old A22—which was already a decent performer. But the key to a transmitter's range isn't just about power output. It's the antenna that makes the difference between reliable communications at altitude and when using the radio around terrain, especially inside the cabin. What we're getting at is don't always expect the same performance as you'd get from a panel-mounted radio that's connected to an external antenna system.

The rubber antenna, which uses a quick-disconnect BNC connector, can be removed and the radio can be connected with a dedicated external antenna. If the aircraft is torn open for an avionics upgrade, consider

The A25N has good ergos and a large LCD display. That's the VOR nav function on the screen. The set's whip antenna is much taller than shown.

CHECKLIST

- **+** Good battery life and a 6-watt comm transmitter make the A25 worthy for primary use.
- **+** Like other Icom gear, it has a rugged build quality and generous feature set.
- **~** The GPS navigation function would be better if the radio had a built-in database.

The A25N feels right in the hand and Bluetooth performance with an iPhone 7 was good. That's a screen grab from the RS-AERO1 smartphone app.

installing a dedicated comm antenna on the aircraft's belly. The shop might run a length of coaxial cable into the cabin and coil it up in a map pocket or other convenient location, or take it one step further and install a panel jack for plug-in. Frankly, we think it's worth the investment.

The radio comes with a headset adapter (you supply the push-to-talk switch, though), plus the set generates transmit sidetone like a panel radio. Without the switch, simply key the PTT on the side of the radio, speak into the built-in microphone and listen to the audio through the headphones.

USING IT

The A25 has a large 2.3-inch LCD display, which has both a day and night mode. Sunlight readability is good and the screen won't kill your night vision in a dark cockpit.

The set has a useful battery status indicator for both the standard lithium ion pack and for the optional alkaline pack. It uses a simple graphic to show the charge status and also confirms the battery is charging.

Setting the desired frequency should be an easy affair and on the A25 it is. You can set the active frequency with the keypad or use the rotary dial at the top of the case. So you don't inadvertently tune it off frequency, you have to press the Function key, plus the keypad has a lock. The set also has a squelch level adjustment, and a dedicated onscreen squelch graphic shows the level that's set. One feature we like with the company's panel radio is the ANL, for automatic noise limiter, and it's standard in the portable. This helps clean up noise (engine ignition, for example) that might sneak into the comm receiver. When the receiver has a signal, RX is displayed. For emergencies, there's a dedicated one-touch 121.5 MHz key. Actually, it's two-touch because you have to hit the Function key to activate it. There's also a 300-channel/15-group storage memory bank, and you can name channels and assign them a type. This includes GND, CLR, APP and other comm and nav acronyms.

The transceiver also stores the previously selected frequencies. This is accessed with the Recall CH key, which sets the frequency after you select which one you want. This might be useful for fetching an updated ATIS when returning to the airport or quickly tuning back to tower or UNICOM frequency. The frequency storage bank is easily accessed with the MR (memory) key.

The A25's VFO scanning function sweeps every frequency on the 108.000 to 136.9917 MHz band, while a priority watch feature looks for and locks in the signal on a programmed priority channel.

If you still navigate with VORs, the A25N has a navigation receiver. When the nav band frequency is in use, the set displays a CDI screen with a basic compass rose, CDI, OBS value indicator, the heading to or from the VOR station and a TO/FROM indicator. The nav functions are accessed via the keypad by pressing the Function key and then the corresponding nav function on the 1,2,4,5 and 6 function keys.

We understand that Icom is trying to make this a full-featured navcomm of sorts, but we wonder how many pilots will make use of the old-school VOR feature. There's no glideslope receiver, as Sporty's builds into its SP400. It performed favorably when we reviewed it in the October 2014 issue of *Aviation Consumer,* in addition to the Yaesu Pro-X. Both are still offered.

What would seem more useful is GPS navigation and the A25N has it with an internal GPS/GLONASS receiver. But, we're disappointed that its functionality is shortchanged

ICOM A25N ERGOS AT A GLANCE

without an internal database. We dinged Yaesu's Pro-X portable for the same reason.

Icon takes the nav interface to a higher level with the RS-AERO1 app. With it you can build flight plans based on lat/long coordinates and then export the data to the A25N via Bluetooth for navigating. The radio's display shows estimated time enroute, speed over the ground, distance to destination and display range. It also stores waypoints in memory and saves transferred flight plans previously built on the app and sent over via Bluetooth, plus you can edit and delete them in the radio's Manage FPL menu. There's no topo map on the radio, but there is in the RS-AERO1 app.

One useful advantage is being able to add a point by touching its location on the app's map page and navigating direct to it with the radio. Maybe you're flying floats or skis and want to mark some play areas. It works, but we'd like to see this expanded with other mainstream apps that might add to the utility. There's also a search function for nearby ground navigation stations that have GPS position.

This is Icom's first stab at this advanced tech (frankly, it's expected on a radio in the over-$500 price point) and we think the Bluetooth in the new A25N is a good start.

The specs say the Bluetooth has a 33-foot communication range and that's plenty of performance for even the largest of cabins. To pair, push Menu and select Bluetooth Set from the Settings submenu and Enter. The radio paired easily with our newer iPhone.

The A25N also has 10 preset weather channels for receiving broadcasts from NOAA. The receiver automatically detects a weather alert tone on the selected weather channel, or while the unit is in scan mode. When an alert is received, the display alternately flashes WX and ALT. Accessing the weather mode is easy. Simply push the Function key and then the WX key.

SLIM COMPETITION

We think the A25N will easily survive at the top of the portable transceiver market. The closest and really only competitor with this many advanced features is the Yaesu Pro-X. After using both, we prefer the Icom's feature set and overall performance.

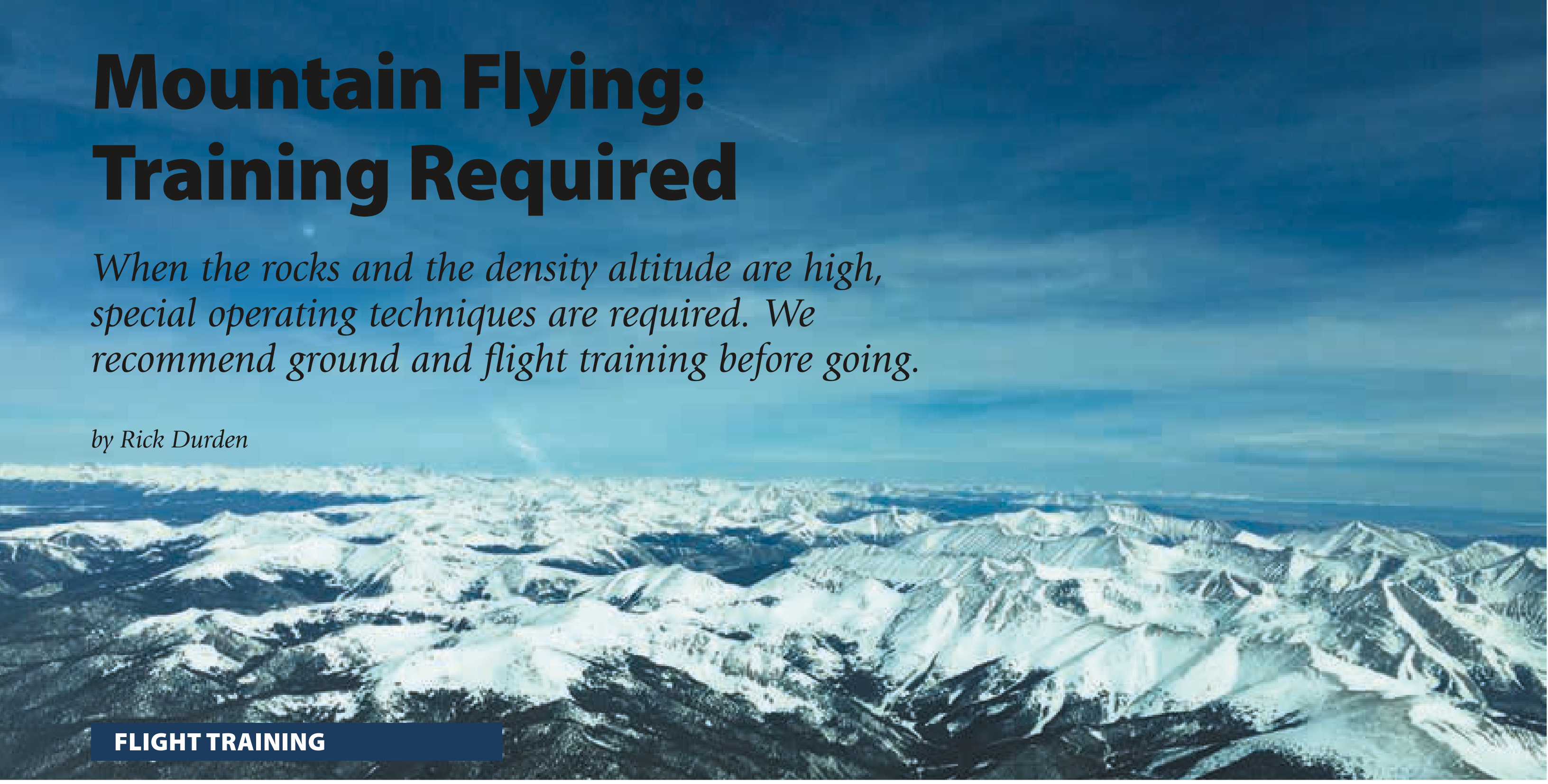
On the other hand, we wonder how many pilots will make use of all its features. Many we've surveyed attest to only wanting easy, reliable communications without having to navigate a deep menu structure, or dance around other supplemental features.

Still, there's only a $100 price delta between the $450 comm-only A25C and the A25N, which sells for $550. We think the flagship model's Bluetooth and app compatibility leaves room for future growth—something you'll sacrifice with the stark (by comparison) A25C.

Icom offers a variety of optional accessories including a remote antenna, a rapid battery charger, belt hangers and also the VS-3 Bluetooth headset (these are earplugs) with push-to-talk switch, which we didn't evaluate. The RS-AERO1 app for iOS and Android is free.

Contact www.icomamerica.com, 800-872-4266 in Kirkland, Washington. Our thanks to Sporty's (www.sportys.com) for providing the demo.

YouTube See a video overview of the Icom A25N at http://tinyurl.com/j95ht2a



Mountain Flying: Training Required

When the rocks and the density altitude are high, special operating techniques are required. We recommend ground and flight training before going.

by Rick Durden

FLIGHT TRAINING

The laws of physics and aerodynamics don't magically change when a general aviation airplane flies from the flatlands into the mountains, yet every year there are accidents in the high country where pilots tried to get more performance from an airplane than was installed. Pilots discover they can't get airborne on the available runway or hit obstructions after takeoff; they discover downdrafts exceed the ability of their airplanes to climb and hit mountain ridges; they hit the sides of canyon walls because they can't make a 180 in the available space; and sometimes their airplanes come to pieces around them because they decided to fly fast where there was severe turbulence.

So what's the big deal? Why do rated pilots continue to run into serious problems when flying in the high country? That was the question we posed to a number of mountain flying instructors. In this article we'll pass along what we learned from them, information on available training and what we think should be included in a mountain flying course. We'll say early and often that based on the research for this article, review of numerous accident reports and some years of flying in the mountains, we strongly recommend that anyone who is planning to fly over the mountainous areas of this country take ground *and* flight instruction in mountain operations before doing so.

We also note that backcountry operations—actually flying into the short, narrow, obstructed airstrips in the mountains—are a specialized subset of mountain flying and require additional instruction, in flight, not merely a ground course.

IT'S JUST PLAIN DIFFERENT

We wholeheartedly agree with AOPA's comment in one of its mountain flying publications in which it recommended getting a checkout from an experienced mountain pilot: "To do otherwise invites the label 'stupid pilot tricks,' and Western landscapes are already littered with aluminum carcasses put there by pilots who discover(ed) in the last minute of their lives that reading about some aspect of mountain flying—say, density altitude—is not at all the same as experiencing it."

In its Safety Alert, *Mastering Mountain Flying*, the NTSB wrote, "Pilots with limited or no training in mountain flying can be surprised about their aircraft's different performance at high density altitude, often leading to serious or fatal accidents." It went on to say, "Wind and other weather phenomena interacting with mountainous terrain often lead unsuspecting pilots into situations that are beyond their capabilities."

Mountain flying instructor Jer/Eberhard (www.jerslash.net) referred to a hypothetical Kansas pilot with a turbocharged Bonanza who was used to flying in the often howling winds of that state. He pointed out that those winds are horizontal and usually steady and said that it all changes when the pilot gets to the Mountain West and that wind becomes vertical due to the effects of flowing over the mountains. "Even if the pilot decides to fly at FL180 he can get into standing wave and experience a rate of descent of 4000 FPM at max power and best rate of climb airspeed."

DOWNDRAFTS

Eberhard said that dealing with a strong downdraft is not intuitive and requires that the pilot stick the nose down, accept an even greater rate of descent and fly fast to get through the downdraft. That applies at all altitudes in the mountains and requires training to do it safely.

Instructors told us that the combination of wind and reduced performance at high density altitudes are something a pilot has to experience and internalize so that she or he viscerally understands that the airplane may only climb at 200 or 300 FPM. And, what that looks like when close to the ground—it's hugely disconcerting that the nose has to be a lot lower in a full-power climb than the pilot is used to—and to think about it in how many feet the airplane is going to go

MOUNTAIN OPERATIONS TRAINING: THE FREE STUFF

While it's not true that every pilot in the world requires a crowbar to open her wallet, it is true that we tend to be unreasonably resistant to taking any training that isn't required by the regs (and much that is) and having to pay for it.

That being the case, we were delighted to find out that there is a lot of excellent information on mountain flying, and some on backcountry flying, available for free on the internet. We looked at everything we could find, including taking the interactive course we located. The following is a list of the free training materials and sources we reviewed that we think are good, solid starting points for mountain and backcountry training. We'll be blunt about the materials—while we think they are quite good and some are excellent, they are NOT a substitute for flight instruction from an experienced mountain flying instructor before you go flying among the vertical rocks.

• The FAA's *Tips on Mountain Flying*: https://tinyurl.com/y9bzes9e

• In the May/June 2012 issue of *FAA Safety Briefing—Rocky Mountain High: The Zen of Mountain Flying*: https://tinyurl.com/y7kkz7uy

• From AOPA—*Mountain Flying*: https://tinyurl.com/yax86jdf

• The Backcountry Pilot website (www.backcountrypilot.org) is full of frequently updated information.

•AOPA's *Mountain Flying* interactive course: https://tinyurl.com/yb9xw9vb. As with most AOPA courses, it's well presented, the quizzes require some thought to get the right answers and upon completion you get a certificate and FAA WINGS credit.

• In the 1960s the FAA made a film on mountain flying that, while it feels dated, we think is a very good reference today. It's available on YouTube in three parts: https://tinyurl.com/yc5vwyh5 takes you to the first and has links to the next two.

• The website of the Recreational Aviation Foundation (www.the raf.org) contains extensive information about backcountry airstrips and operations.

• The Colorado Pilots Association (www.coloradopilots.org) has a number of pages on its website with resources for those interested in mountain flying as well as a list of instructors.

• The website for the Idaho Aviation Association (www.idahoaviation.com) has information on backcountry flying—the state is famous for it—and a list of flight instructors. We like its motto: "Working to preserve Idaho's irreplaceable airports and backcountry airstrips."

• Finally, we like AOPA's Safety Advisor on Mountain Flying: https://tinyurl.com/yb9x342a

up in one mile.

Having a pilot calculate the distance that it will take for the airplane to break ground and how high it will be a mile beyond that point and realize that it may be less than 200 feet is an eye opener. Then having the pilot fly the profile and experience the reality is something multiple instructors said was one way for the effects of high density altitude—and airplane loading—to really sink in.

TRAINING AVAILABLE

There are instructors and flight schools throughout the Mountain West offering training in mountain flying and a few that give more advanced backcountry training.

A sampling of flight schools offering training revealed that most had dedicated training that took place over two days and included three to five hours of ground instruction and three to five hours of flight training. Almost invariably training could be done in the customer's airplane—although the schools usually required that it have a minimum of 160 or 180 HP. Cost for the courses averaged $1000 in the customer's airplane; if a rental were involved, it was $600 to $1000 more depending on the type of airplane.

Backcountry-specific training proved to be more localized to Montana and Idaho, largely due to the number of usable remote strips in those states. Mountain Airdance (www.mountainairdancellc.com), in Helena, Montana, has a dedicated backcountry course in a Super Decathlon at $170 per hour for the airplane and $70 for the instructor. Another is McCall Mountain Canyon Flying Seminars (www.mountaincanyonflying.com) in McCall, Idaho. It offers a series of dedicated "seminars" that range from two-day fundamentals courses to five-day excursions to backcountry ranches, campsites and resorts with prices from $2850 to over $7000. They will tailor courses to the individual pilot and offer instruction in a Super Cub, Cessna 182, T182 and Kitfox at prices starting at $240 per hour.

COURSE CONTENT

We came away from our research into mountain flying with the opinion that the starting point for learning to fly in the mountains is to read the late Sparky Imeson's *Mountain Flying Bible Revised*. Once that is completed, we recommend that any ground and flight training instruction for mountain flying should cover at least the following and include analysis of accidents due to each topic:

Density Altitude. In-depth discussion of the importance and effects of density altitude on aircraft performance including takeoff and landing distance calculations and rates of climb at various aircraft weights. Flights should include high density altitude takeoffs, climbs and landings at more than one airport at different temperatures.

THE BACKCOUNTRY: WHICH AIRPLANE?

As pointed out in the main article, backcountry flying is a more demanding subset of mountain flying. There are a lot of airplanes that are alleged to be good for backcountry ops. Most of them have been reviewed in this magazine.

I interviewed the proprietors of Northwest Backcountry Aircraft of Boise, Idaho, Kasey Lindsay and Bob Hannah—experienced backcountry pilots—asking for their thoughts as to what makes a good backcountry airplane. I've combined their thoughts along with reviews in this magazine of rugged, utility airplanes to come up with a list of attributes of a good backcountry airplane. By the way, that's an American Champion Scout on downwind for the backcountry strip at Sulfur Creek Ranch in the photo to the right.

Landing gear strength and stability. It has to absorb punishment from solid touchdowns as well as ever-present rocks, brush and holes. The brake lines should be protected as there's a good chance a gear leg is going to strike something that could break an exposed line.

The gear geometry should make ground handling as easy as possible and minimize the risk of noseover in tailwheel airplanes. The most common cause of backcountry accidents is loss of control on landing.

Good visibility over the nose during all phases of landing and takeoff. Hitting obstructions short of, on the runway and just after liftoff are common cause of backcountry accidents. An airplane that has the nose block forward visibility is at risk of hitting something. The nosewheel King Katmai is proving popular partially because of its good visibility over the nose. The design of a tailwheel airplane should allow a competent pilot to apply the brakes while the tail is off of the ground to allow good visibility over the nose and maximize deceleration.

Suitable stability in pitch to allow precise speed control on final.

Flaps should provide high drag and rapid deceleration so the airplane doesn't float if the pilot isn't perfect with airspeed control.

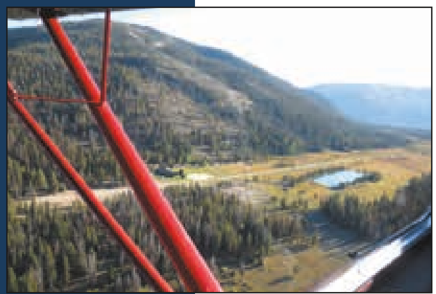
Power. Lots of it. When things go wrong, the ability to climb steeply and rapidly may mean everything. As Kasey Lindsay put it, the airplane has to be able to "climb like a rocket and come out of the sky like a piano."

No nasty behavior in a slip—and the ability to slip steeply, hold the slip into the flare and straighten out at the last moment.

Good prop clearance.

High wing for brush clearance.

Good visibility. When maneuvering for a runway in a canyon, a skylight means you can see what you need in a steep turn. Having lots of window area with few bars and posts that can get in the way is important—especially when looking down and aft, something you do surprisingly often.



Excellent control response in gusty crosswinds and the ability to pin the airplane after landing so a gust doesn't put it back into the air.

Easy access to the flap control.

Easy to use, fast-acting trim system. The ability to go around at the last possible moment, without a lot of trim change when going to full power in landing configuration—you don't want to have to be stiff-arming the stick or yoke while you're trying to get maximum performance out of the airplane.

A good mix between STOL ability and cruise speed. Sacrificing everything for STOL means a slow airplane in cruise.

The ideal backcountry airplane will handle a 500-foot strip safely and get there and back home without having to time the trip with a calendar or worry about running out of fuel.

The pilot should come away with an understanding that the aircraft performs at the density altitude, not the number the pilot sees on the altimeter.

Aircraft Performance. Building on the density altitude segment, this goes into detail on post-takeoff climb performance in feet per mile and what a pilot is going to see when trying to climb in a 1500 FPM downdraft. Takeoff calculations build in the effect of runway slope and surface.

We liked the approach taken by Dave Parker, proprietor of Northern Air (www.northernair.biz) in Bonners Ferry, Idaho. He applies a prerequisite to his training: ensuring the pilot can hold speed on approach and climbout within one to two knots. That's because it is necessary to be that precise to be able to land safely in the space available on mountain strips and to get all of the climb performance out of the airplane.

Takeoff performance calculations should include establishing an abort point on the runway. If there are no obstructions, the airplane must be at 71 percent of liftoff speed halfway down the runway.

Weather. For most flatland pilots, the idea that they can't go flying on a gorgeous summer afternoon sounds like utter nonsense. It takes getting pounded with mechanical turbulence so intense that there is concern about controlling the airplane and/or it coming apart for it to sink in.

In the Colorado Rockies the rule of thumb is that if the winds are out of the west at more than 20 knots at 12,000 feet, you aren't going flying because of the severity of the turbulence and the intensity of the downdrafts. Overall, when flying in the mountains, plan to be done for the day before noon. You've got plenty of time to fly in a day, you just need to start near dawn.

Training should include explanations and experience with where and at what altitudes turbulence is to be expected, slowing to Va for the airplane's weight to survive it and how to safely get out of it—there may be

Backcountry strips often require special techniques for arrival and departure due to terrain and runway conditions—that's Mackay Bar, Idaho, above. Even if the runway's paved, the airport can be challenging—Glenwood Springs Airport, below, is at an elevation of 5915 feet and the runway is not only the shortest paved runway in Colorado at 3300 feet, it has mountains on each side.

relatively smooth altitudes below the ridges or very high. Above the peaks and downwind, standing wave can be expected.

Because most mountain flying in nonturbocharged aircraft is carried out below the ridges—it's rarely necessary to go above 10,000 feet except to cross passes—cloud heights take on increased importance. If you need to cross a ridge that is 5000 feet above your destination airport, you'll want to have at least 1500 feet below you crossing it (and do so at a 45-degree angle so you only have to make a 90-degree heading change to turn away should you hit sink). However, if the airport is reporting what sounds like a good VFR ceiling of 4000 feet, you aren't going to be able to cross that ridge.

Training in local weather phenomena is important as is how to get information from remote weather broadcasting stations in passes and on mountain tops.

Weight. This ties in with performance; however, is important in its own right so that a pilot viscerally understands the effect of weight on takeoff distance and climb and knows that trying to operate at gross weight at high density altitude airports may be impossible

Route. Do not plan on going direct. Routes should follow terrain that maximizes forced landing spots and links to civilization. Much of the flying will be over valleys, but on the upwind side of a valley because that's where the updrafts are.

Physiology. Training in the effects on the body of prolonged flight at altitude—notably the risk of hypoxia and diminished cognition and quality of decision making.

Fuel Mixture. Discussion and inflight use of the mixture control. It must be leaned after start, then for max power on takeoff and during climb. On landing it should be set appropriately lean for a go-around.

Night Ops. In general, because you can't see the mountains, VFR at night should be flown using IFR techniques and procedures.

IFR. MEAs that are not far below the flight levels mean that if there is cloud, there is probably going to be ice, so IFR in IMC in piston-powered airplanes can be iffy. In addition, if your airplane cannot cope with a 4000 FPM downdraft, it's probably not a good idea to fly IFR in the Rockies. Several of the instructors we spoke with said they would not fly IFR in IMC over the highest of the Rockies in piston airplanes.

Survival. Your survival kit consists of what you have on your person—ideally in a vest. The bag you threw in the back may burn up with the airplane or otherwise be unreachable if you are injured. Your knife should be able to be easily opened and closed with one hand.

We covered survival vests in the February 2015 issue of *Aviation Consumer.*

Canyon Flying. On which side of the canyon to fly depending on winds to get the best performance out of the airplane along with appropriate speeds to fly to ensure that a 180 is possible should you need to get out. An effective training tool is to look at the shadow of the airplane on the ground and see how much ground the airplane covers when making a 180.

This gets more advanced with backcountry flying as a number of the strips used are at the bottom of canyons or steep valleys and cannot be seen until on very short final. That means the pilot has to have local knowledge so as to have the airplane properly configured and on speed at that point. A go-around may not be possible.

Airspace. There's a lot of special use airspace out west and firefighting TFRs can pop up on short notice. Training has to include how to find out about restricted airspace and stay out of it.

CONCLUSION

We've found mountain and backcountry flying to be some of the most enjoyable we've ever experienced.

However, even if a pilot is planning something as seemingly easy as following I-80 across Wyoming to Salt Lake City (Cheyenne, Wyoming, is on deceptively high, seemingly flat ground that bites a few pilots annually), we strongly recommend ground and flight training in mountain flying before going.

Not just for tire changes, the $288 Bogert Aviation Tribal floor jack, main image, was designed for aircraft with oleo strut landing gear.

Hangar Tools: Start With The Essentials

Tooling your hangar for light DIY aircraft maintenance should include good lighting, safe parts storage and model-specific specialty items.

by Jim Cavanagh

Whether you've earned the A&P rating to wrench your own aircraft or plan to tackle the FAA-approved light maintenance items you can accomplish as an owner, you need the right tools and workspace for the job.

But don't just think in terms of hand tools. While you'll certainly need them, there are other supporting accessories and space considerations that will make even the simplest of jobs possible. In this article, I'll offer my personal advice based on years of experience wrenching my own aircraft on where you might start.

MAINTENANCE TOLERABLE

A hangar is just a big room that you build, buy or rent until you start to work in it. At that point, it becomes an extension of you. First, decide just what you plan to do with this space and stick with that plan. I have seen hangars that are ratholes and ones that rival B-2 service bays at Whiteman Air Force Base. I know of one hangar that houses a Cirrus along with a mirrored bar, granite countertops and an office with ten-foot-tall, half-inch-thick glass doors where the owner conducts his business. A few bays down there is a hangar equipped with major parts from five Piper Cubs, a Luscombe, a vintage glider, a Cessna 172, several Porsches and tools that make Sanford and Son's junkyard look like an operating room.

The point is, everyone is different, but everyone is the same. It's the approach to wrenching your own stuff that makes the difference. That approach starts with good organization, and it's how good maintenance shops operate. You should follow their lead and start with effective overhead lighting, while considering where even the simplest items will be stored. Basic things like a stepladder, a sturdy stool, extension cords, portable lighting, a vice and a cabinet to hold paperwork, clipboards, office supplies and parts and maintenance manuals for your airplane will take space and need to be considered.

The focal point of your workspace will be the workbench. Every shop must have this go-to location equipped with good lighting, a vice and accessible hand tools. A bench that stands waist high usually works the best and it should have lots of toe space, plus enough surface area to accommodate parts bins for storing removed components and spare hardware. I always keep a lighted magnifying glass close at hand.

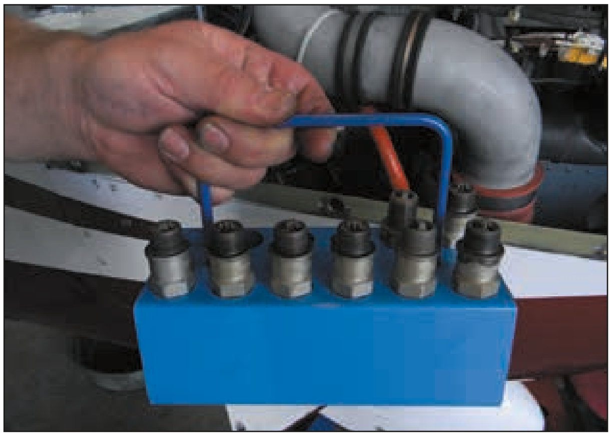
Speaking of lights, LED bulbs make it easier than ever to create a well-lit workspace and I think they're worth the investment. Some directly replace old incandescent lamps. You can never have too much light and for around $100, you can have a space that's as bright as daylight.

Obviously a heated hangar is important for tackling major projects in cold climates, but there are ways to make it more bearable if you don't have central heat. Insulation held in place by plywood with at least an 8-foot reach will offer some climate control, plus provide structure for securing shelves. At the least, it might tame cold drafts.

A propane heater might be enough to take the chill off in the winter and a ceiling fan might be enough to work comfortably in the dog days of summer. How you handle climate control is up to you, but the key is to create a space with enough comfort to make any maintenance tolerable in all seasons.

WORKING ESSENTIALS

A hangar used as a shop has to



The BatteryMinder, top, is key to battery health. A spark plug tray, middle, protects delicate plugs. A multimeter, bottom, is a gotta-have tool.

be comfortable and designed to be "handy." There has to be organized storage for everything simply to make it easy to find and to access stuff while you're working. Commercial or homemade shelving is a must, and a lot of mechanics work off of tool carts that hold the tools for the job, the parts from the job and can be rolled around the workspace.

I've found that a basic yet high-quality tool cart can be sourced at Harbor Freight Tools (www.harborfreight.com) for under $70. A low-profile, roll-around shop stool is a back saver. You might also consider a creeper for working around the underside of the aircraft.

Once you have the space set up, it's time to tool up. I'll say that you don't have to buy the best hand tools, although as the sidebar on page 21 describes, serious wrenching deserves serious tools. Still, you want higher-quality tools that will hold up and are dimensionally precise. If you've ever used a cheap screwdriver or socket and stripped a piece of hardware, you get it.

The majority of aircraft in the U.S. are mostly SAE, not metric (there are exceptions, including Socatas), and for starters, you will need 1/4- and 3/8-inch drive ratchets and sockets. You'll also want a torque wrench that is calibrated. The largest nut you will probably ever work with will be an axle nut or some nosegear nuts like you'd find on Grumman and Cirrus models. Based on how much you plan to tackle, you can figure out the rest of the standard hand tools you'll need. Again, don't source the cheapest quality tools. Breaking a tool in the middle of a job is bad enough; damaging a perfectly good airplane is a mortal sin!

If in doubt, I suggest sticking with Snap-On, Mac Tools and Kobalt, to name a few of the better brands, based on my experience. I discovered Wera Tools at the recent AirVenture and from what I saw, it specializes in ergonomically smart tools, including the Zyklop ratchet and Joker open-end wrench.

Something I think should be in every hangar toolbox is a multimeter. You know, the mysterious gizmo that has a red and black lead and either a digital readout or analog needle. While they look complicated (there are good tutorials all over the internet), the reality is that you will generally use three or four settings when working on your aircraft. All the rest of the numbers, blocks and sections are for more sophisticated work. Multimeters pretty much all work the same way—whether cheap ones or expensive ones—just with different degrees of ease. While many avionics pros will agree that Fluke (www.fluke.com) sets the standard, I simply recommend one that is sturdy, lighted and has an audible tone for the resistance mode. The two most used basic functions are to check for continuity and to check for a current drain or voltage.

For example, if you get a light that doesn't work, is it because the bulb is burned out or is there no power or ground? If you don't measure any power to bulb, it could be the switch, the circuit breaker or a broken wire. Proper troubleshooting even on the most basic level can't be accomplished without a meter. You should have one.

SPECIALTY ITEMS

Besides the basic stuff, you will need certain things that are specific to aircraft. Safety-wiring pliers and aviation-grade wire are a must. Snap ring pliers are also handy to keep close at hand. Like run-of-the-mill hand

A filter cutter, top, is an essential tool for oil changes. Checking spark plug resistance is easy with the Tempest AT5K tester, middle. That's a screen grab from a Bogert Bead Breaker tutorial, bottom.

tools, the specialty tools you stock will depend upon how deep you want to get into the work. I've found that most of what you will need for typical DIY work can be purchased from Aircraft Spruce and Specialty (www.aircraftspruce.com) and other specialty aircraft mail order suppliers, including Chief Aircraft (www.chiefaircraft.com), or directly from tool manufacturers like ATS, Cleveland and Brown.

Even tasks as rudimentary as oil changes can be better accomplished with the right specialty tools. This includes an oil filter torque wrench and an oil filter cutter for inspection of the media for metal contamination. If you use a spin-on filter, including a Champion, Aircraft Spruce offers a $88 cutter made for it. Other specialty tools for specific routine maintenance include a spark plug gapping tool, spark plug storage tray, plus a 7/8-inch deep well spark plug socket to get the plug unthreaded. Don't forget to stock the toolbox with anti-seize compound.

One gadget that gets high marks for simplicity is the Tempest AT5K spark plug resistance tester. This $130 tool (you can source one from Aircraft Spruce) is nothing but a simple resistance bridge with a go/no-go test protocol. Mount the plug on a probe, which connects the harness end of the plug, then touch the tester's lead to the center electrode. If the indicator glows green, the plug is good; if it's red and green, the plug is serviceable. Red means the plug's resistance is greater than 5000 ohms. If you don't want to spend the $130, you might use a multimeter to test the plugs, but the resistance probe might not easily reach the bottom of the plug's center well. Moreover, this isn't a replacement for bomb testing to confirm a clean spark.

Other handy accessories I keep in the toolbox are a set of punches, a full set of Allen wrenches and bits, plus a screw extractor set.

Once you have a healthy start with hand tools and specialty items, you'll want to look at the more esoteric stuff. For example, I've found that an air compressor is your best friend around the hangar. Whether it's a small pancake-style compressor or a large stand-up unit, eventually you'll be looking for compressed air to service tires, for spray cleaning and even paint touchups. The more work you'll do, you'll find the need for more compressed air.

If you plan to tackle your own compression checks (with the help of a qualified assistant) or even have your mechanic make a hangar call to perform an annual inspection, the compression test will require compressed air with the differential tester tool. Also realize that air tools—even cutting tools, ratchets, drills and buffers—require lots of air. Go big. Portable oil-free air compressors might range from $100 to over $500, while gas-driven compressors can run well over $1000. Grainger (www.grainger.com) is one good source for quality units.

ALL JACKED UP

If you work on tires or landing gear, or perform routine inspections, you'll have to lift the aircraft. I like the configurable Tribal floor jack from Bogert Aviation (www.bogertaviation.com). The company was started by Richard Bogert who for years ran a one-man shop and as a result, developed a number of intelligently designed and well-built tools to make the job easier. Many are designed with an emphasis on safety, especially when working on landing gear, tires and brakes.

Bogert has a simple tool for breaking the bead on a tire without damaging the soft aluminum or magnesium wheels. The $207 Tire Bead Breaker was designed specifically for small aircraft tires (although it can work on ATVs and motorcycles) and works on tubeless and tube tires.

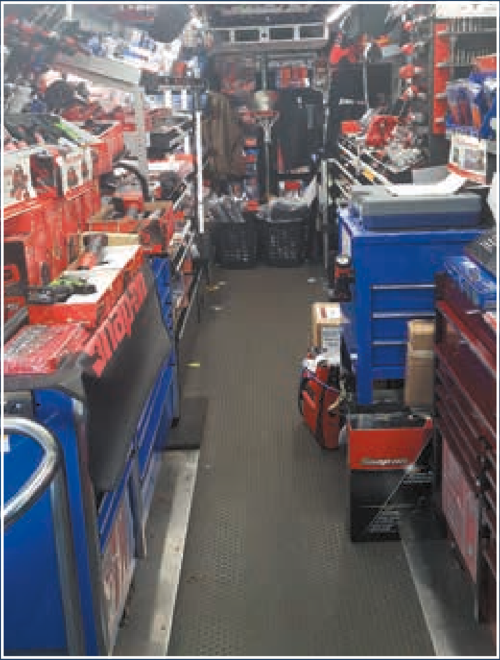
On a side note, Bogert Aviation also makes high-quality replacement aircraft battery housings. When we evaluated them in the February 2015 issue of *Aviation Consumer*, we found the construction quality to be superior to some OEM battery housings.

SNAP-ON TOOLS: STILL THE GOLD STANDARD

Walk through most aircraft maintenance hangars and you won't have to look hard to spot the Snap-On tool logo. Whether it's a gigantic rolling tool cabinet or a pair of cutters, there's a reason why professional technicians invest big for Snap-On tools. There's a rich heritage behind what many believe to be the gold standard in tools, which dates back to 1920.

Gregory Narozniak, an independent authorized Snap-On franchisee in central New Jersey, rattled off a long list of traits that lend to Snap-On quality. The photo to the right is the interior of his traveling tool warehouse—part of the Snap-On convenience and support effort. According to Narozniak, when a tool is designed or an improved version is created there are hours upon hours of engineering incorporated into that tool, which is evident in user ergonomics and precision.

"When the instinct handle on a Snap-On screwdriver fits better in the hand, it simply makes the tool more efficient," Narozniak told me. Additionally, the steel that's used during manufacturing is often specific to a tool. For example, the shock-resistant steel used in Snap-On screwdrivers, punches, chisels and so forth isn't particularly the best fit for the company's sockets, so a different steel blend is used in those sockets. Similarly, a different blend of steel is specific to Snap-On wrenches.



One of the many primary differences between lower-quality tools and high-end tools like Snap-On is accuracy. Snap-On's sockets and wrenches utilize flank drive, a concept that came at the request of the United States Navy in 1960. There was a need to remove bolts with rounded corners and as a result, the socket had to be designed to grab the flat part of the fastener rather than the corners. The design is still in use today on Snap-On flank drive and flank drive-plus tools.

The other draw that keeps technicians coming back to Snap-On is the support and warranty. According to Narozniak, Snap-On battery-powered tools are one of the only industrial product lines that carry an extensive warranty, which can initially be one or two years, depending on the item, and after the warranty expires, the tool is covered with a flat-rate repair should anything go wrong.

Moreover, nearly all of the company's hand tools are covered under a no-hassle lifetime warranty. "Simply hand the item to your Snap-On franchisee and it will be covered," Narozniak told me. He's right. I once dropped a small Snap-On torque wrench off a wing and the visiting rep grabbed a replacement from his truck and handed it to me.

Snap-On tools are available for purchase through a local authorized Snap-On franchisee or via www.snapon.com.

—Larry Anglisano

Another hangar tool I recommend is the BatteryMinder (www.batteryminders.com). It's not a typical battery charger, but instead a tender that's calibrated to aircraft batteries and can automatically diagnose, charge and desulfate the battery based on charge and temperature status. There's also an optional hardwire kit ($69) for easy plug-in.

A more advanced diagnostic tool to consider is a borescope imager. We looked at borescopes in the October 2015 issue of *Aviation Consumer* and found that prices are down and quality is up. They aren't just for cylinder walls, valve and piston inspections.

You can use a borescope as an inspection camera around the airframe, and some can be had for a few hundred dollars. We found various smartphone/app-driven camera cable models that might be used for all-purpose applications.

Last, when doing aircraft maintenance in a personal hangar, abide by the standards set by the airport management. When it comes to wrenching, make an honest assessment of your technical abilities, get the tools to match and then organize the heck out of them.

TIPS FOR TOOLING YOUR HANGAR

- ✔ Consider how extensive your maintenance work will be.
- ✔ Upgrade older incandescent lighting with LED bulbs.
- ✔ Create a central workstation with a spacious bench.
- ✔ Keep replacement parts (and removed ones) in storage bins.
- ✔ Equip the hangar with a compressed air source.
- ✔ Consider an aircraft-grade floor jack.
- ✔ Source the right specialty tools for specialty work.
- ✔ Follow the lead of an organized, established and efficient shop.

AIRCRAFT MAINTENANCE

Alternator Tech 101: Troubleshooting Basics

Arming yourself with a bit of tech savvy can help you recognize the early signs of charging system failure. Some basic hands-on can narrow down common problems.

Staff report

The charging system on the typical GA aircraft isn't exactly what we would call ultra-modern. But it's complex enough that an unexpected failure can leave you stuck far from home, while failures in flight can be full-up emergencies.

Even if you don't have the credentials and knowledge to tackle repairs on your own, there is some basic troubleshooting you can do to catch a failure early, while potentially saving some shop labor so your mechanic doesn't have to start from scratch. Here's a primer.

HOW'S THAT BATTERY?

Once the battery does its job starting the engine, a healthy alternator keeps it charged, while powering the electrical system even at low engine RPM. When the alternator isn't doing its job, there's often a clue: You change batteries a lot. A charging system that keeps a constant (non-fluctuating) voltage across the battery usually makes for long battery life. Longer yet if you keep the battery on a charging tender. But alternator design for piston engines has changed little over the years, and voltage regulator issues remain common.

The regulator system senses the alternator voltage at a predetermined set point and adjusts the field current to keep the output voltage at the desired level. Digital engine monitors are a good way to keep an eye on fluctuations in regulated voltage, but understand that you're looking at bus voltage, which is further downstream. What's normal regulated voltage? What's listed in the service manual rules, but 13.75 to 14.5 volts on 14-volt systems and 27.5 to 28.5 volts on 24/28-volt systems is the desired range. In a practical sense, know where the voltage sits for your system and monitor it closely at all power settings and under different electrical loads. One thing you might do—that many do not—is precisely set the limit warning in the engine monitor so it will get your attention during brief voltage excursions. If you're seeing occasional fluctuations that don't feel right, something likely isn't right.

And yes, there are sensors in the system that might fail, including the output sensor, or alternator-out sensor. It's usually wired to the AUX terminal lug and triggers a warning light when voltage from the positive diode plate has dropped to a level that prevents the alternator from producing current.

The regulator senses the alternator-out condition by determining whether current is going to, or coming from, the battery. Read the aircraft POH carefully to understand what the panel annunciators are telling you. In general, when current flows from the battery, the regulator throws the alternator-out light. In many Cessna singles, this light is labeled "High/Low Volt." In Pipers, it's the "ALT" indicator.

There's also the overvoltage unit generally connected in series, via the power wire to the regulator, between the alternator switch and the regulator. It senses voltage, and when it senses it's too high, it disconnects the power from the regulator. With it out of the picture, the field has no source of current and the alternator stops producing power. You should know the procedures for bringing the overvoltage unit back online. Typically, cycling the alternator switch off and then back on resets it.

There's also low-voltage sensing, and you'll see the annunciator when the system voltage drops to within one-half of a volt above the

Electrical failures could mean landing right now, and that could be someplace with no services. That's what happened when the alternator crumped in the P210 pictured left. This meant flying a mechanic in to troubleshoot in the grass.

In too many repair attempts, mechanics shotgun the alternator, top photo, when the problem lurks elsewhere in the system. Hit the POH and maintenance manual and understand what voltage conditions will throw the annunciator. That's one in a Mooney at the bottom.

battery voltage. A common culprit here might be the battery and not the charging system at all. In many cases, a low voltage situation can be detected in the audio system. You might here a strange tone in the cabin speaker, and when the voltage drops real low, the audio might be unusable.

It's important to remember that the low-voltage function, unlike the high-voltage function, does not shut down the field current. This is because the alternator may just be in an intermittent overload or may still be able to provide enough current to run essentials. Many older singles don't even have a voltage sensor.

EATING REGULATORS?

We've seen the cat and mouse game of replacing multiple regulators, when in fact a deeper problem is ruining them. If the alternator field is shorted or the brush slip rings are badly damaged or built up with carbon and oil, the alternator could well be the cause of the regulator failure. It could also be the ground fault protector (in the newer units only) tripping the regulator offline.

You'll need a VOM (volt/ohm meter) to do a quick resistance check at the field terminal of the alternator, with the field wire disconnected. This is to see if the field is grounding inside the alternator or to see if the brushes aren't touching the slip rings.

The VOM will jump around somewhat while turning the alternator rotor during this check but should never fall below the ohm value of a good rotor. This is 4 to 6 ohms for 12-volt alternators and 10 to 12 ohms for 24-volt alternators. The resistance should also not be consistently high. If it is, and there is no fluctuation when the rotor is turned, then the brushes are in poor contact with the slip rings. Getting to the brushes may be easier than you think. On some alternators, it's a simple matter of removing the brush pack. A very fine, clean Scotch-Brite pad can be used to clean the slip rings by pulling the prop through (check mags and battery off) with at least one plug out of each cylinder.

Hold the Scotch-Brite pad in place on the slip rings and spin the prop through a few revolutions. Don't rub back and forth, as this will brighten up the slip rings and not put any cross scratches on them.

With luck, this can often cure a problem where the first inclination is to replace the regulator.

If there's voltage at the field terminal and the field continuity/resistance check appears good, then you need to find out if the alternator is putting out voltage. If so, is it being shut down by the overvolt unit?

Confirm continuity for the positive battery cable to the bus and connect the VOM to the bus to read bus voltage. Start the engine. With the engine at about 650 RPM, put a fairly heavy load on the electrical system: landing and taxi lights, interior lights, fuel pump(s), beacons and strobes. Switch on the alternator. On most systems, 650 RPM is too low for the alternator to bring the system above battery voltage under load, and the voltage will be below the normal system (not battery) voltage.

Slowly bring the engine RPM up while watching the VOM. The voltage should increase with RPM until it reaches normal system voltage (as sensed by the regulator). On properly operating systems, it will stay there even with an engine RPM increase.

If the voltage keeps rising, provided the overvolt unit is working properly, the bus voltage will suddenly drop to battery voltage with a corresponding alternator-out indication. This means the overvolt box did its duty and shut off power to the regulator. The problem here is going to be in the regulator, likely a short. Worth mentioning is there are generally three basic failure modes of the regulator circuit: an open condition in the field power transistor, a short in the same or a partial short.

An open will give no alternator output, while a short will result in an overvoltage state. Partially damaged field circuits will cause the regulator to go over voltage with a higher engine speed and little or no load. It can also be indicated by difficulty in setting a consistent system voltage. This type of failure is not common but will cause a lot of hair pulling if

continued on page 32

Piper Aztec/Apache

Need a light twin that carries almost a ton of payload and works on short runways? A Piper Aztec can do it, but be ready for moderately intensive maintenance.

The headline groups the Aztec and Apache as one, and sure, while the Aztec could never have been born without the Apache, they are quite different. From an appearance standpoint, the original potato-like shaped Piper PA-23 Apache is easily distinguishable from the sleeker Aztec.

Moreover, the early Apaches had such modest powerplants that single-engine operation could be hazardous—just as with other twins with small engines. The last versions, the Aztec series, by contrast, are impressively capable load-haulers with good short-field performance, although not exactly speed demons.

The Apache is largely relegated to the training function for those looking for a cheap-to-fly time builder but the Aztec remains one of general aviation's stalwart twins and although it has high operating costs, it can be bought relatively cheaply.

MODEL HISTORY

In the early 1950s, the major aircraft manufacturers that had survived the post-war boom and thud scrambled to come up with a light twin. Beech and Aero Commander were first off the mark and Cessna was rumored to be coming out with one as well. Each was all-metal and of semi-monocoque construction. Until then, Piper had been a builder of steel tube-and-fabric machines but had acquired the Stinson Division of Consolidated Vultee. With it came the tube-and-fabric Twin Stinson, with 125-HP engines and twin tails. Piper installed 150-HP engines, changed to a single vertical fin and rather than redesigning the fuselage, simply covered the steel tubes with aluminum, creating the PA-23 Apache. It went on sale in 1954. Its fat, constant-chord wing allowed it to use the abundant short runways of the day but, with the chubby fuselage, kept cruise speeds leisurely.

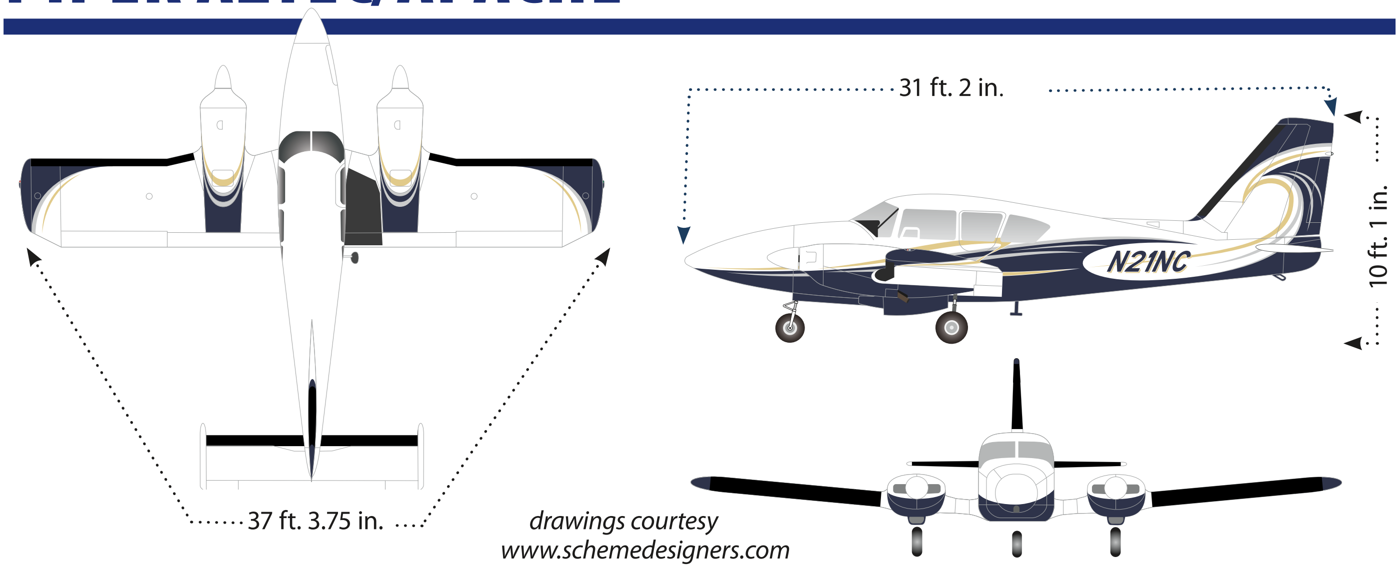
The original Apache had five seats and Lycoming O-320-A1A engines of 150 HP each, swinging two-blade props. Maximum gross weight was 3500 pounds (to put this in perspective, it's only 100 pounds more than a V35 Bonanza and less than most of the big six-place singles), with a 1320-pound useful load. Top speed was 157 knots, with a published (but optimistic) cruise of 148 knots, while 135 to 140 knots proved to be more realistic. Average equipped retail price was $36,235. To contrast, the current *Aircraft Bluebook* suggests a $29,500 retail price for one with good paint and interior, plus no damage history.

Three years later Piper put 160-HP O-320s on the airplane and

The Aztec is not a fill the tanks and fill the seats airplane, but it's remarkably close.

That's a 1976 PA-23-250 Aztec in the lead photo. An easy way to tell an Aztec from an Apache is the pointed nose.

PIPER AZTEC/APACHE

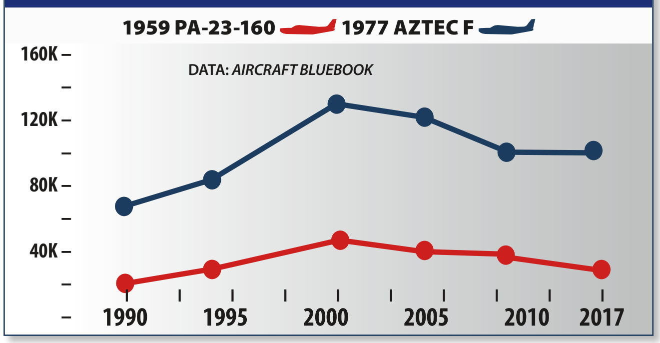


drawings courtesy
www.schemedesigners.com

PIPER APACHE-AZTEC SELECT MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1954 PA-23-150	150-HP LYCOMING O-320-A1A	2000	$21,000	72/108	1300 LBS	148 KTS	±$29,500
1959 PA-23-160	160-HP LYCOMING O-320-B3B	2000	$21,000	72/108	1450 LBS	150 KTS	±$32,500
1962 PA-23-235	235-HP LYCOMING O-540-B1A5	2000	$30,000	140	1900 LBS	178 KTS	±$45,500
1962 AZTEC B	250-HP LYCOMING O-540-A1D5	2000	$28,000	140	2025 LBS	178 KTS	±$28,000
1968 AZTEC C	250-HP LYCOMING IO-540-C4B5	2000	$35,000	140	2270 LBS	178 KTS	±$43,000
1972 AZTEC E	250-HP LYCOMING IO-540-C4B5	2000	$35,000	144	2158 LBS	180 KTS	±$73,000
1977 TURBO AZTEC E	250-HP LYCOMING TIO-540-C1A	1800	$50,000	144	1980 LBS	204 KTS	±$83,000
1977 AZTEC F	250-HP LYCOMING IO-540-C4B5	2000	$35,000	137/177	2150 LBS	176 KTS	±$98,000
1977 TURBO AZTEC F	250-HP LYCOMING TIO-540-C1A	1800	$50,000	147/177	1880 LBS	215 KTS	±$108,000

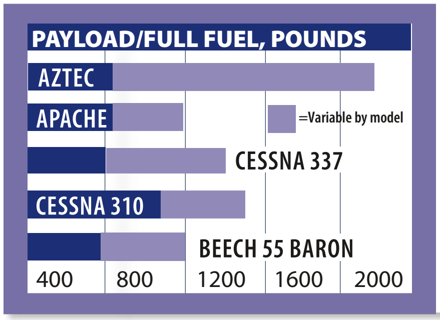
RESALE VALUES

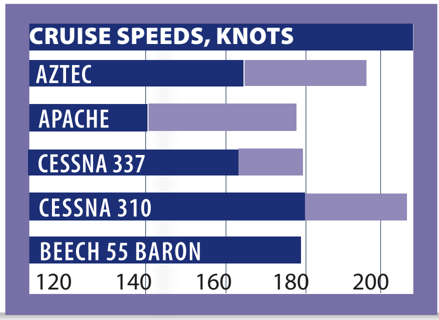


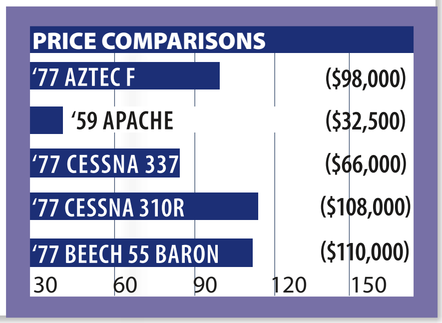
SELECT RECENT ADs

AD 2009-13-06	INSPECT/REPLACE NOSE BAGGAGE DOOR COMPONENTS
AD 2003-09-13	FLAP CONTROL TORQUE TUBE INSPECTION
AD 99-05-09	INDUCTION AIR FILTER REPLACEMENT
AD 96-21-04	INSPECT/REPLACE HYDRAULIC HOSES
AD 81-04-05	INSPECT/REPAIR FLAP SPAR HINGE ATTACHMENT

SELECT MODEL COMPARISONS







Proving its good pitch stability, a properly rigged Aztec flies the ILS like it's on rails, top photo. There's plenty of space for avionics, too. That's a Geronimo panel at the bottom.

low-compression, 80-octane versions of the O-540 on the airplane in 1962, calling it the Apache 235. It hung on through 1965, with a total production run of 114.

Also in 1962, Piper added a longer nose to the Aztec, equipped it with full-feathering props. The primary benefit of the change was a 300-pound boost in gross weight.

Other specs remained much the same, although single-engine performance actually suffered due to the higher allowable weight.

In 1960, Piper introduced the Aztec, a stretched PA-23 airframe with 250-HP Lycoming O-540-A1B5 engines and a larger tail with stabilator. Max gross weight was 4800 pounds. The Aztec was sold side-by-side with the Apache, and hurt the lighter airplane's sales badly. In 1959, 368 Apaches were built. In 1960, only 141 Apaches rolled off the line, compared with 363 Aztecs. In 1961, Apache production had fallen to 28 airplanes.

In a questionable attempt to resurrect sales of the Apache, Piper hung housing a baggage compartment. This airplane, the Aztec B, came with six seats, a pop-out emergency exit window and was available with optional fuel injection and AiResearch turbochargers.

In 1964, with the Aztec C, fuel injection became standard, and there was another boost in gross weight, to 5200 pounds. In 1966, the turbo option became a full-fledged model, with a standard oxygen system. During the run of the Aztec C, the engine TBO went from 1200 to 2000 hours, a benefit retrofittable to the older engines with the installation of half-inch exhaust valves.

The D models had minor improvements, including instrument arrangement. The E and F models have a nose extension with a fiberglass cap. The longer, pointed nose is a detriment from the radar standpoint, according to Aztec expert Tom Baum. The more tapered nose allows only a 10-inch radar antenna, not a 12-inch.

The big changes in the PA-23 all happened in the early 1960s. After the Aztec C, the alterations were mostly refinements. During the 26-year history of the PA-23, 2036 small-engined Apaches were manufactured, 114 Apache 235s and approximately 5500 Aztecs.

MARKET SCAN

The PA-23 should be thought of as two different airplanes—the Apache and the Aztec. With such a variety of power, weight and age, a buyer can find a PA-23 to fit almost any budget. Original Apaches in average condition carry price tags around $30,000, and it's not hard to find one for much less.

It's likely, however, that a PA-23, either Apache or Aztec, bearing a used-car price tag has had quite a tough life, including use as a multi trainer or cargo-hauler and eventually retiring into neglect and disuse. The irresistibly low prices on some of these airplanes could be siren songs and due to the complexity of the systems, keeping one of the neglected birds airworthy has proven to be expensive to more than one buyer seduced by the low price. Twins aren't cheap to operate and the PA-23 is no exception. Figure about $275 per hour, wet, to run a normally aspirated Aztec, based on 150 hours a year.

On the other hand, there are Apaches and Aztecs that have been flown regularly and kept in great shape and although not exactly steals, they can be purchased for the price of a late-model, four-place single. Prices on Aztecs are generally much lower than those on other light twins, such as Beech Barons and Cessna 310s. Owners assert that their Pipers may not be as pretty, quick or fuel-efficient as other light twins, but they are generally easier to fly, reliable and better at hauling heavy loads and operating out of

An Aztec makes a good traveler because it handles bumps and has a fairly spacious cabin. Just don't expect blistering speed.

short fields. We have consistently been informed that a good experience in owning an Apache or Aztec depends on having a thorough pre-purchase inspection and good initial and recurrent training.

ACCOMMODATIONS

The fifth seat in Apaches and early Aztecs is relegated to the back of the cabin, where it takes up a lot of space in the 200-pound capacity baggage compartment. A few Apache owners even remove the seat from the airplane, as it is virtually unusable and is just excess weight. Beginning with the B-model Aztec, there are three full rows of seats and 150-pound capacity baggage compartments fore and aft.

The PA-23 cabin is spacious and comfortable, with plenty of elbow, head and leg room. The airplanes can haul a respectable load, although they can't, as some owners would suggest, fly with anything you can close the doors on. Still, even well-equipped Apaches and Aztecs can carry full fuel, four or five adults and baggage, despite zero-fuel-weight restrictions imposed by an Airworthiness Directive (83-22-01) that was issued to prevent damage to wing-attach fittings.

The Apache 235 and the original Aztec have zero-fuel-weight limits of 4000 pounds. In naturally aspirated B through F models, any load above 4400 pounds must be fuel. The limit in turbo models is 4500 pounds. We have found that a surprising number of owners are not aware of the limitation, so wing attach fittings should be a checklist item on a prebuy inspection. While there, check for corrosion in the tubes in the bottom of the fuselage.

SYSTEMS

All Apache 150s and 160s have one 36-gallon fuel bladder in each wing and many have an 18-gallon aux tank on each side, too. Apache 235s and Aztecs have two 36-gallon cells in each wing. The F model could also be fitted with 20-gallon internal tip tanks. As fuel bladders age, owners report a frustrating frequency of leaks, so periodic inspection and replacement has to be included in the budget.

Also on the Aztec F's options list was an auxiliary hydraulic pump on the right engine. Earlier models came with only one pump on the left engine to operate landing gear and flaps. If the left engine goes kaput, there's a hand pump underneath the control console that requires 30 to 50 strokes to get the gear up or down, a significant challenge during a real emergency. There's also a CO2 bottle to blow the gear down if the emergency pump doesn't work.

The gear and flaps are hydraulic, meaning that the aging system will provide the owner with the joy of tracing leaks on a regular basis. One owner reported that he replaced some valves, hoses and fittings every year so that everything was changed over five to six years.

To check the level of the hydraulic fluid, the airplane must be up on jacks with the gear retracted and flaps extended. Otherwise, adding fluid overfills the system, leading to a very red airplane when the gear is retracted after takeoff. Many, but not all, Apaches have been upgraded with dual alternators and vacuum pumps; avoid those that have not.

Reports of adequacy of cabin heat vary, with one owner stating that his passengers had to wrap up in sleeping bags to stay warm during winter flights. That airplane turned out to have crushed heat ductwork requiring many hours of labor to fix and even then, the result was not adequate, despite also plugging the many leaks in the aft cabin bulkhead. (Airflow in the fuselage is from the tailcone forward.) Some models of the gas-fired heater have maximum hours between overhaul limits, so a Hobbs meter on the heater is a good investment.

PERFORMANCE, HANDLING

The fat, high-lift airfoil has a lot to do with the PA-23's docility and good low-speed performance, but it costs more than a few knots in speed. Owners of 150- and 160-HP Apaches report 135 to 145 knots on 16 GPH at 75 percent power. The big-engined Apache is faster but is a glutton for avgas. Figure on about 160 knots on 29 GPH at high cruise for the Apache 235. Early Aztecs claim 178 to 182 knots while burning about 26 to 28 GPH at 75 percent, more realistic cruise is 160 to 165 knots. The E and F models are a few knots slower on the same fuel. Up high, around 24,000 feet, a Turbo Aztec can sizzle along at 190 to 200 knots with fuel gushing at 30 to 35 GPH.

As mentioned earlier, the airplanes are exemplary short-fielders. The Apache models need less than 1100 feet to get in or out over a 50-foot obstacle, although the published Vx is very near Vmc. Early Aztecs require less than 1250 feet. Newer, heavier Aztecs use up a bit more real estate, but not much: Figure on about 2000 feet to leave and less than 1600 feet to arrive over a 50-foot obstacle in an E or F model.

Single-engine performance is on par with other light twins; that is, it's pathetic. Published single-engine rates of climb vary from 180 FPM for the Apache to 160 to 240 FPM for the Apache 150 and naturally aspirated Aztecs.

The Apache 235 and Turbo Aztecs climb at about 220 FPM on one mill. However, some Apache owners have told us they'd consider themselves lucky to hold altitude at gross weight with only one fan turning, and we saw barely 100 FPM while getting single-engine practice in a lightly loaded Apache 160 on a warm day. We saw little better during a workout in a Seneca III under a hot Florida sun.

In our opinion, the edge of the single-engine performance envelope on light-light twins—those with normally aspirated engines of less than 200 HP—is really too close to being unsafe for comfort. There simply isn't enough horsepower available to produce anything but a barely flyable airplane. A positive rate of climb depends on perfect technique and on top of these demands, the pilot is presented with the specter of engine-out handling difficulties, such as the tendency to roll over toward the dead engine.

In this respect, the Apache is no worse than more modern designs. For example, Piper's own PA-44 Seminole, a late-1970s design, has 180-HP engines and a useful load of about 1400 pounds. The original Apache, with 150-HP engines and

AZTEC/APACHE ACCIDENTS: OTHER

As we looked at the 100 most recent reports of accidents of the Piper Apache and Aztec series we were struck by the low number of runway loss of control (RLOC) accidents—an indication of airplanes with docile ground handling—and the relatively high percentage of fuel-related accidents. Half of the fuel-related accidents were due to contamination, in some cases described as sludge, while the other half were a combination of a pilot failing to select a tank that had fuel in it and running all of the tanks dry.

We were surprised by the percentage of accidents following the loss of one engine in which the pilot did not feather the propeller of the engine that had gone quiet—nearly half. That's such a basic mistake that it's hard to imagine, and it means the airplane is simply not going to hold altitude.

We thought of the pilots who didn't feather when we read of the pilot who, when faced with the inability to extend the landing gear, shut down and feathered two perfectly good engines on final for the gear-up landing. Confirming that you can't fix stupid and that intentionally creating a second emergency when faced with a first one isn't smart, he impacted a berm short of the threshold, seriously injuring himself.

On the other side of the coin, kudos to the pilot who detected an impending engine problem and shut it down (a newly installed cylinder was coming off). Shortly after shutting down the engine, it caught fire. The pilot stuck the nose down, accelerated to a speed that provided an incombustible mixture for the fire and it went out. He continued to what he referred to as an "uneventful" landing.

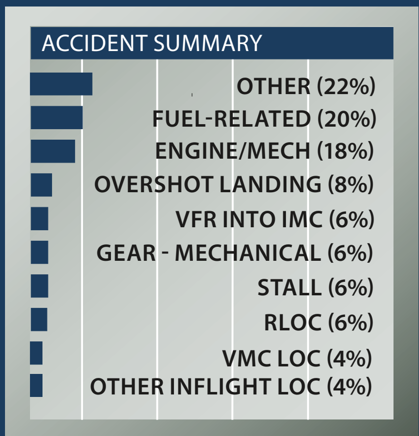
We noted only one report of a pilot forgetting to extend the landing gear prior to landing, a good record for the type. However, a gear-up landing does not rise to the level of a reportable accident under the NTSB regulations, so we may not know about all the gear-ups. There were six reports of either the gear refusing to extend or one leg collapsing after landing—all due to poor maintenance.

Poor maintenance was the underlying cause of two accidents in which the stabilator trim tab failed in flight due to corrosion. In one case the aircraft then broke up, in the other the pilot was unable to prevent a steep nose-down impact.

On the maintenance front, the fuel selectors need to be regularly inspected to ensure that the valves move to the position called for by the cockpit selector. Worn systems led to several engine stoppages.

Not all Apaches/Aztecs have hydraulic pumps on both engines. There were a number of loss of control accidents or off-airport landings following stoppage of the left engine because the pilot did not allow time to manually pump the gear down because the sole hydraulic pump had no power source.

In the what were they thinking department, a DPE terminated a checkride for an unairworthy airplane—one engine was not making power. The FBO owner sent a CFI to fly it home—along with the applicant and a passenger. The affected engine surged repeatedly on takeoff, but the CFI elected to continue. It quit shortly after liftoff, the CFI failed to maintain airspeed and the airplane Vmc rolled into the ground.



That's a 1955 PA-23-180 in the photo above. The venerable Apache isn't a bad choice for building multi-engine time.

a useful load of 1320 pounds, has a higher single-engine ceiling (5300 feet versus 3800 feet), higher service ceiling (17,000 feet against 15,000 feet) and better single-engine rate of climb (240 FPM versus 212 FPM). Proper recurrent training is the best protection against these shortcomings. It also helps to fly as much below gross weight as possible, and to install vortex generators.

In the air, with everything working properly, the twins feel like big Cherokees, but with more responsive controls. However, the ailerons are somewhat heavier than the rudder and stabilator (elevator in early Apaches). One idiosyncrasy that will present itself to the transitioning pilot is the tendency of pre-1976 models to pitch up strenuously when flaps are lowered. In 1966, Piper published a service letter (No. 474) suggesting the deployment of small amounts of flap, rather than stabilator trim, to counter nose-heaviness in the pattern; it works. The manual pitch trim control, by the way, is a large crank on the ceiling with a smaller crank (a knob in later models) inside it for yaw trim; both are very sensitive. Another idiosyncrasy is the location of the gear lever on the right and the flap lever on the left of the center pedestal. Pilots do get these mixed up, and the latch that's supposed to prevent inadvertent gear retraction doesn't always work.

The ability of the bulbous airplanes to bleed off speed rapidly comes in handy when it's time to get into landing configuration. Maximum speeds for lowering gear and flaps in Apaches built before 1960 are a ridiculously low 109 and 87 knots, respectively.

Limiting speeds in later models are a more manageable 130 and 109 knots. Also, in 1965, Piper came out with a modification kit for Aztecs and Apache 235s, allowing quarter-flap deployment at 139 knots and half flaps at 122 knots.

Pre-1971 Aztecs tend to thwart the pilot's best attempts at trimming and roam a bit in altitude. A stronger stabilator down spring in the E model improves longitudinal stability, but control pressure in the flare suffers as a result. The stabilator and stabilator-balance system were changed with the introduction of the F model, but Piper later switched again from external to internal balance weights after AD 79-26-1 targeted cracks and attachment problems. Another change in the F model was incorporation of a flap-stabilator interconnect to reduce the pitch-up tendency.

MAINTENANCE, PARTS

Reports of parts availability are mixed. Some say certain parts are becoming difficult to find, while others told us everything is readily available from Piper, PA-23 specialty shops and salvage yards. Owners also tend to be very picky about who maintains their airplanes. Indeed, many owners do much of their own work under the supervision of IAs. "You can spend a fortune having a mechanic learn your systems," one owner said.

Several ADs require repetitive

A Geronimo conversion on short final. All of the airplanes in the series display excellent manners on landing. The Aztec in the lower photo sports two-blade Hartzell props.

inspections and work, and some are quite expensive. In our check of ADs for the PA-23, we found 108 listed. The most recent, 2009-13-06, applies to all models with a nose baggage compartment and requires inspection and replacement of door and latch components following fatal accidents resulting from a door coming open in flight.

Among the others on the list are: AD 63-12-2, on elevator butt ribs and doubler plates; 63-26-3, elevator and rudder castings; 72-21-1, control pedestal support bracket; 74-10-1, flap hinges; 78-2-3, stabilator tip tubes and weights (on Aztec F); 78-8-3, rudder hinge brackets (Apache 150 and 160); 79-26-1, stabilators (most F models); 80-18-10, fuel selector valves and cables; 80-26-4, cabin entrance step support frame structure; 81-4-5, flap controls and hinges; 85-14-10, Hartzell blade clamps; and 88-21-7, fuel lines, caps and filler compartment covers. In many cases, the repetitive inspections are no longer necessary after affected parts are replaced or modified.

MODIFICATIONS, SUPPORT

There are an astounding number of modifications available for the Apache and Aztec series. The Geronimo conversion of the Apache ups the power to 180 HP a side, reworks much of the fuselage and turns the airplane into a reasonable performer on one engine. Diamond Aire (www.diamondaire.com) performs the Geronimo mod, and offers a number of other mods for the Apache-Aztec line including redesigned noses, dorsal fins, a speed-slope windshield, gap seals, vortex generators, tip tanks and inflatable door seals.

Met-Co-Aire (www.metcoaire.com) offers tip tanks that increase fuel capacity by 48 gallons as well as new wingtips; turbochargers can be had from Rajay (www.rayjayparts.com) and vortex generators from Micro-Aerodynamics (www.microaero.com).

Hartzell (www.hartzell.com) has recently certified a two-blade scimitar "Top Prop" for most of the Aztec models—its data shows a 2-knot cruise speed increase.

Considering the number of Aztecs built, it's curious that there is no organization devoted to their owners. The Piper Apache Club (www.piperapacheclub.com) caters to Apache owners primarily, but includes owners of all versions of the PA-23.

OWNER FEEDBACK

I operated a 1974 Piper Aztec E Model for about two years. I flew it 150 hours in that time and found it to be a docile, easy to fly, very comfortable airplane. The best thing about it is its load-carrying capability. You truly can fill the seats, baggage and fuel (assuming your family all weigh about 150 pounds or less). The worst thing about it is it is slow, about 160 knots, especially for the fuel it consumes—somewhere around 14–15 gallons per side per hour. My plane had a basic cylinder head temperature probe; with a modern one, this consumption might be improved.

The first annual was hugely expensive, around $12,000, but covered a lot of deferred maintenance, the nose landing gear replacement being the largest item. The following year, the annual was under $2,000.

I replaced it with a Cessna 210. The Cessna had the 310-HP Atlantic Aero IO-550 engine, flew faster than the Aztec on much less fuel (9 to 13 GPH depending on altitude) and carried a similar load. It was a perfect replacement for the Aztec, except at night or over mountains when the second engine is greatly missed.

John Warrington
via email

I owned an Aztec in a partnership for nearly 10 years. It had been on a Part 135 certificate so we thought it would have had good maintenance.

It did do well on the prebuy examination, but for the next six months was a huge pain as component after component broke, sometimes stranding us somewhere as we waited for parts.

By being aggressive on repairing and replacing worn or questionable parts, especially hydraulic system components, we got ahead of things and the airplane proved reliable for the rest of the time we owned it. It is necessary to have a knowledgeable mechanic work on the airplane because it has some quirks that can bite someone who doesn't know it. The hydraulic fluid level can only be checked with the airplane on jacks and the gear retracted, otherwise it gives a low indication. One mechanic didn't know that so he filled the reservoir with the airplane on its wheels. When I retracted the gear hydraulic fluid sprayed out of the nosegear area (I couldn't see it). The gear functioned just fine, but taxiing in after landing I noticed people staring at the airplane. When I got out I could see that it was covered with red hydraulic fluid, as if it had been sprayed with blood.

For a ponderous looking airplane, it is surprisingly light in pitch and maneuverable. It flies an ILS as if on rails, one of the easiest airplanes I've ever flown IFR. It rides well in turbulence and while there were a number of times I wished it had the speed of a 310 or Baron, the big cabin was almost a full consolation.

We had our shop do a weight and balance form for it with all the seats installed, and for one middle seat out so we could legally make a quick change for what we wanted to carry. With five or fewer people aboard, the extra space was nice.

We had the airplane weighed after a scary takeoff with what turned out to be the CG two inches behind the aft limit. That's when we found out that the weight and balance data that came with the airplane was wrong. Having the forward baggage compartment helped a great deal with keeping the CG in limits when we had a load of people aboard. It was an absolutely great family hauler; I got spoiled by the amount of stuff I could carry on a trip, especially for camping at Oshkosh.

Keeping the cabin warm in winter was a big problem because the aft baggage curtain leaked cold air flowing forward from the aft fuselage and it turned out that many of the heating plenums under the floor were crushed from wear and tear, so the warm air didn't flow. When we pulled the floor and fixed them, we also found corrosion in some of the steel tube structure. Fortunately, it could be fixed without major surgery on the fuselage, but it wasn't cheap.

We both took recurrent training every six months because although the airplane is pretty easy to fly and single-engine handling is good, you've got to do everything right to get even an anemic rate of climb on one mill. Nevertheless, when flying IFR at night over one of the Great Lakes, it was sure nice to have two engines out there.

Howard Jonson
via email

My wife and I have had the pleasure of owning two different Apaches. Our first was a 1955 PA23-150 that had an updated panel and interior, but completely original airframe. It was a wonderful airplane to fly and while it was not going to blaze a path through the sky, you could carry quite a load and the cabin size was very comfortable. We would plan on 135 knots burning 14–15 GPH total.

Of course, single-engine performance was anemic, but the vast majority of our Midwest flying left the terrain well below the Apache's drift-down altitude.

Maintaining a classic twin can quickly drain the wallet if an owner is not an A&P or actively involved with maintenance. The Apache is very well built, but ease of servicing may not have been a priority, as many maintenance tasks require a lot of labor.

For example, the original nacelles offer quick access to the engines, but to gain access to the oil screen one must drop the lower nacelle assembly. That task can take quite some time, leading many mechanics or owners to skip checking the oil screen.

Parts availability for some airframe parts can be a challenge, but the vast majority of consumable parts are readily available. There are quite a few ADs on the early airframes, but most of the ADs are inspection based and not egregious. The Hartzell propeller AD is a notable exception. If looking to purchase an Apache, I would seek out an aircraft that had the new-style props installed.

Our current Apache is a 1960 model with all of the Geronimo mods. It has the O-360 (180 HP), long nose with baggage, aux electric hydraulic pump, aft baggage, flap gap seals, aux fuel tanks (108 gallons total), squared-off tail and fiberglass nacelles. We flight plan for 150 knots burning 18–20 GPH total.

As much of an Apache purist as I was when we had our 1955 Apache, the Geronimo is a better aircraft. It is faster, carries more and is easier to maintain. The new-style nacelles allow total access to the engines in less than five minutes.

Parts support for the Geronimo mods is excellent. John Tamage of Diamond Aire in Montana (the current holder of the Geronimo STCs) has always been very responsive about parts or support. I would also *highly* recommend an Apache owner join the Piper Apache Club run by John Lumly. The forum is a fantastic resource for parts and maintenance advice.

Our Geronimo has a modern panel centered on the Garmin G500 driven by a GNS430W. We added a GDL69 for weather and installed PlanePower dual alternators to supply adequate and consistent power. For fuel efficiency and cost in a twin, it's hard to beat the Geronimo.

Florian Kapp
via email

I bought into an E-model Aztec after discovering I couldn't afford the twin I really wanted, a Cessna 310. I was reluctant to get involved with an airplane that seemed to be on the trailing edge of technology, with a welded frame structure and systems that seemed about five years behind a 310 or Baron of the same vintage—plus, for the same fuel burn, it was 20 knots slower.

The more I got to know the Aztec, the more I liked it. It is absolutely rock solid on an ILS. Unlike the Baron or 310, it almost feels as if you point it in the right direction and fall asleep until time to flare.

Maintenance is not user-friendly. It takes eight hours for one person to re-

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AZTEC/APACHE

(continued from page 31)

move and replace the cowlings; to me, that's an incredibly stupid design. The hydraulic lines and valves build up a varnish with time; figure on replacing everything over about a 10-year period.

The steel tube frame is subject to corrosion, so inspect carefully, especially under the cabin. If you catch it early, the fix is merely expensive.

The cabin is more passenger-friendly than the 310 or Baron. It is not a fill the tanks and fill the seats airplane, but it's amazingly close. I eventually took one of the middle seats out, which turned the rear seat into a very comfortable spot with great legroom. It also saved on insurance, as my carrier had a price break between five- and six-seat cabins.

The airplane short fields well. I routinely go into fields less than 3000 feet long, with obstacles. When getting on the brakes after landing, if you lower the nose as you would a 310 or Baron, you'll just slide the tires because the wing is lifting and there's no weight on the mains. Keep the yoke well back to keep weight on the mains and retract the flaps right away.

I've come to have a great deal of affection for the Aztec, even though it frequently seems to know how much money I have on hand and breaks something that costs that much. I wish it were as fast as a 310. But for honest handling in a twin and reasonable single-engine performance, it's one of the best out there.

Chuck Guard
via email

ALTERNATORS 101

(continued from page 23)

you're not aware that it may occur.

When one stator phase or an alternator diode fails, the others are usually not far behind. The regulator tries to bring the voltage up and keep the load the same, as it should.

However, this added load on the remaining phases or diodes will heat them up past their maximum allowable temperature and cause further failures, especially in high current demand situations. A bad diode or stator phase is many times indicated by a sudden increase in alternator noise (whine) in the comm radio and a corresponding decrease in capacity.

If you can see into the housing, you can pick up a burned stator by the darker winding color as compared to the other stator windings. The alternator will have to come off for repair. It's surprising how many aircraft continue to fly with faulty alternator diodes. We've seen some owners go to great expense and hassle by paying an avionics shop to install noise filters in hopes of masking the problem. Our advice on ridding noise in an audio system: First start with a known healthy charging system.

THE DREADED GEAR DRIVE

If you have an engine such as a Continental IO-520 or IO-550 with a gear-driven alternator and have low current output, there is one issue unique to this alternator setup of driving the alternator with a gear off of the crankshaft.

The problem is related to a good-intentioned design change, which replaced a heavy steel spring with a rubber clutch mechanism to avoid dumping metal into the sump in the event of a frozen alternator shaft.

Should this rubber clutch mechanism begin to slip under heavy alternator load (there is a specific drag torque test for this), then alternator output will fall even if the alternator and regulator are in perfect condition.

Before troubleshooting, you can learn a lot by looking at the charging system schematics for your model. As for alternators, we'll take a closer look at replacement options, while comparing overhauling versus repairing, in an upcoming issue of *Aviation Consumer.*

FEEDBACK WANTED

PIPER SARATOGA

It's time for a fresh look at the Piper Saratoga and Lance in the Used Aircraft Guide in *Aviation Consumer.* We want to know what it's like to own these big piston singles, how much they cost to operate, maintain and insure and what they're like to fly. If you'd like your Lance or Saratoga to appear in the magazine, send us any photographs (**full-size, high-resolution please**) you'd like to share to the email below. We welcome information on mods, operating expenses or any other comments that can be helpful for buyers considering a 414. Send correspondence by February 15, 2018, to:

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