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The consumer resource for pilots and aircraft owners

The Aviation Consumer®

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The Aviation Consumer

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WHAT IS REALISTIC DOWNTIME?

Other than having to write big checks, one of the toughest things about aircraft upgrades, including avionics retrofits and paint work, is dealing with the downtime. Shops tend to be optimistic in estimating completion times when trying to close the sale. And when it's finally time to fly, expect some debugging, tweaking and maybe a couple of runs back to the shop. Pick one that's reasonably close to home. I got to thinking about the heartburn when an owner called and asked the simple—but impossible to answer—question of how long his airplane should be in the shop for a Garmin avionics project. I certainly wasn't qualified to give him an accurate answer because it wasn't me who had his airplane all over the hangar floor—for four months. That's a long time for the proposed GPS, big-screen EFIS and ADS-B transponder installation. While it was in, the radar was shipped for repair and a maintenance shop was changing the brakes. Four months? No way.

The aircraft is a pressurized piston single and the shop never really committed to an exact downtime, but figured it would be down for a few weeks, "more or less." That might have been a red flag, or not. I'd plan on four weeks for that project. But the big red flags came on week six when he showed up to find the airplane not in the work hangar, but in a transient tiedown spot across the field. Looking into the cabin he could see the new equipment was in, but the interior was mostly removed and there were still some holes in the panel and worse, holes in the fuselage (covered with tape) where new antennas were to go. When asked what was up with his airplane, the shop manager said the schedule was behind after the ADS-B rush, plus it had closed for a bit during the pandemic. That's fair, but the shop never called him off, and the owner got the plane to the shop a bit early. Behind the scenes, the shop was dealing with outside engineering approval for some antenna work that required drilling through the pressure bulkhead. Mental note: If you bring a pressurized aircraft to a shop for major work, it's worth asking if it has the in-house capability to sign off modifications to the pressure vessel. If it doesn't, what are the costs and expected downtime to get the approvals to make it legal. Many shops don't have the capability in-house.

The relationship changed forever when the agitated owner threatened to deduct money off the invoice, presumably as a payback for blowing a few trips. This penalty might happen in the jet maintenance world, but it's not common for privately owned pistons. Shops don't like to be threatened, and as you might expect this one didn't speed the job along after the customer got hard-nosed. It was obviously in no hurry to finish this guy's airplane and finally handed it back to him six months after he dropped it off. These stories are somewhat rare, but they happen during engine swaps, avionics work, paint work and interior upgrades. The moral of the story doesn't change. Do everything you can to pick a shop that knows how to communicate and make accurate estimates on completion times before you commit to the work. In this case, the shop failed every test of good communication. It didn't return calls or emails, and the owner had to chase the shop just to get a written proposal. That should have been an early clue.

As we reported in the paint shop satisfaction survey in the August 2020 issue of *Aviation Consumer,* the shops that keep their customers happy absolutely nail the communication. They send photos and progress reports as the project reaches milestones. Many invite the owner in to see the progress and do what's practical and reasonable to involve an anxious customer in the project. But owners need to do their part. This means abiding by payment terms, checking the shop's references and being realistic and flexible when it comes to downtime. But there's a limit. If a shop says the aircraft will be down for two weeks but it's down for two months, that's certainly too long, unless it runs into major problems that are out of its control. Maybe equipment is put on engineering hold or the shop is waiting for additional approvals (if a complicated FAA field approval is required, you shouldn't bank on a hard completion date—ever).

This current pandemic is creating longer than expected downtimes because parts and people simply aren't moving as fast as they once did, so you want to give the shop some slack. And if key employees or their family fall ill, you can certainly expect smaller shops to fall behind—perhaps even temporarily close. Last, don't schedule important trips directly after you fly it away. Add a healthy buffer to work out the bugs, and expect to be pleasantly surprised if there aren't any. We want to hear about your most recent upgrade experiences—good and bad—so others can learn from it. Let us know how it went. *—Larry Anglisano*

GEAR OF THE YEAR

In your annual Gear of the Year article, which appeared in the July 2020 issue of *Aviation Consumer*, you gave an endorsement to the Sporty's PJ2 as the Best Portable Radio. I purchased this radio in January, 2020, but found it unsatisfactory and returned it to Sporty's.

While it appeared to be a nice radio, I was unable to get more than a loud squeal whenever I tried to transmit using the headset. I tried three different headsets (Lightspeed models), both noise-canceling and passive, and never got it to work. Sporty's admitted that they had experienced this problem and said their engineers were working on it. Since that time, though, I have been unable to confirm that the problem is fixed in the currently shipping units, and they even deleted my review from their website. So, buyer beware!

Craig Dow
Arlington, Texas

We've enjoyed trouble-free performance from our original evaluation unit, but asked Sporty's about your problem. According to John Zimmerman: "The only issue I'm aware of is certain models of Lightspeed headsets (I believe the Sierra is the worst) can cause some issues. These older sets use unshielded audio cables, so when plugging into the radio directly some people have problems. It's hardly common though, and it's easily solved by putting a ferrite bar on the headset cable. We send these free to any customer who needs one."

The day I got my July 2020 issue of *Aviation Consumer* and read the Gear of the Year article, I looked up the award-winning Jeppesen G1000 training bundle on the Jeppesen website and bookmarked it. A week later went to purchase it and it was gone. There followed a series of phone calls over the next day until I finally got someone on the line. She tried to find the product, but failed, and found out internally that the company withdrew the product for lack of sales. I told her about the magazine's award. She thought it was nuts they'd withdrawn the product as it was poised to generate sales, and promised to see if she could rattle some cages to get it reinstated.

Steve Zimmerman
via email

We reached out to Jeppesen on this and while it acknowledged that the G1000 training bundle has been discontinued, would not offer us the details behind its decision.

The good news is we found other worthy G1000 study aids when we scanned the market for the article in the January 2020 issue of Aviation Consumer.

AVEMCO COMES THROUGH

In the Reader Correspondence issue of the August 2020 *Aviation Consumer* I reported that my insurance policy renewal covering me in my Piper Seneca required me to fly with another named insured pilot. The reason given to me was that the market has hardened for pilots over the age of 70 flying retracs.

Since then, I followed the AOPA Insurance broker's suggestion, contacted Avemco and promptly got a quote for insurance without a requirement for a safety pilot. Yes, it costs about 40 percent more, which isn't too hard to bear, since insurance is going up for a lot of pilots, especially in this post-Boeing 737 Max era.

For other pilots over the age of 70, I suggest trying Avemco. Its agents were just great with me.

Phil Steeves
via email

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On The Cover: AirVenture at dusk. We shot the main image while roaming one of the parking areas last year. At few other places will you find such a diverse gathering of experimental aircraft. Want one? Before you make a cool deal, or commit to building your own, check into the realities of getting the insurance coverage you need. We did some market research and prepared a report on insurance for homebuilts, starting on page 8 of this issue.

SYSTEM SAFETY

Is a 406 ELT Worth It? Reduce Expectations

Yes, they perform better, but only marginally and false alerts are a nuisance. A PLB is more cost effective and can be used anywhere.

by Paul Bertorelli

Every other summer, I torture myself with the $1500 biennial ELT switch flip. I install the required 24-month battery, wait for the minute hand to sweep past the top of the hour and press the test switch with bated breath. The crisp woop-woop of the truly ancient EBC 121.5 MHz beacon makes the Cub legal for two more years. But one day, the dreaded decision will come. I'll have to buy a 406 MHz ELT.

That's slightly complicated in the Cub because of the extra effort of siting an antenna on a rag fuselage.

The Cessna 172 in the accident above was equipped with a 121.5 MHz beacon. It activated on impact, but didn't aid in locating the airplane. One occupant was killed, one survived after a night in the woods.

But for all the money thrown at it, it will at least be more likely to actually function in the event of crash. Or will it? To find out, I recently pored over the crash reports of 406 MHz-equipped airplanes and while it's true they work better when they work, they get smashed in crashes just as often as the older beacons do and fail to activate for reasons that aren't always clear.

One downside of ELTs in general and especially 406 MHz models is a staggeringly large number of false alerts—more than 11,000 a year, plus another nearly 7000 false alerts from marine and terrestrial units. Most have to be patiently tracked down by rescue agencies.

Increasingly, as rescue and location aids, ELTs are being displaced by ADS-B, radar and cellphone searches, making their value less impressive. Still, under ideal conditions, a 406 MHz ELT, or a portable locator beacon, will summon help faster than anything short of a 911 call.

CHECKLIST

- When it works correctly, a GPS-equipped 406 MHz ELT is the quickest way to be found.
- 406 MHz ELTs appear to be no better than 121.5 MHz models in surviving crash forces.
- ELTs in general assist in crash location in a little over a third of crashes.

HOW WE GOT HERE

On paper, the emergency locator transmitter is a stunningly great idea: Airplane crashes, transmitter goes off and soon the pararescue person is fast roping in to tend to the survivors. Or at least the victims can be readily found. Or so it was supposed to be following the 1973 FAA regulation mandating 121.5 MHz ELTs after the disappearance of a chartered Cessna 310 carrying two congressmen—Hale Boggs and Nick Begich—in Alaska. Despite a 39-day search, no trace of the airplane was ever found.

General aviation groups then—and now—supported voluntary ELT installation but opposed the mandate. Field experience with ELTs hasn't burnished the idea much. While 121.5 MHz beacons clearly saved lives, a high false-alarm rate—as much as 97 percent—and a low crash-activation rate made owners dubious of their value. A NASA study of early ELT technology found that many did not operate within the specified design thresholds and laboratory impact performance produced erratic results.

In 2011, Embry-Riddle researcher Ajit Jesudoss set out to find out how often ELTs of either type aided in finding accident sites by reviewing NTSB reports between 2006 and 2010. His research was hobbled by sketchy NTSB reports that don't reveal if the ELT helped locate the wreckage. Of 81 cases with usable data, 31 percent aided in locating the accident, 58 percent did not; the

rest were indeterminate. My own sweep of recent accident data was also frustrated by sketchy details. I reviewed five years of accident data between 2013 and 2017, with a keyword search for ELT. For 2017 alone, I bored into the details of 100 randomly selected accidents from 1328 U.S. crashes in the NTSB files.

In the accidents where the data appeared reliable, I found results similar to Jesudoss' findings. For 121.5 MHz beacons, about 41 percent aided in finding the crash while 59 percent did not. Newer 406 MHz beacons did a little better, but not much: 43 percent aided, 57 percent did not. In 26 of the 81 accidents I reviewed, the report either didn't say what type of ELT was aboard or whether it aided in location. My dive into the 2017 data revealed even lower positive trends for both types of ELTs, as shown in the graph at right.

As for beacon activation irrespective of whether it actually aided in crash location, on the whole for both types, they worked as intended in about 54 percent of the accidents, but failed in 42 percent. The rest were unknown. When the beacons are sorted, the numbers get too small to make definitive conclusions, but using the 2017 data, the 121.5 MHz models fired as intended in 38 percent of the accidents, the 406 MHz beacons a bit better at 50 percent.

This is a glass-half-full/half-empty sort of dilemma. But basically, these devices activate as intended half the time or a little more and actually assist in locating the accident site, at best, in a little more than a third of the accidents. I'd call that mediocre performance, but with one bright spot: If a 406 MHz ELT works like it's supposed to, the cavalry is just over the hill. Researchers Ryan Wallace and Todd Hubbard in an Embry-Riddle-published report found that in 139 missions reviewed, the mean search duration for 121.5 MHz beacons was 14.2 hours, 11.8 hours for 406 models, but only two hours for 406 beacons equipped with GPS position input. (Not all are.)

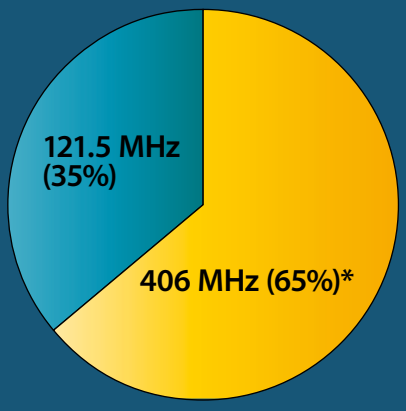
FALSE ALARMS

The National Oceanic and Atmospheric Administration, which oversees the U.S. share of the COSPAS-SARSAT satellite system that monitors the globe for 406 MHz distress signals, reports that 98.6 percent of aviation alerts are false alarms. When marine and terrestrial beacons are added, it was 19,295 alerts in 2019 or about 52 a day 24/7. Can that possibly be right?

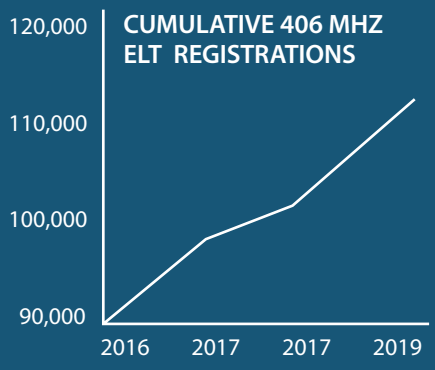
It is right, according to Lt. Col. Matthew Mustain, who's ops director at the Air Force's Rescue Coordination Center at Tyndall Air Force Base in Florida. The day I spoke with him in mid-July 2020, five controllers there had chased down 48 alerts the previous day. To be fair, more than 5000 of those yearly falses are single-pass blips whose source is never determined, probably caused by the odd fumble-finger person accidently firing a 406 beacon. Nonetheless, AFRCC does a lot of wild goose chases.

"We spend a ton of time on the phone doing detective work," Mustain told me. Another bright spot is that 406 MHz beacons are

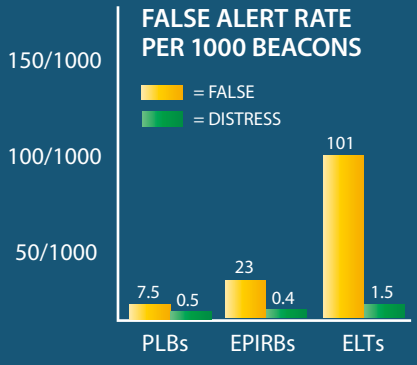
406 MHZ ELT POPULATION TRENDS

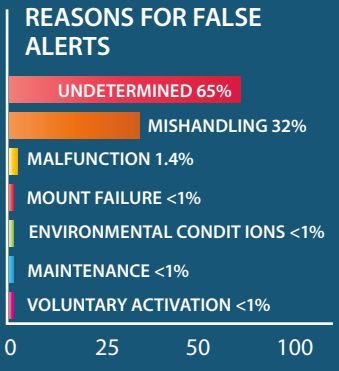


*Estimate based on NOAA registrations and 190,000 GA aircraft.

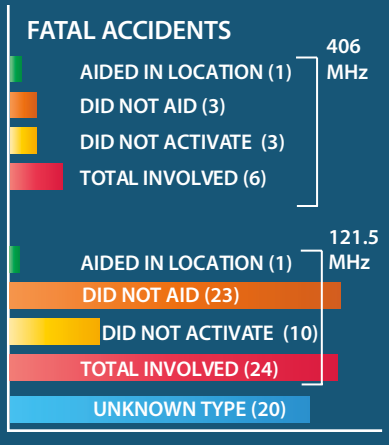


ELT FALSE ALERTS





ELT OUTCOMES



The graph at left summarizes data from 50 randomly selected fatal accidents in 2017. A sweep of 50 more random accidents of all kinds yielded similar ratios. A review of 81 accidents over a five-year period with a keyword ELT search revealed higher location aiding and activation percentages, but other studies have found low activation rates. NTSB reports often don't reveal the type of ELT or whether it aided in crash location.

AN UNBLINKING SATELLITE NET

As a technological marvel, the COSPAS-SARSAT satellite system is right up there with GPS. It was conceived in 1979 by the U.S., Canada, France and the former Soviet Union. Today, 45 countries are signed on to support it.

In all, 55 satellites carry COSPAS-SARSAT receiving and processing packages. Recent additions include a network of so-called MEOSARs for medium earth-orbit satellites. NOAA operates the U.S. space segment and forwards received 406 MHz alerts to the Air Force's Rescue Coordination Center or the U.S. Coast Guard.

With so many satellite passes available, says Air Force Rescue Center's Lt. Col. Matthew Mustain, ELT positions are resolved quickly through triangulated azimuth calculations. That helps with chasing down thousands of false alerts, but registering the beacon and keeping it up to date helps more.

Yet even though this is required by law, many owners forget it or skip it. To register, use NOAA's website: www.sarsat.noaa.gov/beacon.html. You can contact NOAA by phone at 301-817-4576 and report a known false alert to Flight Service or NOAA.

registered—or are *supposed* to be—so often a single phone call to an owner resolves the false.

"As you can imagine, these huge numbers take away from working cases where there's actually a mishap or someone is in distress," Mustain adds. Cases get difficult when the beacon is unregistered or the phones aren't answered. Then it requires N-number lookups, FBO and airport manager calls or whatever it takes to find and silence the beacon.

Because the 406 system resolves position quickly and accurately, many of the non-distress activations are tracked to airports, the result of bungling maintenance or a hard landing. "But if it's on a ridgeline in West Virginia or the middle of the West Texas desert, that's when the ice water goes down your back. That's probably not a false alert," says Mustain, who came up in the GA ranks and flew 10 years as a combat rescue pilot in the Air Force.

"A big piece of what we do is education. When I get a pilot on the line, I say, sir, could you please register your beacon. This is one message I want to get across to people. Make sure your 406 beacon is registered. It makes our job so much easier if you're up to date," Mustain says.

When the 406 system works at its best, location and rescue can be impressively quick. I found one Alaska accident in which the Coast Guard was on the scene while the wreckage was still burning and another with a response time of about two minutes. On the whole, however, cases in which the 406 ELT resolved a life-or-death rescue aren't common. Most crashes are near airports and even when they aren't, the beacon is definitive in the outcome only rarely and aids location finding just short of half the time.

Lt. Col. Mustain reports that despite the profusion of false alerts, 406 signals are resolved much more quickly than 121.5 alerts ever were, often in single-digit minutes.

FINDING YOU

While the Coast Guard handles coastwise and interior Alaska SAR cases, the Civil Air Patrol and local law enforcement do the heavy lifting in the continental U.S. And yes, they still spend a lot of time chasing false alerts on the ground with the same direction finding equipment they've been using for years. CAP, says operations director John Desmarais, has undergone a significant revolution in the way it does business. "We used to do 1200 to 1500 missions a year. Last year, we had 865 missions. When you look at them, only 330 were ELT missions. It used to be 900 a year-plus for ELT missions," he says.

When Desmarais joined CAP in 1987, the organization flew 20,000 SAR hours a year; last year, it flew fewer than 2000. Increasingly, radar, ADS-B and cellphone tracking carry more of the weight on searches. Does that mean the ELT is less of a player than it once was?

"It is. It's helpful in some cases, but to be honest with you, the vast majority of the missing aircraft cases are going to get resolved with cellphone and radar data. The best recommendation I would give is to file a flight plan, making sure the cellphone data is available for the pilot contact info. And some of it's old school. Let people know where you're going. Or if you're changing your plans," Desmarais says.

That's not to suggest that 121.5 beacons are as good as 406 models. The 406s are easier to track and it's often done from AFRCC at Tyndall,

Increasingly, the Civil Air Patrol uses cellphone forensics, left, to locate missing people and aircraft. ELTs are less of a factor.

PLBs like the McMurdo Fast-find, right, are waterproof. Our top choice is the ACR ResQLink, which retails for about $300.

vastly reducing search time. "I can remember in the old days, we had missing aircraft searches that went on for weeks. These days, if we have a missing search that goes longer than a day, I'm really surprised," he adds.

In 2009, COSPAS-SARSAT stopped monitoring 121.5 MHz transmitters, but many pilots monitor guard on a second radio and report signals to ATC. FAA facilities also monitor the frequency. CAP can start a search from these reports.

CAP's cellphone forensics unit—about 10 people—is kept busy with both missing persons and missing aircraft searches. Local law enforcement taps into CAP's capabilities because they don't do enough cell tracking to be proficient at it. Another 14 people are tasked with radar searches and increasingly, that's ADS-B.

"The ADS-B data has been very helpful for a lot of it. Pulling the data together, we've got some incredibly smart guys who work this data behind the scenes. And it's not just the radar data and the ADS-B data, we're looking at the weather patterns, we're looking at data on the airplane. If we know that the airplane had a few sorties that day, we look to see how it flew earlier that day. That helps a lot. Storing the data, we can go back a couple of weeks," Desmarais says. That means if the beacon doesn't work—and the data shows it often does not—CAP has a starting place it never had before.

IS A 406 WORTH IT?

That's now the thousand-dollar question. To be blunt about it, the entire ELT idea never worked very well. The beacons fired when you didn't want them to and failed when you did. It's debatable whether 406 MHz has improved this much. They still fail to activate in nearly half the crashes, which is only a little better than 121.5 MHz beacons performed.

Given the mediocre performance against cost, I could make the argument that ELTs were never well suited for aircraft in the first place because of technological limitations and thus the mandate has, as AOPA always argued, been an undue burden on owners. They activate for unknown reasons, get jostled during maintenance and have proven tender in crashes.

Current 406 MHz ELTs false alarm at a rate four times greater than their marine cousins, EPIRBS, and 13 times greater than PLBs, which are just as easily located in searches. AFRCC's Mustain says that's because a PLB requires a deliberate open-the-case-extend-antenna action to activate it; an ELT is designed to fire on its own.

With all this in mind, if you're nursing along an old 121.5 MHz beacon, as I am, are you placing yourself at risk? The data suggests not much. At best, they help locate the crash in half of cases, but my sweep of 2017 data revealed it was more like one in six or seven. In other words, the crash was found by other means.

ELTs were rarely big players in life-and-death rescues and they still aren't, although it happens from time to time. Being trapped in the wreckage injured and disabled is a pilot's worst nightmare. It just doesn't happen very often.

If that is a worry, a 406 beacon may assuage it. A little. A better solution might be to carry a $300 PLB that you can also use while hiking,

fishing, boating or off-roading. Or, if you're really a worry wart, an active satellite tracker like the Spot or Spidertracks, which are more effective yet. The exception I'd make is if I flew in Alaska or the mountain west, where the 406 might add a measure of risk reduction worthy of its cost. Still, for the money spent, don't expect too much of it.

In my view, the best argument for a 406 ELT is to reduce the stress and strain on Lt. Col. Mustain's troops and the CAP in tracking down false alerts. If it's a real distress case, they'll find you just as quickly with a PLB costing a quarter what an ELT does without the periodic battery replacement.

If you're spending the money on a 406 MHz ELT, spend a little more to get the GPS datastream into it and don't forget to register or re-register if the airplane changes hands.

Insuring Experimentals: Fleet Size Matters

The hardened insurance market is problematic for aging pilots flying complex aircraft. There are fewer options for kit-built aircraft, so get a quote before committing to one.

BY JON DOOLITTLE AND LARRY ANGLISANO

CHECKLIST

- Insurance coverage for popular homebuilts can be easier to get than coverage for rare ones.
- You might have to settle for lower limits of liability no matter what you insure.
- Insurers recognize that homebuilts pose a greater risk than same-class certified models.

Let's go to the dark side. You sell the family Bonanza for a used Lancair, and within the first year of ownership get it into some ice, lose control and join the NTSB reports as a double fatal. The wreck shocked and rattled our airport community a number of years ago, and you can bet it—and others like it—got the attention of the deceased pilot's insurer.

As we've been reporting (and as readers confirm) the insurance industry is playing hardball with the policies for older pilots who fly complex airplanes—no matter the experience level and claim history. Some are facing non-renewals, if not eye-watering rates.

Maybe it's finally time to part with the pressurized twin and buy a speedy homebuilt to satisfy the flying bug for the golden years. Hold it right there. It may not be your ticket to easy insurance. Or is it? We did some research.

EASY SELL

Among GA pilots (and among some who would like to become pilots) there is a growing movement toward experimental amateur-built aircraft. Some are simply drawn by the performance. It's easy to get used to Mooney 201 speeds with the simplicity of fixed gear and a Skyhawk engine. For others, it's the challenge of building their own aircraft, with the freedom to equip and modify it as they wish without the stinging price tag of FAA-certified components.

Then there are the experimental speedsters that offer performance that no other in the certified class will provide. This includes the Lancair IV-P and Evolution turboprop, to name just two. Truth is over the last 50 years, plan-built projects gave way to quick-build kit projects, which keep getting better.

Building your own airplane is still a formidable enterprise, but now there are plenty of owners groups and local EAA (Experimental Aircraft Association) chapters to lean on. Many airplanes are available with the so-called fast-build option, which allows the builder to hire professional help to complete certain parts of the kit, while still remaining within the required 51 percent of the construction that the builder is required to complete.

INSURING THEM

Saying all of that, kit-built aircraft present insurers with some unique challenges. Factory-built, Part 23 airplanes, at least right after they

Walk the grass at AirVenture, lead image, and it's easy to get smitten by a huge variety of experimentals. Better check with your insurer before pulling the trigger on one. A mainstream model might be more favorable.

come off the line, are all pretty much the same. There are equipment options, but the airframe and most of the systems are the same for a given model. And one of the mainstays of insurance is the grouping together of homogeneous units. Given a substantial number of essentially the same aircraft, insurers can predict their loss cost. At the end of the year, they can look at their claims and adjust rates accordingly.

On the other hand, the different types of kit-built aircraft seem to blossom in endless profusion. According to a recently revised FAA list of kits that are available, there are more than 200 offerings, depending on how you count. A large part of the kit-built fleet is made up of two dozen types of aircraft, but insurers are still faced with many more types of kit-built aircraft than factory-built aircraft. Take your pick: Vans, Rans, Lancairs, Glasairs, Glastars, Sonex, Kitfox, Cozies, Pietenpols, Velocities, Vari-Ezes. There are literally hundreds of types to choose from, including airplanes, helicopters, gliders and gyroplanes.

Another difference: Certified aircraft are built in factories, with the factory's name stamped on the data plate of each plane that rolls off the assembly line. Most certified aircraft manufacturers carry aerospace product liability insurance. This is an important point because aircraft insurers frequently bring manufacturers into accident litigation if there is any hint of product liability.

By contrast, amateur-built aircraft proudly carry the name of the individual who built them, and he or she likely doesn't have tens of millions of dollars to defend a product liability suit. The insurance company may not be able to count on the airframe manufacturer's insurance to share the burden.

Physical damage claims may also be slightly more involved for homebuilts. Some obscure types or types whose builder may have gone broke are difficult to get parts for. Total losses are straightforward, but partial loss claims may require more work for the adjuster and the owner. Many maintenance shops are hesitant to work on a type of aircraft they are unfamiliar with,

The turbine Legend, top, can cruise close to 400 knots and an insurer will want to know you can handle it. But models like that flawlessly built Sonex, bottom, will be an easier sell. Those are two Rotax engines hanging off a Lockwood Aircam, middle, one of the few twin-engine kits.

and where there is no product liability backstop, as there would be in the case of a certified craft. In the case of a partial loss, the owner may want to make his own repairs. Together, the insurer and insured come up with a value for the airplane as it sits, and work out an hourly rate for the owner's labor.

Liability claims against the aircraft owner are also straight-up propositions. The aircraft owner is probably the manufacturer—if he built it—and maintains and flies it. Since almost all amateur-built aircraft policies are written with per-passenger or even per-person sublimits of $100,000 per passenger (in some cases $200,000), the insurers pay these limits fairly promptly, both to fulfill their contractual obligation to their client and in order to avoid bad faith claims charges. Although the owner may benefit from the insurer paying for the cost

If you carry passengers, make sure you're comfortable with your coverage in the event the airplane ends up in the trees. Insurers favor models with good factory support, and that means the ability to easily get replacement parts at reasonable prices. The wing in the bottom photo needs a new one. Images courtesy of the NTSB.

of defense, this too will probably end once the company has offered to pay its limit of liability. This is not unique to kit-built aircraft, but owners of certified aircraft often have the opportunity to buy out the per-person or per-passenger limits and purchase what insurance people refer to as "smooth" coverage.

Smooth limits allow the insurer to pay liability claims for bodily injury and property damage in whatever amounts are needed until the limit has been exhausted. This is more likely to be sufficient to take care of injured passengers, and the insured also benefits from having the costs of defense for a longer time, perhaps all the way to settlement. If the insurance company has more at stake, they are more likely to mount a defense than if they only had $100,000 or $200,000 at stake. During our research and in talking with underwriters, we came away with the impression that "smooth" coverage was rather difficult for kit-built aircraft.

HIGHER RISKS

Among people we spoke with about the world of experimental amateur-built aircraft, there was almost universal agreement that these aircraft suffered a higher rate of accidents than their certified brethren. Just how much higher is very much a matter of debate. It's not that there are not any statistics, it is more that the statistics are measuring different things. The FAA only looks at fatal accidents when it looks at homebuilt aircraft. Insurers and those within the homebuilt community who keep track of these things look hard to find all the accidents. And there is nearly universal agreement that homebuilt accident rates in general are higher than those for certified aircraft, but are continuing a long downward trend.

And kit-built aircraft have one area of risk that certified aircraft do not, which makes someone (usually the builder) a test pilot in every sense of the term. That's because prior to being issued its airworthiness certificate or carrying passengers, the FAA requires that the airplane be test flown for between 25 and 40 hours. The stats show that 13 percent of all kit-built accidents happen during this fly-off period, and most of them happen during the first 10 hours.

In order to get a better feel for how much this higher claims activity costs owners when they buy insurance, and how available insurance is for these aircraft, we set up a comparison between three certified airplanes and three kit-built airplanes, with identically qualified pilots. We chose pairs of two-, four- and six-seat airplanes, although there are relatively few four-seat kit-built airplanes, and even fewer six-seat kit-built airplanes. We were surprised by some of the results, which are shown in the table on the next page.

We took the most competitive quotes in each category, so they did not all come from the same insurer. We also showed the number of quotes that we received for each airplane, and the highest limit of liability that we could get for each airplane. Apart from price, the availability of insurance, expressed as the number of successful quotes, and limit of liability are key measures of how likely you

SELECT INSURANCE PRICE QUOTE EXAMPLES: HOMEBUILT VS. CERTIFIED

AIRCRAFT	INSURED VALUE	LIMIT OF LIABILITY	TOTAL PREMIUM
2010 KITFOX (TWO SEATS)	$25,000	$1 million/occurrence, limited to $100,000 per passenger. Max limit available: $1 million/occurrence, $200,000 per passenger	$885 (THREE QUOTES)
1977 CESSNA 152 (TWO SEATS)	$25,000	$1 million/occurrence, limited to $100,000 per passenger. Max limit available: $2 million/occurrence, $200,000 per passenger	$495 (SIX QUOTES)
VAN'S RV-10 (FOUR SEATS)	$200,000	$1 million/occurrence, limited to $100,000 per passenger. Max limit available: $1 million/occurrence, $100,000 per passenger	$2749 (TWO QUOTES)
2005 CIRRUS SR-22 (FOUR SEATS)	$200,000	$1 million/occurrence, limited to $100,000 per passenger. Max limit available: $1 million/occurrence, $100,000 per passenger	$2590 (THREE QUOTES)
MURPHY MOOSE ON WHEELS (SIX SEATS)	$200,000	$1 million/occurrence, limited to $100,000 per passenger. Max limit available: $1 million/occurrence, $100,000 per passenger	$4558 (ONE QUOTE)
1985 CESSNA A185F ON WHEELS (SIX SEATS)	$200,000	$1 million/occurrence, limited to $100,000 per passenger. Max limit available: $1 million/occurrence, $100,000 per passenger	$3983 (TWO QUOTES)

can successfully buy insurance for each type. Note that we made our sample pilots very qualified in order to encourage successful outcomes. The numbers in the chart should be viewed as indices, rather than as insurance quotes. The bottom line is that they are more predictors of whether or not you can find insurance than precise measures of what the insurance will cost.

While some of the numbers there are surprising, some are not. It is still easier to find a variety of insurance offerings for a certified airplane than a kit-built one, and you can more often get a higher limit of liability for a certified airplane than an experimental. For the most part, the highest limit of liability that is available in the market for kit-built aircraft is $1 million combined single limit, subject to a maximum of $200,000 per passenger or per person. Many will limit bodily injury coverage to $100,000, depending on the pilot's experience or the type of aircraft.

THINK IT THROUGH, FIRST

Here are some things to think about if you are seriously considering getting involved with kit-built aircraft.

- Does the aircraft that you are considering have a substantial owners group that can offer reliable guidance on a wide variety of issues?
- Will you be able to easily obtain parts for the aircraft once it's built? This includes major structural components that might be required after a wreck.
- Can you get along with a sublimit of $100,000 per person to $200,000 per person on your insurance policy, for bodily injury and property damage? In the current fraught insurance market, make sure you can obtain the limit that you feel you need.
- Don't wait until you have an aircraft to purchase aircraft insurance. Insurers like long relationships with their clients. You may have to reserve a registration number, but your insurance company or broker can give you valuable advice along the way.

Remember that each kit portion that you have purchased has value, and by the time you are well into the project and have an engine or avionics, that value is considerable.

- Make a plan for the first flight. If you don't, your insurance company may do it for you. Are you already a certificated pilot? Do you have experience in the type you are building? The answer to that is frequently no. In order to make the first flight and test flight period safer, the EAA, the FAA and the manufacturers have provided resources for builders like the EAA Technical Counselor and Flight Advisor programs.

If you don't have any experience in the type of aircraft you are building, does it make more sense to hire a professional for the first flight, or to do it yourself? Again, if you ask the question before you ask your insurance company, it will let them know that you have considered the issues. Preparedness and realism go a long way. The truth is, before getting knee-deep in a kit project (or before buying an existing one), have a real conversation with your insurance provider. They will appreciate being included, and can probably give you good advice that will save you a lot of grief later on.

Jon Doolittle is a regular Aviation Consumer contributor and a principal at Sutton James Aircraft Insurance in Hartford, Connecticut.

Getting Back at It: Efficiently, Safely

Be it COVID-19 or lack of airplane access, a lot of pilots are facing the challenge of getting current without breaking the bank. Here's how.

by Rick Durden

No matter how many times we hit the delete key, 2020 is still here. With Abby Normal the new normal, a lot of pilots have been flying infrequently at best, with many unable to do any aviating at all.

Our readers are nothing if not perceptive—they know that a pilot who isn't flying regularly can be a ball of aircraft aluminum looking for a place to a stop—and they're looking for ways to get back into flying, when the opportunity arises, safely, without breaking the bank. They are also expressing concern about the insurance market and rightfully worried about what will happen to their insurance rates when renewal comes around and they haven't been flying.

We've looked at the issues involved with returning to active flying after a layoff and spent some time talking with instructors and reviewing material specifically designed for pilots who want to get back into the air. We also are very aware that COVID-19 job losses and job cutbacks have meant that a lot of pilots who are determined to resume flying are doing so on tightened budgets. Our recommendations are based on getting safely back in the air in a cost-effective manner.

FREE STUFF

There are a number of commercially available books and study courses designed to get rusty pilots back into the cockpit. All of the ones we've looked at are well done. However, because we don't have any advertisers to aggravate with our comments, we'll say flat out: There is so much good free stuff available, that beyond keeping your AOPA membership current, you don't have to spend a cent to get your hands on excellent recurrent training materials.

At the same time, we're going to recommend—in the strongest terms possible—that the first few flights you make be with an instructor. We'll get into what to do during that time with an instructor in more detail shortly. For now we suggest that you take the money that you don't spend on commercial review materials and spend it on a few hours with a CFI.

We also recognize that it's impossible to social distance in a four-place single. If you take dual, follow CDC guidelines for protecting yourself and the CFI by wearing a mask (we've found no problem using a headset and a mask and talking on the radio), using your own headset and wiping down interior surfaces. We note that Redbird Flight Simulations (www.simulators.redbirdflight.com) allows social distancing—the pilot flies the simulator with the instructor outside.

GROUND PREP

Take a look at our online sister publication *AVweb* (www.avweb.com) for its vast library of articles on everything involved with flight safety and efficiency. John Deakin's pieces on engine operation, for example, are classics that have been relied on by pilots for decades.

The FAA (www.faa.gov) has a stunning amount of free flight safety material. Want the most current regulations? Don't buy them. Every single one is free on the FAA's website, as is the complete Aeronautical Information Manual, all advisory circulars (solid information on a vast array of aeronautical subjects) and flight training manuals such as the *Airplane Flying Handbook* and *Instrument Flying Handbook*—just

Landings, it's all about landings. Reduced to its simplest form, accident data and interviews with CFIs tell us that the pilot skill that erodes the fastest—and that a pilot doesn't recognize how far it's eroded—is the ability to make a landing, particularly in a crosswind. When getting current again, plan on practicing a lot of landings after carefully maintaining the published approach speed.

BACK TO THE COCKPIT IN A HARD INSURANCE MARKET

We've heard our share of horror stories from readers regarding their experiences in the "hard" insurance market that developed in the last two years. We've been tracking the market and reported on it in the February and December 2019 issues. It put an end to a "soft" market that had existed for over 30 years. Aircraft owners luxuriated in an aviation insurance market where there was excess capacity—there were so many insurance companies writing aviation coverage that the competition drove premium prices through the floor. Keep in mind that there are fewer than 15 insurance companies that write aviation insurance, and only about 200,000 airplanes in the U.S.—it's a tiny market.

In addition, the cost of repairs has skyrocketed, especially on composite aircraft, and there are more owner-flown multimillion-dollar turboprops and jets, something that gives insurers the willies.

A few companies left the aviation market because the return on investment was too low. That drove premium prices up. Subsequently, some big losses, notably the two Boeing Max crashes and the Kobe Bryant helicopter accident, meant the aviation insurance industry is facing some large claims.

With that as background, owners of general aviation airplanes are seeing significant increases in premiums at renewal time and a few who fly high-performance machines have found that they can't get coverage, can't get the level of coverage that they feel they need or can't get coverage for a price they can afford. We'll say right here that those most impacted by the hard market are owners flying turbine equipment. They were the greatest beneficiaries of the soft market and have been most affected as the pendulum has swung. The least affected are owners of piston singles, even though we've seen premium increases for them of up to 20 percent.

In preparation of this article we spoke with aviation insurance brokers Mike Pratt of Fifth/Third Insurance and Jon Doolittle of Sutton James. Doolittle is also a regular contributor to *Aviation Consumer*. We also spoke to two aviation attorneys who requested that their names not be used.

Pratt and Doolittle told us that the bottom line for aviation insurers when looking at coverage for an aircraft owner is how much he or she flies annually. That hurts when the COVID-19 shutdown that hit just as the spring flying season was getting rolling.

They went on to tell us that with BasicMed there are more older pilots and insurers are less inclined to insure older pilots. We were told that two insurance carriers are now refusing to look at new submissions if the pilot is over 69 years old.

With the twin problems of less annual flying time and aging pilots, Pratt and Doolittle recommended that pilots do all they can to make themselves attractive to insurers—sell themselves to their broker so that their broker can sell the pilot to the insurance underwriter. Otherwise, because insurers consider general aviation pilots who aren't being paid to fly an airplane as amateurs (accurate, but ouch), your ratings, type of airplane and annual flying time are usually just plugged into a computer program the underwriter has and it spits out a premium.

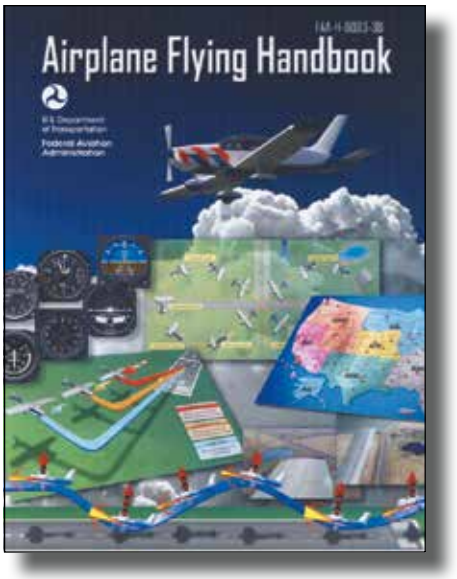
Quick background—all but one aviation insurance company sells insurance through brokers (brokers are NOT insurers, they obtain insurance for you, the client). The broker has a fiduciary responsibility to you, not the insurance company. When you contact a broker and provide your insurance needs and pilot history, the broker goes into the insurance market and shops for coverage for you.

Only one insurer, Avemco, sells directly to the customer. You contact Avemco with your info and it spits out a premium for the coverage it offers.

Since the only way to get quotes from all of the insurers is to go through a broker, here's what Pratt and Doolittle told us you can do to get the best deal:

- Fly more. Definitely more than 25 hours a year.
- Add a rating—especially an instrument rating.
- Set up and stick to a recurrent training schedule—get an FR and IPC every six months or at least annually.
- Complete an FAA WINGS Program phase annually.
- Flying a high-performance aircraft? Set up and take simulator training at least annually.
- Before buying an airplane, make sure that you can get insurance, especially if you're over 60. If you're buying a retractable-gear bird, you'll probably need to have 500 hours TT, 100 hours retrac and an instrument rating. We heard two examples of pilots who bought high-performance retracs and couldn't get coverage.
- Make sure the person you deal with at your brokerage is a pilot or understands the type of flying you do so she or he can knowingly sell you to insurers.

We were also told that if you have a claim, plan on your premium going up, even if it wasn't your fault. After making a claim, stick with the same insurer at renewal—you're more likely to be renewed. Others may be hesitant to cover you.



There is a vast amount of free information available to help pilots start getting back up to speed. We particularly like the FAA's WINGS Program, top; AOPA's and Hartzell's Return to Flight Proficiency Plan, middle; and the FAA's library of training manuals, including the Airplane Flying Handbook, *bottom.*

about anything you need to refresh your aeronautical knowledge.

WINGS

The FAA WINGS program (www.faasafety.gov/WINGS) was designed to address primary accident causal factors in general aviation. It consists of a series of phases that you tailor to the type of aircraft you fly with online courses and guided dual instruction. Completion of a phase counts also counts as a flight review. Our sister publication *IFR Refresher* once referred to the WINGS program as a silver bullet for flight safety because so few pilots who were current in the program were involved in accidents.

AOPA (www.aopa.org) and Hartzell Propeller teamed up to create the Return-to-Flight Proficiency Plan. It contains a series of what we consider to be well-produced videos on topics that will help pilots update and refresh their aeronautical knowledge. While we've included this in our free stuff collection, AOPA membership is required. We recommend AOPA membership if only because of AOPA's strong legislative efforts on behalf of the pilot community and the magazine members receive every month.

One of the most important documents for a pilot to review in detail before getting back into the air is the POH or Owner's Manual (POHs did not come into common usage until about 1976) for the airplane you fly. We recommend taking some time to read through the sections on normal, abnormal and emergency procedures, systems and performance at the very least. We guarantee that you will find stuff you either didn't remember was in there or didn't know about.

Especially if the fuel system is more complicated than an "On/Off" system, make sure you understand how many tanks the airplane has and how to make sure you're selecting a tank that has fuel in it (make absolutely certain that you know which end of the fuel selector knob points at the tank selected—some are not intuitive) because a significant percentage of accidents involve fuel mismanagement.

Every month when we look at accidents for the Used Aircraft Guide we can count on at least 5 percent involving a pilot who ran a tank dry and didn't then select a tank that had fuel in it. Also, make sure you know the procedure for getting the engine stared again if you do run a tank dry. It may require taking action other than just moving the fuel selector.

EMERGENCY PROCEDURES

If you can, go out to the airplane, sit in it and run through the full emergency procedures section in the POH. If you're a renter, do it when your airplane of choice isn't scheduled to fly—so you can keep this a free exercise. CFIs told us repeatedly that one of the weakest areas they saw in recurrent training was emergency procedures—because they don't get practiced in normal operations. It seems to be especially true with pilots who fly frequently and claim that they don't need recurrent training because they fly frequently.

Pilots reported to us that sitting in the airplane, going through the POH emergency procedures section and moving the controls for each step proved to be a big help for them in getting comfortable in the airplane again. When they went through the engine failure after

takeoff section, they also gave a thought to how far they were going to have to shove the nose down—and how fast—to avoid stalling and have enough energy to flare and land.

We in aviation have repeatedly proven the truth of the more than 2000-year-old statement by the ancient Greek poet Archilochus: "We don't rise to the level of our expectations, we fall to the level of our training." As pilots, we do the stuff we've practiced well—when we try something new, not so much.

CFIs watch that play out in recurrent training all of the time—it takes three or four tries for the pilot to handle an engine shutdown on a twin without losing a lot of altitude or control becoming questionable. In the real world you have to get it right the first time, so you have to have practiced emergencies recently.

TAILOR YOUR FLIGHTS

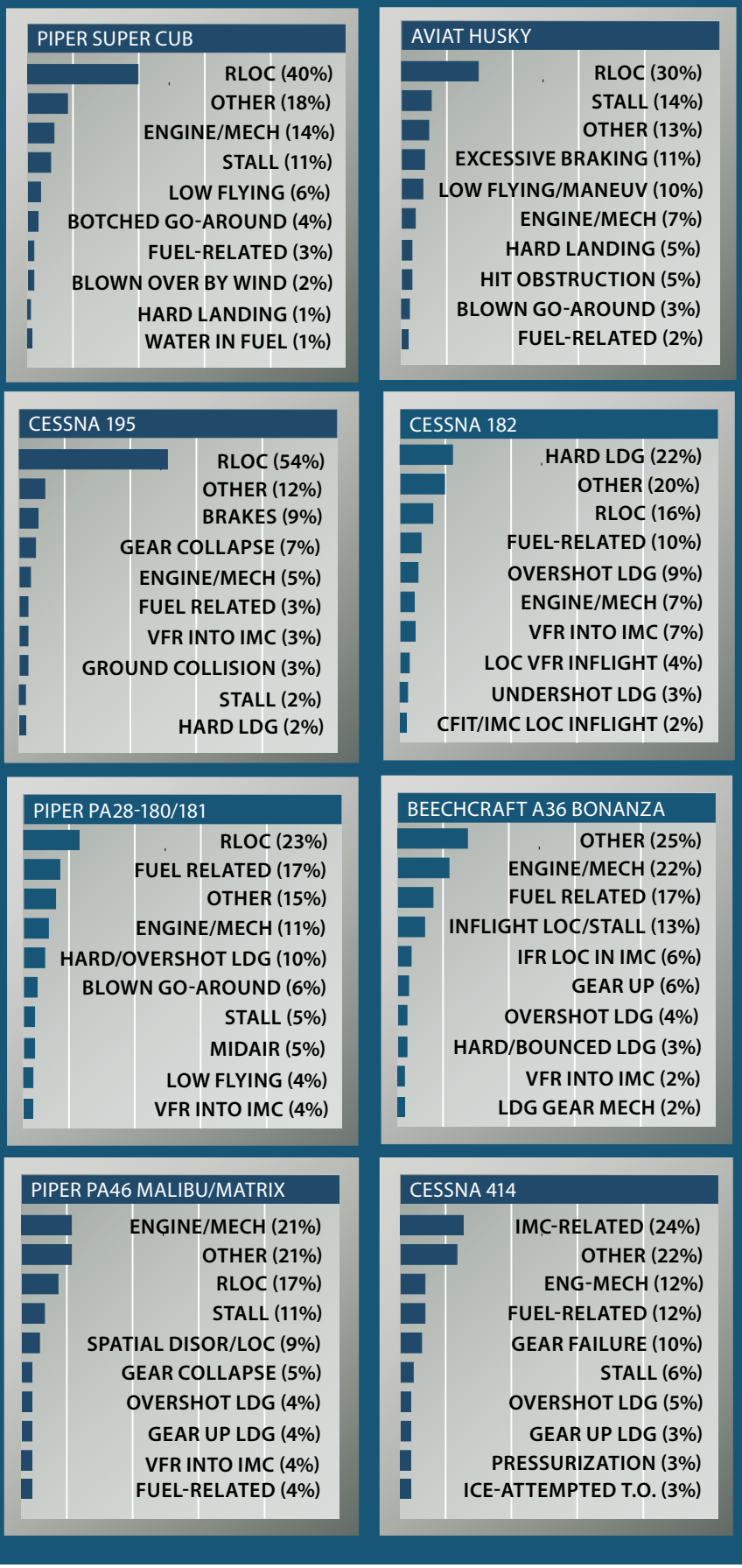
We strongly recommend that when you are able to start flying again that you make the first flight with an instructor. We spoke with the Kathryn Robine, a former airline pilot who currently instructs at the Michigan Flyers, a large flying club in Ann Arbor, Michigan. She told us that the club requires that any pilot who has not flown three hours and made nine landings in the preceding three months has to fly with an instructor and be signed off before flying club airplanes solo or with passengers.

Robine told us that her experience was that the aeronautical skill that erodes fastest was making landings, particularly in a crosswind. That matches what we've seen over the years in reviewing NTSB accident reports for the Used Aircraft Guide in each issue of *Aviation Consumer*.

Robine also recommended that a pilot talk with the instructor before the dual session so that it can be tailored to the type of flying you do and your needs.

Denver-area CFI Michael Shannon said that in pre-instruction conversations with his clients, he asks them to outline their flying goals for the next year. We think that's a good way to help set up the syllabus for the time in the airplane. Shannon also commented that the

ACCIDENT CAUSES BY TYPE



Tailor your return-to-flight training to meet the risks of the type of aircraft you fly. With tailwheel birds, above, it's loss of control/groundloop after touchdown on landing. For high-performance machines, below, look at IFR ops and fuel system mismanagement.

geographical area (including degree of airspace congestion) where a pilot most often flies should affect the way a CFI approaches training to get the rust off.

Michigan Civil Air Patrol instructor Kary Lucas told us that she emphasizes the stick-and-rudder basics in return-to-flying flight instruction and talks with pilots ahead of time about what type of flying they like to do and what makes them uncomfortable. She said that some work on slow flight in various flap and gear configurations often helps expand a pilot's comfort zone and winds up improving their ability to make crosswind landings.

We also recommend tailoring return-to-flight training for the risks associated with the type of airplane you regularly fly. On the previous page, we reproduced the accident causation data on eight types of popular airplanes. Before returning to flight, we suggest searching back issues of *Aviation Consumer* for the most recent Used Aircraft Guide for your type. After reviewing accident data, we have some recommendations based on aircraft type.

TAILWHEEL

Loss of control during landing rollout is the almost always the number one reason tailwheel airplanes visit the body and fender shop. Their rate of RLOC crashes is generally two to three times that of their nosewheel brethren. Real pilots may fly tailwheel, but they wreck a lot of airplanes.

We cannot overemphasize the need for solid landing training when returning to fly tailwheel airplanes—with the pilot demonstrating proficiency in three-point and wheel landings after approaching at no more than 1.3 Vso. We see too many accident reports where the pilot came smoking down final, made a wheel landing at high speed and lost control before the aircraft had decelerated enough to put the tailwheel on the runway.

SINGLE-ENGINE CRUISERS

With the steering wheel up front, the rate of RLOC accidents drops off, although landing-related accidents (hard/bounced landing, RLOC and loss of control on go-around) are still close to the top of the crunch parade.

The next area of concern is fuel management. We recommend that return-to-flight training spend time on fuel system operation and management and engine restarts after running a tank dry.

HIGH-PERFORMANCE

As speed goes up, the frequency of IMC-related accidents goes up, many because of spatial disorientation or a pilot having difficulty hand-flying in the clag. Dropping a wing because you glanced down at your iPad will generate a high-speed diving spiral distressingly quickly in a high-performance machine. Accordingly, we recommend that any instrument-rated pilot undergoing return-to-flight training in a twin or high-performance single complete an IPC.

ON YOUR OWN

Once you've gotten the skills brushed up with a CFI, how can you keep them as sharp as possible when you can't fly as frequently as you'd like? From our talks with CFIs we came away with an overall strategy that is pretty simple. First, in debriefing your last CFI flight, find out where the CFI thinks you should concentrate when you practice. Use that to start creating your checklist of maneuvers to practice.

Once you have the list, put it into an efficient order. Do you have to ferry some distance to the practice area? What can you do to make that time valuable? Try some coordination exercises—rolling back and forth from right to left banks while using the rudder to hold the nose on a point directly ahead of you.

If possible, fly when others aren't so that you can fly a tight pattern and get in more landings than when you have to follow that guy who flies downwind to the next county before turning base.

Do everything you can to be ready to go when you start the engine. You don't want to be sitting around with the engine idling while you mount your iPad and input your route.

If we in aviation have learned nothing from the COVID-19 pandemic it's that flying time is precious. Make the most of every moment of it.

That's the Approach Aviation FlexAlert advisory system installed on the panel of a Bonanza. It works as a landing gear minder, plus has a variety of other alerting functions.

Landing Gear Alerters: Few Standalone Choices

If you fly a retrac or an amphib, a warning system can avoid an insurance-busting crunch. The FlexAlert and PS PMA450B are standouts.

by Phil Lightstone

With insurance premiums skyrocketing—especially for pilots of complex, retractable-gear airplanes—the last thing you need is a gear-up landing because you were distracted. Aftermarket audio and visual alert systems can help, while some can even monitor the status of cabin and baggage doors and other systems.

While there are retrofit systems that focus entirely on monitoring the state of the landing gear, there are some other systems to include audio panels and even flight displays that have customized alerting capability. In this article we'll scan the market for some top picks that won't break the bank, and help you avoid breaking the airplane by landing with the wheels in the wrong position.

FLEXALERT

The Approach Systems FlexAlert multifunction annunciator consolidates gear status, as well as many other critical alerts, in one display. Measuring 3.0 inches wide, 1.3 inches high and 1.5 inches deep, the sunlight-readable and solid state LED FlexAlert panel is reasonably easy to retrofit in a variety of instrument panels, and the optimum location should be within the pilot's primary scan. Mounting is pretty straightforward. There are eight mounting holes built into the chassis: two on the top, two on the bottom and two on each side. Mounting brackets are included with the kit, allowing the installer to select either a side mounting or a top/bottom mounting scheme. It is designed to be flush mounted on the panel.

The unit can be installed in certified and uncertified aircraft, and it's FAA approved for installation as a minor modification (only a logbook entry is required) through the FAA's Non Required Safety Enhancing Equipment (NORSEE) approval process. To review, NORSEE was designed to expedite the approval of new technologies that do not impact existing aircraft systems, but rather enhance them. Essentially, NORSEE approval is based on the premise that the device offers safety benefits that outweigh the potential risks of installing and operating the device. In theory, the failure of the device in the air or on the ground should not result in a reduction in safety.

The FlexAlert isn't intended (based on the approval) to replace existing OEM annunciators, but instead as a supplement. In other words, you can't remove existing type-certified annunciators and warning systems and replace them with the FlexAlert unless additional FAA approval is awarded, generally via field approval.

The FlexAlert is configurable for both retractable (including amphibs) and fixed-gear aircraft, and supports both 14-volt and 28-volt aircraft. For fixed-gear aircraft, a small bezel is included with the kit, which hides the landing gear icons from view. In addition to landing gear status, the unit displays warnings for oil pressure, fuel pressure, low fuel quantity, pitot heat, low voltage, over-voltage, alternator failure, cabin door status, starter engagement, vacuum failure and autopilot glideslope capture. The sensors for each function aren't supplied with the unit. It simply ties in with the existing ones.

There are three individual door warning annunciations (displayed in red as L/DOOR/R). Depending on the configuration of the aircraft, the installer can interface with the existing door warning light(s), configuring the unit for display of a general door warning ("Door"), or even a warning for the left door or

The P2 6601 AAS uses a remote processor and panel annunciator, top images, for generating both aural and visual gear status alerts. Big-screen primary engine monitors like the Electronics International MVP-50, bottom, have inputs and display for wing flaps and landing gear status.

right/rear door warning if equipped. The installer selects which of the individual door annunciations to wire into, individually or in parallel, to match the existing door warning lights in the aircraft. With it you should never take off with an open cabin or baggage door again.

As for setup and configuration, three dip switch banks are located on the rear of the FlexAlert under a removable panel. At the time of installation, the dips are set (on or off) based upon which pre-existing annunciators have been installed in the aircraft. For fixed-gear aircraft, the landing gear dips are set to Off. As a result, when the Test button is pressed, the landing gear indicators will not illuminate, nor will the gear status alerts for Gear Up, Gear in Transit, Gear Warning and Seaplane Water Landing.

The FlexAlert is designed to replicate the existing, primary gear lights for retractable-gear aircraft and will work with a wide range of retractable landing gear annunciation configurations in certified aircraft. There are three individual gear-down annunciations (displayed in green) identifying the nosegear, left main gear and right main gear. Each of the three landing gear lights is controlled through independent inputs to the FlexAlert. Depending on the configuration of the aircraft, the installer can tie into the existing light(s), configuring the unit for display of each individual "gear down and locked," or all three annunciations can be wired in parallel to match the annunciators in the aircraft with a single annunciator for showing that the gear is down and locked. Better yet, the FlexAlert can be configured for a variety of landing gear annunciations including aircraft with one gear light, tricycle landing gear with nosegear, left main gear and right main gear lights, tricycle landing gear with only a retractable nosegear light, or only retractable left and right main gear warning lights. It can also work in aircraft with landing gear warning audio alerts triggered by airspeed, altitude, throttle position and/or flap position. There's also compatibility in aircraft with indications for gear in transit, gear up (stowed) as a normal or abnormal condition, aircraft with indications of gear up (stowed) as a warning condition, plus seaplanes requiring a blue indication of gear up for water operations.

At $595 and made in the U.S., we think the FlexAlert is a good value and worth considering when the plane is open for other upgrades. Visit www.flexalertaero.com.

P2 AVIATION 6601 AAS

After selling his company Lake & Air to Wipaire, P2 Aviation technology founder Steve Petrich continued where the Amphibious Gear Advisory System (AGAS) model 9600 left off. Following his work in the early 1990s researching landing gear accidents and working closely with the NTSB on it, Petrich ultimately developed the 6600 Audio Advisory System, focusing on the retractable-gear general aviation aircraft. In addition to monitoring landing gear, it sported several new features aimed at high-performance retractable singles and light twins. The 6600 eventually evolved into the 6601 Audio Advisory System.

This new version was developed for both pressurized and non-pressurized aircraft. The PMA'd 6601 is currently STC'd with Approved Model List (AML) blanketing 230 models—from small piston retracs to small and midsized turboprops—including the King Air C90.

The 6601 AAS is a remote unit with alerting for landing gear, overspeed and stall conditions with both audible (via the aircraft audio system) and visual cues on some displays. Once airborne, the AAS continuously monitors the airspeed and compares it to the position of the landing gear. Once the aircraft slows down to the preset airspeed threshold, the system will alert the

pilot with an audio queue, "Gear Is Down For Landing" (in a male voice) or "Check Gear, Check Gear" (in a female voice) if it's not down. An optional Hobbs meter can be integrated into the 6601 and will be activated when the aircraft's airspeed exceeds 35 knots. The idea with this approach is engine-time management, providing an accurate time for life-limited components, as well as engine overhaul times.

With an abnormal gear configuration, the annunciation repeats itself until the pilot cancels it by pressing the illuminated AAS annunciator light. The actual value is set at 10 to 15 knots (or MPH) above the final approach speed published in the POH. It can be adjusted up or down in 5-knot increments. The landing configuration airspeed threshold is set during installation and can be adjusted at any time.

The AAS powers on and off with the aircraft master switch, and simply functions by sensing the signal sent to the existing landing gear indicator lights and stall warning horn and by sensing the airspeed from the aircraft's pitot-static system. It communicates with the pilot visually through the AAS push-button panel annunciator.

The computer continuously monitors the airspeed, the landing gear position and the stall warning system, and if the airspeed has exceeded the preset landing gear threshold value, the airspeed-dependent advisories become armed. For normal landings, the male voice is the only annunciation that you will hear ("Gear Is Down For Landing") along with one flash of the annunciator. All abnormals will have a female voice ("Check Gear" and "Overspeed," for example), as well as continuous flashing of the AAS annunciator.

The pilot has the ability to silence the landing gear message at any time by simply pressing the AAS annunciator light. All other messages cannot be canceled.

If the aircraft speed exceeds the threshold, such as in a go-around or missed approach, the advisories are automatically canceled. The re-arming speed is set to 5 knots/MPH above the alerting speed to avoid bouncing in and out of alerts while flying close to the threshold in gusty winds. Ideally, the AAS should be integrated into the aircraft's audio panel and not rely on the aircraft's overhead speaker.

The Laser Gear Advisory System, top, is covered under Wipaire's float STC and is fair game on a wide variety of float-equipped models, including the Cessna 206, bottom.

The 6601 AAS is $2195, and the optional Eaton 582 panel annunciator is $425. A basic panel annunciator/switch comes standard in the kit, along with a mounting tray, serial connector and other install hardware.

We're told the next-generation warning system is in the works, which will be lighter and equipped with more features. Visit www.P2inc.com.

WIPARE LASER GEAR ADVISORY SYSTEM

For over 60 years, Wipaire has been engineering and manufacturing a full line of respected water floats for a wide variety of aircraft. It replaced the familiar model 9600 gear advisory system designed by Steve Petrich with the Laser Gear Advisory system, which is designed for amphibious float ops (although a failed 9600 can be replaced by the new Laser system fairly easily).

As you guessed, the system is indeed laser-based, and the system's laser fixture is installed on most applicable aircraft in the underside of the wing, near the leading edge and facing down. The sensor is small enough that it tucks inside the leading edge with just the addition of the panel, which resembles a typical inspection panel. Others use a rectangular panel. The laser is hard-wired to the main controller, weighs 3 pounds and draws less than 2 amps of current.

The older 9600 system generates "Gear is Up for Water Landing" and "Gear is Down for Runway Landing" advisories, but the Laser system remains quiet when the landing gear and detected surface are in agreement. The laser becomes active at approximately 400 feet above ground level and compares the gear position with the detected landing surface. In the event of a mismatch, the system reminds the pilot to "Check Gear" at about 50

ROLL YOUR OWN GEAR WARNING

With a little bit of creative wiring and the right hardware, you don't always need laser sensors or multifunction warning panels for an added layer of gear warning backstop. Lots of older retracs have landing gear status lights placed in pretty inconvenient places—sometimes in a center pedestal or down low in a subpanel. Add to that an inoperative or failing gear warning horn and it's no wonder some pilots belly it in.

Airplane in for an avionics upgrade? You can have the shop supplement the OEM landing gear lights with a second set of annunciators better placed within your instrument scan. One option is to simply use an Eaton or Staco lighted annunciator that's custom-modified to display whatever warning text suits you. Maybe Gear Unsafe or Check Gear. If the instrument panel is opened up for other work, it might not cost as much as you think. Other than making a cutout for the annunciator, the effort will be running power and ground wiring to it, and tapping in to the existing gear warning system to double-up on the outputs. Some shops might install an airspeed switch to trigger a gear alert, and others might run wiring from the gear warning circuit. Talk to your installer about what can work the best for your given system. If you've been putting off an audio panel upgrade, now may be the time to pull the trigger.

One system worth considering is PS Engineering's PMA450B. It (and the PM8000G) have a feature called Flightmate, where you can custom program your own audible voice alerts (there are up to four discrete inputs) which can be triggered from the existing gear warning system. It's as easy as running a power wire (the audio panel accepts the warning signal in as a voltage) from the existing gear horn/sonalert into the panel. The PMA450B has a built-in display, but Flightmate only uses audible alerts. Garmin's later GMA-series panels also accommodate discrete inputs for gear warning input.

None of these systems and accessories can legally replace the OEM gear warning system, of course, but with the right planning you can build your own supplemental gear warning system that might be better than the OEM's. —*Larry Anglisano*

feet above the surface, allowing the pilot to initiate a go-around to address the gear position. In the event of a laser malfunction, the system controller will revert to the standard gear advisory voice annunciations. If the gear position is incorrect for the landing surface (or an asymmetrical gear position is detected) then an alert will sound. An audio alert of "Check Gear" will be repeated, indicating that a go-around should be initiated and the gear position checked and adjusted. This alert may also be triggered if a water surface is very shallow, has large or dense debris or is extremely choppy. These may all be good reasons to reconsider your landing location.

Wipaire's STC and AML include the following aircraft: Air Tractor AT-802 Fire Boss, American Champion 8GCBC Scout, Aviat Husky, Cessna 172 Skyhawk, 180, 182 Skylane, 185 Skywagon, 206 Stationair, 208 Caravan, 208B Grand Caravan, CubCrafters CC-18 Top Cub, de Havilland DHC-2 Beaver, Piper PA-18 Super Cub, and in the works is the Maule M5/M6/M7.

The Laser Gear Advisory has been included as standard with all new Wipaire amphibious float sales since 2017, and can be purchased separately as a field-installed retrofit kit. The system retrofit conversion kit for preexisting Wipaire floats is $6,400. The company said the Landing Gear Advisory system cannot be installed into Wipaire's competitor's floats due to the variability in how different float models are wired. Visit www.wipaire.com.

CONCLUSION

Frankly we're surprised there aren't as many aftermarket landing gear alerters as there once were. Of course, some larger aftermarket engine monitoring systems accommodate gear and flap signal inputs, and as we discuss in the sidebar above, modern audio panels can offer their own utility. Large-screen EFIS platforms like the Dynon SkyView HDX Certified and Garmin G3X Touch accommodate gear and flap signal inputs, too.

Aircraft Spruce (www.aircraft-spruce.com) sells the Aero Safety System AH500SD central warning panel for $1145. It combines engine, aircraft configuration (gear and flaps) and even flight data in one 6.25 by 1.72 inch display panel. Unfortunately it's not approved for certified aircraft, although the company is working toward an STC. We'll keep tabs on it.

Aviation Consumer Contributor Phil Lightstone owns and flies a Rockwell Commander, and produces the Plane Talk podcast, available on Apple, Google and at www.planetalk.ca.

Stratus Insight: EFB Nouveau

Appareo takes a decent stab at the competitive EFB market with good mapping and an audio interface that decodes ATC transmissions.

by Randy Dufault

Enjoying huge success with the Stratus portable ADS-B receivers, Appareo joins the crowded app market with Insight EFB for Apple iOS. While Insight provides a lot of the flight management functionality pilots expect from a modern EFB, it adds some unique features, including real-time radio encryption.

I spent some time with Insight working through its feature set and prepared this field report.

QUICK TOUR

Like all EFB applications, Insight's center feature is its map. A multitude of layer options allow for a base view showing VFR sectional charts, IFR high or low enroute charts, terrain, street maps and a satellite view. Overlays enhance the base maps with ADS-B traffic, various weather products including weather radar, ground obstruction and terrain warnings, a vector aviation map and fuel prices.

Other than the VFR, IFR and aviation vector base charts, all the other charting requires an active Wi-Fi connection. Insight's approach to managing map overlays consists of a lengthy list of all the options, and a shorter list you have marked as favorites. Overlays are selectable from either list, although selecting a proper set of favorites can eliminate the need to scroll to find them.

Some overlays have features that may be useful to change while underway, without having to dive deep into a buried settings menu. Whenever any of those overlays are active, a large, familiar-looking gear-shaped settings icon appears at the top of the map. Pressing the gear exposes a settings window that grows and shrinks, depending on the selected overlays, and allows for selecting options like map objects, weather observation values and fuel types.

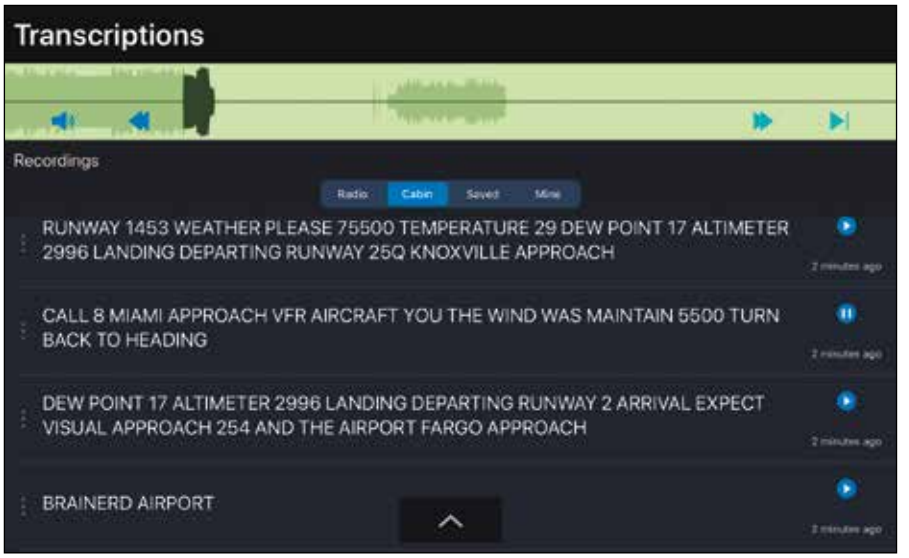
A playback control animates the last 30 minutes of radar data, while you can also play back the previous three hours of METAR data on that layer, making it easy to watch trending conditions—either in a good direction or bad—as a flight progresses.

Maps are the first item on Insight's main menu at the bottom of the screen. To the immediate right of the Map icon is one that launches a full-page view of Transcriptions—Appareo's real-time audio-to-text transcribing function. See the sidebar on page 22 for a summary.

Insight also includes synthetic vision. Activating the feature splits the map page on an iPad or takes over the entire screen on an iPhone. Full screen on the iPad is a choice, too. Using the terrain database, the airport database, GPS data and AHRS data, the screen presents a typical MFD view with attitude information at the top and HSI data at the bottom. Airspeed and altitude tapes round out the display. Upcoming terrain should render below the horizon line and airport runways should appear substantially as they do outside the cockpit windows. Appareo said that a significant rework of the syn vis function is underway for an expected release in early 2021.

Next on the menu is Airports. Entering an identifier, with or without the leading "K," brings up a page on an iPad with a summary of field details and frequencies at the top, and the most current METAR observation in the bottom two-thirds of the screen. A slider scrolls through the previous three hours of weather observations and scrolling down shows observations for nearby fields. Other weather products available on the page include TAF, a text TAF discussion, the Global Forecast System (GFS) Model Output Statistics (MOS) forecast, the North American Model (NAM) MOS forecast and a local graphical forecast similar to the basic weather display available on most phones and tablets. The lack of an internet connection does limit inflight weather to the products available from the ADS-B FIS-B data stream. The Airport pages are necessarily more compressed on an iPhone screen. Insight implements the concept of favorites across many

That's Appareo Insight on an iPad in the main image. The app won't work with Android.



That's the Transcriptions page in the top screen grab, and an ADS-B FIS-B overlay, bottom.

of its features, and airports are no different. A heart icon consistently indicates the favorite option and selecting it on the airport page adds the field to a favorites list accessible at the very top of the page. Buttons at the top of the Airports page bring up the nearest airports, the list of fields marked as favorites and a browsing list organized first by state, and then by city name. Other tabs on the Airport page access frequencies, runways, procedures, NOTAMs, and FBO info for the selected field.

The Notepad button on the main menu opens a page that is just that: a notepad for scrawling anything requiring a record. Notes are graphical only and a finger, a tablet stylus pen or the Apple Pencil—on the models that support it—create whatever shapes or letters make sense. Notes collapse and remain on the page until you explicitly remove them.

PROCEDURES, CHECKLISTS

Insight organizes all the FAA U.S. Terminal Procedures via the Procedures tab on each airport's page. However, a dedicated Plates page button on the main menu serves up quick access to selected procedures. Much like airports, procedures have the heart-shaped favorite icon. Plates you select as favorites will appear in a list on the Plates page. Other lists on the page hold selected plates for the current flight and show recently used plates.

Georeferencing (the ability to see the flight progress on top of the procedure plate) is a standard. Choosing a plate overlays it on top of the current map, in the proper location and orientation, with the aircraft icon positioned where it is relative to the procedure.

Automating checklists is a common feature on most EFB apps. Insight includes a text-to-speech capability where it reads the checklist item to you, assuming you have a means of routing your device's audio to your headset. A large check mark button acknowledges the item and moves on to the next.

The default list of available checklists is short (two). A procedure for loading ones you create through the Stratus website seems simple, but during my evaluation in mid-summer it didn't work as expected. Appareo is looking into it.

A Logbook button brings up a pilot's log with all the expected fields and features. The front page shows your currency status, a list of recent flight tracks and a graph of flight hours over time. A list of options changes the graph to show total flight hours or hours within a category like instrument or multi-engine time. A graphic map on the page shows all your logged flight routes or just the visited airports. You can exchange log data with other logging programs, but I did not test those features.

RADIO TRANSCRIPTION AND PLAYBACK

Insight's voice feature extends well beyond reading checklists. While on the ground it announces an approach to a runway. While in flight the software will warn of obstacles, altitude deviations, nearby ADS-B traffic, terrain and depressurization—if your craft is so equipped. A configurable pre-landing brief reads out destination airport details like elevation, runways, frequencies and other details a set number of minutes before arrival. Descent and climb altitude callouts are another voice option. Appareo's artificial intelligence division created a nifty speech recognition utility that's still a work in progress.

Paired with Appareo's audio cable (plug the headset phone plug into the $49.95 adapter, and the adapter into the iPad/iPhone), the ATC Radio Transcription feature works like visual voicemail. ATC comm is converted to text and is displayed above the audio playback line on the Transcription page. It's not perfect given the challenges of noisy signals, but we think it's a good start. Appareo used what it calls natural language processing to interpret the radio transmissions in a familiar way.

For example, when ATC called our tail number "November three one three three quebec," it correctly transcribed it as N3133Q. Same with "Cleared to land runway two zero," transcribed as Runway 20. On a busy, shotgun-like frequency it chopped some calls, but for the most

part it worked, especially with ATIS.

Got an Apple Watch? Insight offers a companion application. Six pages of data on the watch track the current flight and provide quick access to a list of the closest airports.

FLIGHT PLANNING

I think creating a flight in Insight will be intuitive for much of the pilot population. Press the flight plan button at the top of the map page, search for or point to the departure airport, search for or point to the destination airport, add any waypoints along the way and the plan is ready to fly. Calculating the details of a flight plan is not possible without aircraft performance data. Adding an aircraft definition to Insight is relatively simple. It starts with entry of the tail number and the ICAO type designator. ICAO does offer a web lookup for type designators that Insight links to, but the site is a bit confusing to use on a mobile device. It is best to know before adding the aircraft that your Piper Archer is a P28A.

Insight finds the rest of the performance data by using the type designator to search some other database in the sky. A button lights up showing how many profiles in that database match the type. Simply choose the most appropriate one from the list behind that button and save the aircraft profile. With a route and an aircraft profile, Insight calculates all of the flight details. Buttons on the flight plan panel allow for adding other details necessary for filing a flight plan with the FAA, allow for downloading all the data and charts necessary for the trip and allow for briefing and final filing.

Speaking of briefing, if the device has a network connection Insight connects to Leidos without any additional logon requirements and retrieves the standard briefing text. An email containing the full briefing is also sent to the email address associated with your Stratus account, making it easy to reference it before and during the flight. Another planning feature allows selecting the procedures you expect to need for the flight. Those then appear in a "bundle" on the Plates page. While in flight, it should be faster to select a plate out of the bundle than it is to navigate through the full list of procedures for an airport.

Several other details automatically insert into the flight plan when called for. A route longer than the range of the airplane will add a reminder to make a fuel stop. For IFR flights, the planner also applies the 1-2-3 rule to the destination airport weather and, if required, adds a reminder to select an alternate if you have not already done so. A selection tool helps make a choice that meets the alternate criteria and is within remaining fuel and reserves range.

FLYING WITH IT

To check out Insight in the cockpit, I planned a short cross-country flight with an intermediate waypoint on the way out. A few minutes into the flight, the base sectional map became blurry and did not appear to be updating as we progressed along the magenta line. A bit of troubleshooting found that I had failed to select the offline VFR base map prior to takeoff. Changing the setting cleared the issue. Appareo indicated that the next release will remove the requirement to manually select an offline option. Insight will automatically select the most appropriate map for the situation.

A final approach for the local commercial airport crosses a downwind departure from my home airport's Runway 16. It was not long before Insight's voice began calling out traffic that was laterally close, but thousands of feet above us. There do not appear to be any settings to adjust that specific sensitivity. A bar holding a wide variety of instrument values like groundspeed, ETD and GPS track pops up from the bottom of the map page. One of the instruments is barometric altitude and this was the first opportunity I had to fly with an iPad that included a baro sensor. After entering the current altimeter setting, the instrument was remarkable close to the aircraft's altimeter, varying only by a foot or two. The default configuration has all the instruments enabled. Access to more than the six that fit on a 10-inch iPad screen is by scrolling the entire bar left and right. Settings do allow for shortening the bar by disabling ones you are not interested in.

A flight recorder keeps a log of the actual track over the ground and other flight details. It starts and stops automatically based on GPS speed and will transfer most of the flight details to Insight's logbook if, of course, you are using it.

Insight's altitude departure voice alerts operated as expected. The software detects level flight and reports a deviation of about 100 feet above or below the level altitude. The feature's sensitivity seemed to be about right and did not create excessive alerts. The pre-landing brief played at the appointed time before reaching the destination field. The default briefing is quite lengthy but is editable in the settings. Going forward I will opt for a more concise script. I was disappointed that destination weather observations cannot be part of the briefing.

The synthetic vision feature worked as expected, although some of the tags and labels appearing on the horizon used a ridiculously small, unreadable font. Other than that, I live in an area with only minor variations in terrain level, so it was difficult to give it much of a test. As I noted before, a major rework of the feature is underway.

Selecting a waypoint off the flight plan panel and selecting the Info button opens a summary window for the airport. Sometimes, but not all the time, the panel appeared behind the flight plan bar, requiring a collapse of the flight plan bar to see all the airport details and access other data like procedures and the weather.

GOOD VALUE

At $9.99 per month, that's a good way to describe the app. It implements an extensive feature set, with reasonable access to elements without drilling down through layers of menus. And, at least right now, Insight is the only option with real-time audio transcription. According to Appareo's Kris Garberg, a vision for the software is to continuously improve its automated analysis features and to make the voice aspects a core part of the experience. Voice alerts and transcription are a focus, and we should expect more features like them in the future. Visit www.appareo.com.

Freelancer Randy Dufault splits his flying time between a Cirrus and a Cherokee in Minnesota.

Mooney 201/M20J:

The M20J series appeals for speed, efficiency and handling. Even with Mooney's corporate turmoil, support for the fleet remains good.

There's a reason why Mooney's entry-level speedster has such a loyal following. And you don't have to be a loyalist to appreciate the 201/M20J's high points. It has a familiar Lycoming IO-360 engine mated to a sleek airframe that has timeless good looks and ramp appeal. Plus, you buy a Mooney for speed, and for the 201, the bottom line is 155 knots on roughly 10 GPH. As a bonus you're treated to sports car-like handling that makes it a good IFR traveler, even if you don't fill all four seats.

The M20J had a long production run in the company's rocky history, and the last 201 came off the line in 1999 as the Allegro. But there are plenty of 201s to choose from on the used market in various conditions. Make no mistake—you'll want to choose one carefully. Neglected ones can be a nightmare when they hit the maintenance floor. As for support, we'll set the record straight and say up front that despite the company's recent shutdowns, getting parts and general factory support seems to be a non-issue.

MODEL HISTORY

Eyeball the Mooney line and you'll see the airframes all share the same basic styling. The Mooney airframe has evolved over the years, but the concept of a semi-monocoque rear fuselage mated to a metal-skinned steel-tube cabin, a long and slender tapered wing and distinctive reverse tail has endured, and is mostly responsible for the entry-level 201's speed and efficiency.

The J-model Mooney evolved most directly from the F model, which was itself descended from the short-body C models of the mid-1970s. The first J model or 201—the number derives from its supposed top cruising speed in MPH—appeared in 1977.

At 60 to 65 percent, true airspeeds average 150 to 155 knots and endurance with reserves is 4.5 hours or better.

To be fair, it should really be more like a Mooney 184, since this model doesn't honestly cruise at 175 knots. The old Mooney naming conventions—Executive, Chaparral, Statesman—were ultimately nixed in favor of the top-speed moniker.

For some creative marketing, Mooney even went so far as to reserve as many 201 registration numbers as possible for the new airplanes. It sported a 200-HP Lycoming four-banger—the IO-360—improved landing gear and a sloping windshield, among other changes. All of these were the product of a concerted effort by Mooney to kick the model line up a couple of notches.

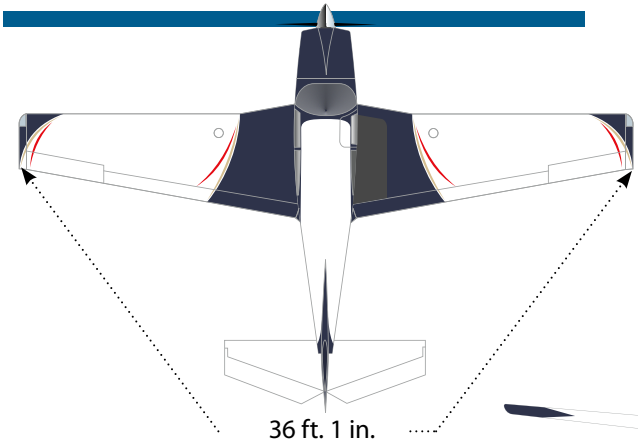
The 201 is, to the surprise of many, very much the work of the late LeRoy LoPresti. LoPresti had a long aeronautical background, including a stint on the Apollo lunar program at Grumman. He became a near legend for his ability to get the utmost from an airplane through aerodynamic cleanups, which he'd done with success on the Grumman Tiger.

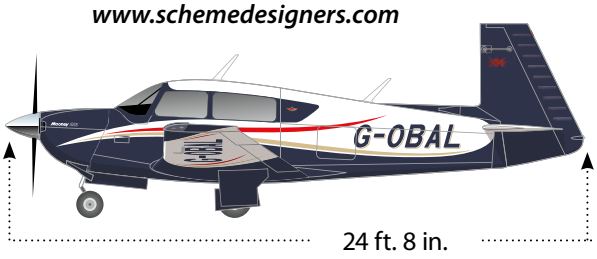
Applying his magic to the M20F model, LoPresti and the Mooney team created the M20J. A number of changes were made, the most visible being a new cowling and a more aerodynamic windshield. The interior was addressed, too, with adjustable seats and a contemporary flat panel with organized electricals and circuit breakers rather than the typical dog's breakfast arrangement of the 1960s and 1970s. But that doesn't mean avionics shops enjoy working on them. It's an unspoken (and sometimes spoken) rule that when quoting an avionics package, you add the "Mooney factor" to

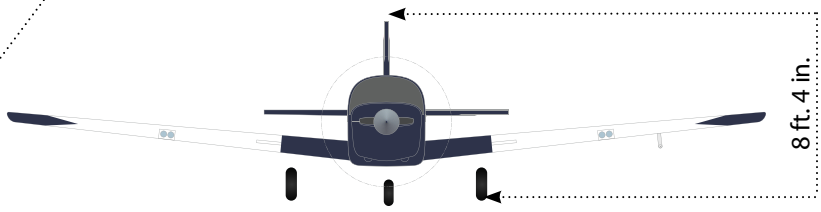
Charles Raines sent the lead image of his good-looking 1979 M20J. It's his fifth airplane, and the one that suits him the best.

MOONEY M20J/201

Drawings courtesy
www.schemedesigners.com



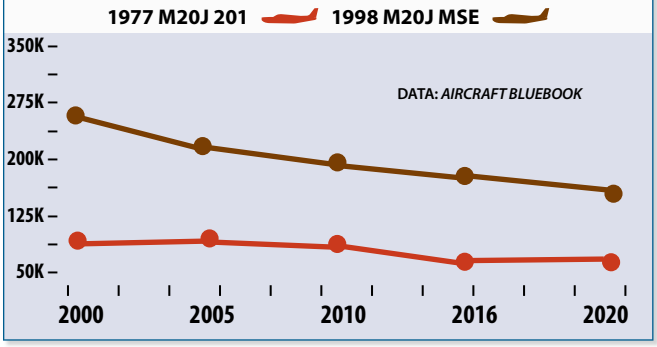




MOONEY M20J/201 MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1977 MOONEY M20J 201	LYCOMING IO-360-A1B6D	2000	$30,000	64	1069 LBS	155 KTS	±$68,000
1984 MOONEY M20J 201	LYCOMING IO-360-A3B6D	2000	$30,000	64	1069 LBS	155 KTS	±$84,000
1985 MOONEY M20J 201 L/M	LYCOMING IO-360-A3B6D	2000	$30,000	64	1069 LBS	155 KTS	±$80,000
1988 MOONEY M20J 201 L/M	LYCOMING IO-360-A3B6D	2000	$30,000	64	1069 LBS	155 KTS	±$77,000
1988 MOONEY M20J 205 SE	LYCOMING IO-360-A3B6D	2000	$30,000	64	1030 LBS	155 KTS	±$101,000
1992 MOONEY M20J MSE-LIMITED	LYCOMING IO-360-A3B6D	2000	$30,000	64	1030 LBS	155 KTS	±$125,000
1992 MOONEY M20J MSE AT	LYCOMING IO-360-A3B6D	2000	$30,000	64	1030 LBS	155 KTS	±$100,000
1992 MOONEY M20J MSE	LYCOMING IO-360-A3B6D	2000	$30,000	64	1030 LBS	155 KTS	±$115,000
1998 MOONEY M20J ALLEGRO MSE	LYCOMING IO-360-A3B6D	2000	$30,000	64	1030 LBS	155 KTS	±$160,000

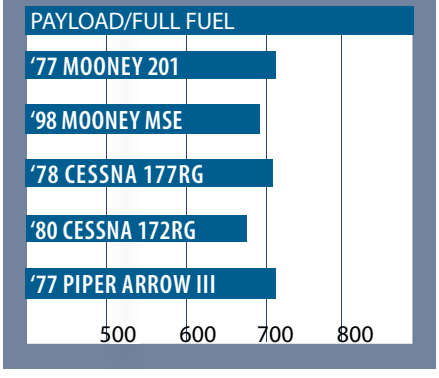
MOONEY M20J/201 RESALE VALUE

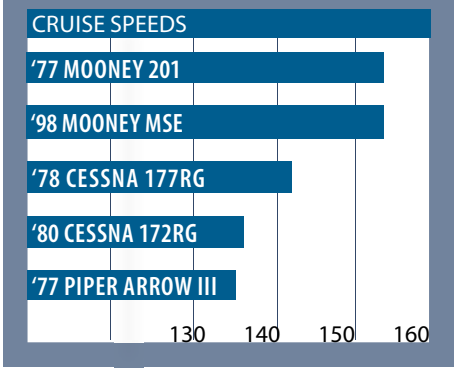


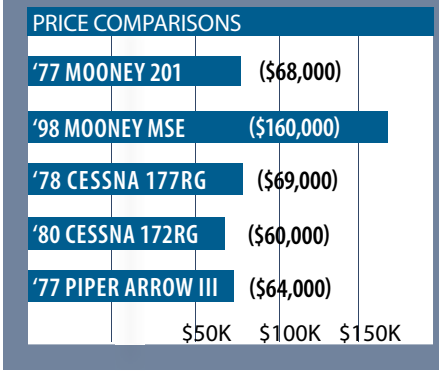
SELECT RECENT ADs

AD 2002-12-07	REPLACE OIL FILTER CONVERTER PLATE GASKET OR REPETITIVELY INSPECT
AD 2003-14-03	REPLACE OR REPETITIVELY INSPECT CERTAIN ROTARY FUEL PUMPS
AD 2006-20-09	REPLACE ENGINE CRANKSHAFT AT OVERHAUL OR AFTER 12 YEARS
AD 2008-14-07	REPETITIVELY INSPECT EXTERNALLY MOUNTED FUEL INJECTOR LINES

SELECT LATE-MODEL COMPARISONS







Mooneys are certainly worthy of avionics upgrades and older panels are more difficult to work with. The one at the top has a couple of Garmin GTN navigators, JPI engine monitor and dual Aspen displays. The late-model 201 at the bottom still sports round gauges, but Garmin radios. Both panels have the original King KFC150 autopilot.

the bottom line, partly because the radio racks are riveted in place. Plus the electronics are packed in like sardines.

PRODUCTION AND PRICING

Even though Mooney sold over 1000 M20Js in the first few years, by 1985 the general aviation slump was taking its toll so Mooney transformed the J into the 201 LM (for "Lean Machine"), a stripped-down version with basic IFR avionics for a bargain price. Two years later, the M20J got some more tweaks (gear doors) and was renamed the 205. Inexplicably, the 201 was still being produced, as was the 201 LM, and oddly, Mooney was selling three airplanes that were more or less the same: all M20Js, but with different equipment. In 1988, the 201 was dropped and the 205 became the 205SE. It's tough to keep straight.

And a year later, Mooney realized it was simply confusing customers and returned to the 201 name. That same year a trainer version was introduced, called the AT. It was intended only for flight schools and is notable for the inclusion of speedbrakes. The new ones we flew at a busy aviation university had minimal avionics—rare for the model that's usually loaded. In fact, we remember that it didn't even have an autopilot and sadly, a student and instructor perished after losing control at night. To this day we wonder if an autopilot would have changed the outcome.

In 1991, Mooney abandoned numerical names and re-dubbed the 201 the MSE. There was a version with special equipment in 1992 called the MSE Limited. In 1993, all special variants were dropped and just before it abandoned the J model, Mooney gave it one more name: the Allegro, ostensibly to go along with the Ovation and the Encore, the redo of the 252 that was also dropped just after it reappeared. Very few Allegros were made, but they're arguably the most luxurious of the 201 litter.

Total production of the M20J—regardless of name—totaled about 2150 with about 1600 registered in the U.S. The airplane retains a loyal following and the fact that demand for it remains strong is evidenced by price trends: The 201's base price more than doubled in the first six years, from $46,725 (1979 base) to $97,500 (1985). On the used market, the 201 continues to be a strong seller.

We hit the Summer 2020 *Aircraft Bluebook* and found that resale values are reasonably good. A 1986 M20J has an average retail of $90,000, while a 1979 is average priced at $70,000. A good one will sell quickly, even against lower-priced hangar queens and especially against ones that are neglected. As one would expect, corrosion is the enemy.

For comparison, a 1986 M20K with its 210-HP turbocharged Continental TSIO-360 has a suggested retail price of $119,000, according to the *Aircraft Bluebook*.

MODEL-YEAR TWEAKS

The biggest operational shortcoming of the original M20J was its low gear-operating speed (V_{lo}) of 107 knots for both retraction and extension. This, together with the low flap extension speed (V_{fe} of 114 knots), caused pilots grief in high-density areas and led to the airplane's reputation as a hot-handling, hard-to-land performance machine, which it really is not, although we were dumbfounded while researching the latest NTSB wreck reports for the airplane. It's littered with landings—and go-arounds—gone wild, evident that Mooney pilots still struggle with landing these airplanes as they always have.

Mooney has tried to help, at least in dirtying the airplane up at higher speeds. V_{le} (gear extended speed)

Mooney cabins get hammered for being a tight squeeze, but at 43.5 inches, the M20J's is slightly wider than a Beech Bonanza cabin. That's the center pedestal of a late-model Allegro in the bottom photo, and an odd place for a suction gauge.

and Vlo/e (maximum gear operating/extend speed) were increased to 132 knots for the 1978 model year. The 107 knots maximum retraction speed remains. Even these speeds are low, given the slickness of the airframe. Speedbrakes were offered as a factory option in 1986 and aren't a bad feature to have; you can retrofit the Precise Flight boards to any model and we think for many the investment is worth it.

Where the first 201s have throttle quadrants with a pistol power lever, carried over from the C model, in 1978 this was changed to conventional push-pull engine controls. The panel and central console/pedestal were redesigned twice. In 1980 (1981 model year), the panel and glareshield were changed to the same configuration as that in the 231, with the extended section over the radio stack to provide more room.

Some Mooneys can be vibey, and this change also is credited with solving vibration and rattling that had been an annoying problem in earlier 201s. For all its reliability, the IO-360 isn't the smoothest engine out there. If you're doing an engine swap, we say change the mounts, too. The ventilation system also was improved and the shaped wingtips with faired navigation and strobe lights that were first introduced on the 231 were added.

Further aerodynamic and several serviceability changes were made for the 1984 model year. The nosegear doors were redesigned to make them close fully on retraction, a fairing was added to the tail cone and a one-piece belly fairing was installed. This is a desirable feature; otherwise maintenance access to the belly is a hassle. The single fairing, which is fastened with 38 Dzus fasteners, replaces eight separate access panels with 175 screws. Access to the engine bay was improved, too.

Over the years, empty weight increased by roughly 80 pounds; basic empty weight was 1640 pounds in 1981, 1671 pounds in 1984 and 1726 pounds in 1992. Some versions have more than 200 pounds in optional equipment and end up with full-fuel payloads around 460 to 470 pounds. In any case, don't plan on much more than 600 pounds with the tanks full.

The big changes in the Model 205 were in the electrical system and landing gear. The 205 electrical system is 28 volts compared to the 14-volt system in earlier M20Js. The higher-capacity system is an improvement even though the 70-amp maximum output of the alternator is unchanged, because it can produce 70 amps whereas the earlier system is capped out at roughly 60 amps. Keep that in mind if you plan to pull the vacuum system in favor of an all-electric avionics suite. Bigger is better.

Battery rating also increased. Along with that, Mooney added an improved electric load monitoring system to supplement the high- and low-voltage annunciators—idiot lights that don't help manage demand to any great extent. Of course these days digital engine monitors and primary engine displays have lots of electrical system health monitoring.

The 205 gear system incorporates the M20K doors that fully enclose the gear when retracted and is the major contributor to the modest claimed speed increase of 4 MPH. The mechanical, three-position cowl flaps were replaced by an electrically operated, infinitely adjustable system. Some pilots like the manual flaps better, but they need to be kept in adjustment. Rigging is important in any airplane, and if you want to chi chi the best speed it's worth the expense to have a good shop rig the airplane by the book.

As with any retrac, landing gear upkeep done by techs who know the model is important. The bottom image is an example of a 201 you'll likely want to avoid. Flat mains and rusted gear is obvious neglect, and a clue for what might lurk in the airframe. Shameful.

Gear speeds were raised to a V_{lo}/extend of 140 knots and V_{le} of 165. A flap preselect system was offered for the first time and V_{fe}/approach (15 degrees) was raised to 132 knots. The higher speeds were lost when the 201 returned in 1989.

HANDLING

Pilots new to the 201 are surprised that control pressures are higher than in other airplanes of similar size and power, thanks to the push-pull tubes rather than cable-actuated flight controls. The result is direct, fast and linear response. The stiff roll feel is due to the tubes bearing against rub blocks that help carry the aerodynamic loads without binding. Autopilots are an asset on long trips.

Rudder is the lightest control in the three axes, but it also is the least powerful, although there's plenty of rudder to handle crosswinds. We've landed 201s—sitting straight up in the seat—with 20 knots across the runway, with control authority to spare. Pitch changes with configuration and power changes are significant. A go-around or missed approach with full flaps requires anticipation and generous use of trim, so be ready for it. And be ready to stuff the nose down without delay should the engine quit in initial climb.

In landing configuration, application of power results in a strong pitch up. One trick of note is that the flap and trim motors run at the same speed, which means that the pitch change with flap extension can be nicely balanced by running the trim in the opposite direction at the same time.

Stalls in a well-rigged 201 with the stall strips properly located on the leading edge are brisk but not tricky. There can be a pronounced wing drop as the nose falls through, as it usually will. The airplane isn't approved for spins and they should be avoided. They're recoverable by conventional means but may require more altitude than the pilot is willing to give up or has available. Again, stay in the bubble during initial climb, and watch the speed with flaps and gear hanging out on approaches.

Mooneys have long had a reputation as floaters on landing. And they will float, if flown too fast on final, which most pilots tend to do. Nail the speed, however, and you can plant the airplane right where you want it, with minimum runway used. Touch down too fast and force the airplane on, and you'll be in for a wild wheelbarrowing or skidding ride that could end in a prop strike or damaged gear. Similarly, takeoffs can be sporting and bouncy, too. The trick during takeoff is to set the trim properly, use flaps as recommended and apply a little back pressure. When the airplane wants to fly, don't try to hold it on the ground. Let it come off.

The biggest handling challenge occurs not in the air but on the ground. The turning radius is fairly large. This, coupled with the long wingspan and low seating position, creates taxiing and ground maneuvering problems for transitioning pilots. The limited nosewheel turning radius also creates maintenance problems. Untrained or careless line workers towing Mooneys (and plenty of other models) are known to exceed the limits and damage steering horns, trusses and other nosegear components.

REAL SPEEDS, DWELLING

At 60 to 65 percent, true airspeeds average 150 to 155 knots and endurance with reserves is 4.5 hours or better. Some owners report 160- to 165-knot airspeeds and, while some airplanes definitely are faster than others, we're skeptical of these claims. Plan on 150 to 155 knots on about 10 GPH.

Be careful with the loading. Typically equipped 201s can haul three 170-pounders plus about 40 pounds of baggage. With partial fuel loads—say 50 gallons—the Mooney still offers good range with seats filled. The 201 has outstanding altitude performance for a low-power, normally aspirated single, thanks to its comparatively high aspect ratio and ef-

For the sake of comparing the fuselages, that's an M20J at the top and an M20R at the bottom, which is nearly two feet longer.

ficient wing. Its performance is good enough to make cruising at 14,000 to 15,000 feet a practical matter, with oxygen of course. Service ceiling is 18,600 to 18,800 feet, depending on the version and if light, a 201 can go there, so bring your oxygen.

The J model isn't a rough-field airplane, although it will handle short runways admirably well. The low-hanging gear doors almost brush the ground and the prop has less than 10 inches of clearance. Well-manicured turf runways are no problem; rutted gravel will beat the heck out of the doors, as will muddy surfaces.

Mooney cabins in general have a reputation for being cramped, but are in fact nearly as wide as a Bonanza. But it's the shape of the cabin section that makes them feel snug. The small frontal area of the airplane means that the seating position is rather sports car-like, with feet stretched out in front. This is in contrast to, say, a typical Cessna, which is more like sitting in a kitchen chair. There is definitely lots of legroom: Pilots shorter than 5 feet 9 or so may have to use a booster cushion to reach the pedals. For folks with bad backs, the Mooney can be an irritant and it's not easy to ingress and egress gracefully. We know pilots who sold their 201s because of it.

The M20J is relatively noisy and some planes are worse than others. Vibration results in cracked cowls, baffling and cowl flaps. Noise-canceling headsets, a good audio system, a thicker windshield and sound insulation help with the noise. So does prop balancing.

The baggage bay is of adequate size and is approved for up to 120 pounds. Most owners don't mind the location of the hatch, which requires you to lift baggage over the sill rather than place it in. The baggage door doubles as an emergency exit for rear seat passengers (although some owners say it's too small or too hard to reach). The earlier models have fixed rear seatbacks, which occasionally causes loading problems for really bulky items. The baggage door isn't all that large so loading in snowboards and golf clubs into the airplane isn't easy. There are mods for fold-down rear seats to address this. Some owners yank the rear seats altogether.

UPKEEP

Like most aging airplanes, corrosion is a concern and fuel tank leaks are common on aging Mooneys. Repairs are expensive and some owners have chronic problems. Others have none, depending on storage. Reseal quotes can run north of $12,000 if the tanks need major work involving hand scraping the old sealant through hard-to-access fuel bays. It's not a fun job.

Another recurring fuel system problem is water contamination caused by faulty fuel cap seals and/or corroded fillers. Avoid it and change the cap O-rings at annual.

Leaking water also is responsible for another expensive problem. Poorly sealed (or deteriorated sealant in) windows or leaking storm windows allow water to seep into insulation, which leads to corrosion of the tubular cabin structure on the pilot's side. We're told that 50 percent of all 201s have the problem to some degree and early (through 1982) Mooneys are the most affected. Keep this in mind when doing a purchase eval.

Inspection and repair is expensive because the interior and insulation have to be removed. Even if an airplane has been repaired, replacing tubes is frequently required and the problem can recur if an improved type of insulation was not installed or if window leaks recur.

We suggest a detailed inspection of all flight control elements, especially if an airplane has been repainted. Paint stripper can penetrate and corrode torque tubes, bell cranks and other elements of the system. Exhaust system elements, especially flame tubes and mufflers, also are repeat maintenance items, in part due to poor quality, according to some maintenance technicians.

The ram air system also is prone to failure and regular inspection for deteriorating gaskets and proper operation is suggested. Some owners recommend sealing it and forgetting it. Using it adds a barely discernible bump in MAP. Finally, the next best things to a warm, bird-free hangar are cockpit

MOONEY M20J MISHAPS: STALL

After reviewing the 100 most recent Mooney M20J accidents we were pleased to observe a very low rate of fuel-related engine stoppages—six. Only one pilot ran a tank dry and then didn't select the other. One pilot did use up all of the fuel in the airplane before arriving at an airport—a rate well below what we expect to see. Both results speak well of the Mooney fuel system.

The other four fuel-related stoppages were from water in the fuel (well, ice in one of them). It appears that the water may have gotten into the tanks due to rain. That's usually a fuel cap issue. We advise checking the fuel caps to see if there's a possibility that they will admit rainwater and—no matter what—check the tanks for water before flight.

There were 19 engine stoppages for mechanical reasons, usually poor or unperformed maintenance. However, six of the stoppages could not be explained.

We wondered about the pilot who was "maneuvering at about 1000 feet" when he said the engine quit. He lined up to land on a street. The engine came back to life. The pilot pulled up, hit power lines and then was confident enough in the powerplant to avoid nearby airports for a precautionary landing. He flew 150 miles back to home plate where he discovered serious damage to the airframe.

At 20, the number of VFR inflight loss of control events, almost all of which were stalls, waved a big red flag. Most were on takeoff or go-around as pilots tried to get performance out of the airplane that had never been built in. One pilot tried an intersection takeoff (sigh, so many accident reports start with that comment) and stalled trying to get over trees at the end of the runway.

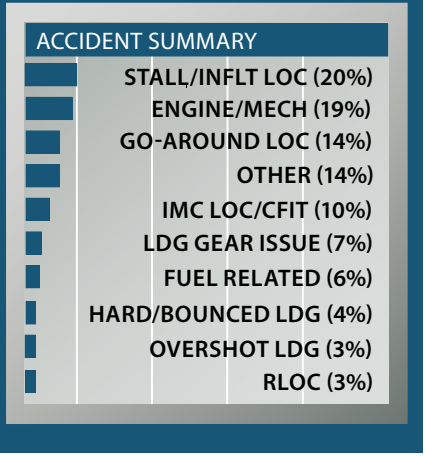
What got our undivided attention was landing-related accidents. Only three pilots lost control while rolling on the runway (we think the M20J has excellent ground handling) and three ran off the end of the runway. By itself, that's not bad. However, the accident reports revealed to us that, in our opinion, there has been an ongoing competition among M20J pilots of which we were not previously aware.

We're calling it the "Let's-see-who-can-fly-fastest-on-final-and-use-the-airplane-again-after-landing" (LSWCFFOFAUTAAAL). Mooneys are clean machines, and pilots seem to have a hard time slowing them to 1.3 Vso on approach, but are determined to force them onto the ground. That rarely goes well. One pilot was so determined to land that he hit the prop on the runway.

One LSWCFFOFAUTAAAL pilot tried to turn his airplane sideways to get stopped but as the airplane crested a hump in the runway it was still going so fast that it became airborne and ended up in the trees off the end.

Not surprisingly, the LSWCFFOFAUTAAAL competition resulted in lots of go-arounds—and lots of crashes on those go-arounds—14 from loss of control plus a half-dozen stalls.

In our opinion, the accident chain in fully a quarter of M20J accidents started with too much speed on final. We strongly suggest that the LSWCFFOFAUTAAAL competition be ended now and the results announced. We don't have a winner, yet, but we know who lost: the airplanes and their occupants.



covers and cowl plugs. Birds like to nest in the tail cone and plugs in gaps will help. They don't seem to like the nose openings as much as in Cessnas or Pipers.

One of the best things you can do to help support a 201 and any Mooney is join the Mooney Aircraft Pilots Association, or MAPA (www.mooneypilots.org), which has a magazine and an active forum. There's also the Mooney Flyer (www.themooneyflyer.com), the official online Mooney magazine. These resources can help you find lots of mods and shops that specialize in Mooneys. Some mods are intended to make older Mooneys more like the 201, with sloping windshields, newer cowls, speed mods and the like.

OWNER FEEDBACK

I have owned my 1979 M20J for ten years and wish I had bought it ten years earlier. This is my fifth airplane and the one that fits my needs better than any of the ones before. Oh sure, I would like to have something faster, roomier, with more useful load and maybe a turbo, but I do not think there is a normal category airplane that does as many things well as my Mooney.

Living on the West Coast, nearly all my trips involve crossing mountains. If weather is no factor, I fly at either 9500 or 10,500 and flight plan for 150 knots at 10 GPH. With full tanks, that is a comfortable 700-NM range with IFR reserves. The extended cabin of the M20J is quite comfortable on long flights. With only two people on board the front seats can be pushed back to where even a tall person cannot reach the rudder pedals. This creates a lot of space for the leg exercises I like to do on long flights. Ventilation is also good and the heater is excellent, even for back seat passengers.

Airplanes prior to 1980 had instrument panels that prevented deep avionics from being mounted near the top of the panel. Two years ago I designed a new panel that integrates an Aspen PFD with my existing (older) avionics. While not as flashy as a new glass panel, it provides an uncluttered layout and the same capability at a fraction of the cost. With ADS-B Out and a Stratus II on a rear window, an iPad mini fits nicely

FACTORY SUPPORT: HANGING ON

With the majority of workers at Mooney's Kerrville, Texas, plant furloughed early last winter, there has been understandable concern—and speculation—about the future support for the fleet of over 7000 registered Mooney models. To find out firsthand, we dialed up Mooney's Kerrville support line and our call was returned in less than an hour from Kevin Kammer, who leads the customer service division.

"We still make parts and we are fully supporting the fleet right now," Kammer told us, although he said there might be longer lead times on some components, and vendor shortages could make it difficult to source parts for older models. But, need a skin to fix a Mooney that's been shredded in a gear-up landing? Kammer said the company can deliver.

"We're sending out kits—composite and metal bellies—for these field repairs all the time," he told us. Stamping, cutting and milling—Mooney is making it happen, but with a skeleton crew.

There are also technical support people available for helping Mooney's nearly 50 service centers troubleshoot and solve problems with the fleet. Shops tell us they generally get what they need.

We asked Kammer (who owned a Mooney 231 for over 20 years) what the most common gotcha is when scoring an M20J (or any older Mooney) on the cheap and not surprisingly he warned of hidden corrosion, especially in fuel tanks and even in the steel frame on airplanes with water intrusion. Still, we're encouraged that factory support lives on, at least for now.

on the yoke and provides a moving map, weather and traffic.

Having flown heavy aircraft for over 30 years, I appreciate the solid feel and stability of a Mooney. I owned a Beechcraft 33 for many years and got used to the "tail-wagging" common to most Beech singles. I was pleased to find that the Mooney has none of that and is an excellent instrument platform.

Most Mooney parts are available from the factory through a network of Mooney Service Centers as well as from many third-party vendors. Numerous modifications are also available, but few are really needed. Deactivating the ram air system makes sense and the one-piece belly mod saves a couple hours at each annual. An LED landing light is also a good addition.

As for maintenance, there are certain things that Mooney owners have come to accept. About every 20 years the fuel tanks need to be resealed. Sealing one leak at a time works for a while, but eventually the tanks need to be professionally stripped and resealed. Likewise, the landing gear "donuts" need to be replaced occasionally. For any Mooney parked outside, it is imperative that the side windows are properly sealed to prevent corrosion of the steel tubing.

The Lycoming IO-360 in the 201 is one of the most proven and reliable engines in the industry. If flown regularly, one can expect it to reach TBO without a top overhaul. Three-blade props do not always get along with this engine. What they gain in climb performance, they lose in cruise speed and often have vibration issues. The two-blade McCauley the factory chose for the airplane has proven to be a good choice. Dynamic balancing can make a noticeable difference in the vibration level in the airplane.

My only recurring problem has been the autopilot. My aircraft came from the factory with a Century 41, which is a full-featured autopilot designed for much larger aircraft. In addition to weighing nearly 30 pounds, it is difficult and expensive to repair. The King autopilots found in most 201s are a better match.

Otherwise, the systems in a 201 are simple, reliable and fairly easy to work on. If something out of the ordinary needs to be repaired, I would recommend a Mooney Service Center. Not all shops have the same expertise in caring for Mooneys. For the past several years, my annuals have averaged $2000. This year my insurance, based on $110,000 hull and $1 million liability, was $975 through AOPA.

MOONEY M20J

(continued from page 31)

Needless to say, I am very happy with my Mooney.

Charles Raines
via email

I purchased a 1987 Mooney 205 in 2018 after sitting in a new Mooney at AirVenture that year. Although I was interested in buying an F model to get my Mooney feet wet, N205MN was available at the same airport/maintenance facility with a dead engine due to a missed AD. After short negotiation with the original owner, a fair deal was struck to somewhat mitigate my additional $55,000 expense to replace the engine with an Airpower factory reconditioned engine with new Power Flow exhaust, separate magnetos, propeller overhaul, oil cooler and engine monitor.

That project took about 10 months, with only one very slowly acquired factory part for the prop cabling bracket due to mag modification. The 205 came with the best of 1987 King Silver Crown avionics including the KAP-150 autopilot, which had some problems. The previous maintenance shop, which missed the engine AD, had evidently lubed the trim cables where the pitch trim motor clamps down. Against all the best advice from *Aviation Consumer*, I decided to stick with the King KT-76A transponder while adding a Garmin GDL-82 ADS-B out. So far so good; however I did buy a spare KT-76A at a near giveaway price.

The 205 is supposedly 4 MPH faster than the 201 because of inner landing gear doors and upswept wingtips. I have no reference point to judge the winner of that speed contest for myself, but I generally see 148 KTAS at 23 inches MP and 2400 RPM around 5500 or 6500 feet. I suppose I could go faster if I wanted to deal with more prop noise and fuel usage, but that already seems like warp speed compared to the Cherokee 180 that the Mooney replaced.

The rate of climb is pretty darn good averaging about 800 to 900 FPM and I give credit to Power Flow for that. The real issue I see here with attaining book speed is a thrust-to-weight issue. Lighter avionics help, but since everything works so well the upgrade is tough to justify.

As for flying the bird, it's pretty darn easy. The 140 KIAS gear speed and 132 KIAS flap speeds are quite helpful. It's slippery on the way down and thinking ahead to plan your descents is necessary.

I don't know how pilots manage to land J models gear up as it's challenging to get slowed down enough if you are operating the engine correctly.

A little trick I learned at the MAPA Mooney Safety Clinic for descending is not reducing the MAP below 20 inches, and then reduce the RPM to 2200. Keep your speed up that you lost in the climb because that's probably why you bought it.

Speed really matters on short final approach and has to be closely monitored. In the flare you have to remember that the plane sits very low to the ground and you don't want to drop it in from too high. That is a setup for a propeller strike on the third pogo unless you take immediate action. The brakes are very effective and short-field landings are doable.

The rudder has handled some serious crosswinds without issue. Because of the short prop clearance to the ground, I haven't taken her into any grass/gravel strips, but nicely manicured grass strips without ruts might be fine.

After a year and several long trips, I think it's a great airplane with long legs and 64-gallon tanks that are stone simple to operate. My annual was $2500 and insurance is $1225 for a $125,00 hull value.

Steve Bulwicz
Bloomington, Minnesota

AERO COMMANDER

We're setting out to cover the Aero Commander series in a future *Aviation Consumer* Used Aircraft Guide. In preparation, we want to know what it's like to own these piston (and turbine) twins, how much they cost to operate, maintain and insure and what they're like to fly. If you'd like your Commander to appear in the magazine, send us any photographs (full-size, **high-resolution**) you'd like to share to the email below. We welcome information on mods, support organizations or any other comments. Send correspondence on these planes by Jan. 1, 2021, to:

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