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The Aviation Consumer®

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The Aviation Consumer

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WANTED: THE NEXT GENERATION OF MOONIACS

That's what Mooney is looking for with its proof of concept M10T, which was on display for the first time at Sun 'n Fun in Lakeland, Florida, this past April. If you're a hard-core Mooney enthusiast, you get it. Mooniacs are a manically enthusiastic bunch and if it weren't for the demand to support the speedsters they fly, the company might not be here today. Mooney was established in 1929 and cranked out over 11,000 M-series aircraft.

Frank Crawford, Mooney's manager of technical resources, told me that for a while he was one of only nine remaining employees at the company's now newly renovated headquarters located in Kerrville, Texas. Anyone that has worked with Crawford on the tech support level will recognize his dedication to the brand name, even when there was a dark cloud over Kerrville.

Today, the employee count has grown to almost 150 as the company ramps up production of the $700,000 Acclaim and the $650,000 Ovation 3. But in a market faced with rapidly changing demographics, stiff competition from Cirrus, a growing refurb market plus a new breed of younger pilots who demand more modern designs, I think it's unlikely the Ovation and Acclaim can be Mooney's staples for long-term success.

Enter the new M10T and M10J models. These are clean-sheet designs, engineered at Mooney's new Chino, California, location and evidence that Mooney's new owner—China's Meijing Group—recognizes the need for models that can appeal to a younger generation of pilots. Judging by the reaction at Mooney's lively display at Sun 'n Fun, the eye-catching M10-series interests these budget-sensitive, tech-savvy younger pilots. More than one told me they have their sights on used Cirrus models because of the modern styling.

With a vertical tail section that's unmistakably Mooney, the composite M10 has lines that look more like a Cirrus than a Mooney, plus a spacious, snappy and well-appointed interior that could easily be at home in an ultra-modern high-end sports car. While some older Mooney pilots were thumbing their noses at the M10 for being another one of those "plastic airplanes"—and seemed more interested in the Ovation 3 on display—younger pilots were definitely feeling the M10's youthful vibes, which will be available as a fixed-gear trainer (M10T) and also as a retrac, labeled the M10J. Both models will be powered by Jet-A-burning and FADEC-contolled Continental diesel engines. The aircraft on display was equipped with Garmin's G1000 integrated avionics.

Mooney pilots enjoy healthy amounts of speed and efficiency, and while the M10-series hasn't flown yet (the company hopes to have a flight test program underway this summer), a rep told me the M10J should follow the lead of other Mooney models. With a 155-HP Continental CD-155 and retractable gear, the M10J is expected to cruise in the 160-knot range. The two-seat M10T (the proof of concept on display had a third-seat option) with a smaller 135-HP Continental CD-135 engine is expected to cruise in the 130-knot range.

Mooney CEO Jerry Chen said that M10 manufacturing will likely be spread out between multiple locations, potentially teaming the Kerrville, Texas, facility with the one at Chino, California, in addition to a factory to be built in China. Chen said that the established United States market has shown great interest in the M10 aircraft. Moreover, he hinted that the established Mooney brand means the new M10 might have a better market potential (or at least be easier to launch) in Western markets than it initially might in China.

Of course, the M10's market success rides on price, which hasn't been announced. I don't know how much a new breed of Mooniacs are willing to pay for it, but based on those I spoke with, it has their full attention.—*Larry Anglisano*

HID LIGHTING REPORT

I read the HID article in your May 2015 issue and thought your readers might be interested in my real-world experience with HID lamps.

I wanted to purchase HID landing lights back in 2006 for my Mooney M20K, but there wasn't an available STC. The lights Knots 2U offered were less expensive than the others I could find, and they were willing to work with me to get a field approval.

My shop referred to their STCs for Cessna and Piper when we sought the field approval.

The warranty was five years or 5000 hours of bulb life, whichever comes first. I keep the lights on whenever I am flying. Just beore the five years was up, one ballast failed. Knots 2U replaced it under the warranty.

About a year later, the other ballast failed, and it was also replaced at no charge, even though it was out of warranty.

I worked with my local A&P to replace that ballast and I noticed that the new ballasts were a different brand than the original ones. Perhaps they will last longer.

The unusual thing I did was replace the two landing lights (10-degree beam width)—both in the nose of the cowling—with HID taxi lights (30-degree beam width.) I wanted the wider beam because my problem with night flying was not landing, but it was finding those pesky taxiway exits from the runway.

I had the new lights adjusted as far outboard as possible. They still overlap some in the center, but they also show the edges of the runway well.

I'm an engineer and naturally tested this setup before installation. The part of the beam where the original landing lights were aimed was brighter than before, plus the side lighting is much better.

Jerry Badger
via email

After reading many articles about LED landing lights, and Paul Bertorelli's article on LED versus HID lights in your May 2015 issue, I decided to take the plunge and convert all the external lights on my 1980 Cessna 210 to LED.

I concluded that the Teledyne Alphabeam and the AeroLED landing lights were the best and ordered one of each to compare on a dark night. My admittedly subjective conclusion was that they are both extremely good, very bright and any differences were subtle.

The outcome of the tests in Paul's article do not jibe with what I saw with my own eyes. I wonder if the AeroLED appeared brighter to the luxometer due to a narrower beam. I preferred the wider spread of the AlphaBeam.

I disagree with the notion that the more LEDs in a light, the brighter it is. There are many factors at work, including the driver circuits, reflectors and heat sinks, but in the end, an LED's brightness is a function of power input and heat dissipation. I think for this application, the size of the PAR 36 receptacle limits the heat sink and the manufacturers have decided that 45 watts is about it. If you want something more than this, have an unlimited budget and want to make a statement, get an HID landing light.

In my subjective tests, the AlphaBeams were superb. I don't know how you could evaluate the lights any differently, other than installing each light in the same airplane and doing a few night takeoffs and landings and asking pilots and passengers their opinions. There are so many variables—taxiing, seeing the runway and visibility from other airplanes. I'm very happy with my Alphabeams and they were cheaper than two Aero LEDs, plus I think the wider spread makes my plane more visible at night.

Peter VerLee
via email

The data is the data. In three separate rounds of testing, the brightness numbers varied slightly, but the directionality was always the same and predictably repeatable. Although it's true that more LEDs don't necessarily equal greater brightness, that was definitely—and measurably—the case for these products. We stand by the conclusions. We'll have a video out shortly showing these results.

CHAMPION SPARK PLUGS

I read Larry Anglisano's Champion spark plug update in the May 2015 issue of *Aviation Consumer* with interest. For many years I used Champion spark plugs in my autos and in my airplanes. About 20 years ago I started getting faulty Champion plugs right out of the box, while the ones in service were failing at an unusual rate compared with ones used in earlier years. Something changed—who knows what—but they are not the same. I no longer use any Champion plugs and haven't for years.

Gus Causbie
Ash Flat, Arkansas

continued on page 32

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INDUSTRY ANALYSIS

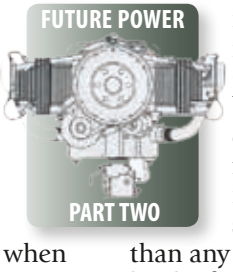
Inside Rotax: Leveraged Technology

Rotax builds aircraft engines, but its ethos is recreational engines. Its mass-production economics trickle down to lower-volume airplane powerplants.

by Paul Bertorelli

Even though Rotax builds 215,000 engines a year, on the aviation side, it's largely one-at-a-time bench work, above.

While companies are defined by what they make, what they decide *not* to make can be just as distinguishing as the product catalog. And that would be the case with Rotax, the Austrian engine giant that all but owns the light-sport engine market. But a decade ago, flush with success, Rotax drew back from an expensive project to take on Lycoming and Continental with its own six-cylinder engine.



On a recent visit to Rotax's Gunskirchen, Austria, factory, when I asked why it bailed on the big engine, the guarded answer was to the effect that Rotax is a company that knows what it's good at and building high-horsepower engines isn't it, at least not yet. The market wasn't ready for a new competitor.

Through a combination of happenstance, geography and savvy marketing, Rotax has positioned itself in a market segment in which Lycoming and Continental have a presence, but not much developmental energy: the low-horsepower, four-cylinder segment. That it understands how to build such engines perhaps better than any other company is evidenced by the fact the company's aviation division is a tiny appendage on a giant factory that builds a dizzying variety of recreational engines for the marine, ATC, motorcycle and snow machine markets. A *lot* of engines. The factory builds more than 215,000 engines a year, 35 times the combined output of Lycoming and Continental. But only about 3000 to 4000 of those are aircraft engines. As a result, it is a far different business than its U.S.-based competitors, which are legacy companies whose survival depends on careful, targeted reinvestment as described in the February 2015 *Aviation Consumer* profile of Lycoming.

ACCIDENTAL AVIATION

Rotax's Gunskirchen factory is located in an industrial corner of Austria noted for steelmaking, but also for KTM's modern motorcycle factory and Steyr, which builds diesel engines in a town of the same name. Like Lycoming, which once built bicycles and sewing machines, Rotax has bicycles in its history, too. Its very name is derived from rotating axle, a free-wheeling hub for a powered bicycle it manufactured a century ago. An example lives

in a glass case in the company lobby, overshadowed by the cutting-edge motorcycle and snow machine engines Rotax makes today.

And snow machines are how Rotax got into the aircraft business. In the late 1970s, as snowmobiling was taking off, Rotax, then owned by Bombardier, whose founder, Canadian Joseph-Armand Bombardier, essentially invented the archetype, had a brisk two-cycle snowmobile engine business in hand. But they noticed something curious. Many more of these engines were being shipped to North America than forecast replacement cycles suggested. A little sleuthing revealed that Rotax snowmobile engines were being adapted to power ultralight aircraft, a trend that eventually morphed into the Rotax 447, the 503 and the 582, all two-stroke, geared aircraft engines, many of which are still flying.

Although the North American ultralight market proved short legged, Europe was another matter entirely and Rotax could see that the industry was on the verge of developing a swarm of light aircraft that were more like real airplanes than the rag-and-tube kites most of us think of as U.S.-style ultralights.

That meant a market for higher horsepower, lightweight engines and thus was born the four-cylinder Rotax that has evolved into the 900-series engines that dominate the light sport segment and that also own a respectable piece of the experimental market. When I was in Austria last summer, Rotax was celebrating 25 years of producing these engines and they threw a big party for the 50,000th four-cylinder to come off the assembly line, a 912 iS with fuel injection and electronic ignition.

DIFFERENT STROKES

When Rotax four cylinders first appeared in quantity in the U.S. in the Diamond Katana 20 years ago, they were the brunt of many a joke about chainsaws and snowmobiles, the fruit of a distinct exhaust note that isn't anything like a Lycoming. The ultimate insult: They aren't "real" aircraft engines. That was given some credence by the Katana's lukewarm performance with the 80-HP 912; it yielded anemic climb in the lightweight Katana and had a reputation for cooling problems. Frustrated with Rotax, Diamond turned to Continental's IO-240, a conventional aircraft engine that buyers and schools liked. But Rotax's stumble was a North American thing; most of the 912-powered A1 Katanas were shipped to Europe, where they're prized for fuel economy.

Rotax is heavily invested in state-of-the-art automated machining centers and robotics, right and bottom. These are used for many aircraft engine parts, reducing costs and increasing quality. Got a Johnson or Evinrude on your boat? BRP Powertrain made it, center.

Rotax never looked back. It continued to build and develop the four-cylinder line, introducing the 100-HP version of the 912, the 115-HP 914 and, more recently, the 912 iS and iS Sport for the light sport and experimental markets. When asked if this development arc means larger four cylinders or even a resurrection of the six-cylinder in the future, Rotax's Francois Tremblay, head of BRP Powertrain, was cagey. "We're not a company that stands still, typically. We're all about innovation," he said.

RECREATION AS BUSINESS

There's little doubt that Rotax has the resources to develop any engine that might find a ready market, nor does the company insist on swing-for-the-fences volume. Its entire aviation division produces about the same number of total engines (new and overhauled) that Lycoming and Continental do, but with an emphasis on new manufacture. Like every other aviation business, its business plan assumes small volume. It took two years to sell 500 of the expensively developed 912 iS and Christian Mundigler, the company's chief aviation engineer, told me that in pitching the iS project to senior management, he envisioned at least a 20-year product cycle. Rotax's long view of the market isn't the only way it differs from companies

Rotax engines have a multi-piece pressed-together crankshaft, top. For balance, pistons are weight matched within two grams, right. Most fasteners are torqued with electric wrenches and the values permanently recorded in the engine's data file for QC.

plying the aviation universe in the U.S. Following its sideways entrance into the aircraft engine business, Bombardier CEO Jose Boisjoli was famously quoted as saying he didn't understand much about aviation, but he clearly appreciated the passion of those involved in it. This may be the reason that the sign out front still says BRP Powertrain, for Bombardier Recreational Products and why Rotax considers itself a recreational engine company, not an aircraft or motorcycle engine company.

That's more than just marketing piffle, for Rotax is rapidly responsive to the wishes of its customers, who are largely builders of gasoline-powered recreational toys, not airplanes, cars or trucks used in commerce. Although it retains Bombardier on the sign, Rotax is now an independent company, having been divested by Bombardier in 2003. But Bombardier happens to be Rotax's largest single customer, so the two remain joined at the hip.

Bombardier's considerable appetite for snowmobile, ATV and watercraft engines has built and sustained a state-of-the-art manufacturing facility, of which the tiny aviation division is a major benefactor.

While Lycoming and Continental subsist on demand for legacy aircraft engines and some new manufacture, Rotax is the reverse. It builds a variety of engines in all power ranges for motorcycles, ATVs and personal watercraft, both for itself and other companies. The BMW 800GT motorcycle I rode to the factory last summer had an engine built in Gunskirchen. When I toured the plant, I saw a production cart stacked with the very same vertical twin engine cases.

Rotax executives told me the company is able to leverage the high-volume recreational engine business to support both development and manufacture of aircraft engines. While Lycoming and Continental have invested carefully to upgrade their dated manufacturing capabilities, Rotax has latest-generation *everything*; there's not a manually operated mill or lathe in sight. The factory is more vertically integrated than U.S. manufacturers tend to be. Although it does no primary foundry or forging, many specialized processes such as heat treating and surface treatments are done in house, both because the economics are better due to Rotax's high volume and because the company believes they have better control of quality if they rely on fewer vendors. A tour of the factory floor reveals acres of automated CNC and some robotics operating without a human in sight.

After a fashion, Rotax even builds its own humans. Following the European tradition of apprenticeship, Rotax runs an in-house trade school from whence it hires the best graduates for its own factory. I was told that the company sees this as both an investment in its own interests and in the wider social good, since those apprentices are free to work elsewhere.

FACTORY WITHIN A FACTORY

Rotax occupies a complex of buildings on the Gunskirchen site, with the aircraft engines built in what's known as Building 1, the original structure that housed the company when it moved there in 1947 from another site in Austria after having been in Germany before that. The main factory contains most of the parts-manufacturing capability and amidst the clatter and hum of machinery, two moving assembly lines turn out as many as 300 of the aforementioned recreational engines a day. From parts bins to an engine ready for a brief test run requires about 90 minutes, typically.

By contrast, the aircraft engine assembly area is as quiet as a library and probably smaller than most that might be found in a medium-sized city. Rotax follows the typical convention we've seen in other aircraft engine plants, notably Continental's diesel engine works at St. Egidien, in the former East Germany. (See *Aviation Consumer*, August 2014.)

All of the engine plants we've visited use an assembly line of sorts and Rotax is no different. Engines are assembled from the inside out, starting with a crankshaft placed into the case, along with the camshaft. Subassemblies such as the oil filter bracket, the gearbox and clutch mechanisms and cylinders are built up on compact work benches surrounding the line, which is only about 30 feet long. The engines are passed along to several assemblers on a traveler rail system.

While the assemblers on the mass production side are journeyman workers, only the elite work in the

aviation division. "Only the best can work here. Everyone wants to work on the aircraft side," Mundigler told me. The assembly work is far from rote; it requires the skill to measure, analyze and use discrete tools and processes. Rotax recognizes this and gives the aircraft assembly staff one 10-minute break per hour, while in the main factory, it's three breaks per day.

For quality control and traceability in assembly, Rotax uses two methods: computer monitoring and so-called four eyes. A program called Filemaker stores a virtual engine as a master.

"We build the engine in reality and in the Filemaker system," Mundigler explained. "When he is ready and he hands the engine to the next guy, he has to check off to see everything is done." The file stores the primary torques and tightening sequences and traces every part installed. That data lives with the serial number for the life of the engine. For those processes that the computer can't track through tool monitoring, a second assembler claps eyes on the work and checks it—the "four-eyes" method. In addition, incoming parts are subject to inspection, some at 100 percent, such as pistons, and some through statistical process control.

After final dressing, the aircraft engines are shipped off to the test cells for trials. They're run for 50 to 90 minutes, depending on the model and whether the engine is certified or not. The major bottleneck in production is obviously the test cells, even in the low-volume aviation side. If a dozen engines trickle off the line a day, the cells have to run multiple shifts to keep up. On the mass assembly side, the engines run for just a few minutes. Nonetheless, the factory burns more than 1000 gallons of gas a day just testing engines—seven days a week. It recovers that otherwise lost energy to produce nearly half of the plant's electricity. Lycoming, by the way, is also practicing heat and energy recovery. In the competitive world of modern manufacturing, they don't exactly have a choice.

ROTAX FUTURE

Two-and-half years ago, Rotax surprised us with the introduction of the 912 iS, which represented a significant investment in what's hardly a bull market. That leads us to believe Rotax has something up its sleeve developmentally. "When you look at the future, people want more power. The industry is going toward four-seaters. So that's something we're looking into now, what should be our next level? We're looking at various options," said Francois Tremblay. It's easy enough to see the marketspace, if not to pencil out a business case. A 160-HP four-cylinder that weighs 75 pounds less than a Lycoming IO-320 or -360 might just find a niche. But to do that, Rotax might have to overcome whatever demons kept it from launching that V-6 a dozen years ago. Then again, it didn't notch out more than seven million engines by being too afraid of failure.

THE BIG ENGINE THAT DIDN'T

At Lycoming, executives roll their eyes when they hear "Lycosaurus" used to describe the lack of innovation in aircraft power plants. That suggests that the market hungers for engine innovation, but the reality is something different, as Rotax discovered in 2006.

With a great deal of marketing flourish, orchestrated by the Bombardier Canadian mothership, the company announced the future of aircraft engines in 2003: Two innovative V-6 designs, one at 225 HP and a second at 300 HP. True to the Rotax philosophy, these were small-displacement, high-revving, geared engines with overhead valve gear. They were watercooled and had both fuel injection and electronic ignition, just as the four-cylinders now have.

The engines attracted a lot of attention, including from us. Rotax spun off the project to a marketing entity called Aircraft Engine Services, which rebranded the product as REV, reflecting the engine's operating envelope.

Two years into the launch, the project was clearly struggling and wasn't supported the way we've seen Rotax do product launches since then. At AirVenture 2006, this was our take on the engine: "AES says it has an OEM customer for this engine, but for more than a year has steadfastly refused to say who the airframer is, claiming the company is worried about overhanging the market and losing sales. Call us skeptical. A couple of OEMs we talked to at AirVenture like the looks of the Rotax engine but wonder if it has enough benefits over a Lycoming or Continental to justify the certification costs. AES may yet prevail, but we think they have an uphill struggle."

Within three months, the project was cancelled, the victim of both market realities and of new management who understood the company's core focus was recreational engines, not aircraft engines. At this juncture, Bombardier had divested itself of direct ownership of Rotax, allowing the company to branch out and sell to other businesses.

During my visit to Gunskirchen last year, I was surprised to learn how far along the project actually got. The production tooling was in place, tested and ready for use. Spare parts, support and training were being arranged and at least one of the mystery OEMs was Cirrus. Alan Klapmeier told me the company was ready to move forward when Rotax pulled the plug.

Could it have succeeded? I think the odds were long, a view shared by some at Rotax. New engines have teething pains and two years after Rotax bailed, the bottom dropped out of general aviation, once again. The V-6 engines missed on a couple of marks.

They still required 100-octane fuel and were more complex than traditional air-cooled aircraft engines, a complaint the four-cylinder engines suffer yet today. They were also relatively heavy. My guess is that Rotax figured this out and did what so many failed aviation companies have not: They killed the project.

Vacuum Pump-411: Continually Improving

Design improvements in dry vacuum pumps mean longer times between failures, if the vacuum system is maintained. A wet pump is a good alternative.

by Rick Durden

While glamorous glass cockpits are probably the wave of the future, in the real world the vast majority of airplanes still sport round-dial panels with gyros spun by air pumps that either suck or blow. We tend to collectively call them vacuum pumps, although on most Beech aircraft they are pressure pumps. No matter the appellation, they are turned by the accessory drive of the engine.

We only seem to pay attention to the air pump in our airplane when it fails—and unless we have a low vacuum annunciator light on the panel, we may not notice for some time, which can have ugly implications as the air-driven gyros spool down. After a spate of loss of control accidents in the 1980s blamed, at least in part, on inflight, in-clag failures of air pumps, a lot of attention was paid to that accessory and much effort went into improving their reliability. From what we can see, the efforts were successful, at least in part.

Nevertheless, when an air pump fails, it's almost invariably in flight. As aircraft owners, what can we do to extend the life of our vacuum pump and what are our options when it's time for replacement?

BACKGROUND

Vacuum pumps were developed in the late 1930s—prior to that air-driven gyros were spun by suction from a venturi attached to the side of the fuselage. That meant the gyros didn't even start spinning up until sometime well into the takeoff roll, making low-altitude entry into the IMC more than a little sporting. A vacuum pump solved that problem, and gave more suction than a venturi could provide. The first pumps were "wet," the interface between the carbon vanes and the interior of the metal housing or stator of the pump was lubricated by oil.

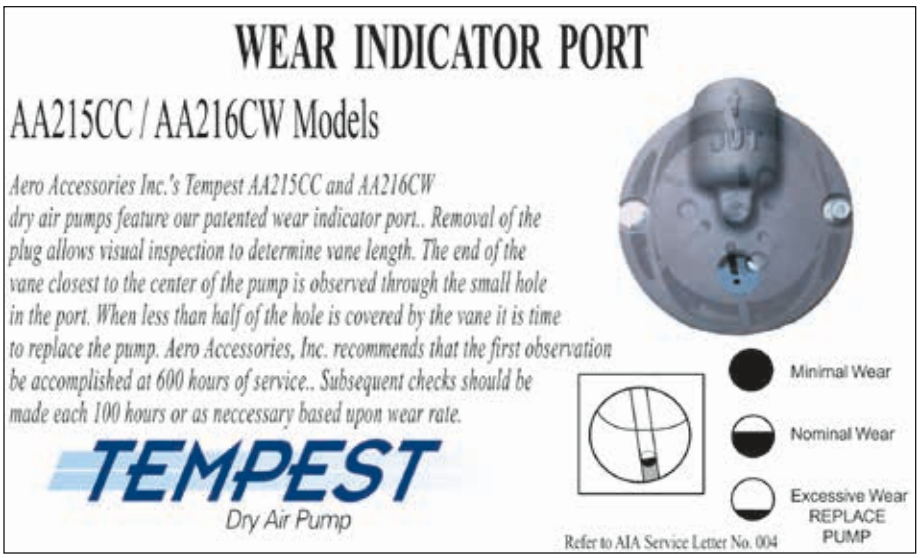
Wet pumps proved reliable, usually lasting through TBO of the engine. The downside to that was they were relatively expensive and because some small portion of the oil lubricating the vanes constantly

CHECKLIST

- ⊕ Improvements to dry air pump design have extended their lives.
- ⊕ A wet pump is a longer-lived option for replacing a dry pump.
- ~ We recommend some type of backup system for single-pump aircraft.

Healthy dry air pump, left, showing graphite vanes angled in carbon rotor. When an air pump fails, its rotor and vanes often shatter, as seen below.

When the vanes of a dry air pump wear far enough, they cannot remain in the rotor and will break, destroying the pump. Aero Accessories/Tempest developed the wear indicator port, above right, allowing removal of a screw to view the vanes and assess their condition. On other pumps, a port on the side allows using a calibrated tool to check on vane wear, below right.



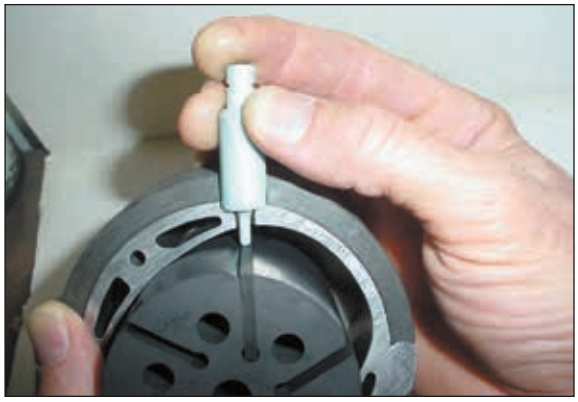
exhausted overboard with the air being pulled through the pump, they left a fine mist on the belly of the airplane. While the amount was often small compared to leaks in the engine itself, there was a perception they were messy and some owners paid for an add-on air-oil separator to return the exhausted (and potentially contaminated) oil to the engine—something we don't recommend.

Dry air pumps debuted in the 1960s and effectively put wet pumps out of business. Lighter and about half the cost of wet pumps, dry pumps used vanes that were made of graphite, which provided lubrication by slowly erasing themselves and leaving a fine layer of dust between the vanes and stator.

The downside is that the thin rectangular vanes (usually six), which move freely in the slots of the central rotor and are held against the stator by inertia as the rotor spins, will eventually wear down to the point where they are too small to stay in position. One will then break into pieces and the pieces will rapidly destroy the rest of the vanes (and rotor), causing catastrophic failure of the pump.

Because of the nature of the design, there is no warning of impending failure—vacuum pressure does not drop as the vanes wear.

Most dry pumps have a carbon or graphite rotor and graphite vanes. Because those materials remain dimensionally stable with temperature changes—and air pumps get very hot in operation—they are excellent for operating efficiency. The tradeoff is that a small piece of foreign material or any liquid can have devastating effects. In our interviews of pump makers and maintenance shops, a common theme we heard about dry pump life was the need to do some preventive maintenance to allow them to last as long as possible.



When washing the airplane and engine, make sure no liquid gets into the pump—it will turn the graphite dust to paste fairly quickly and destroy the pump. Teflon tape should not be used on pump fittings, pieces break off and get into the pump. The vacuum system filters should be replaced at the annual or at 500 hours (main filter) and 100 hours (other filters) of service, whichever comes first.

We learned that one of the most common cause of pump failure is FOD from the vacuum system hoses located under the instrument panel. Scott Utz, president of Arapahoe Aero at Denver's Centennial Airport, said that his shop often sees 30- and 40-year-old airplanes that have never had the vacuum system hoses behind the panel replaced.

If the filters get plugged, the pump has to work harder and fails sooner. Utz told us that if you suddenly start having air pumps fail, the problem probably lies in the system, not with the pump. On de-iced airplanes, it's not uncommon for the regulator valve to malfunction, causing a constant load on the air pump, which can dramatically shorten its life.

One of aviation's old wives' tales is that you'll wreck your vacuum pump if you move the prop backward. Fortunately, that's not true. While most vacuum pumps are unidirectional—they either turn clockwise or counterclockwise in service based on the direction of rotation of the accessory shaft on the engine (and have CC or CW as a suffice to their model number)—it takes more than a few turns in the wrong direction to cause damage.

Vacuum pumps come in two sizes, and are referred to as 200- or 400-series. A 200-series pump will run two gyros—that's it. If your airplane has anything more than that, such as an inflatable door seal, copilot gyros and/or de-icing boots, a 400-series pump is necessary.

One of the smartest safety developments in the world of dry air pumps has been the viewing port invented and patented by Aero Accessories for its 200-series Tempest line of air pumps. Removing a small screw allows you to look into the pump and see how long the vanes are—and how far they've worn down. A published wear guide

THE WET PUMP ALTERNATIVE

After the dry air pump put wet pump makers Pesco and Garwin out of the business, those who used them relied on overhauled pumps. Then, in the 1980s, dry pumps got vilified, and interest in wet pumps returned. Airwolf, known for its line of oil filters, obtained the Pesco data and some of its manufacturing equipment, updated the design, received the necessary certification and started selling wet pump replacements for all 200- and 400-series dry pumps.

Head of production at Airwolf, John Quest, explained that, with oil lubrication, wet pump tolerances are tighter, the vanes are four times as thick as on dry pumps and are bidirectional. While heavier than a dry pump, Quest said that the Airwolf pump is nearly impervious to FOD and requires no maintenance. "Just run it," was Quest's response to our questions about maintenance: "Pieces of rubber from hoses go right through it."

Airwolf stands behind its pump—its warranty is 10 years or 2000 hours of operation. Its advertising claims that an Airwolf wet pump is cheaper than using a dry pump over the course of engine TBO, assuming that a dry pump will have to be replaced every 500 hours and one wet pump will go the distance—plus it asserts that there's no need for a backup system to power the gyros.

Price for either the 200- or 400-series replacement pump is $1599. We saw overhauled prices starting at $479. The Airwolf pump is STC'd for virtually all aircraft.

There is a school of thought that asserts that when using a wet pump, an air-oil separator is needed to keep oil off of the belly of the airplane. We do not share that opinion—the amount of oil mist coming from the pump is small—and are uncomfortable with the idea of returning waste oil, and the contaminates in it, to the engine.

describes when it's time to take the pump out of service and have it overhauled or replaced. Tim Henderson, owner of Aero Accessories, told us that he felt that the wear indicator port (WIP) was an important safety development for dry pumps, so his company licensed the patent to other manufacturers for well under $10 per pump—in our opinion a very low royalty price in the world of aviation.

We strongly recommend that if you are buying a 200-series dry rotary vacuum pump, new or overhauled, it should be one with a wear indicator port. While it will not protect against pump failure due to FOD, it will let you know when it's about to wear out and fail.

NEW OR OVERHAULED?

Wet and dry air pumps can be overhauled by specialty facilities or most manufacturers (not in the field). In general, overhauled units are less expensive than new ones, but come with a shorter warranty. We do not have recommendations one way or another except for de-iced twins. Because 400-series pumps do not last as long as 200-series, the de-icing system places a significant load on the pumps—further cutting into their life expectancy—and because overhauled pumps are less expensive than new, we think it makes sense to go with overhauled pumps in that application.

WHAT'S AVAILABLE NEW

Aero Accessories began overhauling dry pumps in 1987. Shortly after 2000, it came out with its own Tempest line of 200- and 400-series pumps. Tim Henderson told us that the idea of not being able to inspect a pump and running it to failure made no sense to him; it was too much like running a tire until it burst. As a result, he came up with the wear indicator port now available on most 200-series dry pumps. In addition, the Tempest line of pumps incorporates cooling fins that double the surface area of the pump housing, allowing it to run cooler, lengthening its service life. The company also spent a great deal of time redesigning the complex series of curves on the inside of the stator so that the vanes travel outward slower than inward and they remain loaded in compression at all time, minimizing bending loads.

Henderson said that historically, one of the worst culprits for pump failure was oil leakage into the front of the pump. That area was redesigned so that any oil leaking around the engine accessory drive seal drains overboard and not into the pump—which caused oil-related failures to drop by a factor of 20, according to Henderson. Finally, the rear portion of the case was redesigned so that it will not shift and potentially bind the rotor should someone working on the engine inadvertently grab onto and pull or push the vacuum pump.

Henderson told us that the life expectancy of Tempest 200-series pumps has gone from 600 hours to the 700-800-hour range. It's slightly less for 400-series pumps.

Tempest lists prices for its new 200-series air pumps at $1129.80 and 400-series at $1580.74. Overhauled prices for the 200-series range from $418.88 to $724.90; and 400-series from $970.14 to $1039.60. The warranty offered on wear indicator port-equipped pumps is three years or 1300 hours; one year or 500 hours on all others. Based on our survey of websites of various vendors such as Aircraft Spruce, the street prices for new and overhauled Tempest air pumps is on the order of 20 percent less than retail prices listed by Tempest.

Rapco began overhauling dry air pumps in 1981 and now offers a full line of new and overhauled pumps, along with a number of other products for general aviation aircraft. Mike Gaulke, director of sales, told us that as the company shifted from simply overhauling existing pumps to making new ones, it continuously improved the pump design and life with such features as an oil seal on the main shaft to reduce the risk of

DITCH THE PUMP ONCE AND FOR ALL—MAYBE

When a high-priced avionics retrofit produces a panel that's completely electrically driven, the natural question is: why retain the vacuum system at all?

While pneumatic de-ice boots will still require a pump, simpler aircraft with all-electric flight instrumentation (including electric backup instruments) simply don't need a vacuum system. But, is it legal to remove the pump and the plumbing that tags along? The answer should be simple, but it isn't.

We asked a few avionics shops how they approach all-electric upgrades which all but send old-school vacuum instruments to the trash bin. Like most gray-area regulatory matters, there were some differing opinions.

Chris Girman at CE Avionics in Sanford, Florida, told us his shop sees the vacuum system in some aircraft as an optional accessory. The keyword is "some," because in others it might be required by the original type certificate.

A tech at VIP Avionics in Hartford, Connecticut, pointed out that you need to look carefully at the required equipment list for the aircraft. For example, on many Garmin G1000-equipped Cessna models, the vacuum system is listed as mandatory equipment, while on other models it's listed as optional equipment.

On the other hand, CE's Girman reasoned that removing all of the vacuum-driven instruments and replacing them with approved electrically driven ones renders the vacuum system useless. Since it's not connected to anything, it doesn't need to be there. Girman cautioned about carefully following the STC for the new equipment being installed. As he noted, the STC for primary systems like Garmin's G500 and Aspen's PFD system specifically provide for secondary backup instrumentation as a failsafe to electrical failures—and for failure of the display itself. But even that requires some interpretation that's best left to the shop that's signing off the installation.

For example, Aspen's Evolution PFD installation manual requires a standby attitude indicator with a separate power source (among other things), but it doesn't need to be original equipment.

The early 1960s N35 Bonanza in the photo is an example. Its Aspen PFD (equipped with a backup battery) is backed up with an approved Mid Continent Instruments LifeSaver electric attitude gyro that's also backed up with an emergency battery.

The point is, planning a vacuumless retrofit for failures is just as important as complying with FAA regs.

—Larry Anglisano

oil contamination and an inspection port to observe the condition of the vanes. He also pointed out that by placing the vanes at an angle—which requires that the pump turn only in one direction—they can be made longer and thus last longer than if they are perpendicular to the stator/pump housing.

Rapco recommends replacing vacuum system hoses every six years. Gaulke said that with regular hose and filter replacement, flight schools that are using Rapco pumps report that the pumps are successfully running to engine TBO.

Rapco offers a three year or 1300-hour warranty on its new 215- and 216-series pumps and one year or 500-hour warranty on its other new pumps. The warranty on overhauled pumps is two years or 1000 hours on 211-, 212-, 215- and 216-series pumps and one year or 400 hours on all others.

Rapco does not publish prices on its website—our survey of vendors revealed that prices for new 200-series pumps started as low as $325, with overhauled starting at $237; for new 400-series pumps we saw prices starting at $820.00 and overhauled prices starting at $612.00

Sigma-Tek takes a slightly different approach to a dry air pump—while theirs can be used for suction or pressure, it is nonetheless bidirectional—it can be mounted on any engine, no matter which way the accessory shaft turns.

The pump uses an aluminum rotor and stator with carbon-carbon composite vanes that are designed to wear more slowly than graphite vanes. They are mounted perpendicularly to the stator, allowing rotation in either direction. According to Sigma-Tek, the aluminum rotor makes the pump more resistant to FOD or engine oil. It is not designed for supplying air to de-icing boots.

The warranty is for two years or 1000 hours of operation. We did not see any indication that anyone is overhauling and selling the pumps. We saw prices, new, as low as $629.

CONCLUSION

When you need to replace a vacuum pump, there's a wide selection available, new and overhauled. Dry pump quality and life has improved, and we like the wear indicator port that, we think, will help determine when to replace the pump before it fails. If you have use a dry air pump, proper maintenance of the vacuum system is essential, including regular hose and filter replacement. No matter what sort of pump you have spinning the gyros, we think it's wise to have some a satisfactory backup that will allow you to keep the airplane upright when the pump goes out—because at some point, it will.

SkyVision Salus-3: Portable ADS-B Out, In

At $1100, the SkyVision Salus-3 could be the ultimate ADS-B solution the market has been waiting for, but only if the FAA gives it the regulatory nod.

by Larry Anglisano

CHECKLIST

- Forward-thinking design and inexpensive price point makes it a worthy interim solution.
- Salus-3/ Xtreme Vision software interface is limited to Windows OS.
- Lack of certification, particularly its GPS engine, could hinder mandate approval.

Let's play regulatory devil's advocate, shall we? The SkyVision Xtreme Salus-3 portable ADS-B transceiver is nearly the perfect solution for the most basic aircraft. It's packaged in a durable portable housing, it has internal WAAS GPS, it can work with popular tablet apps, can run off its own battery, it doesn't require a pricey installation and it can be carried from one aircraft to the other. Best of all—at $1099—it's priced less than a high-end ANR headset. But without TSO 154C approval, it's still considered another piece of glareshield candy.

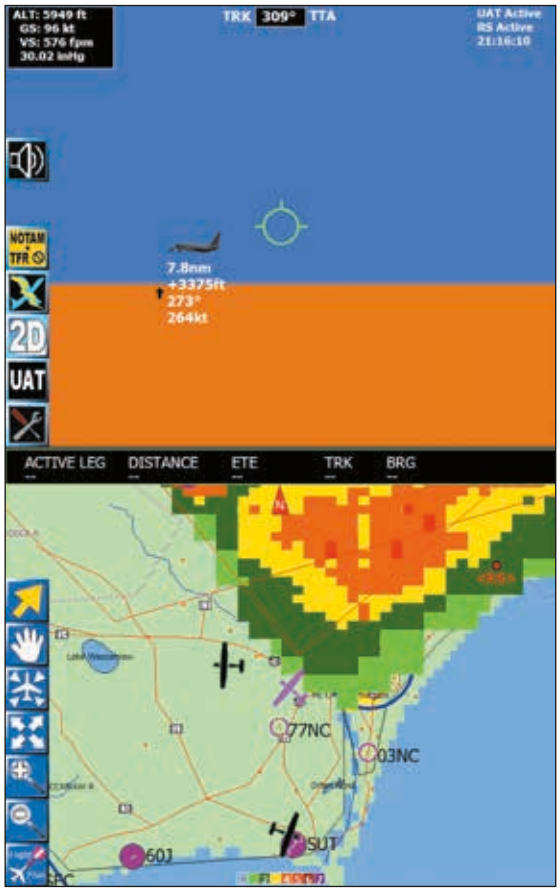
The snag? Its portable design means that winning TSO approval for mandate compliance in certified aircraft might be impossible. On the other hand, it can be argued that since the FAA's original ADS-B Out rule is performance-based, compliant solutions aren't limited to permanently installed equipment.

That's why we think the SkyVision Salus-3 system has potential, since it would likely take another ADS-B rule change to definitively prohibit portable ADS-B solutions, even if they meet TSO 154C performance standards. Let's take a closer look at the Salus-3, a device that SkyVision says meets that standard.

FILLING A VOID

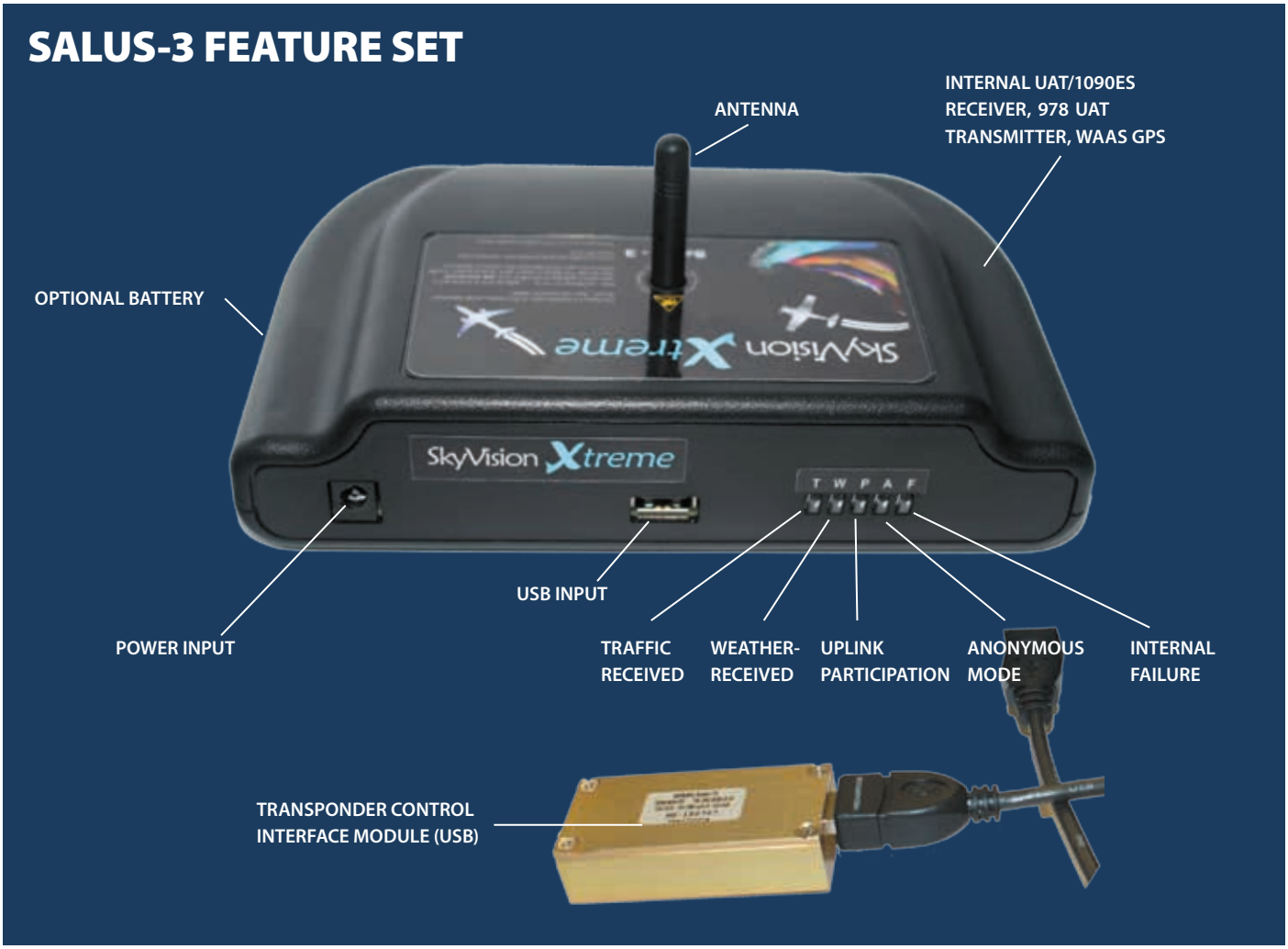
SkyVision's Harry Sanders recognized the need for better traffic alerting while flying with a passive portable traffic device in his Piper Seneca. After countless missed targets and dealing with its overall lousy performance, his research for an alternative took him to the FAA's NextGen program. At the time, the only available ADS-B solution was Garmin's GDL90 UAT transceiver.

In 2008, Sanders teamed with other software writers and began developing ADS-B software which focused primarily on traffic and weather presentation. However, he soon realized he would need his own hardware platform to play it on, even if it's made by third-party vendors and assembled at his Asheboro, North Carolina, facility. The flagship



The SkyVision Salus-3 transceiver, bottom, can interface with third-party tablet apps, but offers more utility when displaying 3D synthetic traffic on its Xtreme Vision app, right. But that interface is limited to Windows-based tablets.

SALUS-3 FEATURE SET



Salus-3 (Latin for "safety", and 3 for third-generation) is the latest device.

At 7 by 4 by 1.5 inches and weighing 1.1 pounds the device is large, but designed to fit between the lower portion of the windscreen and the glareshield. With integral Wi-Fi, it can connect up to seven iOS or Android devices and is powered by a cigar lighter adapter, but there is an optional ($94) Li-ion battery.

The Salus-3 is equipped with an internal WAAS GPS receiver and antenna that SkyVision says meets all of the specifications for an ADS-B positional source, but lacks certification—another snag that could hinder ultimate FAA approval. The device transmits ADS-B Out via 978 MHz UAT and is equipped with a dual band (978 and 1090ES) ADS-B receiver.

The Salus-3 has a simple feature set and requires little user interaction. The rear of the chassis (the aft-facing portion of the device) has five LED indicator lights. These illuminate when traffic alerts are received, when ADS-B weather data is received, when the unit is participating in a ground station uplink, when in anonymous mode (squawking VFR 1200) and a failure annunciator, warning of a processor failure.

Since mandate-compliant solutions require a single point-of-entry pressure altitude input, SkyVision developed a unique interface through the $199 TransMonSPE. This remote sensor module picks up the data (pressure altitude and transponder squawk code) by installing around the transponder antenna coaxial cable. It then automatically provides pressure altitude and squawk code input to the Salus-3 through a USB cable connection, eliminating the need for a remote control head for keeping the ADS-B and Mode A transponder codes in sync.

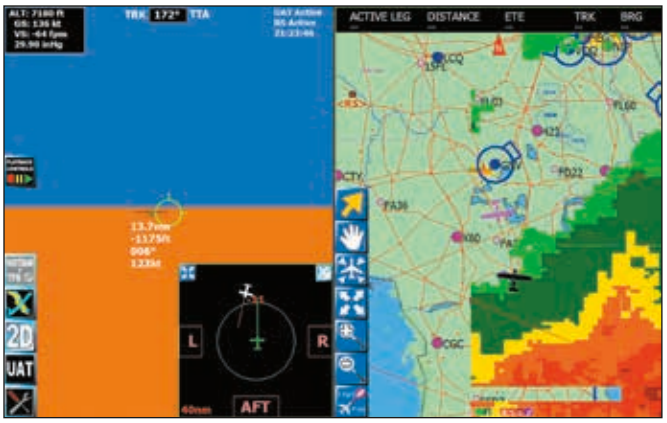
A concern with portable ADS-B Out devices is the potential for signal shadowing when the antenna is contained inside the cabin, although it worked well in our flight trials. SkyVision is working on a configuration for connecting with an external L-Band transponder antenna, plus an external GPS WAAS antenna.

XTREME VISION

This is SkyVision's dedicated ADS-B weather display with synthetic vision traffic software. Like most synthetic vision systems, the software is intended to mirror the real-time traffic and weather environment outside the aircraft, and the user can select 2D or 3D traffic modes.

The software also serves the critical function of programming the Salus-3 for operation in the ADS-B environment. This includes entering the aircraft tail number and ICAO, or Mode S code, as assigned in the FAA registry. Data entry is accomplished within the UAT control panel interface page, accessed through a dedicated onscreen control panel button.

At this time, Salus-3/Xtreme Vision functionality is only available



We like that the Xtreme Vision feature set, top photo, is uncluttered and intuitive to operate. Don't expect high-level flight planning and navigation functions, however. It focuses more on traffic alerting.

on the Microsoft Windows CE operating system. SkyVision offers the Hewlett-Packard Stream 7, a 7-inch tablet computer preloaded with the Vision software for $300. The Stream 7 has a 1280x800 pixel LCD display and an Intel Atom processor. If you're accustomed to using an iPad or current Android tablet, the HP will seem heavy and thick by comparison. Xtreme Vision software and data updates are free.

Xtreme Vision can be displayed in landscape or portrait view, and we found the user interface to be intuitive and uncluttered. A data field in the upper corner of the horizon displays ownship data, including pressure altitude, groundspeed and vertical speed. There is a dedicated data field at the very top of the horizon for displaying the current track, while a status indicator box in the upper right indicates the disposition of the connected UAT.

Accessing FIS-B weather and ADS-B traffic for display is a simple matter of pressing onscreen buttons, including the text button for textual weather products, the NEXRAD button for radar images, plus a TFR/NOTAM button. Weather and traffic is overlaid on a dedicated map.

The text weather button automatically brings up the closest reported text weather information. Text weather is displayed in a text box where you can view METARs and TAFs in plain English or in their encrypted format by clicking the "View Raw/Decode" button. The "look-up wx" button allows you to search for weather reports by typing in specific airport identifiers.

Tapping anywhere on the map will bring up the text weather for all weather reporting stations within 30 nm, while a dedicated pan button enables tap-panning the map. Each tap will re-center the map around the location that was tapped. The NEXRAD window can be expanded for full-screen viewing.

Time-stamp windows indicate the age of the displayed NEXRAD, CONUS NEXRAD and regional NEXRAD images.

A dedicated traffic window includes a text box showing a target's relative distance, altitude, heading and speed. Additionally, "surroundings" scan buttons scan the surrounding area around the aircraft in 3D. The 3D mode can be panned using touch-and-drag on the display. The view rotates (with the ownship as the primary axis) with a full 360-degree range of motion.

Traffic can also be displayed in 2D representation with a circular, adjustable threat veil around the ownship symbol. While this is the more familiar and standard method of monitoring onscreen traffic, the 3D view is far more dynamic and reduces the amount of time it takes to interpret a threat target, in our view. The 2D window can also be moved anywhere on the display by simply touching and dragging it.

The software has audio outputs for alerts, which can be toggled on or off with a dedicated audio alert button.

Xtreme has character representation for ADS-B traffic targets, differentiating rotorcraft, airships and ground vehicles. Aircraft up to 12,500 pounds and not equipped with ADS-B are simply represented as a small high-wing character, while aircraft above 12,500 pounds and faster than 210 knots are painted as a large jet.

Compared to other apps, flight planning and navigation is quite basic, although you can create and edit a flight plan, which is accessed in a dedicated flight plan button. We found it refreshingly simple, actually. Simply add and delete waypoints in a straightforward flight plan window.

Xtreme Vision has a unique data capturing and playback function, allowing you to view the captured 3D flight data on a Windows PC. We didn't try it because it simply won't work on a Mac.

And that's the rub, for now, with the Salus-3. It isn't compatible with Xtreme Vision running on iOS, although SkyVision told us it is working on an upgrade that will offer compatibility with the iPad—something we think will be imperative, moving forward.

The Salus-3 is compatible with iOS through a few third-party apps that support ADS-B functionality, including Wing X, iFly GPS, Naviator and eKneeboard. SkyVision's Harry Sanders made it clear that it will not work with closed applications from Garmin and ForeFlight.

TIME WILL TELL

SkyVision offers a TSO-certified solution with its $3295 Gen2 "briefcase" ADS-B In and Out system. It uses the mandate-compliant NavWorx UAT unit enclosed in a portable casing.

With a little over four years before the ADS-B mandate arrives, SkyVision has some time to work out the regulatory logistics of getting the Salus-3 portable device (or perhaps an updated model) for mandate compliance in certified aircraft. In our view, the current Salus-3 is smartly designed to do just that, especially with its uniquely simple transponder signal/pressure altitude interface. But, an external antenna interface could be a requirement, hindering portability and the ability to share it between multiple aircraft.

Still, we think the FAA should recognize portable systems like the Salus-3 as a worthy solution for aircraft that simply can't accommodate permanently installed systems.

CONTACT

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MANDATE-COMPLIANT, PANEL ADS-B PRODUCTS

PRODUCT	ADS-B SPECS	DISPLAY INTERFACES	PRICE	COMMENTS
APPAREO				
STRATUS ESG	1090ES ADS-B TRANSPONDER	N/A	$3490	Has internal WAAS GPS, interfaces with Stratus portable
ASPEN AVIONICS				
ATX100	978 UAT OUT, 978 UAT IN	EVOLUTION MFD	$2645	Requires external GPS, available Q2 2015
ATX100G	978 UAT OUT, 978 UAT IN	EVOLUTION MFD	$3495	Has internal WAAS GPS, ADS-B In and Out
AVIDYNE				
AXP340	1090ES ADS-B TRANPONDER	N/A	$3995	Partial plug-and-play with some existing BendixKing KT76A/C KT78A transponders, requires WAAS GPS input.
MLB100	978 UAT IN	IFD540/IFD440	$2495	Compatible with Avidyne's IFD540 navigator.
BENDIXKING				
KT74	1090ES ADS-B TRANSPONDER	N/A	$2999	Partial plug-and-play with KT76A/C, KT78A transponders, requires WAAS GPS input
KGX130	978 UAT IN	IOS TABLET MFD TRAFFIC ONLY	$1489	ADS-B In only, for use with 1090ES transponder
KGX150	978 UAT OUT, 978 UAT IN	IOS TABLET MFD TRAFFIC ONLY	$4069	Has internal WAAS GPS.
KGX150	978 UAT OUT, UAT IN	IOS TABLET MFD TRAFFIC ONLY	$3489	Version without internal WAAS GPS
FREEFLIGHT SYSTEMS				
FDL-978-TX	978 UAT OUT	N/A	$2995	Has Diversity, includes control head
FDL-978-XVR	978 UAT OUT, 978 UAT IN	IOS, ANDROID MFD TRAFFIC	$3695	Has Diversity, includes control head and WiFi module
FDL-978-XVR	978 UAT OUT, 978 UAT IN	IOS TABLET MFD TRAFFIC	$4495	Internal WAAS GPS, includes WiFi module for tablet use
FDL-978-TX/L	978 UAT OUT	N/A	$1995	Lite version, no ARINC card, upgradeable to ADS-B In
FDL-1090-TX	1090ES ADS-B TRANSPONDER	N/A	$4495	Remote control head/processor design, requires WAAS GPS input
GARMIN				
GTX330ES	1090ES ADS-B TRANSPONDER	N/A	$3995	Requires external WAAS GPS input
GTX33ES	1090ES ADS-B TRANSPONDER	N/A	$5450	Remote version of GTX330ES
GDL84	978 UAT OUT, DUAL-BAND IN	IOS, ANDROID TABLETS	$3995*	Standalone ADS-B Out and In, wireless Bluetooth connectivity with Flight Stream 110/210. Requires Garmin Pilot tablet app. *$4495 with Flight Stream 210 (built-in AHRS)
GDL88	978 UAT OUT, DUAL-BAND IN	GNS530W/430W GTN750/650 G600/500 *IOS/ANDROID	$3995	Requires WAAS GPS input, tablet interface requires Flight Stream wireless Bluetooth module and Garmin Pilot app
GDL88-W	978 UAT, DUAL-BAND IN	GNS530W/430W GTN750/650 G600/500 *IOS/ANDROID	$5143	Has built-in WAAS GPS receiver, tablet tablet interface requires Flight Stream wireless Bluetooth module and Garmin Pilot app
GDL88-D	978 UAT, DUAL-BAND IN	GNS530W/430W G600/500 GTN750/650 *IOS/ANDROID	$4495	Diversity model (requires top and bottom antenna installation), requires WAAS GPS input, tablet tablet interface requires Flight Stream wireless Bluetooth module and Garmin Pilot app
GDL88-WD	978 UAT, DUAL-BAND IN	GNS530W/430W GTN750/650 G600/500 *IOS/ANDROID	$5643	Has built-in WAAS GPS receiver, Diversity (requires top and bottom antenna installation), tablet tablet interface requires Flight Stream wireless Bluetooth module and Garmin Pilot app
L-3 AVIATION LYNX				
NGT-9000D+	1090ES ADS-B TRANSPONDER DUAL-BAND ADS-B IN	SELF-CONTAINED, GARMIN MX20	$13,384	Rack-mounted, internal WAAS, TAS, Diversity, displays traffic on any display that accepts Skywatch data
NGT-9000D	1090ES ADS-B TRANSPONDER DUAL-BAND ADS-B IN	SELF-CONTAINED, GARMIN MX20	$9584	Has Diversity, but no internal TAS

MANDATE-COMPLIANT, PANEL ADS-B PRODUCTS (CONTINUED)

PRODUCT	ADS-B SPECS	INTERFACES	PRICE	COMMENTS
NGT-9000+	1090ES ADS-B TRANSPONDER DUAL-BAND ADS-B IN	SELF-CONTAINED, GARMIN MX20	$10,651	Has internal TAS, but no Diversity
NGT-9000	1090ES ADS-B TRANSPONDER DUAL-BAND ADS-B IN	SELF-CONTAINED, GARMIN MX20	$8251	No Diversity, no internal TAS
NGT-2500	978 UAT OUT, 978 UAT IN	MX20, TABLET	$3856	iOS, Android tablet interface requires $270 optional WiFi module, $1223 control panel may be required
NGT-2000	978 UAT OUT, 978 UAT IN	TABLET	$3589	Requires $270 WiFi module, built-in WAAS GPS, could require $1223 optional control panel
NGT-1000	978 UAT OUT	N/A	$2521	Basic mandate-compliance, built-in WAAS GPS, could require control panel installation
NAVWORX				
ADS600	978 UAT IN	Garmin MX20, GMX200 *GNS430/530/G500/600	$1199	*Garmin display interface will overlay traffic only. $2399 version with internal GPS can interface to 1090ES transponders
ADS600-B	978 UAT IN, 978 UAT OUT	Garmin MX20, GMX200 *GNS430/530/G500/600	$2399	Has non-certified built-in WAAS GPS for aircraft that don't need to comply with ADS-B mandate
ADS600-BG	978 UAT IN, 978 UAT OUT	Garmin MX20, GMX200 *GNS430/530/G500/600	$3499	Built-in mandate-compliant WAAS GPS, complete with antennas and installation hardware
SANDIA AEROSPACE				
STX360	978 UAT IN/OUT	INTERNAL	TBD	Mode A/C transponder with integral ADS-B In/Out
TRIG AVIONICS				
TT31	1090ES TRANSPONDER	N/A	$2568	Requires external WAAS GPS input, KT76A/C replacement
TT22	1090ES TRANSPONDER	N/A	$2595	Remote control head and processor

NON-CERTIFIED PORTABLE ADS-B PRODUCTS

PRODUCT	PRICE	SIZE	ADS-B SPECS	BATTERY LIFE	MAJOR APPS SUPPORTED	COMMENTS
DUAL XGPS170	$549	4.3 X 2.7 X 0.8	978 MHZ	5 HOURS	WINGX PRO, FLTPLAN.COM, SEATTLE AVIONICS FLYQ, ADVENTURE PILOT IFLY	Convenient chassis design with nonskid base
SAGETECH CLARITY	$1150	2.5 X 2.5 X 1.5	978 MHZ 1090 MHZ	6 TO 8 HOURS	WINGX, ADVENTURE PILOT IFLY, GLOBAL NAV SOURCE, IPAD EFB, SKYVISION EXTREME	ADS-B only; no AHRS, dual band
SAGETECH CLARITY SV	$1400	2.5 X 2.5 X1.5	978 MHZ 1090 MHZ	6 TO 8 HOURS	WINGX, ADVENTURE PILOT IFLY, GLOBAL NAV SOURCE, IPAD EFB, SKYVISION EXTREME	Top overall performer for GPS, ADS-B and EFIS; smallest physical size; runs HOT
ILEVIL AW	$1395	4 X 2.5 X 1.0	978 MHZ	5 HOURS	WINGX, FLYQ, ADVENTURE PILOT, AHRS UTILITY, XAVION, AVNAV EFB, AVARE	Can be be hardwired, pressure transducer interface for airspeed/altitude
ILEVIL SW	$1195	4 X 2.5 X 1.0	978 MHZ	5 HOURS	WINGX, FLYQ, ADVENTURE PILOT IFLY, AHRS UTILITY, XAVION, AVNAV EFB, AVARE	Good performer; lacks dual frequency ADS-B
STRATUS II	$899	6 X 2.6 X 1.25	978 MHZ 1090 MHZ	8 HOURS	FOREFLIGHT ONLY	Good overall value; runs coolest; requires toggling to separate app to use EFIS
STRATUS I	$499	5.75 X 4.25 X 1.0	978 MHZ	8 HOURS	FOREFLIGHT ONLY	First-generation model, no AHRS, single-band receiver
GARMIN GDL39	$599 $699 W/ BATTERY	3.5 X 1.9 X 6.0	978 MHZ 1090MHZ	4 HOURS	GARMIN PILOT FOR IOS AND FOR ANDROID, GARMIN GPS396/496/696/AERA500 VIA CABLE, GARMIN 796	Bulky footprint, especially with optional battery installed
GARMIN GDL39 3D	$849 $899 W/ BATTERY	3.5 X 1.9 X 6.0	978 MHZ 1090 MHZ	4 HOURS	GARMIN PILOT FOR IOS AND FOR ANDROID, GARMIN GPS396/496/696/AERA500 VIA CABLE, GARMIN 796	Has AHRS output for driving Garmin Pilot attitude and synthetic vision display
SKYVISION SALUS-3 978UAT/1090ES	$1099	8.0 X 3.0 X 2.0	978 MHZ 1090ES	EXTERNAL VOLTAGE	XTREME VISION, WINGX PRO, SKYRADAR, ADVENTURE PILOT, XAVION	First portable solution attempting to meet ADS-B mandate certification
SKYVISION GEN2 PORTABLE	$3295	11.6 X 8.3	978 MHZ	EXTRERNAL VOLTAGE	WINGX PRO, XTREME VISION, SKYRADAR, ADVENTURE PILOT, XAVION	Uses NavWorx UAT transceiver, packaged in a "briefcase" housing, TSO-approved

Fire Extinguishers: Halon, Not Dry Chem

Halon and its newer alternatives are effective aircraft fire extinguishing agents. Things you bring with you in the cabin can make a fire much worse.

by Rick Durden

CHECKLIST

- Halon and Halon alternatives are effective and safe for use in aircraft.
- Halon alternatives are twice the weight of Halon but cost about the same.
- Dry chem extinguishers pose a crew risk and should not be used.

The idea of an inflight fire rightfully scares the bejabbers out of pilots. Uncontrolled combustion in a confined space is ugly enough—adding altitude and speed to the mix can make a fire lethal in short order. It's no wonder that pilots dealing with an inflight fire have jumped out of their aircraft even though they had no parachute.

While inflight fires are rare, we think that every aircraft should have an effective fire extinguisher in the cabin where the pilot can reach it quickly and easily.

Our research and testing has led us to a two-fold conclusion as to what type of extinguisher you should carry in your aircraft: First, effective means an extinguisher that uses a "clean agent," either Halon or one of the Halon alternatives—if it is possible to extinguish the fire you're dealing with, they will do it and they won't hurt you or the aircraft in the process. Second, a dry chemical extinguisher—the most common type we see in aircraft—uses chemicals that have effects on the occupants and the aircraft that are so pernicious that we recommend against their use in aircraft. We'll tell you why we came to those conclusions.

THE FIRE QUADRILATERAL

For years we've been told about the fire triangle—with three essential elements for a fire: heat, fuel and oxygen—and that removing any one will put out a fire. That description is true, but incomplete. There is a fourth essential element: the chemical reaction that allows the other three to combust. Without the chemical reaction of the three other elements, heat, fuel and oxygen will happily coexist without starting to burn.

Fire extinguishers act to remove one or more of the fire quadrilateral—as we'll discuss below, extinguishers we consider appropriate for aircraft primarily interrupt the chemical reaction and don't remove the oxygen.

Despite interior fabrics made of materials that will self-extinguish or at least act to slow fire propagation, aircraft and their cabins have plenty

Clean agent H3R fire extinguishers: 5B:C-rated model C352TS using Halon 1211, left, and 2B:C-rated model B385TS using Halotron, a Halon alternative, in front of our test fire.

DRY CHEM? NOT IN AIRCRAFT

Dry chemical extinguishers have long been attractive because they are less than half the price of Halon and Halon alternative units. A visit to our local Home Depot store and a quick survey on the web found prices for 5B:C and larger dry chem extinguishers in the $35 to $70 range. However, the FAA specifically recommends against using them in aircraft in AC 20-42D. "In general, dry chemicals are not recommended for hand extinguishers for internal aircraft use, due to the potential for corrosion damage to electronic equipment, the possibility of visual obscuration if the agent were discharged into the flight deck area, and the cleanup problems from their use."

We agree with the FAA—there are serious downsides to dry chem extinguishers in aircraft. First, there's the blinding, choking chemical cloud. As we observed first-hand in our testing and the FAA stated in an earlier version of the AC, "Dry chemical extinguishing agents when discharged in crew compartments of confined areas may cause serious impairment to visibility. In addition, they may cause temporary breathing difficulty during and immediately after discharge."

Second, the agents used in dry chem extinguishers are highly corrosive. In our research for this article, we saw warnings indicating that the post-discharge cleanup from a dry chemical extinguisher can be so involved that it may preferable to scrap the airplane because the chemicals work their way into every nook and crevice of the avionics and aluminum structure.

of stuff that will burn nicely, thank you. Much of it is what we bring in, clothing, paper, pillows and baggage. This is a good spot to note that you should not wear synthetic materials, such as nylon, when flying—exposed to flame, they melt onto your skin, causing serious burns.

Aircraft fabrics that self-extinguish only do so when the fire source is removed. If there is an electrical or avgas-fed fire involved, the interior materials will burn. What's worse is that once they do burn, the fire-blocking chemicals with which they are treated cause them to give off gases that are toxic in small quantities—in addition to the usual toxic products of combustion, carbon monoxide and carbon dioxide that will do their best to kill you as the fire deprives the cabin of oxygen.

Bottom line, a fire in an aircraft cabin will kill you via the toxic gases it emits or the flames themselves. Unless you are on the ground and stopped when a fire breaks out, your survival may be dependent on having an effective fire extinguisher that you can reach right now.

We are aware of hangar-flying sessions in which pilots have said they wouldn't use a fire extinguisher in the cabin because the gases it expels are worse than the fire. That's absolutely untrue. While we don't recommend a dry chemical extinguisher, in an emergency using one is safer than letting a fire burn. Visibility will go to zero for some time and you'll be left with a large, corrosive mess.

Discharging Halon and Halon-alternative extinguishers pose little risk to occupants. The FAA put it bluntly in Advisory Circular AC 120-80, "The toxic effects of a typical aircraft seat fire, for example, far outweigh the potential toxic effects of discharging a Halon fire extinguisher."

Fire extinguishers are rated for the type of fire they are designed to fight, per the National Fire Protection Association (NFPA). Class A fires are ordinary combustible materials such as wood, cloth, paper and plastic. Class B fires are flammable liquids, oil, grease, paint and flammable gases. Class C fires are from energized electrical equipment—the extinguishing agent should be non-conductive. Class D fires are combustible metals such as magnesium, titanium and lithium.

For aircraft fires, the NFPA recommends—and all the sources we researched agree—the fire extinguisher should be capable of handling Class B and C fires. The letter rating is shown on the extinguisher

Fire extinguishers for Class A and B fires also display a numeric rating in front of the letter rating—the higher the number, the more effective the extinguisher for a particular fire. The number rating is a statement of how big a fire, in square feet, the unit should be able to extinguish.

For a two- or six-place general aviation airplane, we recommend at least a 5B:C extinguisher.

HALON

The most effective extinguishing agent for Class A, B and C fires, bar none, is Halon—which the FAA describes as one of the class of halocarbon chemicals. It, and newer Halon alternatives, are considered clean agents because they pose little risk to humans in the area when discharged. The clean agents stop the chemical reaction necessary for a fire.

Unfortunately, Halon is a chlorofluorocarbon that does tremendous damage to the ozone in our atmosphere, and its manufacture has been illegal since 1994. Enough was made that, through recycling of Halon from extinguishers that have not been used during their 12-year service life, there is still an adequate, but shrinking supply. Halon alternatives do not have the adverse effect on the atmosphere, have a low carbon footprint and are legal to manufacture.

We spoke with Chris Dieter, senior vice president of H3R Aviation, the major player in the aviation fire extinguisher world, who told us that there has been a great deal

The H3R Halotron 2B:C extinguisher knocking down flames on our test rig, above right. The throw pillow on the seat was protected from the extinguishing agent by the seat back and kept burning after the Halotron agent was exhausted. A dry chem extinguisher was used to put out the remainder of the fire—note the cloud of chemical, not something we'd want in the cockpit, below right.

of research into finding a Halon replacement—and Halon is gradually becoming harder to get. The most common of the Halon alternatives is Halotron. Currently, a fire extinguisher using Halon weighs half that of the same-rated extinguisher using a Halon alternative. However, according to Dieter, that may be changing in the near future as more effective clean extinguishing agents are being developed.

Weight is the only difference when it comes to Halon and Halon alternative extinguishers—the same rated extinguishers are priced about the same. For a 2B:C Halon or Halotron, we saw prices between $100 and $120. For a 5B:C extinguisher, street prices ranged from $165 to $220.

TESTING

In 2008, before the FAA recommended against using dry chem extinguishers, *Aviation Consumer* tested Halon and dry chem fire extinguishers on a rig designed to simulate aircraft cabin materials. Both types extinguished the fire. This time we decided to go one better by constructing a wood structure about the size of an aircraft seat, stapling burn-tested interior materials provided to us by Centennial Aircraft Interiors as well as fabrics aircraft occupants would wear. We put a throw pillow of the sort we see routinely carried in airplanes on the seat. The pillow proved to be a big deal.

We then tried to light the self-extinguishing fabric—oriented vertically. It would smoke and melt when the flame was applied, but the fire went out when the flame was removed. We stayed out of the smoke emitted.

Next we sprinkled a quarter-cup of mogas on the various fabrics and the pillow. When we applied flame (using an fireplace igniter), the rig lit and became an inferno within 20 seconds.

We used a 2B:C Halotron extinguisher per the instructions—start eight feet from the fire, aim at the base and use a sweeping motion. We used short bursts (figure on about 10 seconds of extinguishing material) and knocked the fire down completely on the side of the rig facing us. However, the pillow was shielded by the seat back and was burning intensely. We moved around to spray it, but we ran out of agent.

Using a 1AB:C dry chemical extinguisher, we were able to put out almost all of the remaining fire—a bit of fabric continued to smolder. Stepping on it a few times solved the problem.

We came to three conclusions: we disagree with recommendations that a 2B:C extinguisher is large enough for a two- to four-place airplanes—we recommend a 5B:C extinguisher. Second, after seeing (and breathing some of) the cloud generated by a small dry chem extinguisher, if we ever have to use an extinguisher in anger in the cabin of an aircraft, we want it to be a clean agent rather than dry chem. Finally, that throw pillow you use behind your back can be a menace.

RECOMMENDATION

Modern fire extinguishers are remarkably resilient—but they are not set-and-forget devices. They should be visually inspected every 30 days. At six years the extinguisher should be emptied, inspected and recharged by a fire extinguisher repair facility. Every 12 years the extinguisher must be hydrostatically tested.

We'll put it bluntly, if you don't have a fire extinguisher in your airplane, buy a Halon alternative clean agent unit—or Halon, if weight is an issue—5B:C extinguisher and mount it where you can reach it easily. If you have a dry chem extinguisher in your airplane, follow a two-step approach: first, take it home and put it in your kitchen where it can be easily reached; second, follow the recommendation in the previous sentence before further flight.

Garmin G600/500: Upgraded for ADS-B

Garmin modernizes its G600/500-series retrofit PFD to display ADS-B traffic and weather, L3 Stormscope data, plus better mapping and charting.

by Larry Anglisano

In avionics life, nine years is a long time. That's how long Garmin's G600 retrofit primary flight display has been on the market. While that's long enough for a product to lose its tech edge, Garmin generally doesn't let that happen.

Luckily, periodic software upgrades can give an otherwise aging product a new lease on life, although FAA certification can limit major changes without requiring a time-consuming and costly recertification process.

Still, Garmin has been taking some heat for the system's inability to interface with the GDL88 ADS-B transceiver, the lack of georeferencing on Garmin's FliteCharts, lack of Stormscope interface and some other missing features that buyers expect from a system in this price category, including a touchscreen interface.

The latest GDU display version 7.0 software upgrade steps the system up several notches and finally brings it into the age of ADS-B, but doesn't give it a touchscreen.

REAL-TIME ADS-B

Perhaps the most important enhancement to the system is its compatibility with Garmin's GDL88 ADS-B system, where traffic symbology is displayed on the MFD and on the PFD in units equipped with Garmin's SVT synthetic vision option.

The new GDL88 interface also enables FIS-B ADS-B weather for overlay on the MFD.

When Garmin developed the GDL88, it also developed TargetTrend—an enhanced traffic symbology feature which was launched on its GTN-series touchscreen navigators. TargetTrend provides interactive onscreen velocity trend vectors in real time, depicting how ADS-B traffic targets are maneuvering with relation to the host aircraft.

We think TargetTrend offers better functionality on the GTN, which is enhanced by its touchscreen feature set. For example, since TargetTrend groups traffic targets together to declutter the screen, the user can easily ungroup them and show more details about a threat target by simply touching it on the screen. The non-touch G600/500 requires knob scrolling. Not a huge deal, but not as seamless as touch, in our opinion.

Garmin has also added TerminalTraffic, a feature that displays taxiing ADS-B-equipped aircraft and moving ground vehicles (while differentiating them using distinct colors and symbology) in the airport environment. This data is displayed on the airport surface chart.

Speaking of charting, a major enhancement in version 7.0 addresses the system's mediocre mapping performance. If you're accustomed to operating the system with the previous software, you'll find much improved base maps. They have a more modern, vibrant appearance.

Garmin said the new mapping technology it incorporated in the

CHECKLIST

- A new interface with the GDL88 brings ADS-B traffic symbology and TargetTrend features.
- Garmin's electronic FliteCharts finally get georeferencing.
- Some new features are better served by a touchscreen, which is noticeably missing.

The G600/500 GDU, left, can now display georeferenced Garmin FliteCharts on its integral MFD. Note the magenta aircraft symbol at the top of the chart. The new operating system is loaded on an SD card located on the bottom of the bezel.

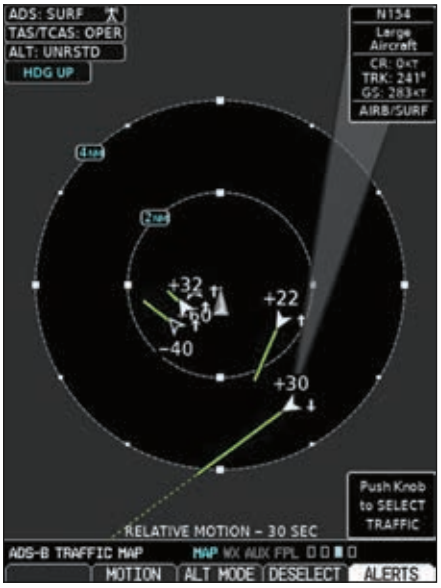
new G600/500 comes from the GTN750/650 navigators. We found that map redraws and range changes are faster than in the previous software.

A nag we've always had with the G600/500 is the lack of georeferencing with Garmin's NACO-based electronic FliteChart feature. Georeferencing is the overlay of ownship data on the charts. FliteChart is Garmin's default charting product (it's also standard in Garmin's GPS696 portable GPS and in the Pilot tablet app) and comes preloaded in a new G600/500 without the need to buy an unlock key to enable the feature.

Previously, to get georeferenced charts you would have to purchase the $2395 Jeppesen ChartView feature unlock option, in addition to a Jeppesen charting subscription. An annual FliteChart subscription for North America is $499.

With the new mapping, Garmin added Smart Airspace, a feature found in the Pilot tablet app. The function automatically highlights the airspace nearest to the aircraft's current altitude, while drawing less attention to irrelevant airspace. Software 7.0 enables interface with a variety of external sensors, including the L3 Avionics WX500 remote Stormscope, Garmin's GRA55 and GRA5500 radar altimeter, plus adds turbulence detection compatibility when displaying the GWX70 ship's weather radar.

In addition to ADS-B weather products, the new software adds more weather products when connected to the GDL69 SiriusXM satellite receiver, including icing, turbulence, PIREPs and Canadian weather products.



Traffic symbology on the G600/500 was limited to plain-vanilla TCAS-like symbology, top photo, but Garmin's latest upgrade adds ADS-B TargetTrend vector data, bottom photo, when interfaced with its GDL88 ADS-B transceiver.

WHICH SYSTEM?

If you're confused about whether to buy the G600 or G500, part of the buying decision depends on the aircraft it's going in.

While both systems have a variety of TSO approvals for use as primary flight instrumentation, in addition to a liberal AML-STC (approved model list), the G600's higher level of software certification makes it a player in Class 3 aircraft. In general, these are larger piston and turbine models between 6000 and 12,500 pounds. Those larger aircraft generally require Level C software certification status, compared to Level B in smaller aircraft, as one example. Both the G600 and G500 have nearly identical installation processes and require either a GTN or GNS-series navigator for GPS position and nav signal input.

Moreover, both systems share the same dual 6.5-inch diagonal color screens housed in a single bezel. Fly with either system and it's unlikely you would recognize a difference.

But pricing is another matter. Major functions which come standard on the G600 are optional on the G500. This includes the GAD43 autopilot gyro emulator, SVT synthetic vision software, out-of-the-box compatibility with Garmin weather radar systems, plus built-in, certified TAWS-B terrain alert functionality, which is only available in the G600.

The G600 has a starting price of $29,995, while the G500 starts at $15,995. The SVT synthetic vision—a popular option—adds another $5000. After installation, expect a buy-in that closes in on $30,000 for a lightly equipped G500. As a comparison, Aspen's dual-screen, non-touch Evolution 2000 PFD/MFD system starts at $19,235, plus $3000 for synthetic vision, not counting installation.

Garmin's version 7.0 field-installable software for existing G600/500 units is $575, not including labor, and $200 when you trade in the old software card. It's standard on all new G600/500 systems.

Contact www.garmin.com.

ForeFlight For Desktop: Cloud-Based Planner

ForeFlight's new web flight planner replicates the familiar ForeFlight Mobile tablet app, plus it syncs route data between the desktop computer and tablet.

by Larry Anglisano

CHECKLIST

- Desktop/tablet data syncing is automatic and seamless, thanks to cloud technology.
- Stadium TFR layer in ForeFlight Web is a welcomed feature.
- We're not convinced the Apple Watch interface offers enough inflight utility to buy one.

For a while it seemed that desktop flight planning was headed for extinction, replaced by do-it-all tablet computers running apps that capably serve double duty as flight planners and cockpit navigators. At Sun 'n Fun 2015, navigation app developer ForeFlight introduced a new web planner that automatically interacts with its iOS Mobile navigation app.

Additionally, ForeFlight released version 7.0 software for the app, a major update which adds a new procedure advisor function, cabin pressure altitude alerting, faster nav data downloads and an interface for the Apple Watch. Here's a rundown.

PLAN IT ON A BIG SCREEN

ForeFlight Web for use on iOS desktop computers replicates much of the look and feel of the ForeFlight Mobile app for iPad and iPhone.

It has the same map layers as you'll find in the Mobile app, plus it overlays weather radar, TFRs, METARs, AIRMETs, SIGMETs and satellite imagery. It's all stuff that you would want to see during preflight planning, but in a larger form factor than it is on a tablet.

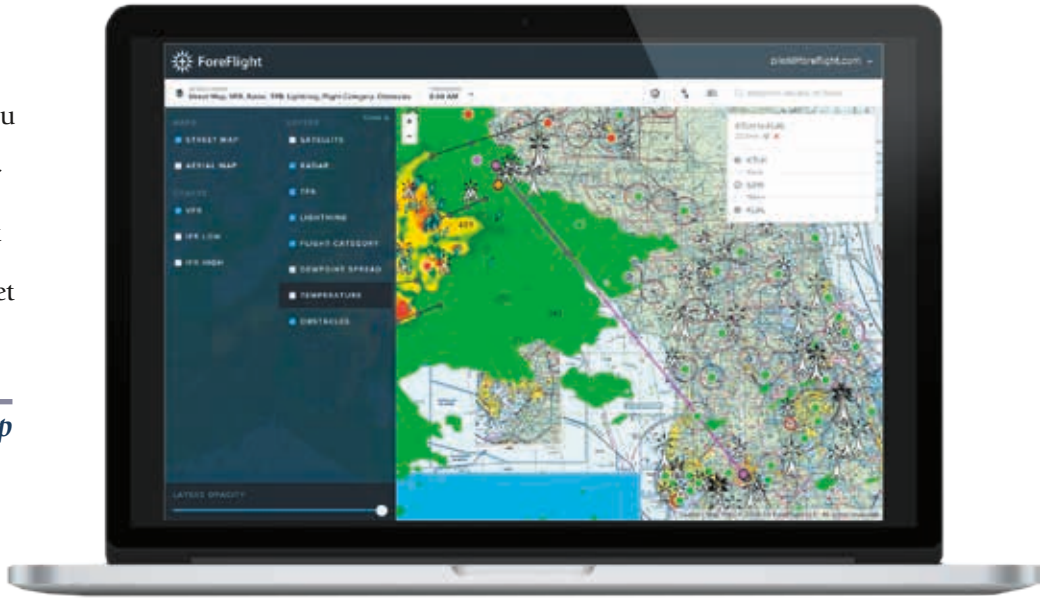
The menu structure for ForeFlight Web is accessed on the left side of the screen where you can select street maps or aerial maps, plus VFR, low IFR and high IFR maps.

ForeFlight Web has a cut-to-the chase search function, operating on top of its global navigation data, while automatically synchronizing data from the desktop to the iPad or iPhone via ForeFlight's Connect data syncing system. It's similar to the way ForeFlight syncs data from an iPhone to an iPad, using cloud-based data transferring of routes, favorites and other user-specific data. We think ForeFlight did a good job of keeping the planner simple.

For example, let's say you wanted to plan a direct route from Greenville-Spartanburg Airport in South Carolina, to Tampa Executive Airport in Florida at 170 knots. Simply type KGSP KVDF 170 in the dedicated waypoint search field (which has autocompletion, based on waypoint identifier) in the upper right corner of the screen. The program creates a visual preview of the route overlaid over a VFR sectional or IFR enroute chart, which also has weather overlay. From there you can load the route as a flight plan and make it a "favorite," which immediately appears on the ForeFlight iPad app. Route data can also be transferred from the tablet app to the desktop.

An extremely useful feature is the planner's ability to include stadium TFRs, something that isn't always included in other flight planning tools. Consider that our home field at Brainard Airport in Hartford, Connecticut, is adjacent to the University of Connecticut football stadium—a TFR that's easy to bust without closely monitoring game schedules. ForeFlight monitors event schedules for Major League Baseball, the NFL, NCAA football, Indy Car, NASCAR Sprint Cup and Formula 1 events and integrates that information into the TFR layer in ForeFlight Web.

A beta version of ForeFlight Web



ForeFlight's cloud-based desktop planner, right, automatically pushes flight plan and route data to ForeFlight-equipped tablets and phones.

FOREFLIGHT ON APPLE SMARTWATCH

We've seen this before. First it was Garmin's D2 pilot watch for interfacing with its Pilot tablet app and VIRB action camera. Then it was the Google Pebble watch, compatible with the Wing X Pro 7 app. Now ForeFlight introduces its own app interface for the Apple Watch.

While we like gadgets as much as the next flying geek, it's tough to get excited about wearable technology in the cockpit. We aren't alone because none of the aforementioned interfaces have been game-changing and doubt the ForeFlight/Apple Watch combo will be different. Still, ForeFlight's Watch interface seems obligatory.

It was reported that the debut of Apple's Watch was greeted with a lukewarm reception. This includes the Asian market, where previous iconic Apple product launches created widespread hysteria. Why? Our sense is that the typical consumer has reached gadget overload—perhaps Apple overload—something that's also true in the cockpit. We'll go out on a limb here and predict that the typical pilot would rather put the $400 toward an analog Breitling than on another Apple product. Moreover, you still need an iPhone 5 or later model phone to make the interface work, since all Apple Watch apps require tethering. For some pilots, we think there is enough gee-whiz factor to at least give it a try (it's a complimentary function with a paid ForeFlight subscription). The interface affords at least some utility, although it's greatly limited by the display.

ForeFlight Mobile for Apple Watch can display textual weather, including METAR data from the Appareo Stratus ADS-B receiver. It also displays GPS altitude, ground speed, distance to destination and other waypoint data. In our view, some of the more useful features include interactive timers (for nudging you to switch fuel tanks, for example) and route clearance notifications.

While Apple's Watch has the Retina display technology found on the iPad, it is a small screen for aging eyes that struggle even with a full-sized iPad. ForeFlight's Tyson Weihs told us he believes pilots will use a ForeFlight-enabled Watch more on the ground than in flight, but it can be useful for at-a-glance waypoint data. We agree with that, but we also don't see it to be game-changing enough to run out and buy one for the cockpit.

can be requested on www.foreflight.com. We're currently evaluating other desktop planners and will report on them in a future issue.

FOREFLIGHT 7.0

Included in the latest revision 7.0 is ForeFlight's Procedure Advisor. The new feature allows you to first preview arrival, departure, approach and VFR traffic pattern procedures before loading them into the active flight plan.

It works by first entering a departure and destination in the Route editor and then tapping the Procedure button in the Edit view. A separate window displays the available procedures. Tapping each procedure then previews the procedure onscreen.

For instrument approaches, a flag appears on the best wind runway, based on the current METAR. Once you select an approach, you can preview different entry points on the actual approach plate. Select which one you want and then use the Add to Route command.

The Cabin Altitude Advisor uses the barometer that's integrated within the Apple iPhone 6, 6 Plus and iPad Air 2. When passing through 12,000 feet and 25,000 feet (MSL), the app triggers an audio and visual alert once every 30 minutes for each altitude. The advisory function is enabled in the Settings menu, where you can independently select audio and visual alerting.

The bugaboo with downloading charting and navigational data is the amount of disk space it occupies on the tablet. For larger downloads, you might have to delete apps and other data just to make room. ForeFlight attempts to reduce the required disk space with its Delta Download feature.

ForeFlight says the feature can also reduce the download time up to 70 percent, since the new system only delivers data that's changed each month. Another welcomed improvement is found in the Downloads view, where VFR Tacs and Sectional charts are listed by the chart name instead of their location.

Last, the version 7.0 upgrade includes Chart Touch, which enables the viewing of Sectional and IFR enroute chart legend panels directly in ForeFlight's Maps view. It's uncommon to find chart margins in many tablet apps, but ForeFlight has added them, making it easier to transition from each chart on the map. Simply tapping anywhere on the map brings the chart forward and it shows the margin data for a given chart.

The base yearly ForeFlight Mobile subscription is $74.99 and the flagship Pro version with synthetic vision is $174.99.

Taylorcraft: Affordable, Simple

Originally pitched as a high-performance cruiser, an LSA-capable Taylorcraft with an 85-HP engine can outrun a Piper Cub and a Cessna 150.

Post World War II, the state-of-the-art for a personal airplane was a basic, two-seat taildragger of modest horsepower and tube-and-rag construction. Wood, as often as not, was a major airframe constituent and IFR flight was something not even all the airlines practiced.

Still, as the war wound down, manufacturers like Aeronca, Cessna, Piper and Taylorcraft were putting the finishing touches on new designs they were convinced would be market leaders. Wartime training had turned out scores of thousands of pilots, most of whom it was thought would want something to fly when they got home.

But, as it turned out, most returning pilots just wanted to settle down and raise a family; they'd had enough flying for one lifetime.

While the hoped-for boom in demand for personal airplanes went bust, anticipated competition resulted in some classic designs: The Cessna 120/140, the Piper PA-11/12 and the Taylorcraft series come to mind, all of which remain popular today. And many—though by no means all—have seen a renewed interest, thanks to the FAA's light sport aircraft rules. Of them, the Taylorcraft is among the types with the longest production history, new, non-LSA-compliant models having been produced as recently as the 1990s. Though it's unclear how many—if any—new Taylorcraft will be manufactured moving forward, service parts are available, as is some level of factory support, based on experience from Taylorcraft owners we spoke with.

Meanwhile, the Taylorcraft's simplicity and low operating costs, combined with many models' LSA compliance, make a highly affordable fun flyer for pilots who want to operate an airplane for pocket change and who are content to putt around the pattern or venture off on short cross-country flights.

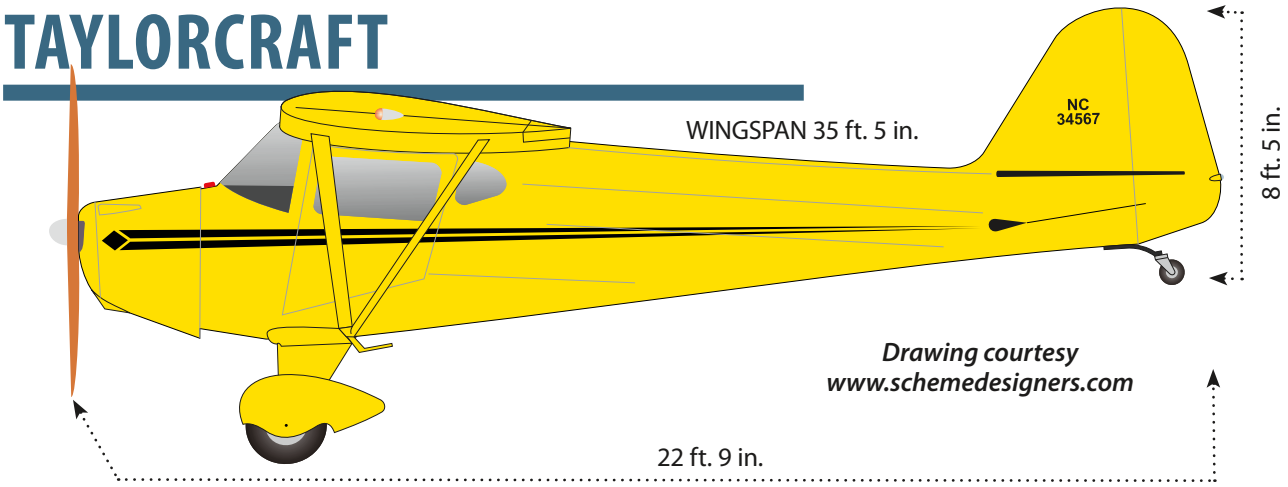
When state-of-the-art was welded tubes and rag wings, the Taylorcraft was cutting edge.

MODEL HISTORY

The Taylorcraft's brand, ownership and production histories read just as you might expect for this child of the 1930s and 1940s. It was designed by C. G. Taylor, the very same guy responsible for Piper's Cub. In the early 1930s, Taylor teamed with money-man William T. Piper; what the two came up with was known as

The pristine 1946 Taylorcraft BC12-D in the lead photo belongs to Tim Hicks. After a long restoration process, including a C85 engine, it's the envy of the Taylorcraft community.

TAYLORCRAFT

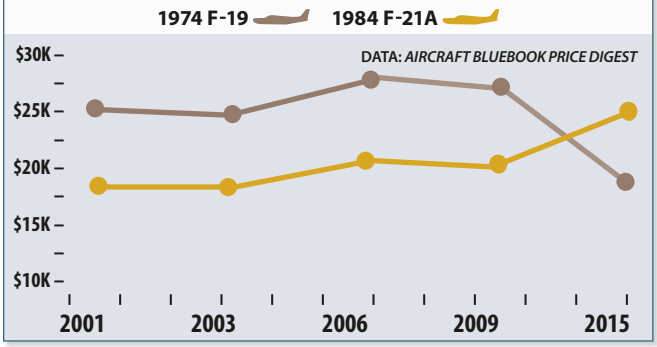


Drawing courtesy
www.schemedesigners.com

TAYLORCRAFT MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1939-1940 BC	65-HP CONT	1800	$11,000	12	500	90 KTS	±$20,000 (est)
1938-1940 BL	65-HP CONT	1800	$11,000	12	500	90 KTS	±$20,000 (est)
1939-1940 BF	65-HP FRANKLIN	1800	$11,000	12	500	90 KTS	±$20,000 (est)
1940-1941 BC12	65-HP CONT	1800	$11,000	12	500	95 KTS	±$20,000 (est)
1950-1957 BC12D	65-HP CONT	1800	$11,000	12/18	500	96 KTS	±$20,000 (est)
1974-1979 F-19	100-HP CONT	1800	$20,000	24	600	110 KTS	±$19,000
1980-1983 F21	118-HP LYC	2400	$21,000	24	510	110 KTS	±$22,000
1983-1984 F21A	118-HP LYC	2400	$21,000	40	500	110 KTS	±$24,000
1986-1990 F21B	118-HP LYC	2400	$21,000	40	610	105 KTS	±$28,000
1992-1994 F22	118-HP LYC	2400	$21,000	24	600	105 KTS	±$39,000
1992-1994 F22C	180-HP LYC	2000	$21,000	40	600	105 KTS	±$49,000

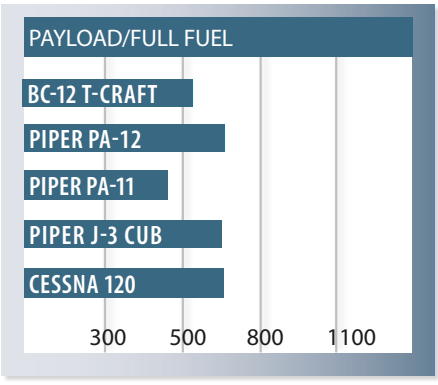
TAYLOR CRAFT RESALE VALUES

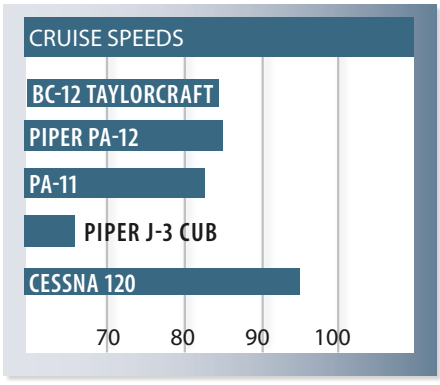


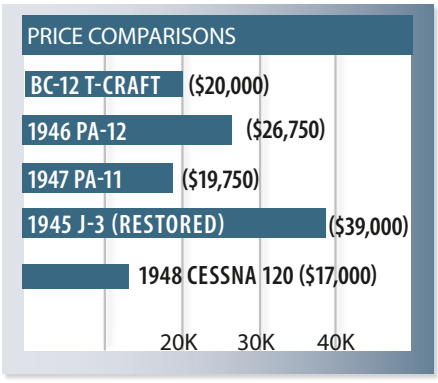
SELECT RECENT ADs

AD 2008-09-18	WING STRUT ATTACH FITTINGS
AD 2008-04-09	LEFT AND RIGHT WING FRONT AND AFT LIFT STRUTS
AD 1951-09-03	FUEL SHUTOFF VALVE CLIP
AD 1947-16-03	WING STRUT FITTINGS

SELECT MODEL COMPARISONS







Unlike many aircraft of its type, the Taylorcraft has control yokes rather than control sticks. To say the instrument panels in vintage Taylorcrafts are stark is an understatement. Basic round dials and roundish yokes lend to an appearance that resembles a classic automobile, top and bottom photos at left.

the Taylor Cub. But—in a development familiar within the industry—the principals soon had a falling out and went their separate ways.

But Taylor stuck with the idea of developing his brand, and the Model A Taylorcraft—a 40-HP two-seater closely resembling a J-3 Cub, but with side-by-side seating—soon hit the market in 1936. Then, on April 5, 1939, the Model BC was type-certificated. The newer Taylorcraft had control wheels in place of the Cub's sticks and an entirely different wing.

These first Taylorcraft airplanes began to appear in substantial numbers in 1939 and 1940, just as the Great Depression was ending and World War II was beginning. The BC—a Model B airframe powered by a Continental engine—was soon joined by a Franklin-powered Model BF and the Model BL, powered by—you guessed it—a Lycoming. Originally sporting a 50-HP Continental A-50-1 engine, the BC model was soon upgraded to the BC-65, powered by an A-65-1.

Likewise, the BF started life with a 50-HP Franklin 4AC-150, which also came in an olive drab paint scheme as the United States Army's L-2G. It was powered by a Franklin 4AC-171.

Similar Lycoming engine variations resulted in the BL and BL-65 (Army L-2F) variants. Regardless, few of these pre-war airplanes retain the original engines, with the vast majority now flying behind Continental powerplants, with 100-HP, O-200 variants being a popular upgrade.

In spring 1941, with war looming, the BC12-65 (L-2H), BF12-65 (L-2K) and BL12-65 (L-2J) were introduced. In addition to some minor structural modifications, this revision also featured an elevator trim tab. More important: Better-quality steel was used in the fuselage tubing.

Civilian production was suspended during the war but resumed in 1946 with the BC12-D. A Franklin engine would not power a factory-new Taylorcraft again, while Lycomings wouldn't reappear until after ownership changes and other drama, in 1980.

According to the TCDS, the "D" model was the same "as Model BC12-65 except for alternate tail surface, revised aileron travel, alternate one-piece windshield and other miscellaneous structural and non-structural changes."

One of those changes was installation of a six-gallon fuel tank in a wing, complementing the 12-gallon tank mounted between the firewall and instrument panel, a design in place since the first Taylorcrafts.

Riding the wave of post-war prosperity, thousands of Taylorcraft were built that year; the majority of older BC12-Ds are 1946 models. But in what was to become a familiar refrain for Taylorcraft and other companies hoping to cash in on the mythical post-war aviation boom, the company went bankrupt. Soon, though, it was reorganized and continued building the BC12 series with 65- and 85-HP engines.

Throughout these years, a seaplane version also was available alongside the wheeled models (e.g., BCS12D-85, type certificated in 1948). Significantly, no Taylorcraft landplane model produced up to this point featured a maximum gross takeoff weight exceeding 1320 pounds, making them all compliant for operation under the FAA's light sport aircraft standard.

Another detail regarding Taylorcraft's early history: In 1938, Taylorcraft Aeroplanes Ltd. was established in Leicestershire, England, to manufacture airplanes under license. That company developed the Taylorcraft Model D and the Auster Mk. I through Mk. V, which were used extensively by the British during World War II as observation platforms. A name change to Auster Aircraft Limited occurred in 1946, and the company was merged into Beagle Aircraft in 1960. By 1968, the Auster name was dropped altogether, but numerous aircraft were developed from the basic model C.G. Taylor first designed in 1936.

MODERNIZED

The Model 19, an improved version,

It's not uncommon to find a Taylorcraft on snow skis. That's a mid-1970s model F-19, right photo. It's equipped with a 100-HP Continental O-200 engine. That's a soldier (Post-Pearl Harbor) hand-propping the L-2 military liaison and spotter model, lower photo (courtesy of Smithsonian Institution.)

was type-certificated on June 20, 1951; a couple of hundred were sold before the company again went bankrupt for the last time in 1957. The Model 19 had the Continental C85-12 85-HP engine, a gross weight boosted 300 pounds—to 1500, removing it from the LSA category—a three-tank, 24-gallon fuel system replacing the older 12- and 18-gallon designs, an overhead skylight, better brakes, a bigger baggage compartment and other improvements.

The late 1950s might have seen the end of the Taylorcraft but, improbably, it was resurrected once again by a former dealer named Charles Feris. As has happened before in the GA market, Feris was a Taylorcraft bug and spent years tracking down parts, tooling and jigs following the bankruptcy sale. Feris assembled a group of Taylorcraft old timers, at least some of whom dated back to the days of C.G. Taylor himself, and began building the airplane at the old factory in Alliance, Ohio.

Along the way, he got the FAA to approve a Continental O-200-A 100-HP engine installation and rechristened the airplane the Model F19, which was granted a type certificate on July 3, 1973. Although Charles Feris died that year, his widow, Doris, kept the company operating.

In 1980, the F19 underwent yet more design changes with the introduction of a 118-HP (maximum horsepower limited to five minutes) Lycoming O-235-L2C, designated the Model F21, which yielded a cruise speed of 110 knots, a real speedster for this class of airplane. In context, the F21 appeared after the great GA sales peak of the late 1970s, but before the mid-1980s market meltdown.

The F21A earned its type certificate on November 15, 1982. The big news was removing the fuselage-mounted 12-gallon fuel tank and installing a 42-gallon fuel system—two 21-gallon wing-mounted tanks—along with other minor changes.

The fuel system changes alone greatly improved the new model's crashworthiness. Soon, the F21B was approved, in 1985, still powered by a Lycoming O-235, but now sporting a whopping 1750-pound max gross weight.

Things got even more interesting after August 1, 1988, when the FAA approved the Model F22. According to the TCDS, the new entrant was "basically a Model F21B with the addition of wing flaps, wider doors, top-hinged windows, and fore and aft adjustable individual seats." It retained the F21B's 1750-pound gross weight.

To this point, all Taylorcraft models had been two-seat taildraggers, still made principally of fabric stretched over a steel-tube fuselage frame. While the basic fuselage and covering didn't change for the F22A, the landing gear did: This model, introduced in early 1991, came with tricycle gear. Gross weight was the same, making for a slightly reduced useful load. Of course, Taylorcraft aficionados rarely wanted the small wheel under the nose, so very few F22As were sold.

A year after the trike-geared F22A emerged, in 1992, the company brought out what might be the ultimate Taylorcraft: An F22 powered by a 180-HP Lycoming O-360-A4M. This model, the F22B, was somewhat

On the ground, the Taylorcraft has no shortage of classic charm, top photo. In the air, it surprises with decent cruise speed and pleasant handling characteristics, bottom.

popular as a bush airplane. Another model, the F22C, a tricycle-gear version of the F22B, was brought out for 1992, also, but by this time the end was near. The Alliance factory continued to build the F22/A/B/C models until 1994, but then shut down.

In 2002, a Texas car dealer named Harry Ingram bought the type certificates, formed Taylorcraft Aviation and opened up a new facility in a defunct cabinet factory at the La Grange, Texas, Airport. As we reported back in the December 2004 issue of *Aviation Consumer*, Ingram planned to offer four models, including the F22 Classic for $59,995, the F22A Tracker for $63,995, the F22B Trooper for $69,995 and the F22C Ranger at $73,995. Also in 2004, and hoping to cash in on the then-nascent LSA market, the company announced the Taylor Sport, essentially the 1946 airplane manufactured to 2004 standards and powered by a 100-HP Continental O-200 engine, 42-gallon fuel capacity and a claimed top speed of 127 MPH. First deliveries were expected in January of 2005.

But none of that happened. In early 2008, Ingram's company was repossessed by Taylorcraft 2000, which had owned at least some of the type certificates. That twist apparently left several owners in a bind, especially in the aftermath of two airworthiness directives issued in 2007 and 2008 (more below), addressing wing struts and their attach points. While Ingram's company apparently had FAA part manufacturing authority (PMA) to produce struts and other components, Taylorcraft 2000 did not.

In 2009, type certificates, tooling, parts and other materials associated with the Taylorcraft brand went up for sale by Taylorcraft 2000. According to Scott Ruffner, contact person for Taylorcraft 2000 at the time, the company "cannot manufacture new parts or pieces, and can only sell parts manufactured by Harry Ingram's former company, Taylorcraft Aviation," he told *Aviation Consumer* in an interview back in 2009.

Ruffner added that the question of whether any parts will be manufactured in the future will be up to the company's new owners, whoever they may be. This is a bit of a mystery today.

While preparing this report, we tried to contact the company at the phone number listed on its website, www.taylorcraft.com, but nobody answered. We also sent several emails, which were unreturned. According to the website, the company still goes by Taylorcraft 2000, LLC, and is located in Brownsville, Texas.

Nevertheless, the website shows that many parts and drawings are available. It also lists two Light Sport models—the 37-HP Continental A-40-powered Taylor Cub and the 100-HP Continental O-200-powered Taylor Sport. It also shows two certified models, the familiar BC-series and the F-series.

A Taylorcraft forum, www.taylorcraft.org, has discussions about folks visiting the factory, but the threads are outdated.

HANDLING

Did we mention the Taylorcraft is a simple airplane? Like most designs with their roots in the 1930s, all models are built around a welded steel fuselage and conventional ribbed wings. The structure is then covered with fabric. Cable-operated control surfaces also are fabric-covered, though the pair of yokes in the cockpit—instead of sticks—is a decidedly uncommon feature for this type of airplane.

Systems are simple. Early airplanes had no electrical systems, but the later Alliance-manufactured airplanes were

equipped with both electrical and vacuum systems. As noted, fuel capacity varies by model year with some models having both fuselage and wing fuel, some just fuselage fuel and the later models wing fuel only.

Again, like most designs of its era, the Taylorcraft won't be mistaken for a luxury ride. Two adults of average size will bump shoulders in the cockpit and all but the shortest occupants will find their knees crowding the instrument panel; headroom is also tight, although adequate.

You'll probably want a noise canceling headset when flying it. The early ones are terrifically noisy and owners tell us the later models aren't much better. When the weather turns cool, bring a sweater; the cabin heat isn't especially good, at least by modern standards, and the cabin can be drafty.

As taildraggers go, the T-craft is not especially pleasant to fly. Aileron control tends to be stiff and on the sluggish side, and adverse yaw is pronounced. Pilots wishing to learn the importance of rudder control would do well to log a little Taylorcraft time.

Owners tell us the airplane is widely known as a floater on approach and landing, primarily due to its unusually low wing loading of barely six pounds per square foot. That's less than some low-performance gliders. By comparison, the Cessna 150, no slouch in gliding flight, has a wing loading of 10 pounds per square foot.

In general, gusty crosswinds are the nemesis of taildragger pilots and that's especially true for the T-craft, again because of that low wing loading. As with a high-performance airplane, pilots have to nail the proper approach speed: If it's planted on at too fast a speed, it will bounce, balloon and become a real handful to control, as taildraggers are wont to do.

Planting it on hard in a three-point attitude is not helpful if the speed is too fast, for the airplane will happily bounce back into the air and continue flying. Thanks to that fat wing, approach speeds in the 50- to 55-MPH range are the norm, say owners, and even at that, it has a flat glide angle that takes some getting used to.

There are no wing flaps—except for the F22 models—but the airplane can be readily slipped and with a little practice, a skilled pilot can put it right on the numbers every time. Any pilot with Cub, Luscombe or Stinson time will adapt to the Taylorcraft easily. Tri-gear pilots with no taildragger time are advised to get a thorough checkout from a knowledgeable instructor. Or buy one of the tri-gear versions, if you can find one, but be prepared to lose out on some of the fun from owning this class of airplane.

Among some with aerobatic aspirations, a popular mod is to shorten the Taylorcraft's wings. The so-called "clipped-wing" mod—accomplished by removing the wings along with a few feet from their roots, then reinstalling them—should alleviate some of the float on landing, but also requires different technique. Depending on how and where the wing-clipping occurs, along with other changes, the result may place the airframe in the Experimental category.

PERFORMANCE

Compared to other airplanes of the era, the Taylorcraft's strong point is performance. C.G. Taylor saw his design as a cheap "high-performance" airplane; thus, it's much faster than Piper's J-3. With a 65-HP engine, the T-craft will scoot along at about 95 MPH while the 85-HP engine makes 100 MPH attainable.

The newer F-19 models with the 100-HP Continental will hit 115 to 120 MPH, leaving a yellow Cub in the dust and even giving later models, such as the Cessna 150, a run for the money. The 180-HP models, if you can find one, improve on all that, of course, but they aren't competitive with other, more modern 180-HP designs.

Rate of climb is also quite good—say from 500 FPM to 800 FPM initially—depending on aircraft weight and power loading. That's decent performance against anything and the airplane will come out of short and turf fields without complaint. Indeed, it's probably more at home on such fields.

Climb speed is about the same as the approach speed, about 55 to 60 MPH, yielding a reasonable climb angle with a view over the nose.

In turbulence, the Taylorcraft does better than most airplanes, even considering the low wing loading. The 23012 airfoil provides excellent pitch stability but, as you'd expect, the ride can be bumpy. Cross-country trips

THE CRASHES: LANDING AND TAKEOFF

We were interested, and pleased, to see that runway loss of control (RLOC) only accounted for 21 of the most recent Taylorcraft accidents—when we do an accident scan for tailwheel airplanes we expect to see RLOC account for 50 to 60 percent of the total. Even though it appears the classic T-craft has better than average manners on the ground for a tailwheel airplane, the modest power available means that if something starts going wrong on landing, it's wise to go-around early. We counted six blown go-around accidents; three involved hitting obstructions off to the side of the runway, and three hit obstructions off the end of the runway.

We also noted that 13 accidents involved hitting obstructions on takeoff or landing—seven were on landing and included everything from hitting power lines to snagging the tailwheel on the airport fence. The modest power and climb rate may have been a factor in the six airplanes that crashed into something, usually trees, after takeoff.

One pilot allowed only 600 feet of clearance when he tried to cross a ridge in the mountains. He hit a downdraft. Not much later, he hit the ridge and wrecked the airplane. Fortunately, he survived.

Of the 16 engine power loss accidents, five were attributed to carb ice, enough to warrant attention.

Two things got our attention during the accident sweep—one a coincidence, the other a concern.

First the coincidence—in looking at 100 accidents, we almost never see two that occur at or near the same community, yet four of the Taylorcraft accidents showed as occurring at Wasilla, Alaska. We wondered if there was some T-craft-specific form of heavy gravity in the area.

Second, the concern—we saw way too many stupid pilot tricks that killed or injured Taylorcraft owners. Not the usual things such as VFR into IMC—there was only one such crash—or running out of fuel—there were only two of those— but there were eight crashes where the pilot decided to fly low and hit something—more than double the number we usually see in 100 accidents.

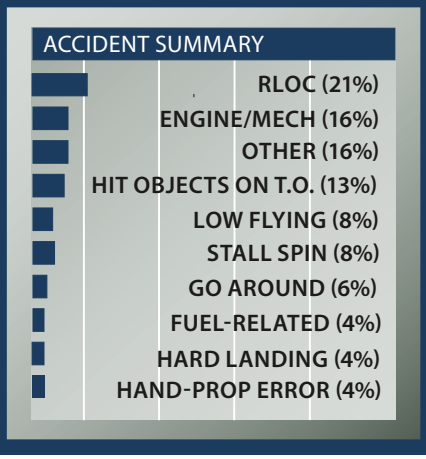
What we saw was further along the "what was he thinking?" spectrum. With limited space, we can only cite a select few.

Following a precautionary landing on a road, the pilot hit a truck when he attempted to take off.

Four pilots tried to hand prop their airplanes without anyone at the controls—although one had a helper hanging on to the tail. You guessed it—the airplanes got away. One of the pilots, of a T-craft on floats, was grievously injured when he stuck his leg into the prop disk as he tried to stop the airplane from hitting a dock.

Two owners suffered engine stoppage due to debris in the fuel system—the airplanes hadn't been annualed for five and seven years, respectively.

One pilot convinced a construction crew to move its equipment off of a NOTAMed closed runway. He took off downwind. When he returned, he landed downwind, with a crosswind, and caught a wing on one of those pieces of equipment that was parked off of the runway. It was his fourth accident in three years. One more and he's an ace for the other side.



of more than a couple of hours may prove trying on green air days.

If you're interested in such trips, the Taylorcraft is better than most at flying them. With the 12-gallon tank, figure on 200 miles, in still air. With a later BC12D model and 18-gallon capacity, the range extends to 350 miles. The 19 and F19 versions carry 19 gallons, which allows them to easily keep pace, rangewise at least, with modern two-seaters.

In terms of efficiency, the 65-HP Taylorcraft gets better mileage than any non-experimental design we can think of, short of a powered glider or new-age airplanes such as Diamond's DA40 diesel-powered Star. A speed of 95 MPH on four gallons per hour works out to about 24 MPG, outdoing even the vaunted Mooney 201.

MAINTENANCE, SUPPORT

Given its simplicity, there's not much to go wrong in a Taylorcraft. The engine may require the most attention, with routine plug and oil changes, and magneto inspections. Very few owners fly enough to run out an engine—TBOs on the newer models are between 1800 and 2000 hours. Figure overhaul costs of $10,000 to $12,000.

We think anyone contemplating a fabric airplane should have a hangar available. The elements are brutal on fabric and even harder on the underlying tube steel structure. Nothing can turn a $500 Taylorcraft annual into one costing 10 times as much faster than finding corrosion in the steel. And anyone shopping for a fabric aircraft should have the fabric thoroughly punch-tested. If it's found wanting, that will be a huge hit against the asking price.

Before 2007, asking a T-craft owner about ADs usually resulted in chuckling. Up to then, there were only six airworthiness directives against the entire line; the latest one was in 1987, and called for inspection and replacement of the oil pressure gauge hose. Before that, AD 78-20-11 required inspection of the aileron control stop pins. The other ADs, dating to the late 1940s and early 1950s, are too minor to be worth mentioning.

That changed in 2007 when the FAA issued AD 2007-16-14 after a float-equipped BF12-65 crashed on July 28, 2007, in Oregon, killing both occupants.

The NTSB found the accident's

probable cause to include corrosion, fatigue fracture and subsequent separation of the left wing lift strut attachment fitting.

The AD required owners to inspect wing struts for corrosion or cracks and to replace any damaged struts with original (vented) parts or new, sealed ones. After an initial eddy current or ultrasound inspection, additional inspections were to occur every 24 months.

In 2008, however, the FAA determined a radiograph inspection of the struts should be accomplished instead of the eddy current procedure (the ultrasound inspection remained). A new action, AD 2008-04-09, was developed and replaced the eddy current inspection. The new action superseded AD 2007-16-14. Installing new, sealed struts was a terminating action under the AD.

But that wasn't enough, apparently, so the FAA three months later issued AD 2008-09-18, which required ultrasound and radiograph inspection of the wing strut attach fittings for cracks and corrosion.

In particular, the FAA was concerned about airplanes to which floats or skis had been fitted at any point during their service; owners of ski- or float-equipped airplanes had only 30 days to comply, while those with airplanes only on wheels had 90. Both 2008 ADs incorporate separate factory service bulletins, which are available free from the factory's website, www.taylorcraft.com.

Parts and support—both overall and to comply with the 2008 ADs—are available from Wag-Aero (www.wagaero.com) and from Univair (www.univair.com), both companies with a long history of serving the classic airplane market. As noted, the Taylorcraft Owner's Club and Foundation offers information on history, modifications, technical advice and the like.

OWNER FEEDBACK

My father has used the BC12-D Taylorcraft for primary student instruction continuously since 1949.

Of all the similar aircraft on the market at the time, the Taylorcraft models were available at a very reasonable cost, are easy to maintain, only a handful of ADs apply, they feature a modern side-by-side cockpit with a wheel and are less susceptible in crosswinds. That's because they come with firm landing gear that will take quite a bit of side load when compared to others.

Cost of operation is minimal at 4.5 GPH, the engines are nearly bulletproof and the airframe will demonstrate most any flight maneuver, including limited aerobatics. Duane Cole, Margaret Ritchie and Randy Henderson have certainly used the airplanes to their advantage during their airshow careers.

Dad had a new student who, after his first lesson, was shown the advantages and disadvantages of fabric versus metal airplanes. Dad explained that a metal airplane is subject to corrosion and possibly unrepairable damage in a hail storm, while a fabric airplane could survive small hail with no noticeable damage or be easily recovered after a severe storm. He did mention that fabric was more prone to vandalism as he punctured the fuselage with a knife and cut the fabric from tail to nose, rendering the aircraft unairworthy.

The new student was obviously shocked and never returned, unaware that this airplane was due for new fabric anyway.

My father is one of the rare career instructors in the world who was more interested in really teaching the student about safety and good judgment, rather than taking their money while advancing toward another goal. The Taylorcraft is the perfect vehicle to teach a student how to "fly," while nosewheel trainers create "drivers."

I wanted an affordable airplane that would be easy to maintain and enjoyable to fly. During the restoration, my goal was to not only create an airworthy aircraft, but to keep it as original as possible. Since completion, I've enjoyed taking it to many shows where others have shared my appreciation for Taylorcrafts. While not a Grand Champion, it's received many awards at a variety of shows.

Direct operating costs are very reasonable, even with the higher cost of fuel. I use autofuel except on trips, due to availability. I would calculate an engine reserve at $2 per hour based on 2000 hours with a $4000 overhaul cost. Fabric reserve would approximate $1.28 per hour with an average 125 hours annually for 25 years.

continued on page 32

The Aviation Consumer

Letters

(continued from page 3)

In the Champion spark plug follow-up article in your May 2015 issue, you only briefly mention the spark plug resistance problem. After finding several Champion plugs with very high resistance (<20MΩ), I replaced them with new Champion plugs and again found resistance problems. I gave up on them and switched to Tempest plugs. I no longer have to deal with spark plug resistance problems.

At several aviation events attended by Champion, I asked its representative about the problem and they've always denied it. Now, without announcement, last year it redesigned its aviation spark plugs, while revamping its manufacturing process. I have lost confidence in a company that won't admit to problems, then tries to fix them without announcement.

Mike White
Kennewick, Washington

As we reported in that follow-up article, Champion's new aviation spark plugs represent a major design change. This includes a fired-in suppressor seal, or FISS—a design used on its automotive plug for years. We'll keep tabs on reliability.

Taylorcraft

(continued from page 31)

In my Taylorcraft, there are no avionics to worry about, just a handheld VHF and GPS. That brings the direct hourly costs to $11.23. I'm fortunate that my annual inspections are very affordable due to the fact I am an A&P and am assisted by a very close friend with an IA.

Jim Zangger
Via e-mail

I've owned four Taylorcraft, including my current 1946 BC12D. It was completely rebuilt in 1988. I installed a turbine wind alternator and added an auto fuel STC, which makes it very inexpensive to operate. I use a Garmin portable GPS, an ICOM handheld comm radio and portable intercom, plus a 12-volt, 7-amp battery.

It's a nice flyer, inexpensive and easy to operate. It burns about 4 GPH and cruises about 90 MPH with a climb propeller and 105 MPH with a standard propeller. I have a short home grass strip, so I use a climb prop (41x74) and, on occasion, a 46x72 for higher cruise.

The Taylorcraft is cheap to operate, easy to work on and can carry two people in relative comfort, if you don't mind being close.

My aircraft holds 50 pounds of baggage and I also have the 12-gallon nose tank plus two six-gallon wing tanks, giving me 24 gallons or about six hours flying time to empty. Most times I only fill one wing tank to use as a reserve. This gives me about an hour and a half after the nose tank goes dry.

I think the Taylorcraft is a good-looking, very fine flying machine. I have owned over 20 airplanes in my 50 years of flying, with nearly 10,000 hours flying time. I hold a SEL/SES-MEL, instrument and CFI, so I have flown many different aircraft during my flying career and still believe the Taylorcraft is one of the best buys today.

Lee and Shirley Dautreuil
New Iberia, Louisiana

My airplane is a 1946 BC12-D with a 65-HP Continental A-65-8 engine, 24-gallon fuel capacity and a 1200-pound gross weight. A complete rebuild was completed in November 2001.

As you are aware, this aircraft meets the light sport aircraft rule definitions and is the most economical and practical fun flying you can buy at 4.2 GPH and true 90 MPH speed.

Richard Young
Oakwood, Ohio

FEEDBACK WANTED

CESSNA SKYMASTER

For the September 2015 issue of *Aviation Consumer*, our Used Aircraft Guide will be on the Cessna 337 Skymaster. We want to know what it's like to own these planes, 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) you'd like to share to the email below. We welcome information on mods, support organizations or any other comments. Send correspondence on the Skymaster by July 1, 2015, to:

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