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The Aviation Consumer

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BUILDING 51 PERCENT OF A TURBOPROP

With some new flagship piston singles flirting with the $1 million mark, it's logical that qualified buyers are eyeballing the entry-level turboprop single market. That could give Texas-based Evolution Aircraft (previously Lancair, before it was sold last summer) more opportunity to sell its Evolution Turboprop experimental airplane kits.

If you think the average new Cirrus, Cessna TTx or Mooney owner doesn't have time to build an airplane, you may be right. But building an Evolution isn't like building a typical homebuilt in the garage. Traditional homebuilders are the first to roll their eyes and say so. That's because nearly all of the Evolution Turbine kits (there's also the Evolution Piston kit) are built at an Evolution Aircraft-affiliated build center. Still, the choice may be sparking enough competition in the upper end of the Part 23 sales world that Evolution Aircraft expanded the product line, adding more variants of the Pratt & Whitney PT6A engine to the Turbine kit. The four-place flagship EVOT-850 has a 330-knot cruise speed. The completed kits I looked at had impressive fit and finish, were loaded with Garmin avionics and had luxurious interiors.

While hanging around the Mooney exhibit at Sun 'n Fun last month without wearing my fake mustache, a reader flagged me down and politely asked if I'd take a walk with him to the Evolution Aircraft exhibit. "I have the money to buy a new Mooney, a new Cirrus or hand-build this Evolution turboprop; tell me why I shouldn't consider the turboprop," he said. I reminded him that turbines and pistons are apples and oranges for a lot of reasons. He figured with custom paint and interior work the price tag would approach $1.3 million.

This would be a business travel airplane to fly himself, his golf caddy and equipment to various stops on the U.S. PGA Tour. During the off-season, he reasoned, he could build (under professional supervision) the legally required 51 percent portion of the aircraft. Based on my rough calculations, the Tour's off-season is only a few months. How the heck will he pull that off? According to Evolution, from the initial two-week building period at its facility, the first flight test usually comes in six months. If you don't know a torque wrench from a rivet bucking bar (don't fret, these are composite airplanes), the company assures buyers there's enough professional help to get them through it.

Although on paper you build the "major" portion of the aircraft, which is defined as more than 50 percent of the fabrication and assembly tasks, the serious fabrication and some assembly is already completed. Major systems—including avionics, interior and paint work—aren't governed by the FAA rules so you don't have to do any of it. While advisory circular AC 20-27G covers the certification and operation of amateur-built aircraft, there's little in the way of FAA oversight (it does issue the airworthiness certificate), although the circular says to notify your FSDO if you intend to use commercial assistance.

One of Evolution's key selling points is that it follows FAA Part 23 regulations as guidance, but stresses that customization and modification is fair game—something that's limited in the Part 23 world without expensive STCs. Speaking of STCs, there's no FIKI (flight into known icing) certification since that's a supplement to an aircraft's type certificate—something an experimental doesn't have. When the build is done and the 40-hour fly-off requirement is completed (you don't have to be the first to fly the aircraft), the rules say the aircraft can't be flown for charter, lease or rental. You need an instrument rating with high-performance and complex endorsements, plus a high-altitude training endorsement. The Evolution is restricted to FL280 because it doesn't have RVSM certification.

If you aren't ready to burn Jet A, the pressurized Lycoming-equipped Evolution Piston is the same aircraft from the firewall back. While experimentals generally aren't a major portion of our coverage, we've had requests for a closer look at the growing Evolution line, so it's on the list. —*Larry Anglisano*

ADS-B TSO: FANS AND FOES

In the May 2017 *Aviation Consumer* ADS-B article sidebar, "It's Time to Relax the ADS-B TSO," you advocate for the use of portable ADS-B In/Out devices and further, to relax or eliminate the TSO governing the performance of ADS-B equipment.

There are very good reasons for not permitting the use of portable ADS-B Out devices and to retain the TSOs as they currently exist. Starting in 2020, ADS-B will be the primary mode of ATC surveillance, and will largely replace the current ATCRBS (ATC radar beacon system, with portions of the ATCRBS retained as a backup). Portable ADS-B Out devices suffer from some major limitations, including reliability of powering, RF radiation pattern nulling and attenuation resulting from the antenna being inside the aircraft. There's also the lack of connection to the aircraft static system.

Antennas inside the aircraft are subject to nulling and attenuation of the transmit signal caused by the airframe and aircraft structure. As the aircraft attitude changes in flight, the transmit signal from the portable ADS-B transmitter to the ADS-B ground-based transceivers and other aircraft will fluctuate in strength. In some cases, depending upon attitude, altitude and antenna placement inside the aircraft, the transmit signal may be attenuated completely, rendering the aircraft invisible to ATC and other aircraft. This is not merely a safety issue for your aircraft, it adversely impacts the safety of other aircraft as well.

Battery operation and temporary connections to the aircraft electrical system are not reliable, compared to hardwired installations. For accurate altitude reporting, the encoder within the portable device must be connected to the aircraft static system because typically, the pressure within the aircraft is lower than the outside ambient pressure.

The TSO requirements for ADS-B and other avionics ensure the performance, reliability and safety of the device. Non-TSO equipment has not undergone the extensive testing for (and generally has not been designed to meet) the TSO requirements for parameters like electromagnetic compatibility/interference, temperature, humidity and vibration even if the performance of the equipment meets the TSO requirements.

One of the factors that has enabled the high degree of safety and reliability of ATC and the IFR system is the requirement for avionics and equipment to meet stringent engineering and technical requirements, which is the purpose of the TSO. For these reasons, the FAA likely will not permit the use of portable ADS-B Out devices.

Barnet M. Schmidt
West Orange, New Jersey

We were hanging with you until you mentioned Mode C altitude encoders being built into the ADS-B transmitter. With ADS-B Out, the traditional altitude digitizer and Mode A/C transponder is used.

Our point in relaxing the TSO isn't for the purposes of allowing degraded performance, but instead to eliminate the costly and time-consuming process that's involved in getting the TSO. Non-TSO'd avionics have been used in experimental aircraft (and some in certificated ones, too) for years with great success.

You raise a good point in suggesting that the FAA drop the TSO requirement for the ADS-B mandate and allow portable solutions. Nothing in the way of performance requirements would have to change if the FAA kept the WAAS GPS spec in place and required the use of an external ADS-B antenna, ship's power and the same battery backup that's required of primary EFIS displays.

The SkyVision Xtreme portable ADS-B Out is the poster child of how it could be done. As you reported in your product evaluation, the device has been solid in my homebuilt.

Steven Resnick
via email

SUPERSTITION AT CIRRUS?

In the SR22 G6 flight trial (April 2017 *Aviation Consumer*) the reference to the Cirrus G6 being the "sixth generation" model is technically inaccurate.

As the Cirrus cognoscenti know, there was no G4. The number four is unlucky to the Chinese because in that tongue the word four sounds like the word for "death."

Accordingly, the company's Chinese owners bypassed the G4 and went straight to the G5 from the G3. So the current G6 is actually the fifth-gen Cirrus.

Joseph Matalon
via email

We tried to get the Cirrus marketing folks to confess, but they wouldn't touch this theory. We were told that since there were so many product improvements made between the G3's release in 2007 and the G5's release in 2013, it skipped the G4. That sure sounds like a good call to us.

CORRECTION

In the Ercoupe/Cadet article in the May 2017 issue, we incorrectly said the aircraft in the lead photo was flown by Tom Murell. It was actually Syd Cohen. We're grateful for the images readers send for our monthly Used Aircraft Guide.

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NEW AIRCRAFT INTROS

Diamond Gasses It: New Singles Planned

With three new models, it's going after Cirrus by reviving the DA50. One has a Lycoming FADEC engine, but SMA diesels are in the works, too.

by Paul Bertorelli

Diamond Aircraft CEO Christian Dries is nothing if not a pragmatist, albeit an adventurous one. At April's Aero in Friedrichshafen, Germany, he showed both sides of the same coin when he announced three new single-engine piston models, one powered by an untried new gasoline engine from Lycoming. The latter even he concedes is an admission of sorts. The diesel engines Diamond has championed for 15 years haven't fared well in the high-performance single-engine market simply because the power options haven't been there.

But Diamond is hardly giving up on Jet A-burning piston singles. The new models Diamond announced all have diesel engine options and, as if to show Diamond hasn't lost its nerve, one of the engines is entirely untried and one, SMA's four-cylinder SR305, is well known but largely unproven for lack of wide market acceptance.

Diamond's large-cabin DA50, top photo, will be available in three models, including a trainer version powered by the Safran/SMA SR305-230E Jet-A piston engine, left.

Diamond's product rollout is significant on several counts. For one, it represents confidence in what is undeniably a moribund market and it signals Diamond's intent to go head to head against Cirrus with new airframes. Moreover, these new aircraft give Lycoming more demand for its IE2 FADEC-controlled 540-series engine which, heretofore, has been something buyers have insisted they've always wanted while OEMs have been just as insistent in not offering it.

EXPANDING THE LINE

Diamond's Dries told us that the new models actually comprise one airframe in two variants and three models, all to be designated DA50s. The DA50-IV will be a four-place airplane powered by the Safran/SMA SR305-230E, a 230-HP four-cylinder diesel. It will be pitched at the training market to compete against the Cirrus SR20 that has found some success as a trainer. Besides the diesel's fuel economy, the DA50 offers a larger cabin than both Diamond's own DA40 and the SR20/22.

"We lose one or two contracts each year against Cirrus because they say in a Cirrus airplane, I feel much more comfortable. Particularly in North America, flight instructors, at least a lot of them, are not very light. Flight instructors are a big part of the decision making," Dries says.

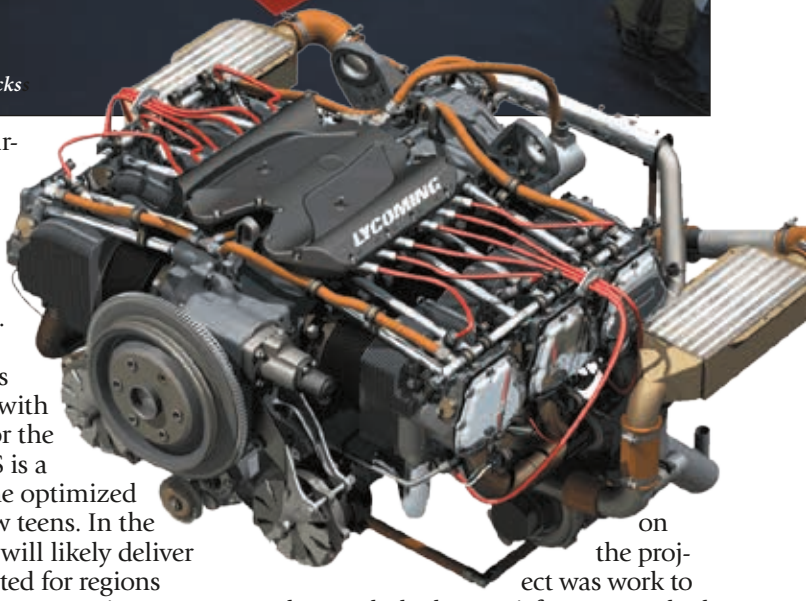
The DA50-V will have the same airframe but with an honest five seats, thanks to a wide bench seat behind the two front seats. The -V will be powered by an upgraded version of the SR305 with 260 HP. Dries said the additional power will come from modifications to the engine's fuel delivery system.

HEAVY AND FAST

To compete against Cirrus' top-selling turbocharged SR22, Diamond will offer the DA50-VII, the same basic airframe but one equipped with Lycoming's new 380-HP TEO-540 six-cylinder engine, with the "E" in TEO signifying electronic. The so-called IE2 engine, which has been under

At Aero 2017, Tecnam showed off the P2012 Traveler, right, sporting the same Lycoming IE2 engine (lower photo) Diamond will use in the DA50-VII.

Photo courtesy Ed Hicks



development for almost a decade, is FADEC-driven, has single-lever control and is capable of burning unleaded fuel. However, it still requires 100-octane fuel, presumably the unleaded avgas replacement the FAA promises will emerge from the FAA's PAFI process next year. The IE2's most notable OEM customer is Tecnam, with the new P2012 Traveler twin shown at Aero in April. It also has some military applications, specifically the Northrop Grumman Firebird.

The DA50-VII will eventually include a seven-seat option, with two small seats behind the three-person bench, space that would otherwise be devoted to a generous baggage area.

Continuing its commitment to diesel, Diamond will also offer a -VII version with yet another untried engine, the 370-HP six-cylinder SMA SR460. That engine first appeared at Aero three years ago and although it's at the test-cell stage, it hasn't flown yet and certification remains in the distance.

While the -IV and -V DA50 variants will be fixed gear, the -VII will be a retractable with cruise performance projected to be about 230 knots. The airplane is the first truly new piston retractable we've seen in three decades and will be the most powerful single-engine piston on the market. Diamond's Dries told us the company's aggressive 2018 or 2019 certification schedule is realistic because the -VII's wing center section and landing gear will be lifted directly from the DA62, thus the structures are already certified and proven.

TURBINE, TOO

Just in case you're bored by piston engines, Diamond will also offer a turbine version of the -VII powered by a Ukrainian-sourced engine called the Ivchenko-Progress AI-450S. The engine is a free-turbine design similar to Pratt & Whitney's workhorse PT6A and was developed by Ivchenko-Progress, a remnant of the old Soviet design bureau structure and manufactured by Motor Sich JSC, another Ukrainian company with more than a century of engine manufacturing experience in both pistons and turbines. The AI-450S has 465 HP with fuel specifics similar to the PT6.

But Diamond's turbine aspirations aren't to compete with Piper's Meridian or the TBM. The AI-450S is a low-altitude engine optimized for, at best, the low teens. In the DA50 airframe, it will likely deliver a heavy hauler suited for regions where neither avgas nor maintenance are available. Diamond first flew the engine in 2015 in a test bed it called the DA50-JP7. Dries said in its current form, the AI-450S is not certified to EASA standards but is expected to be by 2018 or 2019.

While these models may appear to be new, the airframe itself is a reheat of sorts, having first appeared at a surprise Christmas party at Diamond's Wiener Neustadt factory headquarters in 2006. It was shown in prototype form at AirVenture in 2007 as the DA50 SuperStar. At the time, the planned powerplant was Continental's TSIOF-550J, Continental's version of an electronic piston engine that predates Lycoming's effort. But the SuperStar was not to be, tanked both by Diamond's travails with the then-Thielert Centurion diesels and later the global economic downturn in 2008. Nonetheless, Diamond's effort on the project was work to the good; the larger airframe morphed into the DA62 twin, which is seeing brisk sales success and refinement on that airframe will definitely inform the resuscitation of the DA50.

BOLD OR NUTS?

When Diamond announced the DA42 twin in 2002, it mated completely untried engines—the Thielert Centurion diesels—with a new airframe, a two-fanged risk that more cautious aircraft manufacturers have avoided. It paid a steep price when the engines proved tender and ran into maintenance and reliability issues. After the fact, Dries vowed that he would never repeat the mistake and his contentious relationship with Thielert led him to found his own engine company, the Austria-based Austro.

Isn't he potentially repeating the mistake, this time with not just one, but three unproven engines? Dries

admits there is risk, but he points out that as far as the Lycoming IE2 is concerned, "Lycoming is the only engine company we have never had trouble with." Although Continental now owns the assets of the former Thielert Aircraft Engines, Dries says the bad blood runs too deep for him to consider a new engine deal with Continental.

But turning to SMA has its own risks. What's now the SR305 first flew in prototype form in 1998, but it has proven difficult to both certify and market. In 2012, to jumpstart its diesel program, Continental bought the technology from SMA to develop its own version of the engine. Five years later, it still hasn't certified the engine nor found a significant market for it. In 2012, Cessna announced an SMA-powered 182, but for reasons we believe are related to the engine, the project has been effectively cancelled. There are a handful of SMA-converted legacy 182s flying, but SMA never seemed enthusiastic about the program. Even Cirrus toyed with the SR305, eventually dropping it because of cold weather starting and operation issues.

Competing with the Lycoming IE2 in the DA50, Diamond will also offer the Safran/SMA SR460 six-cylinder diesel, below. It's rated at 370 HP.

Dries told us he's undaunted by all of this and that because Diamond has more diesel experience than any other OEM, they expect to sort out whatever problems the SR305 might have. As it did with the Mercedes-based Austro engines, Diamond plans to squeeze more horsepower out of the basic SR305 engine platform for the DA50-V. The larger risk might be the six-cylinder SR460, which is still under development and some distance from flight test, much less certification. It's loosely based on the SR305 in that it's horizontally opposed with direct drive and has combination air and oil cooling. As does the SR305, the 460 uses the old-school Bosch mechanical fuel injection system, but it incorporates a common rail design.

A turbine version of the DA50 will have the Ukrainian-built Ivchenko-Progress AI-450S at 465 HP.

If Diamond gets it flying and certified, it will become the highest power aero-diesel in the market thus far. At Aero, Continental announced that its V-6 diesel has completed testing, but it's not certified yet. That engine, capable of at least 310 HP, has been flying in a Cirrus and since both Cirrus and Continental are owned by the same Chinese-based AVIC mothership, it seems likely the V-6 is headed for the SR22.

MARKET APPEAL

With sales of piston aircraft essentially flat if not in decline, manufacturers have come to all but abandon the hope of significant market expansion for the foreseeable future, perhaps even to include Asia and Africa.

Cirrus continues to dominate piston sales, with a 31 percent market share in 2016, compared to 13 percent for Diamond, 27 percent for Cessna and 9 percent for Piper.

With its diesel twins popular for training, Diamond owns the twin market with exactly half of all twin sales. "But," says Christian Dries, "we know from our surveys that a certain amount of people do not consider a twin-engine airplane; about 60 percent. It's a natural step to develop a new single-engine airplane."

One sales executive we talked to said Diamond taking on Cirrus was like "kicking an elephant in the shins." But Dries sees an opening. "With the -VII, with this [Lycoming] engine and 230 knots, I think it will provide customers with quite an interesting airplane," Dries told us.

He says it will be faster than the SR22, carry more passengers and stuff and offer more comfort in a technologically adept package. Like the DA62 twin, the cabin, at least in the -7, will have configuration flexibility

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and be able to carry large, heavy loads or more people. The airframes are constructed largely of carbon fiber so they are lighter than the equivalent fiberglass structure and stronger, too. At 4800 pounds max gross, that's 1200 pounds heavier than a Piper Saratoga and the useful load ought to be impressive.

As a sales point, Dries said Diamond considered offering a ballistic parachute but hasn't ruled it in or out. The DA50 line will have Garmin's latest glass-panel product, the G1000 NXi, and possibly some version of autoland technology. Diamond has been developing this in Austria and has demonstrated it on the DA42 twins. Dries hinted that Garmin is working on its own version and it seems likely that this will be the next big thing in avionics, ultimately leading to integrated autonomy in the distant future.

When Diamond trial ballooned the DA50 in 2007, it did so in a different world. That was the most recent peak year in piston sales, with 2675 aircraft sold and a booming economy. Veteran sales executive Fred Ahles, of Premier Aircraft, says Diamond took at least 50 advance orders for the airplane with the appeal being the larger cabin and slightly higher cruise speed over the SR22. Other salespeople have told us there's a niche of buyers who want the extra seats and cargo-carrying capacity and Cirrus has nothing to offer them, at least at the moment.

"If there's a better mousetrap than Cirrus, they may not make the pie bigger, but they could certainly take a lot away from Cirrus," Ahles says. Diamond might eke out additional sales for the DA40 line, which hasn't seen a major revision since it got the Garmin G1000 in 2003. As the company announced the new models, it was well into moving production between its Austria and London, Ontario, factories.

DA62 production, including composite layup, will move to London, as will all versions of the DA40 single. One model, the DA40 NG, is powered by the Austro diesel and has a higher gross weight to accommodate the heavier engine. London plant manager Peter Maurer told us that refitting that model with the lighter Lycoming could yield a DA40 with higher useful load, giving it an edge against the Cirrus SR20 for the training and personal-use market. While the industry has been touting the revision of FAR 23 to reduce production and certification costs, that won't apply to the DA50 series, says Dries.

The new singles lift much of their structure from the already completed DA62, so the costs are baked in. That means invoices in the high six figures, says Dries. The DA50-IV, for example, will sell for an estimated $650,000 while the -VII will be north of $800,000. If it's any less expensive than an SR22, the margin may not be enough to yield significant sales leverage. We're sure to know more about that when the DA50s begin to trickle into the market next year and into 2019.

DIESEL SHARE: ALL ABOUT DIAMOND

In 2002, Diamond invented the aerodiesel market with the introduction of the DA42 twin and it has owned both the twin and diesel market ever since. As the chart below shows, diesel's share of all new airplanes has grown modestly since the last time we examined it nearly a decade ago. It averages between 11 and 15 percent of the new aircraft market, but has been as much as 18 percent.

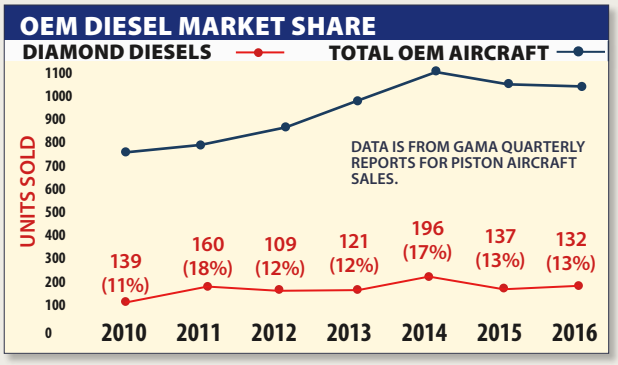
Why not a bigger share? Diamond's Christian Dries says it has a lot to do with lack of diesel interest in North America, where the majority of new aircraft are still sold. "In North America," says Dries, "gasoline is cheap. You don't think so much about the cost of the fuel."

And that explains why both new single-engine diesels and conversions of gasoline aircraft to diesel haven't done well. Redbird has had modest success with its Redhawk conversions and Africair, a Miami-based Cessna dealer and mod house, has done about 70 conversions in 10 years, many of them sold in Africa where they're used as primary trainers in the airline industry.

Lately, that market has softened, says Africair's Travis Tinsey. "It has more to do with commodity prices being down in these African countries. They don't have the money to buy anything, not just airplanes," Tinsey told us. Any interest in those conversions in the U.S. market? "None," Tinsey told us, although the company's sales efforts continue.

As for OEM singles, demand has been soft for those, too. Two years ago, Piper introduced the Archer DX and has found some takers in the U.S. or offshore, but not many. Cessna promises a diesel Skyhawk, with Continental's CD155. The company says it will be available later in the year or next year and it will be offered under an STC conversion that Continental got when it bought the assets of Thielert Aircraft Engines. Cessna had planned a diesel 182, but that project has been shelved, despite strong interest.

Twins are a different story. Diamond continues to pump its diesel DA42 into the training market and although it certified a Lycoming-powered version, it hasn't built one in eight years. The DA62, with a pair of Austro engines, has been well received by buyers, despite the $1.2 million base sticker price. Dries believes that when production of the DA62 moves to London, Ontario, sales of the airplane can be doubled. At current production rates, that's enough to move Diamond's diesels to nearly 20 percent of OEM production.



Airbag Seabelts: Pricey, But Effective

Airbag seatbelts are now available for retrofit in 150 different types of general aviation airplanes. We think the added occupant protection is worth the cost.

by Rick Durden

We've long urged aircraft owners to retrofit shoulder harnesses for all seats of their airplanes if at all possible. The simple reason is that a restraint system that keeps your head and upper torso from smacking into the instrument panel or seat in front of you during an accident sequence is the single most effective mod you can make to your airplane to radically increase the chance of everyone aboard surviving an accident.

As technology has improved, we're now strong advocates of a system that goes further to protect occupants during an impact—the airbag seatbelt from AmSafe (www.amsafe.com), a Phoenix, Arizona, manufacturer that specializes in occupant protection testing and products for cars and aircraft.

Before we go into details of retrofitting airbag seatbelts—they're now standard features for most seats of nearly all new general aviation aircraft—we'll take a look at the realities of accident dynamics and how to reduce your risk of injury.

THE QUICK STOP

We'll start out by pointing out that the "thrown clear and survived" reports that are sometimes made after accidents are nonsense. A human being, even in excellent condition, cannot survive hitting the ground at 60 MPH. He or she will either stop instantly or bounce across the surface like a rag doll, suffering repeated impacts that will cause massive trauma to internal organs and the brain that is not survivable. For example, one of the chief causes of death in automobile rollover accidents is that occupants who aren't wearing seatbelts get thrown out of the vehicle and come to a quick stop against the ground or an obstruction.

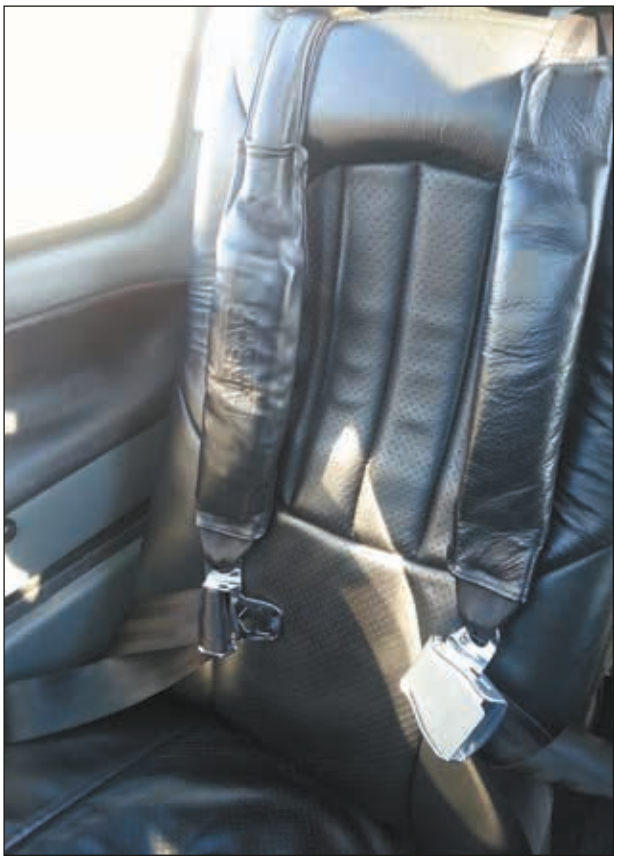
After World War II there was extensive research into airframe crashworthiness. By the 1960s Cessna, Piper and Beech were doing full-scale impact testing. Cessna and Piper gave NASA some airplanes for it to crash under varying conditions for the in-depth studies it was doing on impact dynamics and modeling what went on during a given crash sequence to help develop ways to keep aircraft occupants alive.

LESSONS LEARNED

Simplified, the testing demonstrated that: The slower the impact, the better. The longer in time and distance the deceleration can be spread over, the better (airbags use this fact). The more impact load that can be absorbed by a progressively collapsing aircraft structure and not transmitted to the occupants, the better. Occupant restraint is essential—keeping the full torso restrained to the seat during the impact sequence vastly improves the odds of survival—the FAA says shoulder harnesses cut fatality rates by 20 percent and injury rates by a whopping 80 percent. Finally, designing the cabin area in front of the occupants to be free of objects that can hurt the occupants as they go forward during airframe deceleration and the panel comes back due to impact forces improves survivability (airbags also take advantage of this fact).

The AmSafe seatbelt airbag deploys when impact is sensed, providing occupant protection in addition to the shoulder harness.

In a three-point restraint system, the airbag is installed in the seatbelt, above right. For a four-point restraint, there is an airbag in each shoulder harness, below right.



Because of constraints of weight and keeping cabins small to minimize frontal area to reduce drag and maximize speed, most general aviation aircraft cabins have limited "flail space." Flail space is the area in front of an occupant's seat in which his or her arms, legs and head are going to flail around—uncontrollably—in an impact sequence. If there's something in that space, the occupant is going to hit it, *hard*.

While it seems beyond foolish, we keep running into people who claim they can "brace" and protect themselves from getting hurt in a crash. It's not possible. You cannot keep your head off the panel if you don't have a shoulder harness—the impact forces will either overpower you in an instant or snap your locked elbows, adding to your injuries and stunning you or rendering you unconscious, delaying your exit. Further, jackknifing over the seatbelt can give you a spinal injury that can cause paralysis. Do we have your attention?

TECHNOLOGY EVOLVES

Shoulder harnesses provide good protection in the general aviation environment of limited flail space. The next step up is a five-point belt restraint system—two lap belts, two shoulder harnesses and a crotch strap that keeps you from submarining under the belts. The top tier, under current technology, of occupant protection is a combination of a two-, three-, four- or five-point restraint system and a smart airbag that deploys when an impact is sensed.

In the world of general aviation, the only purveyor of FAA-certified airbag restraint systems is AmSafe. Using a two-, three-, four- and five-point restraint with airbag(s), inflator(s) and sensor, the AmSafe system positions the occupant with the seatbelt and shoulder harness(es)—without the occupant positioning provided by the belt and torso restraint an airbag system ranges from worthless to counterproductive—and protects against impact forces with an airbag specifically tailored for the shape of the space.

CABIN SHAPE

Because the shape of the space of general aviation cabins varies widely, seatbelt airbags are not one size fits all. They have to be developed for the individual seat in the individual airplane, including the degree of seat travel and occupant sizes—which means from the smallest five percentile adult female through the largest 95-percentile adult male. As might be imagined, the development process is complex; nevertheless, more than 150,000 AmSafe airbag seatbelts have been installed and are approved for installation in some 150 different types of general aviation airplanes, according to Jim Crupi, AmSafe's business development and technology support manager.

During manufacture, each airbag is sewn and folded onto one of the belts. A gas hose runs from the bag to the inflator. A wire runs from the inflator to a sensor that tells the system when to activate.

The airbag is designed to deploy some 50 milliseconds into an event that meets the design parameters for the sensor to trigger—longitudinal

AMSAFE'S NEW CHILD AVIATION RESTRAINT SYSTEM—CARES

While we were researching this article on AmSafe's aircraft seatbelt airbag restraint systems we came across a new product developed by AmSafe—its Child Aviation Restraint System, acronym: CARES. While it is not an airbag system, we are including it in this article because we are passionate about occupant protection during accidents and from what we've seen, CARES looks like a product that offers comparable impact protection to a car seat without the bulk and at a fraction of the weight.

CARES is FAA-certified for use in general aviation and airline aircraft. It's one of those creatively simple designs that causes folks to slap their foreheads and ask why they didn't think of it—upper photo.

The system includes a band that wraps tightly around the seat in which the child will be sitting at a level above the child's shoulders. A set of shoulder straps hang from the band. The regular seatbelt for the seat is threaded through the loop at the base of each shoulder strap and the seatbelt is then buckled at the child's waist and tightened. The next step is to fasten the clip connecting the two shoulder straps about midway between the child's waist and shoulders. Finally, the shoulder straps are tightened. If the seat the child is occupying has shoulder harnesses, they are not used; the CARES unit has its own, designed for the size of the child, built in.

That's it. We watched videos of one person settling a child into the seat and securing her with CARES within a minute.

In an emergency, all that's necessary to release the restraint system is to unbuckle the seatbelt and lift the CARES unit over the child's head. It looked to us to take about five seconds. We've used a number of car seats that took longer.

Priced at $74.95 and sold through Kids Fly Safe (www.kidsflysafe.com), CARES is designed for children from two to four years old with a weight range of 22 to 44 pounds and who are less than 40 inches tall. It may only be used in forward-facing aircraft seats.

We were very impressed to see that AmSafe also developed versions of CARES it refers to as "Special CARES" for special needs children from 41 to 56 inches tall as well as children and adults more than five feet tall. Using one of the Special CARES systems requires an exemption letter from the FAA; however, the Kids Fly Safe website explains how to apply for and get an exemption and provides a template for the application.

The entire CARES unit weighs a pound and folds into a small carrying case—lower photo. It is NOT to be used in automobiles—it does not replace the car seat in a car, but it does allow the car seat to be stowed in the luggage compartment of a general aviation airplane or checked as baggage on an airliner.

Having installed car seats into the back seats of a number of general aviation airplanes and experienced the gyrations required—and sometimes being unable to get one secured without a second person helping out—we think CARES may simplify life for general aviation pilots flying with kids.

Taking kids in general aviation airplanes requires some planning and effort to keep them safe and happy. We think AmSafe's CARES system just made things a little easier for pilots who want to do so. For more information on flying with babies and kids, see our sister publication *AVweb* (www.avweb.com) and search on flying with babies and kids.

(and only longitudinal) deceleration greater than between 6 and 9 G (varies slightly with installation). A hard landing, no matter how impressive, won't cause a seatbelt airbag to deploy.

We are aware of unsuccessful testing carried out by an aircraft manufacturer exploring the idea of installing automotive-style airbags into agricultural airplanes starting in the 1970s. As with cars, they were mounted in the instrument panel and deployment meant that the stick was forced aft violently. During an impact sequence there was concern that the aircraft was still moving fast enough that rapid up-elevator deflec-

A retrofit seatbelt airbag system laid out ready for installation.

tion could have unintended, and bad, consequences.

Inadvertent deployment of a panel-mounted airbag in flight that shoved the stick aft could be catastrophic. That led us to inquire about testing for inflight deployment of a seatbelt airbag.

As part of the testing for certification of the seatbelt airbag system under 26-G requirements of FAR 23.562 (and 18-G requirements for older seat designs), AmSafe had to demonstrate that an inadvertent inflight deployment would not adversely affect control of the aircraft and would not knock the pilot's hand off of the yoke or stick. Certification also required demonstration that the risk of inflight activation was so small that it approached zero.

AmSafe has numerous videos on its website of full-scale, dynamic crash testing. They show that the airbag deploys primarily upward to protect the occupant's head and chest. In describing how that works to protect the occupant as well as avoid hitting the controls, AmSafe says, "The occupant hitting the bag is resisted by increasing air pressure, essentially creating a pneumatic spring. The maximum compression of the bag occurs before the occupant's head hits the interior structure. The venting of the bag acts as a damper, reducing the rebound and dissipating the energy through the air flowing out of the bag."

Jim Crupi told us that AmSafe seatbelt airbag systems have logged more than 400 million hours of service and that there has not been a reported inflight activation.

RETROFIT

AmSafe's website has a full list of aircraft for which its seatbelt airbags can be installed as retrofit equipment. In general, if you own an all-metal or composite aircraft built after 1960, there's a good chance that you can have seatbelt airbags installed for at least the front seats. Often the rear-seat retrofits replace a seatbelt-only system, greatly improving occupant protection.

Prices for seatbelt airbags range from $4000 to $5000 per kit—a kit retrofits two adjacent seats. Most installations do not require modification of the airframe. Scott Utz, director of maintenance of Arapahoe Aero on Denver's Centennial Airport, an AmSafe-approved service center, told us that installation times range from eight to 40 hours per seat and depend on the type of airplane and the options, notably TKS, installed. He said that retrofits on Pipers and Cessnas are the easiest—Mooneys take the longest.

There are ongoing maintenance requirements: The crash-sensing electronic module (one for each two seats) has a seven-year service life—it's currently $1031 for replacement and $385 for refurbishment—and it can be refurbished once. The inflators also have to be replaced at the 10-year mark—they are currently $590 each. The seatbelts must be inspected at the annual inspection using a dedicated system diagnostic tool—which means going to one of the many AmSafe-approved service centers or buying or renting the tool from AmSafe.

AmSafe recommends that any time any component of the system is disconnected that the full system diagnostic be run after the system is reconnected.

FIRING IN ANGER

We were directed to a number of videos on AmSafe's website for examples of seatbelt airbag deployments in general aviation aircraft. A CFI who was almost able to get a Cirrus to an airport after an engine stoppage and discovered the terrain where he touched down was rough enough to violently stop and flip the airplane after only rolling 100 feet walked away from the crash unhurt. Things happened fast enough, he said, that he was unaware of the airbags deploying. It was only during an inspection of the aircraft afterward that he learned they had functioned as designed. He credited the airbags with preventing injury to the occupants.

While individual reports and videos are anecdotal, they, combined with the hard data on impact loads, are powerful evidence of the value of seatbelt airbags in saving lives and reducing the level of injury.

CONCLUSION

We're strong supporters of retrofitting AmSafe's advanced-technology occupant restraint systems to reduce the risk of injury in a general aviation aircraft crash. We especially like the magnitude increase in occupant protection airbag seatbelts provide for seats that only have a seatbelt—no shoulder harness. We're watching to see whether they will eventually be made available for older airplanes in which it's not possible to retrofit shoulder harnesses.

Cirrus SR20 Re-engined: Simpler, Lighter

The entry-level SR20 G6 loses its six-cylinder Continental in favor of a four-cylinder Lycoming. The result is better climb performance and a needed boost in useful load.

by Larry Anglisano

For the 2017 model year, Cirrus released the G6 SR20, which gets both an avionics upgrade and a new IO-390 Lycoming engine.

Cirrus said its decision to re-engine the entry-level SR20 is significant for a couple of reasons. For one, it plans to aggressively market the aircraft to fleet operators who've expressed a strong preference for a four-cylinder Lycoming over a six-cylinder Continental. Moreover, the IO-390 substantially reduces weight, while also stretching the TBO for high-use operations.

To see how the G6 SR20 compares to the previous model, we flew one during a recent visit to the Cirrus Vision Center in Knoxville, Tennessee. Here's a report.

OUT FROM THE SHADOWS

In our view, the SR20 has been overshadowed by the flagship SR22, despite the company's efforts to market it as a dual-role aircraft. That role includes traveling and training—which we think well suits the SR20. On the other hand, buyers might struggle with pricing. Those who can handle the SR20's typically equipped starting price (low $400,000) can likely afford the SR22, which starts at around $539,900.

Park a G6 SR20 nose-to-nose with a new SR22 and you'll be hard-pressed to tell the difference, save for the single exhaust stack on the SR20, compared to the twin pipes on the SR22.

Forget everything you know about earlier cookie-cutter SR20s. Just like the flagship G6 SR22, the new SR20 is available in upgraded paint schemes (and Cirrus' paint and interior Personalization design), plus it has Garmin's new G1000 Perspective+ integrated avionics.

CHECKLIST

- The four-cylinder Lycoming could reduce maintenance costs.
- The extra horsepower and lower weight means better runway and climb performance.
- With desirable options, the SR20's price is within shouting distance of a base SR22.

In many ways, the SR20 is a good choice for pilots who aren't ready for the faster and less forgiving SR22, without having to sacrifice styling, avionics capability and safety systems.

Additionally, the new Lycoming adds a layer of simplicity that perhaps didn't exist with the Continental-powered SR20. After all, there are two fewer cylinders to worry about. As Cirrus' senior line manager Ivy McIver put it, "From a maintenance and operational perspective, the four-cylinder Lycoming in the new SR20 is simpler and will be less expensive to maintain just because it has fewer parts."

MORE HORSES AND UTILITY

While the Lycoming IO-390-C3B6 has two fewer cylinders than the Continental IO-360ES, the re-en-

The Lycoming IO-390 in the SR20 mates to a three-blade aluminum or optional weight-saving composite Hartzell propeller.

gined SR20 G6 still benefits from a boost in power—up to 215 HP versus 200 HP for the Continental.

Cirrus also certified the airplane with a lightweight Hartzell composite prop (it's optional), which shaves nearly 30 pounds from the airplane. With the new engine (and lighter avionics), Cirrus was able to change the maximum gross takeoff weight to 3150 pounds—an increase of 100 pounds from the old airplane. With as much as 150 pounds increase in useful load (1030 pounds), you can haul around another passenger, or more of your stuff.

Like the SR22, the SR20 has a 60/40 folding rear seat configuration, which from our experience really simplifies loading items like snowboards and golf clubs into the cabin. The maximum allowable loading in the baggage area is 130 pounds.

Cirrus pegs the cabin payload at 776 pounds when loaded with three hours of trip fuel, plus the typical 45-minute IFR reserves.

The SR20 holds 58.5 gallons of fuel (56 gallons are usable) and managing the system is stone simple with a left/right/off tank selector mounted aft of the throttle and mixture control in the center console. The boost pump is switched on during takeoff, climb, landing and while switching fuel tanks.

Like the G6 SR22, a major upgrade to the new SR20 is the external lighting system and upswept wingtips. Gone is the landing light housed in the front cowling. It's been replaced by the Whelan-designed Spectra LED wingtip lighting, which houses landing, nav and position lights, plus aesthetic Halo lighting that automatically comes on when you unlock the doors with the new key fob. There's also under-wing ground lighting for those dark nights on the ramp, plus a variety of new convenience lighting in the footwells, baggage area and around the cabin steps.

But what we like best about the new lighting is the automation. For instance, the landing lights automatically switch to wig-wag mode when you climb through 300 feet AGL after takeoff, and then they go solid when you descend through 300 feet AGL for landing.

The new SR20 benefits from many of the same refinements and creature comforts we like about the G6 SR22, including a standard leather interior, no fewer than four USB charging ports, impressive Beringer brakes and wheels, plus airbag seatbelts for the two front seats.

Since Lycoming engines dominate the training fleet, the four-cylinder IO-390 in the SR20, top, means more competition for Piper, Cessna and Diamond. You lean the Lycoming for best power by setting 100 degrees rich of peak EGT, middle photo. Unlike the SR22, the SR20 gets a single exhaust stack, bottom.

FLYING IT

What makes the SR20 a good training airplane for transitioning to the faster SR22 is the standardized cockpit. Both aircraft share the same avionics/autopilot and the sight picture out the windshield is identical. Standard are the 10-inch Garmin displays, while 12-inch displays are optional.

The Perspective+ has an integrated engine data and fuel quantity display, of course. Engine system health, cautions and warning messages are displayed in color-coded text in the crew alerting system (CAS) window located to the right of the altimeter and vertical speed indicator on the PFD. There's also a new graphical weight and balance utility. Plug the numbers in for your current fuel status and people/baggage loading and the system does the rest.

The ignition and starter system includes the Champion SlickSTART, which changes the ignition timing and adds energy to the spark to aid

The G6 SR20 gets the new Perspective+ avionics suite, top photo, which is based on Garmin's latest G1000 NXi. Like the G6 SR22, the SR20 has the new upswept wingtips with integrated automotive-inspired LED strip lighting, middle and bottom images.

in starting. Otherwise, starting the fuel-injected Lycoming is the same as it ever was—prime it, crack the throttle and advance the mixture control as it fires.

The normally aspirated Lycoming IO-390 retains the Cirrus automatic propeller control, which keeps operation as simple as it can get. With a single-lever throttle, a separate cable attached to the propeller governor adjusts the governor oil pressure to increase propeller pitch to maintain engine RPM. The system is set to maintain 2500 RPM from idle through the cruise power setting range, and 2700 RPM at full power. The throttle control has Max, Power and Idle settings. The mixture control is set for full rich during takeoff.

Like the SR22—and any other G1000 aircraft—you run the checklist on the MFD. Cirrus changed the Perspective's data entry console to one that finally has a QWERTY keypad. That just makes data entry so much easier, from our experience.

We flew the G6 SR20 after flying the turbocharged G6 SR22T. Let's just say the SR20 doesn't jump off the runway like the SR22 does. Still, it's no slouch and the extra 15 horsepower in the new Lycoming is apparent, compared to the Continental-powered SR20s we've flown.

At sea level for a 3150-pound SR20, the book calls for a 1685-foot ground roll at ISA conditions. For Cirrus instructors, the rule of thumb is to strictly obey the 1500-foot takeoff and landing distance, and add a 50-percent safety factor. That's 2500 feet of runway. On the takeoff run, rotate at approximately 75 knots with the flaps at 50 percent. The Lycoming has plenty of climb authority. With two onboard and tanks half full, we saw almost 1200 FPM departing the McGhee Tyson airport in Knoxville, Tennessee. The optional air conditioning system can be left on during takeoff, but you want to turn it off for max climb performance.

Retract the flaps at 85 knots and enroute climb is made at full power. When it's time to lean the IO-390, leave your Continental IO-360 procedures at home. Lycoming doesn't condone lean of peak EGT operations. Instead, the Garmin Perspective+ onscreen leaning guidance is based on best economy, or peak EGT. When pulled back to 8.5 GPH, plan on 135 knots. Want to set best power? Enrichen the mixture to 100 degrees rich of peak EGT. At 4000 feet and 75 percent power, plan on nearly 150 knots burning 12 GPH, which yields four hours of no-wind endurance.

YouTube See a video about the SR20 G6 at http://tinyurl.com/j95ht2a

Approach and landing in the SR20 isn't much different than in the SR22, although everything happens a more slowly—that's good for training. For us, 75 knots on short final worked well and like all SR models, the pitch and roll compression springs create moderate control pressure (and impressive roll and pitch stability), which means you absolutely must keep the aircraft trimmed.

The flaps have three positions: 0, 50 percent (16 degrees) and 100 percent (32 degrees), and the first notch can be extended at 150 knots. Incidentally, the Vpd—for CAPS parachute deployment—is 133 knots.

INCREASED TBO

Another selling point for training operators is the SR20's engine TBO. For high-time usage (flown more than 40 hours per month), the IO-390's recommended TBO gets bumped to 2400 hours. The Continental IO-360ES has a 2000-hour TBO.

As for price, the G6 SR20 has a base price of $389,900, which includes 10-inch Perspective+ displays, a three-blade aluminum propeller, a mandate-compliant ADS-B Out transponder (plus ADS-B In) and a three-day transition training package. But this base airplane probably isn't the way individual buyers might spec a new SR20. Desirable upgrade packages jack the price up in a hurry.

The Hartzell lightweight carbon composite propeller is $12,900; the Cirrus Select package—which includes 12-inch displays with an EVS enhanced vision system, plus eTAWS terrain alerting—is $39,900. There's also the $27,900 Digital Advantage package, which ditches the individual round-gauge mechanical backup instruments for the four-in-one digital standby instrument, adds Garmin's Flight Stream 510 wireless system, plus SiriusXM weather and entertainment. Air conditioning is $26,900. All that adds up to a $500,000 SR20. The flagship SR20 GTS, which has many of those options—plus an upgraded appearance package—is $564,900.

The SR20 comes standard with a two-year spinner-to-tail warranty. As we go to press, new deliveries are scheduled out to November 2017. That's impressive in an otherwise grim new airplane market.

Contact www.cirrusaircraft.com.

O2 Concentrators: Inogen Aviator Is Tops

Bottled oxygen may be cheaper than rigging up a portable oxygen concentrator, but we think the convenience outweighs the cost. Inogen has the best solutions.

by Paul Millner

CHECKLIST

- Inogen Aviator G-series concentrators are smartly designed for smaller cabins.
- Concentrators eliminate the chore of filling traditional oxygen bottles.
- You might still need bottled O2 backup for high-altitude ops and multiple users.

There are good reasons to make oxygen available at altitudes less than those recommended by the FAA. Face it, unless you're using a pulse oximeter on every flight (we certainly don't when flying at lower altitudes), you don't really know how your physiology is reacting on a given day. We think blood oxygen saturation is an important biometric to keep on top of.

So having determined that supplemental oxygen is either a legal requirement or simply a good idea, is a portable oxygen concentrator—instead of bottled O2—a good idea? For some we think it is.

Given the clinical-focused form factor and electrical power requirements of systems we've looked at in the past, we all but dismissed them as impractical for use in small aircraft. But a fresh scan of the market reveals there are some viable options, mainly from Inogen.

O2 CONCENTRATORS 101

Oxygen concentrators were developed in the 1970s to meet both industrial and consumer needs, creating a relatively inexpensive, limitless supply of oxygen. Starting in the 1980s, oxygen concentrators became an option for the oxygen-dependent, providing the COPD or congestive heart failure-afflicted with an ongoing supply of O2, and allowing freedom of movement by not being dependent on a compressed bottle.

The purity delivered by a concentrator isn't as great as for bottled oxygen, which can deliver O2 purities greater than 99.9 percent, if you want to pay for it—which might not be necessary.

For our purposes in the airplane (and for certain industrial solutions), 95 or even 90 percent pure oxygen from a concentrator is acceptable. Unlike bottled oxygen, concentrators do not remove water vapor, and the pulsed bolus (more on that in a minute) doesn't constantly stream

The Inogen Aviator G2 oxygen concentrator, lower left, is priced under $3000 and meets FAA standards for supplemental oxygen. The $13,500 OxyFly Light, lower right, has enough output capacity for up to six users.

The Inogen G-series Aviator concentrators connect to a common nasal cannula, top photo. The concentrator works well stored on the cabin floor and between the seats, bottom.

across sensitive membranes, giving concentrators a desirable advantage. Face it, nobody likes dealing with dry nasal passages.

The basic technology behind modern, small form-factor O2 concentrators is a zeolitic compound. Zeolites are a naturally occurring aluminum/silicate mineral that is microporous. Scientists choose from among 40-some natural zeolites (or from over 200 man-made ones) based on pore size, which determines which molecules get trapped, and which are allowed to pass through. In this case, a zeolite is selected that when air (80 percent nitrogen) is put through the zeolite under pressure, it traps the nitrogen molecules, but allows oxygen and water vapor to pass through.

The concentrator box contains a compressor that grabs surrounding air and boosts it to roughly 20 PSI to pass through a filter. Then, a microprocessor controls the compressor speed to match the airflow set as the desired outflow of oxygen. The processor also controls the switching (think of a manifold) amongst two or more filters.

Once a filter's zeolite is saturated with nitrogen, it can be allowed to discharge and rest, outgassing the nitrogen, while a second filter strips out the nitrogen during its turn in the cycle. Chemical engineers among us call this pressure-swing adsorption. Note that this isn't absorption—that's a subject for an entirely separate lecture.

So where's the O2 in a concentrator? It's stored in a pressurized tube where it's pulsed—on demand— to the nostrils via traditional cannulas. Thanks to microprocessors, concentrators are smart enough to sense human breathing and flow (pulse) accordingly.

The process eventually switches back to the freshly nitrogen-depleted filter, giving the alternate zeolite canister a rest in turn, while the cycle continues.

INOGEN'S AVIATION MIGRATION

It was inevitable that someone would consider aviation applications. Windblade Corporation took on the challenge a decade ago, working with the founders of Inogen to tweak the small Inogen One G1 system's hardware for aviation use. It worked with the FAA to identify potential problem areas like radio interference, while addressing the concern of optimal battery endurance. The other task was modifying the system to work acceptably up to 17,999 feet. Consumer-grade concentrators are generally rated for airline travel, where typical cabin altitudes of 8000 feet are the norm.

The resulting Inogen Aviator concentrators are simple to use and they include a pulser, which flows a bolus (think of it as a single gulp of oxygen) whenever you inhale. This is much more efficient than continuously streaming oxygen that is ultimately lost between inhalations. Each unit includes a detachable battery to assure at least four hours of use if the DC power input is interrupted during flight.

The battery has a self-discharge rate of about twenty days if disconnected, or just five days if the computer-style power supply is left attached. This makes inflight recharging useful. An AC power adapter is also provided so the batteries can be kept topped off in the hangar between flights.

There are three models in the Inogen Aviation line (the G2, G3 and soon the G4) and all meet FAA guidelines for supplemental oxygen, are certified to FAA radiated emissions standards and have simple controls and decent LCD displays. The $2795 Aviator G2-1265 is the flagship unit tested to 18,000 feet. Why not higher?

While you might wear an oxygen mask above 18,000 feet, the pulse delivery of an oxygen concentrator doesn't generally work well with a mask. On the other hand, we've heard reports from pilots who successfully use concentrators in the low flight levels. Still, we think backup oxygen is a smart plan.

Consider that 1265 ml/min is the maximum available oxygen flow rate, or just over 1.3 liters on the unit's maximum output setting. The G2 weighs 7.25 pounds, including the

battery, and measures 10.7 inches long and 9.5 inches high. At only 3.9 inches wide, it's easy to wedge between the seats. Inogen says the single battery lasts up to five hours, but the optional double battery lasts up to 10 hours.

The $2795 Aviator G3 (yes, it's the same price as the G2) has been tested to 15,000 feet and delivers 840 ml/min. What the 4.8-pound G3 lacks in output it makes up in portability and a smaller form factor. It measures 8.75 inches long and 8.25 inches high. At 3 inches wide, it might fit even better between the seats. Its single battery can last up to four hours, while an optional double battery increases the endurance to nine hours.

While it might seem like a logical plan, the Inogen concentrators aren't practical for remote mounting because they require a key press to power on and off, plus the operator needs to have access to the front panel display. There's also an alert annunciator.

Accessories include a higher-capacity battery pack for $495, or a spare standard-capacity battery for $395. External battery chargers are $275. Replacement particle filters are $19 each. Windblade also sells a spare cannula for $99, which also includes an inline flow-confirming spinner. The systems come standard with a DC power converter, which serves double duty for charging the battery.

Inogen is working on the $2999 G4 Aviator. It has an even smaller footprint than the other Aviator models—measuring only 5.91 inches long, 7.2 inches high and 2.68 inches wide. It weighs 2.8 pounds. Inogen tested the G4 to 13,000 feet and the system delivers 630 ml/min output.

Inogen says the Aviator units can be shared amongst two users, but this reduces the service ceiling. For example, the G2-1265 can be shared between two users up to 14,000 feet (reduced from 18,000 feet for one user), but this depends on demand. We've shared the Inogen on two occasions, but with mixed results. Plan on having backup oxygen when carrying a passenger.

We've been using the older Inogen G2-1080 for six years with good results. You might find this and the older G1 on the used market.

OTHER OPTIONS

A few years ago we evaluated the OxyFly Light O2 concentrator made by Germany-based Durr Technik, reported in the March 2013 *Aviation Consumer*. While we liked the capability, we weren't convinced that a unit weighing nearly 50 pounds and drawing 25 amps of current is a good across-the-board portable solution. It's hardly budget based.

Inogen's G4, top, has the smallest footprint of any system in the Aviator product line. That's the control set on the Inogen G2, bottom.

We found that the compressor heats to almost 250 degrees F, plus several mechanics we consulted with were concerned about the unit's lack of chafe protection for the exposed wiring bundles.

We do like that the OxyFly can supply oxygen for up to six people (up to 18,000 feet) when using the Oxymizer oxygen-conserving cannula, or up to four people wearing traditional cannulas. The OxyFly's output is 90 to 95 percent pure oxygen. The OxyFly Light is priced at $13,500 and only works on 28 volts DC.

There are plenty of non-aviation portable concentrators, but many are much larger than the Inogen units. In our research, we found that some European aviators seem to have good results with the SeQual Eclipse 5 portable concentrators, which may be available online for about $1500. The specs are 96 ml per bolus or gulp of air. Even with some performance degradation, they may match Inogen performance. There haven't been reports of interference issues with onboard avionics and we haven't evaluated them. If you use one, we want to hear about your experience.

Use caution with low-cost concentrators. While many can be found for as little as $300, most deliver only a 35 percent oxygen concentration, which won't provide much benefit above 10,000 feet. Plus, altitude performance, heat and RF interference issues are unknown.

WHAT'S IT WORTH?

While bottled oxygen might be cheaper than a concentrator, there's peace of mind in knowing you'll always have a supply, instead of relying on someone to fill the bottle.

From our experience, you might discover that without any apparent direct costs (in dollars or refill effort), you'll use oxygen more often and benefit from the lack of fatigue and better mental acuity at times when you really need to be at your best.

Our top pick is the Inogen G2-1265 for its 18,000-foot operating ceiling and simplicity. If size is a concern, consider waiting for the Inogen G4 if you can live with its 13,000-foot ceiling.

The Inogen Aviator line is sold by the California-based Windblade Corporation. Contact them at www.inogenaviator.com, 805-448-5289.

Contributor Paul Millner is a Cessna turbo Cardinal owner, the technical editor of the Cessna Cardinal Flyers type club and is based in California.

Oil System Upkeep: Control Heat and Flow

Changing the oil is only the first step in maintaining your engine's lubrication system. It pays to dig deeper with DIY preventive maintenance.

Staff Report

Other than changing the engine's oil and watching for drips of it on the hangar floor, you may not pay much attention to the engine's lubrication system as a whole. It is a major system with critical hoses, fittings, oil cooler and pump, to name a few components.

While you might leave the maintenance of those items up to your shop or mechanic, there are specific things you should do and understand about the engine's oil circulation system. Here's a technician's overview.

OIL SYSTEM BASICS

The oil system on most light aircraft engines is simple and mostly effective. Most systems are of a wet sump, low-pressure design. Typically, the oil reservoir (or sump) is located within or attached to the lower part of the crankcase and oil is continuously returned by gravity to the sump after the oil has done its job of lubricating and cooling.

The oil pump cavity is fed by gravity and/or suction through a filter screen, and then the gear-type pump pressurizes the oil manifold or pressure lines. Some engines (the original Continental O-470 series comes to mind) also employ an oil pressure screen (as opposed to a filter on later models), which is intended to trap large particles before supplying the oil cooler and engine. More on what you should know about filter technology in a minute.

In addition to the pressure screen is a pressure relief valve designed to prevent excess pressure from damaging engine parts and the oil cooler.

A technician at Pacific Oil Cooler Service (left) bench repairs a cooler. The company can provide exchanges or in many cases repair and overhaul yours.

Farther down the line is the oil temperature bulb, which sends the oil temperature reading to the oil temperature gauge (upstream of the oil cooler) just prior to supplying oil to the engine's main bearings.

Oil temperature is typically controlled by a thermally operated valve—or vernatherm—which either bypasses the oil around the cooler, or routes it though the cooler passages. Some early Lycomings instead employ a viscosity valve, which is arguably a less effective method to control oil temperature, in concert with a healthy oil cooler.

Along with the oil temperature sender unit is the main oil pressure fitting. The fitting is directly attached to the oil pressure galley. This fitting, as in most oil pressure fittings, has a restrictor in it to limit pressure surges and to prevent large-scale leaks from occurring should the plumbing to the gauge fail.

What you probably didn't know is that in addition to the restrictor in the fitting, the oil in the line connected to the pressure gauge is normally a lighter grade of oil than regular engine oil. This provides faster responses to changes in oil pressure, especially during cold-weather operations. This oil doesn't circulate, but instead is contained inside the line transferring the oil pressure to the gauge.

While engines may have slightly different oil systems, all have some type of screen or filter in the suction side to avoid contaminating the pump. As for measuring temperature, engine manufacturers have specific locations for locating the sensor.

We've seen some installers take shortcuts when installing aftermarket engine monitoring systems, deviating from these locations when installing the temperature probe, which often results in inaccurate oil temperature readings. If you've been using an analog gauge, you may never recognize the difference after the upgrade.

Some early Lycoming engines that have oil coolers do not have a

thermostatic valve, so oil is routed continuously through the oil cooler. These are known as continuous cool systems and require the use of a winterization plate during cold-weather operations. The plate is attached externally to the air supply of the cooler to block off cooling air to the unit.

OIL COOLER UPKEEP

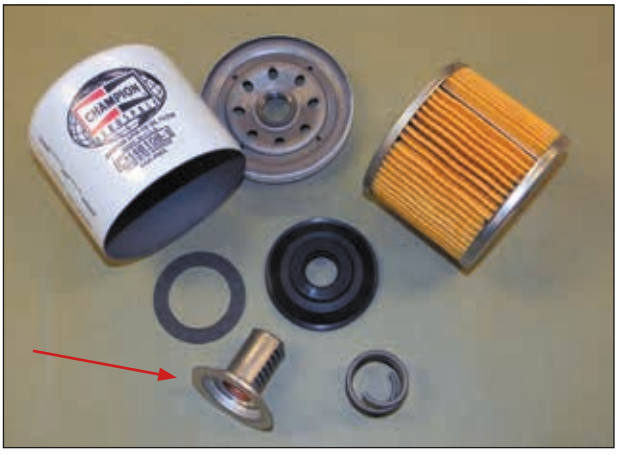
While aircraft engine oil coolers resemble those of automotive radiators, the cooling fins of an oil cooler are much smaller—usually .006-inch thickness—and are made of weldable aluminum. What you need to know about aircraft oil coolers is that the fine passages of the internal tubes are susceptible to clogging and the buildup of carbon deposits. This definitely has a negative effect on cooling efficiency. Cylinder blowby and neglecting the oil change intervals add to the problem.

On larger Continental engines, the oil cooler is mounted directly to the engine, while Lycoming engines connect to remote coolers. The obvious advantage to the direct-mount Continental design is its lack of external oil transfer hoses, a source of potential leakage. Still, engine-mounted coolers live harder and shorter lives because they sustain more engine vibration than firewall-mounted remote models.

Common failure modes include stress cracks and corrosion-induced leakage. Remote coolers can last a long time, but only if serviced regularly and properly. According to repair facilities and manufacturers we spoke with, the primary reason for premature oil cooler failure is the simple lack of preventive maintenance.

We're told that oil coolers are designed to last as long as the engine, but only if they're kept clean. When new, the TIG-welded cooler is chemically cleaned and treated with a corrosion preventative and then pressure-tested.

Topping the chart of improper oil system care is mating a contaminated oil cooler with a freshly overhauled engine. Instead, while you're waiting for the engine, send the cooler to an approved shop that's experienced with overhauling and repairing them. If it's badly damaged, replacement may be the only option.



An oil flow restriction, catastrophic failure and subsequent inflight fire from spewing oil turned the Lycoming in the top photo to charred metal. The oil filter pressure relief valve in the middle photo helps keep oil flowing when the filter is clogged. Always cut the filter open and look for metal when doing an oil change. Don't forget to safety wire the new one.

There are mixed views on overhauling oil coolers. Some believe that no matter how extensive the cleaning process is, you simply can't wash out all of the containments from the cooler's nooks and crannies. That may be the case with field cleaning, but established shops with years of experience have the process down.

Pacific Oil Cooler Service in La Verne, California (a sister company to manufacturer Aero-Classics) has a time-consuming overhaul/ultrasonic cleaning process. Pacific's Wayne Thomas told us the company sends coolers through three different flushing machines. Additionally, the key to effectively cleaning a cooler is sending high volumes of high-pressure Stoddard solvent flush (reversing the flow direction every 60 seconds) followed by flushing it using a 10-micron filter screen. Thomas said oil coolers it overhauls spend two

Oil coolers, top, are designed to last as long as engine TBO, but only if cared for along the way. Engine baffling, middle, can play a huge role in oil temperature as rubber seals alter the airflow. That's an Airwolf remote filter kit for a Continental, bottom.

hours on each flushing machine. The first machine targets oil and internal sludge, the next machine focuses on carbon deposits and the last removes any residual cleaning material.

The cooler is then inspected and any remaining paint, anodyne and corrosion is stripped off using a special proprietary cleaner after either a dye penetrant or magnaflux inspection is employed. If the unit passes that inspection it is then pressure/leak tested. If it passes, the unit is re-coated with a protective chemical coating that will prevent oxidation and corrosion. It's then returned to the customer with an FAA 8130-3 airworthiness form.

A major concern with oil coolers is blockage. By nature of its design, the oil cooler makes for an effective secondary filtration system, catching carbon, metal and other engine contaminants. Simple flush cleaning probably won't do it much good.

But you might also have to deal with physical damage, including stress cracks and leakage. In general, remote-mounted oil coolers tend to live longer than engine-mounted coolers, but there are things you can do to keep any cooler in top shape.

Start with a visual inspection, while looking for corrosion. Check for obstructions in the air passages and clean if necessary. While you're at it, check for cracks and oil leaks over the entire oil cooler, especially around mounting brackets and oil fitting attachment areas. Clean the fins with compressed air in a reverse flow if possible. See any bent cooling fins? There are straightening tools designed to carefully bend the fins back into position.

Is the oil cooler even securely attached? We remember uncowling one airplane only to find the remote cooler missing two of the four attachment bolts. That must have been a Friday afternoon job.

While you're at it, check that the proper spacers and washers are used in the remote oil cooler installation to prevent the squeezing or binding of the mounting bracket. This is a common cause for cracked coolers.

Check that oil fittings and lines are tight and are not leaking. When removing or installing oil fittings to oil lines always use two wrenches, one to hold the fitting and one to turn the "B" nut. Distorting or twisting the remote cooler during maintenance may cause stress or cracks to develop in the cooler or mounting brackets.

Last, have the cooler repaired or overhauled by professionals. It's money well spent. We've seen plenty of shoddy field repairs made to oil coolers. Welding, brazing and epoxy may be a temporary fix for oil leakage, but these are probably not going to survive long-term use. In general, quality overhauls or exchanges for common oil cooler models start at around $800.

HEAT TRANSFER CONCERNS

In hot climates and in summer operations, high oil temperature is as much of a concern as cold temperature is in the winter, but for different reasons. Assuming the temperature gauge is accurate, it's generally considered that continuous oil temperature in excess of 220 F during cruise flight is too high and should be investigated (180-200 F is the preferred temperature).

Also, with extended operation, oil tends to break down while in operating temperatures above this range, so consider changing it more frequently. But excessive oil temperature might not be related to air temperature. Assuming that you're using the proper grade of oil for the air temperature—and the correct quantity for the engine—there are things to check.

First, is the gauge reading correctly? Boiling water at sea level should prove accurate enough to measure 212 degrees F when put in contact with the temperature sensor. It's a cheap test.

Beyond the sensor and the gauge, check that the oil cooler (both the cooling air inflow and outflow) is free of obstructions. This includes leaves, bird nests, pollen, dirt and any other substance that limits airflow. If that all looks good, focus on the engine cowling.

First, check that engine baffling is intact, that the rubber seals are sealing and that cooling air over and around the cylinders is not obstructed. Related to this are problems with the cowling bending or bulging in flight, allowing intended cooling air

to escape through gaps created by distorted cowlings.

If the aircraft has cowl flaps, their proper rigging is essential for cooling efficiency—and for getting the most speed from the airframe. This is tough to check because while they might appear to be operating perfectly on the ground, this might not be the case in the air.

We used to fly a Piper Arrow that suffered from high oil temperature in the summer. Turns out that worn pivot bushings were causing the flap to close (we never could figure out how much, but it was enough to spike the oil temperature), restricting airflow.

When inspecting oil supply and return hoses, look for more than just leakage. There could be restrictions that you can't see. The hoses should be soft and flexible. If the hoses are coming apart on the inside, it's the perfect setup for an oil flow restriction—including a blocked oil cooler.

Sometimes it's the engine itself that's prone to high oil temperature simply because of its inefficiency. Worn or poorly maintained engine components place more heat transfer demand on the engine because it's working hard. Think of the big picture. Engine compression, proper ignition timing, correct fuel mixture and the mentioned oil cooler play a role in generating heat.

CLOSING WORDS ON OIL FILTRATION

Everyone knows that oil filters help keep engine oil clean by filtering metal, dirt and other contaminants. Oil filters for certified engines carry TSO and PMA approvals, and spin-on filters from Champion and Tempest are the most common brands.

When we last looked extensively at these two brands in a head-to-head shootout (March 2013 *Aviation Consumer*), we determined that both Tempest and Champion performed equally well, at least from a filtration standpoint. Consider that paper filters have an average porosity of 40 microns. That means that particles smaller than 40 microns can enter the engine—which is part of the reason we change engine oil at around 50 hours. For engines that have oil screens, that interval is reduced to 25 hours, on average.

Some oil filters have an internal filter bypass—a mechanical failsafe pressure valve that opens if oil flow through the filter element becomes restricted. This happens if it becomes clogged with contaminants or if cold oil is too thick to flow through the filter. The idea here is that dirty oil is better than no oil.

The bypass valve is really nothing more than a pressure valve-spring cage that, when open, allows oil to continue to flow toward the filter's outlet. Since most Lycoming engines have a filter bypass somewhere on the engine, the Lycoming-specific 48110-series filters omit the bypass valve. What can go wrong with a bypass-equipped filter? Enough that Tempest designed its filters with additional failsafe.

Unique to the design is a bypass valve safety cap, which surrounds the valve in case it were to break loose from the securing spot welds, avoiding sending pieces of the metal valve into the engine.

Tempest oil filters also have a unique filtering ring magnet intended to catch fine particles of steel that could easily pass through the filtering paper. But the magnet is also handy for spotting critical metal during an oil change. More than one mechanic told us the filtering ring is the first place they look (second to looking for larger pieces of metal when cutting the filter open) when changing oil. Fine pieces of steel, which creates a fuzzy appearance on the surface of the ring magnet, could indicate valve and cam wear.

If you accomplish your own oil changes and dread the task of replacing the filter because it's a bear to access (some might even change the oil, but—unwisely—not the filter), you might consider a remote oil filter kit.

Airwolf Filter Corporation (www.airwolf.com) has a wide-reaching STC for remote filter kits for Continental, Lycoming, Franklin and other engines. There are also filtration kits for engines with filter screens, which get rid of the screen while extending the oil change interval.

The remote filter kit weighs just shy of 5 pounds and puts the filter in a more accessible area. This means less time-consuming oil changes and less mess. Airwolf's kit, which is anodized to eliminate corrosion, filters the oil before it enters the oil cooler and is STC'd with a Champion filter. The kit doesn't come standard with hoses because not every installation is the same, but Airwolf offers TSO'd hoses it sources from a third party.

Airwolf's remote filter kits are offered by numerous OEMs, including Aviat, American Champion and Maule, and is a popular accessory for aerobatic aircraft.

Airwolf told us that installation can generally be accomplished in one shop day and is best done during an oil change or while the aircraft is opened up for an inspection or engine swap. The typical kit is around $600. Airwolf also offers oil filter cutting tools, air/oil separators and oil filter chillers.

Like most systems on the aircraft, the engine lubrication system—and other systems that contribute to its efficiency—needs regular maintenance. Luckily, you can do a lot of it yourself.

LUBRICATION SYSTEM UPKEEP TIPS

- ✔ Always replace the oil filter when changing engine oil.
- ✔ Ensure the accuracy of oil temperature sensors and gauges.
- ✔ Consider an oil analysis service when changing oil.
- ✔ Routinely inspect oil hoses, fittings and the oil cooler for leaks.
- ✔ Keep the oil cooler's fins clean by using compressed air.
- ✔ Drain remote coolers during oil changes.
- ✔ Never connect a contaminated oil cooler to a fresh engine.
- ✔ Ensure engine baffling and cowl flaps are in good condition.

Garmin G5 DG/EHSI: Low Cost, STC Limited

Garmin's G5 electronic directional gyro/EHSI doesn't have autopilot interface yet, but it will likely play an integral role in new low-cost autopilot interfaces.

by Larry Anglisano

As a follow-on product to the STC'd G5 electronic attitude indicator, Garmin's G5 electronic directional indicator is taking sizable criticism because the instrument doesn't interface with autopilots. While Garmin says this is a temporary limitation, it's easy to understand the backlash.

After all, the G5 EHSI is intended to replace mechanical, vacuum-driven DGs—many of which work with the heading channel on a variety of existing autopilots. But looking to the future—as in the coming months—there's a bigger story here.

As TruTrak and Trio move closer to earning STC approval for experimental autopilots, Garmin's standalone G5 series instruments seem perfectly positioned to play with them. Here's why, plus an overview of the G5 heading indicator.

CHOOSE ONE OR BOTH

From a technical standpoint, the main thing that differentiates the $2449 G5 heading indicator from the $2195 G5 attitude indicator is a remote heading sensor. The instrument, which was born in Garmin's experimental line, is certified via an approved model list (AML) STC for close to 600 aircraft makes and models.

The G5 DG/EHSI and the G5 attitude instrument share the same chassis (3.4 inches wide and 3.6 inches high), the same 3.5-inch QVGA LCD color display and both have a four-hour lithium-ion backup battery.

When the two instruments are installed as a pair, the secondary G5 (as a directional instrument) can also be used as a reversionary attitude display because it has an independent ADAHRS.

Garmin said that when the G5 attitude instrument is installed in the primary attitude position, it can't revert to a full-up heading display (the STC doesn't allow it), although it can display the current heading in a data field at the top of the screen.

For magnetic heading resolution, the G5 requires the $275 GMU 11 magnetometer—a remote heading sensor that can connect with two G5 displays. The magnetometer, which uses a similar housing as Garmin's Flight Stream 110/210, is mounted inside the airframe in an interference-free location.

The G5 EHSI display is simple and uncluttered. There's a power key and rotary bezel knob. The heading bug has no outputs—yet.

CHECKLIST

- At roughly $5000 installed, it hits a sweet spot in the market's lower end.
- Built-in ADAHRS gives the G5 heading instrument a reversionary attitude display.
- The current STC prohibits autopilot interfacing. But, we think that's temporary.

You don't have to use the G5 directional indicator as a navigation display (EHSI), but if you do, it requires the GAD 29 navigation data interface module (which bumps the price to $2975, including the magnetometer and backup battery), plus a Garmin navigator or navcomm.

Compatible GPS navigators include the current GTN750 and 650, legacy and WAAS GNS navigators and the GNS480. Navcomms include the GNC255 and discontinued SL30. The GNC255 and SL30 interface don't require the GAD 29 nav adapter as these radios communicate directly with the display over a CAN bus.

Without a nav or GPS interface, think of the G5 simply as a digital directional gyro with heading reminder, plus there is a data field at the top of the display showing current heading. With battery-equipped dual G5s, you can remove the vacuum system.

As an EHSI, the G5 is approved as a primary source for displaying vertical and lateral GPS/VOR/LOC course deviation, plus it shows groundspeed and the distance to the next waypoint. Since the G5 is approved for both VFR and IFR, it can be used as the one and only indicator for Garmin's navcomm radios and IFR navigators.

The G5 directional indicator's feature set couldn't get easier. You adjust the onscreen course pointer with a rotary bezel knob

that serves double duty as a heading bug. There's a Micro SD port and a power key on the lower bezel.

LIMITED BY THE STC

If you're wondering why the G5 doesn't work with autopilots, don't think for a second that Garmin doesn't have the engineering expertise to make it happen. The company's retrofit G500/600 PFD has been installed with almost every certified GA autopilot, plus the G5 currently works with the G3X experimental autopilot. While there are some technical challenges in interfacing with old analog autopilots, that's hardly the issue.

Recall that it was Dynon and EAA that pioneered the first AML-STC for an experimental attitude instrument (the Dynon D10A) last year. Although the certification of an experimental EFIS for Part 23 aircraft was huge progress, the FAA's regulatory compromise was to prohibit any interfacing with autopilots—or even with navigation systems.

Just months after the Dynon/EAA STC, the FAA issued Garmin an STC (but with a much broader AML) for its scaled-back version of the experimental, non-TSO'd G5, while ordering the same limitations it did for the Dynon D10A. That meant no autopilot or navigation interfacing—a limitation that remains in place even with the latest approval for adding heading and nav functions. To get more background, we went right to the source.

Robert Murray at Garmin's aircraft certification division made it clear that while the FAA's Small Aircraft Directorate has been a huge proponent of new safety-enhancing equipment (these recent instrument STCs are proof), it's proceeding with caution. Worth mentioning is that approval is being done using ASTM function verification standards, not traditional DO-178 software standards, which is a far more costly certification process. The tradeoff is baby steps when it comes to more advanced functions, including interaction with autopilots.

"In expanding the G5, we're currently laying out our safety case with the FAA, proving that a basic autopilot interface doesn't induce hazards when controlling the aircraft," Murray told us. This functionality doesn't include driving the autopilot with the G5's ADAHRS-derived pitch and roll guidance, but instead providing basic heading command and potentially, nav/GPS course tracking.

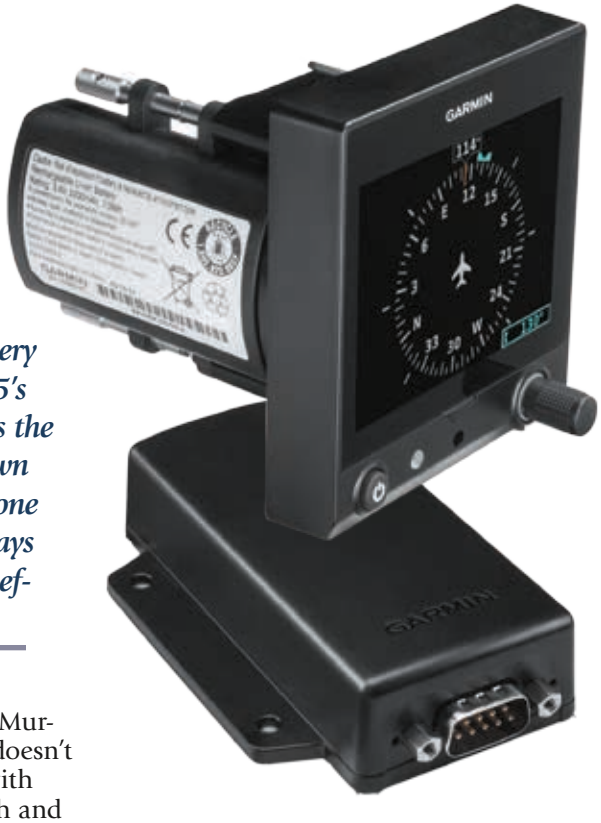
The bottom line is that gaining autopilot approval will require a change to the autopilot-forbidding policy used for the original G5 (and Dynon D10A) AML-STC. As it stands now and as Murray put it, "We think we can satisfy the FAA with our current G5 architecture such that they'll adjust the policy in our favor."

A LARGER ROLE

Moving forward, we see Garmin's budget-priced G5 flight instruments eventually playing a sizable role in the market of STC'd experimental autopilots, including interfaces with TruTrak and Trio systems. For one thing, a pair of G5's connected to the autopilot can provide sizable amounts of redundancy because they offer independent ADAHRS and crosscheck—something the FAA will likely require under ASTM approval.

Last, we fully expect to see Garmin move aggressively with a wide-reaching STC for its existing experimental autopilot, with the G5 attitude and directional instruments front and center in the interface.

YouTube See a video about the Garmin G5 at http://tinyurl.com/j95ht2a



Whether you install a single G5 heading instrument or a dual-screen setup with the G5 attitude instrument as shown in the Cessna panel at the top, the instruments fit in existing 3-inch instrument cutouts. The backup lithium-ion battery attaches to the side of the G5's chassis, middle image. That's the GMU 11 magnetometer shown at the bottom. We like that one GMU 11 can serve two displays because it saves installation effort.

Cessna 185

Think of the 185 Skywagon as a working pilot's backwoods aerial pickup. It also makes a good floatplane.

These days, there is no shortage of aircraft marketed as backwoods utility machines. The short list includes Maule, CubCrafters, Aviat and American Champion. But in the world of working airplanes, Cessna's long-discontinued 185 is often regarded as one of the most capable.

You don't have to spend much time around a 185 to understand its reputation as the airborne version of a four-wheel-drive, three-quarter-ton pickup truck, easily able to haul heavy loads into and out of short, unimproved strips. With plenty of power and two front cabin doors, it also works well as a floatplane. And for all of that, plus a healthy offering of aftermarket mods, some owners just like the 185 for fun flying.

SKYWAGON ORIGINS

The 185 was a thoroughly logical development in the Cessna product line, which began with the taildragging 120, evolved to the 170 and 180 and then, when owners indicated the need for something bigger, the 185. It came along in 1961, a follow-on product to the Cessna 180, which enjoyed considerable popularity. But don't forget, by 1961, the tricycle gear revolution was well established.

Being a bush and utility favorite, there are lots of aftermarket mods available for the 185 Skywagon.

The 172 and 182 were out there and so was the complex 210. The larger 206 Stationair soon followed.

Outwardly, the 180 and 185 evolved into virtually identical-looking airplanes, with comparable overall dimensions and major parts. The primary difference, of course, is the engine. The 180 had a 230-HP Continental, which was adequate but didn't elevate it to the status of a super load hauler.

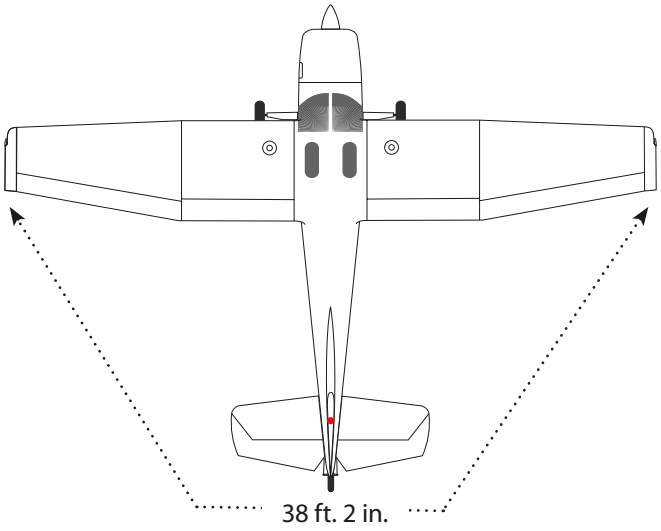
When the 185 debuted in 1961, it had a 260-HP Continental IO-470F and 84-gallon fuel tanks and could perform the rather remarkable feat of lifting more than its own weight: The useful load of 1680 pounds is about 200 pounds more than its standard empty weight, something bush operators prized. Locked securely in the utility market, the 185 was spared some of the cosmetic "improvements" applied to nosewheel Cessnas. It never got the swept-back tail, for example, or the rear window that was added to the nosewheel line. Buyers bought it for what it did, not for how it looked. Unfortunately, it also never got the fuselage "bulge" applied to some of the nosewheel line, leaving the cabin a little tight at 41 inches wide.

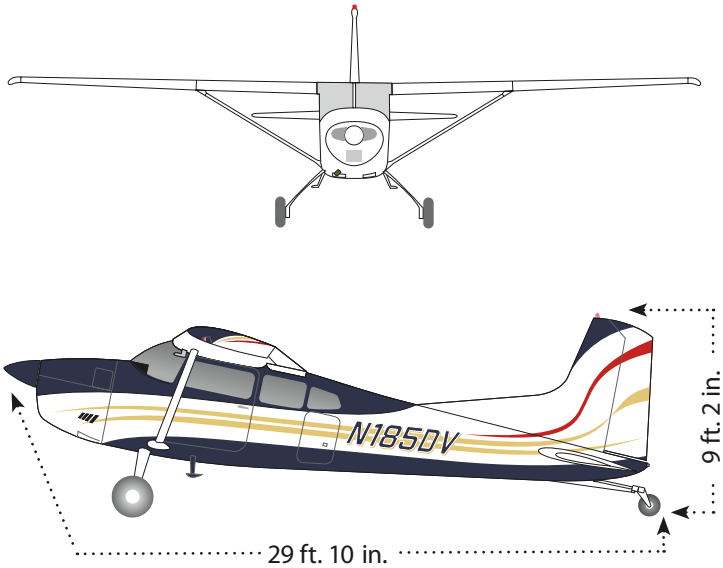
However, you could order a new

Outside of the cowling, the 185 and 180 seem identical. In the main photo, Jerry Callen's blue and white A185F is parked to the left of the red and white C180J.

CESSNA 185 SKYWAGON

drawings courtesy
www.schemedesigners.com

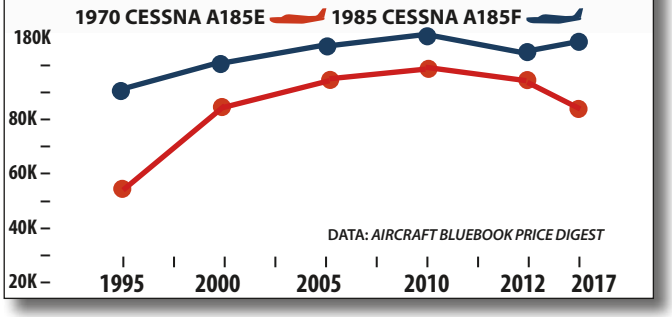




CESSNA185 SELECT MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1961-1963 CESSNA 185,A,B	260-HP CONT IO-470-F	1500	$30,000	65	1600 LBS	145 KTS	±$72,000
1964-1966 CESSNA 185,C,E	260-HP CONT IO-470-F	1500	$30,000	65	1600 LBS	145 KTS	±$77,000
1966-1969 CESSNA A185E	300-HP CONT IO-520-D	1700	$30,000	65	1700 LBS	147 KTS	±$82,000
1970-1974 CESSNA A185E,F	300-HP CONT IO-520-D	1700	$30,000	65	1700 LBS	147 KTS	±$98,000
1975-1977 CESSNA A185F	300-HP CONT IO-520-D	1700	$30,000	65	1700 LBS	147 KTS	±$118,000
1978-1981 CESSNA A185FII	300-HP CONT IO-520-D	1700	$30,000	88	1550 LBS	147 KTS	± $135,000
1982-1985 CESSNA A185FII, A	300-HP CONT IO-520-D	1700	$30,000	88	1550 LBS	147 KTS	± $165,000

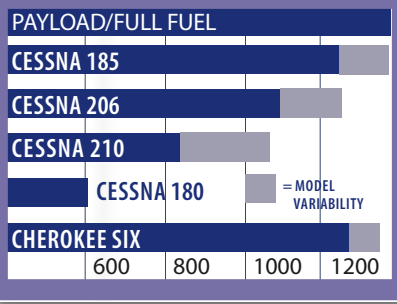
RESALE VALUES

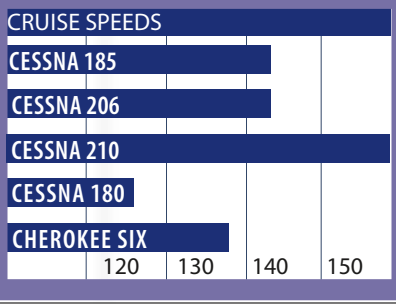


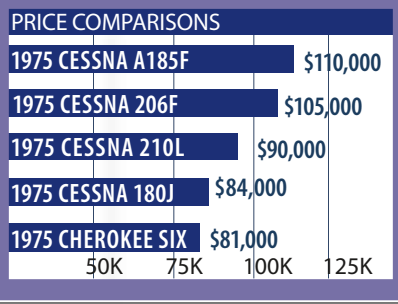
SELECT RECENT ADs

AD 2011-10-09	SEAT RAILS ROLLER HOUSING
AD 2008-26-10	ALTERNATE STATIC AIR VALVE
AD 2004-19-04	SHOULDER HARNESS ADJUSTER
AD 2000-06-01	FUEL STRAINER STANDPIPE
AD 1997-26-10	CRANKSHAFT INSPECTION, REPLACE

SELECT MODEL COMPARISONS







Newer 185 panels have a center radio stack and a more standard "T" instrument arrangement, top, but older models like the one in the center aren't as accommodating. Owners say the 185's cabin, bottom, is adequate, but tight on legroom.

185 with Edo floats, a massive belly cargo pod that could accommodate 300 pounds or a spray application rig, to name a few options. Towing setups and flip-up doors for skydiving operations were also available.

Anyone who hauls stuff for a living always wants more power, so in 1966, Cessna replaced the IO-470F with a 300-HP Continental IO-520D as an option. The 300-HP Skywagons are called A185s.

The bigger engine improved the 185's already exceptional performance. For a mere 10-pound increase in empty weight, the airplane received a 150-pound increase in gross, five more knots of cruise speed and some 200 feet was shaved off the takeoff ground roll, a boon for back-country operators. The engine was such a hit that it was made standard in 1967.

Also new that year was the addition of an aft baggage compartment, along with an optional stretcher door, both of which made loading bulky objects easier. From 1972 through 1979 you could order a full aerial application rig, with belly tank and spray booms. The package turned the airplane into the "AgCarryall."

In 1973, a new cuffed leading wing profile was introduced. The so-called camber lift wing was created by Robertson as part of a STOL kit for the Cessna line and it reduces stall speed slightly, improving roll control at low speeds. Since it's a leading edge mod, Robertson can retrofit it to earlier 185s. The cuffed leading edge is much prized among float operators.

The re-winged 185 became the A185F, which is by far the most numerous variant, accounting for more than half of all airframes. As of 2017, the FAA registry shows nearly 1750 185s of all models; 1224 are A185Fs.

More work-related options came along in 1975, including bubble side windows for photography and skylights. In 1976, flap-extension speed (V_{fe}) went from 96 to 120 knots and the fuel selector was changed to Cessna's left-right-both arrangement. Lift handles were added to the tail to give ground handlers a safe means to muscle the airplane on the ramp without damaging the stab.

One change that was a mixed blessing was the reduction in usable fuel from 81 to 74 gallons, which cut into the airplane's range.

The 1979 models had a new wet wing fuel system with 88 gallons, 84 of which is usable. The older bladder-style tanks were optional. While the bladders had less potential for leakage, they deserve careful inspection during prepurchase evaluations.

The original Skywagon had a two-blade prop, with the three-blade version surfacing as an option in 1978 and becoming standard in 1980. The three-blade can be retrofitted. Owners report no cruise speed loss. It also reduces vibration and noise, and climb is said to be better, plus it looks undeniably sexier.

The 185 enjoyed brisk if not spectacular production numbers

until 1981, when only 389 were built. By 1984 and 1985, only 34 Skywagons were made as prices shot up and Cessna's sales went the other way. That the average equipped price of a new 185 nearly doubled, from $55,670 in 1979 to $108,090 in 1985, probably didn't help. Today, a good used one of early- to mid-80s vintage will bring between $165,000 and $180,000. Some sellers demand a lot more for one tricked out in modern avionics or floats.

PERFORMANCE, HANDLING

Given the performance of retracts equipped with the IO-520, the Skywagon won't set any speed records, but few of them will do what the 185 can: Fly with full tanks, full seats and baggage. Load a Skywagon with full fuel, four 220-pound people and perhaps 50 pounds of bags, and the airplane will take off in just over 800 feet, climb at better than 1000 FPM and then fly 800 miles at 140 knots, outdistancing a handful of retracts and twins. Even at higher altitudes, the IO-520 has plenty left.

Fuel flows range around 14.5 GPH, rich of peak, depending on power setting. Installing GAMIjectors and operating lean of peak will pay for itself with fuel savings and engine longevity with only a moderate loss of cruise speed. We always wondered why Cessna never hung a turbocharger on the 185, as it would seem to have made a great deal of sense for the mountain operators. Tornado Alley Turbos will turbonormalize your 185, and owners report cruise speeds of 165-175 knots at FL200 while burning 14.5 GPH.

In stock form, the 185 is nearly a STOL airplane. With those big barn door flaps at 40 degrees, stall speed is under 45 knots so 55-knot approach speeds are doable. We've been told of skilled bush pilots plunking the Skywagon down in as little as 300 feet in a rough clearing or river sandbar.

As with any airplane, the technique is a high-alpha approach with flaps and power at a speed between 50 and 55 knots, followed by a full-stall three-pointer. Watch the aggressive braking, however, since the airplane can and will nose over with locked wheels.

Although the airplane handles well in the air, some owners say it's not easy to land and won't tolerate lazy feet on the rudder, especially in crosswinds, and the accident reports confirm the assessment. Yet as taildraggers go, it's not overly twitchy and the deck angle allows seeing over the nose so S-turns aren't necessary.

The 185 makes a decent amphib. That's Steve Gruenberg's IO-550-powered A185 in the top photo. The one in the lower photo is parked on skis, photo courtesy of John Faulkner.

Wheel landings, while doable, require some finesse due to the 185's spring-steel landing gear legs. If the pilot doesn't convert a botched wheelie into a three-pointer, loss of control may follow. Most owners seem to prefer three-pointers, which are aided and abetted by the locking tailwheel, which also helps in crosswinds. Just don't forget to unlock it before taxi turning, otherwise you risk tire damage on the tailwheel.

In the air, handling of a Skywagon is similar to another Cessna product, the Skylane. Trim, unlike that on most Cessnas, is through a jackscrew in the tail rather than via a trim tab, and the system's low gearing means you move the wheel a bit before noticing the effect.

Cessna didn't offer electric trim, but some autopilot installations include it and pilots who have it like

Wipaire's IO-550 engine kit is a popular mod for the 185. That's a belly cargo pod installed on the 185 in the bottom photo.

it better than the manual system. Cessna never offered electric flaps in the 185, either, a real blessing in our view. Manual flaps are simply superior for ease of use—get them down or up quickly with no question of flap position. They're also easier to maintain.

Like most Cessnas, the 185 is susceptible to a trim-induced stall on a full-flap go-around. If the nose-up moment isn't dealt with via forward yoke and trim, the airplane's angle of attack will exceed the stall value. It's better to apply partial power, arrest the sink, then go to 20 degrees of flaps before applying full climb power and retracting the rest of the flaps.

A 185 can haul just about anything you can get into it. But the cabin volume is not all that great compared to a Cherokee Six or Cessna 206. There is no way that anything large will go through the 18- by 20-inch baggage door or the two cabin doors of a 185.

On the other hand, the right front door can be removed easily (a mod allows flight with the door off), as can the back seat, but that still doesn't leave much maneuvering room in the cabin for large objects.

The optional fiberglass belly pod is 9 feet long and 14 inches deep and while huge objects still can't be loaded, the pod is ideal for awkward cargo such as chainsaws, tools, skis and fishing gear. (Not to mention the smelly fish.)

INTERIOR, MAINTENANCE

Cessna's marketing photos of the day show interiors with six seats and the airplane was billed as a six-placer. As is typical of such marketing claims, that's a gross exaggeration. Calling the third row "seating" is generous, except perhaps for a child. The seat is limited to 120 pounds and most owners leave it in the hangar, opening more space for baggage.

An option on later 185s was a pair of articulating seats for the front row, with adjustable height and reclining seat backs. The back on the rear seat was split and it too could recline. The seating position is quite upright, with good head and legroom but not generous shoulder room in a cabin measuring 41 inches in width.

Cessna singles have a reputation for being maintainable as well as durable. That's the 185 in spades. It's a derivative airplane, being based on the 180, which was, in turn, a bigger version of the 170. Therefore, Cessna got the flaws hammered out in what was a good airplane from the beginning.

Owners tell us to watch these trouble spots: Tailwheel shimmy can be caused by wear of the bolt that holds the fork to the tailwheel spring. Airplanes with McCauley wheels and brakes aren't as desirable as those with Clevelands, which can be retrofitted.

Mufflers tend to crack after a few hundred hours, so inspect them carefully. Airplanes built before 1981 had trouble with the trim because in cruise, the jackscrew needs 300 foot-pounds of torque to move. This stresses roll pins connecting the trim wheel to the chain drive sprocket. If the pins shear, the trim is stuck. Later airplanes replaced the pins with rivets.

Cessna offered shoulder harnesses as options for all seats in all of its singles after World War II; however, safety didn't sell until the early 1980s and no one ordered them. The good news is that it means retrofitting them is easy; the hard points are under the headliner. From a safety

Rob Duncan says his 1967 "buck eighty five" is the most modified Skywagon flying. When not camping, he puts on the wheel fairings shown in the photo above.

standpoint, especially given the high rate of landing accidents and head injuries to occupants, for the 185, it's a retrofit we strongly recommend.

As Continental engines go, the O-470 and O-520 series have delivered decent service. In many models, the engine installation is at the root of short engine life but that doesn't seem to be the case in the 185. It has a roomy cowl and large cowl flaps, so overheating isn't an issue. Advertised TBO is 1700 hours, which is realistic if the owner is prepared to do a mid-time top overhaul. If the top isn't needed, consider it gravy.

Give Cessna credit for one thing: It has delivered on parts and support, even in the lean years when no piston production was alive. If flown often and worked hard, expect to replace landing gear boxes now and again, plus tailwheel parts.

The Skywagon is a typical Cessna single, so there are plenty of mechanics around qualified to examine one for prepurchase and to maintain it afterward.

Of particular note, however, is the possibility of corrosion if the airplane has ever been on floats, as many 185s have. Check the logs for this history. Like any corrosion, it can be expensive to repair, and it's likely to be there in some form on any aircraft operated on salt water.

MODS, CLUBS

Being a bush and utility favorite, lots of mods are available for the 185, some of them also found on other Cessna singles. STOL kits are available from Horton (www.hortonstolcraft.com) and Sierra (www.sijet.com). We have received complaints from owners on STOL kits on the 185 in which the ailerons are drooped with full flaps resulting in loss of roll control during crosswind landings, possibly due to misrigging causing a lack of up aileron deflection.

Because VGs do essentially the same as a STOL kit without the weight, we would suggest a VG kit from Micro Aerodynamics (www.microaero.com), although a number of owners have installed both STOL kits and VGs.

There are engine and prop upgrades—including the 300-HP Continental IO-550—from Davis Aviation Services (www.davisaviationservices.com) and Wipaire (www.wipaire.com). We've gotten extremely positive feedback from owners on the IO-550 mod on the 185, particularly with the Hartzell Trailblazer prop. There is also the long-range fuel tank upgrade from Flint Aero (www.flintaero.com).

From Tornado Alley Turbo, www.taturbo.com, a turbonormalizing system will allow the 185 to operate in the flight levels. For 185s that do not have the retractable handles on the tailcone forward of the horizon-

CESSNA 185 CALAMITIES: RUNWAY LOC

If there's a spot in the wide world of strange places to land an airplane in which it is physically possible to do so (and take off), we think the odds are good that a Cessna 185 has landed on it. The odds are also, sadly, good that someone has crashed a 185 there as well. Our review of the 100 most recent Cessna 185 accidents and the ways their pilots found to wreck them had us thinking of the ageless quote from the late Hunter S. Thompson: "When the going gets weird, the weird turn pro."

Pilots wrecked 185s nearly everywhere: on glassy-water lakes, hitting power lines, making take-offs in strong tailwinds, but mostly, by losing control on landing and, by only a slight minority, doing so somewhere in Alaska. We're not saying Alaska pilots can't fly 185s, it just seems that there are a lot of 185s in that state and pilots there take them to the edge of their capacity and sometimes beyond.

We'll start with the good stuff. To our amazement, there were only four engine power loss events due to either a mechanical issue or of unknown reason. That's great—for aircraft used in the bush, we're used to seeing on the order of 20 engine power loss events, mostly due to crummy maintenance.

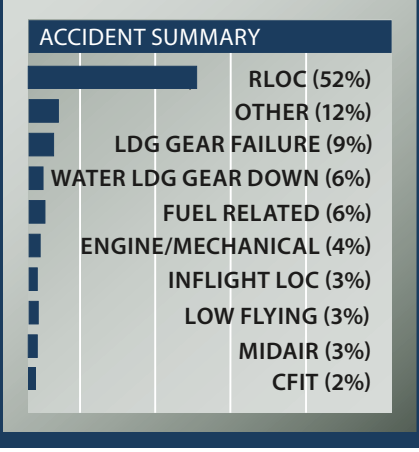
We did see nine landing gear failures—about half were the result of a one-time hard landing or striking an object during skiplane operations. The others were the result of undetected fatigue cracking of some portion of the landing gear leg, usually at the base—inspect regularly.

We think Cessna made a mistake in changing the fuel system from an "off/on" arrangement to a "left/right/both/off" system. When pilots are given fuel tank choices, some inevitably mess up. Of the six fuel-related accidents, one pilot left the fuel caps off of his airplane—otherwise no one ran out of fuel—each just ran a tank dry and either didn't try to change tanks or didn't understand that by leaving the aux fuel pump on they would rich out the engine and it would not run. Not one of the pilots followed the POH restart procedure—which works.

Six 185 amphib pilots landed on the water with the gear down. All of the airplanes flipped. We were pleased to learn that only one of the events was fatal as the proportion of fatalities in such landings in other aircraft tends to be high.

The elephant in the room for such a remarkable utility airplane is the huge proportion of runway loss of control accidents (RLOC), almost always on landing and often following a wheel landing. Many pilots reported losing control just as the tailwheel came down after a wheel landing—right at the time aerodynamic control is deteriorating and there is not yet good rolling control. 185 pilots we spoke with recommended three-point landings so as to touch down with minimal energy and maximum control. If doing a wheel landing, fly final at the same speed as for a three-point landing and touch down so as to have minimal energy to manage on rollout—extra speed is not your friend.

We do have to express our concern for the pilot who decided to land on the airport ramp rather than on the single runway in a blistering crosswind. It was a legal, smart decision. Unfortunately, he still didn't control the airplane well and stuck a wing into a building on the ramp.



tal stabilizer, BAS handles (www.basinc-aeromod.com) will go a long way toward protecting the vertical and horizontal stabilizers and their spars and ribs from damage during ground handling.

Prospective purchasers should join two groups: The Cessna Pilots Association is worthwhile for those who own or regularly fly Cessnas, and the International 180/185 Club is a good model-specific organization.

The latter is more focused on 185s than the CPA and is worth the modest cost of dues, in our view. Cessna Pilot's Association is at www.cessna.org. The International 180/185 Club is at www.skywagons.org.

OWNER FEEDBACK

I've owned my 1967 Skywagon since 1995 and have performed substantial modifications. I operate it from my airpark in mountainous (6400 feet MSL) Colorado.

For any Skywagon owner, several things should be reviewed by a knowledgeable A&P. Here's the short list.

Later models had square fuselage inspection covers just above the leading edge of the horizontal stabilizer. These allow unimpeded inspection of the rudder bell cranks and springs, which often are found to have elongated holes that you can't see otherwise. The alternative is to crawl into the fuselage tail cone. Bulkhead mounting hole cracks can also be better seen. Replacement bell cranks should have bushings installed.

Owners should have these inspection covers fabricated and installed, generally approved via FAA form 337. Cessna stock covers and requisite doubler parts may not be available. Later models also have a square inspection cover at the bottom of the fuselage that allows better inspection and lubrication of the critical elevator trim jackscrew. This also should be installed for more complete, safer inspections.

The D-shaped bulkhead where the tailwheel spring end attaches is known to crack at the upper square corners. Newer models used thicker bulkheads.

Three-piece McCauley main wheels have been known to separate where the six bolts are threaded into the center section. I recommend these wheels be replaced with thru-bolt, Cleveland wheels and brakes,

which are covered by an STC.

The 185 Skywagon came in three categories for float readiness, starting with nothing. From the second level onward, the airframe included a full primer coat of paint throughout the interior, stainless control cables and a V-brace behind the front windshield that keeps the fuselage from flexing with the wings. This is the preferred category. The last level included the fuselage "pork chops" where the floats attached.

As for empty weight specs, most arrived from the factory at about 3300 pounds empty weight and a 1600-pound useful load. The 185s are notorious for gaining weight—mine is no exception. It is amazing what a light stock Skywagon will do for performance. The "commando" bare interior is often seen.

I earned/own the STC for a 285-HP TSIO-520C engine and turbo, taken from a T210, using the T210/206 exhaust manifold and custom turbo mounting bracket, intake cross-over and relocated cabin heater inlet box. This allows easy access to flight level flying, plus additional power at the high density altitudes in my western Colorado neighborhood. I own the STC, but have not applied it to any other aircraft due to liability concerns. This is combined with a 86-inch McCauley seaplane propeller and it's been tested to 28,000 due to the 185's higher lift airfoil.

The hotter-running turbocharged engine in the T210/206 uses a much more efficient cylinder baffling system, although it makes spark plug and other maintenance more difficult. I added "gills" and a Martin Aviation baffling kit, which improved cooling for the normally hottest number-five cylinder by 30 degrees.

My airplane has an STC-approved Oilamatic engine pre-oiler that I use during the first start of every day, and I am sure contributes to my going well beyond TBO. I also use the ADC oil filtration system, change the oil every 25 hours and complete an Aviation Laboratories oil sample check, plus a borescope check done at the same interval.

I also have a Robertson STOL kit for full-length flaperons, combined with both wing and horizontal stabilizer Micro Aerodynamics vortex generators. After the VG installation, roll rate and angle of attack measurements showed a small decrease in stall speed, but a huge improvement in both aileron and elevator control through increased roll rates and angle of attack achieved at low approach speeds. I have a lift reserve/AoA system to ensure the lowest airspeed for achieving the shortest landing distances.

The STC'd XP Modifications 14-inch tailwheel gives a better view over the cowling, plus it's of rugged construction and the big tire rolls over anything.

My cargo pod is a Cessna stock replica built by Aeropod and it has an STC. Unless this is used, you simply can't overload the aircraft. It just doesn't have enough cubic inches of space unless you are hauling liquids. It takes about 30 minutes to install or remove the pod, with most of the time taken up with installing and safety wiring the cowl flap extension hardware. Large cargo pods like mine are only available on the 185 model, but smaller and newer ones are available for 180s. I carry a weight and balance sheet showing all installation configurations of the cargo pod and custom seating.

The best modification I made for passenger comfort is the second-row articulating passenger seating (with headrests) from a C206. This provides passengers more legroom and comfort than most 185s. I never use the stock third-row bench seating.

Bottom line: My Skywagon can fly higher, faster and slower than nearly any others I have seen. My wife and I have flown it all over North and Central America.

Rob Duncan
via email

In the north, the 185 is the local equivalent of a pickup truck. Ours is used to access and supply our lake cabin and our son's trap line. Cargo has included boats, motors, lumber, fuel drums, groceries, furs and moose meat. The airplane is used year-round, operating on Edo 3430 floats in summer and Airglide 3600 wheel skis in the winter.

Conventional gear makes for much easier changeovers from wheels to floats and if you want to run skis, 180s, 185s and Cubs are about the only game in town.

The Aviation Consumer

Cessna 185

(continued from page 31)

Aircraft with training wheels make lousy ski planes, in general.

With the 300-HP engine, performance is good on either floats or skis: On wheels, the thing is phenomenal. Useful load on wheels is typically around 1500 pounds. Usually you'll run out of space before you get her over gross.

We run the McCauley Black Mac 86-inch three-blade prop, which pulls like crazy, but makes an ungodly racket at full 2750 takeoff RPM. When you visit the big-city airports where decibel is a dirty word, best dial her back to 2550. You'll still only need 600 to 700 feet of that 10,000-foot runway. One great performance enhancer on the 185 is the manual flap system.

On floats, heavy loads, glassy water and hot days can conspire to make getting off the water difficult. Even once you're at flying speed, you can't rotate, because the heels of the floats dig in, causing more drag. So, the drill is to get to flying speed and then pull on full flaps. She'll leap right out of the water. You level off, milk off the flaps, build up some speed and climb out.

The 185 is a tailwheel airplane with lots of power, a big billboard tail and springy landing gear. If you are new to tail dragging, doing 10 hours first in a Citabria or a Cub would be money well spent. It will also be worth the effort, because the Skywagon will take you to all the places you can't get to in your Cirrus.

We plan on a block fuel burn of 15 GPH on typical trips of an hour. For 300 HP, cruise speed is nothing to brag about: 130 knots on wheels, 115 knots on skis and 110 knots on floats, all at 65 percent power. However, uptown 185s (without oversize tires, bubble windows and a coat of mud) do much better.

The 185 has been very reliable over nearly 14 years and 2000 hours of ownership. This is despite the fact that ours does a lot of off-airport work and is operated in temperatures down to –40 and below. It's also despite the fact that ours, like most of the breed, spent a lot of years as a commercial bush airplane and was rode hard and put up wet more than once.

Given that these airplanes are now 30 to 50 years old (ours was built in 1966), checking for cracks, wear, tear and corrosion is a big part of the annual. Pay particular attention to the landing gear boxes and the gear legs themselves, especially if the aircraft is operated on skis. It is a sobering sight to watch the airplane take off on skis from rough snow. Those chunky spring steel gear legs will be flapping around like limp spaghetti.

Another potential trouble spot is the pair of jackscrews used to trim the horizontal stab. They need to be lubed regularly, but are hard to get at (and thus ignored) unless you install the service kit that provides access panels in the fuselage. BAS tail handles are another great mod. For float and ski planes, where lower cruise speeds limit engine cooling, the cowl louver STC (available from the 180/185 Club) is also well worth the trouble.

Parts have not been a problem, with good availability from the aftermarket, used part dealers like Skywagon City and, yes, from Cessna, itself. People gripe about wait times and cost on factory parts, but try going to Ford to get stuff for your 1966 F-100!

For a utility airplane, the 185 suffers from two major faults. First, the cabin is narrow and the back seats are tight on legroom as well as width. Big guys in parkas need to be friendly. Second, the baggage door is postage-stamp sized, and the cargo needs to be schlepped in and out through the front doors. This is the one time you will envy your buddy with the 206. Fortunately, the doors and back seats are easily removable. Membership in the International Cessna 180/185 Club and Cessna Pilots Association is highly recommended.

John Faulkner
Whitehorse, Yukon

FEEDBACK WANTED

LAKE AMPHIBIAN

For an upcoming issue of *Aviation Consumer*, our Used Aircraft Guide will be on the Lake Amphibian. We want to know what it's like to own these aircraft, how much they cost to operate, maintain and insure and what they're like to fly. If you'd like your airplane to appear in the magazine, send us any photographs (**full-size, high-resolution please**) you'd like to share to the email below. We welcome information on mods, operating expenses or any other comments. Send correspondence by July 1, 2017, to:

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Email at:
ConsumerEditor@hotmail.com